Allotaxonometry

Last updated: 2023/08/22, 11:48:21 EDT

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

Prof. Peter Sheridan Dodds | @peterdodds

Computational Story Lab | Vermont Complex Systems Center Santa Fe Institute | University of Vermont

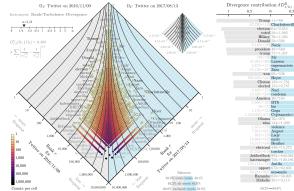
000

Licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License

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:



The PoCSverse

Allotaxonometry 1 of 121

A plenitude of

Rank-turbulence divergence

distances

Probability-

turbulence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

Explorations

Mechanics of

Superspreading

Turbulent times

Stories

Fame

Stories

Fame

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



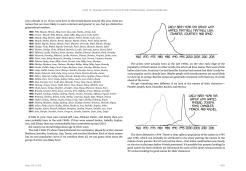
"Probability-turbulence divergence: A tunable allotaxonometric instrument for comparing heavy-tailed categorical distributions" Dodds et al., , 2020. [11]

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.

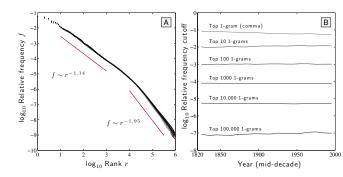
¹See the lexicocalorimeter 🗷

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]

The PoCSverse

Allotaxonometry

A plenitude of

Rank-turbulence

5 of 121

distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

References

Stories

Stories

Fame

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

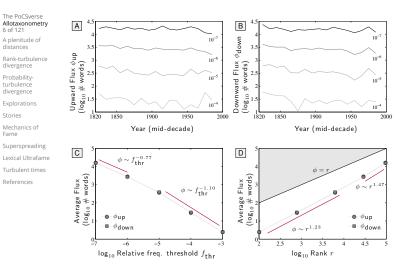
When comparing two texts, define Lexical turbulence as flux of words across a frequency threshold:

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

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 $\nu' \simeq 1.47.$



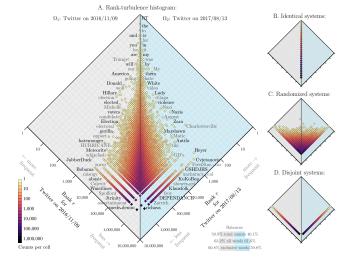
8 of 121 A plenitude of distances Rank-turbulence divergence Probability turbulence divergence Explorations Stories Mechanics of Fame

The PoCSverse

Allotaxonometry

Superspreading Lexical Ultrafame Turbulent times



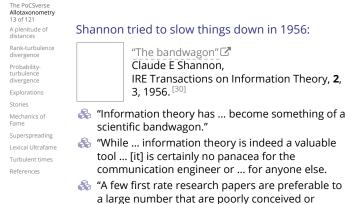


Exclusive types:

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

The PoCSverse

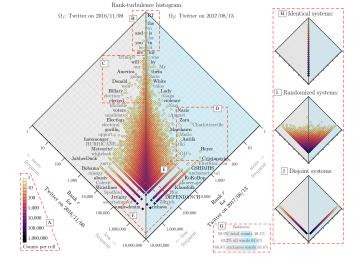
Allotaxonometry

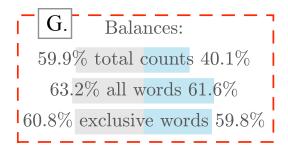
A plenitude of

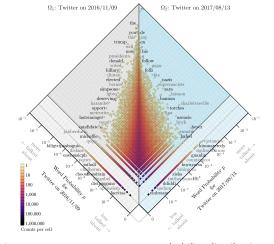
16 of 121

distances

Lexical Ultrafam Turbulent time: References







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"

The PoCSverse

Allotaxonometry

Rank-turbulence

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafam

Turbulent times

References

A plenitude o

12 of 121



- 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."

