

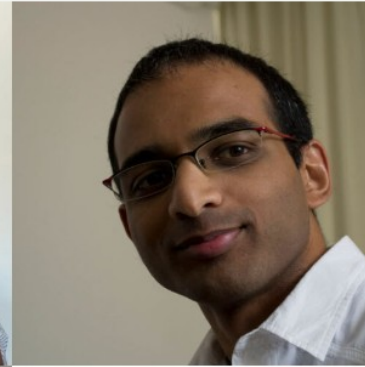
Social Physics and Complexity- SPAC

Física das Sociedades e
Complexidade

O uso do “big data” para perceber as
interações humanas



Joana Gonçalves de Sá



why am i so

why am i so **tired**
 why am i so **ugly**
 why am i so **gassy**
 why am i so **thirsty**
 why am i so **angry**
 why am i so **itchy**
 why am i so **sad**
 why am i so **hungry**
 why am i so **emotional**
 why am i so **bloated**

how to

how to **make slime**
 how to **tie a tie**
 how to **buy bitcoin**
 how to **lose weight**
 how to **draw**
 how to **buy ripple**
 how to **kiss**
 how to **make pancakes**
 how to **mine bitcoin**
 how to **train your dragon**

como posso ser|

como posso ser **amigo de alguem**
 como posso ser **feliz**
 como posso ser **inteligente**
 como posso ser **uma pessoa melhor**
 como posso ser **salvo**
 como posso ser **rico**
 como posso ser **feliz sozinho**
 como posso ser **um hacker**
 como posso ser **popular no facebook**
 como posso ser **cantora**

como é que se

como é que se **beija**
 como é que se **diz eu te amo**
 como é que se **beija de lingua**
 como é que se **engravidar**
 como é que se **beija na boca**
 como é que se **escreve**
 como é que se **beija pela primeira vez**
 como é que se **faz um facebook**
 como é que se **faz um relatório**
 como é que se **faz panquecas**

pourquoi je suis

pourquoi je suis **moche**
 pourquoi je suis **triste**
 pourquoi je suis **toujours fatigué**
 pourquoi je suis **célibataire**
 pourquoi je suis **toujours célibataire**
 pourquoi je suis **devenu rebelle pdf**
 pourquoi je suis **seule**
 pourquoi je suis **toujours fatiguée**
 pourquoi je suis **jalouse**
 pourquoi je suis **triste sans raison**

comment faire

comment faire **du slime**
 comment faire **un cv**
 comment faire **des crepes**
 comment faire **une dissertation**
 comment faire **une capture d'écran**
 comment faire **une bibliographie**
 comment faire **un gateau**
 comment faire **du caramel**
 comment faire **de la glue**
 comment faire **du pain**

e só vai ler isso aqui por último

**VOCÊ VAI LER ISSO
AQUI PRIMEIRO**

depois vai ler isso aqui

e depois isso aqui

● Higgs
Termo de pesquisa

+ Comparar

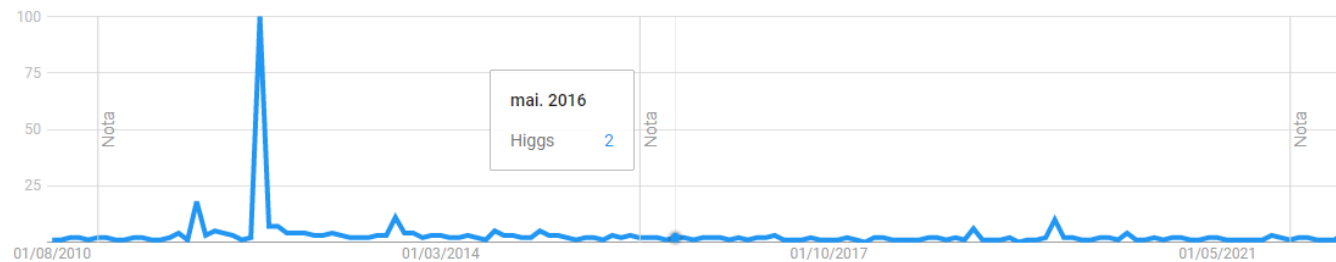
Portugal ▼

27/07/10 – 27/07/22 ▼

Todas as categorias ▼

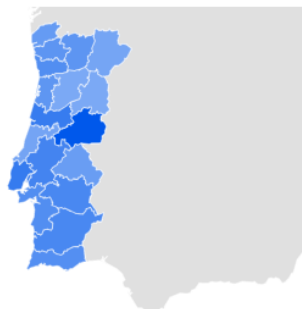
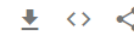
Pesquisa Web do Google ▼

Interesse ao longo do tempo ?

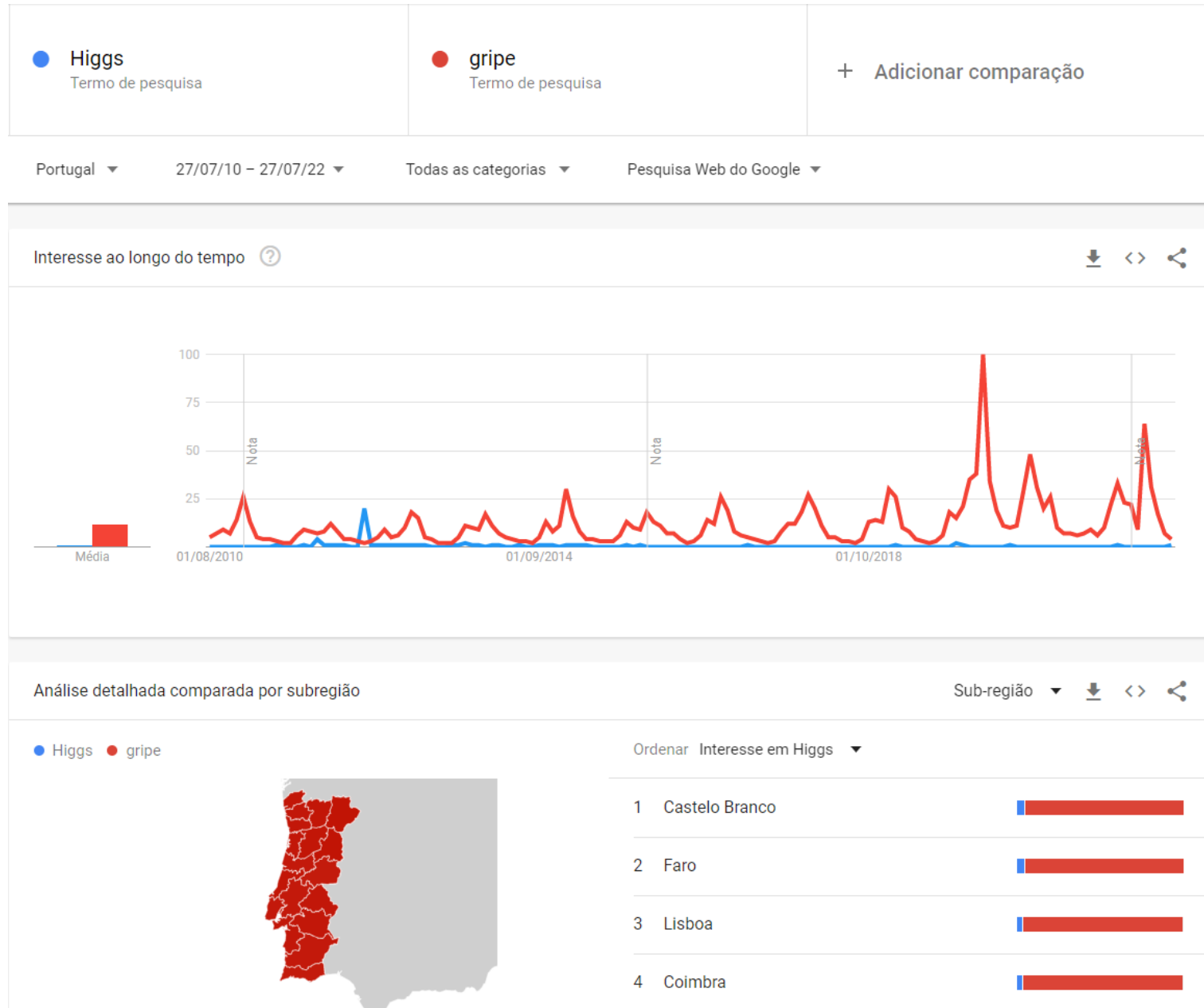


Interesse por sub-região ?

Sub-região ▼



1	Castelo Branco	100	
2	Lisboa	70	
3	Coimbra	69	
4	Santarém	62	
5	Beja	59	



Higgs
 Termo de pesquisa

gripe
 Termo de pesquisa

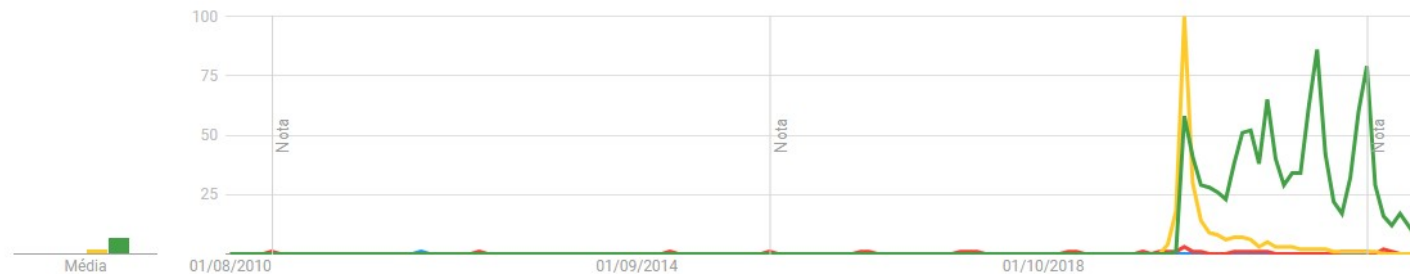
Coronavirus
 Termo de pesquisa

Covid
 Termo de pesquisa

+

Portugal ▼
 27/07/10 – 27/07/22 ▼
 Todas as categorias ▼
 Pesquisa Web do Google ▼

Interesse ao longo do tempo ?



Análise detalhada comparada por subregião

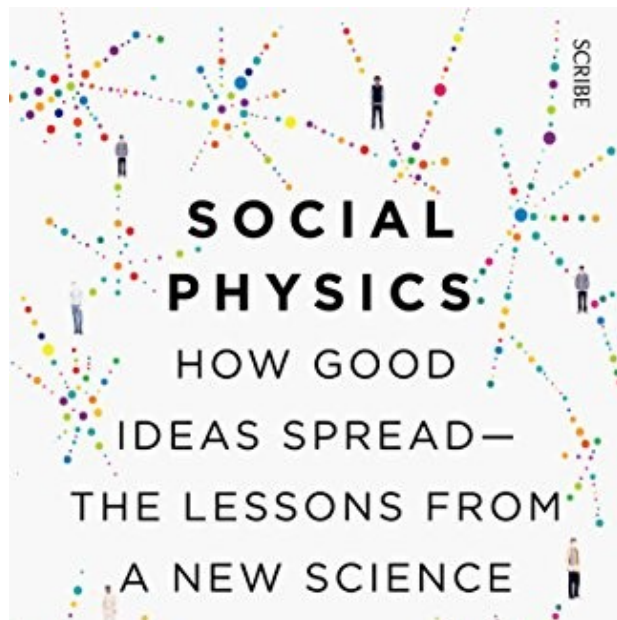
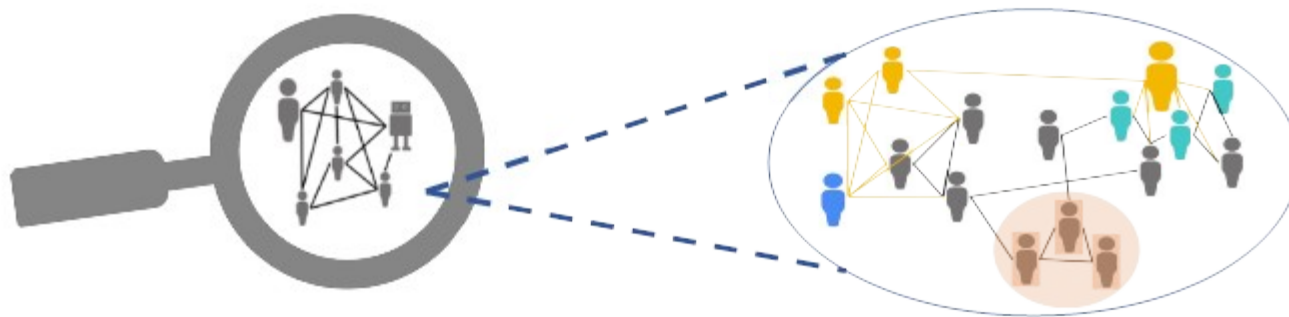
Sub-região ▼ 

