Allotaxonometry

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Principles of Complex Systems, Vols. 1, 2, & 3D CSYS/MATH 6701, 6713, & a pretend number, 2023-2024 | @pocsvox

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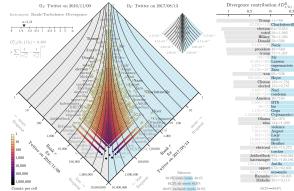
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Outline

- A plenitude of distances
- Rank-turbulence divergence
- Probability-turbulence divergence
- **Explorations**
- **Stories**
- Mechanics of Fame
- Superspreading
- Lexical Ultrafame
- Turbulent times
- References

Goal—Understand this:



Site (papers, examples, code):

http://compstorylab.org/allotaxonometry/

Foundational papers:



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"Allotaxonometry and rank-turbulence divergence: A universal instrument for comparing complex systems" Dodds et al., 2020. [9]



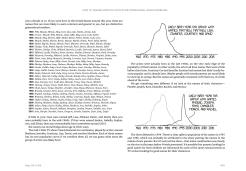
"Probability-turbulence divergence: A tunable allotaxonometric instrument for comparing heavy-tailed categorical distributions" Dodds et al., , 2020. [11]

The PoCSverse Basic science = Describe + Explain: Allotaxonometry 2 of 121

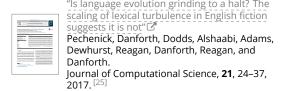
- Dashboards of single scale instruments helps us understand, monitor, and control systems.
- Archetype: Cockpit dashboard for flying a plane
- 🚳 Okay if comprehendible.
- Complex systems present two problems for dashboards:
 - 1. Scale with internal diversity of components: We need meters for every species, every company, every word.
 - 2. Tracking change: We need to re-arrange meters on the fly.
- 🚳 Goal—Create comprehendible, dynamically-adjusting, differential dashboards showing two pieces:1
 - 1. 'Big picture' map-like overview,
 - 2. A tunable ranking of components.

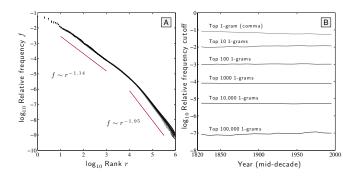
¹See the lexicocalorimeter 🗷

Baby names, much studied: [23]



How to build a dynamical dashboard that helps sort through a massive number of interconnected time series?





For language, Zipf's law has two scaling regimes: [34]

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$$f \sim \left\{ \begin{array}{l} r^{-\alpha} \text{ for } r \ll r_{\rm b}, \\ r^{-\alpha'} \text{ for } r \gg r_{\rm b}, \end{array} \right.$$

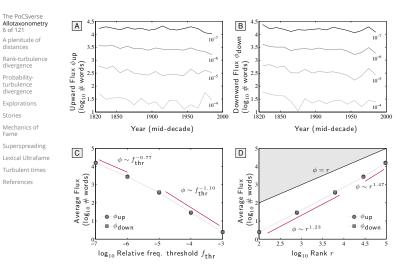
When comparing two texts, define Lexical turbulence as flux of words across a frequency threshold:

$$p \sim \left\{ \begin{array}{l} f_{\mathrm{thr}}^{-\mu} \mbox{ for } f_{\mathrm{thr}} \ll f_{\mathrm{b}}, \\ f_{\mathrm{thr}}^{-\mu'} \mbox{ for } f_{\mathrm{thr}} \gg f_{\mathrm{b}}, \end{array}
ight.$$

Estimates: $\mu \simeq 0.77$ and $\mu' \simeq 1.10$, and $f_{\rm b}$ is the scaling break point.

$$\phi \sim \begin{cases} r^{\nu} = r^{\alpha \mu'} \text{ for } r \ll r_{\rm b}, \\ r^{\nu'} = r^{\alpha' \mu} \text{ for } r \gg r_{\rm b}. \end{cases}$$

Estimates: Lower and upper exponents $\nu \simeq 1.23$ and $\nu' \simeq 1.47.$



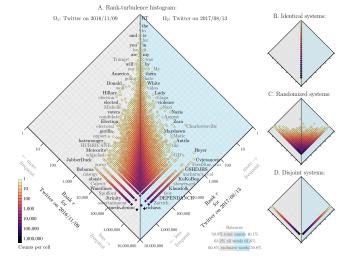
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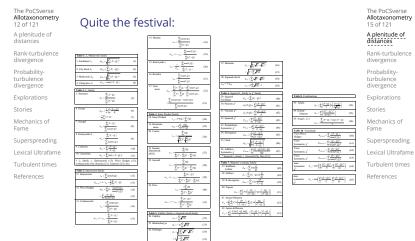


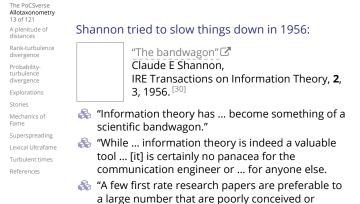


Exclusive types:

Probability-turbulence histogram:

- lacktrian were as the set of the 'exclusive types'.
- 🗞 When warranted, we will use expressions of the form $\Omega^{(1)}$ -exclusive and $\Omega^{(2)}$ -exclusive to indicate to which system an exclusive type belongs.





Rank-turbulenc divergence Probability divergence Exploration Stories Mechanics of Superspreading

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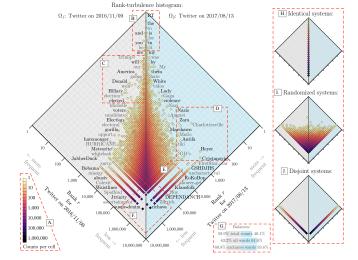
Allotaxonometry

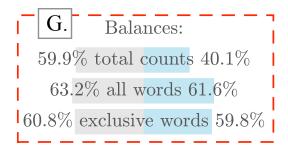
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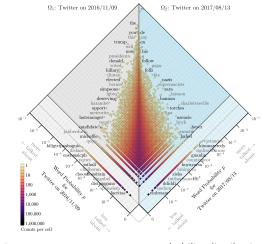
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So, so many ways to compare probability distributions:

- "Families of Alpha- Beta- and Gamma-Divergences: Flexible and Robust Measures of Similarities" Cichocki and Amari,
 - Entropy, **12**, 1532-1568, 2010.^[6] "Comprehensive survey on
 - distance/similarity measures between probability density functions"

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- Sung-Hyuk Cha, International Journal of Mathematical Models and Methods in Applied Sciences, **1**, 300–307, 2007.^[3]
- Comparisons are distances, divergences, similarities, inner products, fidelities ...
- 60ish kinds of comparisons grouped into 10 families
- A worry: Subsampled distributions with very heavy tails
- Table 1. L. Minkowski family The PoCSverse We want two main Allotaxonometry Euclidean L d : things: A plenitude of 1. A measure of 2. City block L₁ difference between Rank-turbulence . Minkowski L. systems 4. Chebyshev L_{sc} 2. A way of sorting which types/species/words divergence Table 2. L1 family contribute to that 5. Sørensen Explorations difference d.... : Mechanics of For sorting, many 8 6. Gower comparisons give the Superspreading same ordering. Lexical Ultrafame . Soergel Turbulent times 2 A few basic building d.,, blocks: . Kulczynski a $|P_i - Q_i|$ (dominant) \bowtie max (P_i, Q_i) $\widehat{\mathbf{v}}$ min (P_i, Q_i) 9. Canberra P_iQ_i 10. Lorentzian $|P_i^{1/2} - Q_i^{1/2}|$
 - (Hellinger)

half-finished."

