UNIT OF EXCELLENCE MARÍA DE MAEZTU

MACROECOLOGICAL PATTERNS OF INFORMATION ECOSYSTEMS

Violeta Calleja-Solanas[1], Carlos A. Plata[2,3], María J. Palazzi[4], Albert Solé-Ribalta[4], Javier Borge-Holthoefer[4], Samir Suweis[3,5,6] & Sandro Meloni[1]

[1]Institute for Cross-Disciplinary Physics and Complex Systems, CSIC-UIB, 07122 Palma, Spain [2]Université Paris-Saclay, CNRS, LPTMS, 91405 Orsay, France [3]Dipartimento di Fisica "G. Galilei", INFN and University of Padova, Via Marzolo 8, 35151 Padova, Italy [4]Internet Interdisciplinary Institute, Universitat Oberta de Catalunya, 08018 Barcelona, Catalonia, Spain [5]Padova Neuroscience Center, University of Padova, Via Orus 2/B, 35131 Padova, Italy [6]European Center of Living Technology, Dorsoduro 3911, 30123 Venezia, Italy

Abstract

Humans are generating data as never before. This causes a bottleneck in our ability to tackle information (memes). As a consequence, online communication systems become an environment where memes compete for users' attention[1,2]. Thus, it is crucial to understand the complex dynamics taking place in these information ecosystems because our vision of the world is partially obtained through them.

If we want to characterise the mechanisms that shape them, a starting approach is to study the statistical regularities or organisational patterns that arise. Although some statistical relationships already exist in social networks, it is in ecology where emergent patterns have been used for a long time[4]. Exploiting the similarities between natural and information ecosystems, we can map the characterisation of information systems into the study of ecological communities.

Here, we have systematically analysed 7 major macroecological patterns in Twitter. We have analysed tweets' streams, and we have found that the same functional forms predicted for ecological communities hold for online social systems. This universality gives us robust support for a stable bridge and pave the way for a fruitful co-fertilisation of the two fields[1,2,3].

A question:

What drives our online behaviour?

Are there common regularities?

Our approach:

Seeking for general patterns make possible simplification, model-construction and predictability.

Exploit tools and theories from Theoretical Ecology to understand Human Behavior.

Mapping:

