

**And now for something completely  
different**



# SPAC- Social Physics and Complexity

1. What is SPAC?
2. What is Digital Epidemiology?
3. Some examples of our work
4. Bias and Risks

# SOCIAL PHYSICS AND COMPLEXITY

DISINFORMATION



Fake News



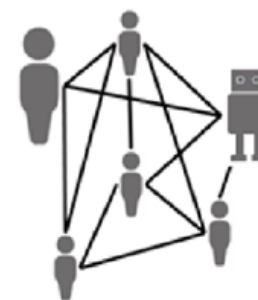
Pathogens



Humans



Hosts



Networks

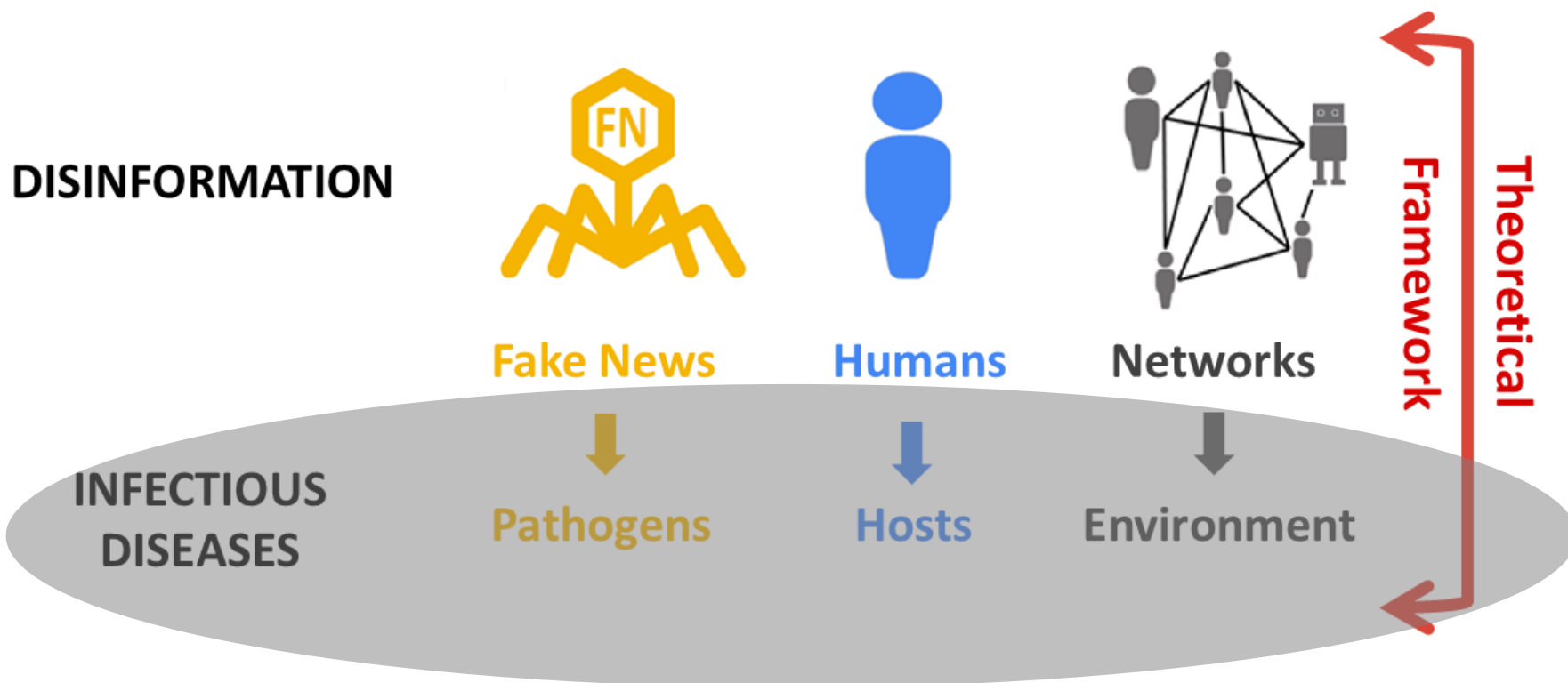


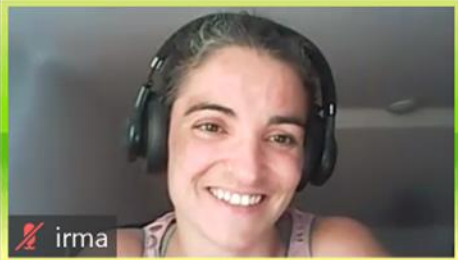
Environment

INFECTIOUS  
DISEASES



# SOCIAL PHYSICS AND COMPLEXITY





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# 1. What is Digital Epidemiology?