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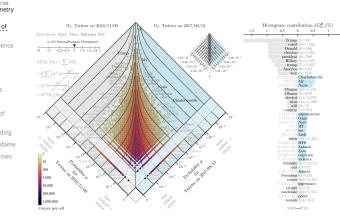
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The PoCSverse Allotaxonometry $\int_{-\infty}^{d} |P_i - Q_i|^2$ (1) 17 of 121 A plenitude of $d_{CB} = \sum_{i=1}^{d} |P_i - Q_i|$ (2) distances Rank-turbulenc $d_{Mk} = \sqrt[d]{\sum_{i=1}^{d} |P_i - Q_i|}$ (3) divergence $d_{Cheb} = \max_{i} |P_i - Q_i|$ (4) divergence $\sum_{i=1}^{n} |P_i - Q_i|$ Explorations (5) $\sum_{i=1}^{d} (P_i + Q_i)$ lechanics of $d_{gow} = \frac{1}{d} \sum_{i=1}^{d} \frac{|P_i - Q_i|}{R}$ (6) Superspreading $=\frac{1}{d}\sum_{i}^{d}|P_{i}-Q_{i}|$ (7) exical Ultrafam $\sum_{i=1}^{n} |P_i - Q_i|$ Furbulent time: (8) $\sum_{i=1}^{d} \max(P_i, Q_i)$ References $\sum_{i=1}^{d} |P_i - Q_i|$ (9) $\int_{-\infty}^{d} \min(P_i, Q_i)$ $d_{Con} = \sum_{i=1}^{d} \frac{|P_i - Q_i|}{P_i + Q_i}$ (10) $d_{Lor} = \sum_{i=1}^{d} \ln(1 + |P_i - Q_i|)$ (11) L_1 family \supset {Intersectoin (13), Wave Hedges (15), Czekanowski (16), Ruzicka (21), Tanimoto (23), et

	Table 1. Lp Minkow	vski family		The PoCSvers
	1. Euclidean L ₂	$d_{Eac} = \sqrt{\sum_{i=1}^{d} P_i - Q_i ^2}$	(1)	Allotaxonome 18 of 121
	2. City block L ₁	$d_{CB} = \sum_{i=1}^{d} P_i - Q_i $	(2)	A plenitude o distances
	3. Minkowski $L_{\rm p}$	$d_{Mk} = \sqrt[p]{\sum_{i=1}^{d} P_i - Q_i ^p}$	(3)	Rank-turbuler divergence
	4. Chebyshev L_{∞}	$d_{Cheb} = \max_{i} P_i - Q_i $	(4)	Probability-
	Table 2. L ₁ family			turbulence divergence
	5. Sørensen	$\sum_{i=1}^{d} P_i - Q_i $		Explorations
🚳 Information theoretic		$d_{sor} = \frac{\sum_{i=1}^{n} P_i - Q_i }{\sum_{i=1}^{d} (P_i + Q_i)}$	(5)	Stories
sortings are more				Mechanics of
0	6. Gower	$d_{gaw} = \frac{1}{d} \sum_{i=1}^{d} \frac{ P_i - Q_i }{R_i}$	(6)	Fame
opaque		$= \frac{1}{d} \sum_{i=1}^{d} P_i - Q_i $	(7)	Superspreadi
🗞 No tunability	7. Soergel	$d_{sg} = \frac{\sum_{i=1}^{d} P_i - Q_i }{\sum_{i=1}^{d} \max(P_i, Q_i)}$	(8)	Lexical Ultraf Turbulent tim References
	8. Kulczynski d	$d_{kal} = \frac{\int_{i=1}^{d} P_i - Q_i }{\sum_{i=1}^{d} \min(P_i, Q_i)}$	(9)	hereferees
	9. Canberra	$d_{Com} = \sum_{i=1}^{d} \frac{ P_i - Q_i }{P_i + Q_i}$	(10)	
	10. Lorentzian	$d_{Lor} = \sum_{i=1}^{d} \ln(1 + P_i - Q_i)$	(11)	
	* L ₁ family ⊃ {I Czekanowski (16), I			



The PoCSverse 🗞 Shannon's Entropy: Allotaxonometry 19 of 121 $H(P) = \langle \log_2 \frac{1}{p_\tau} \rangle = \sum_{\tau \in R_{1,2;\alpha}} p_\tau \log_2 \frac{1}{p_\tau}$ A plenitude of (1)distances Rank-turbulence divergence

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Kullback-Liebler (KL) divergence:

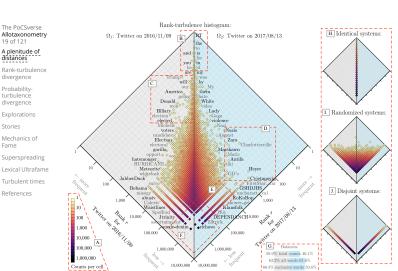
$$\begin{split} D^{\mathsf{KL}}\left(P_{2}\mid \middle| P_{1}\right) &= \left\langle \log_{2} \frac{1}{p_{2,\tau}} - \log_{2} \frac{1}{p_{1,\tau}} \right\rangle_{P_{2}} \\ &= \sum_{\tau \in R_{1,2;\alpha}} p_{2,\tau} \left[\log_{2} \frac{1}{p_{2,\tau}} - \log_{2} \frac{1}{p_{1,\tau}} \right] \\ &= \sum_{\tau \in R_{1,2;\alpha}} p_{2,\tau} \log_{2} \frac{p_{1,\tau}}{p_{2,\tau}}. \end{split}$$
(2)

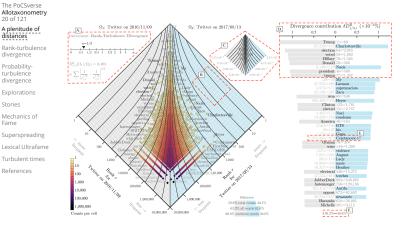
- Problem: If just one component type in system 2 is not present in system 1, KL divergence = ∞ .
- Solution: If we can't compare a spork and a platypus directly, we create a fictional spork-platypus hybrid.
- New problem: Re-read solution.

- lnvolving a third intermediate averaged system means JSD is now finite: $0 \le D^{\text{JS}}(P_1 || P_2) \le 1$.
- Generalized entropy divergence: [6]

$$\begin{split} D^{\text{AS2}}_{\alpha}(P_1 \parallel P_2) = \\ \frac{1}{\alpha(\alpha - 1)} \sum_{\tau \in R_{1,2;\alpha}} \left[\left(p_{\tau,1}^{1-\alpha} + p_{\tau,2}^{1-\alpha} \right) \left(\frac{p_{\tau,1} + p_{\tau,2}}{2} \right)^{\alpha} - \left(p_{\tau,1} + p_{\tau,2} \right) \right]. \end{split} \tag{4}$$

Produces JSD when $\alpha \rightarrow 0$.





Desirable rank-turbulence divergence features:

- 1. Rank-based 2. Symmetric.
- 3. Semi-positive: $D_{\alpha}^{\mathsf{R}}(\Omega_1 || \Omega_2) \geq 0$.
- 4. Linearly separable, for interpretability.
- 5. Subsystem applicable: Ranked lists of any principled subset may be equally well compared (e.g., hashtags on Twitter, stock prices of a certain sector, etc.).
- 6. Turbulence-handling: Suited for systems with rank-ordered component size distribution that are heavy-tailed.
- 7. Scalable: Allow for sensible comparisons across system sizes.
- 8. Tunable.
- 9. Story-finding: Features 1–8 combine to show which component types are most 'important'

Some good things about ranks:

- Working with ranks is intuitive
- Affords some powerful statistics (e.g., Spearman's rank correlation coefficient)
- line can be used to generalize beyond systems with probabilities

A start:

 $\left| \frac{1}{r_{\tau,1}} - \frac{1}{r_{\tau,2}} \right|.$ (5)

- lnverse of rank gives an increasing measure of 'importance'
- High rank means closer to rank 1
- line we assign tied ranks for components of equal 'size'
- lssue: Biases toward high rank components

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We introduce a tuning parameter:

 r_{τ}

$$\frac{1}{1\right]^{\alpha}} - \frac{1}{\left[r_{\tau,2}\right]^{\alpha}} \bigg|^{1/\alpha}.$$

- As $\alpha \to 0$, high ranked components are increasingly dampened
- line texts, for example, the weight of common words and rare words move increasingly closer together.
- As $\alpha \to \infty$, high rank components will dominate.
- For texts, the contributions of rare words will vanish.

