

Temporal Dynamics

TM the Great Unread

K.L. Nielbo

DTL |Digital Arts Initiative
Interacting Minds Centre|Aarhus University

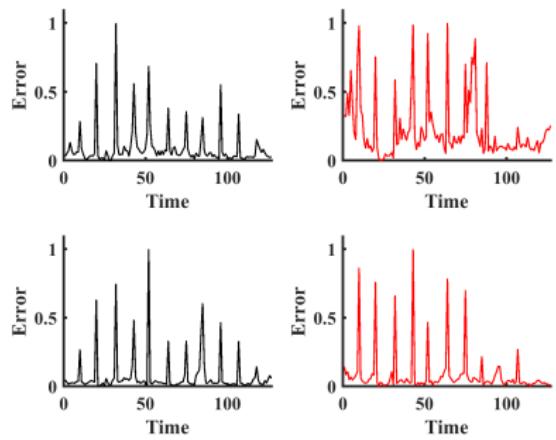
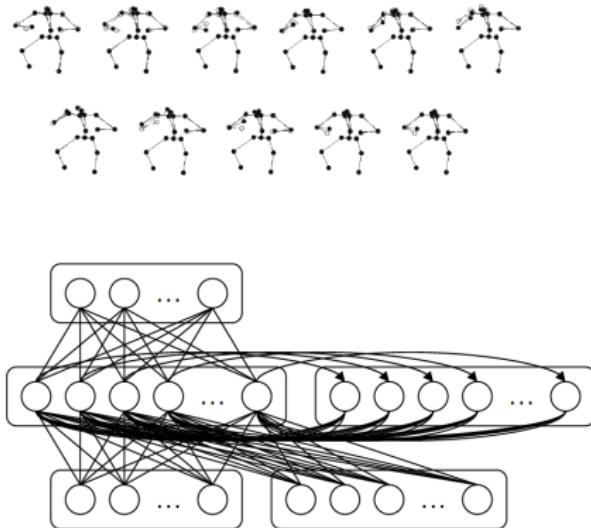
August 4, 2016