14 of 121

distances

divergence

Probability

turbulence

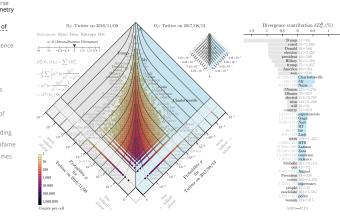
Stories

Fame

Reference

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

Probability

turbulence

Stories

Fame

References

Kullback-Liebler (KL) divergence:

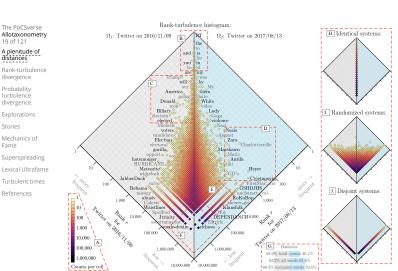
$$\begin{split} D^{\mathsf{KL}}\left(P_{2}\mid \middle| P_{1}\right) &= \left\langle \log_{2} \frac{1}{p_{2,\tau}} - \log_{2} \frac{1}{p_{1,\tau}} \right\rangle_{P_{2}} \\ &= \sum_{\tau \in R_{1,2;\alpha}} p_{2,\tau} \left[\log_{2} \frac{1}{p_{2,\tau}} - \log_{2} \frac{1}{p_{1,\tau}} \right] \\ &= \sum_{\tau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

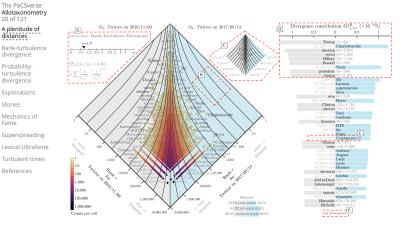
- Problem: If just one component type in system 2 is not present in system 1, KL divergence = ∞ .
- Solution: If we can't compare a spork and a platypus directly, we create a fictional spork-platypus hybrid.
- New problem: Re-read solution.

- 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

The PoCSverse Allotaxonometry 26 of 121 A plenitude of distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

(6)

Rank-turbulence

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.

The PoCSverse Allotaxonometry 24 of 121 A plenitude of distances Rank-turbulence

divergence

Probabilityturbulence divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times

References

Allotaxonometry 25 of 121 A plenitude of Rank-turbulence divergence Probability divergence

The PoCSverse

Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times

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.

The PoCSverse Allotaxonometry 27 of 121 A plenitude of

distances Rank-turbulence divergence

Probability-

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

28 of 121

Explorations

Mechanics of

Superspreading

Turbulent times

29 of 121

distances

divergence

turbulence divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Rank-turbulence

Stories

Allotaxonometry

References

Stories

Fame

(7)

turbulence

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)

divergence Explorations Stories Mechanics of

The PoCSvers

Superspreading Lexical Ultrafame Turbulent times References

The PoCSverse

Allotaxonometry

A plenitude of distances

Rank-turbulence

divergence Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

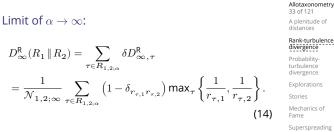
Lexical Ultrafame

Turbulent times

References

Stories

32 of 121



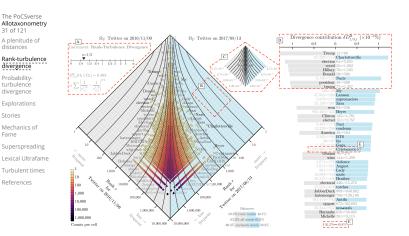
The PoCSverse

Lexical Ultrafame

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)

The PoCSverse Allotaxonometry A plenitude of

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:

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

The PoCSverse Allotaxonometry 36 of 121

A plenitude of distances

Rank-turbulence

Probability-turbuler

divergence

divergence

Explorations

Mechanics of

Stories

Fame

37 of 121

A plenitude of

Rank-turbulence

Probability-turbuler

divergence

divergence

Explorations

Turbulent times

The PoCSverse Allotaxonometry 38 of 121

divergence Explorations

Superspreading

Turbulent times

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,

The PoCSverse Allotaxonometry 39 of 121 A plenitude of distances

Rank-turbulence

divergence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

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].