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Trouble:

 \Im The limit of $\alpha \rightarrow 0$ does not behave well for

$$\frac{1}{\left[r_{\tau,1}\right]^{\alpha}} - \frac{1}{\left[r_{\tau,2}\right]^{\alpha}} \bigg|^{1/\alpha}.$$

The leading order term is:

$$1 - \delta_{r_{\tau,1}r_{\tau,2}} \Big) \, \alpha^{1/\alpha} \left| \ln \! \frac{r_{\tau,1}}{r_{\tau,2}} \right|^{1/\alpha},$$

which heads toward ∞ as $\alpha \rightarrow 0$.

🚳 Oops.

But the insides look nutritious:



is a nicely interpretable log-ratio of ranks.

$$\delta D^{\mathsf{R}}_{\alpha,\tau}(R_1 \mid\mid R_2) \propto \frac{\alpha+1}{\alpha} \left| \frac{1}{\left[r_{\tau,1}\right]^{\alpha}} - \frac{1}{\left[r_{\tau,2}\right]^{\alpha}} \right|^{1/(\alpha+1)} \cdot \begin{array}{c} \text{A plentude of distance of distance of the second second$$

- 🗞 Keeps the core structure.
- & Large α limit remains the same.
- $\Rightarrow \alpha \rightarrow 0$ limit now returns log-ratio of ranks.

 \clubsuit Next: Sum over τ to get divergence.

🚳 Still have an option for normalization.

Rank-turbulence divergence:

$$D^{\mathsf{R}}_{\alpha}(R_1 \mid\mid R_2) = \frac{1}{\mathcal{N}_{1,2;\alpha}} \sum_{\tau \in R_{1,2;\alpha}} \delta D^{\mathsf{R}}_{\alpha,\tau}(R_1 \mid\mid R_2) \quad \text{(9)}$$

Normalization:

- 🚯 Take a data-driven rather than analytic approach to determining $\mathcal{N}_{1,2;\alpha}$.
- Sompute $\mathcal{N}_{1,2:\alpha}$ by taking the two systems to be disjoint while maintaining their underlying Zipf distributions.
- \bigotimes Ensures: $0 \leq D_{\alpha}^{\mathsf{R}}(R_1 || R_2) \leq 1$
- Limits of 0 and 1 correspond to the two systems having identical and disjoint Zipf distributions.

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Rank-turbulence divergence:

Summing over all types, dividing by a normalization prefactor $\mathcal{N}_{1,2;\alpha}$ we have our prototype:

$$D_{\alpha}^{\mathsf{R}}(R_{1} || R_{2}) = \frac{1}{\mathcal{N}_{1,2;\alpha}} \frac{\alpha+1}{\alpha} \sum_{\tau \in R_{1,2;\alpha}} \left| \frac{1}{[r_{\tau,1}]^{\alpha}} - \frac{1}{[r_{\tau,2}]^{\alpha}} \right|^{1/\ell}$$
(10)

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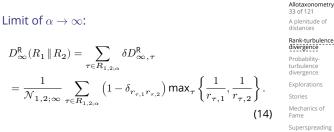
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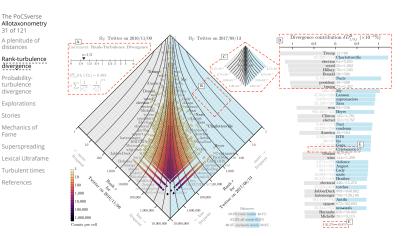
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where

$$\mathcal{N}_{1,2;\infty} = \sum_{\tau \in R_1} \frac{1}{r_{\tau,1}} + \sum_{\tau \in R_2} \frac{1}{r_{\tau,2}}.$$
 (15) Turbulent times

🚳 Highest ranks dominate.



Probability-turbulence divergence:

$$D^{\mathsf{P}}_{\alpha}(P_1 \mid\mid P_2) = \frac{1}{\mathcal{N}_{1,2;\alpha}^{\mathsf{P}}} \frac{\alpha+1}{\alpha} \sum_{\tau \in R_{1,2;\alpha}} \left| \left[p_{\tau,1} \right]^{\alpha} - \left[p_{\tau,2} \right]^{\alpha} \right|^{1/(\alpha+1)}$$
(16)

Solution For the unnormalized version ($\mathcal{N}_{1,2;\alpha}^{\mathsf{P}}$ =1), some troubles return with 0 probabilities and $\alpha \rightarrow 0$.

 \bigotimes Weep not: $\mathcal{N}_{1,2:\alpha}^{\mathsf{P}}$ will save the day.

🚳 Largest rank ratios dominate.

& lif the Zipf distributions are disjoint, then in $\Omega^{(1)}$'s merged ranking, the rank of all $\Omega^{(2)}$ types will be $r = N_1 + \frac{1}{2}N_2$, where N_1 and N_2 are the number of distinct types in each system.

Similarly, $\Omega^{(2)}$'s merged ranking will have all of $\Omega^{(1)}$'s types in last place with rank $r = N_2 + \frac{1}{2}N_1$. The normalization is then:

$$\mathcal{N}_{1,2;\alpha} = \frac{\alpha+1}{\alpha} \sum_{\tau \in R_1} \left| \frac{1}{\left[r_{\tau,1}\right]^{\alpha}} - \frac{1}{\left[N_1 + \frac{1}{2}N_2\right]^{\alpha}} \right|^{1/(\alpha+1)} \xrightarrow{\text{Sup}}_{\text{Lexi}} + \frac{\alpha+1}{\alpha} \sum_{\tau \in R_1} \left| \frac{1}{\left[N_2 + \frac{1}{2}N_1\right]^{\alpha}} - \frac{1}{\left[r_{\tau,2}\right]^{\alpha}} \right|^{1/(\alpha+1)}.$$
(11)

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Limit of $\alpha \to 0$:

$$D_0^{\mathsf{R}}(R_1 \| R_2) = \sum_{\tau \in R_{1,2;\alpha}} \delta D_{0,\tau}^{\mathsf{R}} = \frac{1}{\mathcal{N}_{1,2;0}} \sum_{\tau \in R_{1,2;\alpha}} \left| \ln \frac{r_{\tau,1}}{r_{\tau,2}} \right|,$$
(12)

where

$$\mathcal{N}_{1,2;0} = \sum_{\tau \in R_1} \left| \ln \frac{r_{\tau,1}}{N_1 + \frac{1}{2}N_2} \right| + \sum_{\tau \in R_2} \left| \ln \frac{r_{\tau,2}}{\frac{1}{2}N_1 + N_2} \right|.$$
(13)

Normalization:

With no matching types, the probability of a type present in one system is zero in the other, and the sum can be split between the two systems' types:

$$\mathcal{N}_{1,2;\alpha}^{\mathsf{p}} = \frac{\alpha+1}{\alpha} \sum_{\tau \in R_1} \left[p_{\tau,1} \right]^{\alpha/(\alpha+1)} + \frac{\alpha+1}{\alpha} \sum_{\tau \in R_2} \left[p_{\tau,2} \right]^{\alpha/(\alpha+\mathfrak{M}) \text{espreading}}_{\text{Lexical Ultrafarmed}} (17)$$

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Combine these cases into a single expression:

$$D_0^{\mathsf{p}}(P_1 \| P_2) = \frac{1}{(N_1 + N_2)} \sum_{\tau \in R_{1,2;0}} \left(\delta_{p_{\tau,1},0} + \delta_{0,p_{\tau,2}} \right).$$
(20)

- \bigotimes The term $\left(\delta_{p_{\tau,1},0} + \delta_{0,p_{\tau,2}}\right)$ returns 1 if either $p_{\tau,1} = 0$ or $p_{\tau,2} = 0$, and 0 otherwise when both $p_{\tau,1} > 0$ and $p_{\tau,2} > 0$.
- Ratio of types that are exclusive to one system relative to the total possible such types,

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Connections for PTD:

- Probability-turbuler $\alpha = 0$: Similarity measure Sørensen-Dice coefficient [8, 31, 20], F_1 score of a test's accuracy^[32, 29].
 - $\approx \alpha = 1/2$: Hellinger distance ^[16] and Mautusita distance^[21].
 - $\alpha = 1$: Many including all $L^{(p)}$ -norm type constructions.
 - $\ll \alpha = \infty$: Motyka distance^[7].