Higgs
gripe
Coronavirus
Covid



Ordenar Interesse em Higgs ▼

1	Leiria	
2	Faro	
3	Vila Real	
4	Viseu	



Alex Pentland, 2014

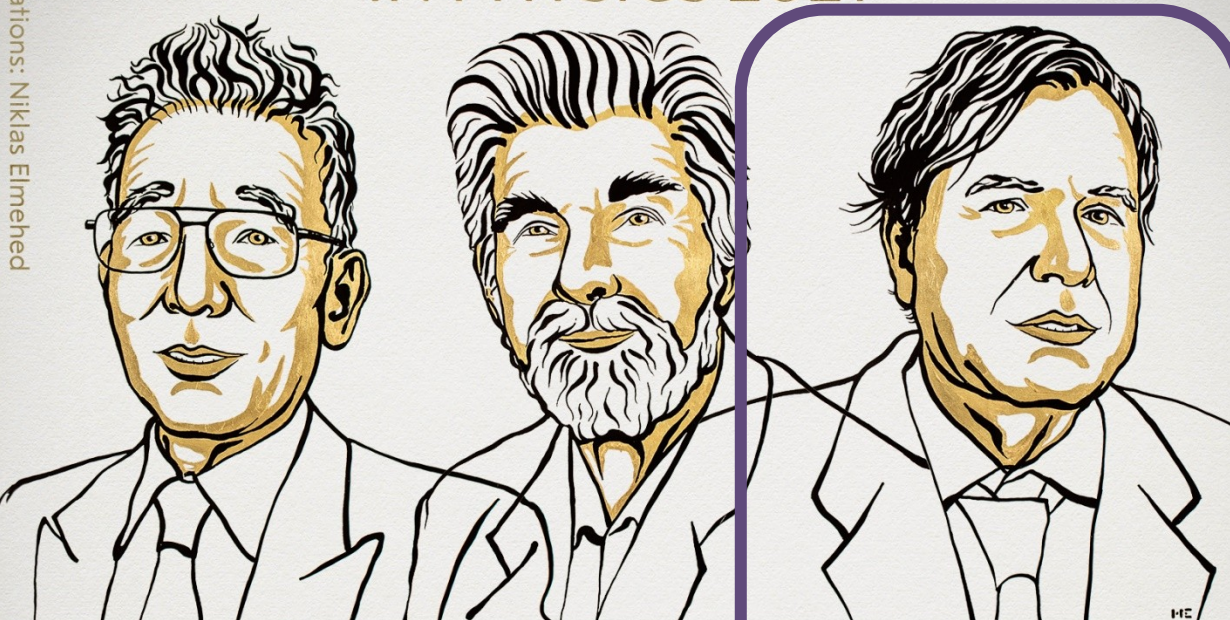
These problems—and a wide range of similar problems in the biological, medical, psychological, economic, and political sciences—are just too complicated to yield to the old nineteenth-century techniques which were so dramatically successful on two-, three-, or four-variable problems of simplicity. These new problems, moreover, cannot be handled with the statistical techniques so effective in describing average behavior in problems of disorganized complexity.

These new problems, and the future of the world depends on many of them, requires science to make a third great advance, an advance that must be even greater than the nineteenth-century conquest of problems of simplicity or the twentieth-century victory over problems of disorganized complexity. Science must, over the next 50 years, learn to deal with these problems of organized complexity.

Warren Weaver, 1947

Illustrations: Niklas Elmehed

THE NOBEL PRIZE IN PHYSICS 2021



Syukuro Manabe
"for the physical modelling of Earth's climate, quantifying variability and reliably predicting global warming"

Klaus Hasselmann

Giorgio Parisi
"for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales"

THE ROYAL SWEDISH ACADEMY OF SCIENCES



First

Water and steam power is used to create mechanical production facilities.



1800

1784: First mechanical loom



Second

Electricity lets us create a division of labor and mass production.



1900

1870: First assembly line

Third

IT systems automate production lines further.



2000

1969: First programmable logic controller

Fourth

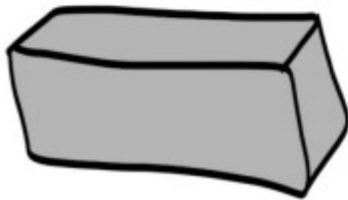
IoT and cloud technology automate complex tasks.

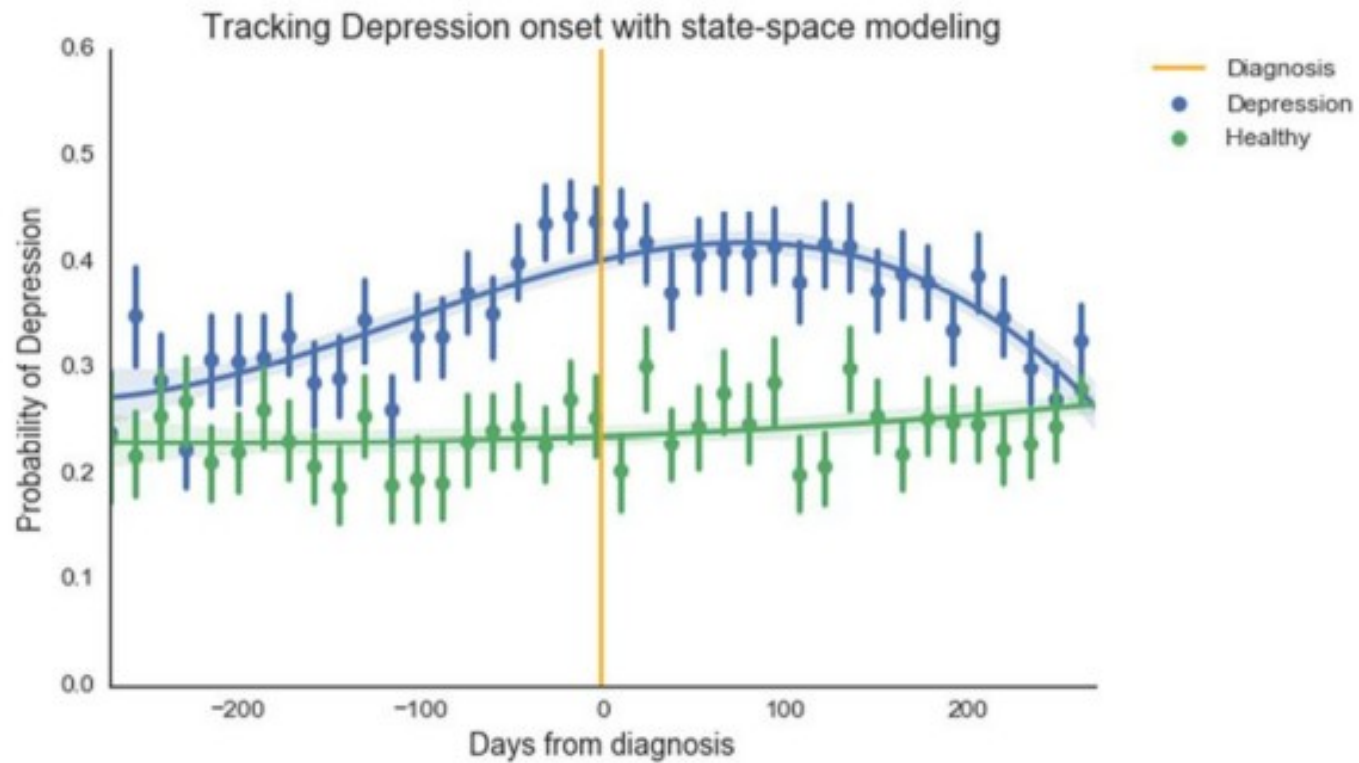


Today

What if a picture knew it was making you feel calmer, more mindful...just happier?

Using
sensors,
apps &
museums
to enable
wellbeing





<https://www.nature.com/articles/s41598-017-12961-9>

DALL·E mini by craiyon.com

AI model generating images from any prompt!

sunset by Picasso

Run



DALL·E mini by craiyon.com

AI model generating images from any prompt!

cell phone by van gogh

Run



<https://huggingface.co/spaces/dalle-mini/dalle-mini>

DALL·E mini by [craiyon.com](https://www.craiyon.com)

AI model generating images from any prompt!

Run

<https://huggingface.co/spaces/dalle-mini/dalle-mini>

<https://www.craiyon.com/>

DALL·E mini by craiyon.com

AI model generating images from any prompt!

doctor

Run



DALL·E mini by craiyon.com

AI model generating images from any prompt!

nurse

Run

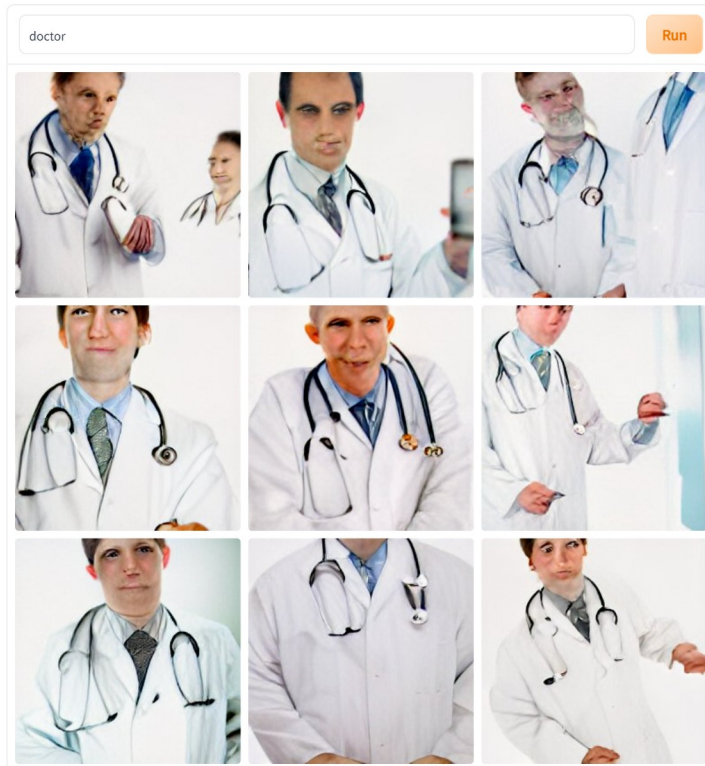


<https://huggingface.co/spaces/dalle-mini/dalle-mini>

<https://www.craiyon.com/>

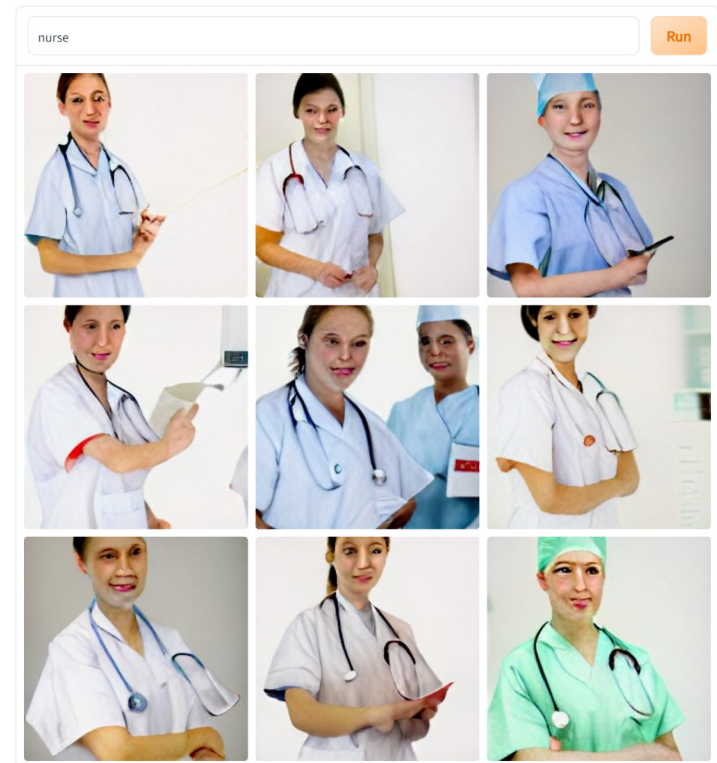
DALL·E mini by craiyon.com

AI model generating images from any prompt!



DALL·E mini by craiyon.com

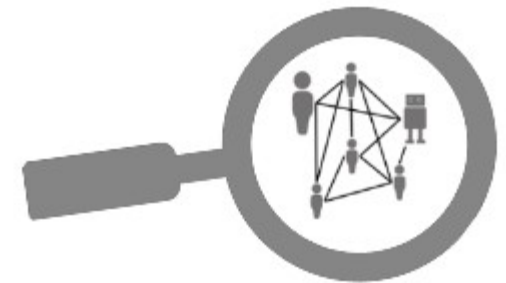
AI model generating images from any prompt!



▼ Bias and Limitations

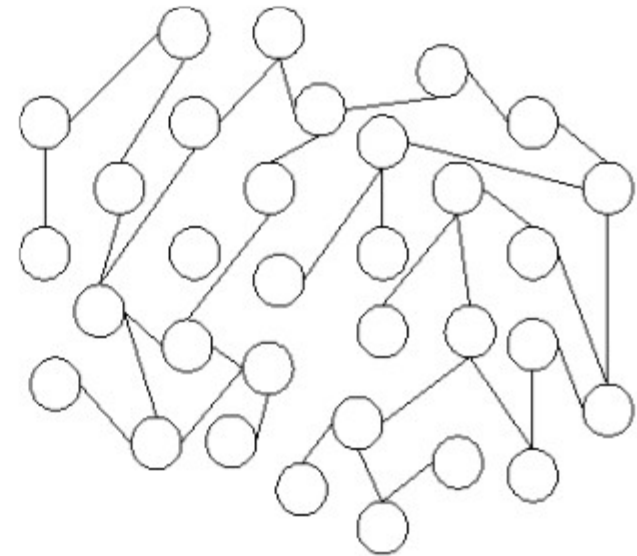
While the capabilities of image generation models are impressive, they may also reinforce or exacerbate societal biases. While the extent and nature of the biases of the DALL·E mini model have yet to be fully documented, given the fact that the model was trained on unfiltered data from the Internet, it may generate images that contain stereotypes against minority groups. Work to analyze the nature and extent of these limitations is ongoing, and will be documented in more detail in the [DALL·E mini model card](#).