The PoCSverse Allotaxonometry 42 of 121 A plenitude of distances

> Rank-turbulence divergence

Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times References

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

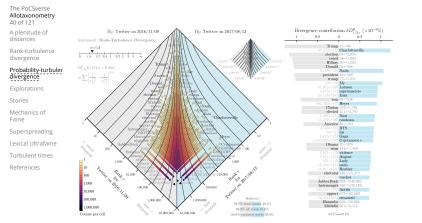
Limit of α =0 for probability-turbulence divergence \Rightarrow if both $p_{\tau,1} > 0$ and $p_{\tau,2} > 0$ then

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

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:

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

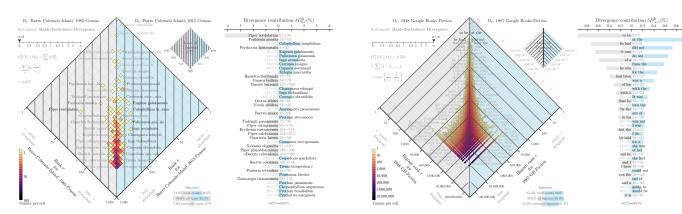
Because the normalization also diverges as $1/\alpha$, the divergence will be zero when there are no exclusive types and non-zero when there are exclusive types.

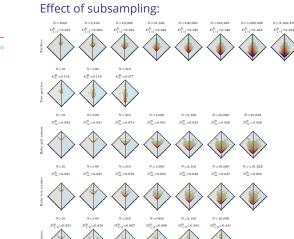
divergence

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

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)





The PoCSverse Allotaxonometry 51 of 121

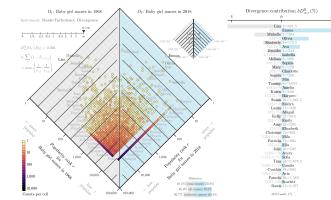
A plenitude of distances Rank-turbulence divergence

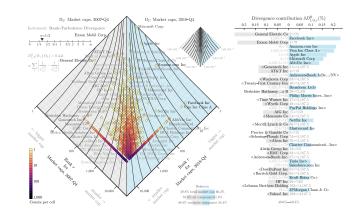
Probabilityturbulence divergence

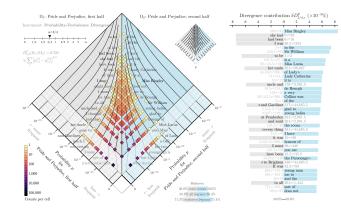
Explorations Stories

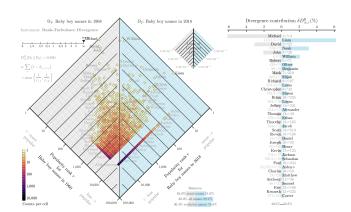
Mechanics of Fame Superspreading

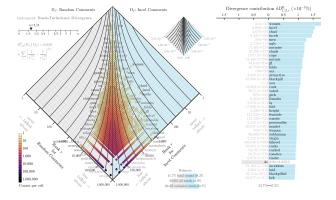
Lexical Ultrafame Turbulent times References

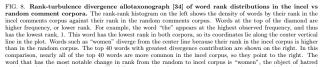


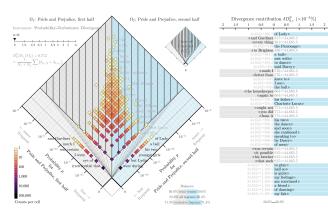


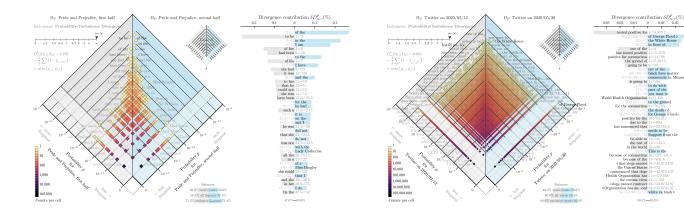












Flipbooks for PTD:

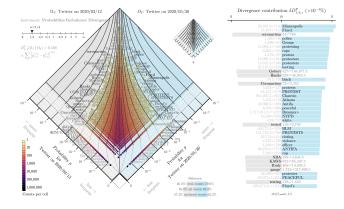
🚳 Jane Austen:

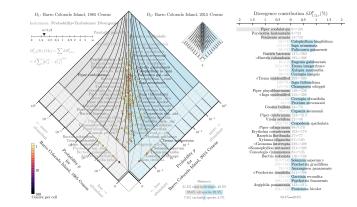
Pride and Prejudice, 1-grams Pride and Prejudice, 2-grams Pride and Prejudice, 3-grams

🚳 Social media:

Twitter, 1-grams

Ecology: Barro Colorado Island III





Code:

https://gitlab.com/compstorylab/allotaxonometer

The PoCSverse Allotaxonometry 61 of 121 A plenitude of

distances Rank-turbulence

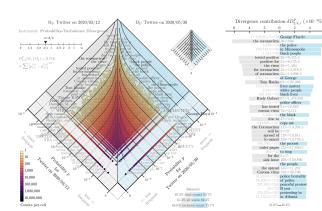
divergence Probabilityturbulence

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:	
-----------------------------------	--

- 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)

The PoCSverse Allotaxonometry 62 of 121 A plenitude of distances Rank-turbulence

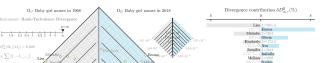
divergence Probabilityturbulence

divergence

Explorations Stories

References

Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times













64 of 121

distances

divergence

Probability-

turbulence

Explorations

Mechanics of

References

The PoCSverse

Turbulent times

References

Stories

Fame

A plenitude of



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]

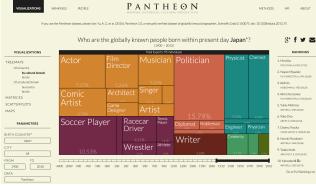




"Once Upon an Algorithm" 🧕 🗹 by Martin Erwig (2017). [14]

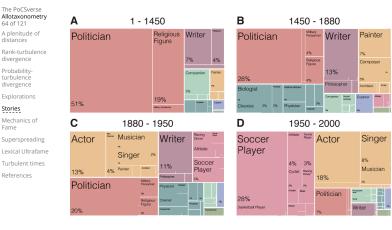
Also: Numerical Recipes in C^[26] and How to Bake π ^[4]

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:

The PoCSverse Allotaxonometry 69 of 121 A plenitude of distances



Rank-turbulence

divergence Probabilityturbulence divergence Explorations Stories

Mechanics of Fame

Superspreading Lexical Ultrafame Turbulent times References

The dismal predictive powers of editors



Allotaxonometry A plenitude of distances Rank-turbulence divergence Probability turbulence divergence Explorations Stories

The PoCSverse

Mechanics of Fame Superspreading Lexical Ultrafame

Turbulent times

References

The completely unpredicted fall of Eastern Europe:

Twelve ...

The PoCSverse

Allotaxonometry

A plenitude of

Rank-turbulence

68 of 121

distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafam

Turbulent times

References

Stories

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

The PoCSverse

Mechanics of Fame

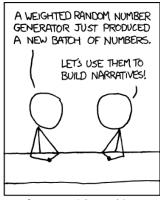
Superspreading Lexical Ultrafame Turbulent times References

We understand bushfire stories:

The PoCSverse Allotaxonometry 72 of 121	
A plenitude of distances	
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



Lexical Ultrafame

Turbulent times

A plenitude of

distances

74 of 121

distances

divergence

turbulence

divergence

Explorations

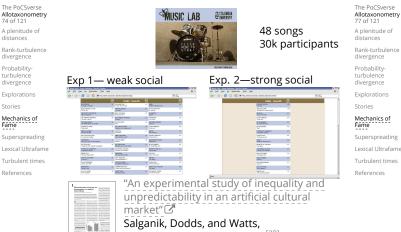
Mechanics of Fame

References

Stories

A plenitude of

See "Becoming Mona Lisa" by David Sassoon



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

The PoCSverse Allotaxonometry 77 of 121 A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence Explorations Stories Mechanics of Fame Superspreading

The PoCSverse

Allotaxonometry 75 of 121

A plenitude of

Rank-turbulence

distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

Stories

Fame

belong to us'

"Mistake" 2:

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



The PoCSverse Allotaxonometry 78 of 121



divergence Probability turbulence divergence Explorations Stories

Mechanics of Fame

Superspreading Lexical Ultrafame Turbulent times References

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}

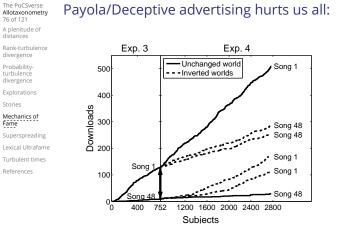
12

24

36

48

48



A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence

The PoCSverse

Allotaxonometry 79 of 121

Explorations Stories Mechanics of Fame

Superspreading Lexical Ultrafame Turbulent times References

The PoCSverse Allotaxonometry 80 of 121 A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence Explorations Stories

