

Singular Value Decomposition

Matrixology (Linear Algebra)—Tofuspace 25/25
MATH 122, Fall, 2016

The Fundamental
Theorem of
Linear Algebra

Hubs and
Authorities

Approximating
matrices with SVD

Prof. Peter Dodds

Dept. of Mathematics & Statistics | Vermont Complex Systems Center
Vermont Advanced Computing Core | University of Vermont



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Fundamental Theorem of Linear Algebra

Tofuspace 25/25:
Singular Value
Decomposition

- Applies to any $m \times n$ matrix A .
- Mirroring of A and A^T .

The Fundamental
Theorem of
Linear Algebra

Where r lives:

- Row space $C(A^T) \subseteq R^n$
- (Right) Nullspace $N(A) \subseteq R^n$
- $\dim C(A^T) + \dim N(A) = r + (n - r) = n$
- Orthogonality: $C(A^T) \otimes N(A) = R^n$

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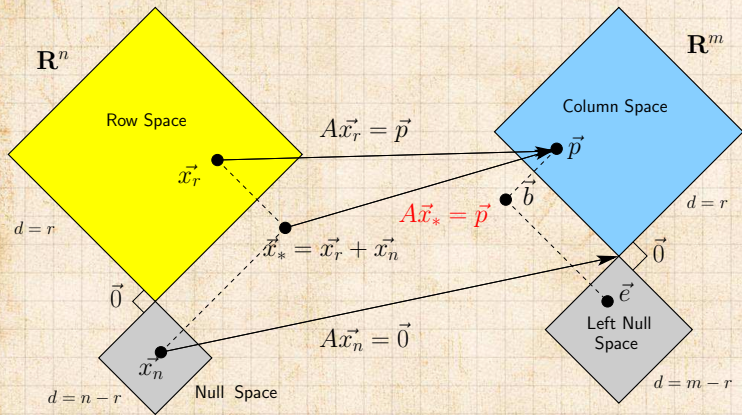
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Best solution \vec{x}_* when $\vec{b} = \vec{p} + \vec{e}$:

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Now we see:

 Each of the four fundamental subspaces has a 'best' orthonormal basis

 The \hat{v}_i span R^n

 We find the \hat{v}_i as eigenvectors of $A^T A$.

 The \hat{u}_i span R^m

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The Fundamental
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Happy bases

 $\{v_1, \dots, v_r\}$ span Row space

 $\{\hat{v}_{r+1}, \dots, \hat{v}_n\}$ span Null space

 $\{\hat{u}_1, \dots, \hat{u}_r\}$ span Column space

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-  $\{r_1, \dots, r_r\}$ span Row space
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Fundamental Theorem of Linear Algebra

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How $A\vec{x}$ works:



$$A\hat{v}_i = \sigma_i \hat{u}_i \text{ for } i = 1, \dots, r.$$

and

$$A\hat{v}_i = \hat{0} \text{ for } i = r + 1, \dots, n.$$

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Matrix version:

$$A = U\Sigma V^T$$

- A sends each $\hat{v}_i \in C(A^T)$ to its partner $\hat{u}_i \in C(A)$ with a positive stretch/shrink factor $\sigma_i > 0$.
- A is diagonal with respect to these bases.
- When viewed in the right way, every A is a diagonal matrix Σ .

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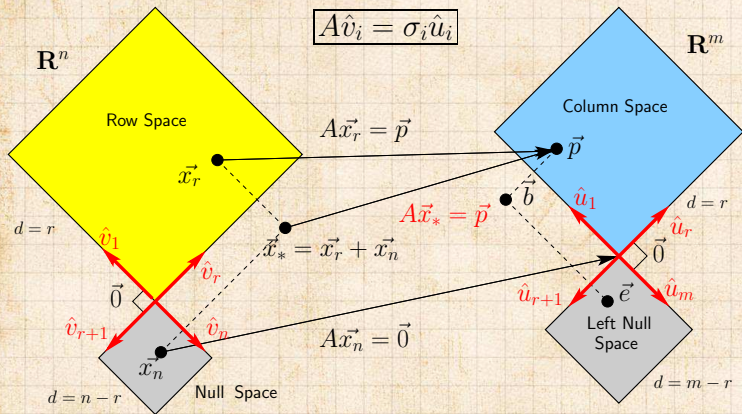
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The complete big picture:

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Hubs and Authorities

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 Idea: allow nodes in a knowledge network to have two attributes:

1. **Authority**: how much knowledge, information, etc. held by a node on a topic.
2. **Hubbiness (or Authority of Hubs)**: how well a node 'knows' where to find information on a given topic.

 Original work due to the legendary Jon Kleinberg.

 Best hubs point to best authorities.

 **Reciprocity**: Hubs authoritatively link to hubs, authorities hubbishly link to other authorities.

 More: look for dense links between sets of 'good' hubs pointing to sets of 'good' authorities.

 Known as the HITS algorithm 
(Hyperlink-Induced Topics Search).

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matrices with SVD


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Hubs and Authorities

Tofuspace 25/25:
Singular Value
Decomposition

 Idea: allow nodes in a knowledge network to have two attributes:

1. **Authority**: how much knowledge, information, etc., held by a node on a topic.
2. **Hubness (or Hubosity or Hubbishness or Hubtasticness)**: how well a node 'knows' where to find information on a given topic.

 Original work due to the legendary Jon Kleinberg.

 Best hubs point to best authorities.

 **Regularities**: Hubs authoritatively link to hubs, authorities hubbishly link to other authorities.

 More: look for dense links between sets of 'good' hubs pointing to sets of 'good' authorities.

 Known as the HITS algorithm 
(Hyperlink-Induced Topics Search).

The Fundamental
Theorem of
Linear Algebra


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Tofuspace 25/25:
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Decomposition

 Give each node two scores:

1. x_i = authority score for node i
2. y_j = hub score for node j

 We connect the scores of neighboring nodes.

 I: a good authority is linked to by good hubs.

 Means x_i should increase as $\sum_j A_{ji} y_j$ increases.

 Note: indices are ji meaning j has a directed link to i .

 II: good hubs point to good authorities.

 Means y_j should increase as $\sum_i A_{ji} x_i$ increases.

 Linearity assumption:

$$x_i \propto A^T y \text{ and } y_j \propto A x$$

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Give each node two scores:

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Means x_i should increase as y_j increases.



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Means x_i should increase as $\sum_{j=1}^N a_{ji} y_j$ increases.

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Show me
the SVD!!

 So let's say we have

$$\vec{x} = c_1 A^T \vec{y} \text{ and } \vec{y} = c_2 A \vec{x}$$

where c_1 and c_2 must be positive.

 Above equations combine to give

$$\vec{x} = c_1 A^T c_2 A \vec{x} = \lambda A^T A \vec{x}$$

where $\lambda = c_1 c_2 > 0$.


 It's all good! we have the heart of singular value decomposition before us...

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We can do this:

Tofuspace 25/25:
Singular Value
Decomposition

- 🍷 $A^T A$ is symmetric.
- 🍷 $A^T A$ is semi-positive definite so its eigenvalues are all ≥ 0 .
- 🍷 $A^T A$'s eigenvalues are the square of A 's singular values.
- 🍷 $A^T A$'s eigenvectors form a joyful orthogonal basis.
- 🍷 The splendid Perron-Frobenius theorem [↗](#) tells us that only the dominant eigenvalue's eigenvector can be chosen to have non-negative entries.
- 🍷 So: linear assumption leads to a solvable system.
- 🍷 What would be very good: find networks where we have independent measures of node 'importance' and see how importance is actually distributed.

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Show me
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Image approximation (80x60)

Idea: use SVD to approximate images

 Interpret elements of matrix A as color values of an image.

 Truncate series SVD representation of A :

$$A = U\Sigma V^T = \sum_{i=1}^r \sigma_i \hat{u}_i \hat{v}_i^T$$

 Use fact that $\sigma_1 \geq \sigma_2 \geq \dots \geq \sigma_r > 0$.

 Rank $r \leq \min(m, n)$.

 Rank $r \leq \#$ of pixels on shortest side.

 For color: approximate 3 matrices (RGB).

Show me
the SVD!!

Image approximation (80x60)

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Show me
the SVD!!

And now for the Exciting Scottish Fabric Image Guessing Game ...

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Connor MacLeod of Clan MacLeod:

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There Can Be Only One: 

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👁️ Things there should be only one of: Highlander Films.

👁️ Redemption: Queen's It's a Kind of Magic 



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 Redemption: Queen's It's a Kind of Magic 



Image approximation (640 x 640)

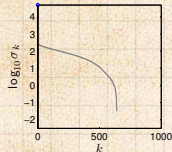
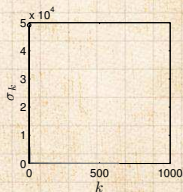
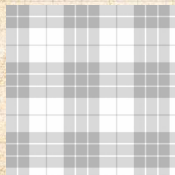
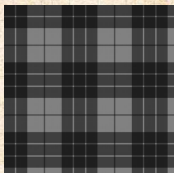
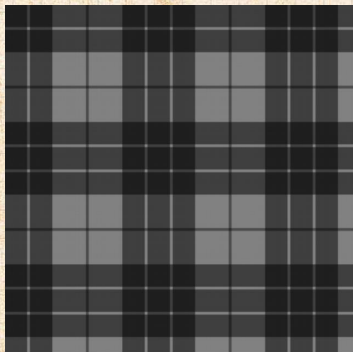
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Image approximation (640 x 640)

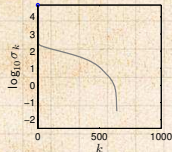
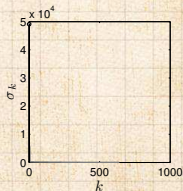
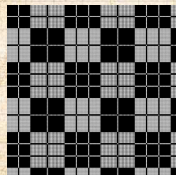
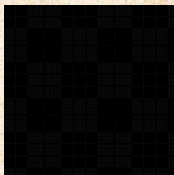
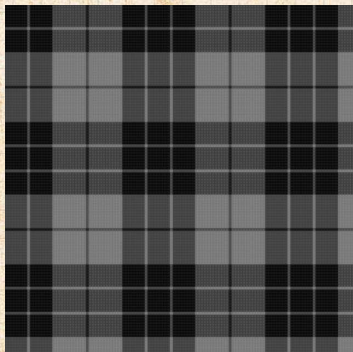
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

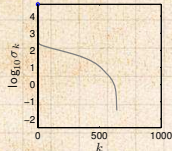
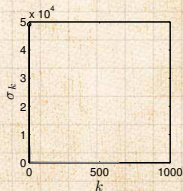
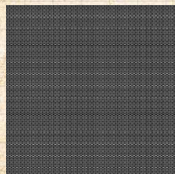
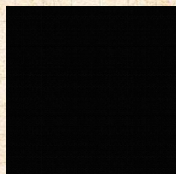
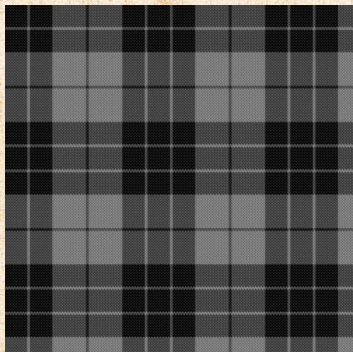
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

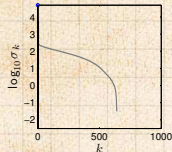
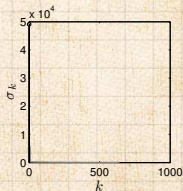
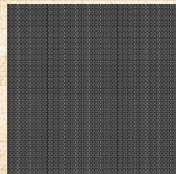
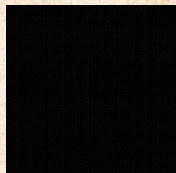
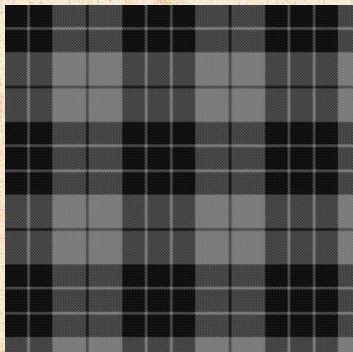
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

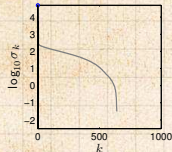
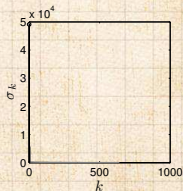
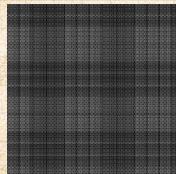
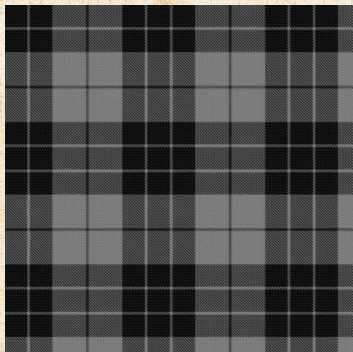
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

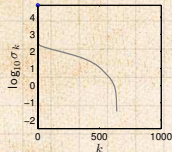
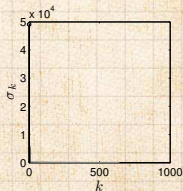
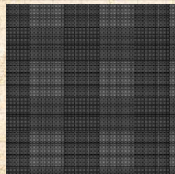
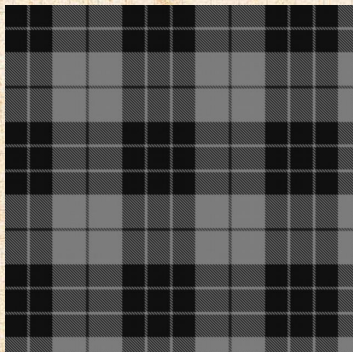
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

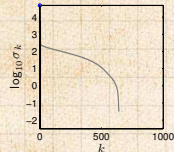
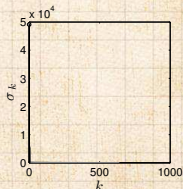
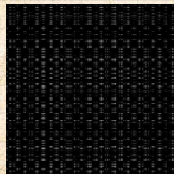
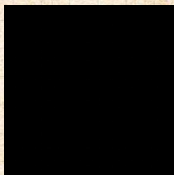
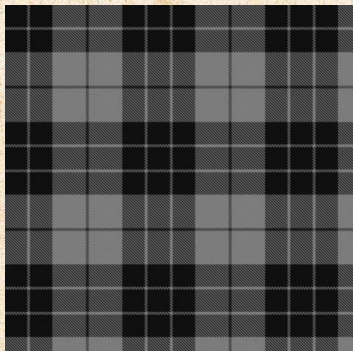
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

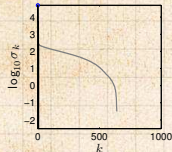
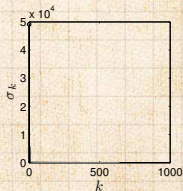
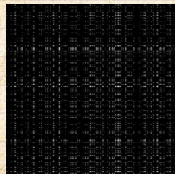
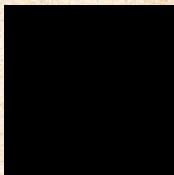
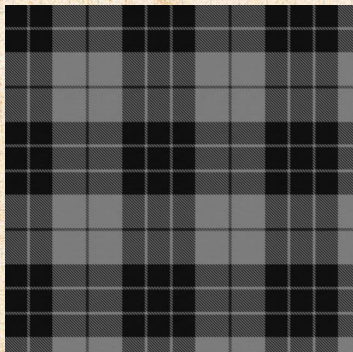
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

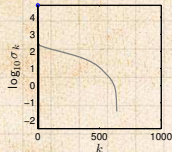
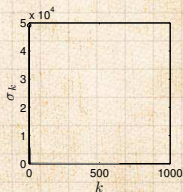
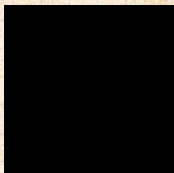
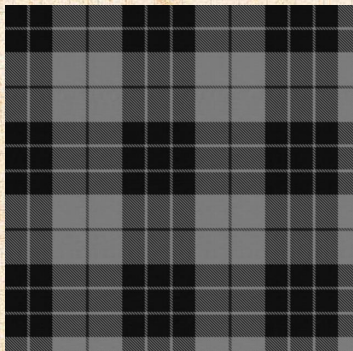
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

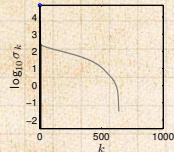
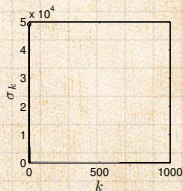
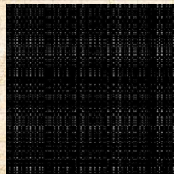
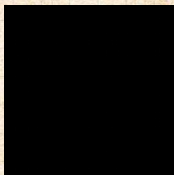
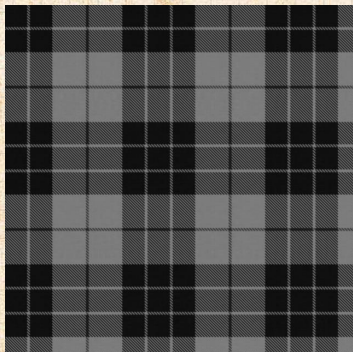
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

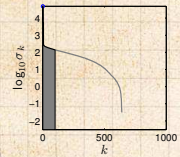
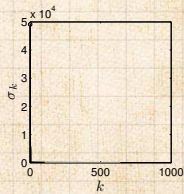
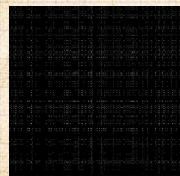
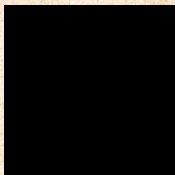
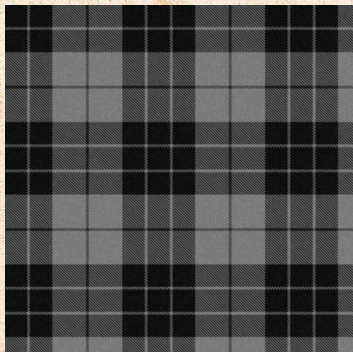
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

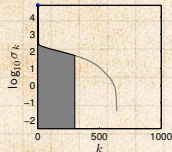
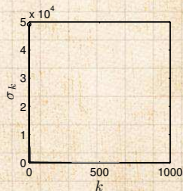
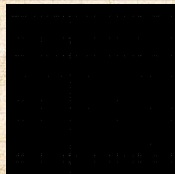
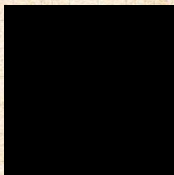
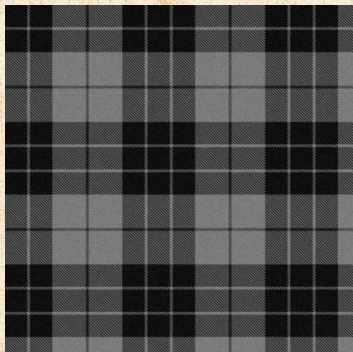
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

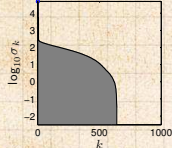
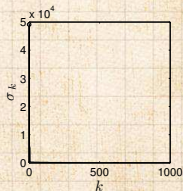
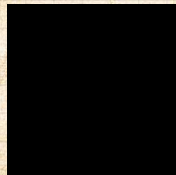
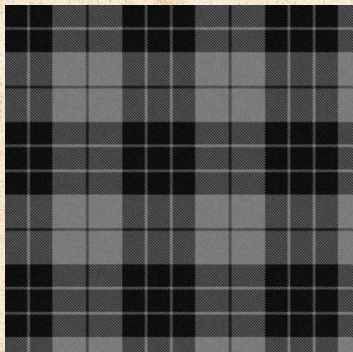
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{640} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

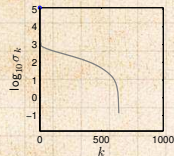
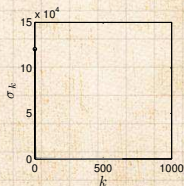
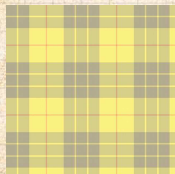
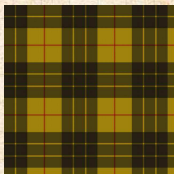
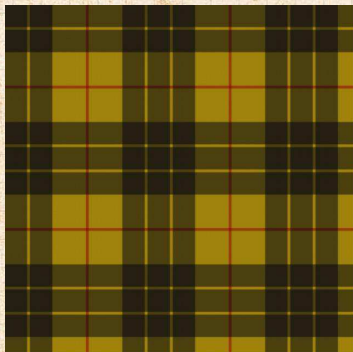
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

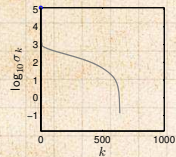
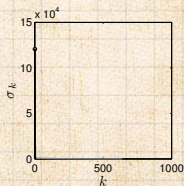
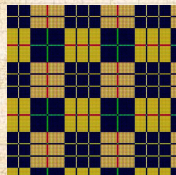
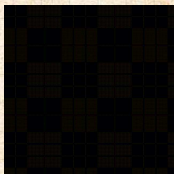
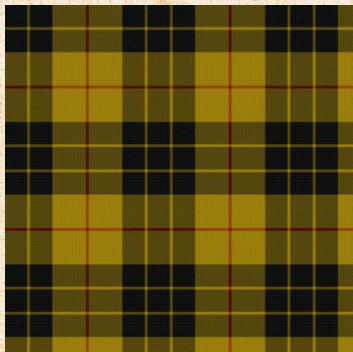
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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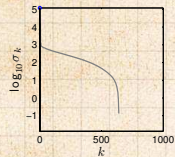
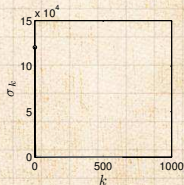
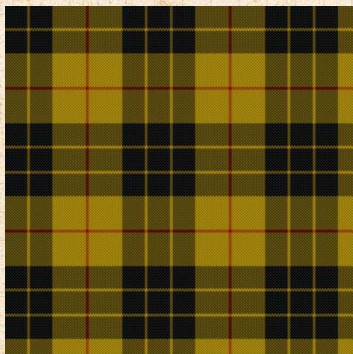
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

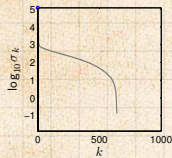
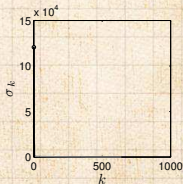
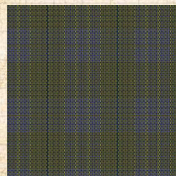
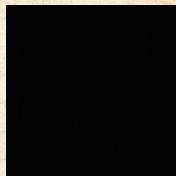
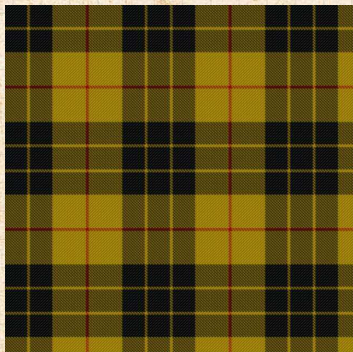
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

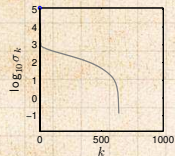
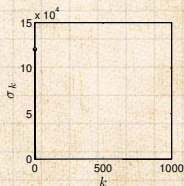
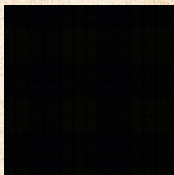
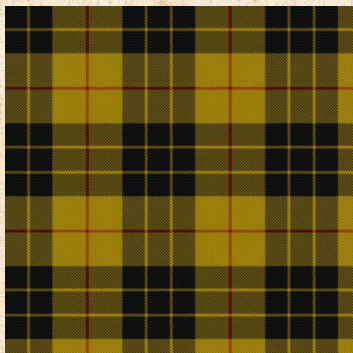
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

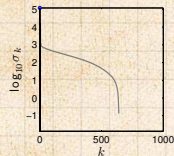
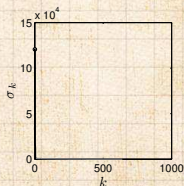
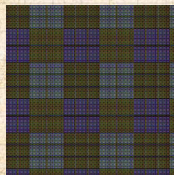
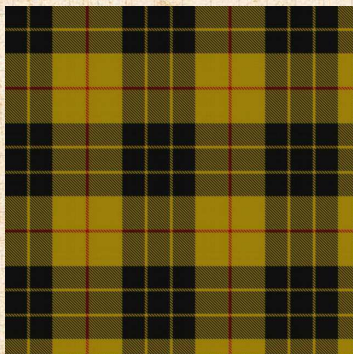
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

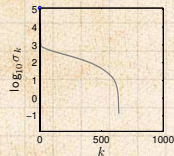
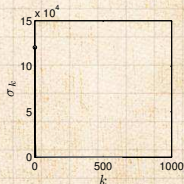
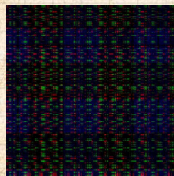
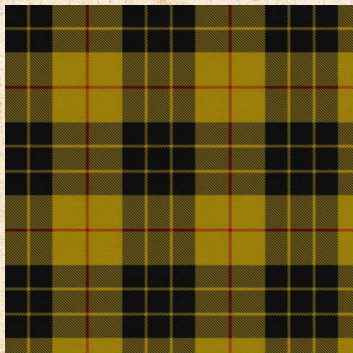
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