- O comportamento humano é um problema complexo
- Temos cada vez mais dados para perceber essa complexidade
- Os dados não são neutros, eles refletem os nossos enviesamentos
- Temos de saber lidar com esses enviesamentos

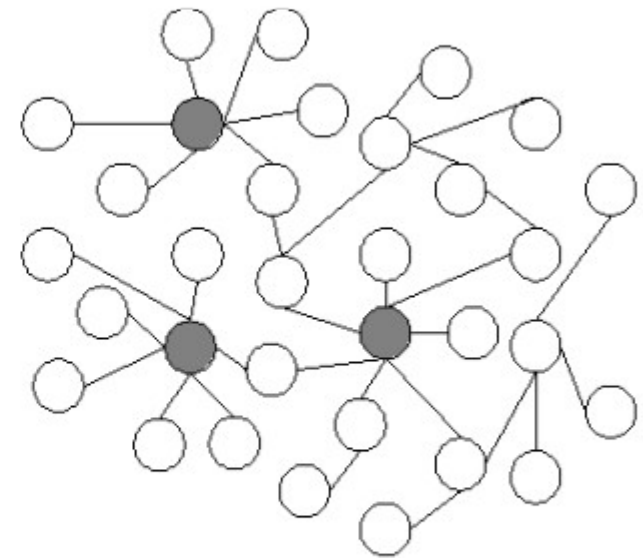


COMO É QUE A INFORMAÇÃO SE ESPALHA NUMA REDE SOCIAL?

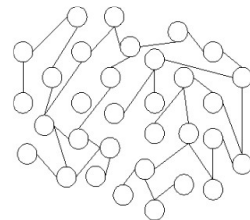
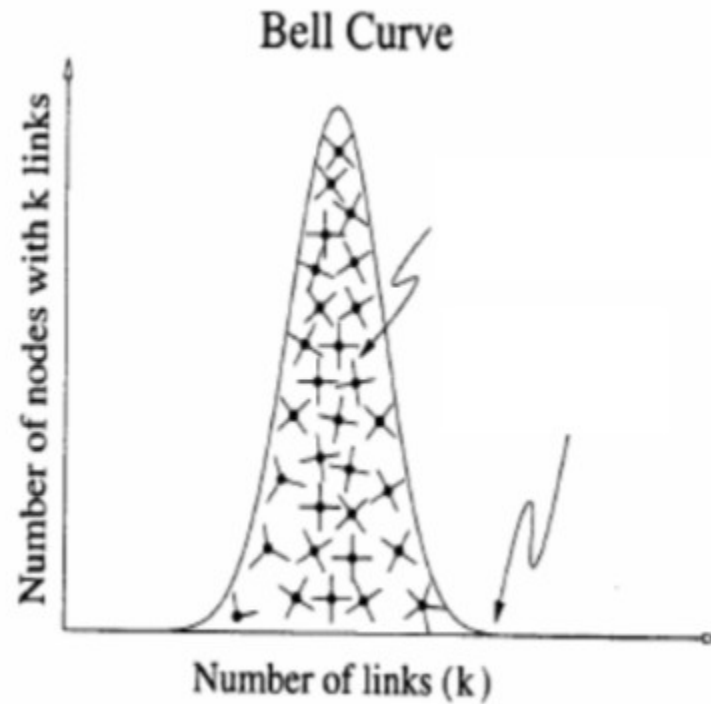




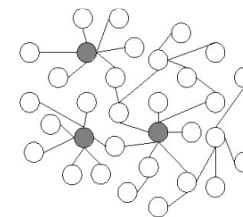
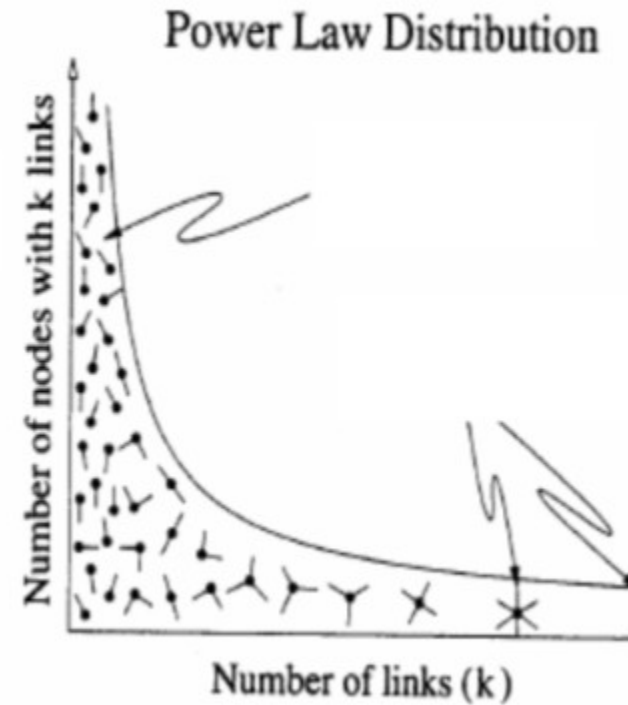
(a) Random network



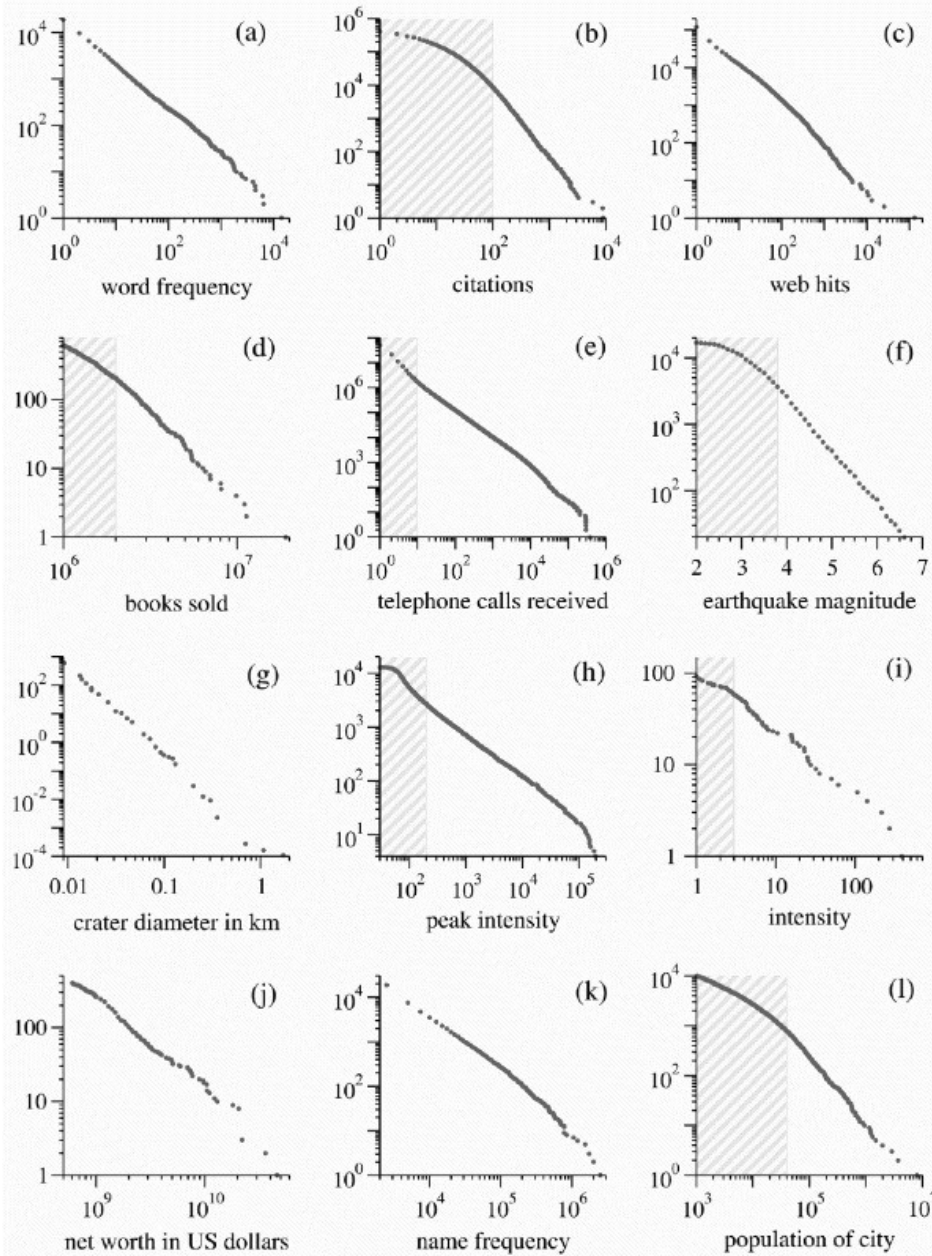
(b) Scale-free network



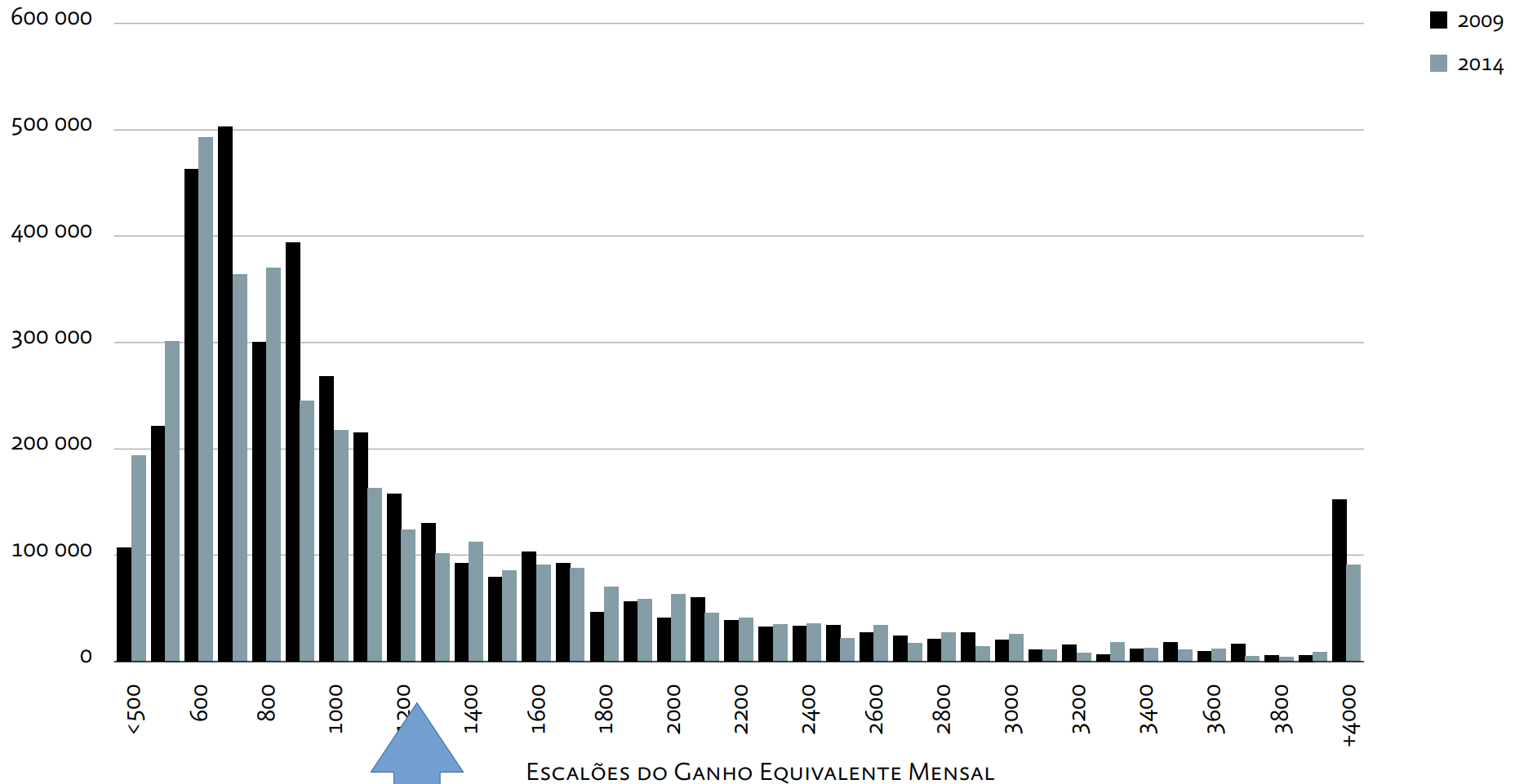
(a) Random network



(b) Scale-free network

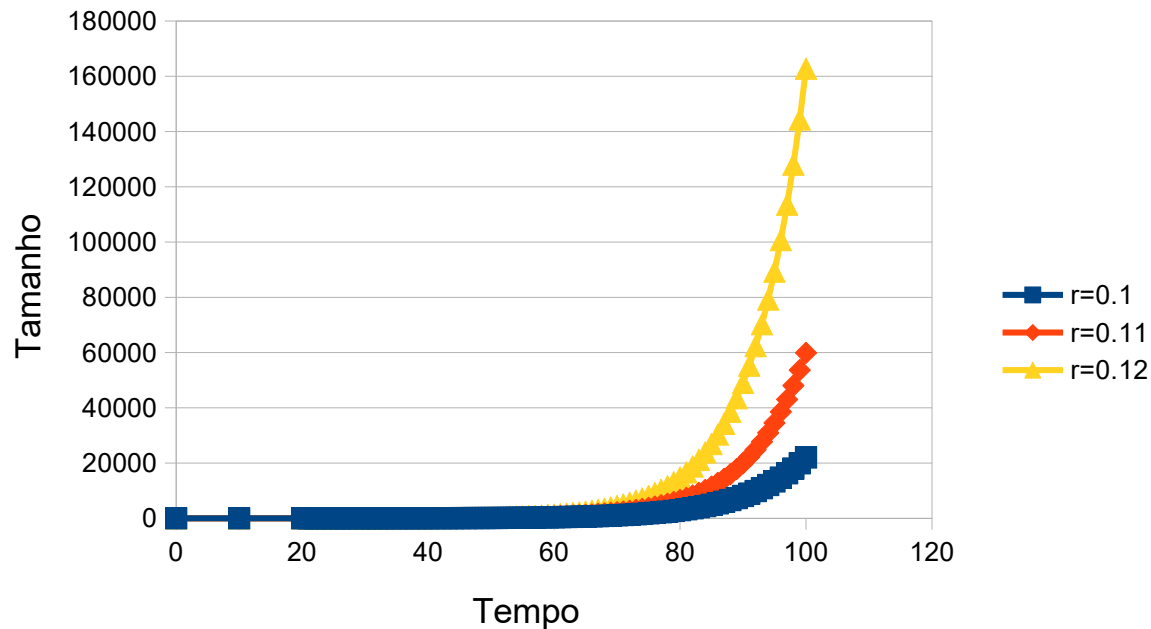


Newman, M. E. (2005). Power laws, Pareto distributions and Zipf's law. *Contemporary physics*, 46(5), 323-351.