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> Rank-turbulence divergence

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ribution $\delta D_{1.0.6}^{P}$, (×10⁻⁴%)

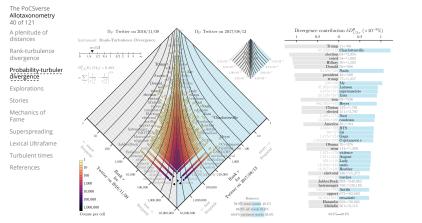
Limit of α =0 for probability-turbulence divergence \Rightarrow if both $p_{\tau,1} > 0$ and $p_{\tau,2} > 0$ then

$$\lim_{\alpha \to 0} \frac{\alpha + 1}{\alpha} \left| \left[p_{\tau,1} \right]^{\alpha} - \left[p_{\tau,2} \right]^{\alpha} \right|^{1/(\alpha+1)} = \left| \ln \frac{p_{\tau,2}}{p_{\tau,1}} \right|. \qquad \begin{array}{c} \text{Stories} \\ \text{Mechanics of Fame on a strength of the store of the stor$$

But if $p_{\tau 1} = 0$ or $p_{\tau 2} = 0$, limit diverges as $1/\alpha$.

The PoCSverse Allotaxonometry Type contribution ordering for the limit of α =0

- ln terms of contribution to the divergence score, all exclusive types supply a weight of $1/(N_1 + N_2)$. We can order them by preserving their ordering as $\alpha \rightarrow 0$, which amounts to ordering by descending probability in the system in which they appear.
- line and while types that appear in both systems make no contribution to $D_0^{\mathsf{P}}(P_1 || P_2)$, we can still order them according to the log ratio of their probabilities.
- The overall ordering of types by divergence contribution for α =0 is then: (1) exclusive types by descending probability and then (2) types appearing in both systems by descending log ratio.



ability-turbulence

$$(1 - \delta_{p_{\tau,1}, p_{\tau,2}}) \max(p_{\tau,1}, p_{\tau,2})$$

$$(21)$$

$$p_{\tau,1} + p_{\tau,2}) = 1 + 1 = 2.$$

$$(22)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

$$(22)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

$$(21)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

$$(22)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

$$(21)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

$$(21)$$
References
$$p_{\tau,1} + p_{\tau,2} = 1 + 1 = 2.$$

The PoCSverse

$$p_{\tau,2}) \begin{array}{c} \text{Allotaxonometry} \\ \text{Allotaxonometry} \\ \text{d of 121} \\ \text{Aplenitude of distances} \\ \text{Rank-turbulence divergence} \\ \text{Rank-turbulence divergence} \\ \text{Probability-turbuler} \\ \text{Drops prime allots of Fame biological states of the state o$$

Limit of α =0 for probability-turbulence divergence \delta Normalization:

$$\mathcal{N}_{1,2;\alpha}^{\mathrm{P}} \rightarrow \frac{1}{\alpha} \left(N_1 + N_2 \right). \tag{19} \quad \ \ \begin{array}{c} \text{Stories} \\ \text{Mechanics of} \\ \text{Fame} \end{array}$$

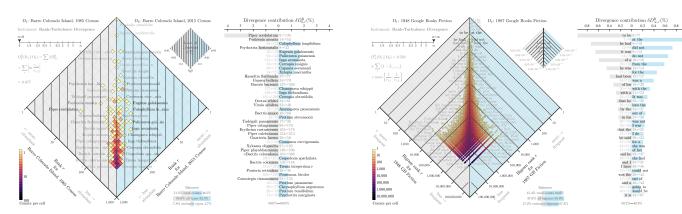
Because the normalization also diverges as $1/\alpha$, the divergence will be zero when there are no exclusive types and non-zero when there are exclusive types.

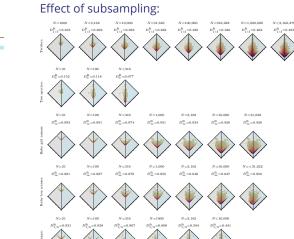
divergence

$$D^{\rm P}_{\infty}(P_1 \,\|\, P_2) = \frac{1}{2} \sum_{\tau \in R_{1,2;\infty}} \left(1 - \delta_{p_{\tau,1},p_{\tau,2}}\right) \max\left(p_{\tau,1},p_{\tau,2}\right) \max\left(p_{\tau,1},p_{\tau,2}\right) \left(p_{\tau,1},p_{\tau,2}\right) \left(p_{\tau,2},p_{\tau,2}\right) \left(p_{\tau,1},p_{\tau,2}\right) \left(p_{\tau,1},p_{\tau,2}\right) \left(p_{\tau,1},p_{\tau,2}\right) \left(p_{\tau,2},p_{\tau,2}\right) \left$$

where

$$\mathcal{N}_{1,2;\infty}^{\mathsf{p}} = \sum_{\tau \in R_{1,2;\infty}} \left(p_{\tau,1} + p_{\tau,2} \right) = 1 + 1 = 2.$$
 (22)





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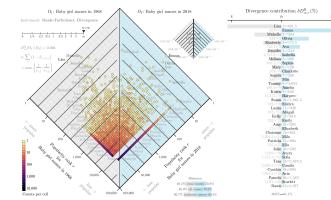
A plenitude of distances Rank-turbulence divergence

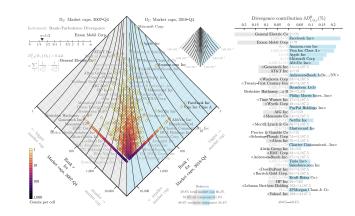
Probabilityturbulence divergence

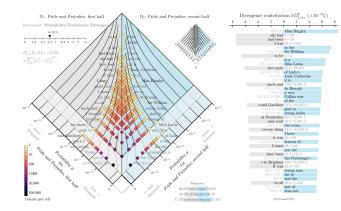
Explorations Stories

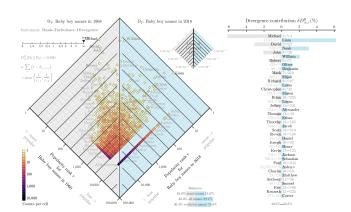
Mechanics of Fame Superspreading

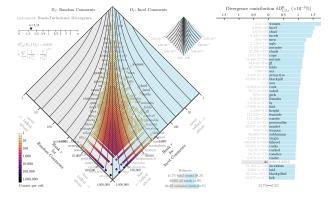
Lexical Ultrafame Turbulent times References

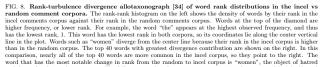


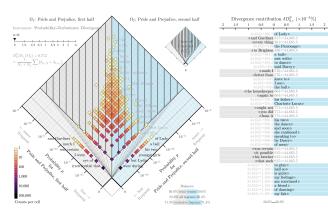


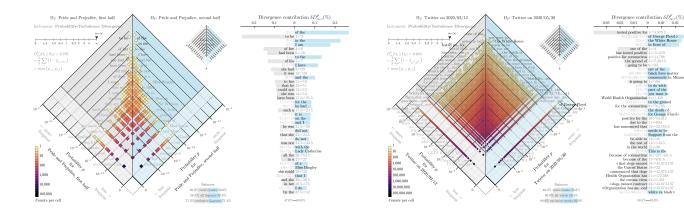












Flipbooks for PTD:

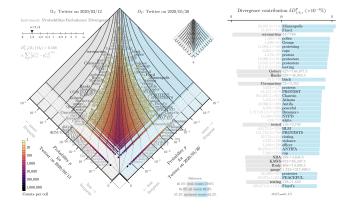
🚳 Jane Austen:

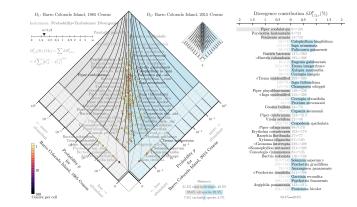
Pride and Prejudice, 1-grams Pride and Prejudice, 2-grams Pride and Prejudice, 3-grams

🚳 Social media:

Twitter, 1-grams

Ecology: Barro Colorado Island III





Code:

https://gitlab.com/compstorylab/allotaxonometer

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distances Rank-turbulence

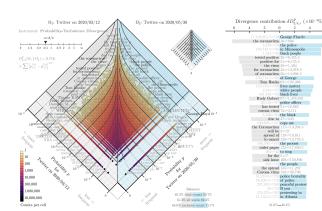
divergence Probabilityturbulence

divergence Explorations

Stories

Mechanics of Fame Superspreading Lexical Ultrafam Turbulent times

References



Flipbooks for RTD:

🗞 Twitter:

instrument-flipbook-1-rank-div.pdf []] C Instrument-flipbook-2-probability-div.pdf []] C Instrument-flipbook-3-gen-entropy-div.pdf []] C

🚳 Market caps:

instrument-flipbook-4-marketcaps-6years-rank-div.pdf 🖽 🗷

🚳 Baby names:

instrument-flipbook-5-babynames-girls-50years-rank-div.pdf

🚳 Google books:

instrument-flipbook-7-google-books-onegrams-rank-div.pdf Instrument-flipbook-8-google-books-bigrams-rank-div.pdf Instrument-flipbook-9-google-books-trigrams-rank-div.pdf III C

Claims, exaggerations, reminders:	
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- Needed for comparing large-scale complex systems:
 - Comprehendible, dynamically-adjusting, differential dashboards
- Many measures seem poorly motivated and largely unexamined (e.g., JSD)
- Of value: Combining big-picture maps with ranked lists
- Maybe one day: Online tunable version of rank-turbulence divergence (plus many other instruments)

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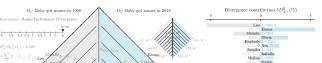
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The everywhereness of algorithms and stories:

CIAL WILL



'On the Origin of Stories: Evolution, Cognition, and Fiction" **a**, **C** by Brian Boyd (2010).^[2]



"The Storytelling Animal: How Stories Make Us Human" a.C by Jonathan Gottschall (2013).^[15]



'The Written World: How Literature Shaped Civilization" by Martin Puchner (2017).^[27]

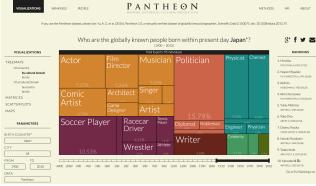




"Once Upon an Algorithm" 🧕 🗹 by Martin Erwig (2017). [14]

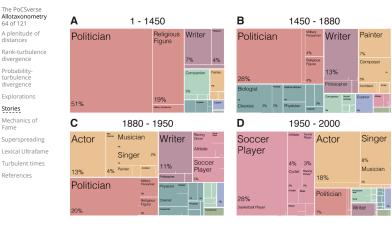
Also: Numerical Recipes in C^[26] and How to Bake π ^[4]

The PoCSverse The famous are storytellers—Japan:



For people born 1950-

http://pantheon.media.mit.edu/treemap/country_exports/JP/all/1900/2010/H15/pantheon



https://www.media.mit.edu/projects/pantheon-new/overview/

Super Survival of the Stories:



🗞 Study of Agta, Filipino hunter-gatherers.

- Storytelling valued well above all other skills including hunting.
- 🗞 Stories encode prosocial norms such as cooperation.
- Like the best stories, the best storytellers reproduce more successfully.

The most famous painting in the world:

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The dismal predictive powers of editors



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The completely unpredicted fall of Eastern Europe:

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The Desirability

Storytellers 2,

The Atlantic.

2017-12-05.

Ed Yong,

of



Timur Kuran: ^[18] "Now Out of Never: The Element of Surprise in the East European Revolution of 1989"

Allotaxonometry 71 of 121 A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence Explorations Stories

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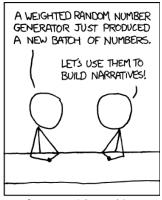
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We understand bushfire stories:

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Rank-turbulence divergence	
Probability- turbulence divergence	
Explorations	Reason 3—We are spectacular imitators.
Stories	
Mechanics of Fame Superspreading	BBC/David Attenborough.

- 1. Sparks start fires.
- 2. System properties control a fire's spread.
- 3. But for three reasons, we make two mistakes about Social Fires ...

Reason 1—We are Homo Narrativus.



ALL SPORTS COMMENTARY

http://xkcd.com/904/

Reason 2—"We are all individuals."

Archival footage:

lndividual narratives are not enough to understand distributed, networked minds.

The PoCSverse Mistake 1: Allotaxonometry 73 of 121

Success is due to intrinsic properties



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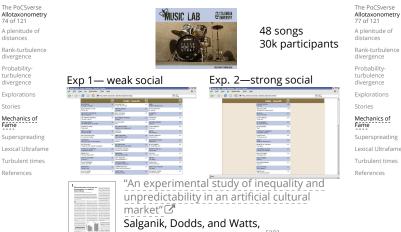
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See "Becoming Mona Lisa" by David Sassoon



Science, 311, 854-856, 2006. [28]

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belong to us'

"Mistake" 2:

Seeing success is 'due to social' and wanting to say 'all your interactions are



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Increased social awareness leads to Stronger inequality + Less predictability.

36

24

Rank: m_{indep}

12

1

Resolving the paradox:

Exp. 2

D

Rank: *m*_{influence}

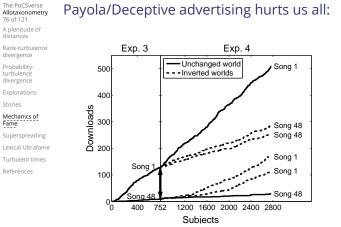
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48



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The hypodermic model of influence:

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The PoCSverse The network model of influence: Allotaxonometry 81 of 121

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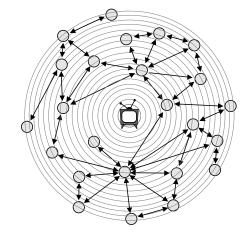
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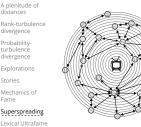
Stories

Allotaxonometry

Stories



The network model of influence: Allotaxonometry 82 of 121





How superspreading works: Many interconnected, average, trusting people must benefit from both receiving and sharing a message far from its source.

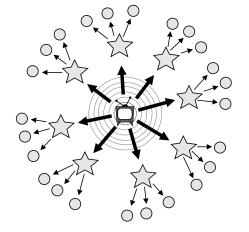
"Influentials, Networks, and Public Opinion Watts and Dodds,

. Consum. Res., **34**, 441–458, 2007. ^[33]

The two step model of influence: [17]

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 $\hat{\Box}$

Etymological clarity:

- Fate—from the Latin fatus: meaning "spoken".
- 🚳 Fate is talk that has been done. "It is written", fore-tell, pre-dict.
- 🗞 "There is no such thing as fate, only the story of fate."
- Destiny is probablistic.
- 🗞 Fame—from the Latin *fāma*: meaning "to talk."
- 🗞 Fame is inherently the social discussion about the thing, not the thing itself.
- 🗞 Renown 🗷: Repeatedly named, talked about. Old French renon, from re- + non ("name").
- 🗞 Réclame 🗹. "Clamo"—Proto-Indo-European: "to shout" (again). Connected to "lowing".