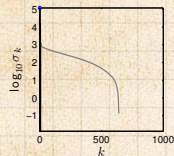
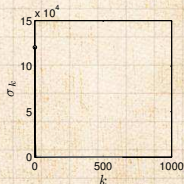
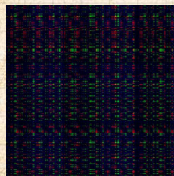
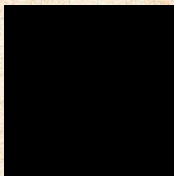
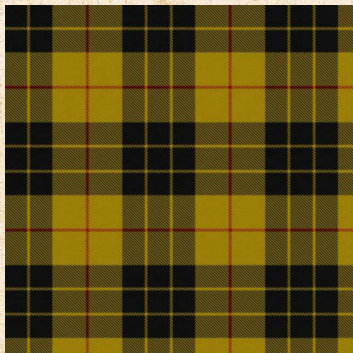
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

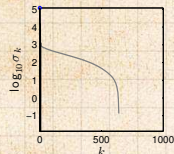
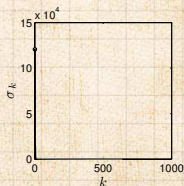
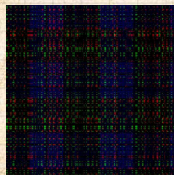
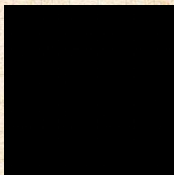
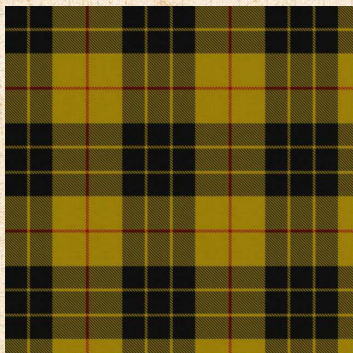
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

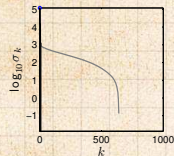
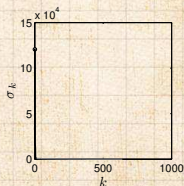
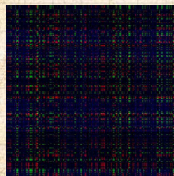
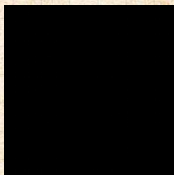
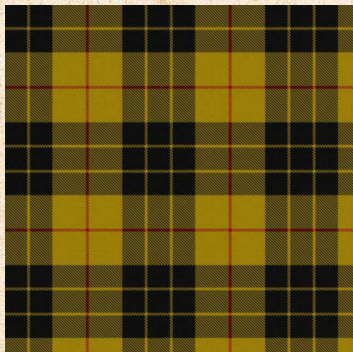
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

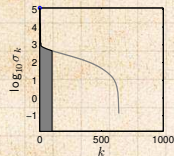
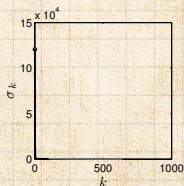
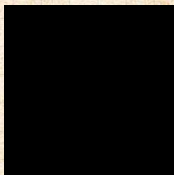
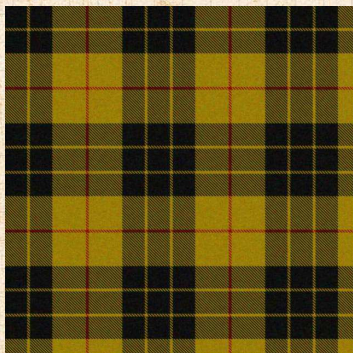
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

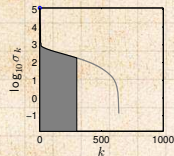
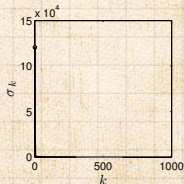
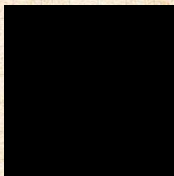
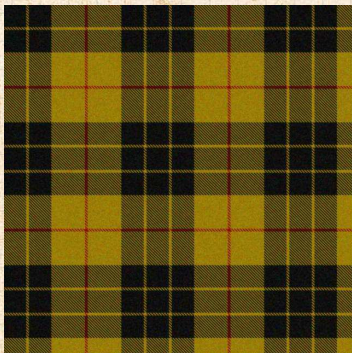
Tofuspace 25/25:
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Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

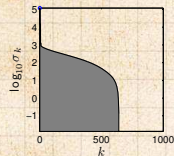
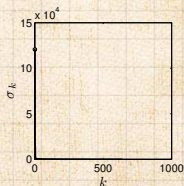
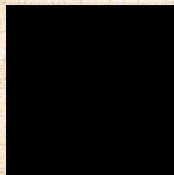
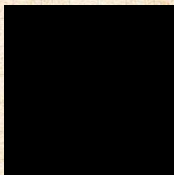
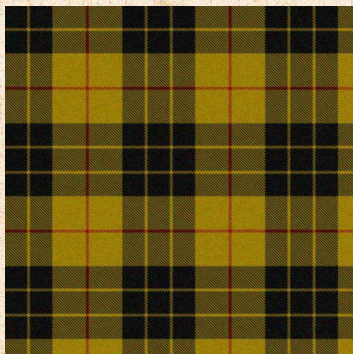
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{640} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

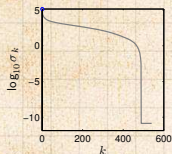
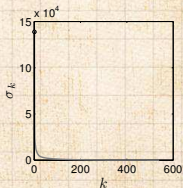
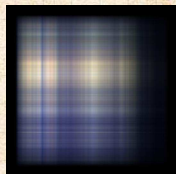
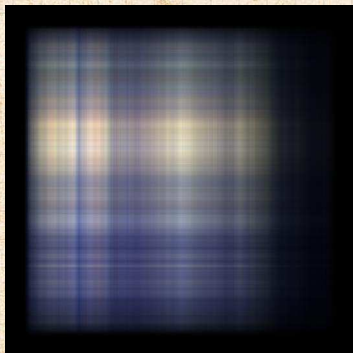
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

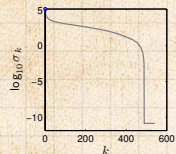
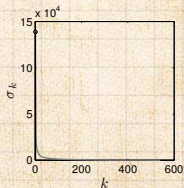
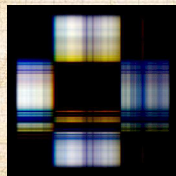
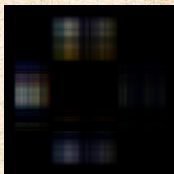
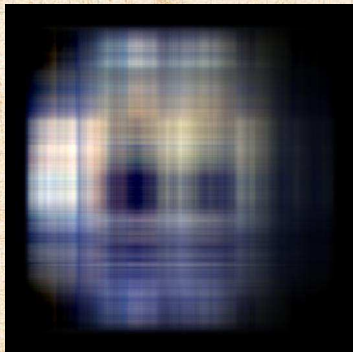
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

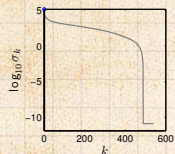
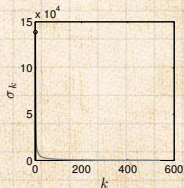
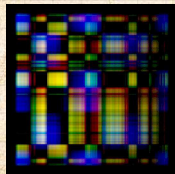
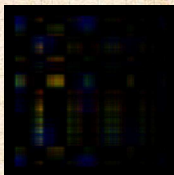
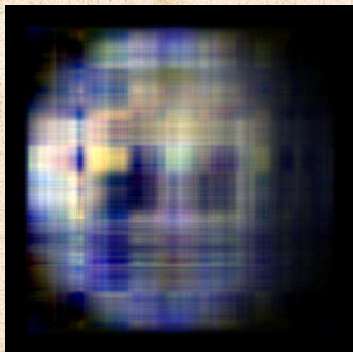
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

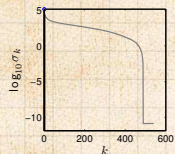
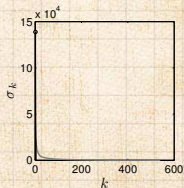
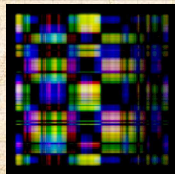
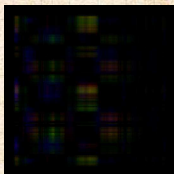
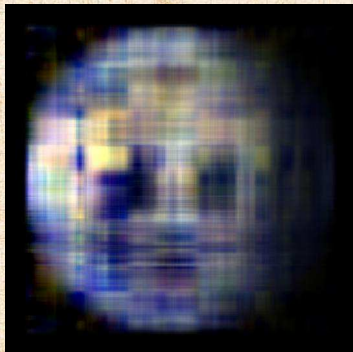
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

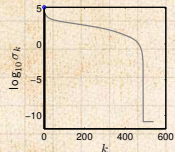
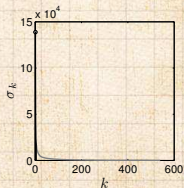
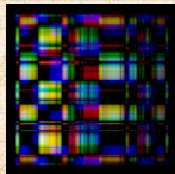
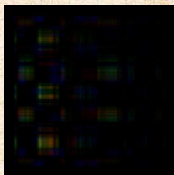
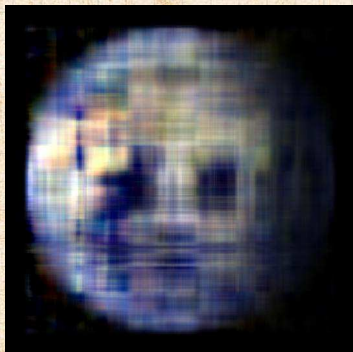
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

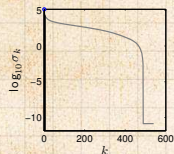
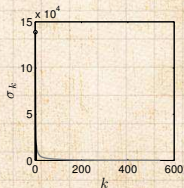
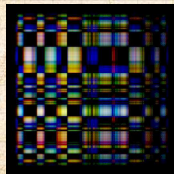
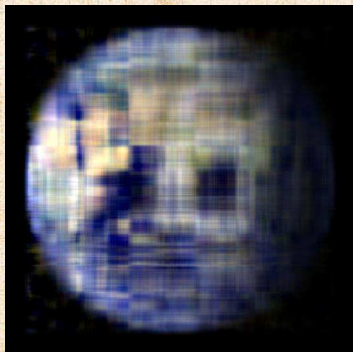
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

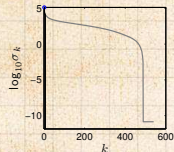
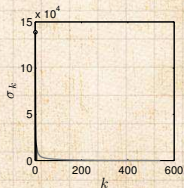
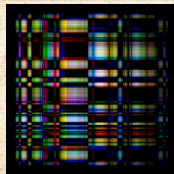
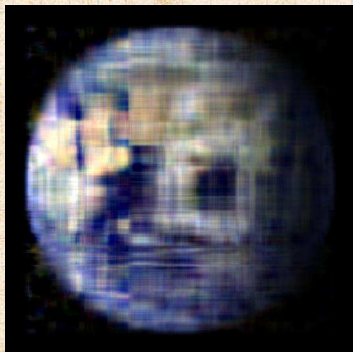
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

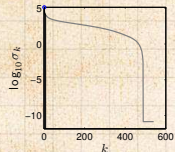
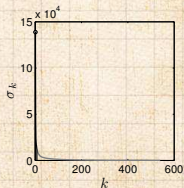
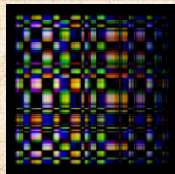
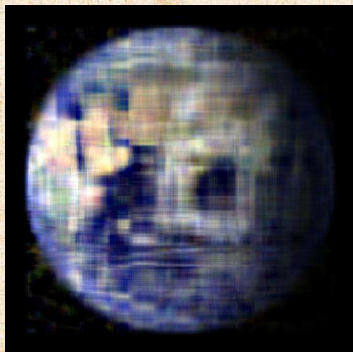
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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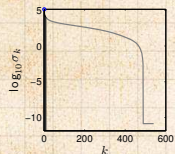
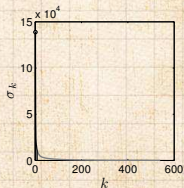
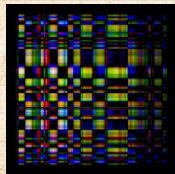
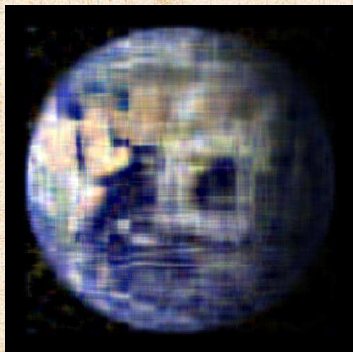
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

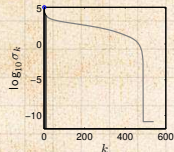
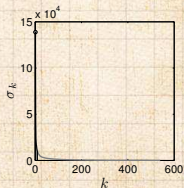
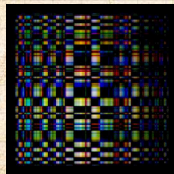
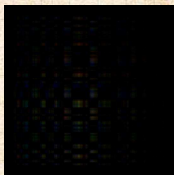
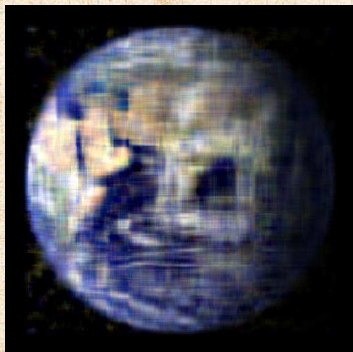
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

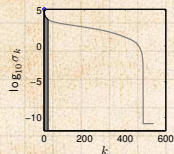
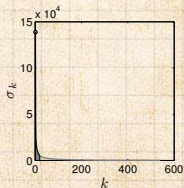
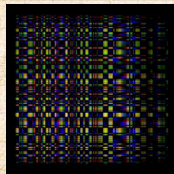
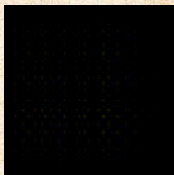
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

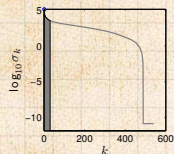
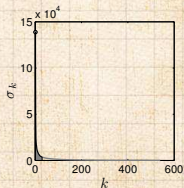
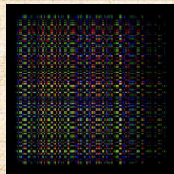
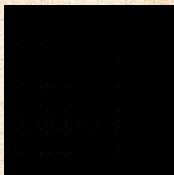
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

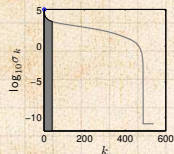
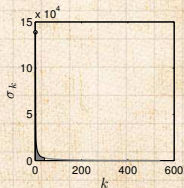
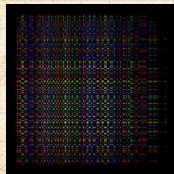
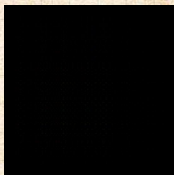
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

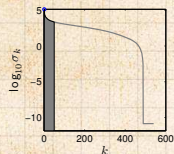
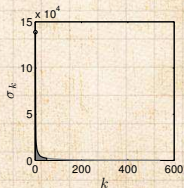
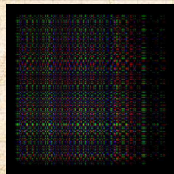
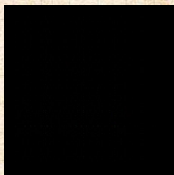
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

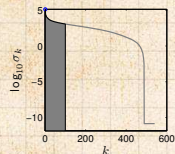
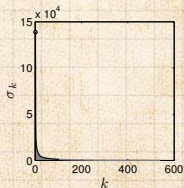
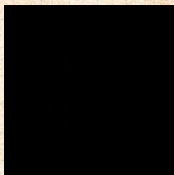
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

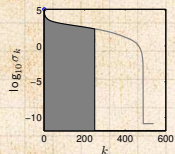
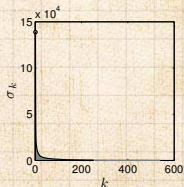
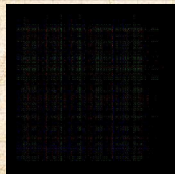
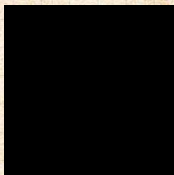
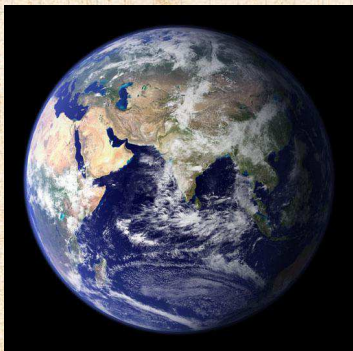
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{250} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (540 x 540)

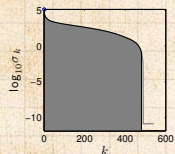
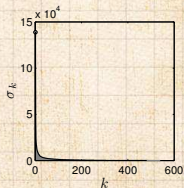
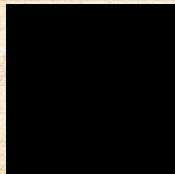
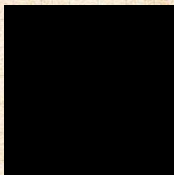
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{480} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

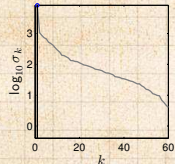
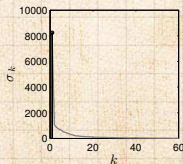
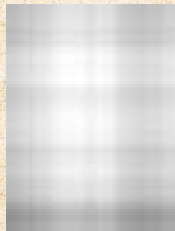
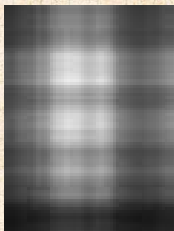
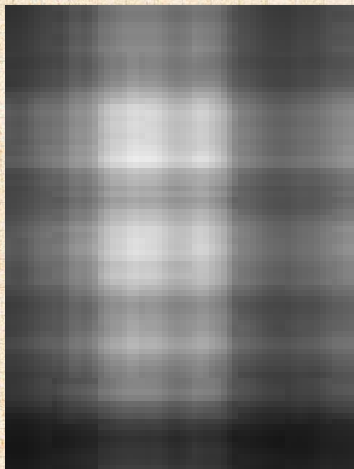
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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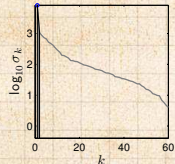
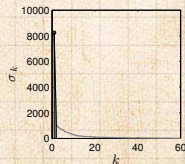
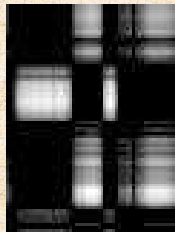
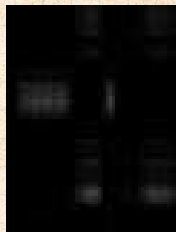
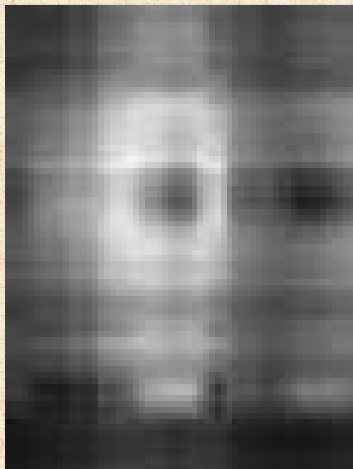
Image approximation (80 x 60)

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

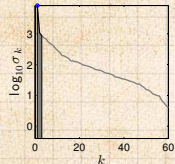
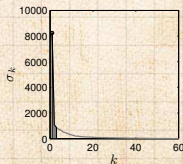
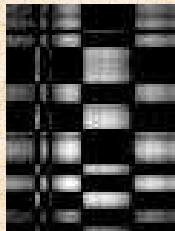
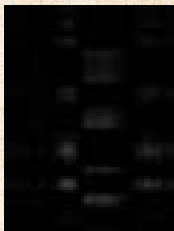
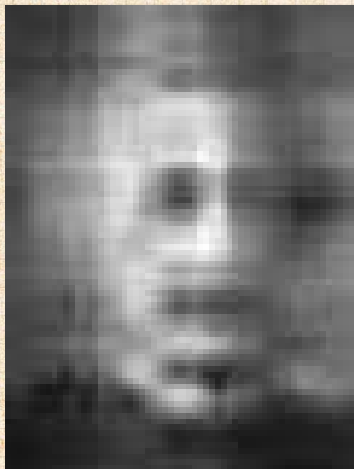
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

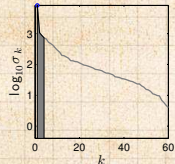
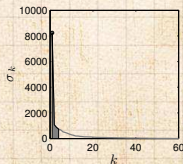
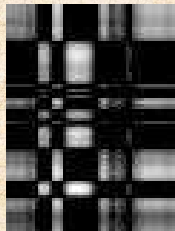
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

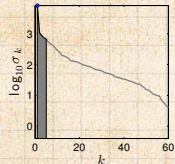
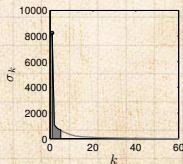
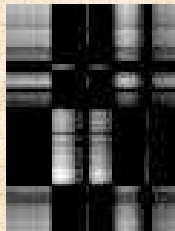
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

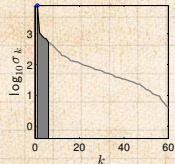
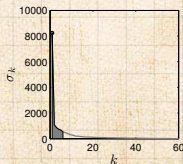
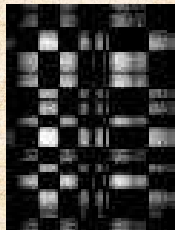
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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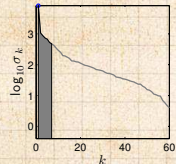
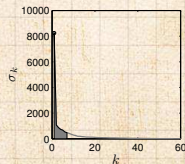
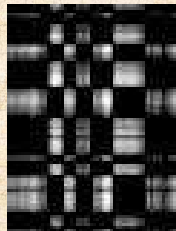
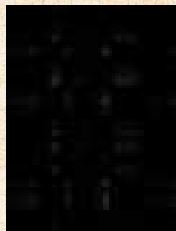
Image approximation (80 x 60)

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

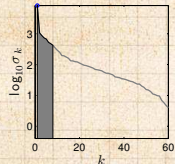
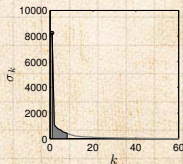
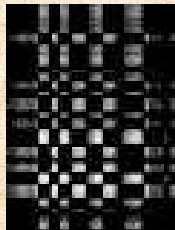
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

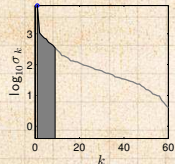
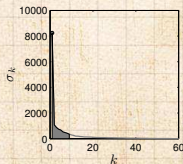
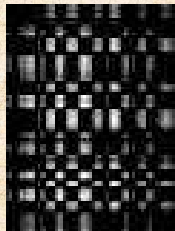
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

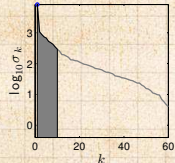
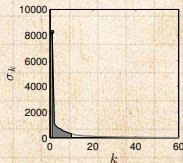
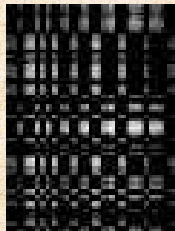
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

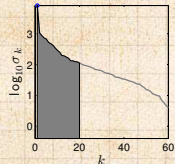
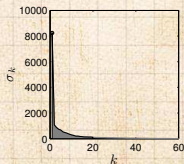
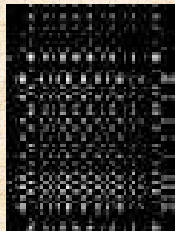
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

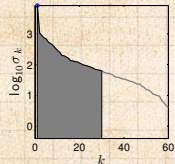
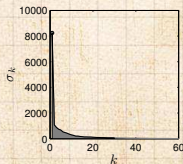
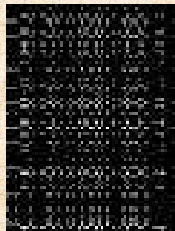
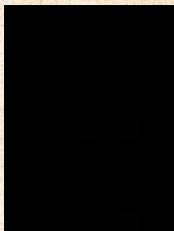
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

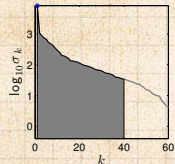
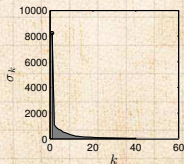
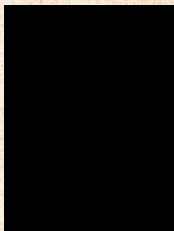
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

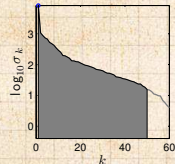
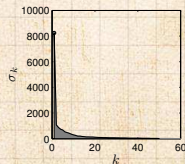
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (80 x 60)

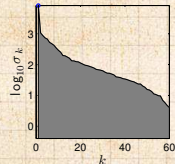
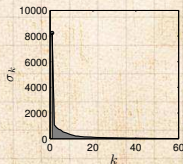
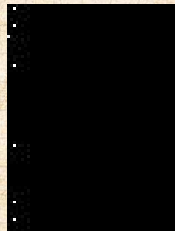
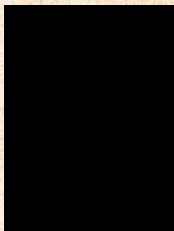
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{60} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