Mechanics of Fame

Superspreading Lexical Ultrafam

Turbulent times References



The hypodermic model of influence:

 \bigcirc

 \bigcirc

Ó

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

A plenitude of

Rank-turbulence divergence

distances

Probability-

turbulence

Stories

Fame

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

distances

divergence

Probability

turbulence

Explorations

Mechanics of

Turbulent times

References

The PoCSverse

A plenitude of

Rank-turbulence

83 of 121

distances

divergence

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafam

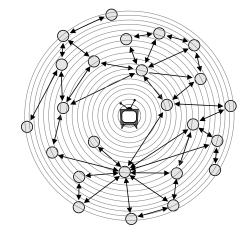
Turbulent times

References

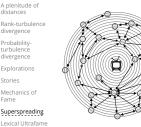
Stories

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.

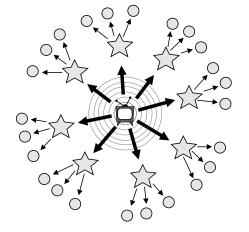
"Influentials, Networks, and Public Opinion Watts and Dodds,

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

The two step model of influence: [17]

 \bigcirc

 \bigcirc

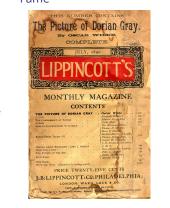


 $\hat{\Box}$

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."

> The PoCSverse Allotaxonometry 88 of 121 A plenitude of distances Rank-turbulence divergence Probability turbulence divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent time:

> > A plenitude of

Rank-turbulence

distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent time:

References

Stories

Fame

The PoCSverse

Allotaxonometry 87 of 121

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

Superspreading Lexical Ultrafame

The PoCSverse

Allotaxonometry 84 of 121

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

Allotaxonometry

A plenitude of

Rank-turbulence

divergence

Probability

divergence

Explorations

Mechanics of

Reference

The PoCSverse

Allotaxonometry

A plenitude of

Rank-turbulence

86 of 121

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

Stories

85 of 121

References

Stories

Fame



References The PoCSverse "Fame and Ultrafame: Measuring and Allotaxonometry 89 of 121

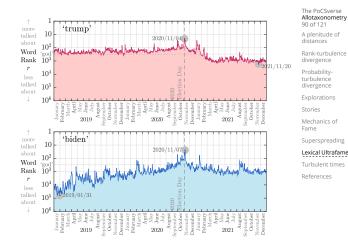
comparing daily levels of 'being talked about' for United States' presidents, their rivals, God, countries, and K-pop" Available online at https://arxiv.org/abs/1910.00149, 2019.^[10]

"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.,





The PoCSverse

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

distances

Stories

Fame

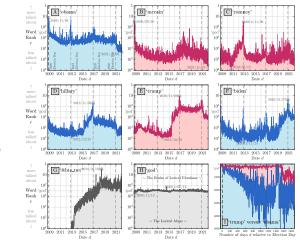
Ultrafame: Nobody expects the Spanish Inquisition K-pop:



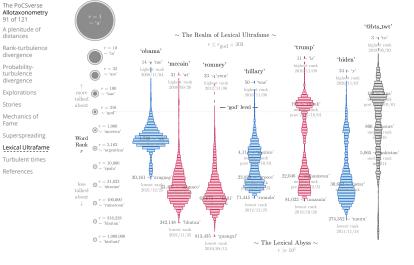
Vox (2019-04-17): BTS, the band that changed K-pop, explained

Telegnomics	The PoCSverse Allotaxonometry 92 of 121
	A plenitude of distances
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	

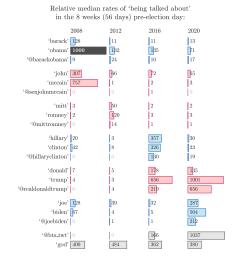
zless	2021-01-06/1grams/en_	*.tar.tsv
zless	2021-01-07/1grams/en	*.tar.tsv