E-epidemiology (also known as Digital Epidemiology) is the science underlying the acquisition, maintenance and application of epidemiological knowledge and information using **digital media** such as the internet, mobile phones, digital paper, digital TV. E-epidemiology also refers to the large-scale epidemiological studies that are increasingly conducted through distributed global collaborations enabled by the Internet (...) Modern IT technology provides means for storage, organization and retrieval of **large amounts of biological and lifestyle data**, which will ensure more data and more reliable statistical results. Efficient number crunching computing, using **modern analytical tools** and simulation-based inference procedures allow knowledge to be extracted from the resulting large and complex data-structures. (...) Important aspects of e-epidemiology include the development of **security and confidentiality** preserving solutions to protect individual integrity and research data ownership.

Adapted from Wikipedia

- Contact Tracing (CT);
- Internet of things (IoT)
- Large Medical Datasets
- Data integration
- Online Activity
  - Searches
  - Social Media



DIGITAL REVOLUTION



DATA + MODELS -> DATA SCIENCE



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## How Antibiotic Resistance Happens

**1.**

Lots of germs.  
A few are drug resistant.



**2.**

Antibiotics kill  
bacteria causing the illness,  
as well as good bacteria  
protecting the body from  
infection.



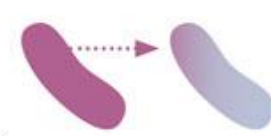
**3.**

The drug-resistant  
bacteria are now allowed to  
grow and take over.