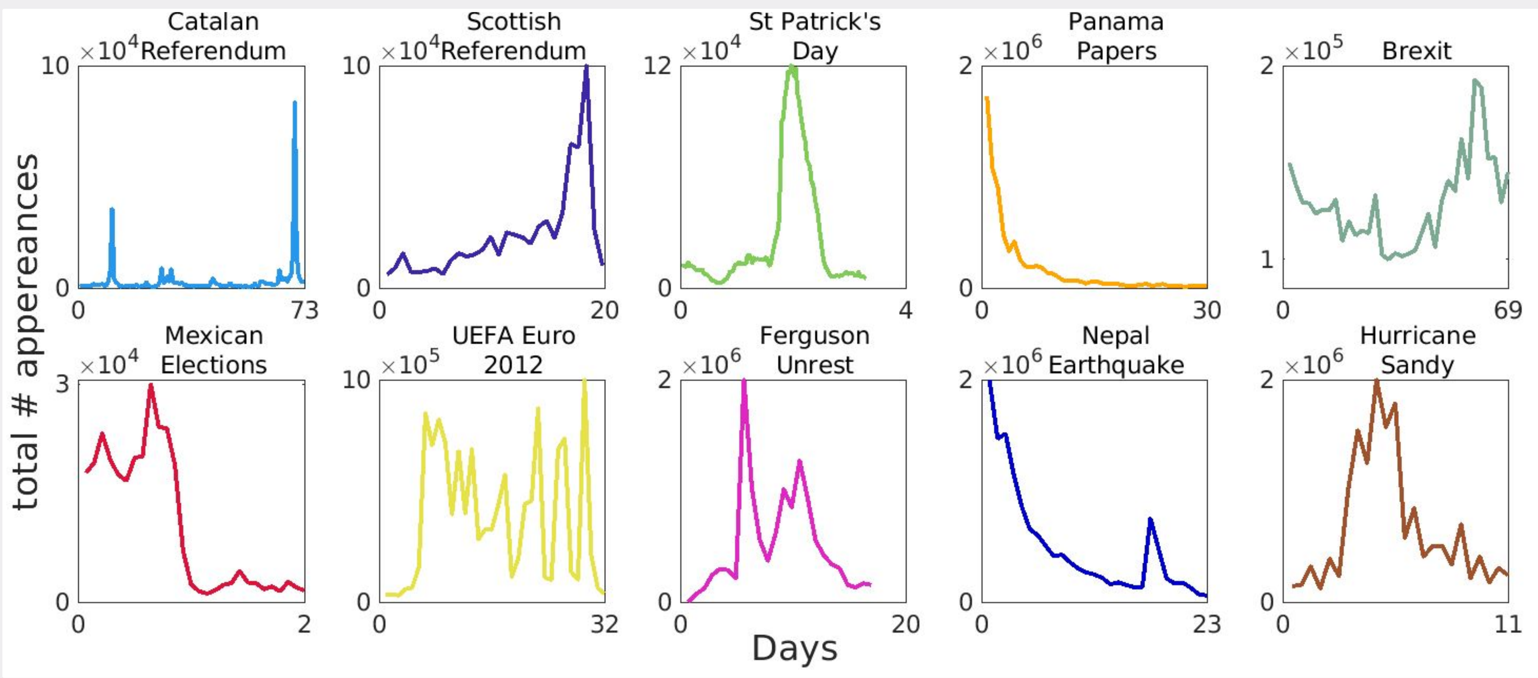
Species ↔ #, Users

Abundance ↔ Popularity

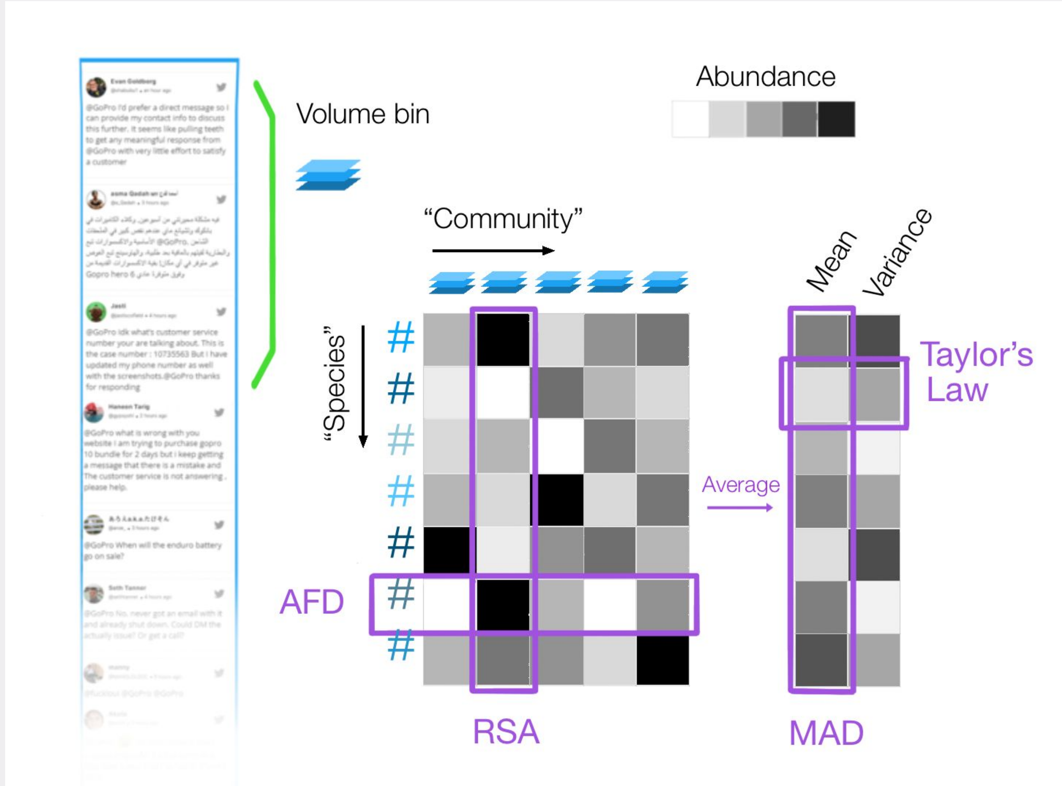
Resources ↔ User's attention

Methods:

We have fit 12 datasets of events and random samples of Twitter activity to 7 ecological patterns.