Fonte: INE, ICOR 2010-2015. Cálculo dos autores.

$$N = e^{rt}$$



- As diferenças na taxa de crescimento são 10% (linha vermelha) e 20% (linha amarela)
- As diferenças de tamanho final são 171% e 639% respetivamente

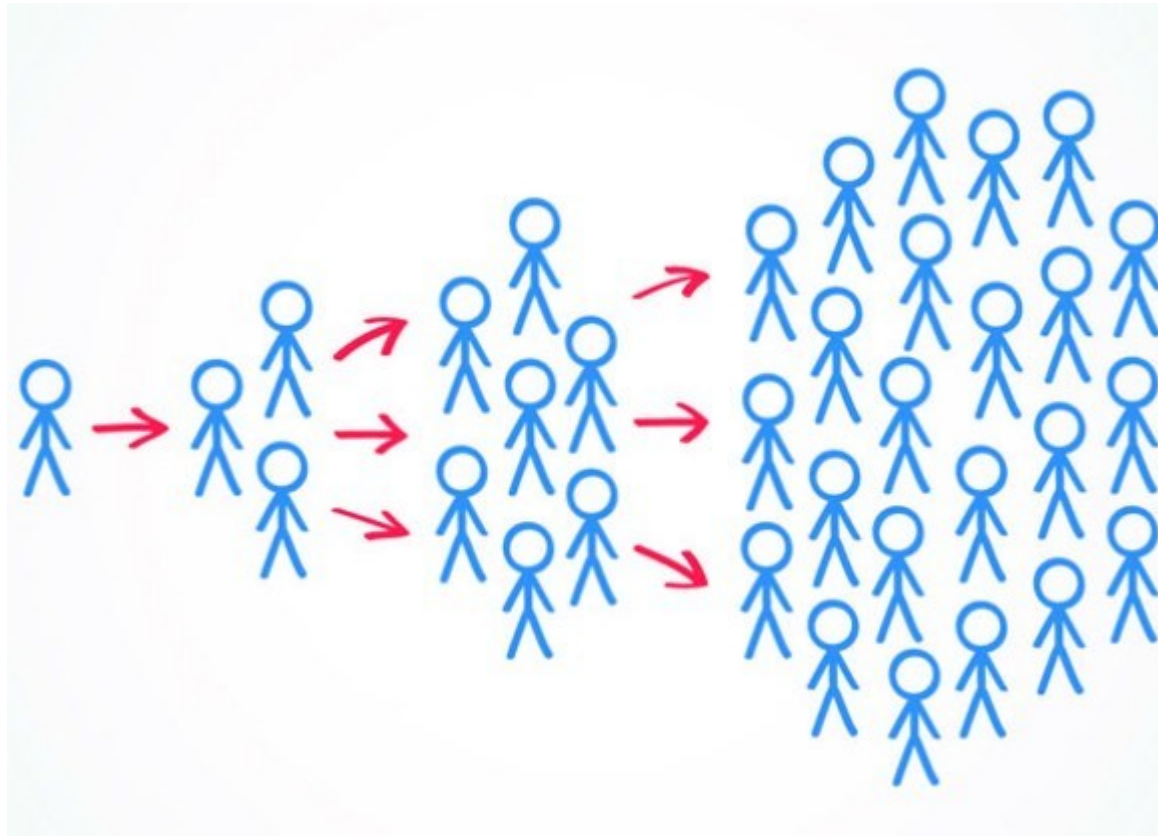
Paradoxo da amizade: Em média os nossos amigos têm mais amigos que nós

- Em média os nossos amigos são mais:
 - Populares
 - Ricos
 - Bonitos
 - ...



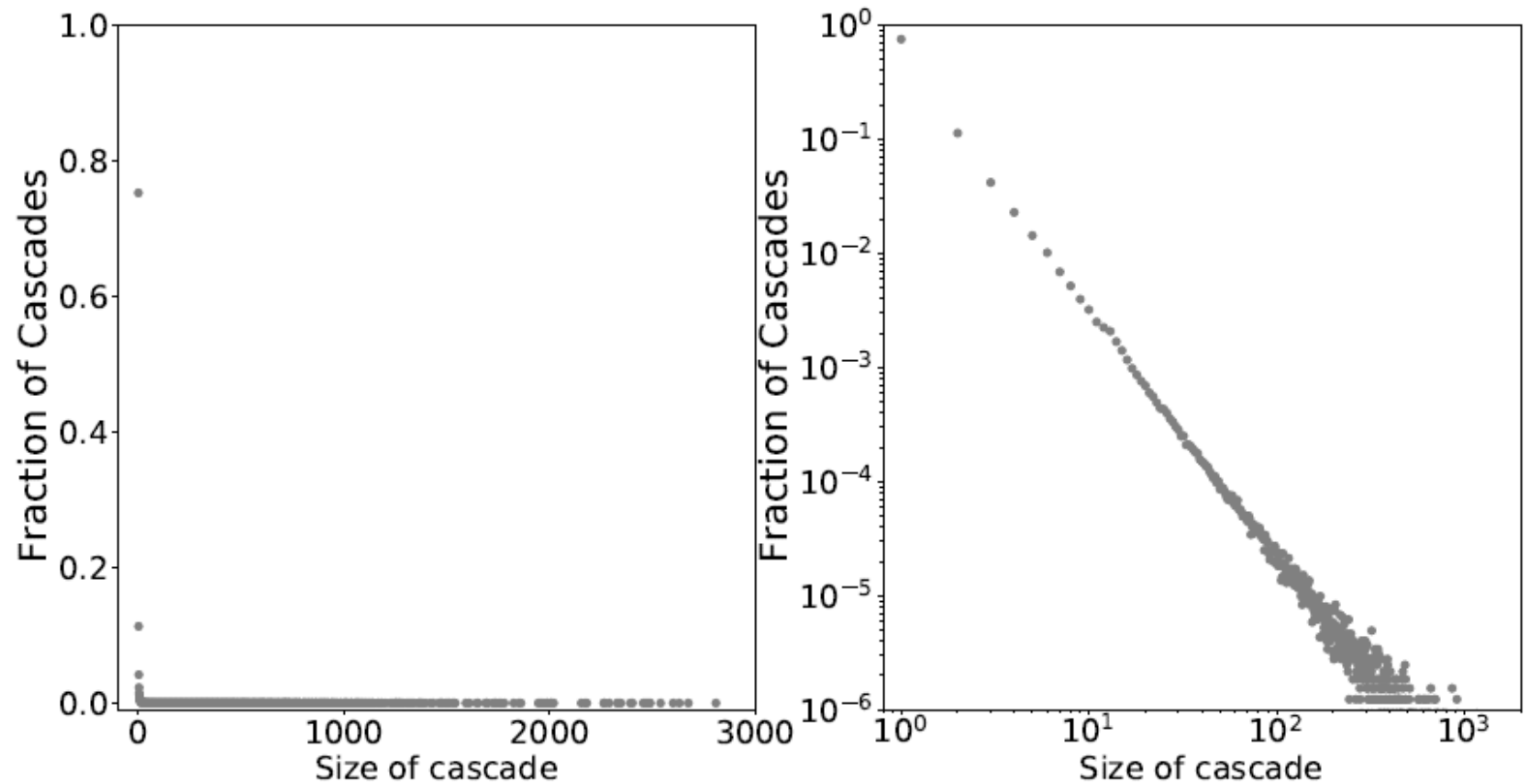
Feld, Scott L. "Why your friends have more friends than you do." *American Journal of Sociology* 96.6 (1991): 1464-1477.

A informação (real e falsa, científica ou não, etc.) espalha-se nas redes sociais de uma forma análoga à reprodução biológica.



- **Cascata de Tweets:** Todas as cópias de um tweet inicial
- **Fitness:** Taxa de cópia de um tweet

O tamanho das cascata de tweets também é powerlaw

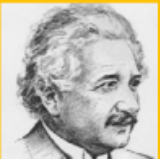




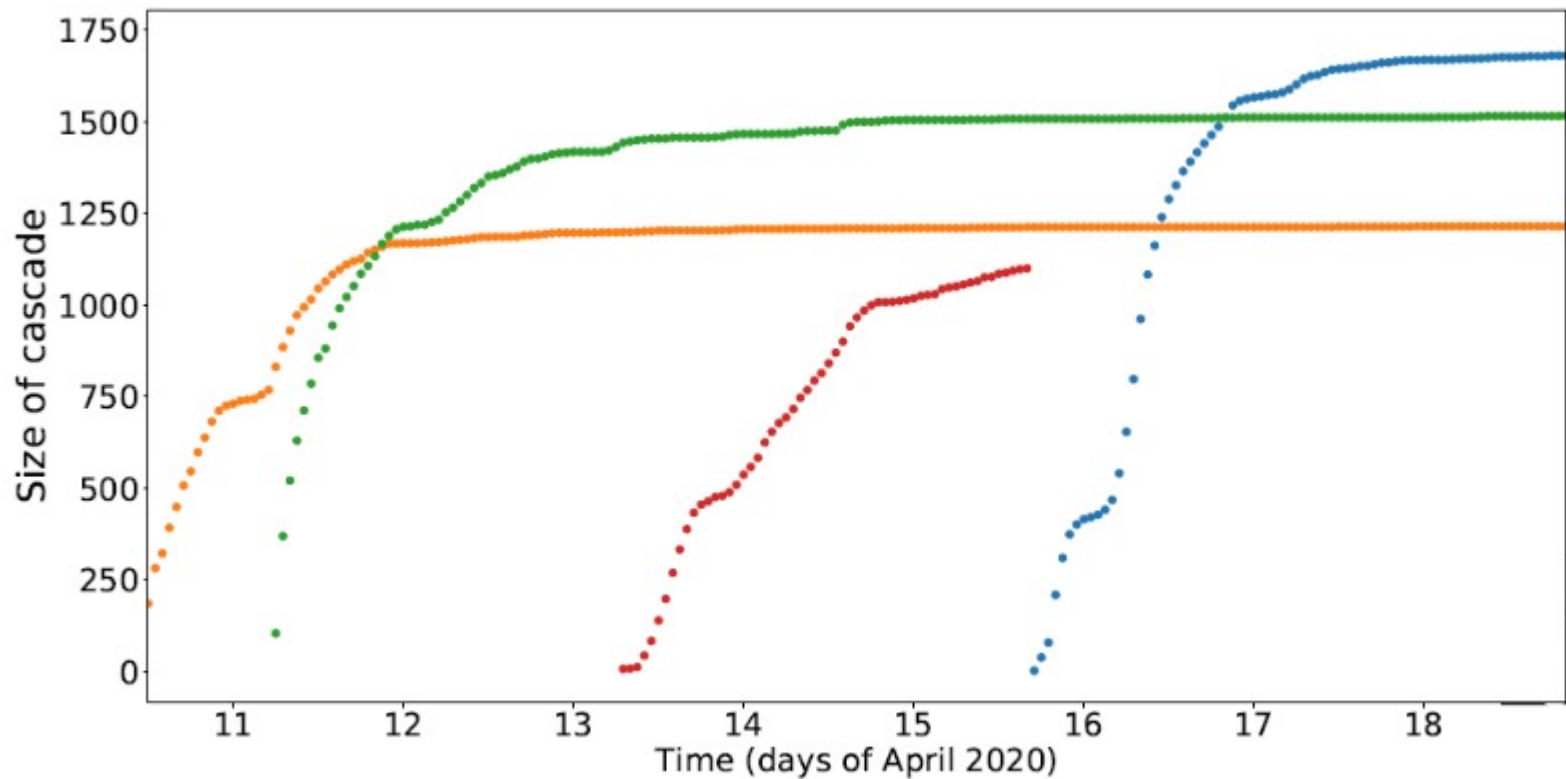
“Todos os modelos estão errados,
mas alguns são úteis”