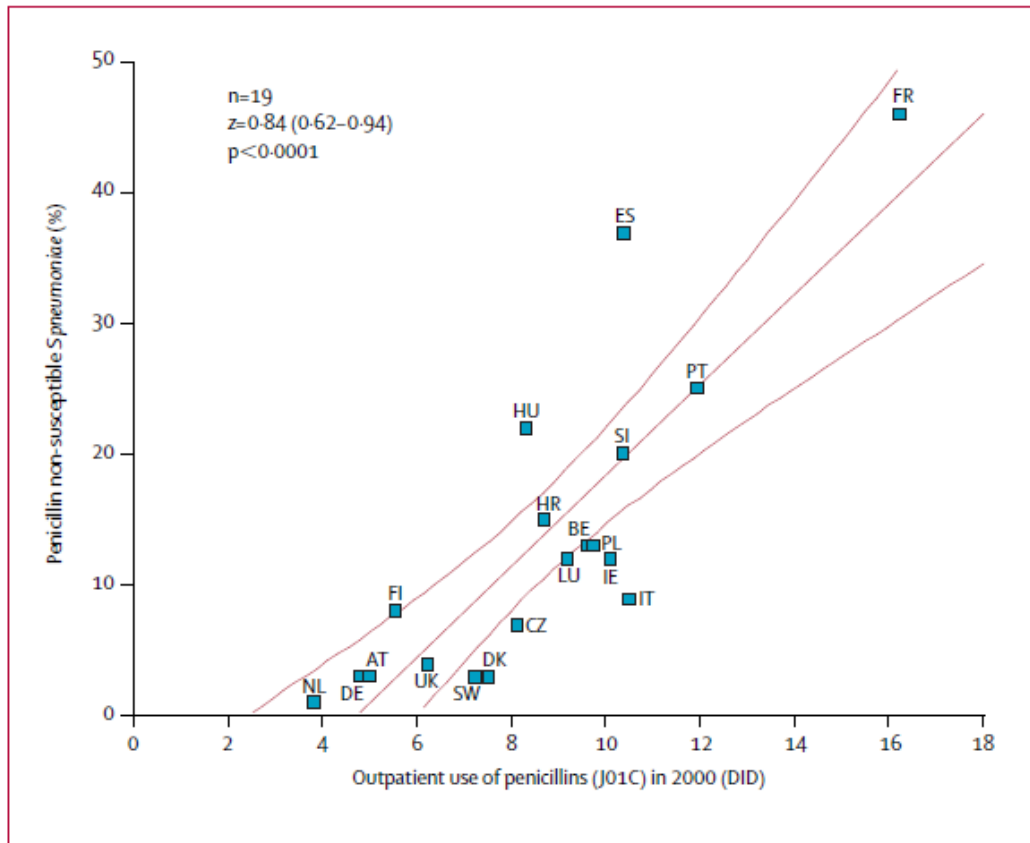


**4.**

Some bacteria give  
their drug-resistance to  
other bacteria, causing  
more problems.



# STATE OF THE ART – Prescription correlates with resistance



**Figure 6: Correlation between penicillin use and prevalence of penicillin non-susceptible *S pneumoniae***  
 AT, Austria; BE, Belgium; HR, Croatia; CZ, Czech Republic; DK, Denmark; FI, Finland; FR, France; DE, Germany;  
 HU, Hungary; IE, Ireland; IT, Italy; LU, Luxembourg; NL, The Netherlands; PL, Poland; PT, Portugal; SI, Slovenia;  
 ES, Spain; UK, England only.

Goossens, Herman, et al. "Outpatient antibiotic use in Europe and association with resistance: a cross-national database study." *The Lancet* 365.9459 (2005): 579-587.

Portugal is one of the top prescribers

- Poor prescribing practices?
- Sicker than average population?
- Both



# PEM

Prescrição Eletrônica  
Médica

- Outpatient data
- 2017 to 2019
- 152 million prescriptions
- 10.5 million unique patients.

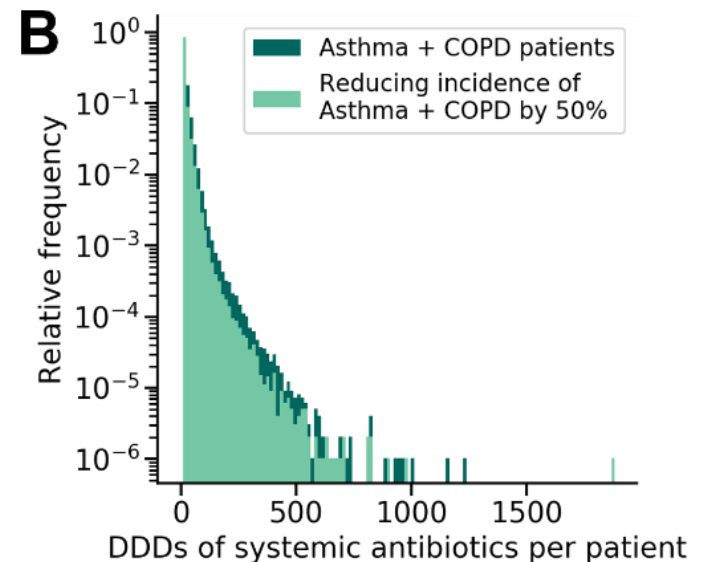
- Can we identify top prescribers?
- Can we can infer diagnosis? – reduce incidence

1. Start with some drugs we know are prescribed to specific diseases
2. Use a similarity metric to identify others “like them” – word2vec

King ----- Queen

Metformin ----- ?