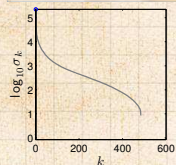
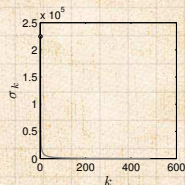
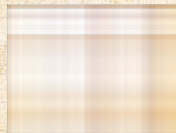
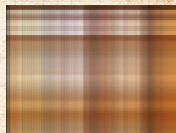
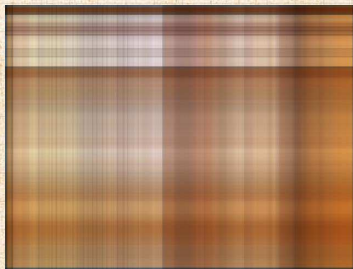
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

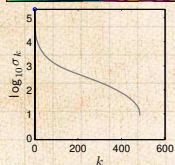
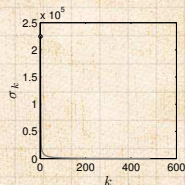
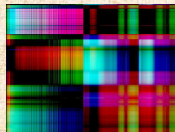
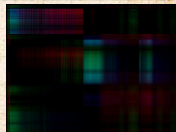
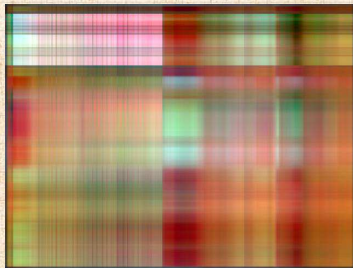
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

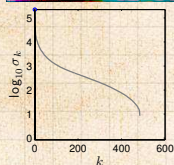
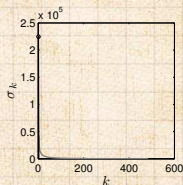
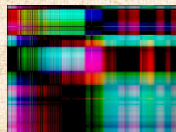
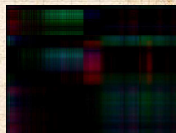
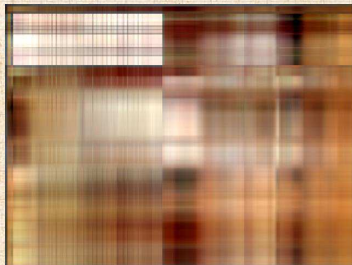
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

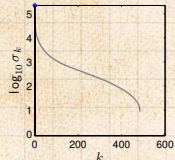
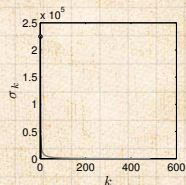
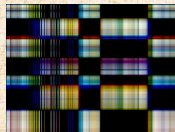
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

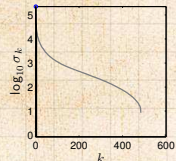
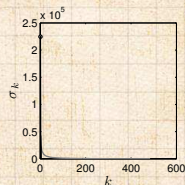
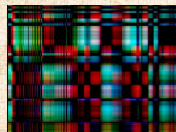
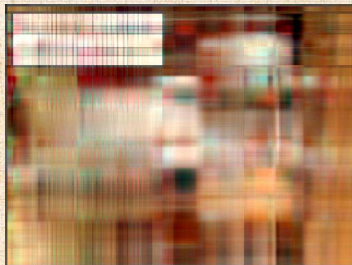
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

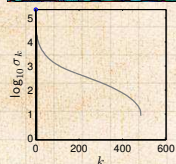
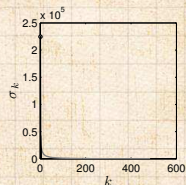
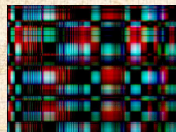
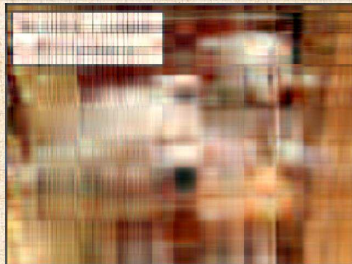
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

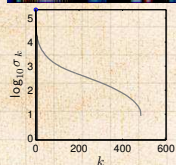
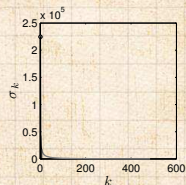
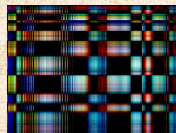
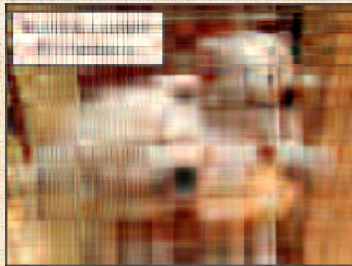
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

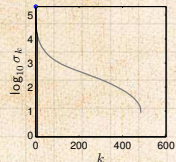
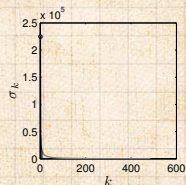
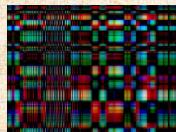
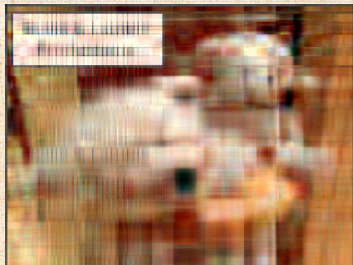
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (484 x 640)

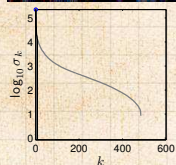
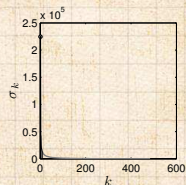
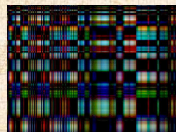
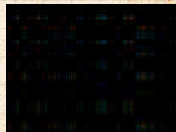
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{u}_i \hat{v}_i^T$$

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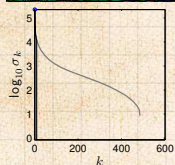
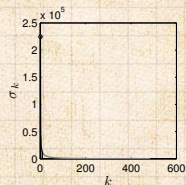
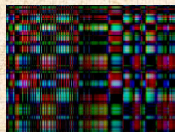
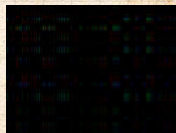
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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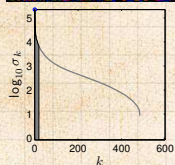
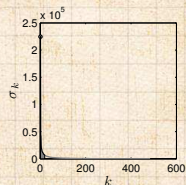
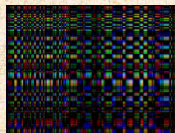
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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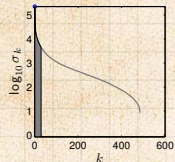
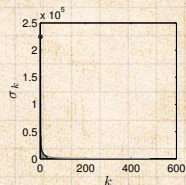
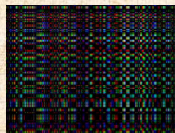
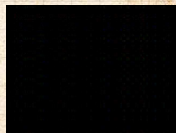
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{u}_i \hat{v}_i^T$$

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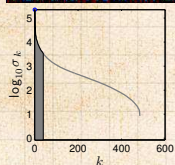
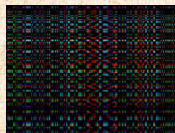
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{u}_i \hat{v}_i^T$$

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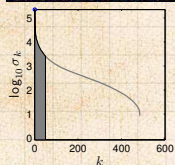
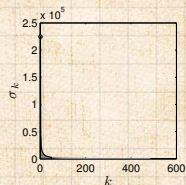
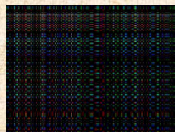
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

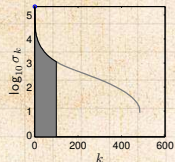
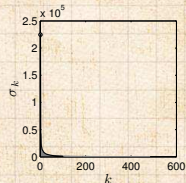
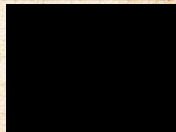
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

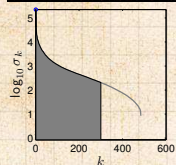
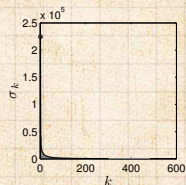
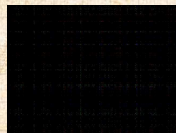
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (484 x 640)

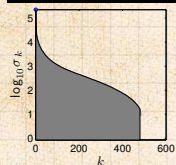
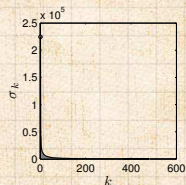
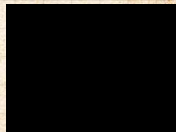
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{480} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (640 x 640)

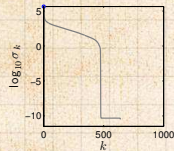
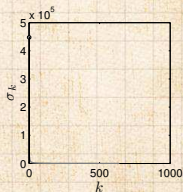
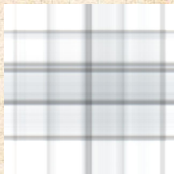
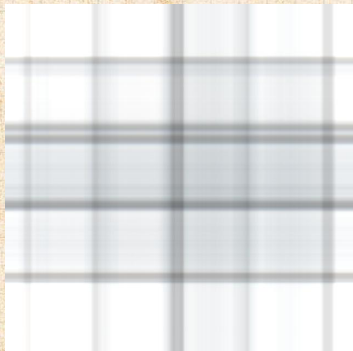
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (640 x 640)

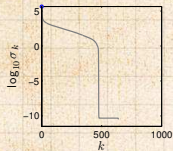
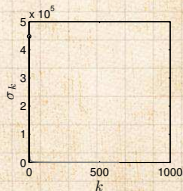
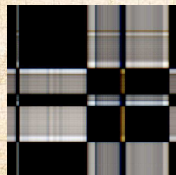
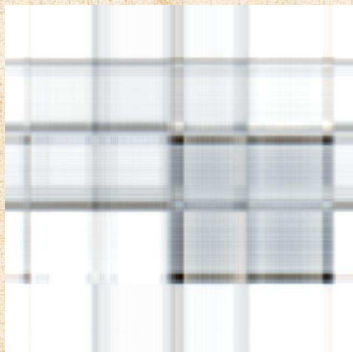
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

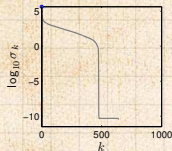
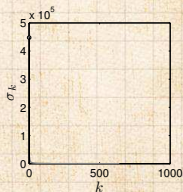
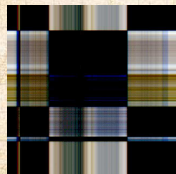
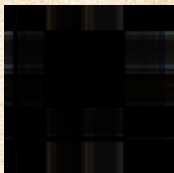
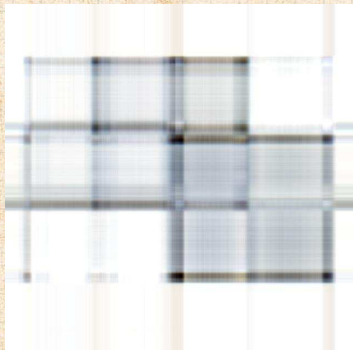
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

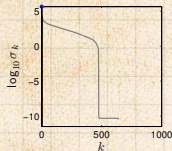
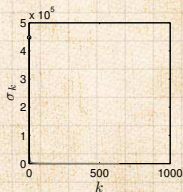
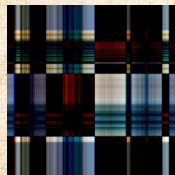
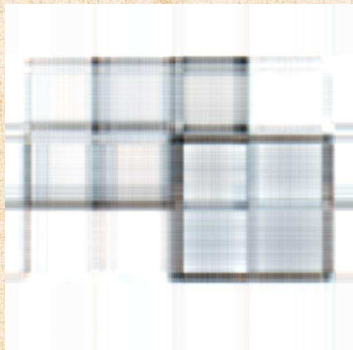
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

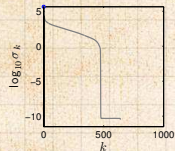
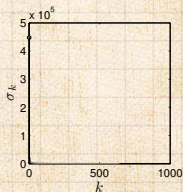
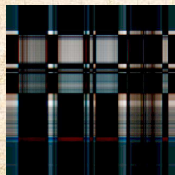
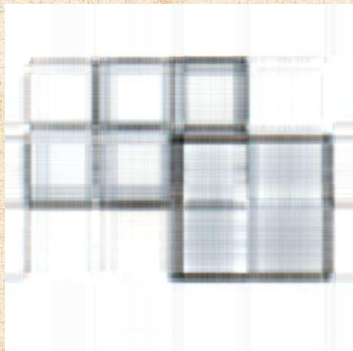
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

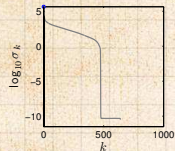
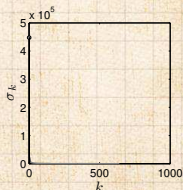
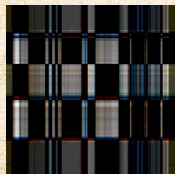
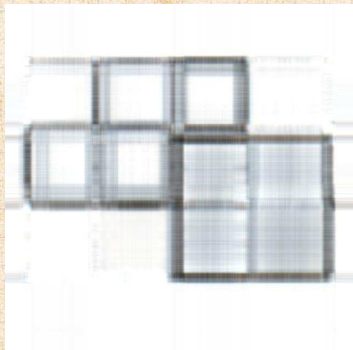
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

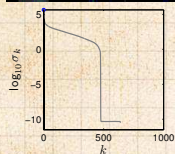
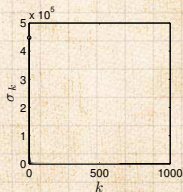
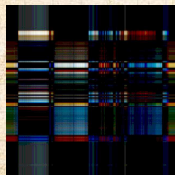
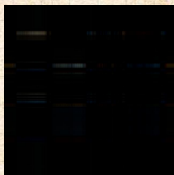
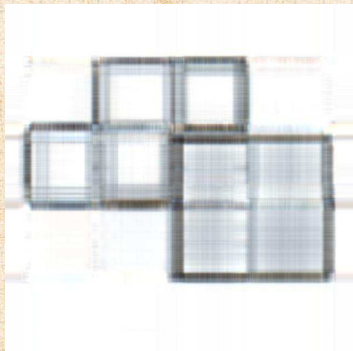
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

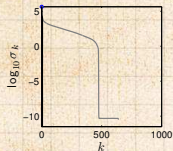
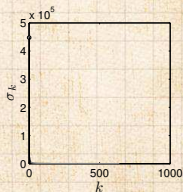
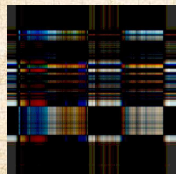
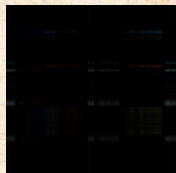
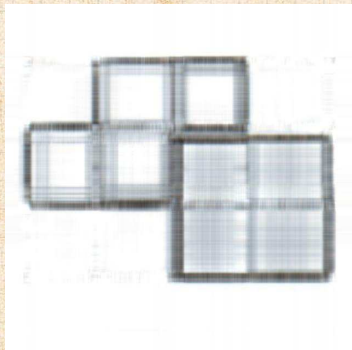
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

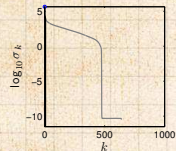
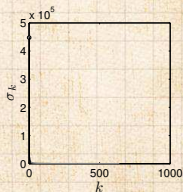
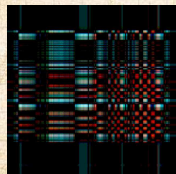
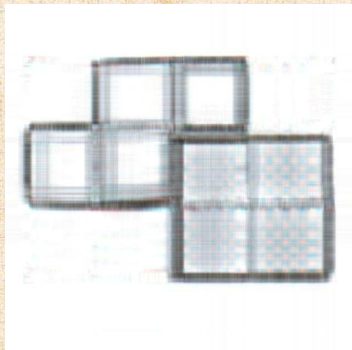
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

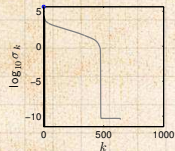
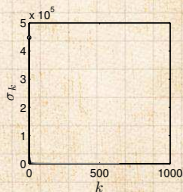
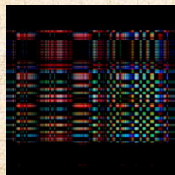
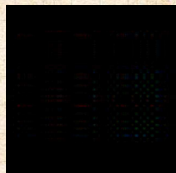
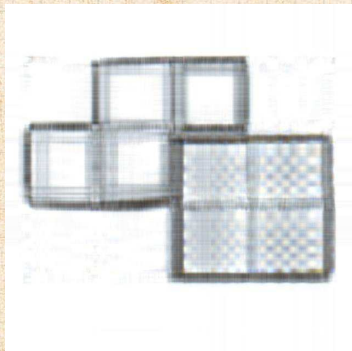
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

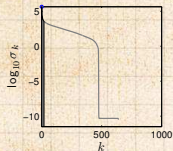
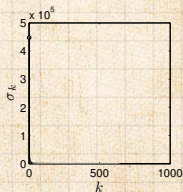
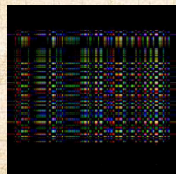
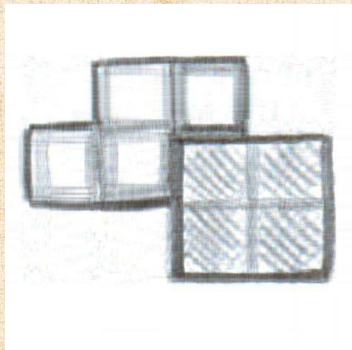
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

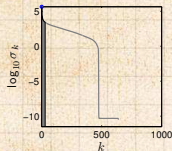
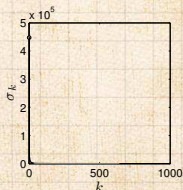
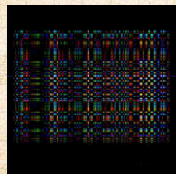
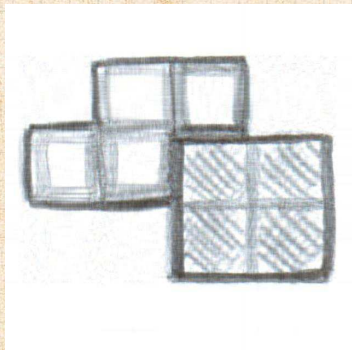
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

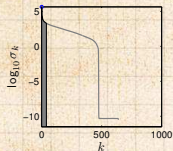
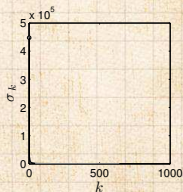
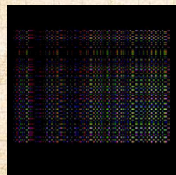
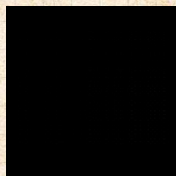
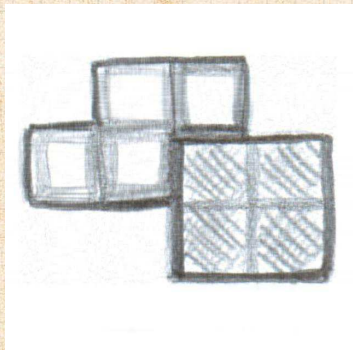
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

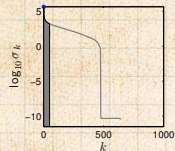
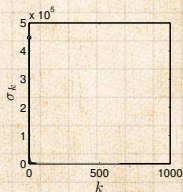
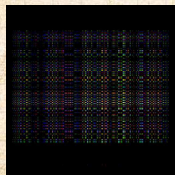
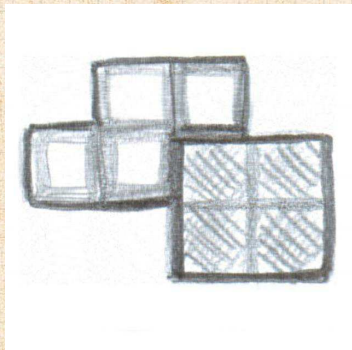
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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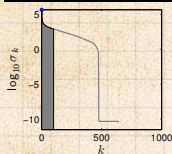
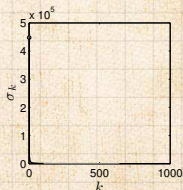
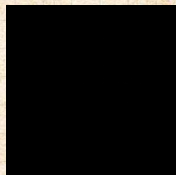
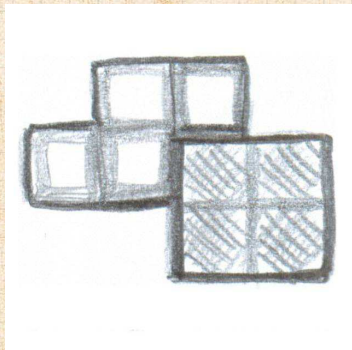
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

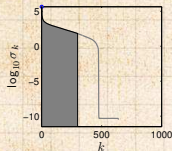
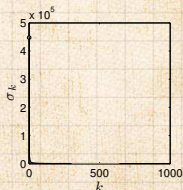
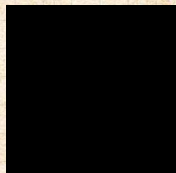
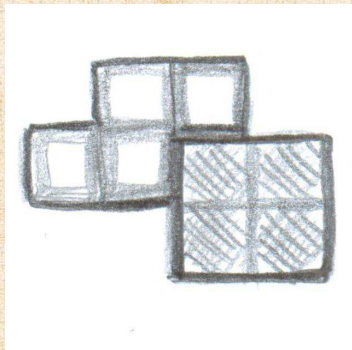
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

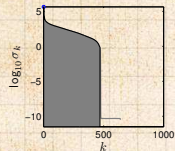
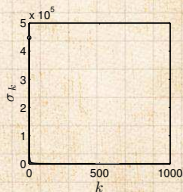
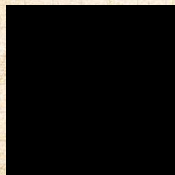
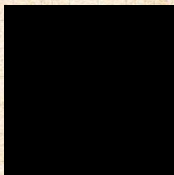
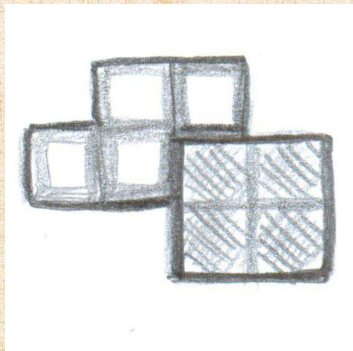
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{470} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

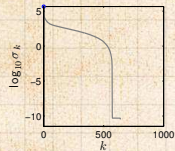
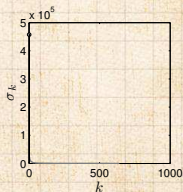
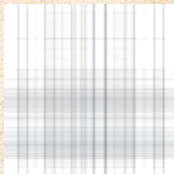
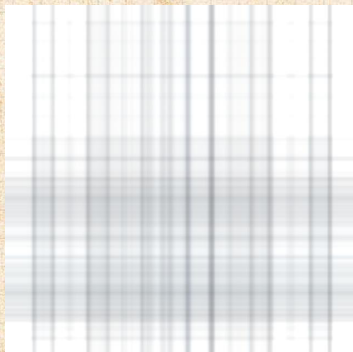
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

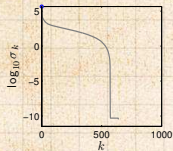
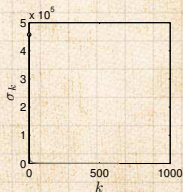
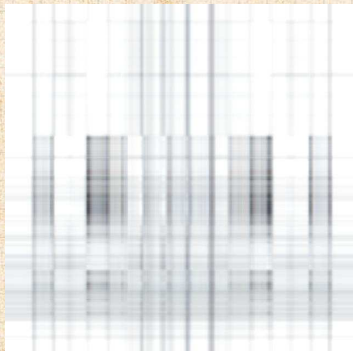
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

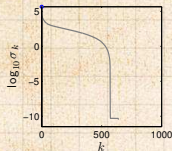
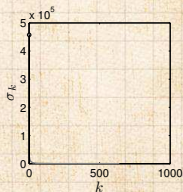
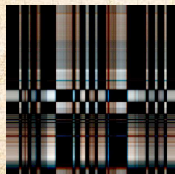
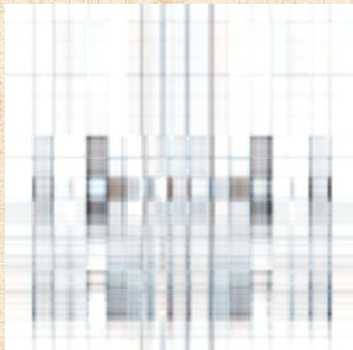
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

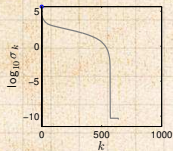
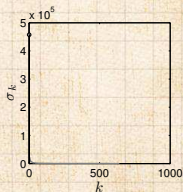
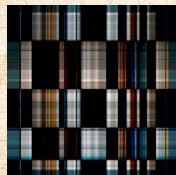
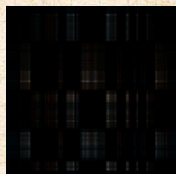
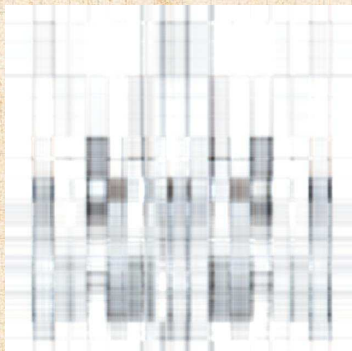
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