Patterns
Taylor's Law
Abundance Fluctuations Distribution AFD
Mean Abundance Distribution MAD
Relative Species Abundance RSA
Species Area Curve SAC
Daily Abundance Change μ
Species vs Innovation rate[3]

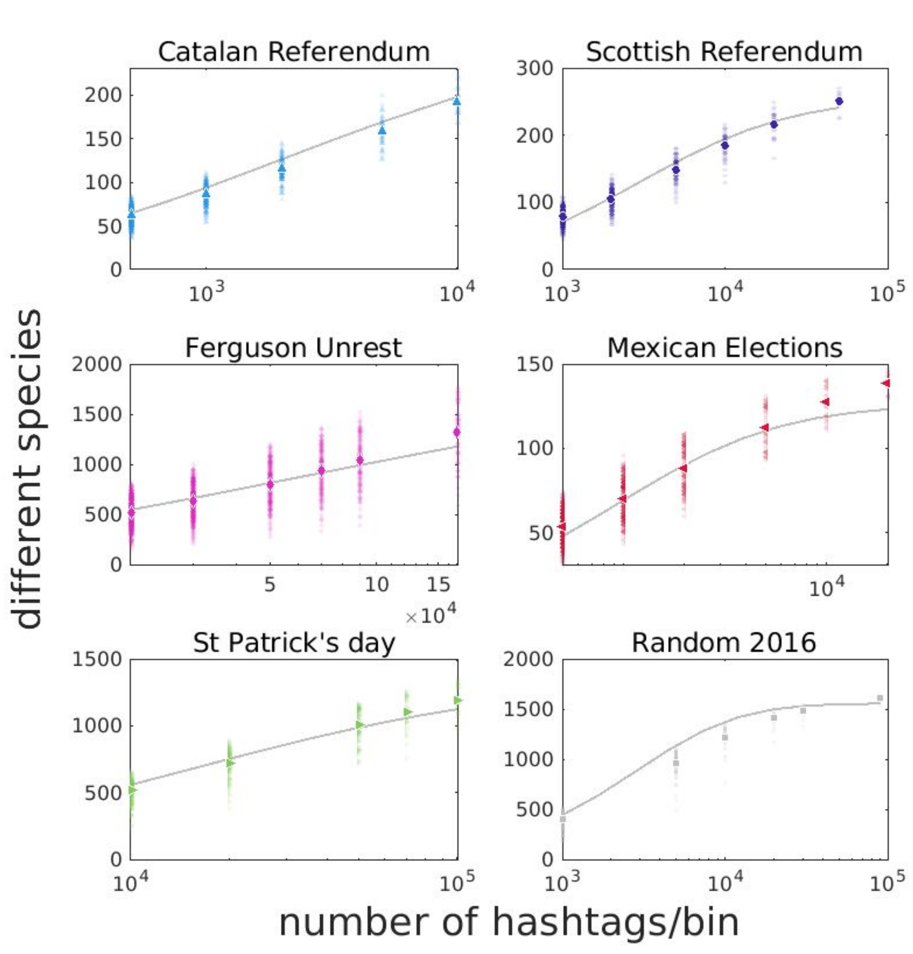


Results:

The patterns hold for information ecosystems! For example…

Species Area Curve - SAC

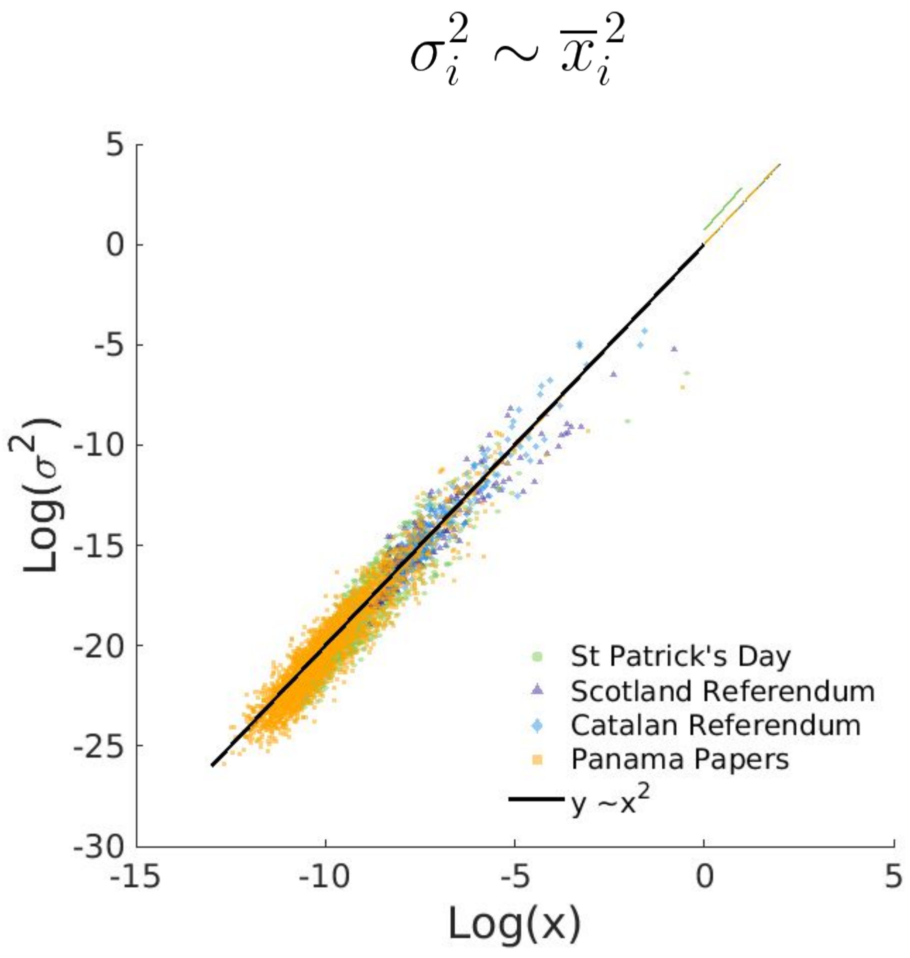
how species diversity increases with sampling size



Taylor's Law

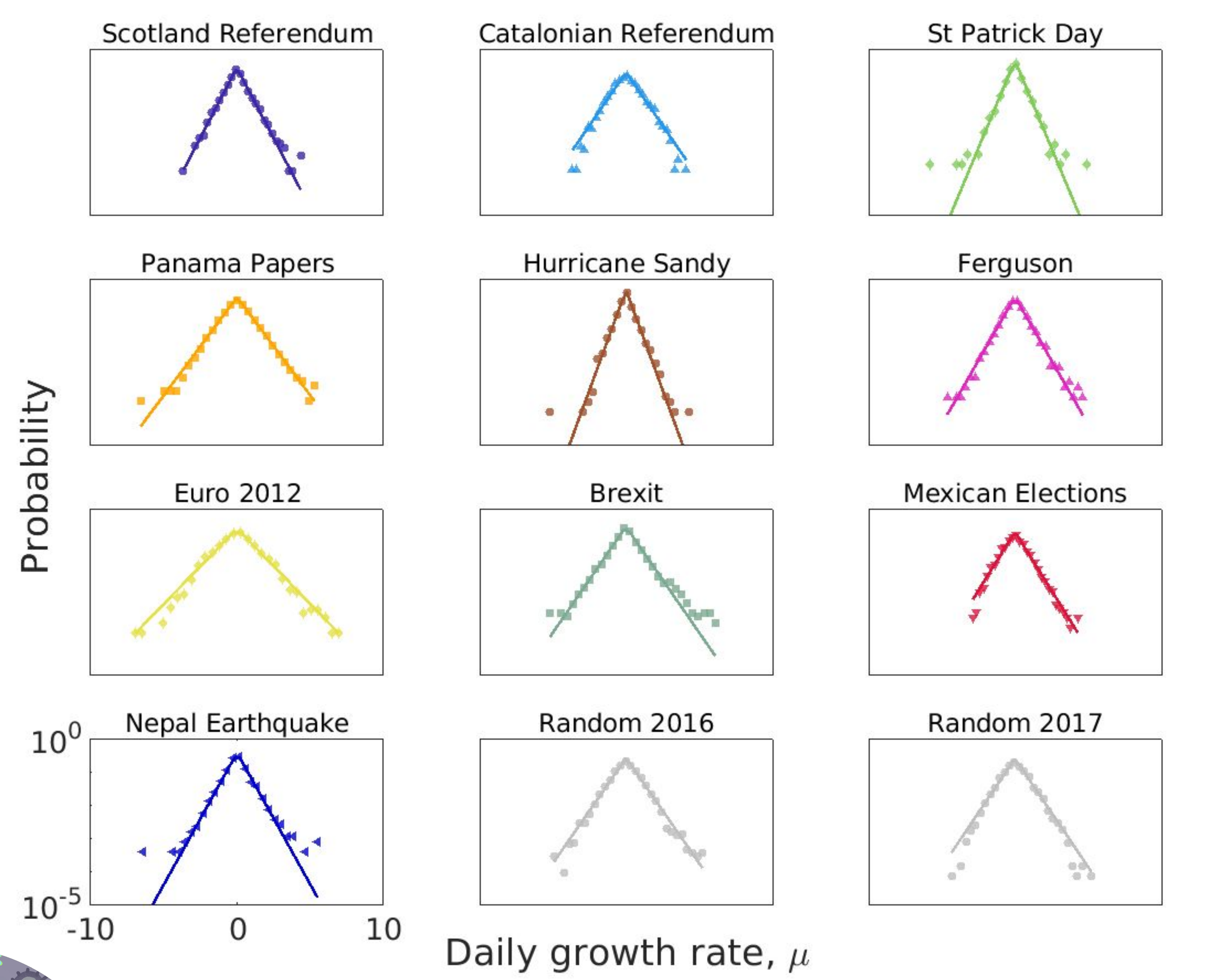
Connects the mean abundance of a species with its variance:

$$\sigma_i^2 \sim \bar{x}_i^2$$



Daily Abundance Change - μ

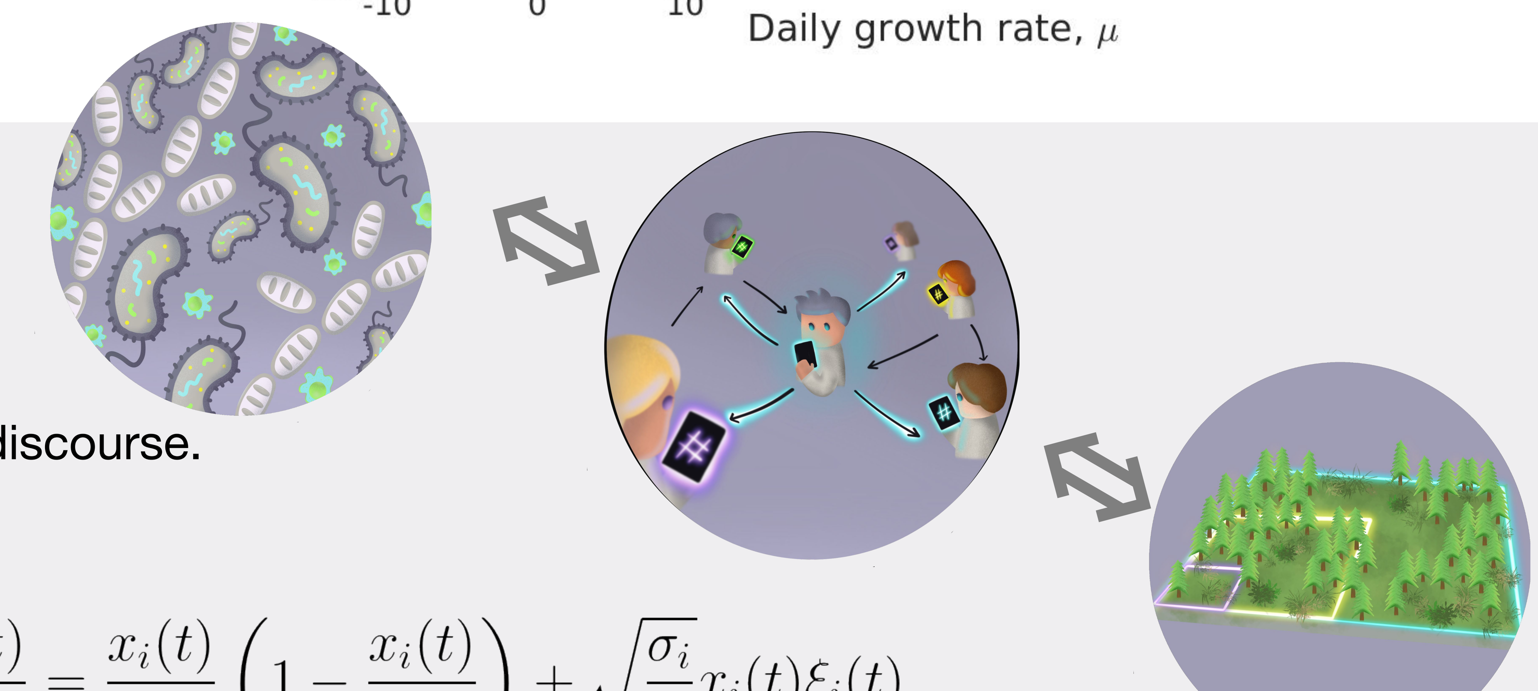
Distribution of the ratio between abundance at time t + 1 and time t