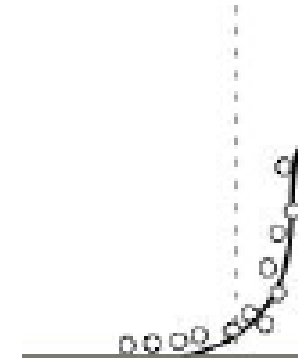
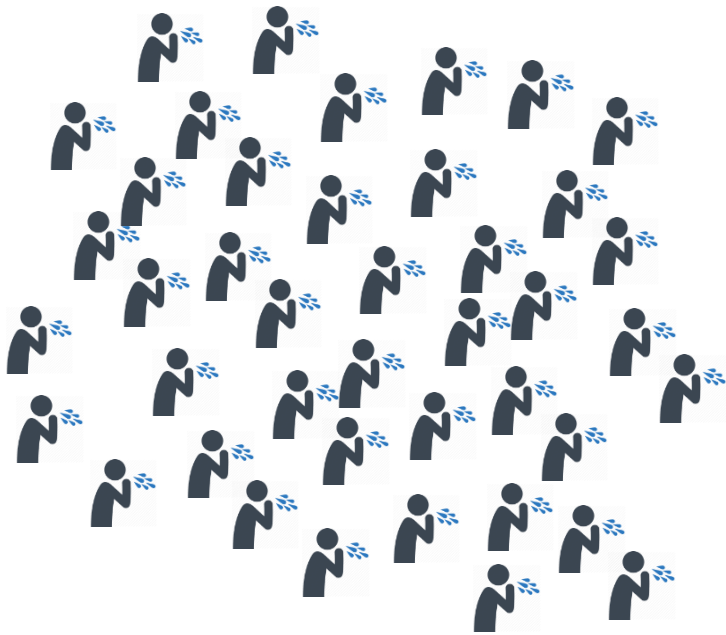
3. Validate
4. Estimate diagnosis
5. Estimate the impact on Ab reduction



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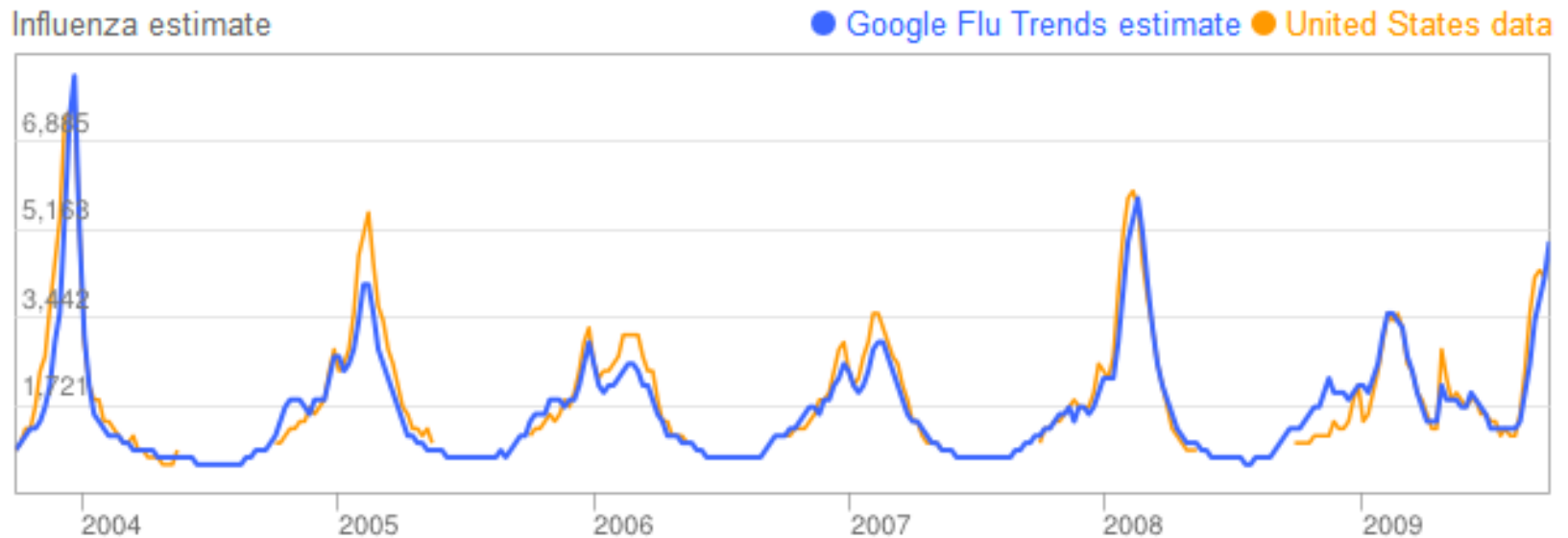






Fever  
Cough  
Cold  
Tamiflu  
Nose  
Flu

## Google Flu Trends



United States: Influenza-like illness (ILI) data provided publicly by the [U.S. Centers for Disease Control](#).