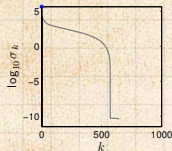
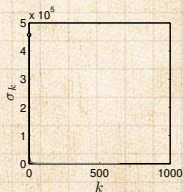
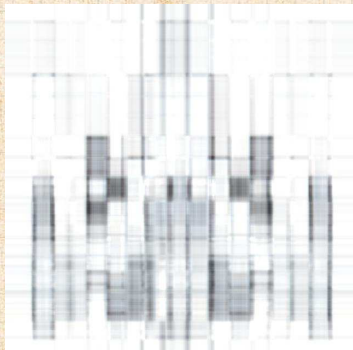
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

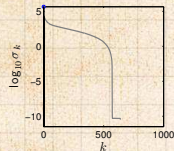
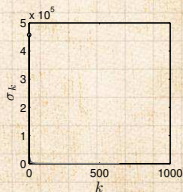
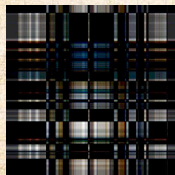
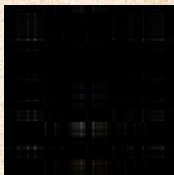
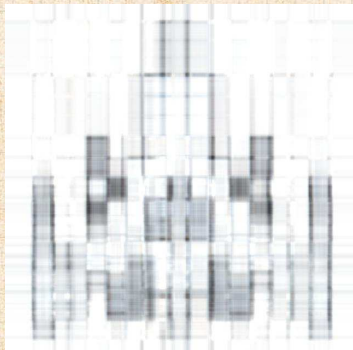
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

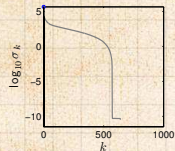
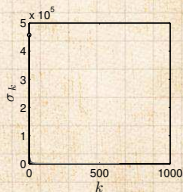
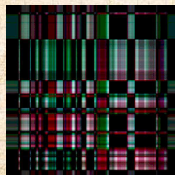
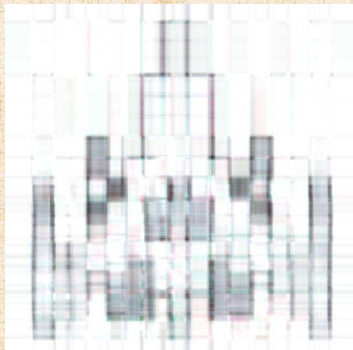
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

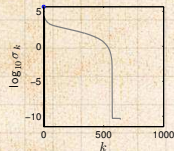
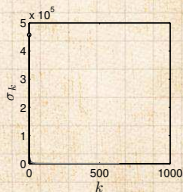
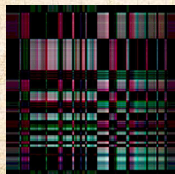
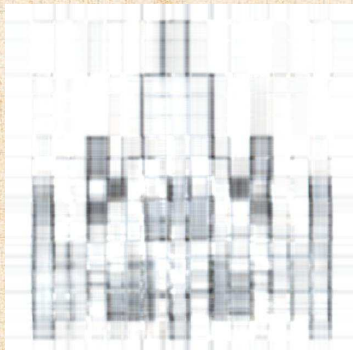
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

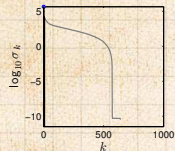
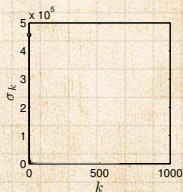
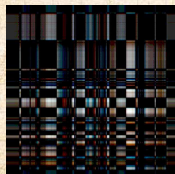
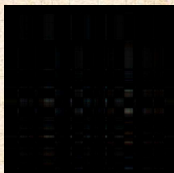
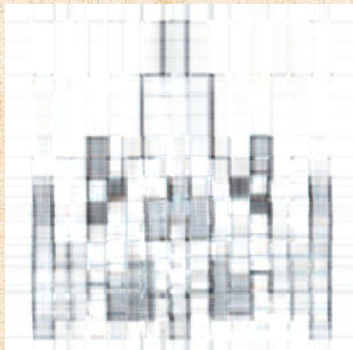
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

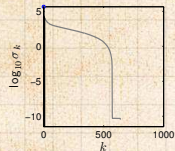
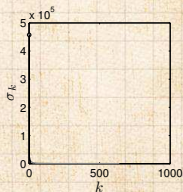
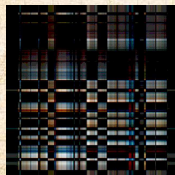
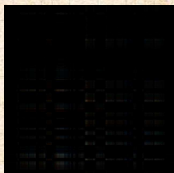
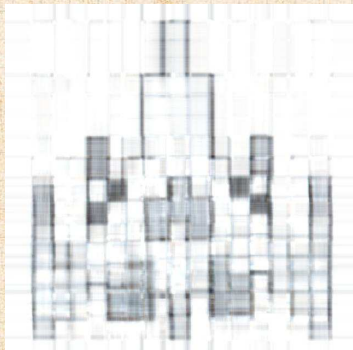
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

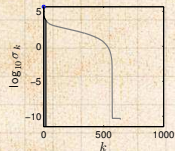
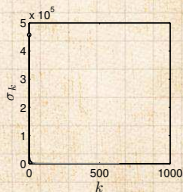
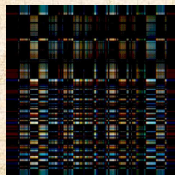
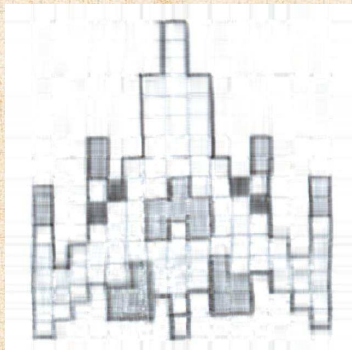
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

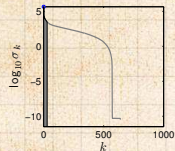
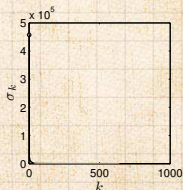
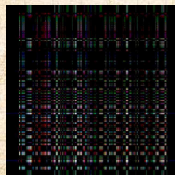
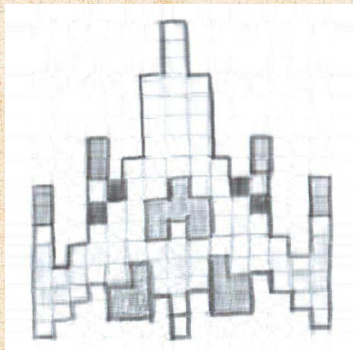
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

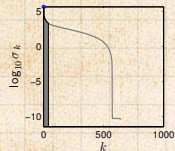
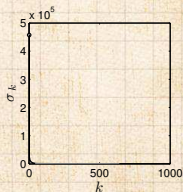
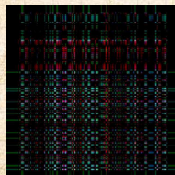
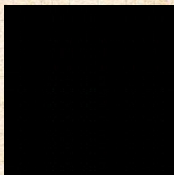
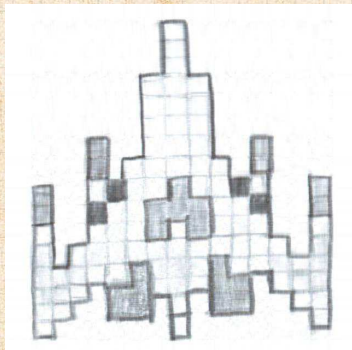
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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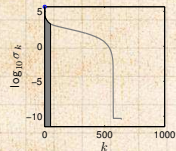
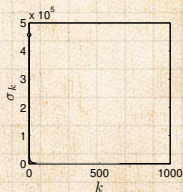
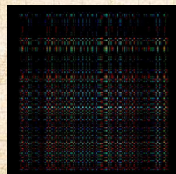
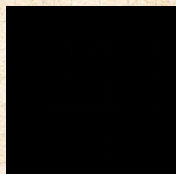
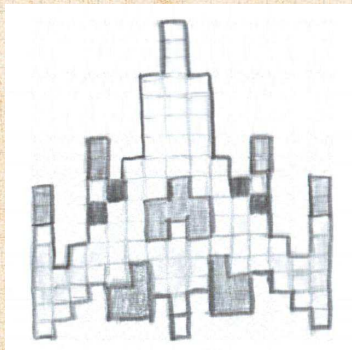
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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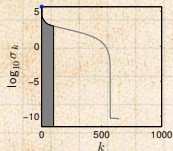
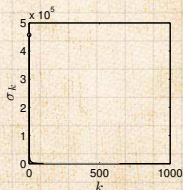
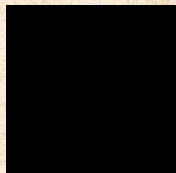
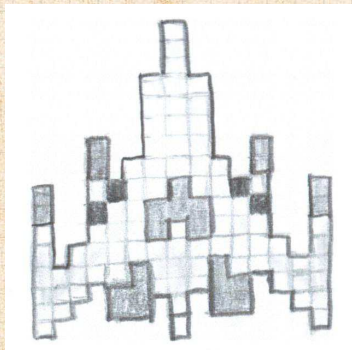
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

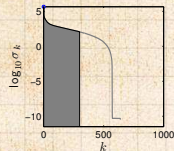
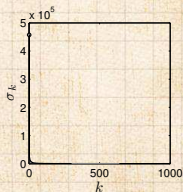
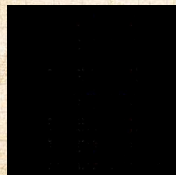
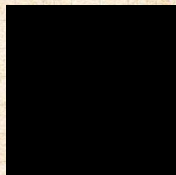
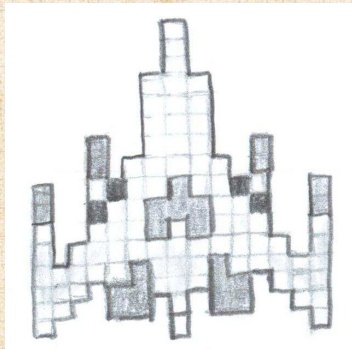
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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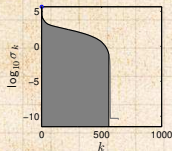
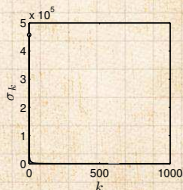
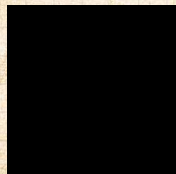
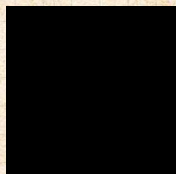
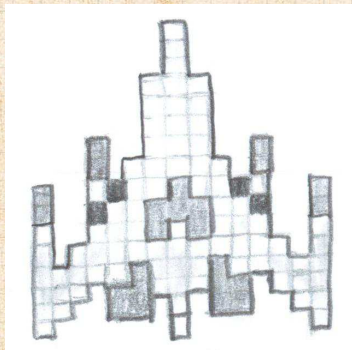
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{560} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (640 x 640)

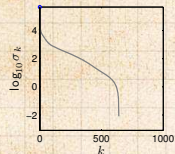
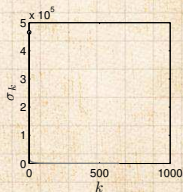
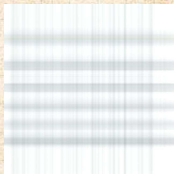
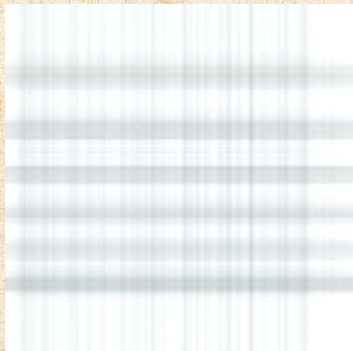
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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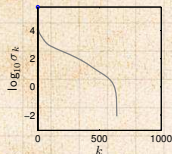
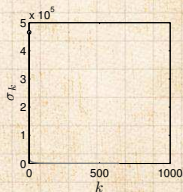
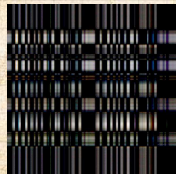
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

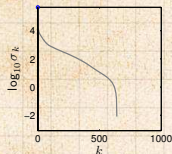
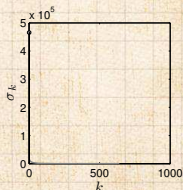
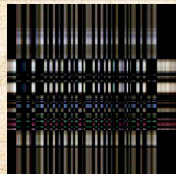
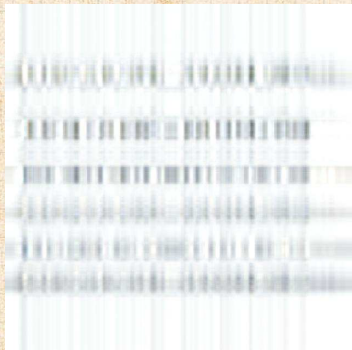
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

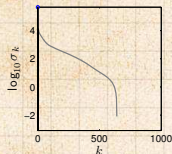
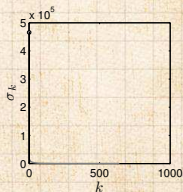
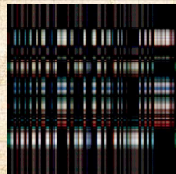
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

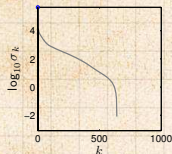
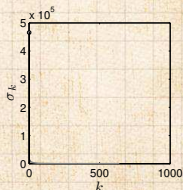
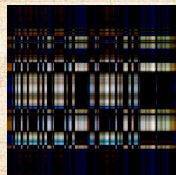
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

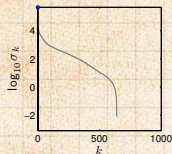
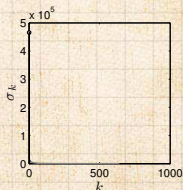
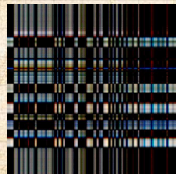
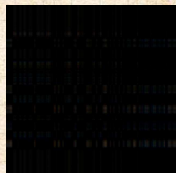
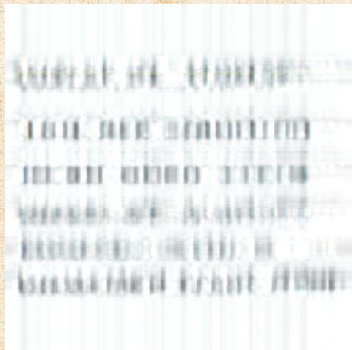
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

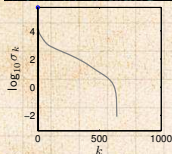
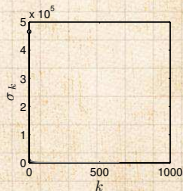
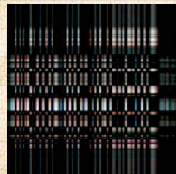
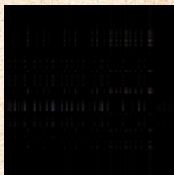
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

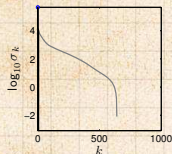
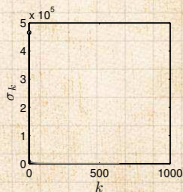
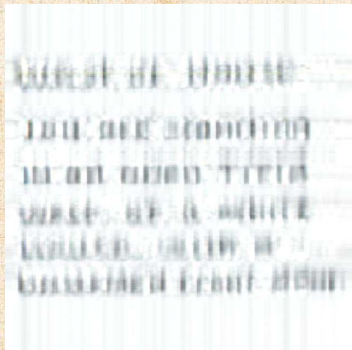
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

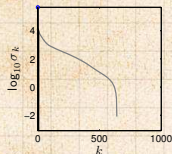
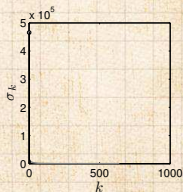
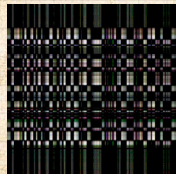
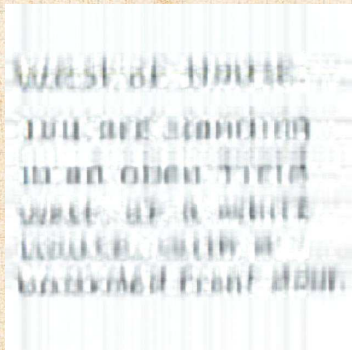
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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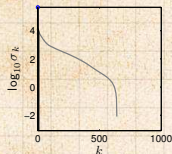
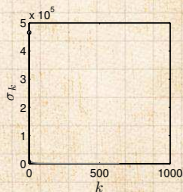
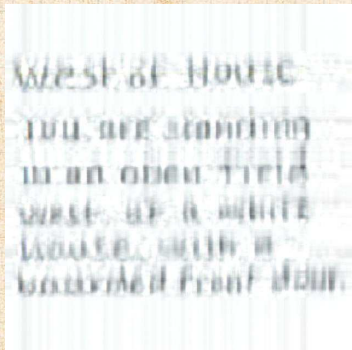
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

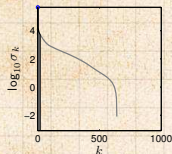
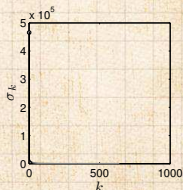
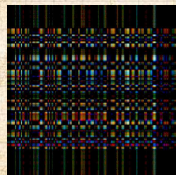
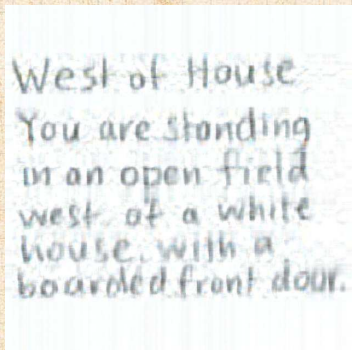
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

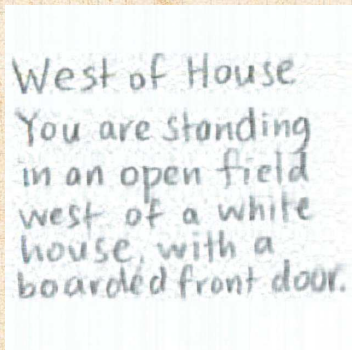
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

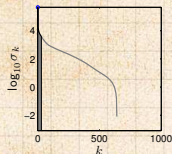
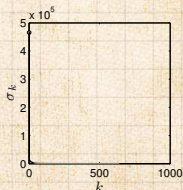
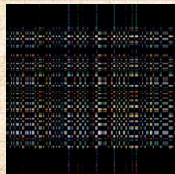
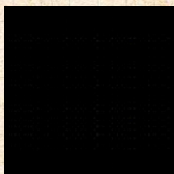
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You are standing
in an open field
west of a white
house, with a
boarded front door.



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Image approximation (640 x 640)

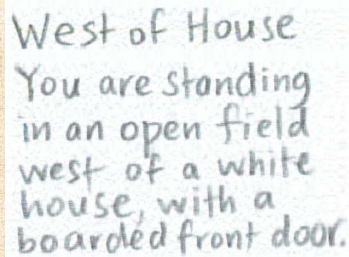
Tofspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

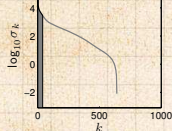
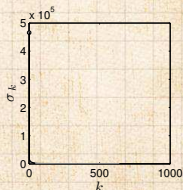
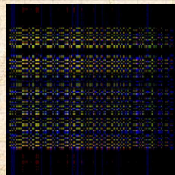
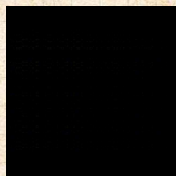
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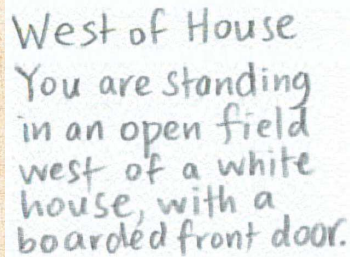
Tofuspace 25/25:
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Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

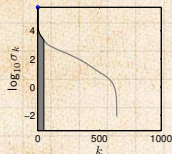
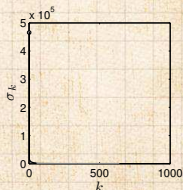
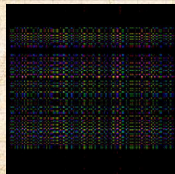
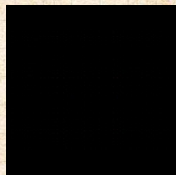
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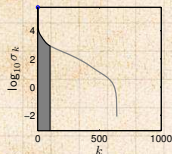
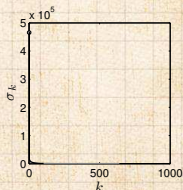
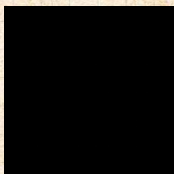
$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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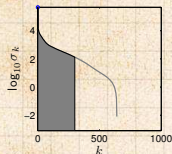
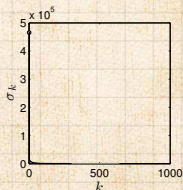
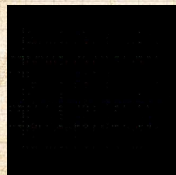
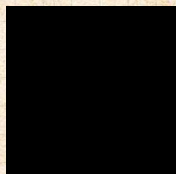
$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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West of House
You are standing
in an open field
west of a white
house, with a
boarded front door.



Show me
the SVD!!

Image approximation (640 x 640)

Tofuspace 25/25:
Singular Value
Decomposition

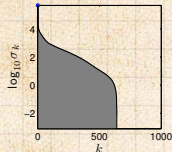
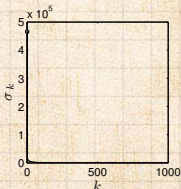
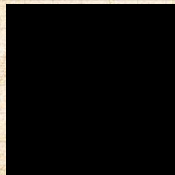
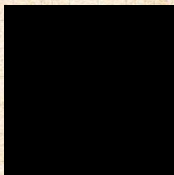
$$\mathbf{A} = \sum_{i=1}^{640} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

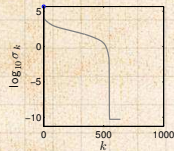
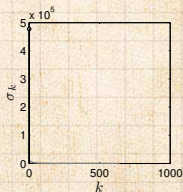
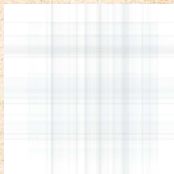
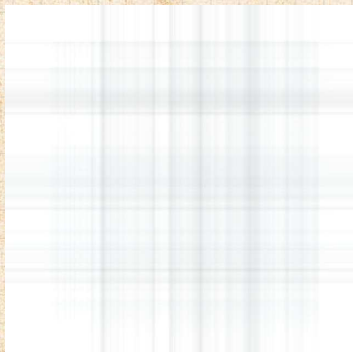
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (640 x 640)

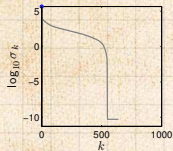
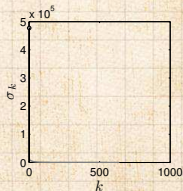
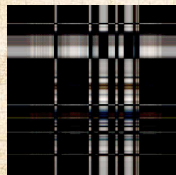
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

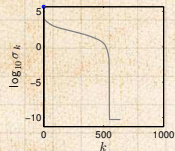
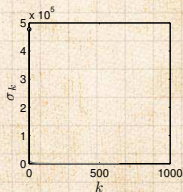
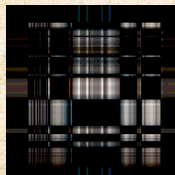
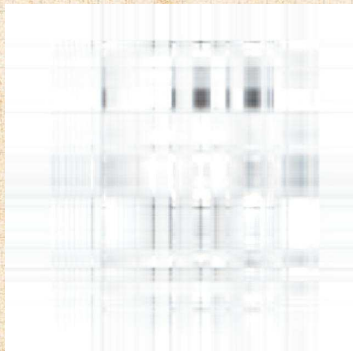
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

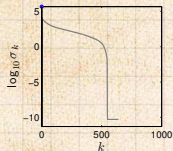
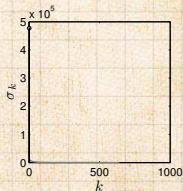
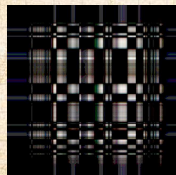
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

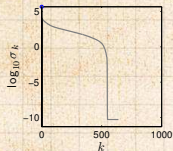
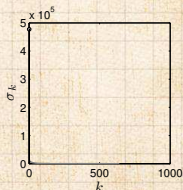
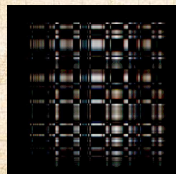
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

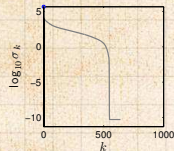
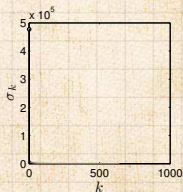
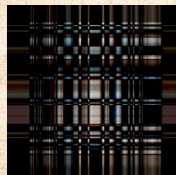
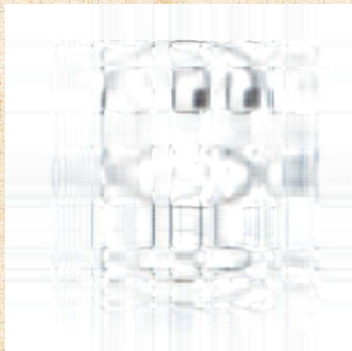
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