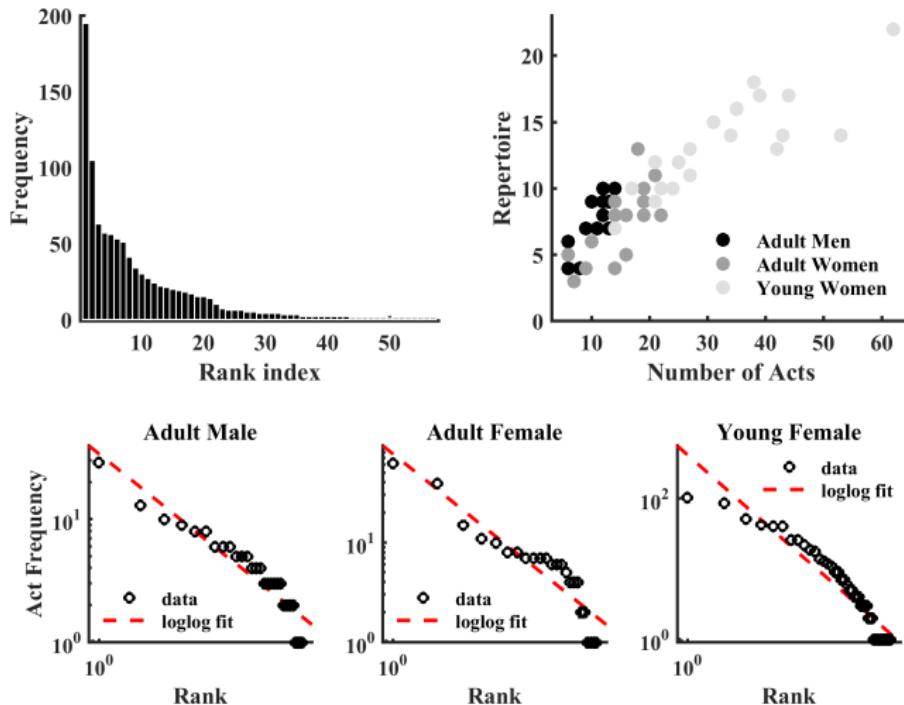


Study the temporal development/evolution of a system

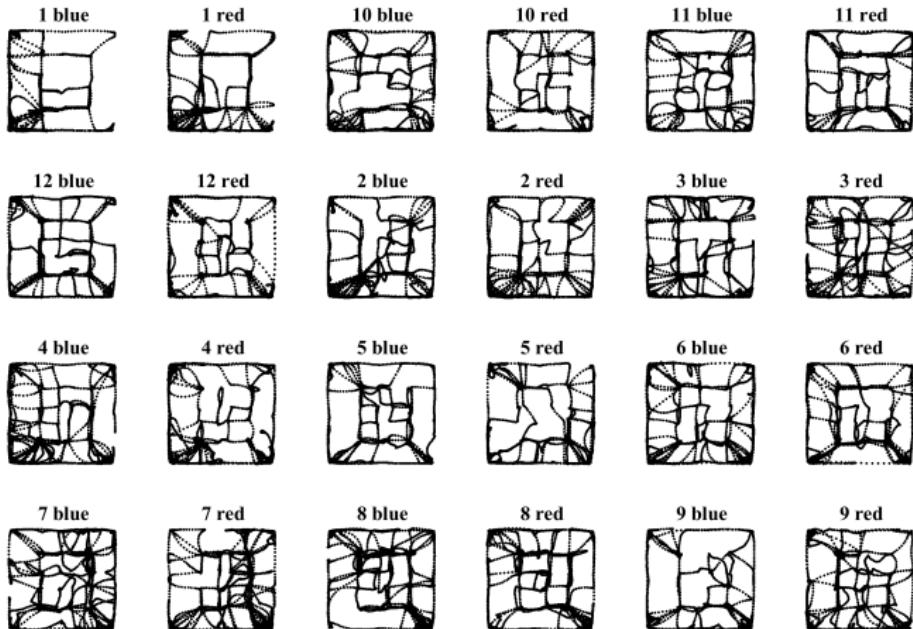
Human behavior



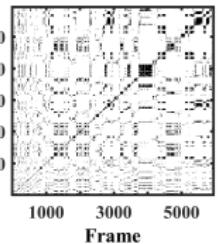
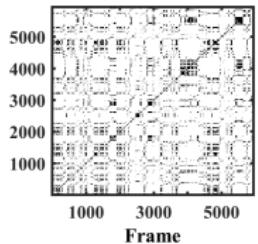
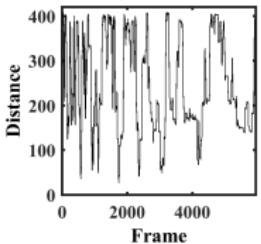
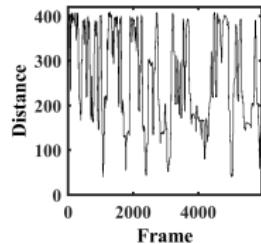
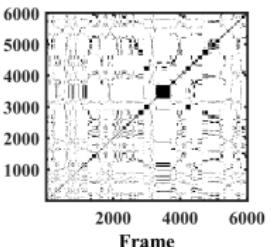
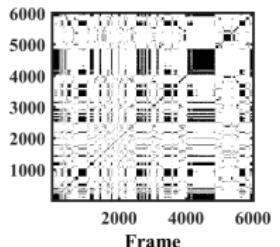
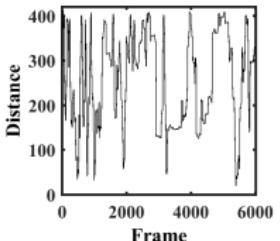
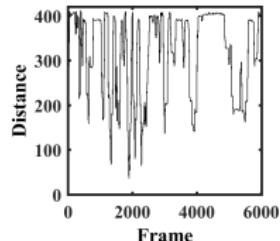
Cultural behavior is just another expressive system