Oscar Wilde, The Picture of Dorian Gray: Raw Fame



"There is only one thing in the world

worse than being talked about,

and that is

not being talked about."

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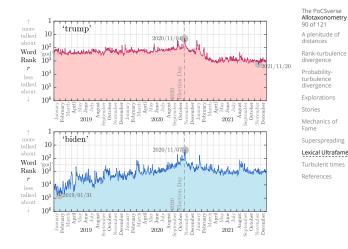
comparing daily levels of 'being talked about' for United States' presidents, their rivals, God, countries, and K-pop" Available online at https://arxiv.org/abs/1910.00149, 2019.^[10]

"Computational timeline reconstruction of the stories surrounding Trump: Story turbulence, narrative control, and collective chronopathy" Dodds et al., , 2020. [12]

POTUSometer with the Smorgasdashbord: http://compstorylab.org/potusometer/ Stories surrounding Trump: http://compstorylab.org/trumpstoryturbulence/

Dodds et al.,





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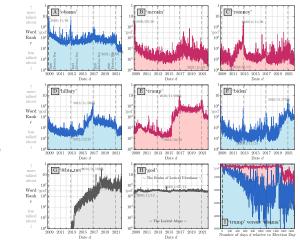
Ultrafame: Nobody expects the Spanish Inquisition K-pop:



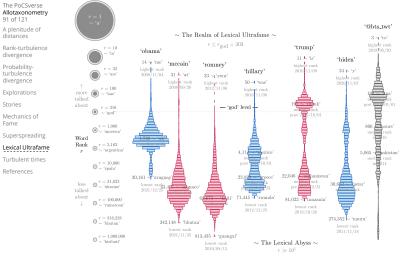
Vox (2019-04-17): BTS, the band that changed K-pop, explained

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Distant reading by smashing texts into storyons:	Rank-turbulence divergence
cd ~/work/stories/2019-10story-turbulence-trump/ 2616	Probability- turbulence divergence
2010	Explorations
more updateall.sh	Stories
file names:	Mechanics of
compute rank turbulence divergence sweep the leg	Fame
	Superspreading
Zip files:	Lexical Ultrafame
1	Turbulent times
<pre>zless 2018-01-06/1grams/en_*.tar.tsv</pre>	References
zless 2021-01-05/1grams/en_*.tar.tsv	

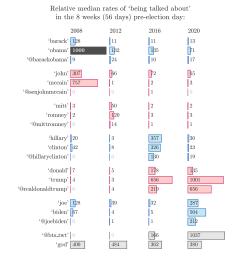
zless	2021-01-06/1grams/en_	*.tar.tsv
zless	2021-01-07/1grams/en	*.tar.tsv

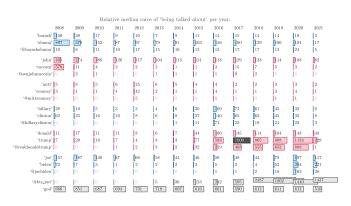




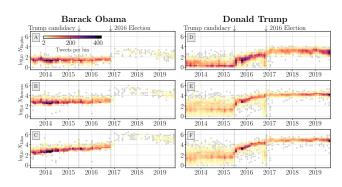


Ultrafame—Percentage of days per year ranked above 'god' 2010 2011 2012 2013 2014 2015 2016 2017 2018 2008 2009 2019 2020 2021 @barackobama' 'john' 3.5% 0.6% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.3% 0.8% 0.3% 0.5% 0.0% "@senjohnmccain" 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.8% 0.0% 0.0% 0.0% 'mitt' 0.0' 0.0% 0.0% 1.6% 0.0% 0.0% 0.0% 'romney' 0.0% 0.0% 0.0% 0.3% 0.0% 'hillary' 0.0% 10.4% 0.09 'donald' 2.7% 0.5% 0.0% 8.2% 0.6% 'joe' 3.5% 2.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 'biden' 1.8% 0.0% "@bts_twt" 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 8.5% | 50.7% | 100.0% | 100.0% | 98.9% | 93.1%



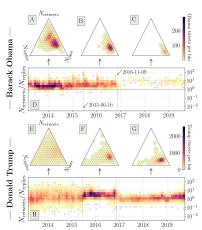


Ratiometrics:



"Ratioing the President: An exploration of public engagement with Obama and Trump on Twitter," Minot et al., 2020 [22]

Ratiometrics:



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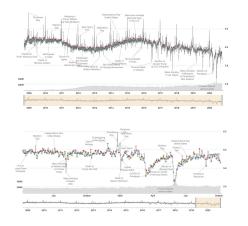
Fame Superspreading

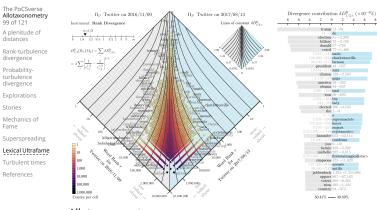
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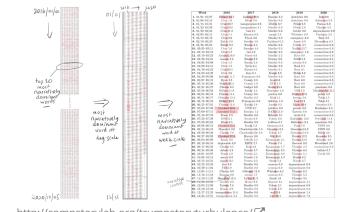
Fame

Emotional turbulence:





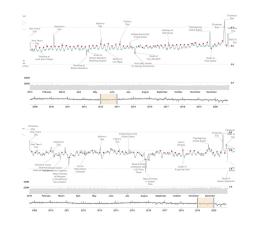
Allotaxonometrythe comparison of complex systems: http://compstorylab.org/allotaxonometry/



http://compstorylab.org/trumpstoryturbulence/

http://hedonometer.org/

Emotional turbulence:

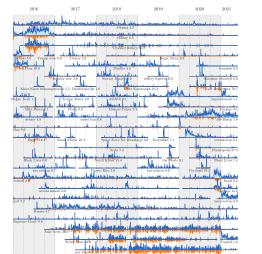


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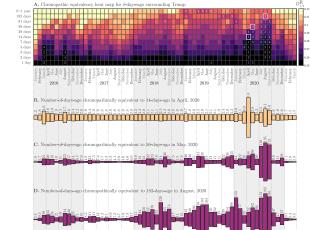
1. 01/01-01/07	Hillary 34.7	hacking 28.6	Bannon 2.2	shutdown 0.0	Iran 9.6	Georgia 14.7
 01/08-01/14 	Cruz 1.0	Mergl 5.0	Mueller 0.0	shutdown 0.0	Soleimani 5.9	Capitol 0.1
3. 01/15-01/21	Cruz 10.7	inauguration 0.6	DACA 6.7	Pelosi 6.8	Parnas 0.0	Capitol 0.0
4. 01/22-01/28	Cruz 10.6	inauguration 3.1	Mueller 0.0	Pelosi 2.6	Ukraine 5.5	insurrection 0.0
 01/29-02/04 	Crut 11.2	ban 2.1	Mueller 0.0	border 0.0	impeachment 0.0	Greene 0.0
 6. 02/05-02/11 	Cruz 5.1	Bannon 0.0	memo 2.3	Whitaker 0.0	Vindman 2.5	insurrection 0.0
7. 02/12-02/18	Cruz 6.9	Flynn 0.0	Mueller 0.0	emergency 0.0	Barr 2.2	Capitol 0.0
 02/19+02/25 	Rubio 3.8	Sweden 4.9	Parkland 0.3	Jussie 0.0	Bloomberg 6.3	Capitol 0.0
9. 02/26-03/04	Rubio 9.2	Russia 6.4	Mueller 0.0	Cohen 3.7	coronavirus 0.0	Capitol 0.0
10. 03/05-03/11	Cru2 1.0	Russian 4.8	Mueller 0.0	Nadler 13.7	coronavirus 0.0	insurrection 0.0
11. 03/12-03/18	Cruz 5.7	tax 1.8	Mueller 2.2	emergency 1.6	coronavirus 0.0	Biden 0.0
12. 03/19-03/25	Arizona 16.8	Nunes 0.0	Mueller 2.2	Barr 0.0	coronavirus 0.0	Biden 0.0
13. 03/26-04/01	women 8.3	Russia 9.9	Stormy 0.0	Schiff 5.2	coronavirus 0.5	Capitol 0.0
14. 04/02-04/08	Cruz 1.5	Russia 2.8	Mueller 0.0	peturns 0.0	coronavirus 0.0	Matt 0.0
15. 04/09-04/15	Cruz 1.7	Syria 0.4	Mueller 2.0	Barr 2.4	coronavirus 0.0	Capitol 0.0
16. 04/16-04/22	Cruz 10.5	Russia 0.5	Mueller 0.1	Barr 0.1	coronavirus 0.0	Capitol 0.0
17. 04/23-04/29	Cruz 3.0	days 0.1	Kanye 8.0	Biden 6.0	coronavirus 0.0	audit 0.0
18, 04/30-05/06	Indiana 11.5	Trumpeare 0.0	Mueller 0.0	Barr 0.0	coronavirus 0.0	Cheney 0.0
19.05/07-05/13	Ryan 2.5	Comer 2.8	Iran 6.6	Barr 0.0	coronavirus 0.0	Cheney 0.0
20. 05/14-05/20	Bernie 25.3	Comey 1.0	ZTE 4.5	Barr 0.0	coronavirus 0.0	Cheney 0.0
21. 05/21-05/27	Clinton 9.5	budget 0.0	Korea 18.2	Barr 0.0	pandemic 0.0	Weisselberg 0.0
22. 05/28-06/03	Hillary 11.9	Kathy 4.4	Roseanne 4.0	USS 3.0	Minneapolis 32.1	reinstated 0.0
23, 06/04-06/10	Clinton 11.1	Comey 0.8	pardon 0.0	Mexico 27.6	police 4.2	McGahn 0.0
24. 06/11-06/17	Orlando 12.4	Mueller 0.0	Kim 4.1	foreign 2.0	Tulsa 4.5	DOJ 0.0
25. 06/18-06/24	Hillary 23.9	Trumpcare 0.0	children 1.0	Iran 12.9	Tulsa 2.1	Capitol 0.0
26, 06/25-07/01	Clinton 13.0	Russin 5.8	Justice 8.3	Moon 29.9		Organization 0.0
27, 07/02-07/08	Crooked 80.6	CNN 0.7	toddlers 0.0	parade 0.0	Rushmore 2.3	Weisselberg 0.0
28. 07/09-07/15	Crooked 71.5	Russian 1.2	NATO 13.0	Epstein 0.0	coronavirus 0.0	CPAC 0.0
29. 07/16-07/22	Pence 2.9	Mueller 0.0	Helsinki 3.1	racist 0.8	coronavirus 0.0	vaccinated 0.0
30. 07/23-07/29	DNC 6.1	Scouts 0.0	Cohen 0.0	Baltimore 13.6	Portland 11.8	Jan 0.0
31. 07/30-08/05	Khan 6.5	Mueller 0.0	LeBron 0.7	Baltimore 9.4	pandemic 0.0	Capitol 0.0
32, 08/06-08/12	Crooked 55.2	Koren 5.8	Omarosa 0.4	Paso 7.6	USPS 0.0	Rosen 0.0
33. 08/13-08/19		Charlottesville 1.5	Omarcea 9.5	Greenland 6.9	USPS 0.0	Taliban 0.0
34. 08/20-08/26		Charlottesville 3.8	Cohen 2.7	Greenland 8.0	Biden 6.6	Taliban 0.0
35. 08/27-09/02	Crooked 57.4	Harvey 0.0	Ohr 14.0	Dorian 12.2	Kenosha 9.5	Taliban 0.0
36. 09/03-09/09	Bondi 0.0	DACA 2.4	Kavanaugh 2.1	Dorian 12.6	Atlantic 4.8	Afghanistan 0.0
37.09/10-09/16	deplorable 0.0	ESPN 2.7	Puerto 7.5	flavored 0.0	Woodward 2.6	Milley 0.0
38, 09/17-09/23	Clinton 6.5	Kim 4.9	Kavanaugh 1.7	Ukraine 4.5	coronavirus 0.0	Eastman 0.0
39. 09/24-09/30	debate 4.9	Puerto 4.7	Kavanaugh 9.5	Ukraine 6.8	ballots 0.7	audit 0.0
40, 10/01-10/07	Pence 4.9	Puerto 2.1	Kayanaugh 6.8	Ukraine 5.1	Covid 1.4	Bannon 0.0
41. 10/08-10/14	sexual 0.3	Puerto 1.8	Kavanangh 4.3	Kurds 8.2	COVID 1.4	Jan 0.0
42. 10/15-10/21	rigged 10.1	Puerto 0.2	Saudi 5.3	Kurds 3.7	Biden 8.2	Powell 0.0
43. 10/22-10/28	star 0.0	Mueller 0.0	caravan 0.0	impeachment 0.0	Biden 9.2	Jan 0.0
44. 10/29-11/04	FBI 5.9	Mueller 0.0	caravan 0.0	impeachment 0.0	Biden 10.0	Youngkin 0.0
45, 11/05-11/11	Clinton 0.9	Gillespie 12.0	Whitaker 6.2	Ukraine 6.2		infrastructure 0.0
46, 11/12-11/18	Bannon 0.0	sexual 1.7	caravan 0.0	Ukraine 5.2	Dominion 23.2	Christie 0.0
40. 11/12-11/18 47. 11/19-11/25	Hamilton 12.4	LaVar 21.3	Saudi 1.6	Ukraine 3.5	Sidney 0.1	Rittenhouse 0.0
48, 11/26-12/02	recount 0.0	Moore 0.0	Moscow 0.1	impeachment 3.1	votes 24.1	Waukesha 0.0
49, 12/03-12/09	Taiwan 7.8	Mueller 0.0	Cohen 2.1	impeachment 0.0	Georgia 20.2	Meadows 0.0
50. 12/10-12/16	Russia 2.9	Mueller 0.0	Cohen 6.9	impeachment 0.0	vaccine 11.1	Meadows 0.0
51. 12/17-12/23 i			wall 9.8	impeachment 1.4	vaccine 15.4	Manchin 0.0
52, 12/24-12/31		Mueller 0.0	wall 20.4	impeachment 7.6	Election 60.2	Brandon 0.0
oz. 12/20-12/31	manugur dettore 3.2	transmer 0.0	W 1944 20178	improcatient r.o	Annual 00.2	191 minup361 (0.0)