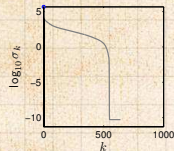
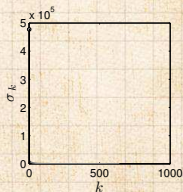
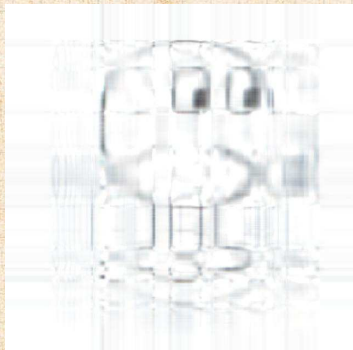
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

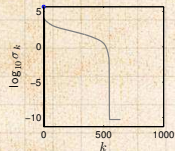
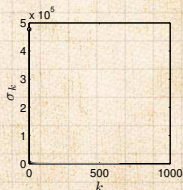
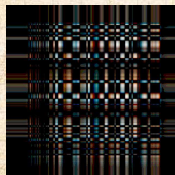
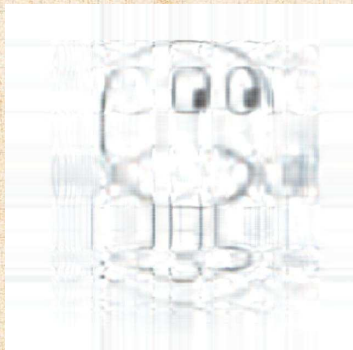
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

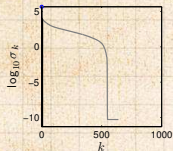
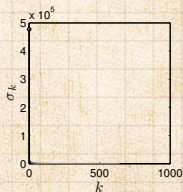
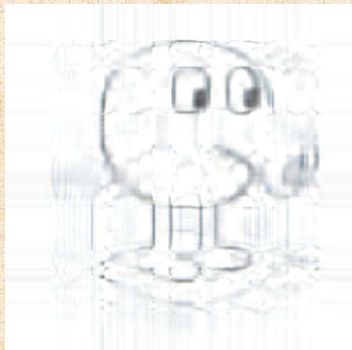
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

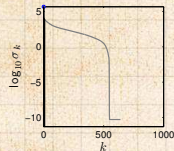
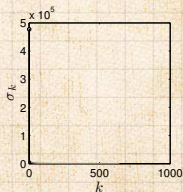
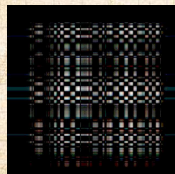
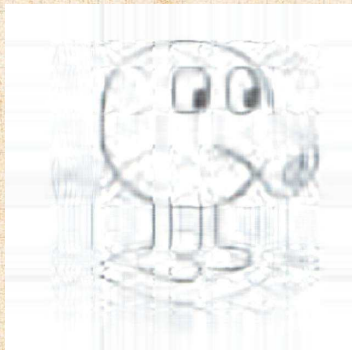
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

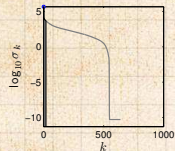
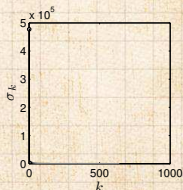
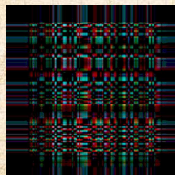
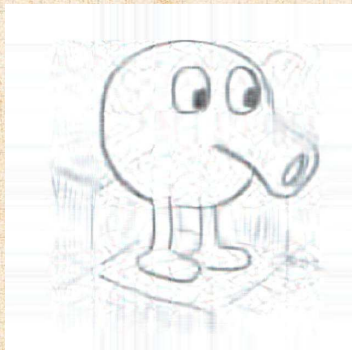
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

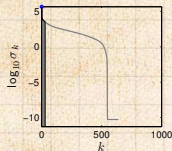
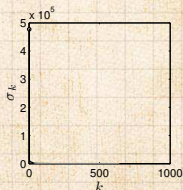
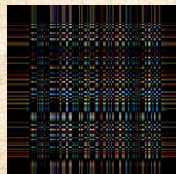
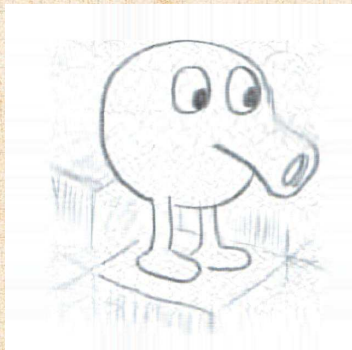
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

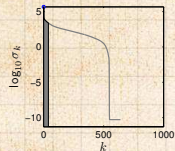
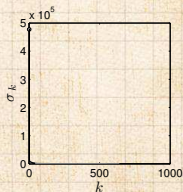
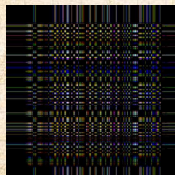
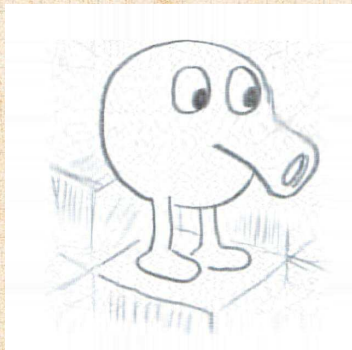
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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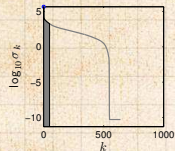
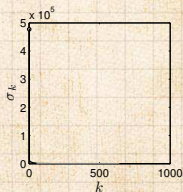
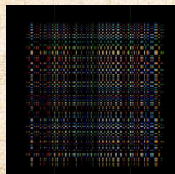
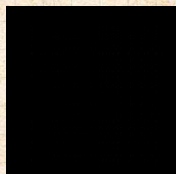
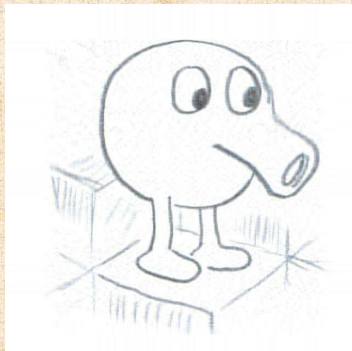
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (640 x 640)

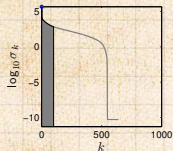
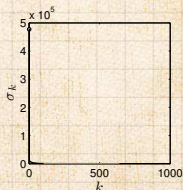
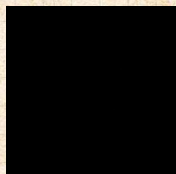
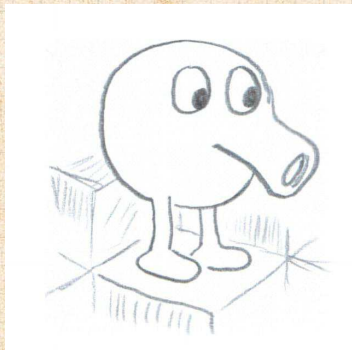
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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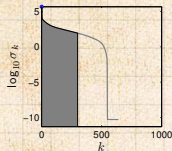
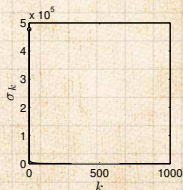
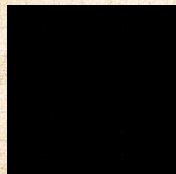
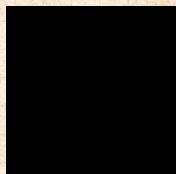
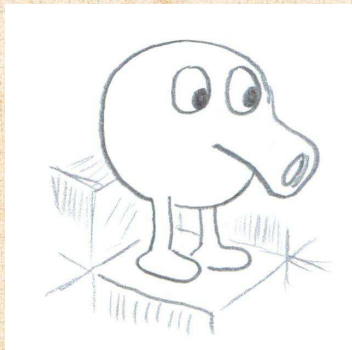
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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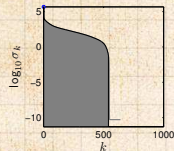
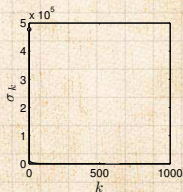
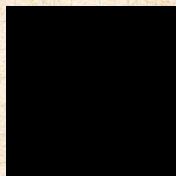
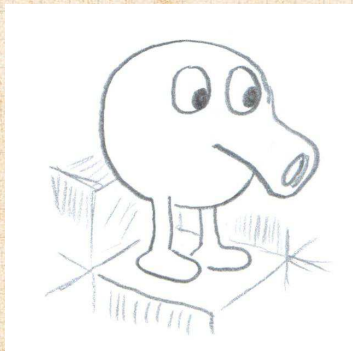
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{540} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

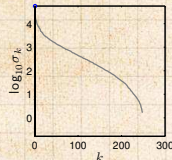
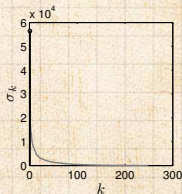
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

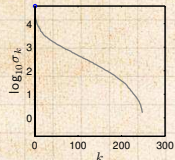
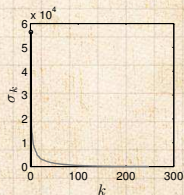
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

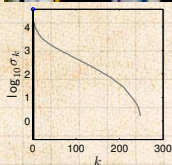
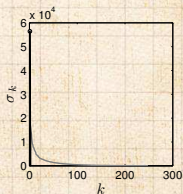
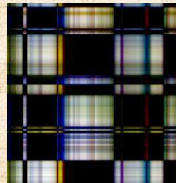
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

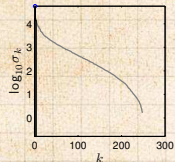
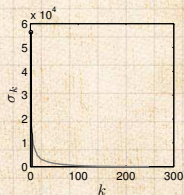
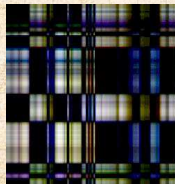
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

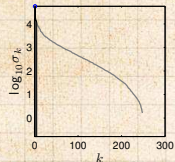
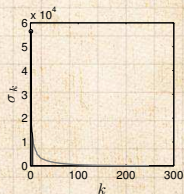
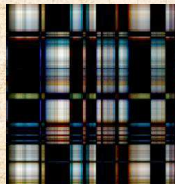
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

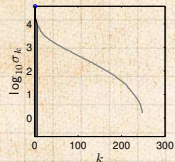
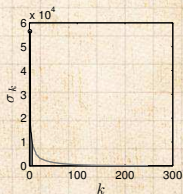
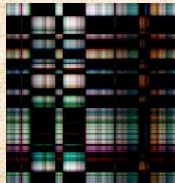
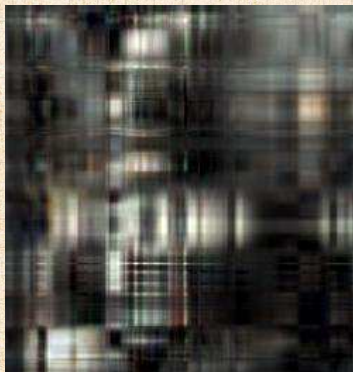
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

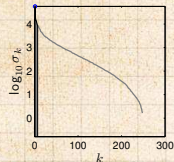
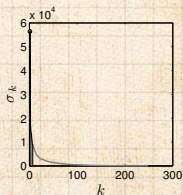
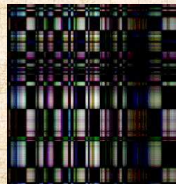
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

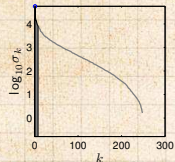
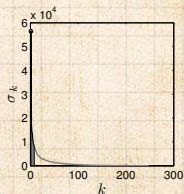
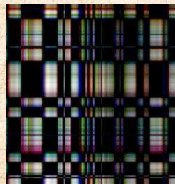
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

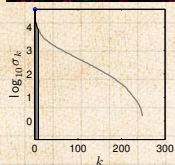
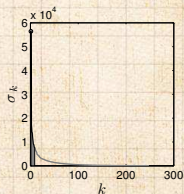
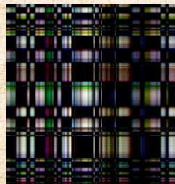
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

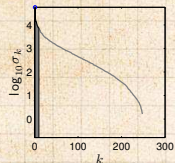
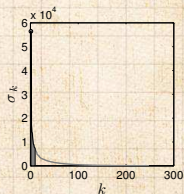
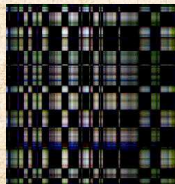
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

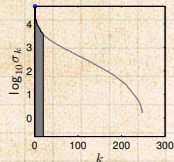
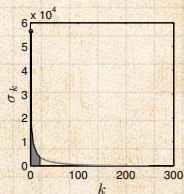
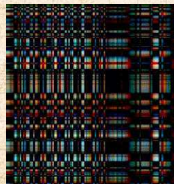
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

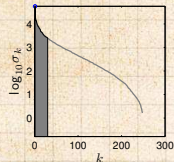
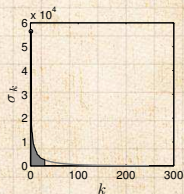
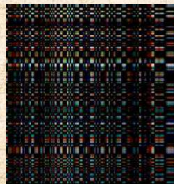
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

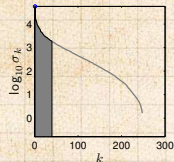
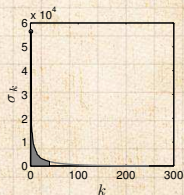
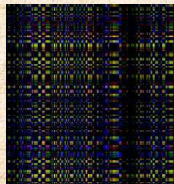
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

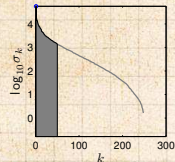
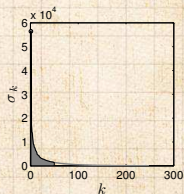
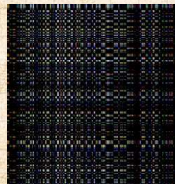
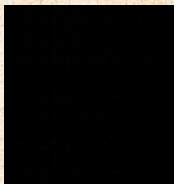
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

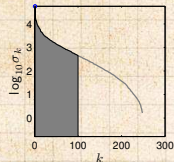
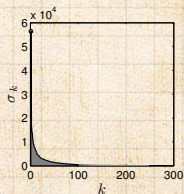
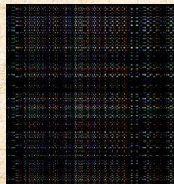
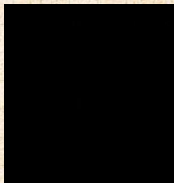
Tofspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

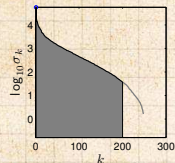
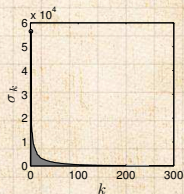
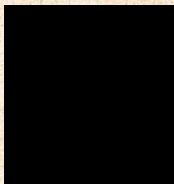
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (262 x 248)

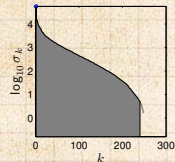
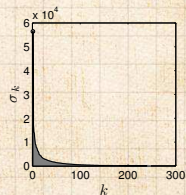
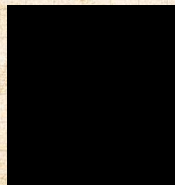
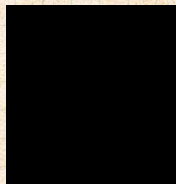
Tofspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{240} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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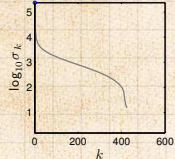
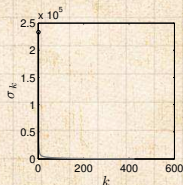
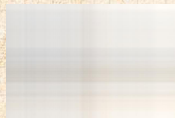
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{\mathbf{1}} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

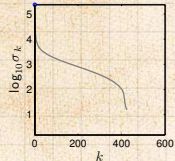
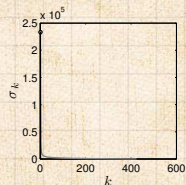
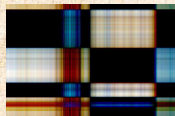
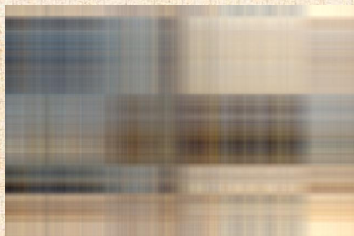
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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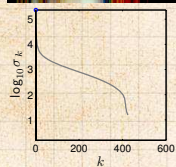
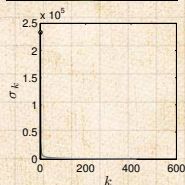
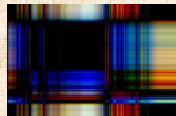
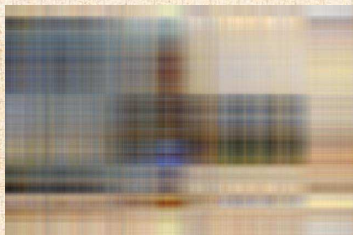
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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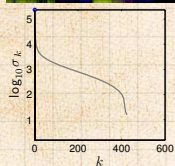
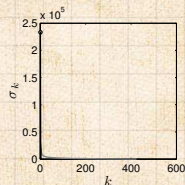
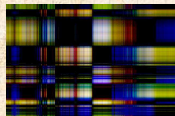
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

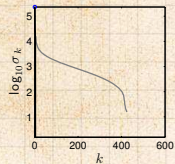
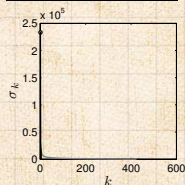
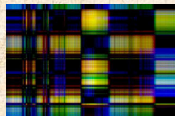
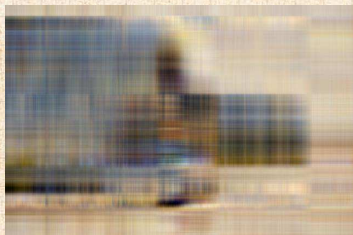
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

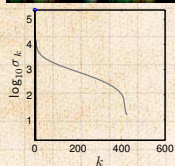
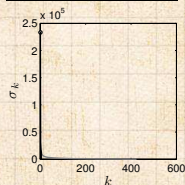
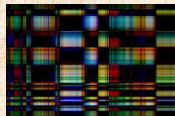
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

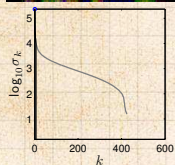
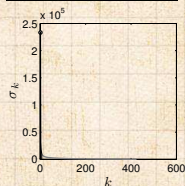
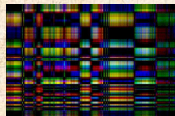
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

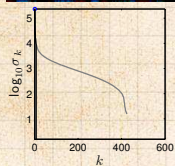
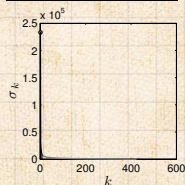
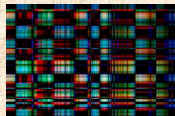
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

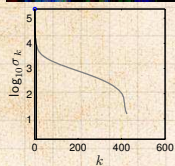
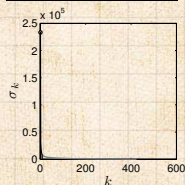
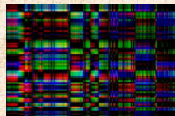
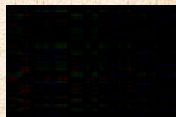
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

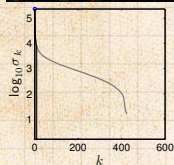
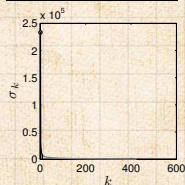
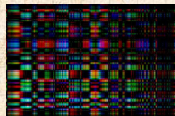
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

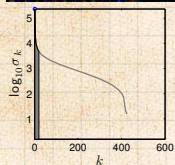
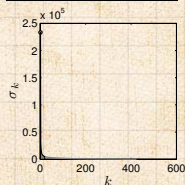
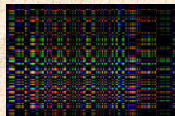
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

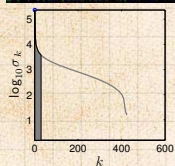
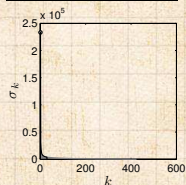
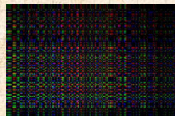
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

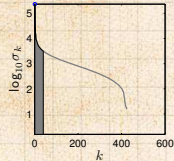
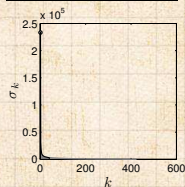
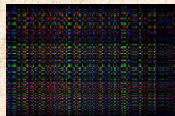
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

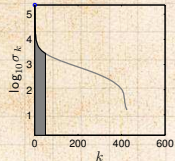
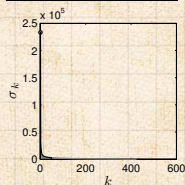
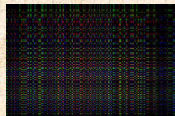
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

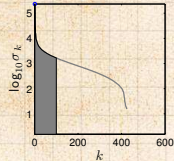
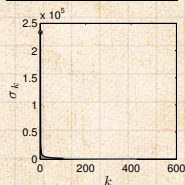
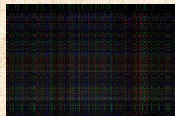
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

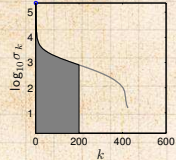
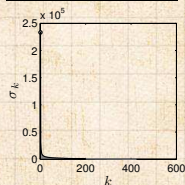
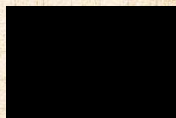
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

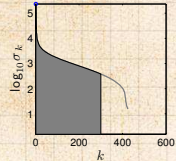
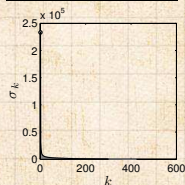
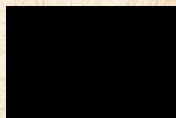
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

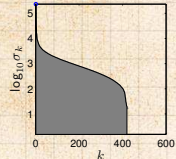
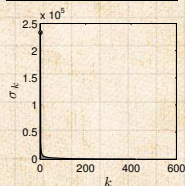
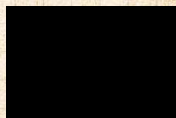
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

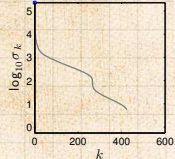
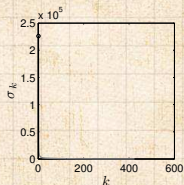
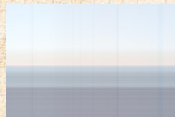
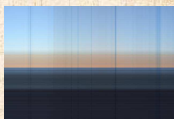
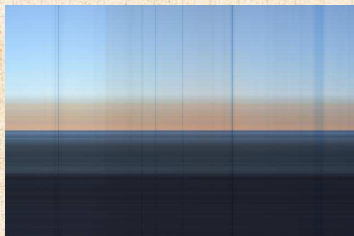
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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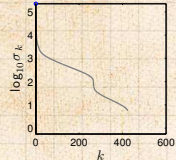
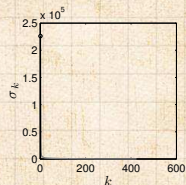
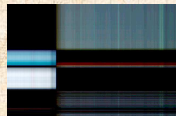
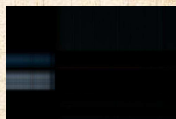
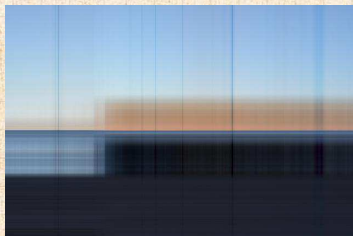
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

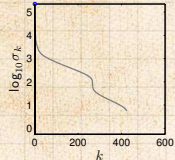
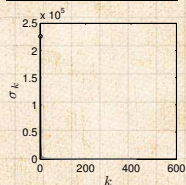
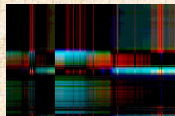
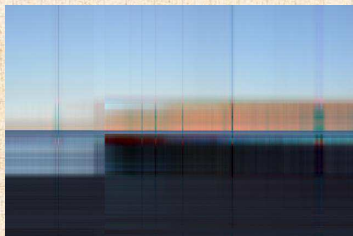
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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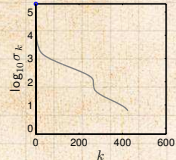
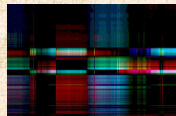
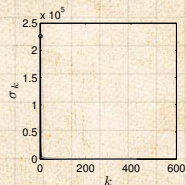
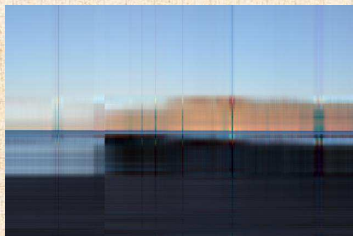
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

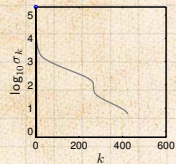
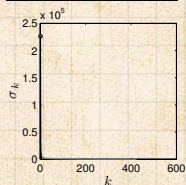
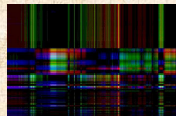
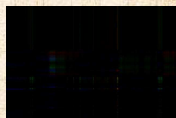
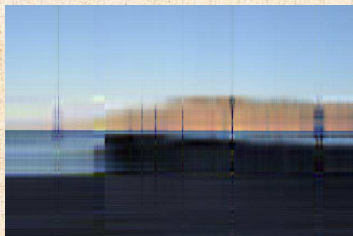
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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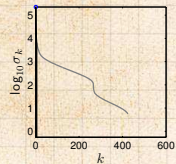
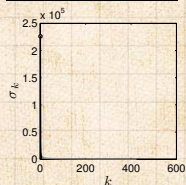
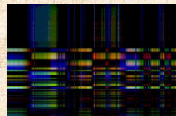
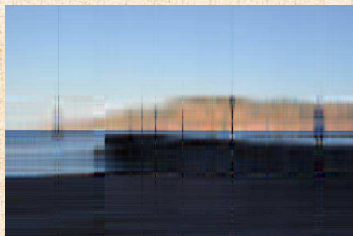
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