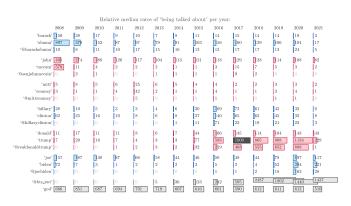




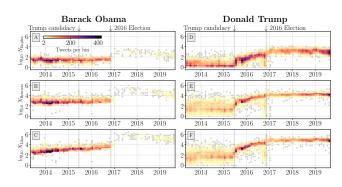


Ultrafame—Percentage of days per year ranked above 'god' 2010 2011 2012 2013 2014 2015 2016 2017 2018 2008 2009 2019 2020 2021 @barackobama' 'john' 3.5% 0.6% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.3% 0.8% 0.3% 0.5% 0.0% "@senjohnmccain" 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.0% 0.8% 0.0% 0.0% 0.0% 'mitt' 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%



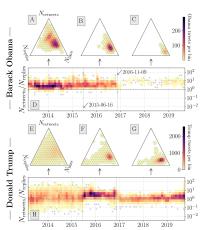


Ratiometrics:



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

Ratiometrics:



Stories

Fame

The PoCSverse

Allotaxonometry 100 of 121

Rank-turbulence

A plenitude of

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

Allotaxonometry 101 of 121

Rank-turbulence

A plenitude of

distances

divergence

turbulence

divergence

Explorations

Mechanics of

Lexical Ultrafame

Turbulent times

References

Stories

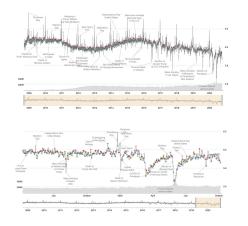
Fame Superspreading

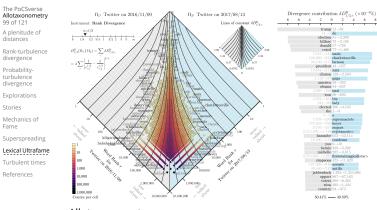
References

Stories

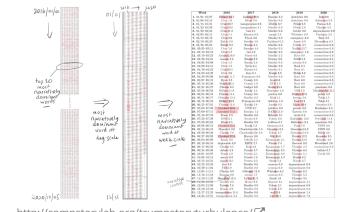
Fame

Emotional turbulence:





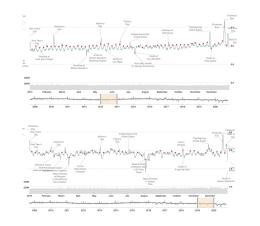
Allotaxonometrythe comparison of complex systems: http://compstorylab.org/allotaxonometry/



http://compstorylab.org/trumpstoryturbulence/

http://hedonometer.org/

Emotional turbulence:

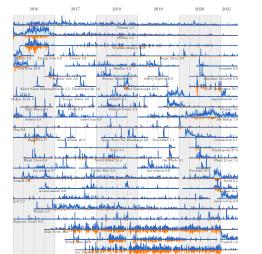


http://hedonometer.org/

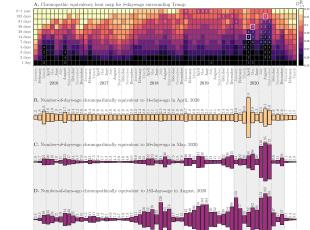
1. 01/01-01/07	Hillary 34.7	hacking 28.6	Bannon 2.2	shutdown 0.0	Iran 9.6	Georgia 14.7
 01/08-01/14 	Cruz 1.0	Mergl 5.0	Mueller 0.0	shutdown 0.0	Soleimani 5.9	Capitol 0.1
3. 01/15-01/21	Cruz 10.7	inauguration 0.6	DACA 6.7	Pelosi 6.8	Parnas 0.0	Capitol 0.0
4. 01/22-01/28	Cruz 10.6	inauguration 3.1	Mueller 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









Rank-turbulence

divergence

Probability-

turbulence

divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame

Turbulent times References

Understanding the Sociotechnocene—Stories:

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

No^{Rokosto}

ding!

References I

[1] P. E. Auerswald.

History.

B. Boyd.

Fiction.

S.-H. Cha.

pdf 🕑

[2]

[3]

۲

- Toward a Science of Stories.
- 🚳 Claim: Homo narrativus 🖾—we run on stories.
- 🚳 "What's the John Dory?"
- lost the plot/thread" 🚳
- Stories Narrative hierarchies and scalability Mechanics of of stories 🗹. Fame
- Superspreading Research: Real-time and offline extraction of metaphors, frames, Turbulent times plots, narratives, conspiracy theories, References and stories from large-scale text.
- 🗞 Research: The taxonomy of human stories.
- 🚳 To be built: Storyscopes-improvable, online,
- interactive instruments.