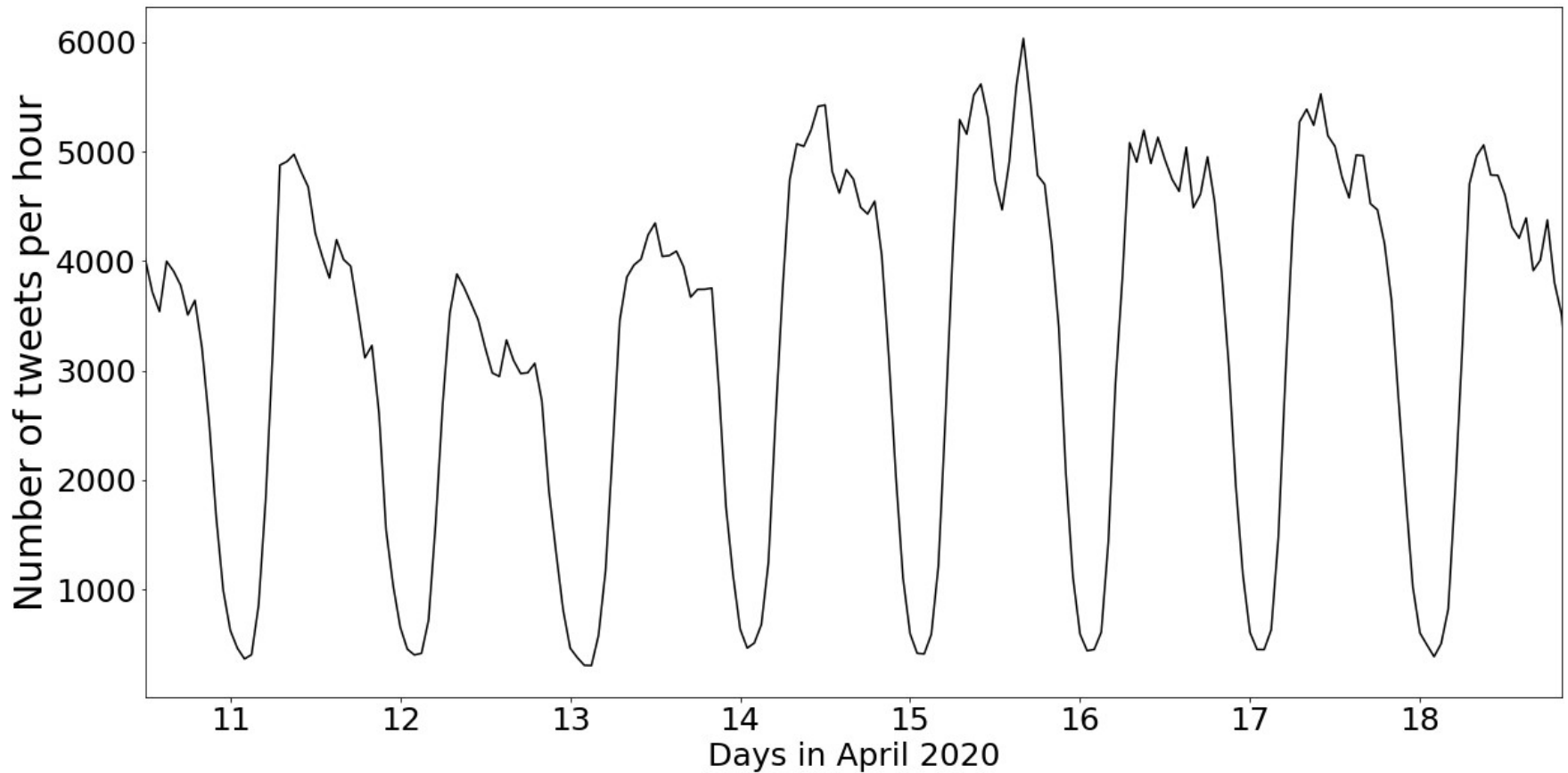


“Não vamos assumir pluralidade
quando não é necessário” – a navalha
de Occam

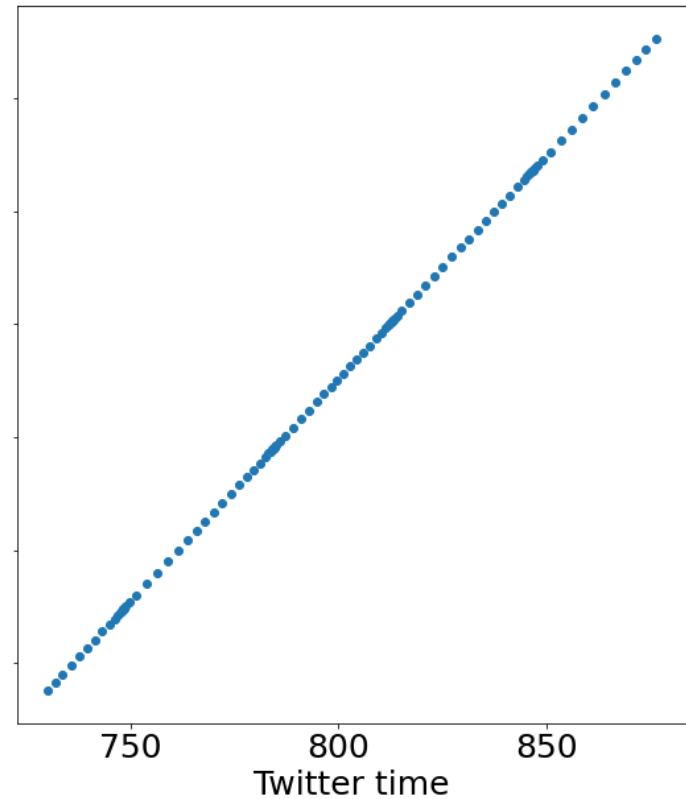
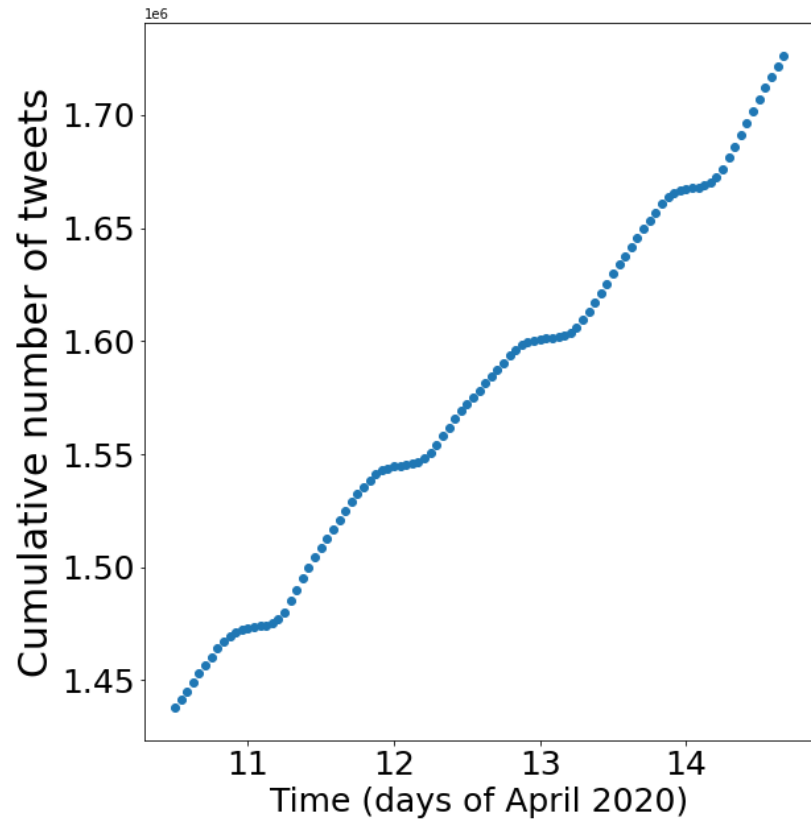


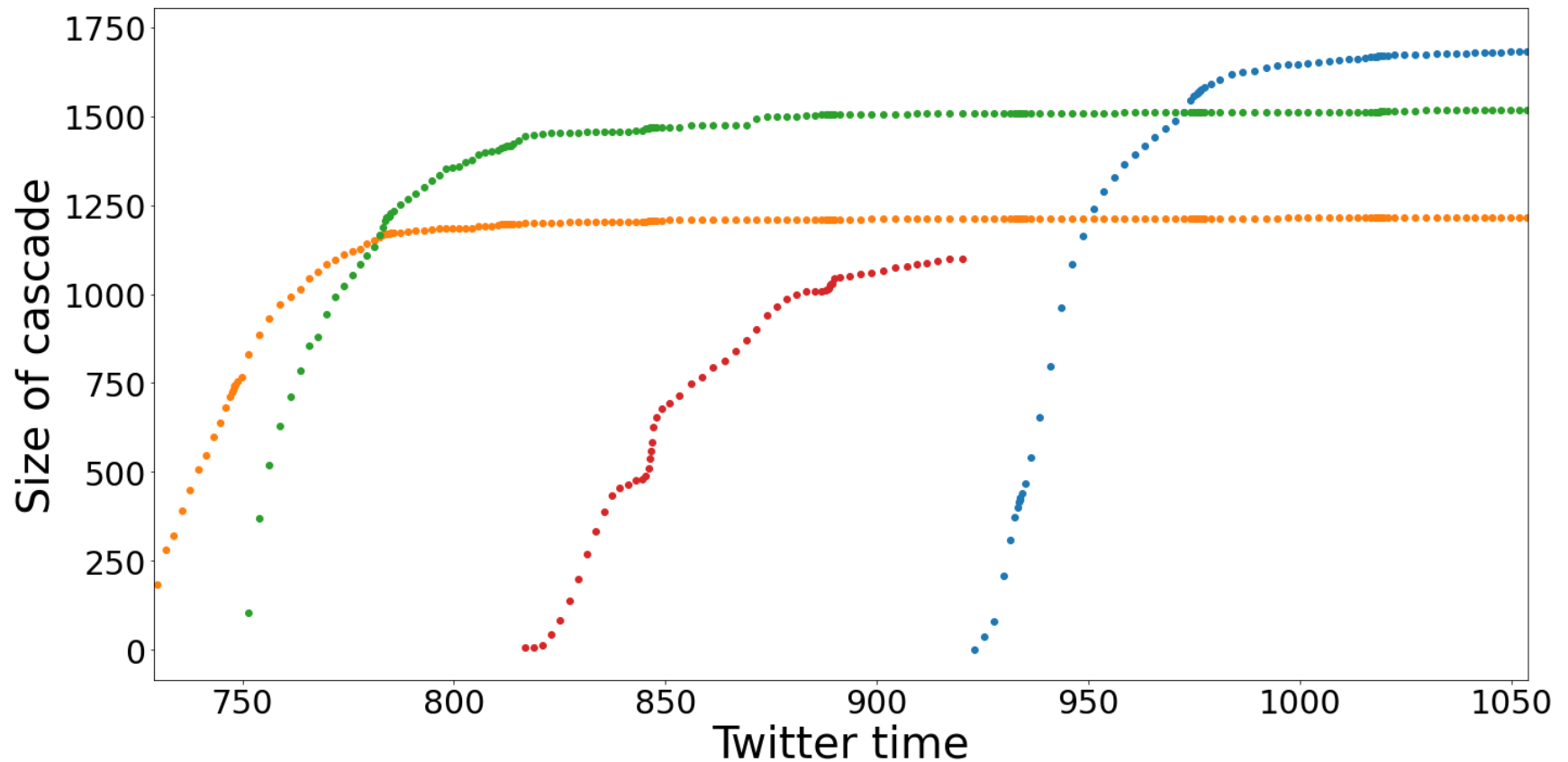
“Devemos tornar tudo o mais simples
possível, mas não mais que isso”