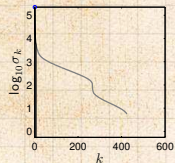
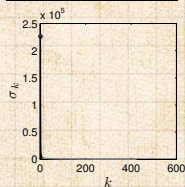
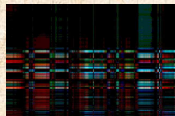
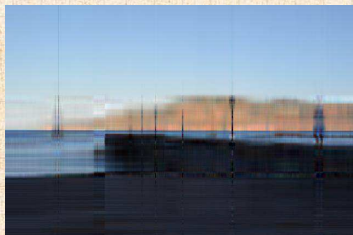
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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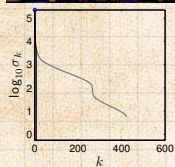
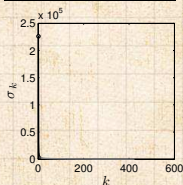
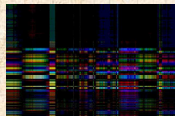
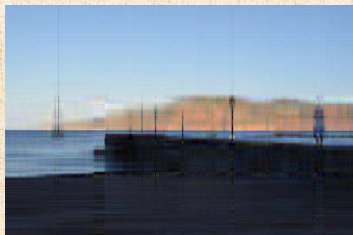
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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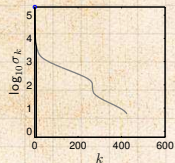
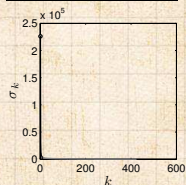
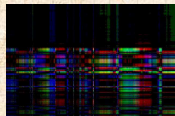
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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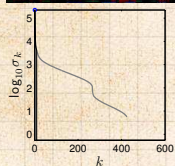
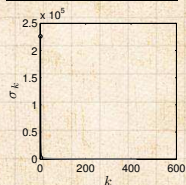
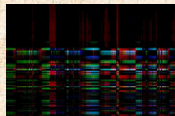
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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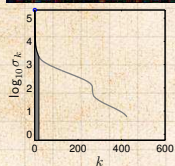
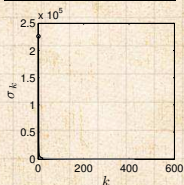
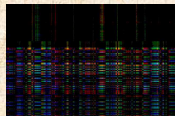
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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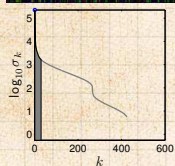
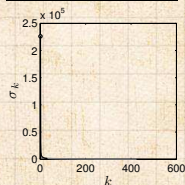
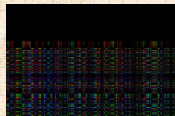
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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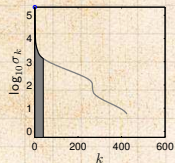
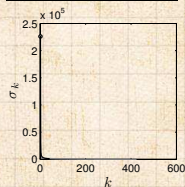
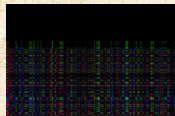
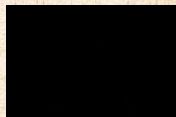
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

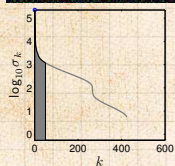
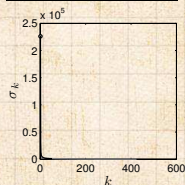
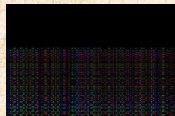
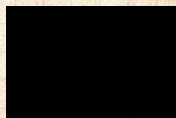
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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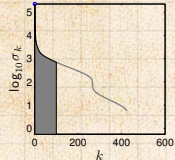
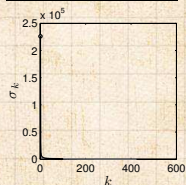
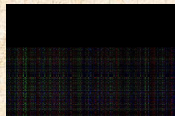
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

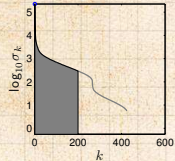
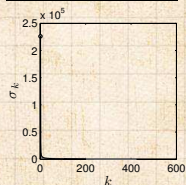
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

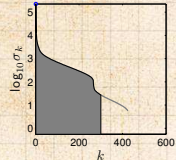
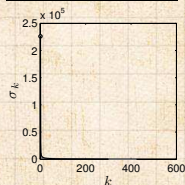
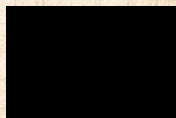
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

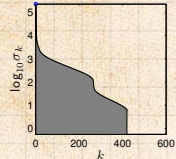
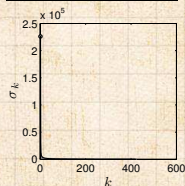
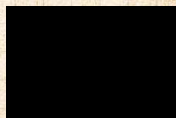
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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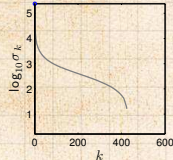
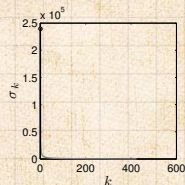
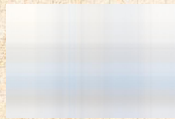
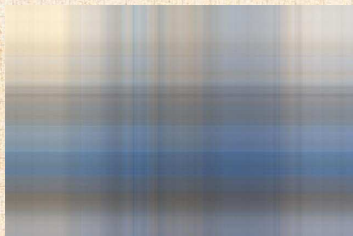
Tofospace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{\mathbf{1}} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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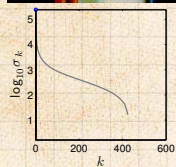
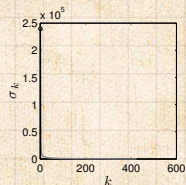
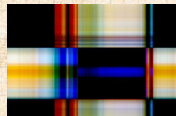
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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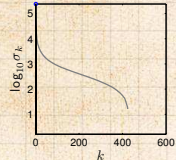
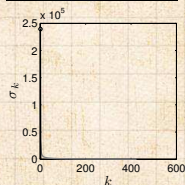
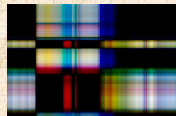
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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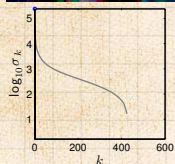
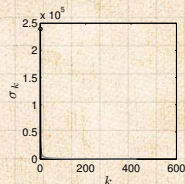
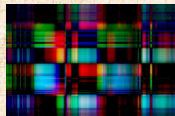
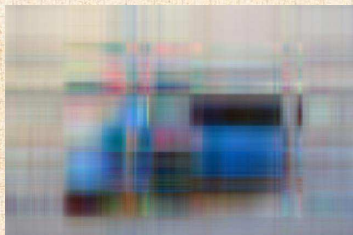
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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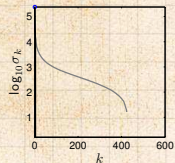
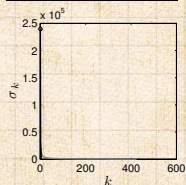
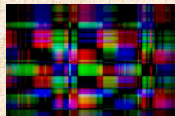
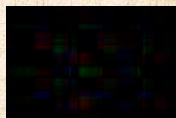
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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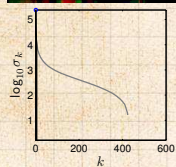
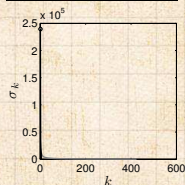
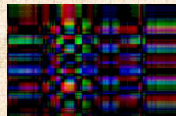
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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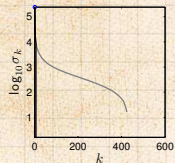
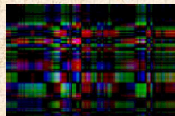
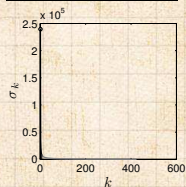
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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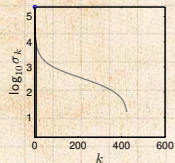
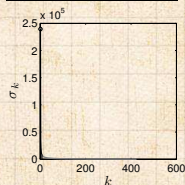
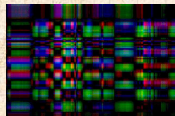
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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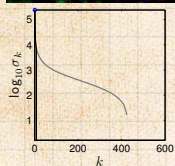
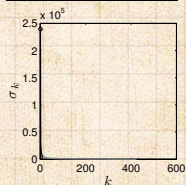
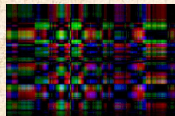
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

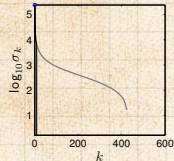
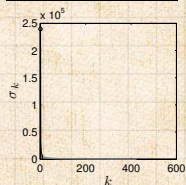
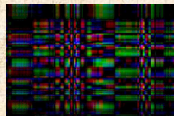
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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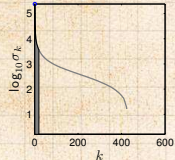
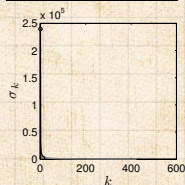
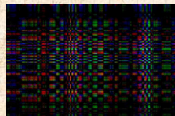
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

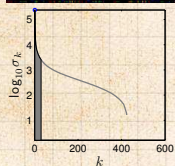
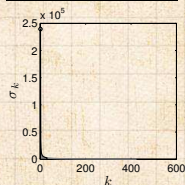
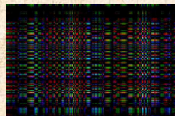
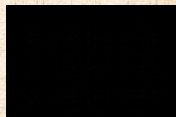
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

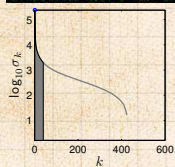
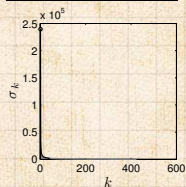
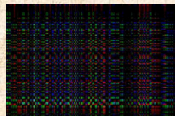
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

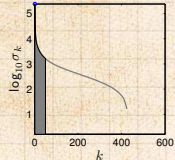
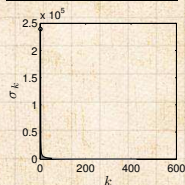
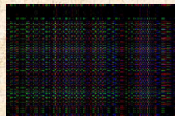
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

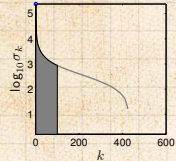
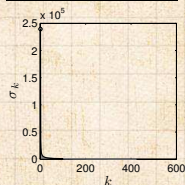
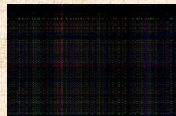
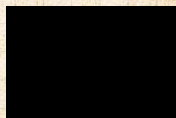
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

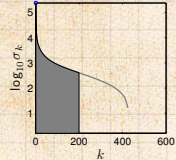
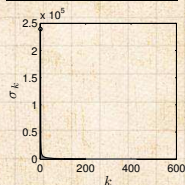
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

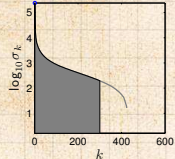
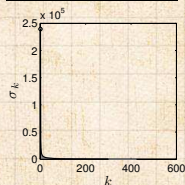
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

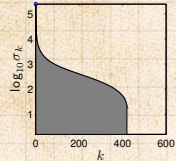
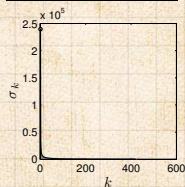
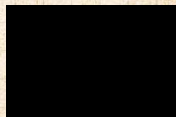
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

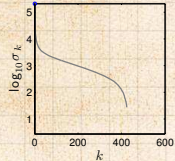
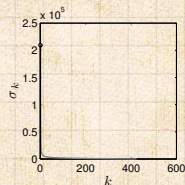
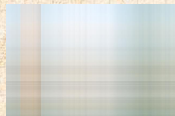
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

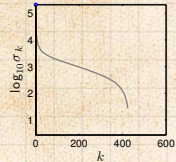
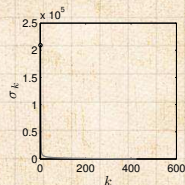
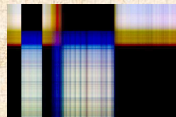
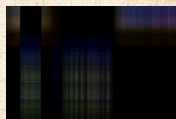
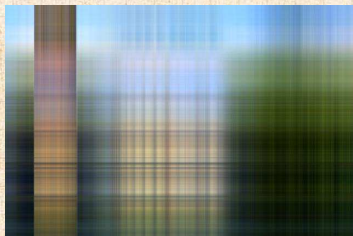
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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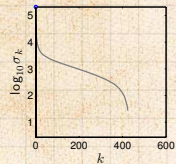
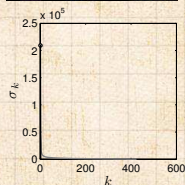
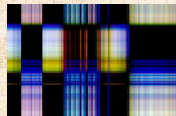
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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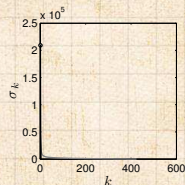
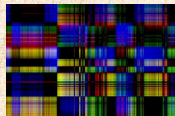
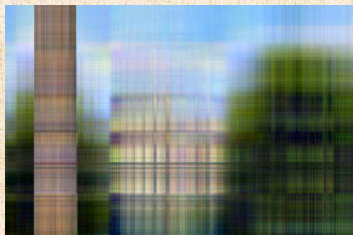
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

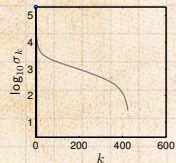
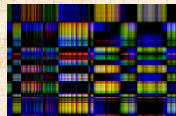
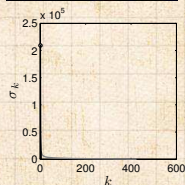
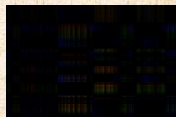
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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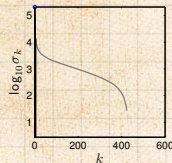
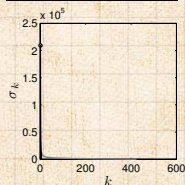
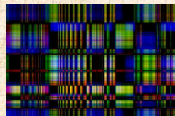
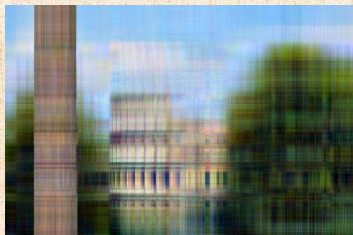
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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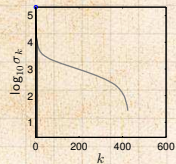
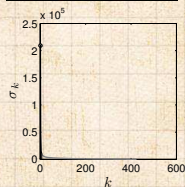
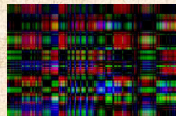
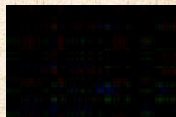
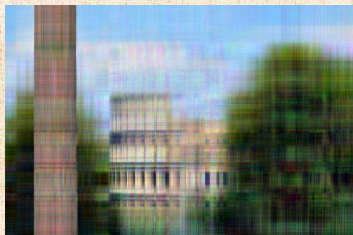
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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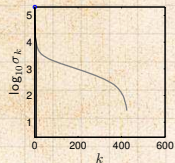
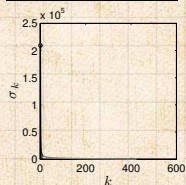
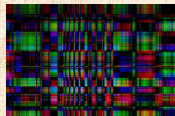
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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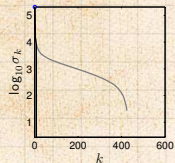
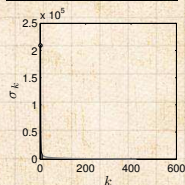
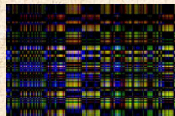
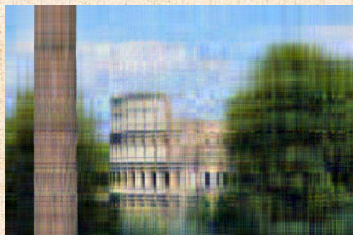
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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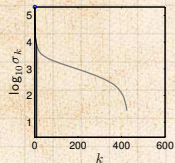
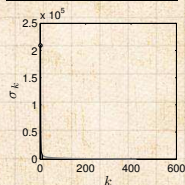
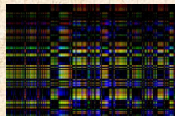
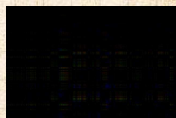
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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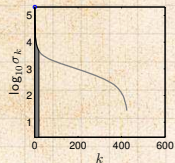
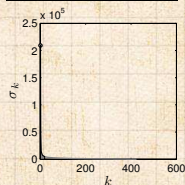
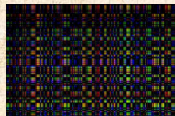
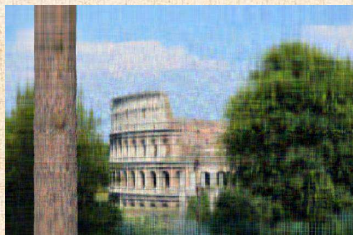
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

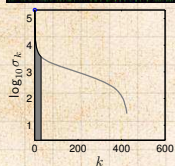
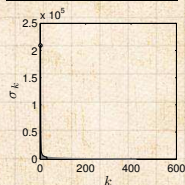
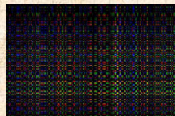
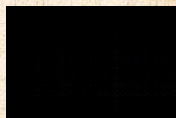
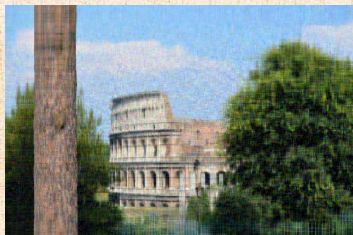
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

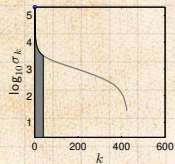
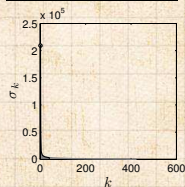
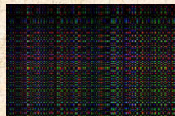
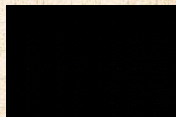
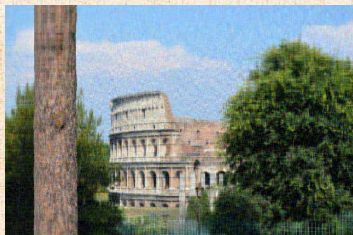
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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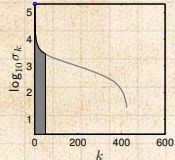
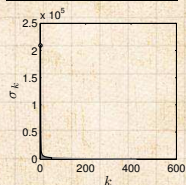
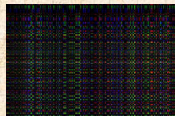
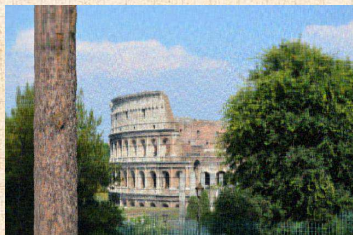
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

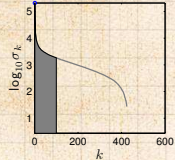
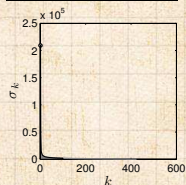
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

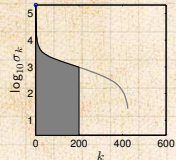
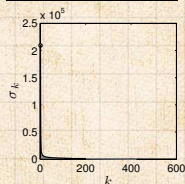
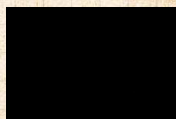
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$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

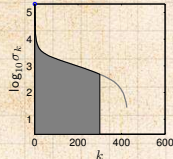
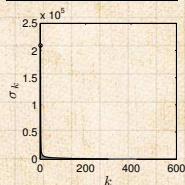
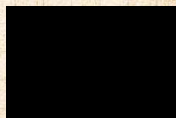
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

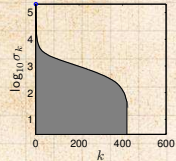
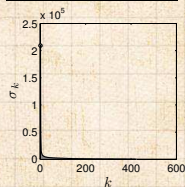
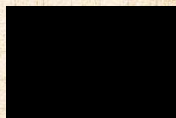
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$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

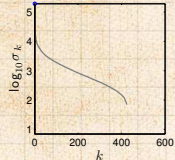
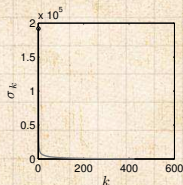
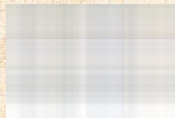
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

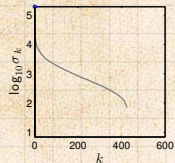
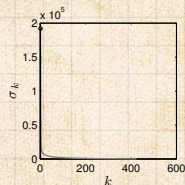
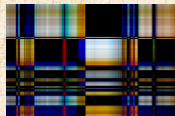
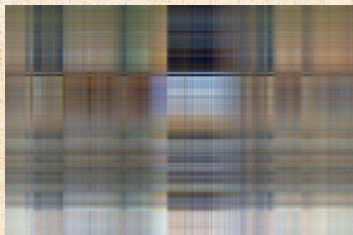
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

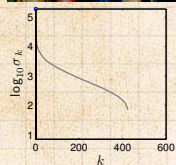
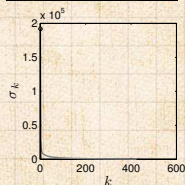
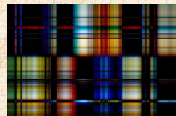
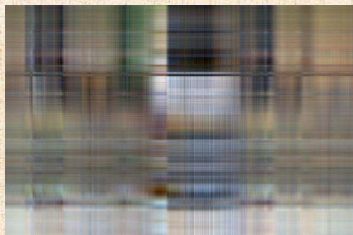
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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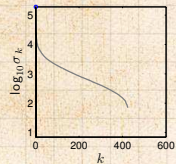
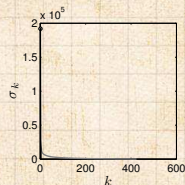
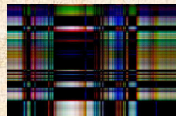
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

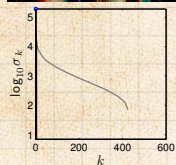
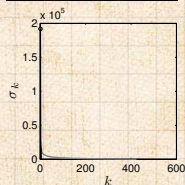
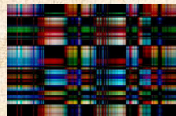
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

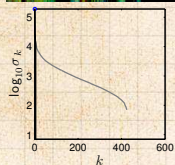
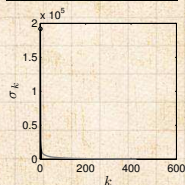
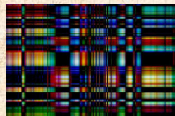
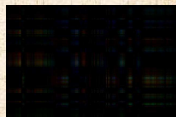
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

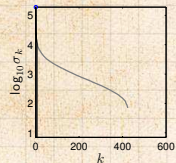
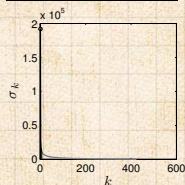
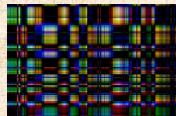
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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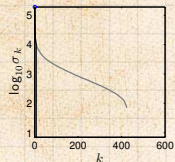
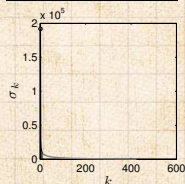
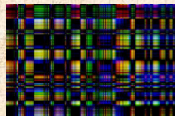
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

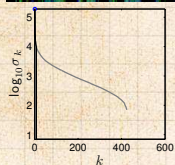
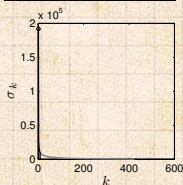
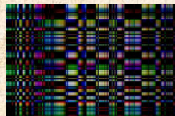
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

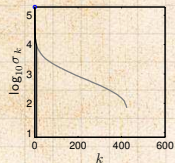
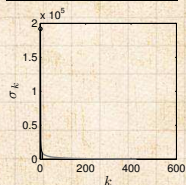
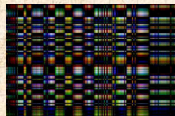
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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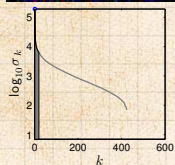
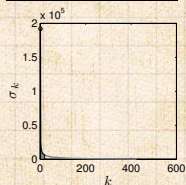
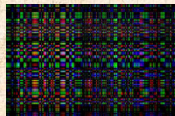
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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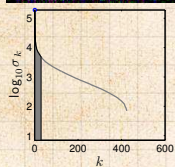
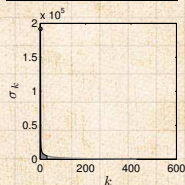
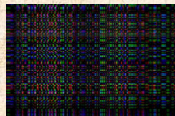
Tofspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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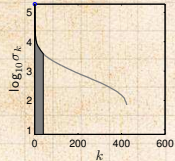
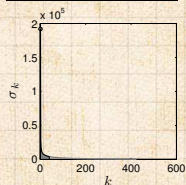
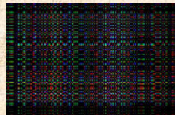
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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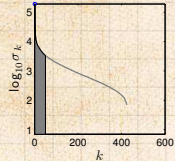
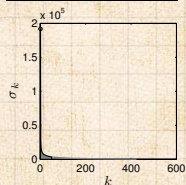
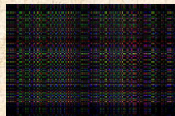
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