Cool but… so what?

Why is discover universal patterns important?

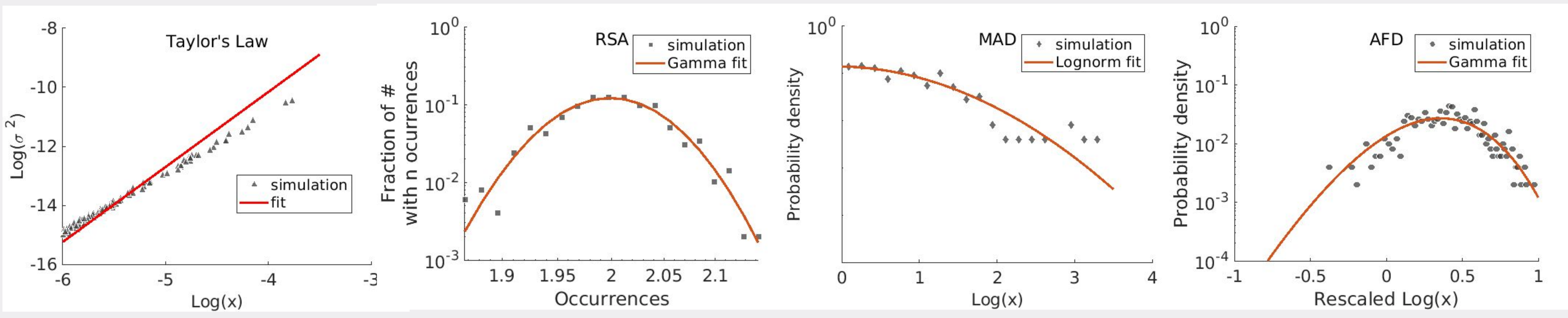
1. They connect micro, macro and virtual dynamics.
2. They allow us to classify the streams (expected vs unexpected events)
3. They inform us about the "health" of our information ecosystem. Ex: breaking the democratic discourse.
4. They set a benchmark for future models: these models will have to reproduce them!



A model: SLM

The Stochastic Logistic Model is able to reproduce several patterns:

$$\frac{dx_i(t)}{dt} = \frac{x_i(t)}{\tau_i}\left(1 - \frac{x_i(t)}{K_i}\right) + \underbrace{\sqrt{\frac{\sigma_i}{\tau_i}}x_i(t)\xi_i(t)}_{\text{noise}}$$



References:

1. Calleja-Solanas, Violeta, et al. "Quantifying the drivers behind collective attention in information ecosystems." Journal of Physics: Complexity 2.4 (2021): 045014.
2. Palazzi, María J., et al. "An ecological approach to structural flexibility in online communication systems." Nature communications 12.1 (2021): 1-11.
3. Plata, Carlos A., et al. "Neutral theory for competing attention in social networks." Physical Review Research 3.1 (2021): 013070.
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Did it sound interesting? Stay tuned! Preprint in the making.

sandro@ifisc.uib-csic.es, violeta@ifisc.uib-csic.es, @VioletaCalleja