Ginsberg, Jeremy, et al. "Detecting influenza epidemics using search engine query data"  
*Nature* 457.7232 (2009)

DAVID LAZER

RYAN KENNEDY

OPINION 10.01.2015 07:00 AM

# What We Can Learn From the Epic Failure of Google Flu Trends

BIG DATA

## The Parable of Google Flu: Traps in Big Data Analysis

David Lazer,<sup>1,2\*</sup> Ryan Kennedy,<sup>1,3,4</sup> Gary King,<sup>3</sup> Alessandro Vespignani<sup>3,5,6</sup>

Mar 23, 2014, 09:00am EDT

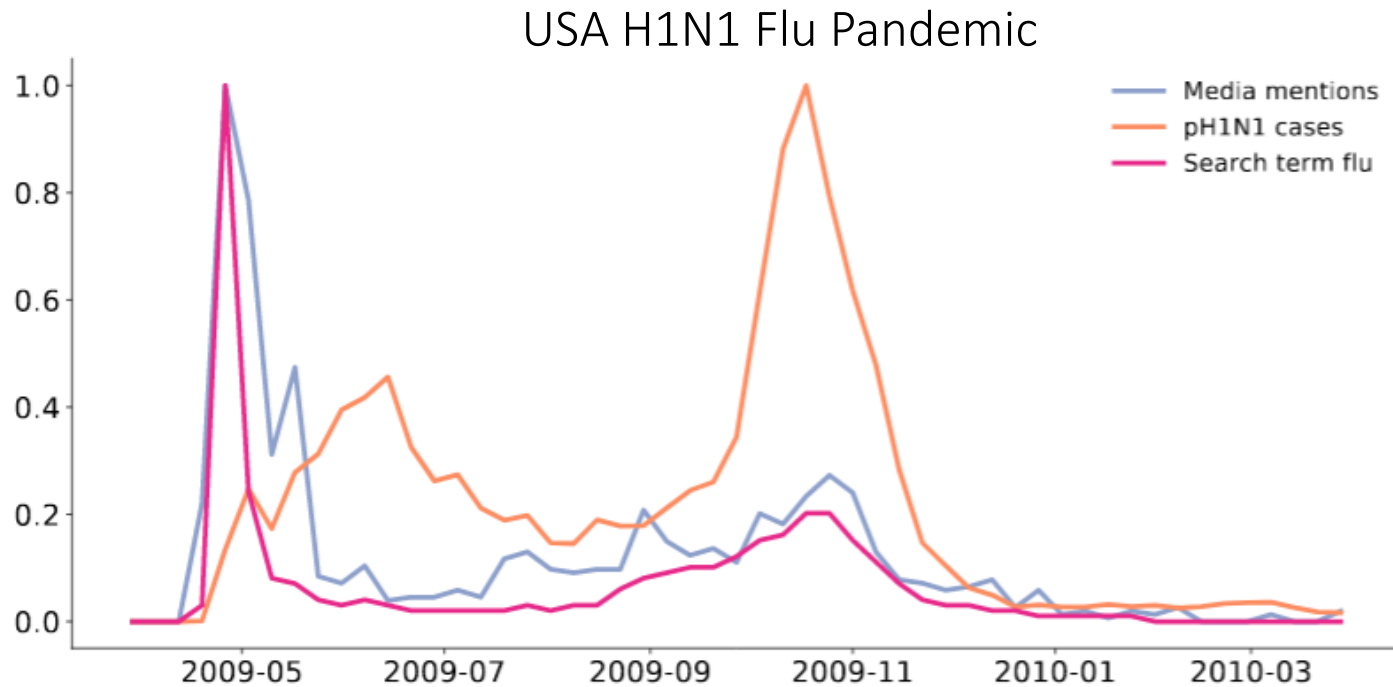
## Why Google Flu Is A Failure



**Steven Salzberg** Contributor ©

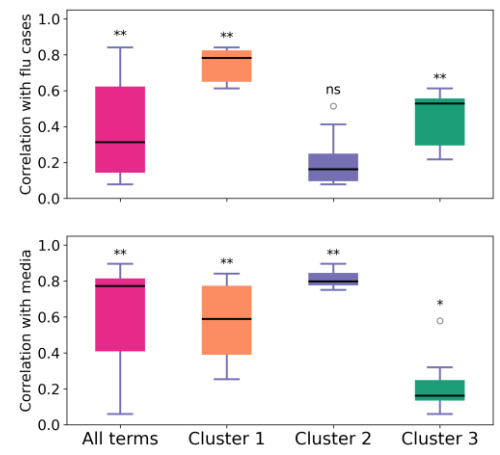
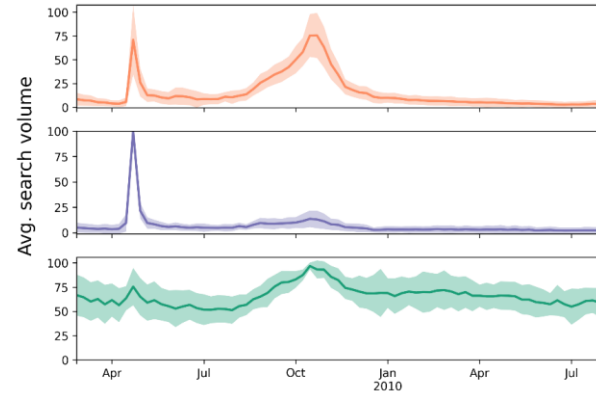
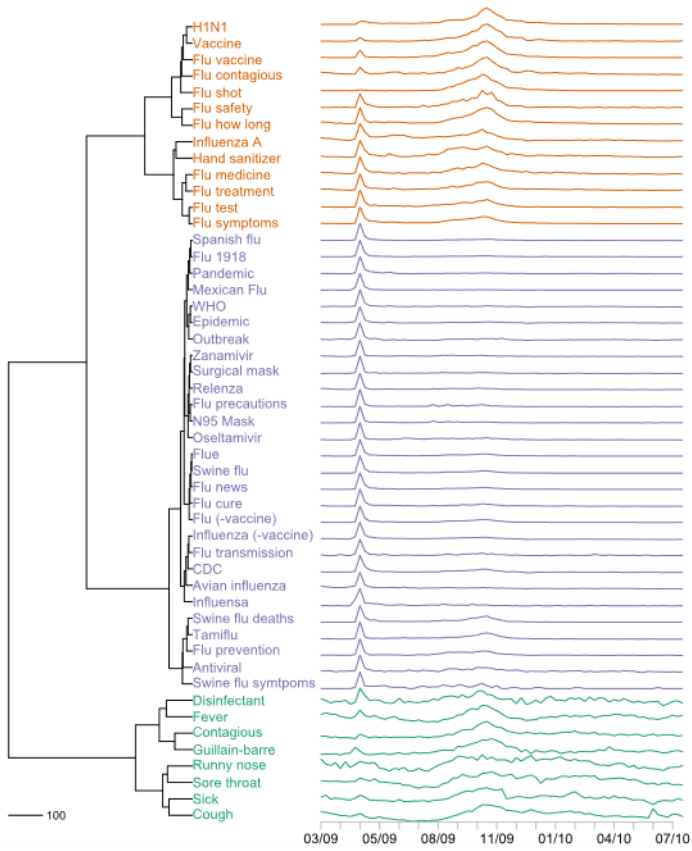
Healthcare

It seemed like such a good idea at the time.