On Instagram at pratchett_the_cat

The Code Economy: A Forty-Thousand Year

On the Origin of Stories: Evolution, Cognition, and

Comprehensive survey on distance/similarity

measures between probability density functions.

Methods in Applied Sciences, 1:300-307, 2007.

International Journal of Mathematical Models and

Oxford University Press, 2017.

Belknap Press, 2010.

References II Allotaxonometry 108 of 121

The PoCSverse

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

Explorations

The PoCSverse

109 of 121

distances

divergence

Probability-

turbulence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

110 of 121

distances

divergence

urbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

A plenitude of

Rank-turbulence

References

Stories

Fame

A plenitude of

Rank-turbulence

- [4] E. Cheng How to bake pi: An edible exploration of the mathematics of mathematics. Basic Books, 2015.
- [5] B. Christian and T. Griffiths. Algorithms to Live By. Macmillan, 2016.
- [6] A. Cichocki and S.-i. Amari. Families of Alpha- Beta- and Gammadivergences: Flexible and robust measures of similarities. Entropy, 12:1532–1568, 2010. pdf
- [7] M.-M. Deza and E. Deza. Dictionary of Distances. Elsevier, 2006.

References III Allotaxonometry

- [8] L. R. Dice. Measures of the amount of ecologic association between species. Ecology, 26:297-302, 1945.
- [9] P. S. Dodds, J. R. Minot, M. V. Arnold, T. Alshaabi, J. L. Adams, D. R. Dewhurst, T. J. Gray, M. R. Frank, A. J. Reagan, and C. M. Danforth. Allotaxonometry and rank-turbulence divergence: A universal instrument for comparing complex systems, 2020. Available online at

https://arxiv.org/abs/2002.09770.pdf

References IV Allotaxonometry

- [10] P. S. Dodds, J. R. Minot, M. V. Arnold, T. Alshaabi, J. L. Adams, D. R. Dewhurst, A. J. Reagan, and C. M. Danforth. Fame and Ultrafame: Measuring and comparing daily levels of 'being talked about' for United
 - States' presidents, their rivals, God, countries, and K-pop, 2019. Available online at

https://arxiv.org/abs/1910.00149. pdf

[11] P. S. Dodds, J. R. Minot, M. V. Arnold, T. Alshaabi, J. L. Adams, D. R. Dewhurst, A. J. Reagan, and C. M. Danforth.

Probability-turbulence divergence: A tunable allotaxonometric instrument for comparing heavy-tailed categorical distributions, 2020.

The PoCSverse References V Allotaxonometry 111 of 121

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

A plenitude of

distances

divergence

Probability

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

References

Stories

Stories

Fame

Available online at https://arxiv.org/abs/2008.13078.pdf

- [12] P. S. Dodds, J. R. Minot, M. V. Arnold, T. Alshaabi, I. L. Adams, A. J. Reagan, and C. M. Danforth.
 - Computational timeline reconstruction of the stories surrounding Trump: Story turbulence, narrative control, and collective chronopathy, 2020. https://arxiv.org/abs/2008.07301.pdf
- [13] D. M. Endres and J. E. Schindelin. A new metric for probability distributions. IEEE Transactions on Information theory, 2003. pdf 🖸

Probabilityturbulence divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times References

The PoCSverse

Allotaxonometry

A plenitude of

Rank-turbulence

115 of 121

distances

divergence

Probability

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

References

Stories

Fame

The PoCSverse

Allotaxonometry 114 of 121

A plenitude of

Rank-turbulence

distances

divergence

The PoCSverse References VI Allotaxonometry 112 of 121 [14] M. Erwig. Rank-turbulence

- Once Upon an Algorithm. MIT Press, 2017.
- [15] J. Gottschall. The Storytelling Animal: How Stories Make Us Human. Mariner Books, 2013.
- [16] E. Hellinger.