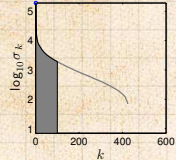
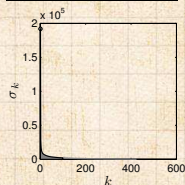
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

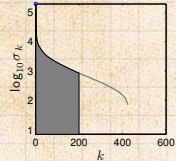
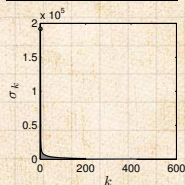
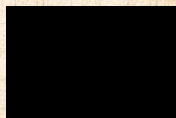
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

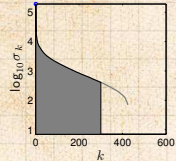
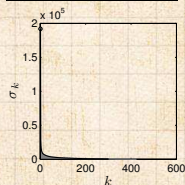
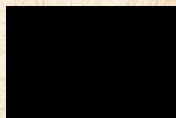
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

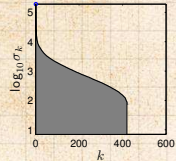
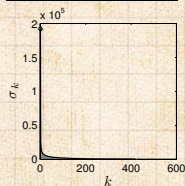
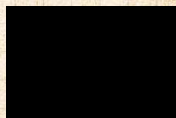
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

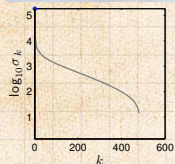
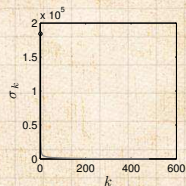
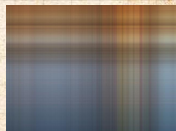
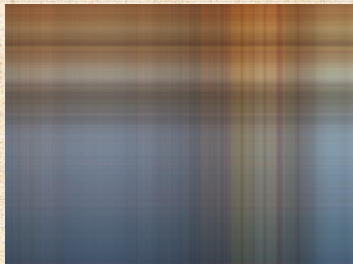
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

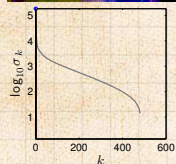
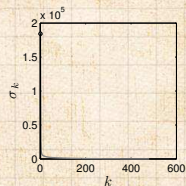
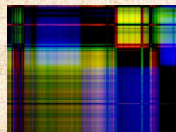
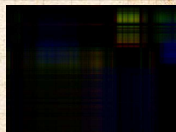
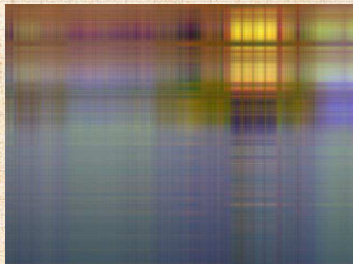
Tofuspace 25/25:
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Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

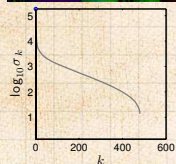
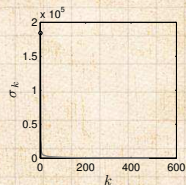
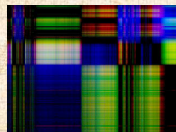
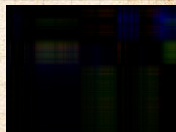
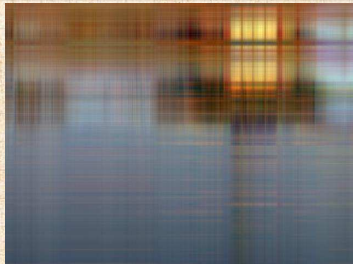
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

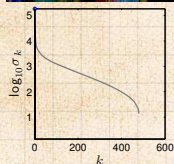
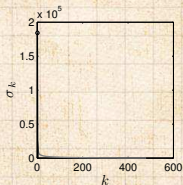
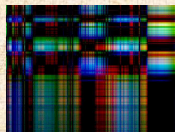
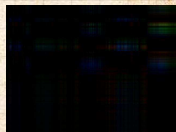
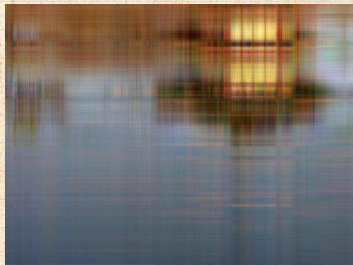
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

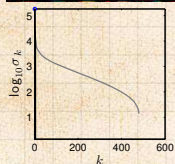
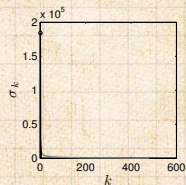
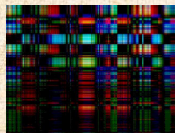
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

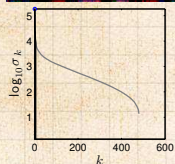
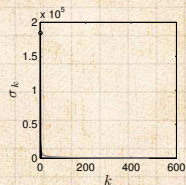
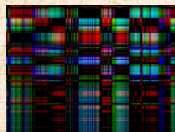
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

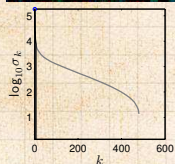
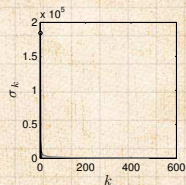
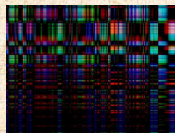
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

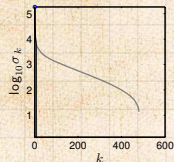
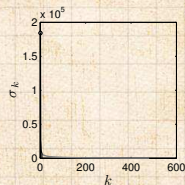
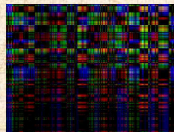
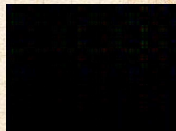
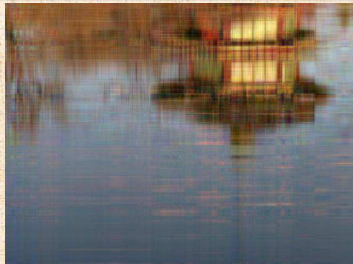
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

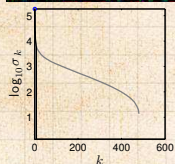
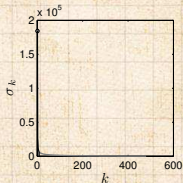
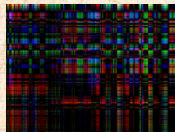
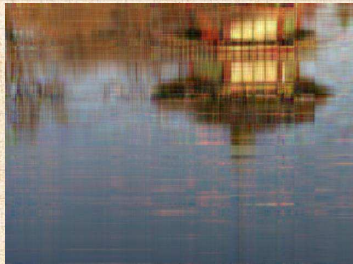
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

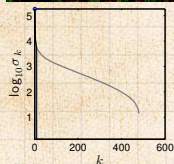
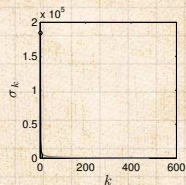
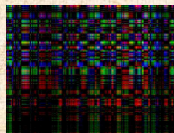
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

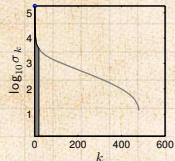
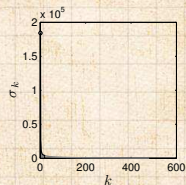
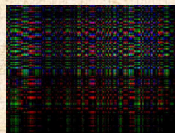
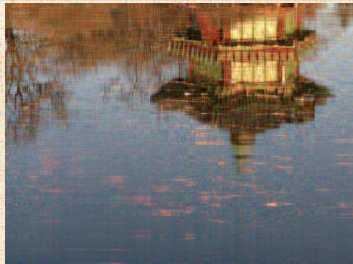
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

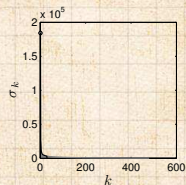
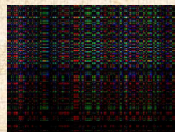
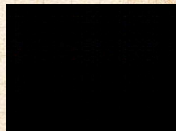
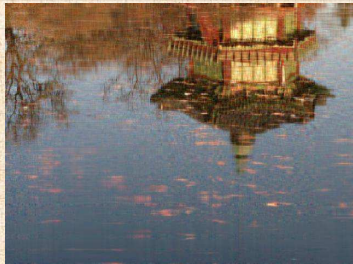
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

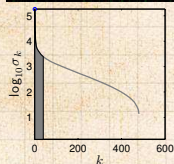
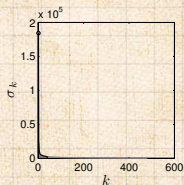
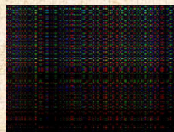
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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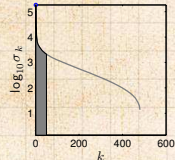
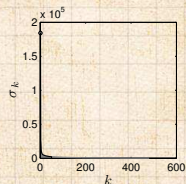
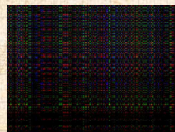
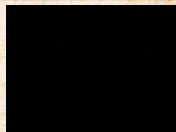
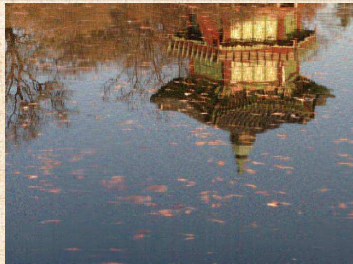
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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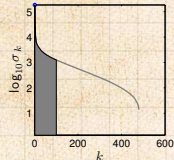
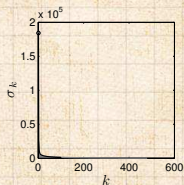
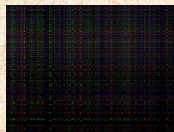
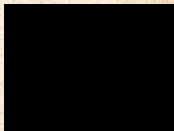
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

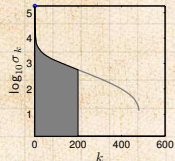
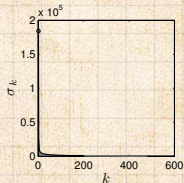
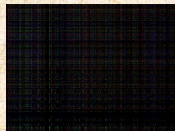
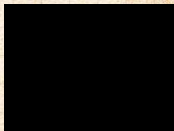
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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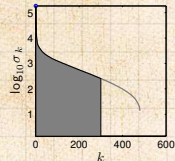
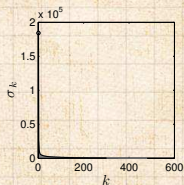
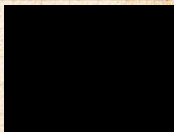
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{u}_i \hat{v}_i^T$$

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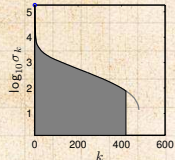
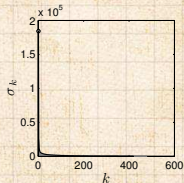
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

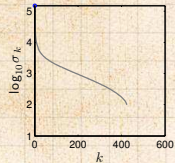
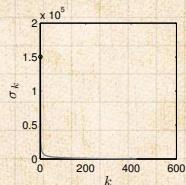
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (424 x 640)

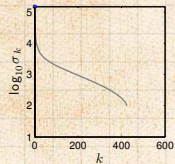
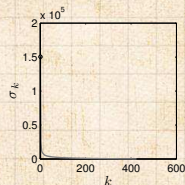
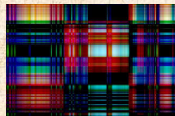
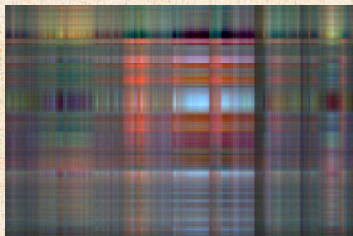
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

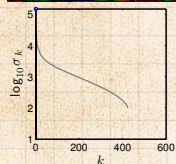
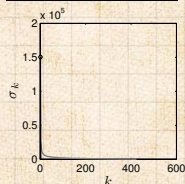
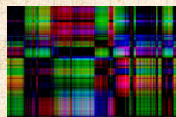
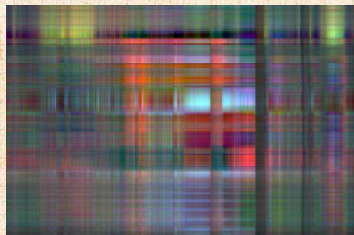
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

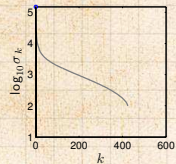
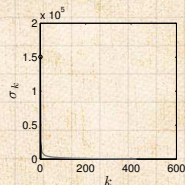
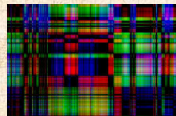
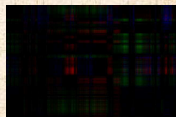
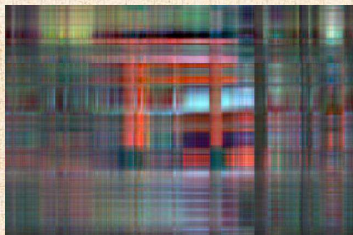
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

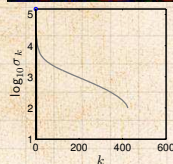
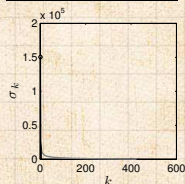
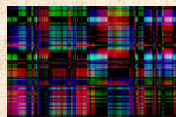
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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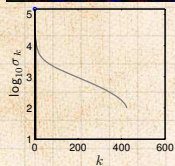
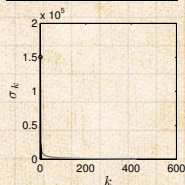
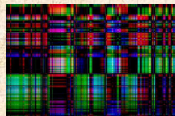
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

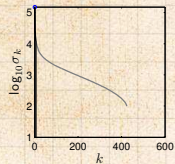
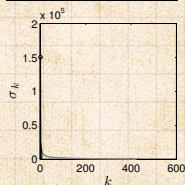
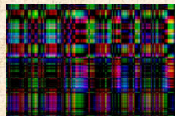
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

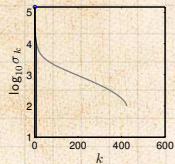
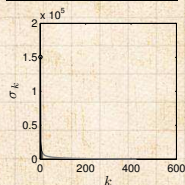
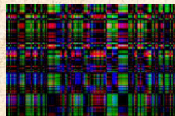
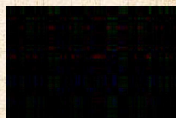
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

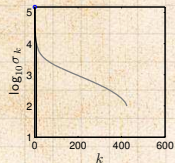
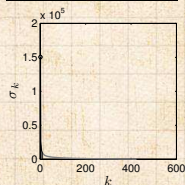
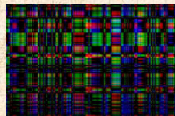
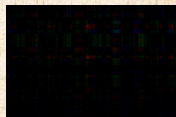
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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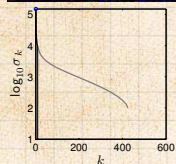
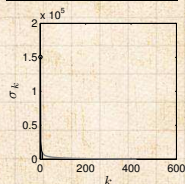
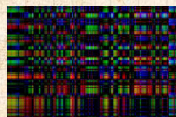
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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Image approximation (424 x 640)

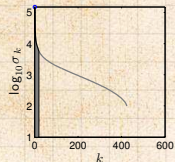
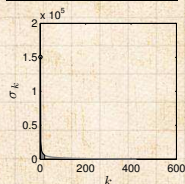
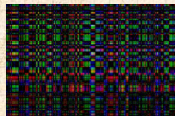
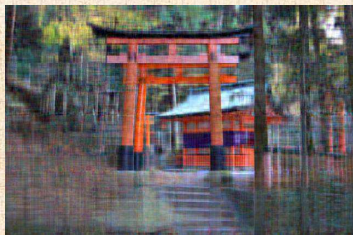
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

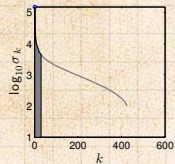
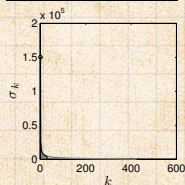
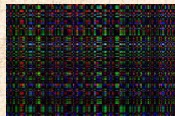
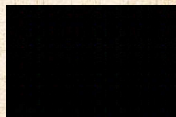
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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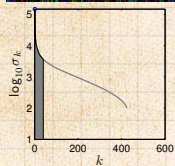
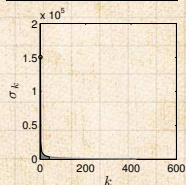
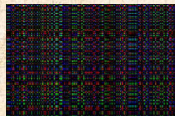
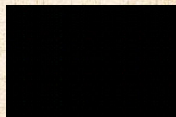
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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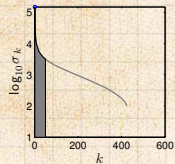
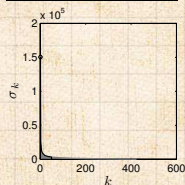
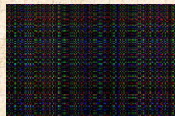
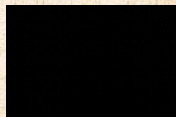
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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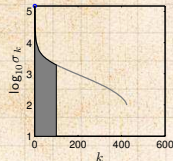
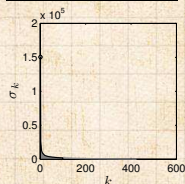
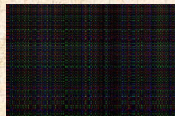
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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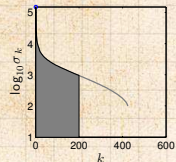
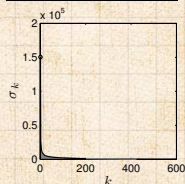
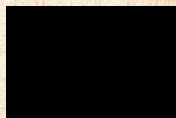
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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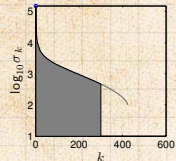
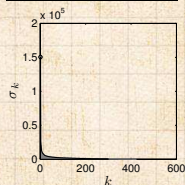
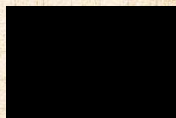
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (424 x 640)

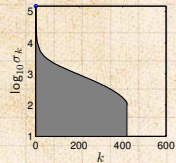
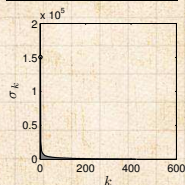
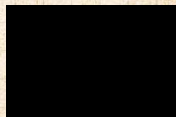
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{420} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

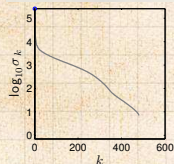
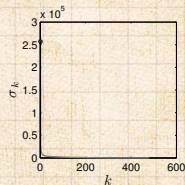
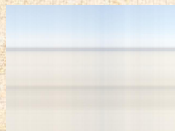
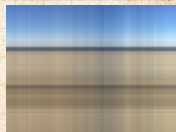
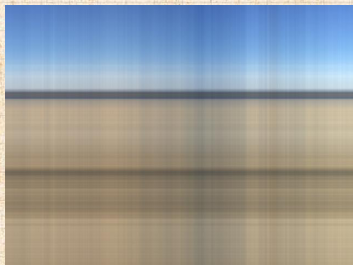
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (480 x 640)

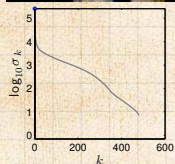
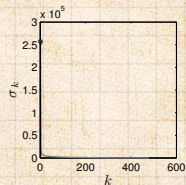
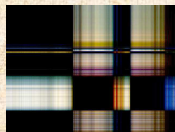
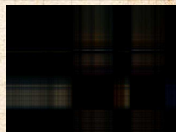
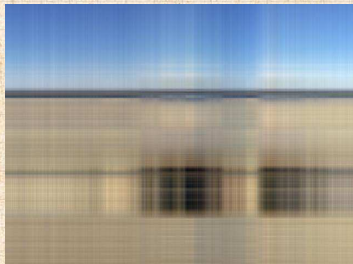
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

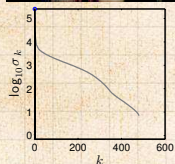
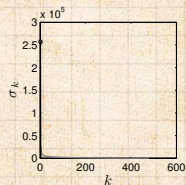
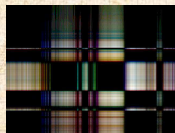
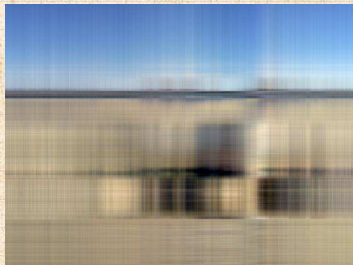
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

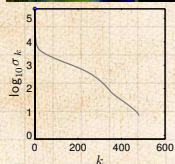
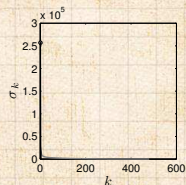
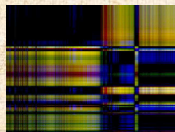
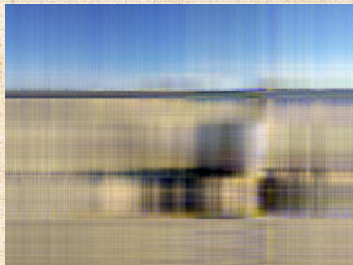
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

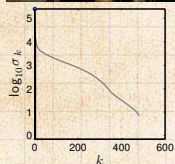
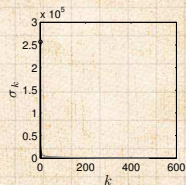
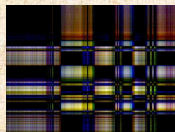
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

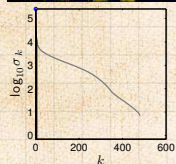
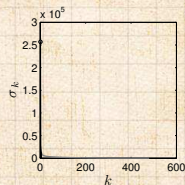
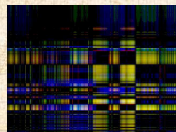
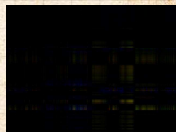
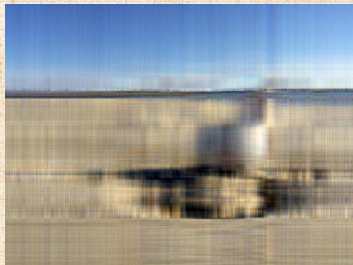
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

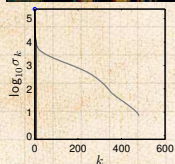
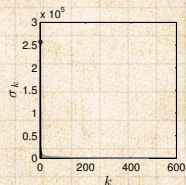
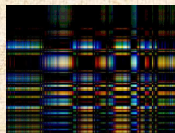
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

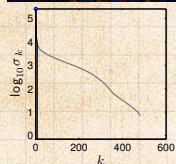
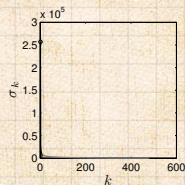
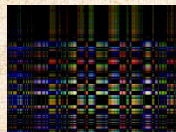
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

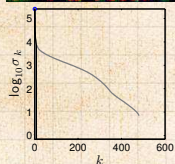
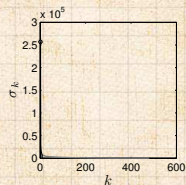
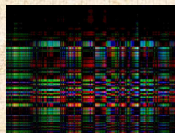
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

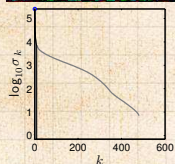
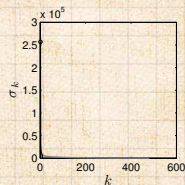
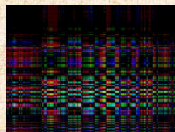
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

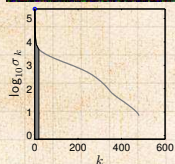
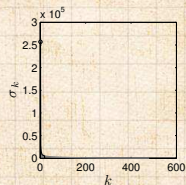
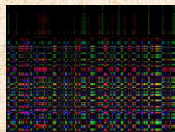
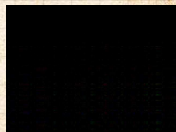
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

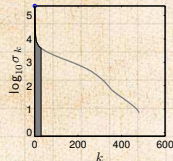
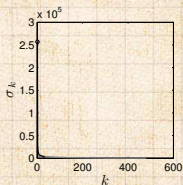
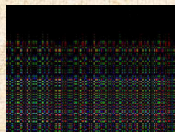
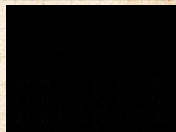
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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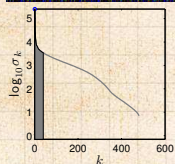
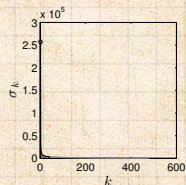
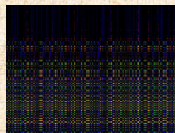
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

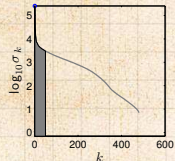
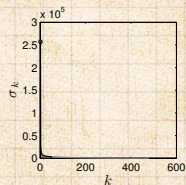
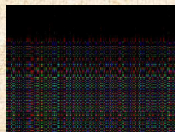
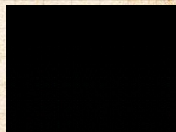
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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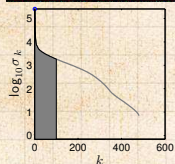
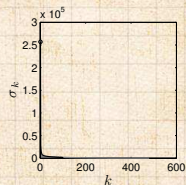
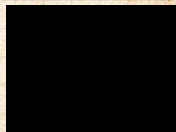
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (480 x 640)