Google searches for “flu” might be driven more by the media than by disease

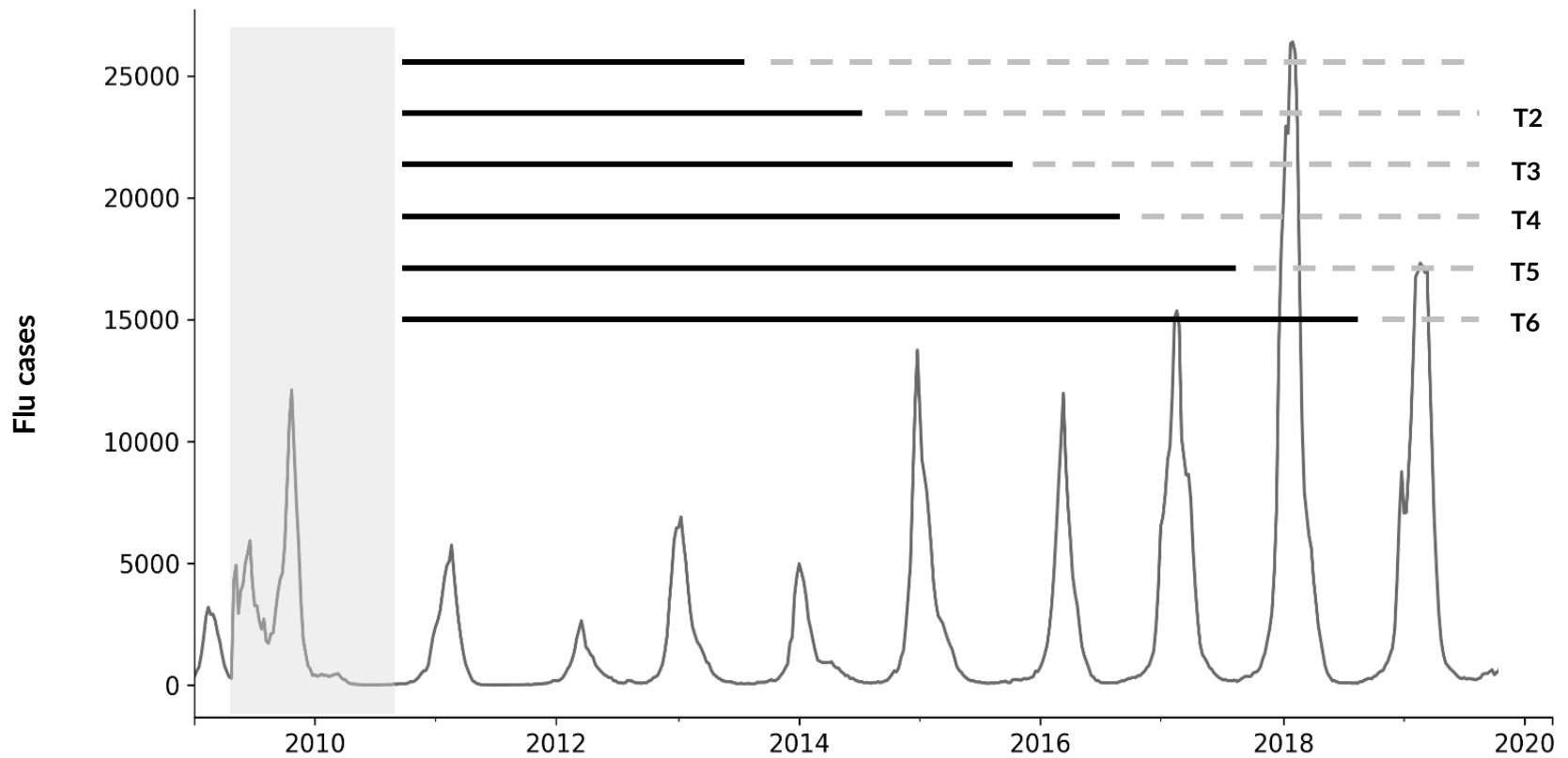
Signal to noise problem



Some search terms correlate strongly with the number of cases

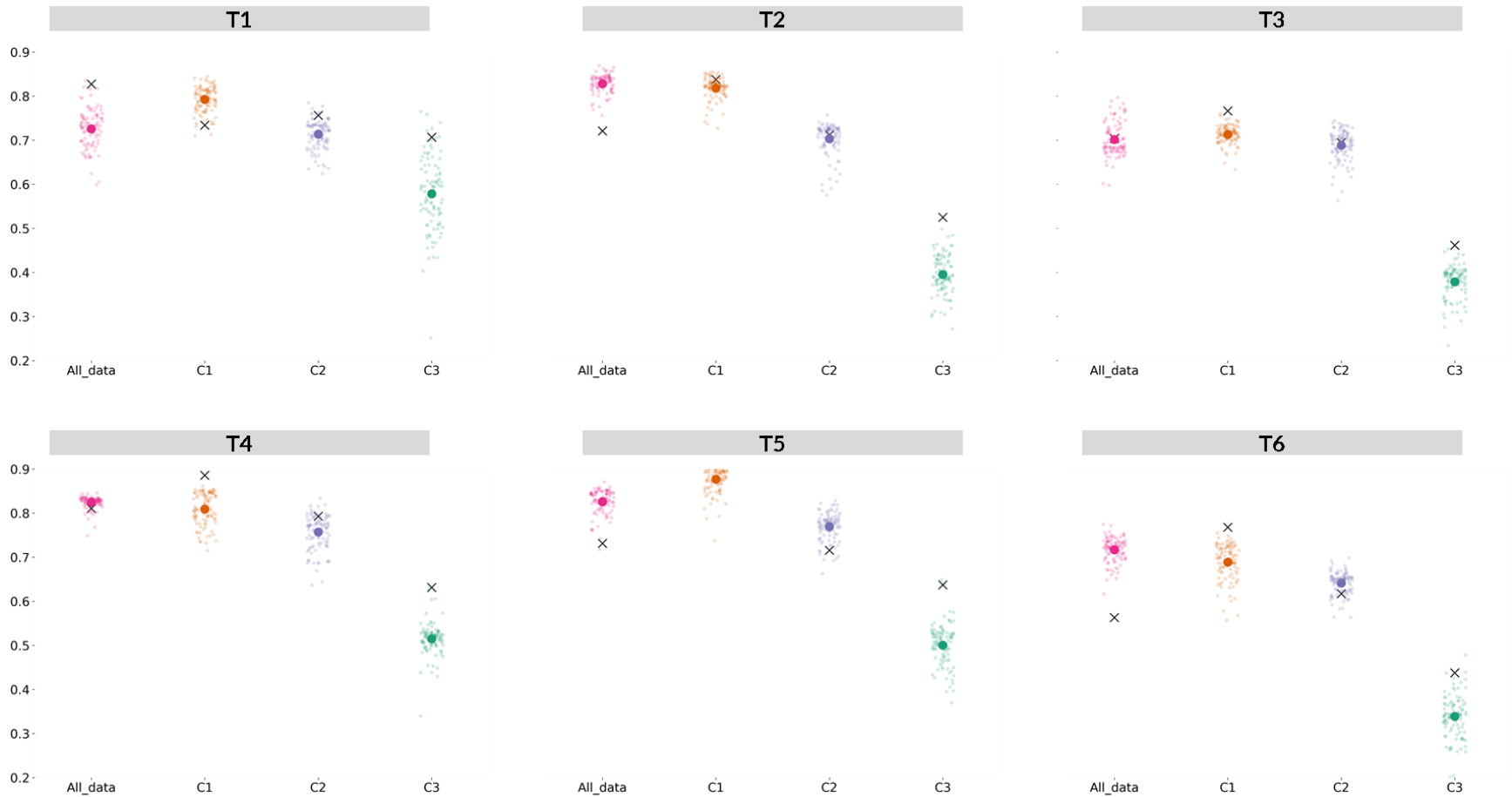