Week	2016	2017	2018	2019	2020	2021
 01/01-01/07 	Hillary Clinton 32.7	plant în 85.1	Steve Bannon 5.7	the government 0.0	a war 6.6	in Georgia 20.2
 01/08-01/14 	Trump rally 0.0	Meryl Streep 6.6	shithole countries 0.0	the border 1.0	impeachment trial 0.0	the Capitol 0.0
 01/15-01/21 		Frump's inauguration 0		Cohen to 0.0	impeachment trial 0.0	the Capitol 0.0
 4. 01/22=01/28 	Megyn Kelly 4.9	executive order 0.0	the FBI 5.6	the government 0.0	impeachment trial 0.0	the Capitol 0.0
5. 01/29-02/04	Ted Cruz 19.7	travel ban 1.6	the FBI 9.4		impeachment trial 0.0	the Capitol 0.0
 02/05-02/11 	New Hampshire 19.5	travel ban 1.1	military parade 0.0		Alexander Vindman 0.0	
 02/12-02/18 	Ted Cruz 15.7	Michael Flynn 0.0	school shooting 3.1	national emergency 0.0		the Capitol 0.0
8. 02/19-02/25		Frump administration 0		Jussie Smollett 0.0	Bernie Sanders 13.6	the Capitol 0.0
 02/26=03/04 	vote for 4.4	to Russia 22.0	Hope Hicks 0.0	Michael Cohen 5.3	the coronavirus 0.0	the Capitol 0.0
10. 03/05-03/11	Ted Cruz 2.4	travel ban 0.0	Stormy Daniels 0.0	Tim Apple 0.0	the coronavirus 0.0	voted for 0.0
11. 03/12-03/18	Trump is 0.1	Meals on 0.0	Stormy Daniels 0.0	New Zealand 17.9	the coronavirus 0.0	Lara Trump 0.0
12. 03/19-03/25	Lyin' Ted 66.2		Cambridge Analytica 0		the coronavirus 0.0	the border 0.0
13. 03/26-04/01	Trump is 0.0	Freedom Caucus 20.8	Stormy Daniels 0.0	Mueller report 0.0	the coronavirus 0.0	Matt Gaetz 0.0
14. 04/02-04/08	Ted Cruz 3.9	Susan Rice 0.3	National Guard 0.0	tax returns 0.0	the coronavirus 0.0	Matt Gaetz 0.0
15. 04/09-04/15	New York 19.3	in Syria 0.2	Michael Cohen 0.0	sanctuar <mark>y c</mark> ities 5.3	the coronavirus 0.0	Matt Gaetz 0.0
16. 04/16-04/22	Ted Cruz 28.1	turnout for 0.0	Michael Cohen 2.4	Mueller report 0.0	the coronivirus 0.0	Maxine Waters 0.0
17. 04/23-04/29	Trump rally 0.0	tax plan 0.0	the Korean 0.0	Mueller report 0.0	the coronavirus 0.0	Liz Cheney 0.0
18. 04/30H05/06	Ted Cruz 5.5	health care 0.0	Stormy Daniels 0.0	Mueller report 0.0	treated worse 0.0	Liz Cheney 0.0
19. 05/07-05/13	Paul Ryan 2.0	James Comey 6.7	the Iran 9.0	tax returns 0.0	tested positive 0.0	Liz Cheney 0.0
20. 05/14=05/20	Hillary Clinton 26.5	Saudi Arabia 12.5	are animals 0.0	Lindsey Graham 0.0	the pandemic 0.0	Kevin McCarthy 0.0
21. 05/21-05/27	Hillary Clinton 24.8	Saudi Arabia 8.2	the FBI 23.3	Nancy Pelosi 12.5	a mask 6.3	the January 0.0
22. 05/28-06/03	Trump University 3.4	Kathy Griffin 5.7	Samantha Bee 4.4	John McCain 0.0	photo op 0.0	Memorial Day 0.0
23. 06/04-06/10	Hillary Clinton 18.6	James Comey 0.2	Justin Trudeau 8.5	with Mexico 39.2	Left Democrats 75.1	Jean Carroll 0.0
24. 06/11-06/17	Trump is 0.0	obstruction of 12.6	their parents 0.0	the FBI 8.5	in Tulka 7.4	Trump DOJ 0.0
25. 06/18-06/24	Hillary Clinton 20.6	Karen Handel 16.6	their parents 3.4	need soap 0.0	in Tulsa 2.2	the Capitol 0.0
26. 06/25-07/01	Hillary Clinton 20.5	Fake News 37.6	Supreme Court 3.7	Jean Carroll 0.0	Mount Rushmore 3.9	frump Organization 0.0
27. 07/02-07/08 28. 07/09-07/15	Crooked Hillary 82.8 Crooked Hillary 73.3	Trumri Jr 0.0	Frump administration (Supreme Court 7.9	Jeffrey Epstein 0.0	Roger Stone 0.0	Ashli Babbitt 0.0 the Capitol 0.0
28. 07/09=07/15 29. 07/16=07/22	Mike Pepre 6.8	Secret Service 0.0	in Helsinki 1.7	a racist 0.0	in Portland 0.0	Tom Barrack 0.0
30. 07/23-07/29	Crooked Hillary 79.6		Walk of 0.0	Elijah Cummings 27.2	in Portland 8.9	the Capitol 0.0
31. 07/30-08/05	Khizr Khan 0.0	Maxine Waters 0.0	enemy of 22.2	El Paso 11.1	the election 3.4	the Capitol 0.0
32, 08/05-08/12	Hillary Clinton 10.5	North Korea 5.7	Space Force 11.1	El Paso 7.7	Social Security 0.0	overturn the 0.0
33. 08/13-08/19		white suppimacists 0.0			the USPS 0.0	the Taliban 0.0
34. 08/20+08/26	Hillary Clinton 19.1	Joe Arpaio 3.5	Michael Cohen 4.3	Prime Minister 28.7	Joe Biden 5.9	the Taliban 0.0
35. 08/27-09/02			John McCain 0.2	Hurricane Dorian 9.6	Joe Biden 2.7	the Taliban 0.0
36. 09/03-09/09	in Detroit 0.0	to end 0.0	Brett Kayanaugh 7.6		Joe Biden 3.4	Robert E 0.0
37. 09/10-09/16	tax returns 0.0	white supremacist 0.0		Dan Bishop 37.7	Joe Biden 13.3	the Taliban 0.0
38, 09/17-09/23	Trump Jr 0.0	North Korea 12.8	Blasey Ford 0.0	a foreign 6.4	Supreme Court 7.3	to overturn 0.0
39.09/24-09/30	Hillary Clinton 7.5	Puerto Rico 5.2		Impeachment inquiry 0.		debt ceiling 0.0
40, 10/01-10/07	Mike Pence 8.9	Puerto Rico 2.6	Supreme Court 6.9	Adam Schiff 13.3	Walter Reed 5.7	the debt 0.0
41. 10/08-10/14	sexual assault 0.0	Puerto Rico 2.2	Kanye West 0.0	the Kurds 11.3	Biden is 26.5	the January 0.0
42. 10/15-10/21	Hillary Clinton 19.9	families of 0.0	Saudi Arabia 6.6	the Kurds 3.8	Joe Biden 12.1	the January 0.0
43, 10/22-10/28	Hillary Clinton 11.7	Myeshia Johnson 0.0	the bombs 0.0	World Series 0.0	Joe Biden 10.1	Alec Baldwin 0.0
44. 10/29-11/04	Hillary Clinton 6.5	Twitter employee 0.01	birthright citizenship 0	.0 the impeachment 0.0	Joe Biden 12.6	in Virginia 0.0
45. 11/05-11/11	Trump wins 0.0	mental health 0.0	Jim Acosta 0.0	pro quo 8.1	the election 2.2	infrastructure bill 0.0
46. 11/12-11/18	Steve Bannon 0.0	ban on 0.0		impeachment inquiry 0.		Chris Christie 0.0
47. 11/19-11/25	Mike Pence 24.3	Roy Moore 0.0	Saudi Arabia 2.5	quid pro 1.3	the election 6.7	Kyle Rittenhouse 0.0
48. 11/26-12/02	popular vote 17.4	Native American 0.1	Trump Tower 2.5	Hong Kong 0.0	voter fraud 32.2	Donald Trump 0.0
49. 12/03-12/09	Air Force 18.2	Roy Moore 3.5	campaign finance 0.0	to impeach 7.7	in Georgia 12.9	Donald Trump 0.0
50. 12/10-12/16	of State 7.6	of sexual 0.0	Michael Cohen 7.8	articles of 0.0	the election 9.0	Mark Mendows 0.0
51. 12/17-12/23	Electoral College 5.8	tax bill 0.0	the wall 13.7	Christianity Today 8.1	election fraud 13.9	the Capitol 0.0









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A WEIGHTED RANDOM NUMBER GENERATOR JUST PRODUCED LET'S USE THEM TO BUILD NARRATIVES! ALL SERVICE COMMENTAL xkcd.com/904/ 🗗

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