Neue begründung der theorie quadratischer formen von unendlichvielen veränderlichen. Journal für die reine und angewandte Mathematik

(Crelles Journal), 1909(136):210–271, 1909. pdf 🕑

Now out of never: The element of surprise in the

Divergence measures based on the Shannon

IEEE Transactions on Information theory,

[17] E. Katz and P. F. Lazarsfeld. Personal Influence. The Free Press, New York, 1955.

References VII

[18] T. Kuran.

[19] J. Lin.

entropy.

Allotaxonometry 113 of 121 A plenitude of distances Rank-turbulence divergence Probability turbulence divergence Explorations

The PoCSverse

Stories Mechanics of Superspreading Lexical Ultrafame

Turbulent times References

[20] J. Looman and J. B. Campbell. Adaptation of Sørensen's k (1948) for estimating unit affinities in prairie vegetation.

37(1):145-151, 1991. pdf

east european revolution of 1989.

World Politics, 44:7-48, 1991. pdf

Ecology, 41(3):409–416, 1960. pdf

The PoCSverse Allotaxonometry 116 of 121 A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafam Turbulent times

References VIII

[21] K. Matusita et al.

Decision rules, based on the distance, for problems of fit, two samples, and estimation. The Annals of Mathematical Statistics, 26(4):631-640, 1955. pdf

[22] J. R. Minot, M. V. Arnold, T. Alshaabi, C. M. Danforth, and P. S. Dodds. Ratioing the President: An exploration of public engagement with Obama and Trump on Twitter, 2020. Available online at https://arxiv.org/abs/2006.03526.pdf

[23] R. Munroe. How To: Absurd Scientific Advice for Common Real-World Problems. Penguin, 2019.

References IX

[24] F. Osterreicher and I. Vajda.

A new class of metric divergences on probability spaces and its applicability in statistics. Annals of the Institute of Statistical Mathematics, 55(3):639-653, 2003.

[25] E. A. Pechenick, C. M. Danforth, and P. S. Dodds. Is language evolution grinding to a halt? The scaling of lexical turbulence in English fiction suggests it is not.

Turbulent times Journal of Computational Science, 21:24–37, 2017. pdf 🖸

[26] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery.

Numerical Recipes in C.

Cambridge University Press, second edition, 1992.

References X

The PoCSverse

Allotaxonometry 117 of 121

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

Turbulent times

The PoCSverse

A plenitude of

Rank-turbulence

distances

divergence

Probability-

turbulence

divergence

Explorations

Mechanics of

Superspreading

Lexical Ultrafame

References

Stories

Fame

References

Stories

Fame

[27] M. Puchner.

- The Written World: How Literature Shaped Civilization. Random, 2017.
- [28] M. J. Salganik, P. S. Dodds, and D. J. Watts. An experimental study of inequality and unpredictability in an artificial cultural market. Science, 311:854-856, 2006. pdf
- [29] Y. Sasaki.

The truth of the *f*-measure, 2007.

[30] C. E. Shannon. The bandwagon.

IRE Transactions on Information Theory, 2(1):3, 1956. pdf 🕑

References XI Allotaxonometry 118 of 121

[31] T. Sorensen.

A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. Videnski Selskab Biologiske Skrifter, 5:1-34, 1948.

[32] C. J. Van Rijsbergen. Information retrieval.

Butterworth-Heinemann, 2nd edition, 1979.

[33] D. J. Watts and P. S. Dodds. Influentials, networks, and public opinion formation.

Journal of Consumer Research, 34:441–458, 2007. pdf 🖸

The PoCSverse References XII Allotaxonometry 119 of 121

A plenitude of Rank-turbulence [34] J. R. Williams, J. P. Bagrow, C. M. Danforth, and P. S. Dodds. Text mixing shapes the anatomy of rank-frequency distributions. Superspreading Physical Review E, 91:052811, 2015. pdf Lexical Ultrafame Turbulent times

The PoCSverse Allotaxonometry 121 of 121 A plenitude of distances Rank-turbulence divergence Probabilityturbulence divergence Explorations Stories Mechanics of Fame Superspreading Lexical Ultrafame Turbulent times

References

The PoCSverse Allotaxonometry 120 of 121 A plenitude of distances Rank-turbulence divergence Probability turbulence divergence Exploration Stories Mechanics of Superspreading Lexical Ultrafam

distances

divergence

Probability

turbulence

divergence

Explorations

Mechanics of

References

Stories

Fame