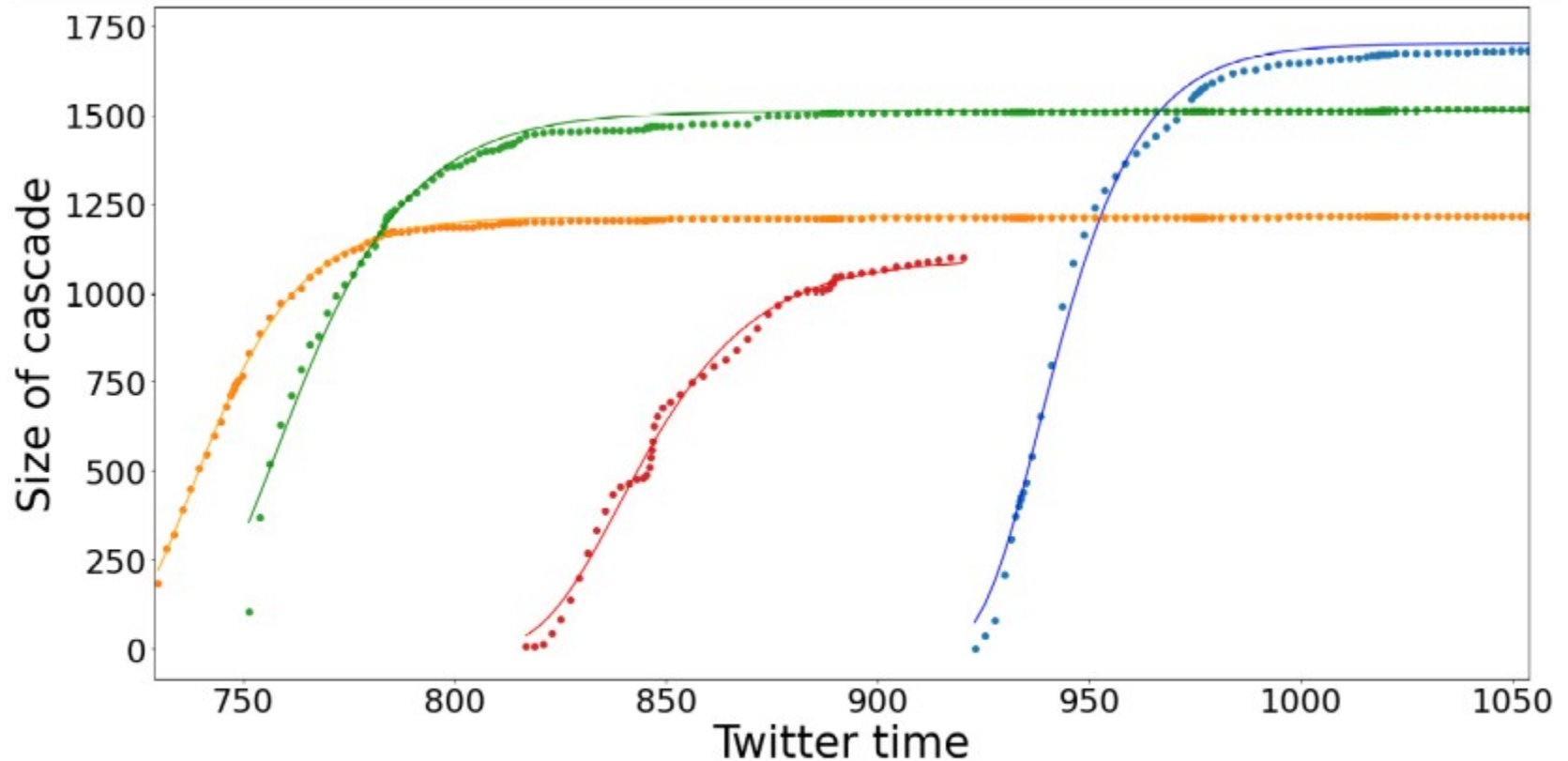




O tempo no Twitter passa de um modo diferente

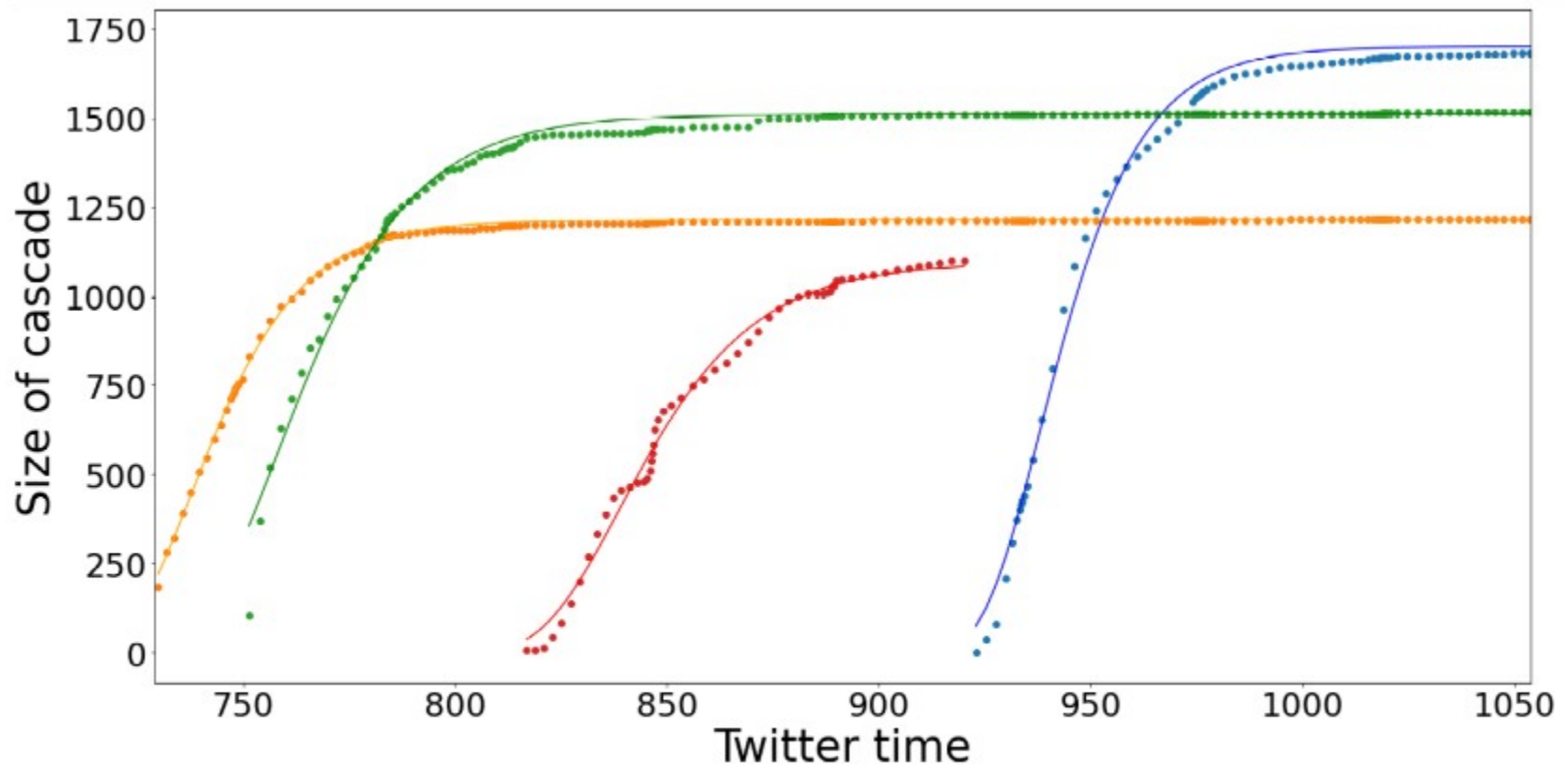






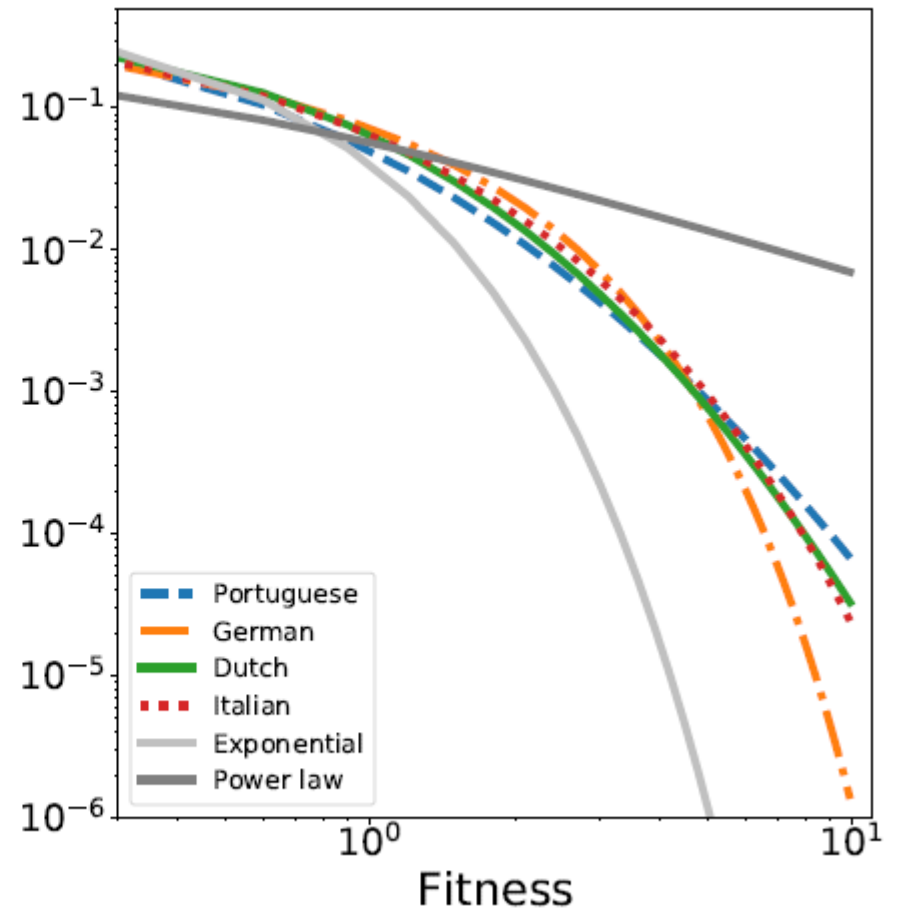
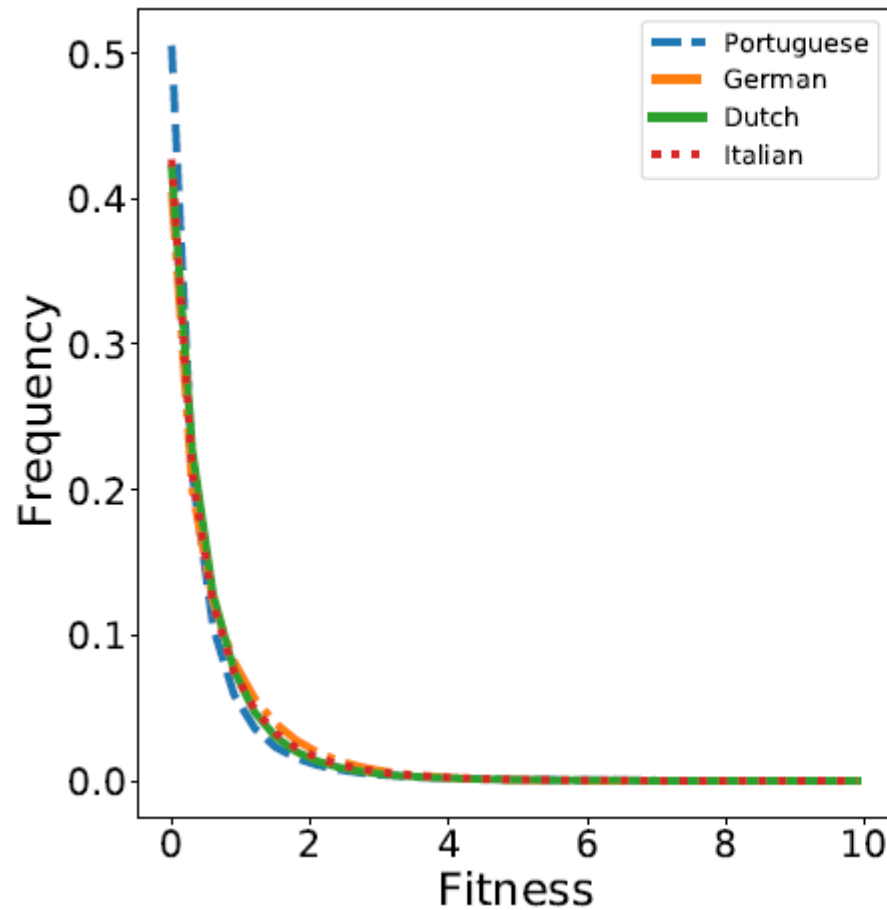
$$N(t) = N(0) \cdot e^{\frac{a}{g}} e^{a \cdot e^{-g \cdot t}}$$

O modelo mais simples para o crescimento de uma cascata



$$N(t) = N(0) \cdot e^{\frac{a}{g}} e^{a \cdot e^{-g \cdot t}}$$

fitness



- Um modelo simples descreve bem a difusão de informação no Twitter;
- Não é necessário incluir informação sobre a rede;
- Embora o tamanho das cascatas siga uma distribuição powerlaw, o fitness não.

PODEMOS SABER QUANTOS CASOS DE GRIPE EXISTEM NA
POPULAÇÃO ANTES DE FAZERMOS TESTES MOLECULARES?