Animal behavior



Animal behavior



N.F.S. Grundtvig

GRUNDTVIG

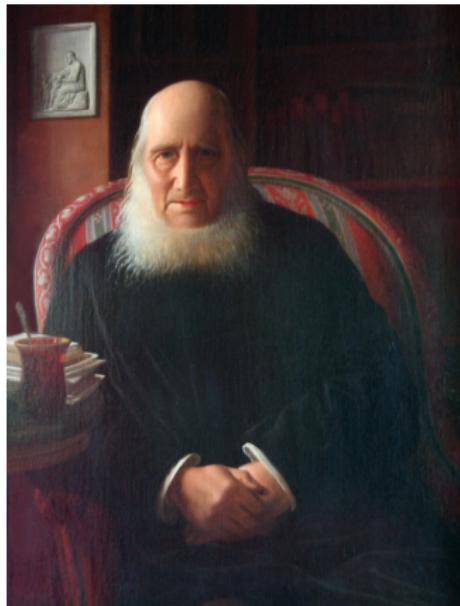
- ▶ 1783-1872
- ▶ pastor & liberal thinker
- ▶ national identity & cultural heritage
- ▶ popular figure in DK

INTERESTING

- ▶ productive for a long time (~ 70yrs)
- ▶ graphomanic (N = 962)
- ▶ psychology (bipolar)
- ▶ competing theories

ALTERNATIVELY

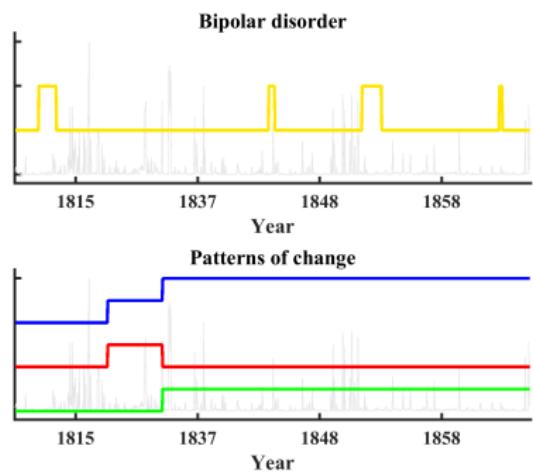
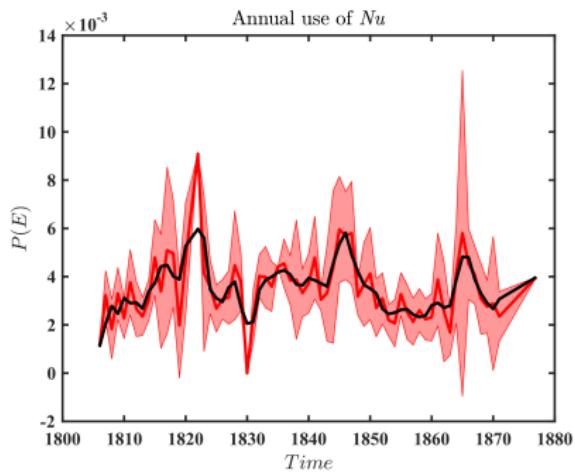
- ▶ author
- ▶ periodic literary tradition

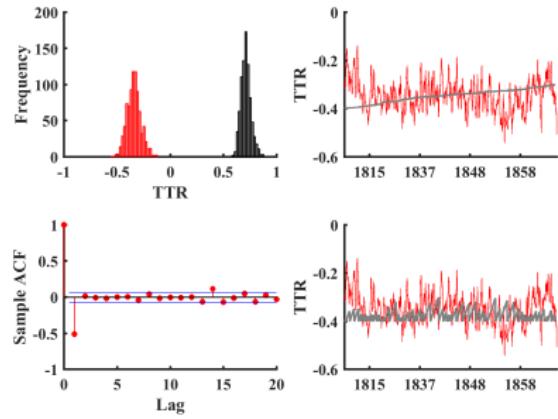
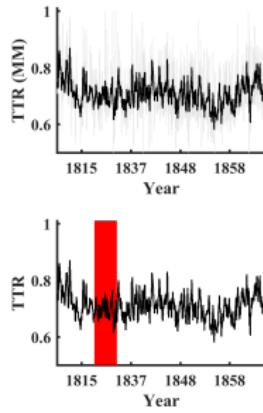
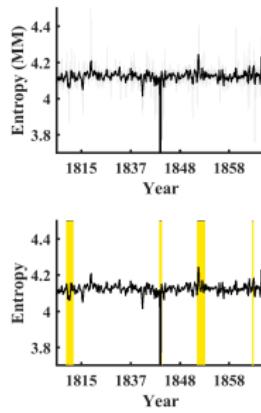