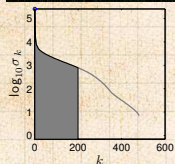
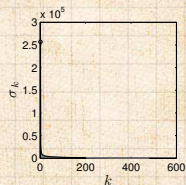
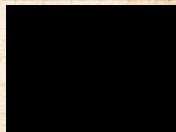
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (480 x 640)

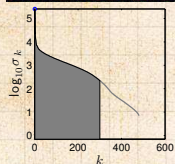
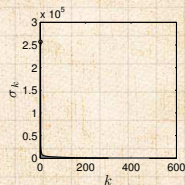
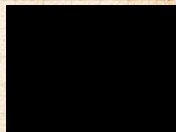
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{u}_i \hat{v}_i^T$$

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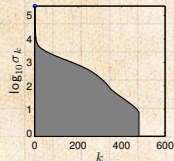
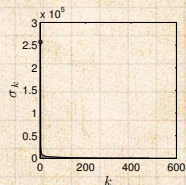
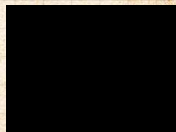
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{480} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (150 x 640)

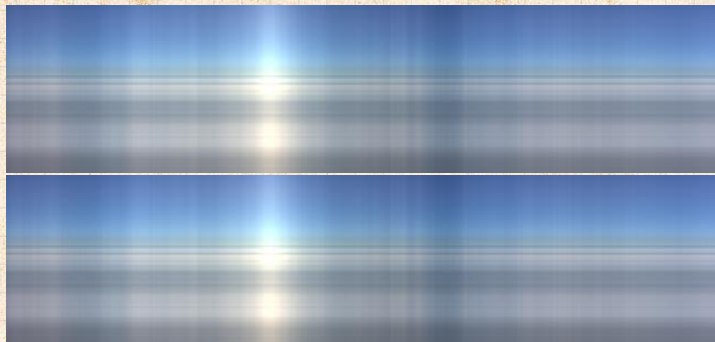
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (150 x 640)

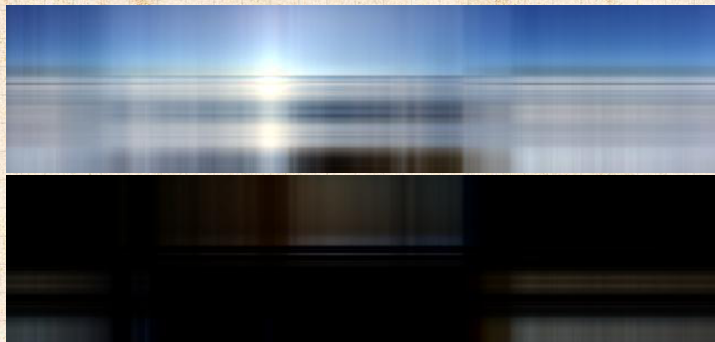
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (150 x 640)

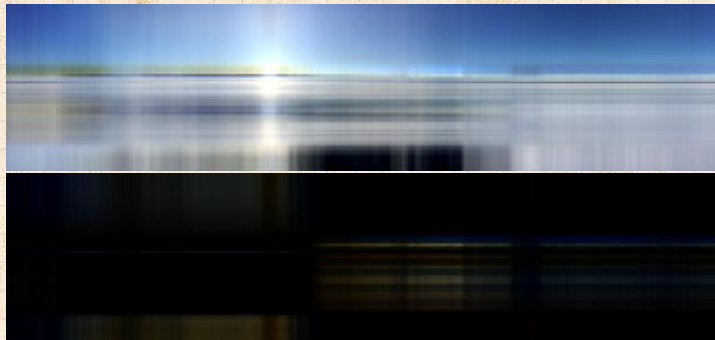
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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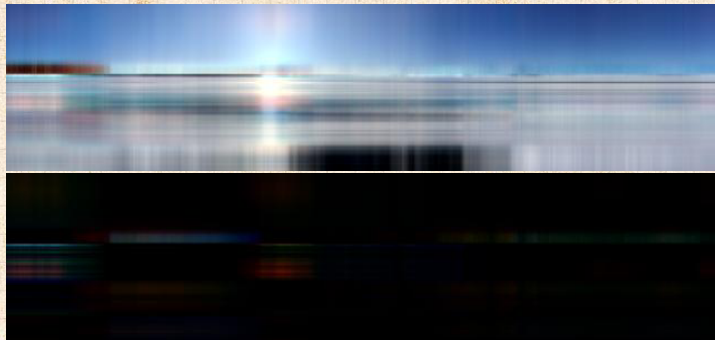
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{u}_i \hat{v}_i^T$$

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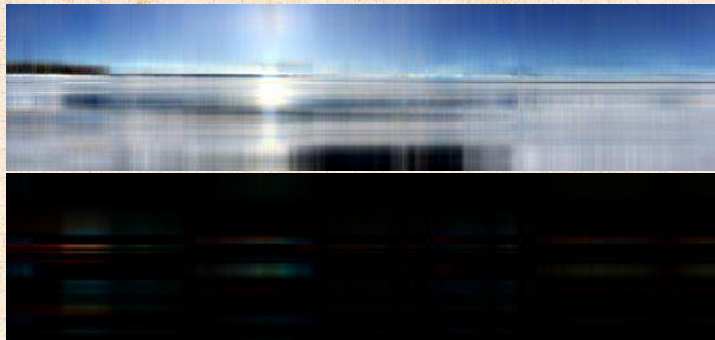
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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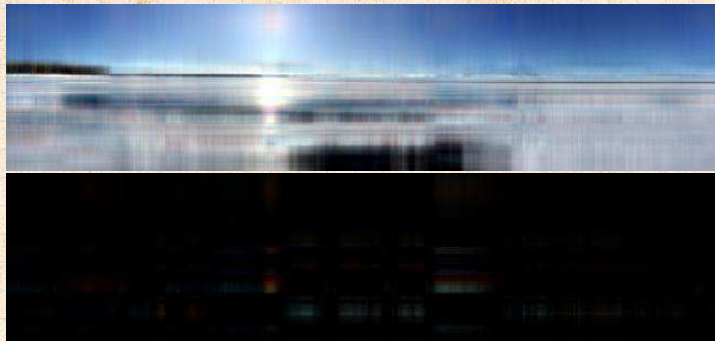
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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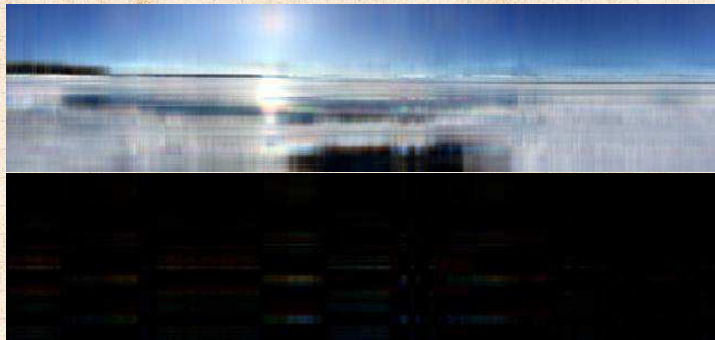
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{u}_i \hat{v}_i^T$$

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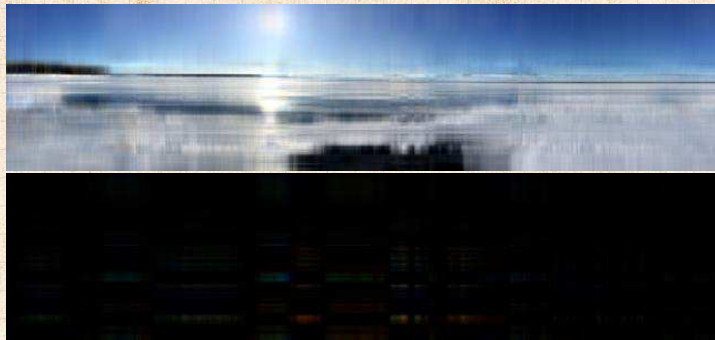
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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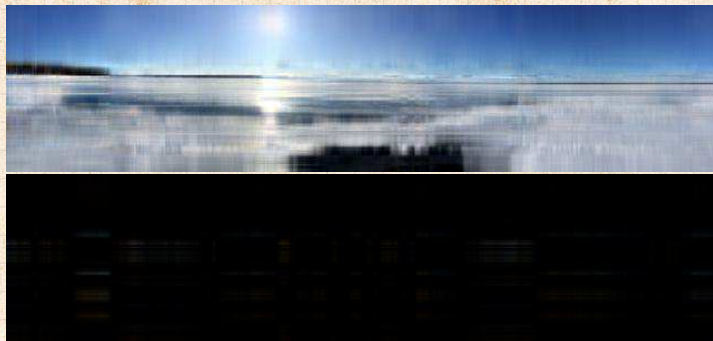


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Tofuspace 25/25:
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Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$



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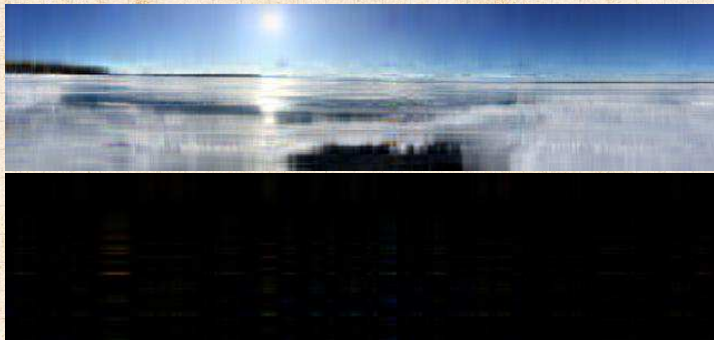
Tofuspace 25/25:
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Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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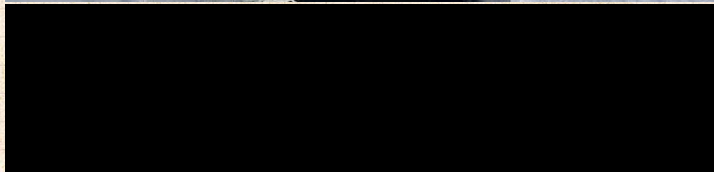
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$$\mathbf{A} = \sum_{i=1}^{150} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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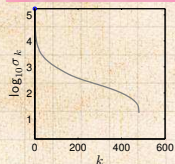
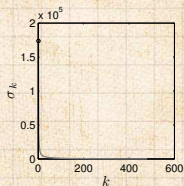
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$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{u}_i \hat{v}_i^T$$

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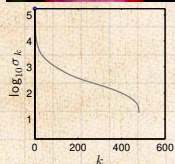
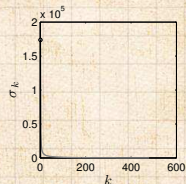
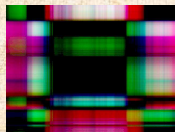
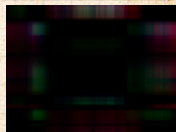
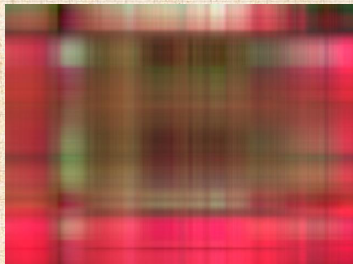
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$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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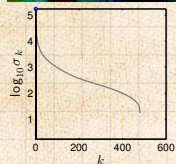
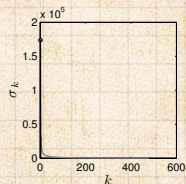
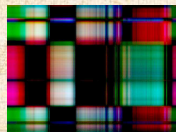
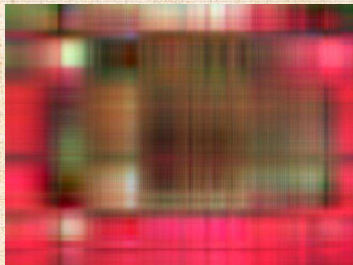
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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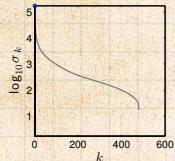
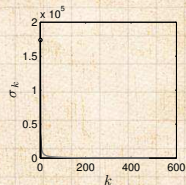
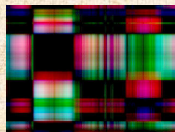
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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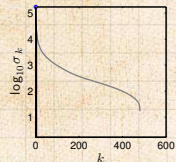
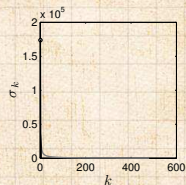
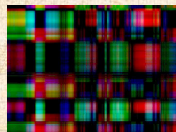
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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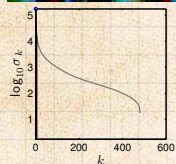
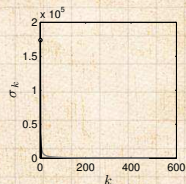
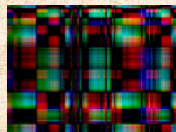
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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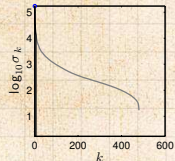
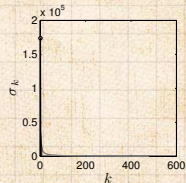
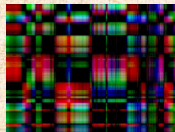
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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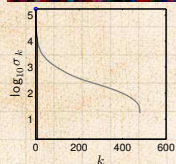
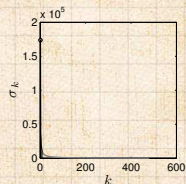
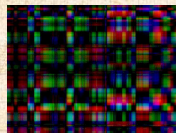
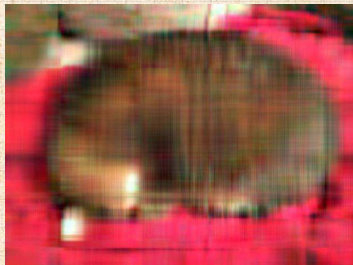
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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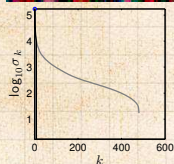
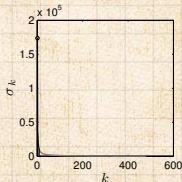
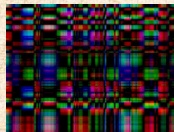
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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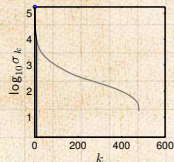
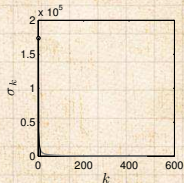
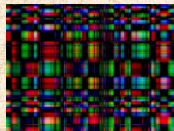
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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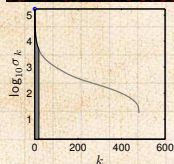
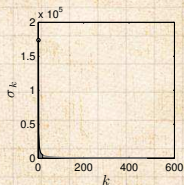
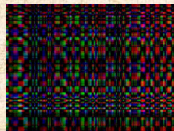
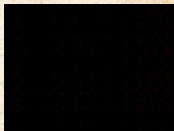
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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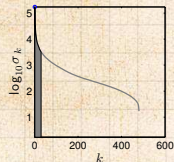
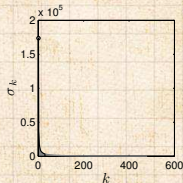
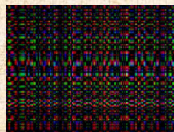
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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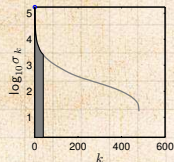
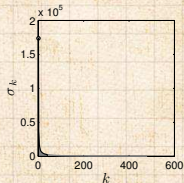
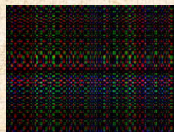
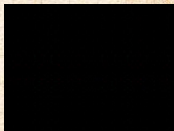
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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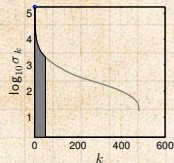
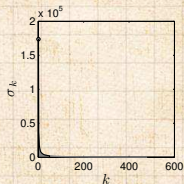
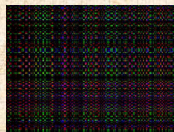
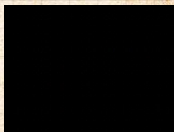
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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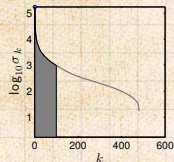
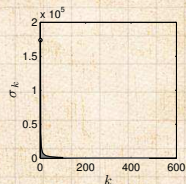
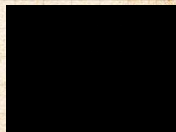
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{u}_i \hat{v}_i^T$$

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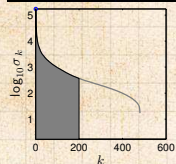
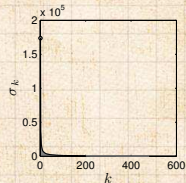
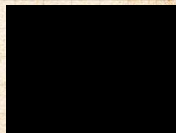
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{u}_i \hat{v}_i^T$$

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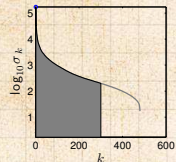
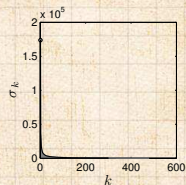
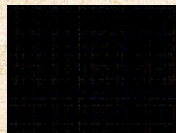
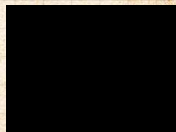
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{u}_i \hat{v}_i^T$$

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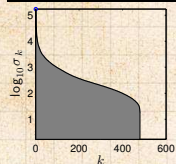
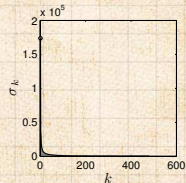
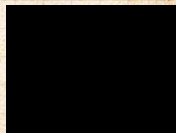
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{480} \sigma_i \hat{u}_i \hat{v}_i^T$$

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Image approximation (480 x 640)

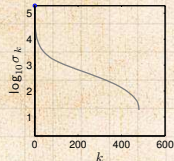
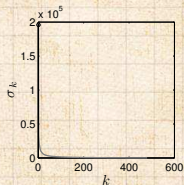
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^1 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

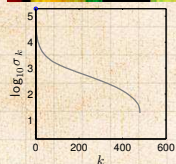
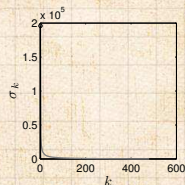
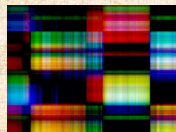
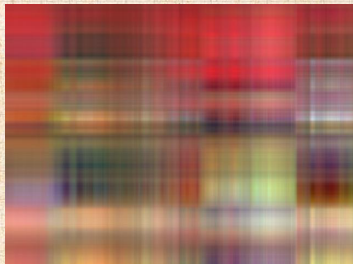
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^2 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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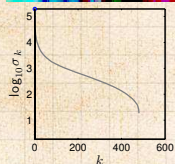
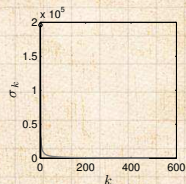
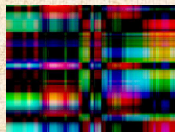
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^3 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

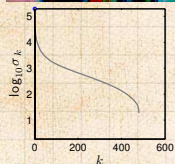
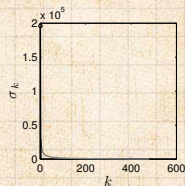
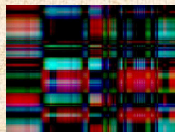
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^4 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

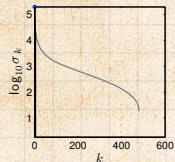
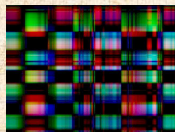
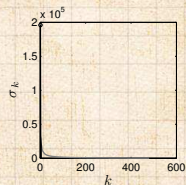
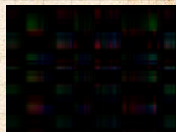
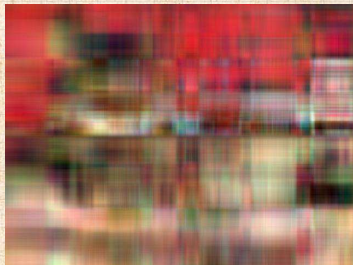
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^5 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

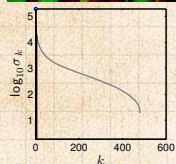
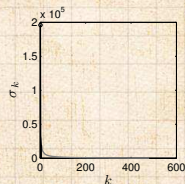
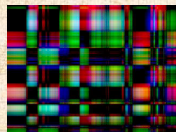
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^6 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

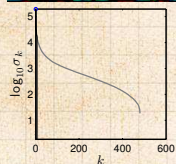
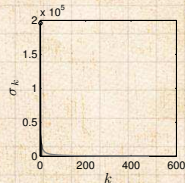
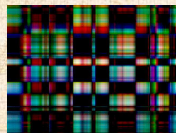
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^7 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

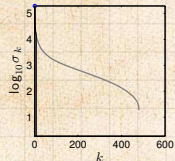
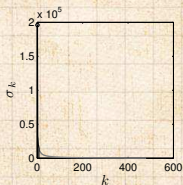
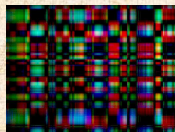
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^8 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

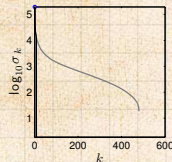
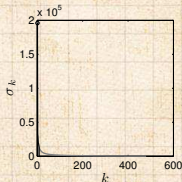
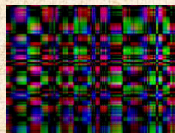
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^9 \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

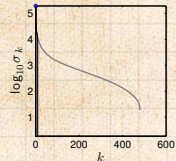
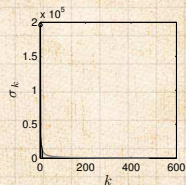
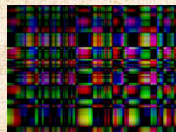
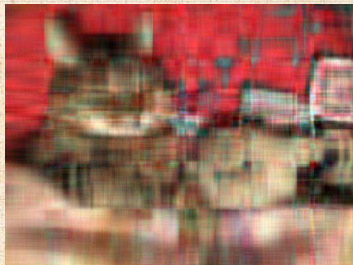
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{10} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

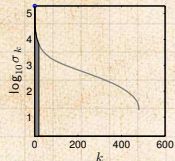
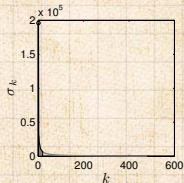
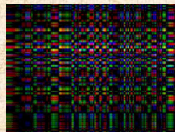
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{20} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

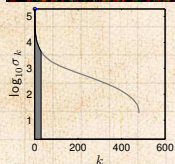
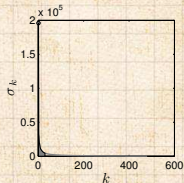
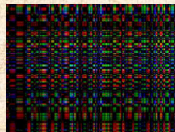
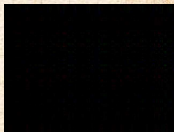
Tofuspace 25/25:
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$$\mathbf{A} = \sum_{i=1}^{30} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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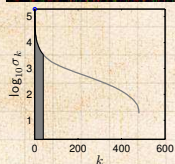
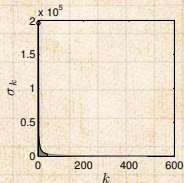
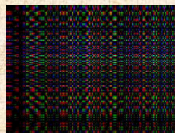
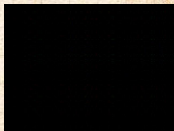
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{40} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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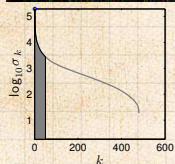
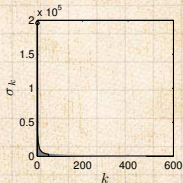
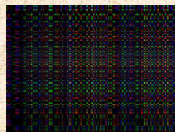
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{50} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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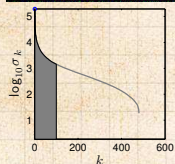
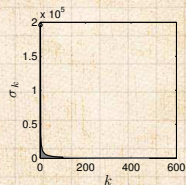
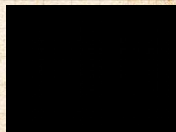
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{100} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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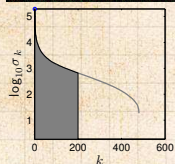
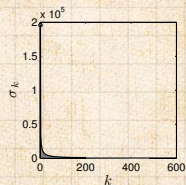
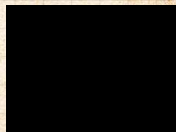
Tofuspace 25/25:
Singular Value
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$$\mathbf{A} = \sum_{i=1}^{200} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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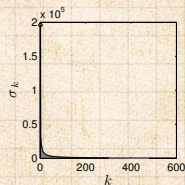
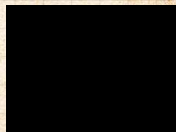
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{300} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

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Image approximation (480 x 640)

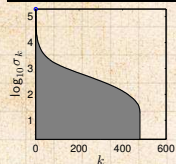
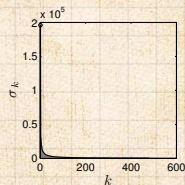
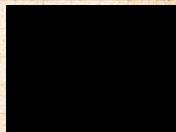
Tofuspace 25/25:
Singular Value
Decomposition

$$\mathbf{A} = \sum_{i=1}^{480} \sigma_i \hat{\mathbf{u}}_i \hat{\mathbf{v}}_i^T$$

The Fundamental
Theorem of
Linear Algebra

Hubs and
Authorities

Approximating
matrices with SVD



Show me
the SVD!!