● Flu
Termo de pesquisa

+ Comparar

Estados Unidos ▼

01/07/09 – 01/07/13 ▼

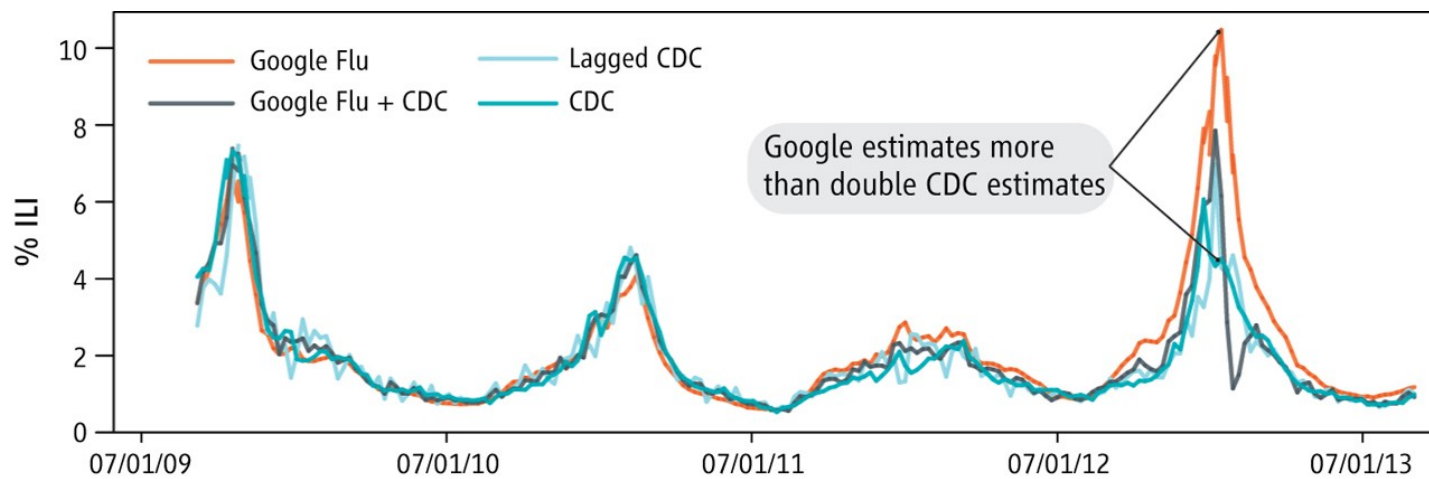
Todas as categorias ▼

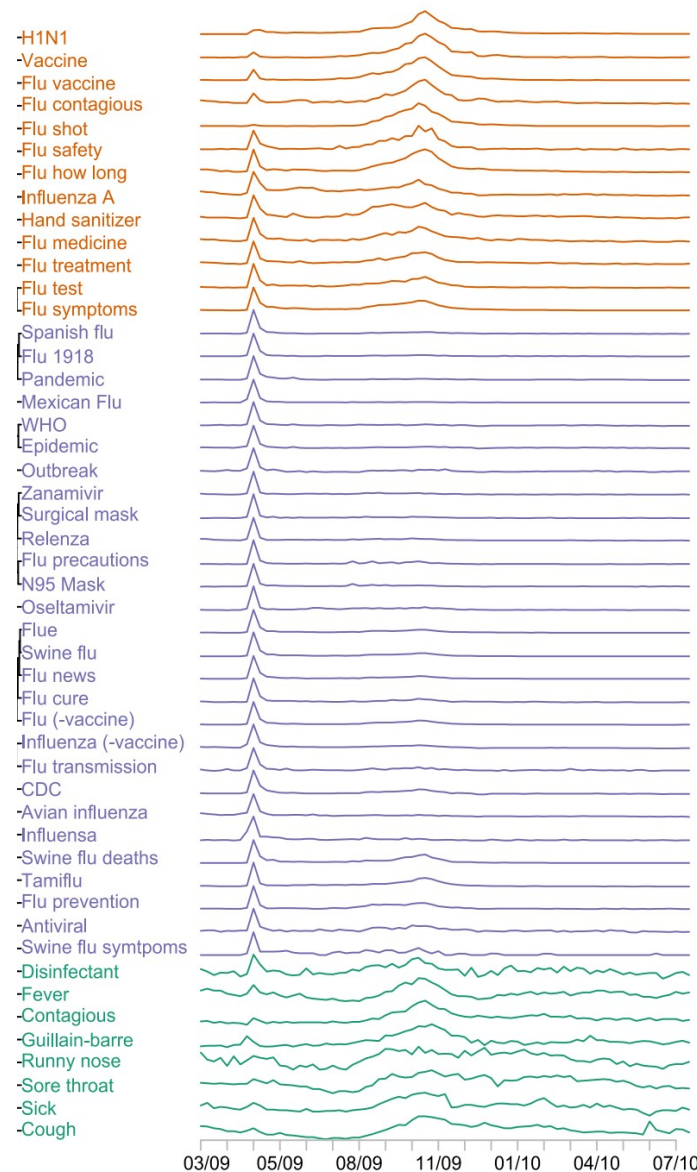
Pesquisa Web do Google ▼

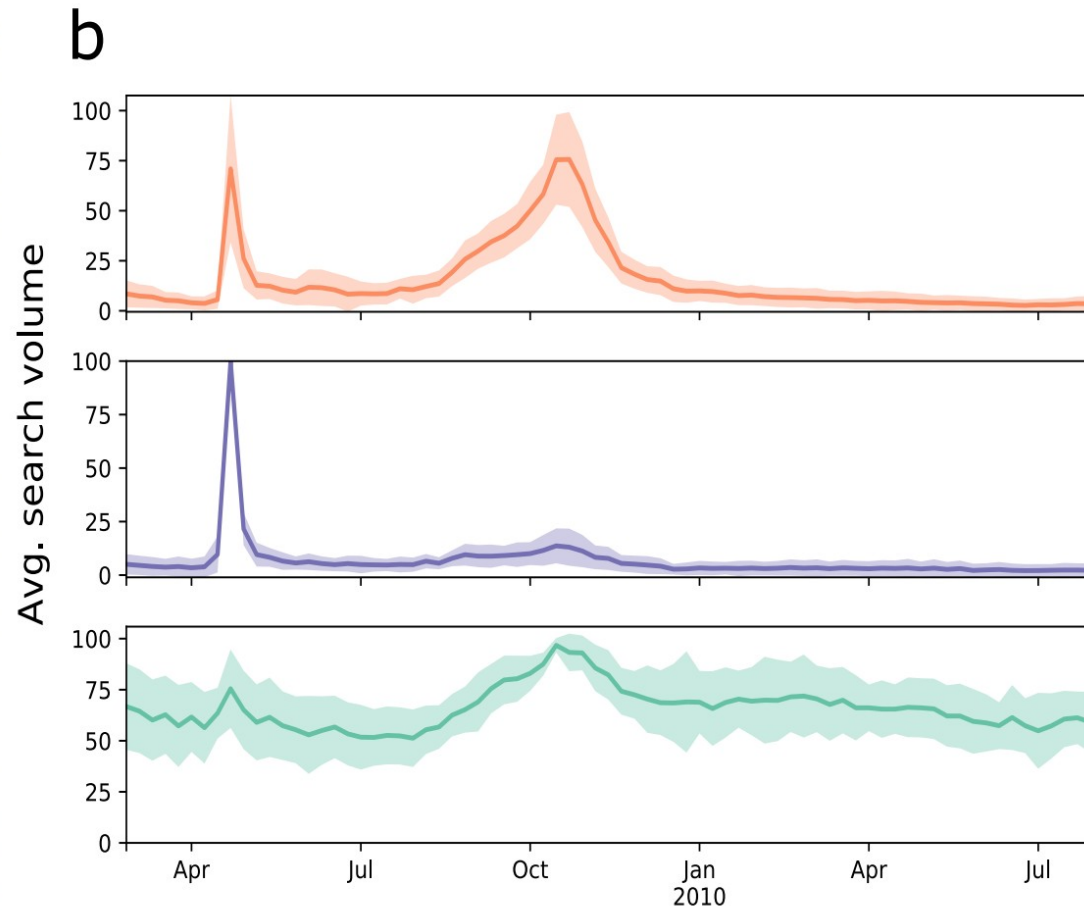
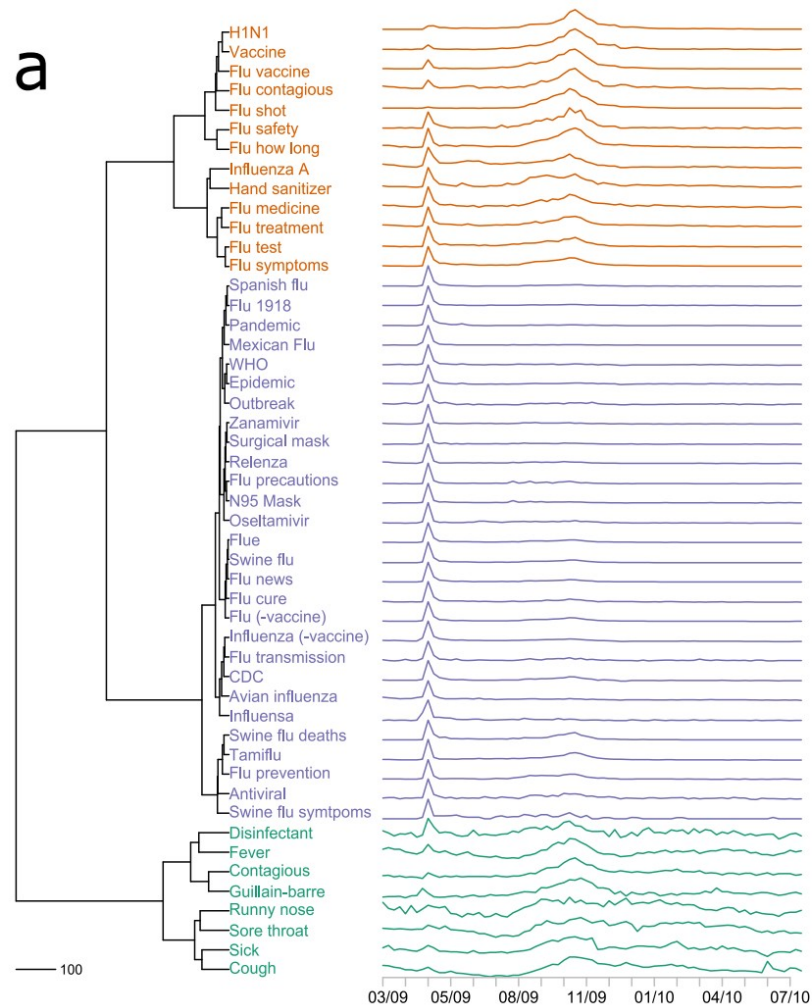
Interesse ao longo do tempo ?



Interesse ao longo do tempo ?





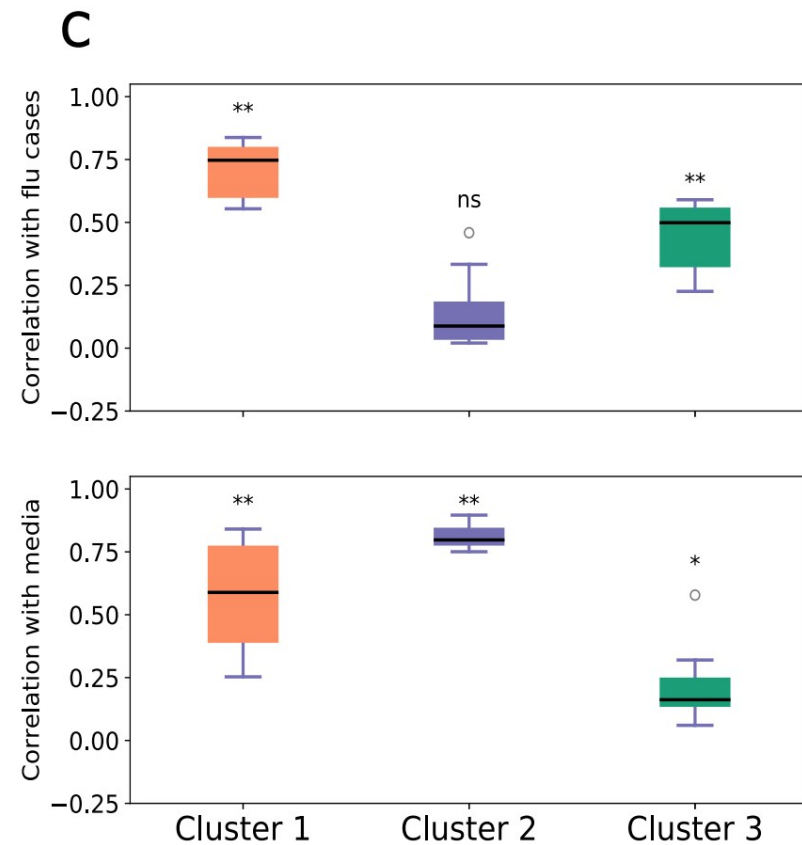
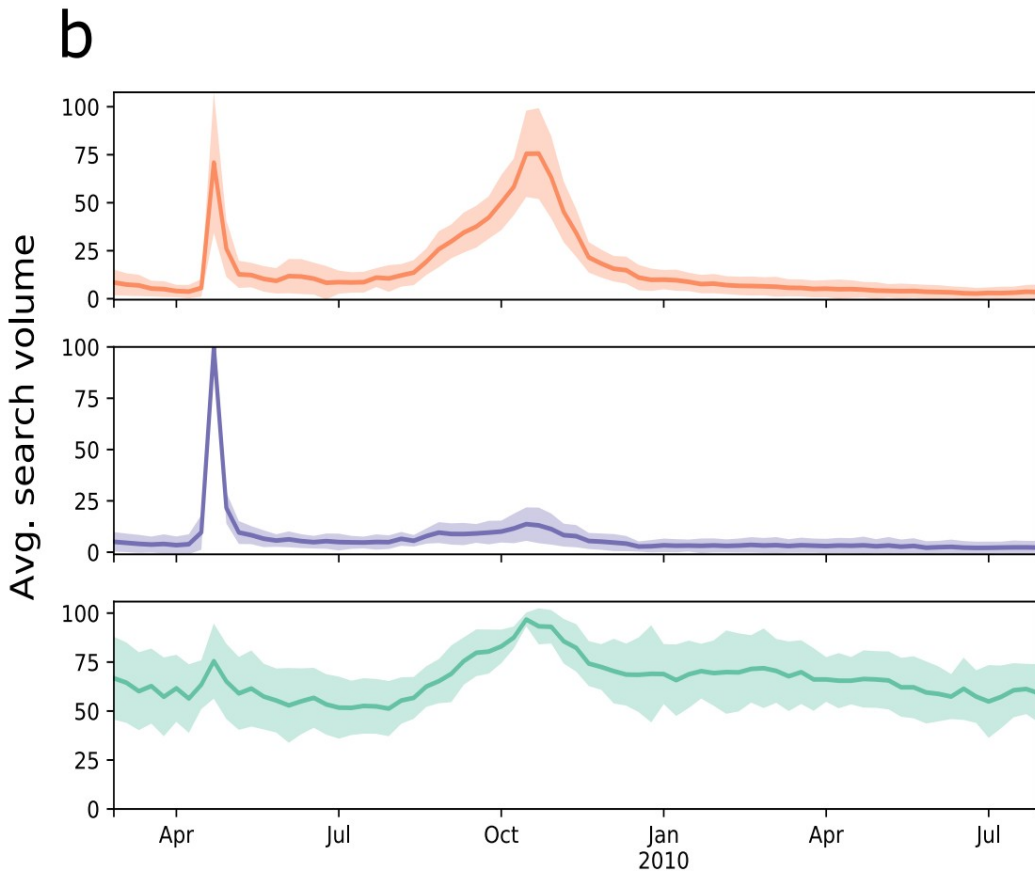


O que pode levar as pessoas a procurar sintomas no Google?