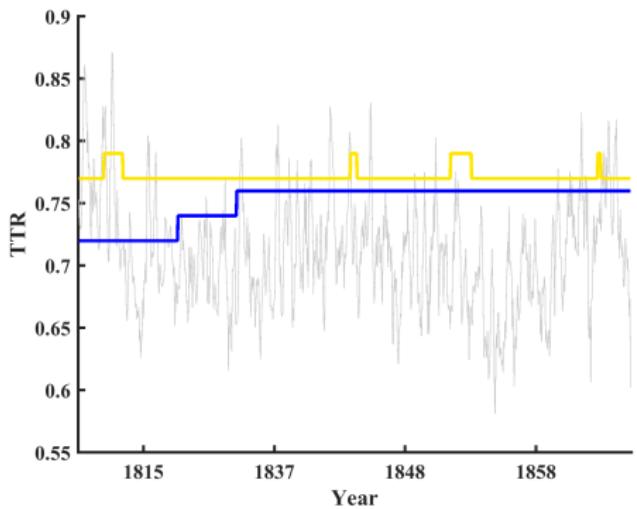
N. F. S. Grundtvig by Constantin Hansen

<http://www.xn--grundtvigsverker-71b.dk/>

<http://grundtvigcenteret.au.dk>







Jens Hansen havde en bondegård

Jens Hansen havde en bondegård

Lirum Larum Lej

Og på den gård der var en ko

Lirum Larum Lej

Det var muh muh her

det var muh muh der

det var muh her, muh der

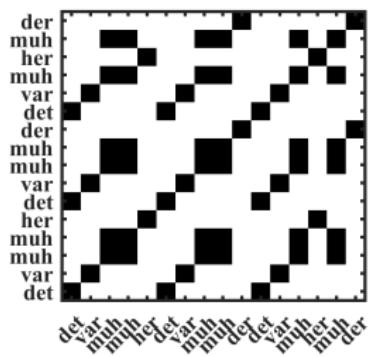
alle steder muh

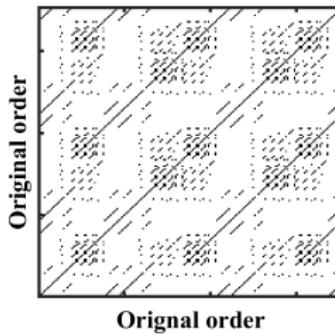
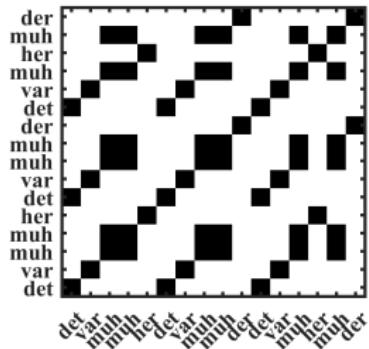
Jens Hansen havde en bondegård