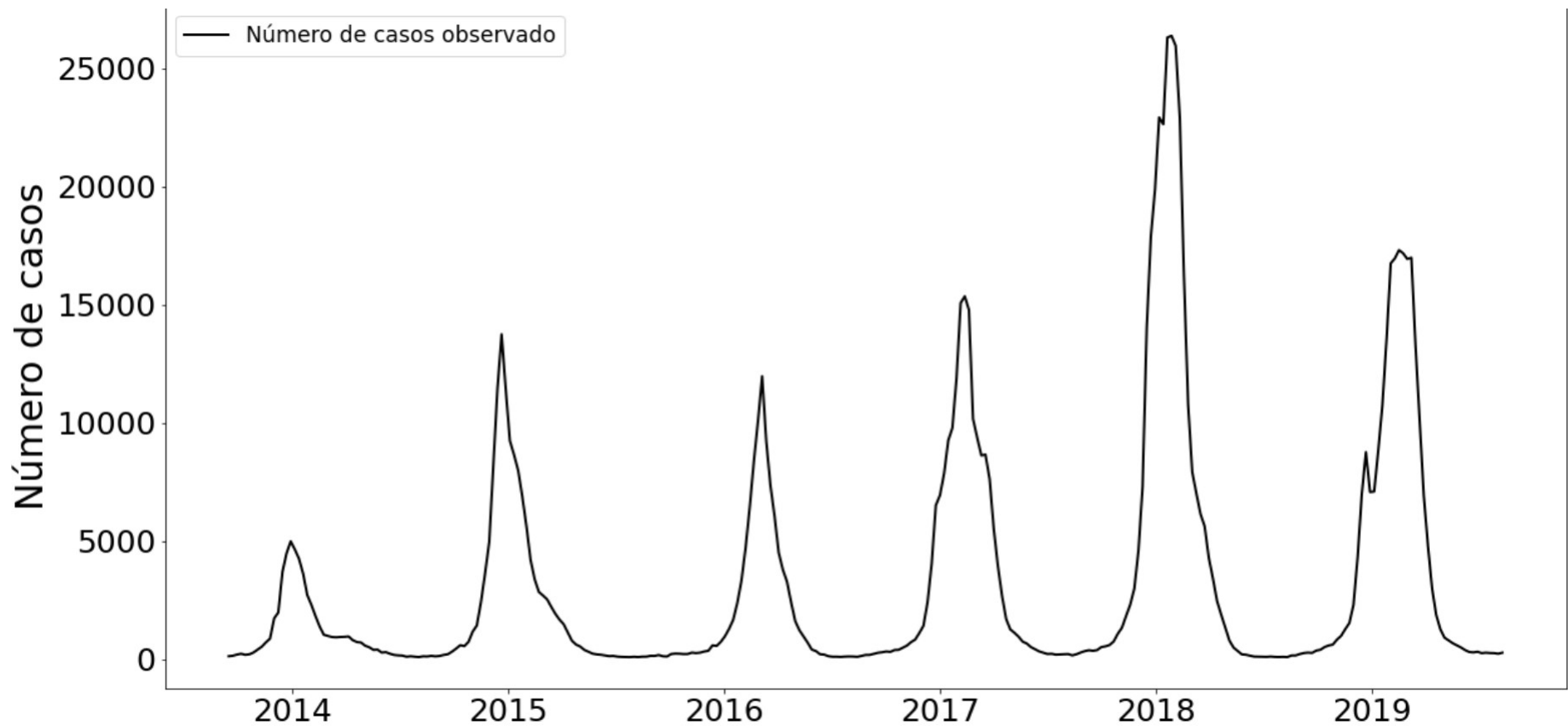


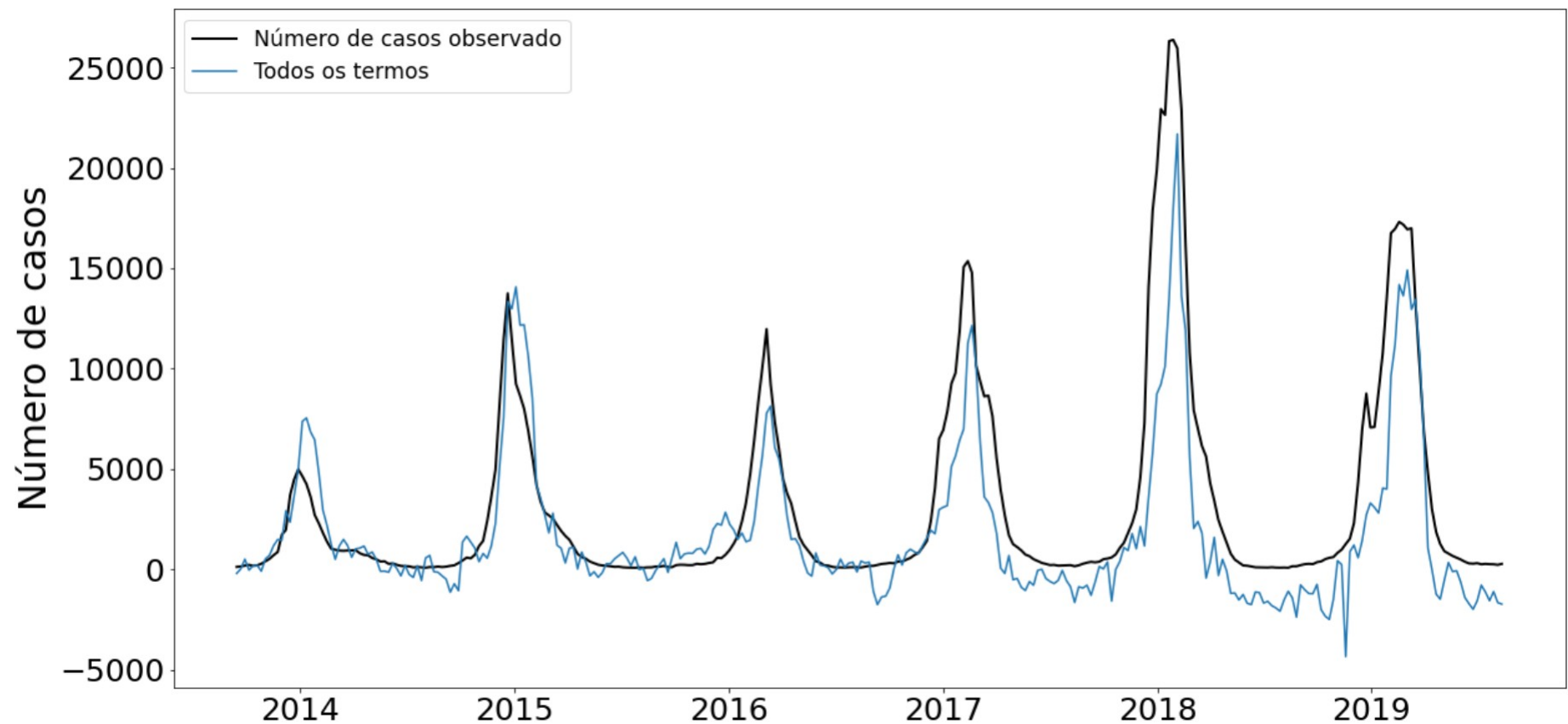
versus

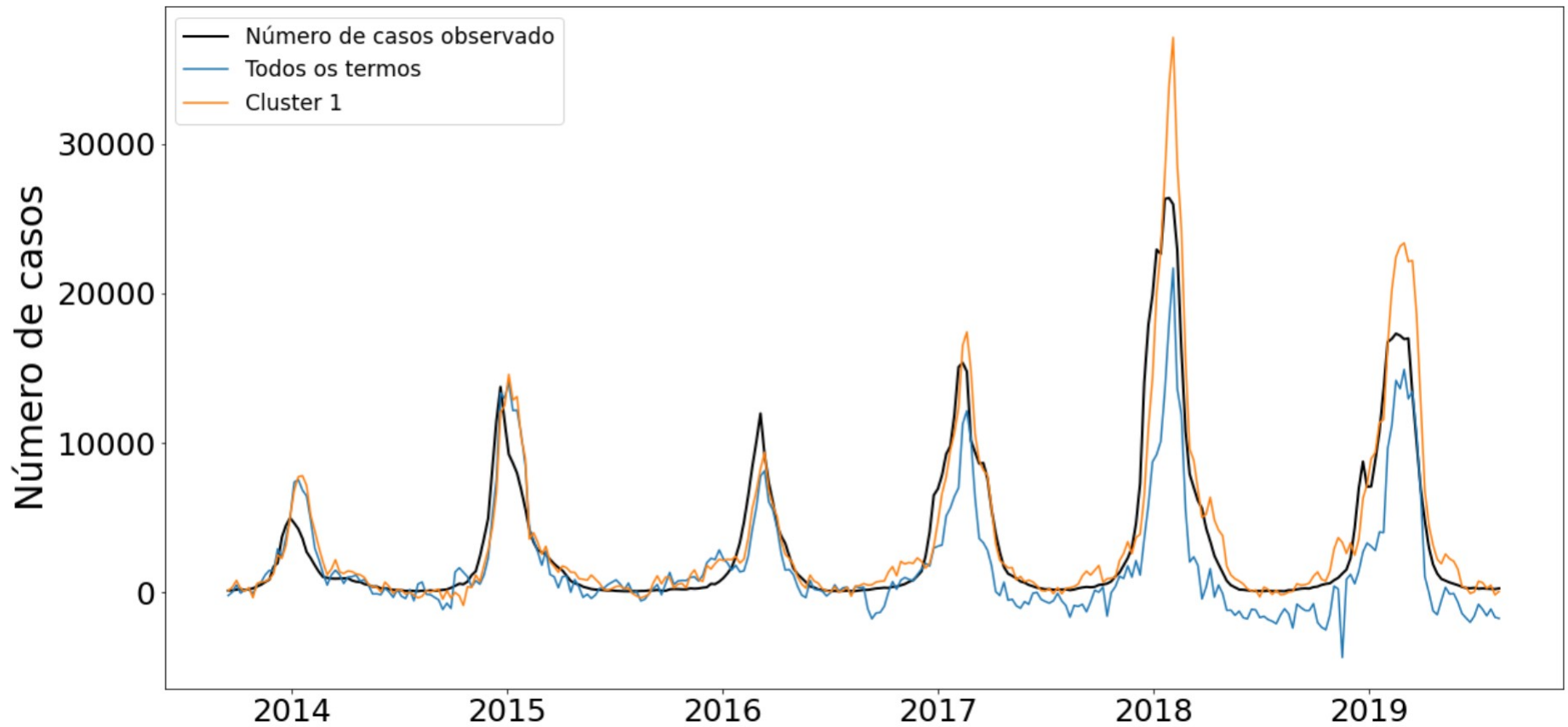


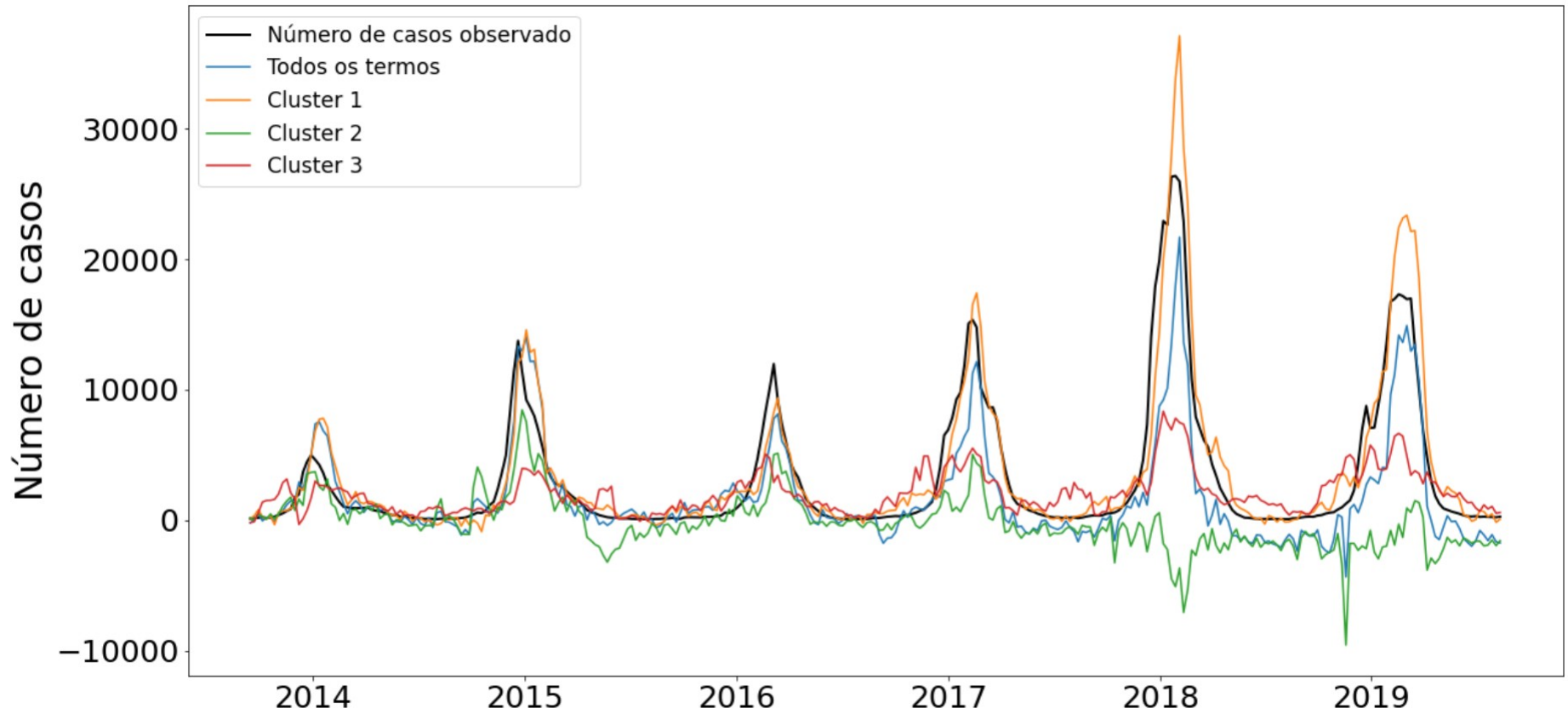


$$I_i = \beta_0 + \beta_1 \times W_1 + \beta_1 \times W_1 + \dots + \beta_n \times W_n + \varepsilon_i$$









- Podemos distinguir diferentes padrões nas buscas no Google
- No caso da gripe (e Covid) algumas buscas parecem associadas à doença e outras aos meios de comunicação
- Podemos usar esta informação para melhorar os modelos de antecipação dos casos de doença (o chamado *nowcasting*)

[https://socialcomplexity.eu/
spac@lip.pt](https://socialcomplexity.eu/spac@lip.pt)

Thanks to all of the SPAC group
LIP!!



lperfeito@lip.pt



joanagsa@lip.pt



@SpacLab @Dr_Lil @mjoanasa