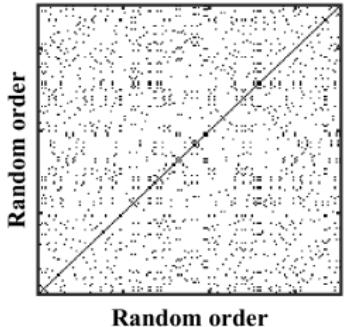
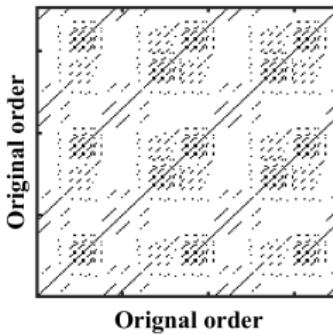
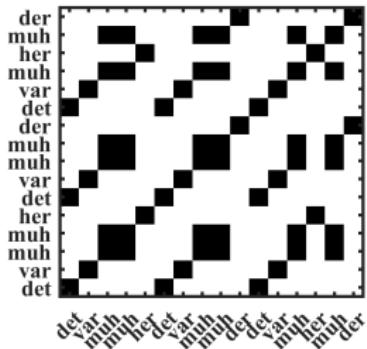
Lirum Larum Lej.

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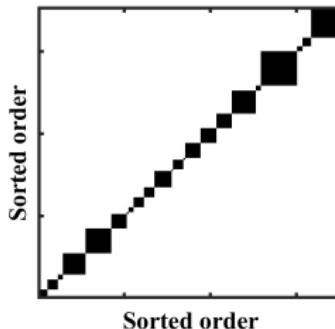
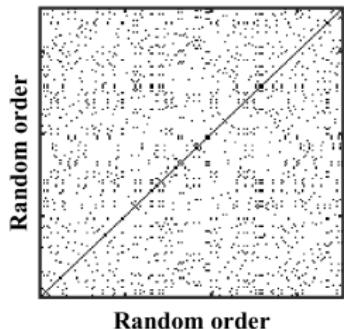
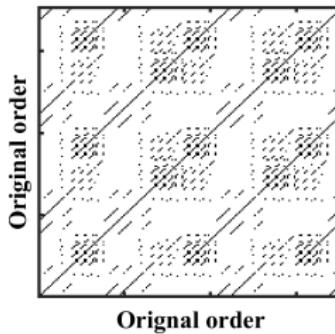
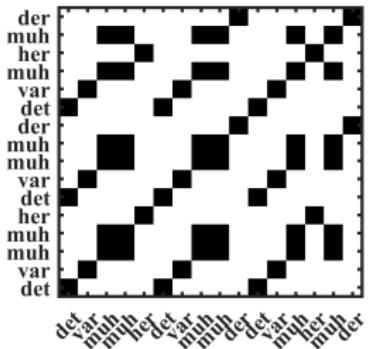
(text: Otto Leisner, melody: 'Old MacDonald Had a Farm')



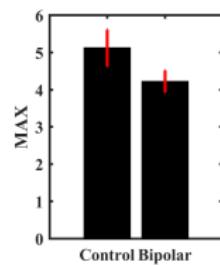
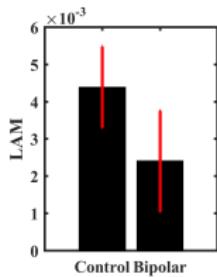
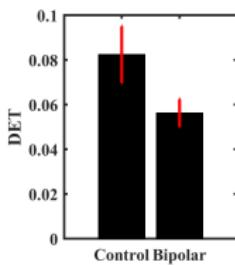
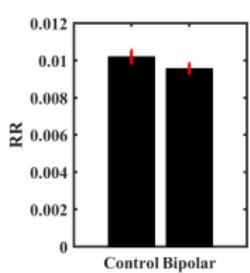




Random order

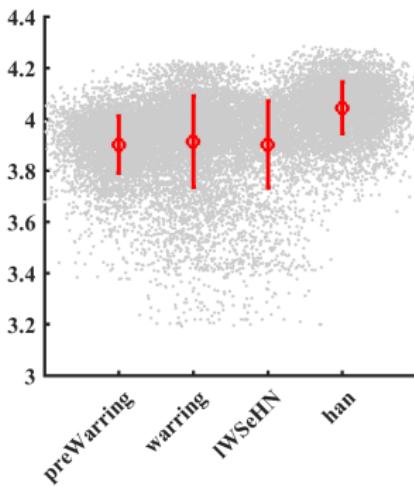
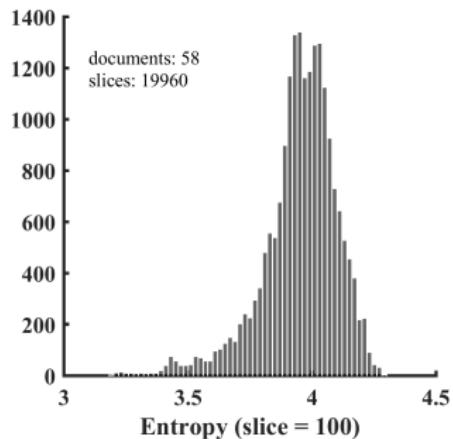


Bipolar disorder in historical writings



Classical Chinese Literature

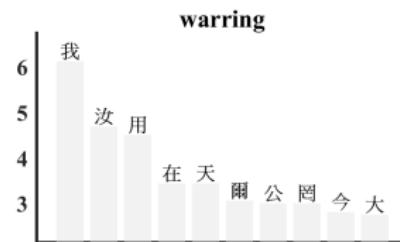
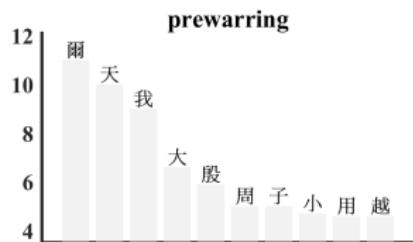
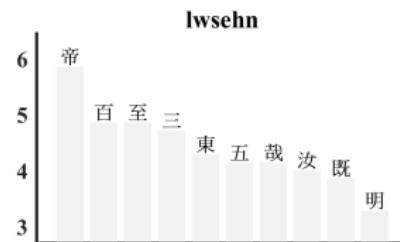
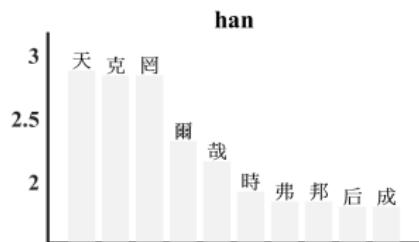
Simple trajectories underlying complex cultural evolution: condensation, eruption,



Error semantics

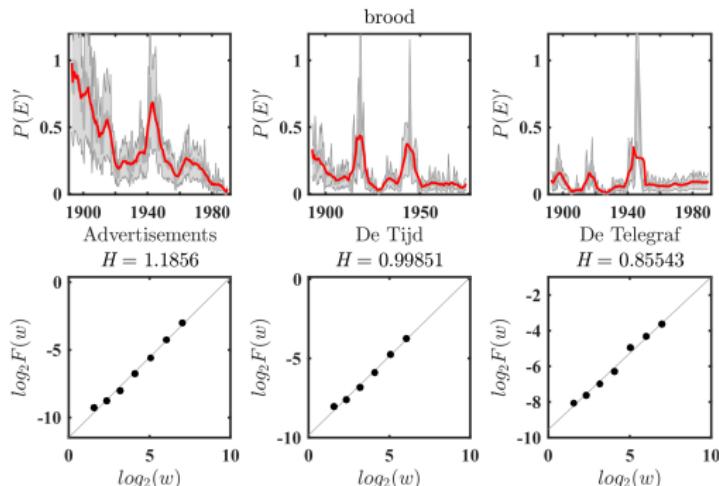
		Output			
		han	lWSeHN	preWarring	warring
Target	han	24	1	0	0
	lWSeHN	0	6	0	1
	preWarring	0	0	10	0
	warring	0	0	1	15

Era-specific characters



Dutch newspapers

Understand differences in product trajectories over time between advertisements and articles ~ long-range correlations (+/-).



Hurst Exponent

H of 0-0.5 indicates anti-correlated process; $H = 0.5$ indicates absence of long-range correlations; H of 0.5-1 indicates long-range correlation; and $H > 1$ is indicative of non-stationary processes

Test if advertisements influence articles $\sim x$ cause y

Granger Causality

Compare the nested (Ω) and full model (π) to see which one does the better job at explaining y :

$$\Omega = y_t = \beta_0 + \beta_1 y_{t-1} + \dots + \beta_k y_{t-k} + \epsilon$$

$$\pi = y_t = \beta_0 + \beta_1 y_{t-1} + \dots + \beta_k y_{t-k} + \alpha_1 x_{t-1} + \dots + \alpha_k x_{t-k} + \epsilon$$

Compare residual sums of squared error and test null and alternate hypothesis

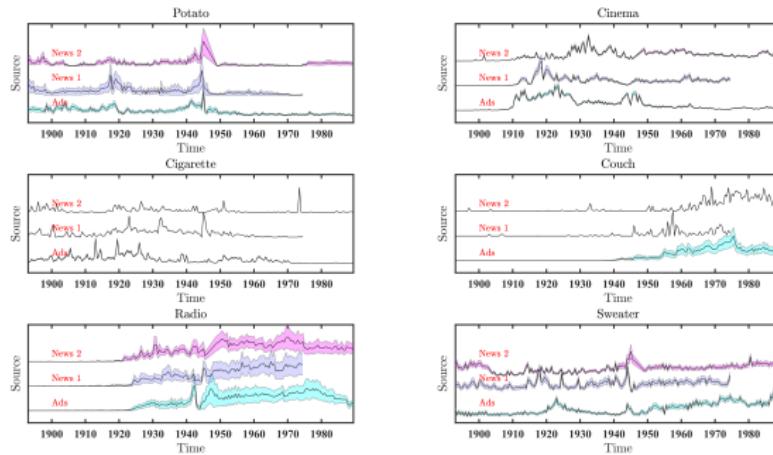
$$H_0 : \alpha_i = 0 \text{ for each } i \text{ of the element } [1, k]$$

$$H_1 : \alpha_i \neq 0 \text{ for at least one } i \text{ of the element } [1, k]$$

\sim Do advertisements provide more information about future values of articles than past values of articles alone? Not causation, we need to run the reverse model to rule out exogenous variable.

Results

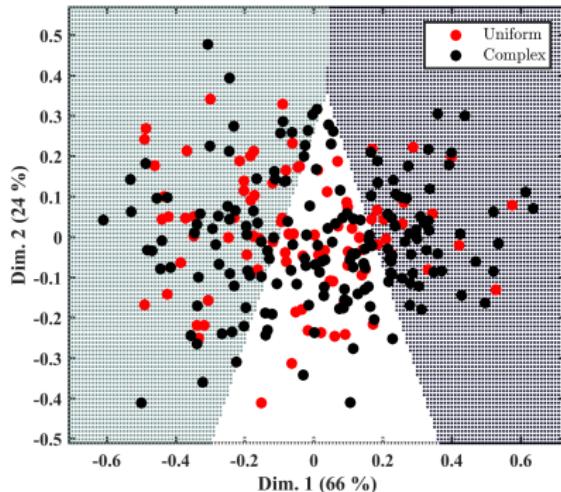
Indication of **different scaling-laws**, advertisements exhibit non-stationarity ($H > 1$), while articles show long-term dependencies ($0.5 < H < 1$).



Two dominant causal patterns, **uniform causation** (advertisements \Rightarrow articles) and **complex causation** (advertisements \Leftrightarrow articles)

Causal relationship	LRD in <i>ads + articles</i>	LRD in <i>ads</i>	LRD in <i>articles</i>	no LRD
Uniform ($ads \Rightarrow article$)	cigarettes	\emptyset	LIFESTYLE sweater flanel cocker spaniels parakeet bikes	ENTERTAINMENT cinema restaurent
Complex ($ads \Leftrightarrow article$)	PRODUCE potatoes apples beans lettuce cauliflower	\emptyset	INTERIOR couch dressoir carpet	TECHNOLOGY tape-recorder radio television

The story is slightly more complicated due to **product groups**. Partitioned the products on the Hurst exponent and causal patterns.



k-means method

Euclidean distance metric for the Hurst features and Hamming distance metric (percentage of bits that differ) for causal patterns. Various internal and external validity indices to determine k for $k = 2, 3, \dots, N$