Other search terms correlate better with media attention

# Can we use it to improve prediction?



X = Linear Regression results  
● = Random Forest

## 2009 Flu pandemic



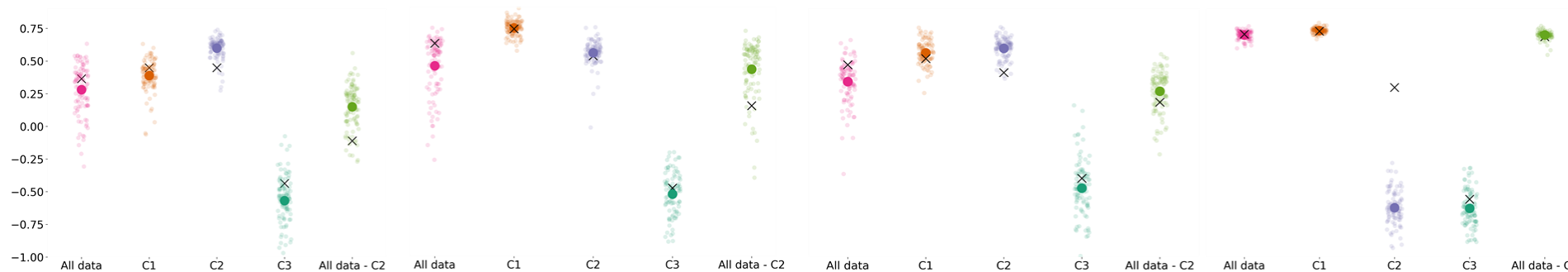
Curating the data improves forecasting, over using all data

T1

T2

T3

T4

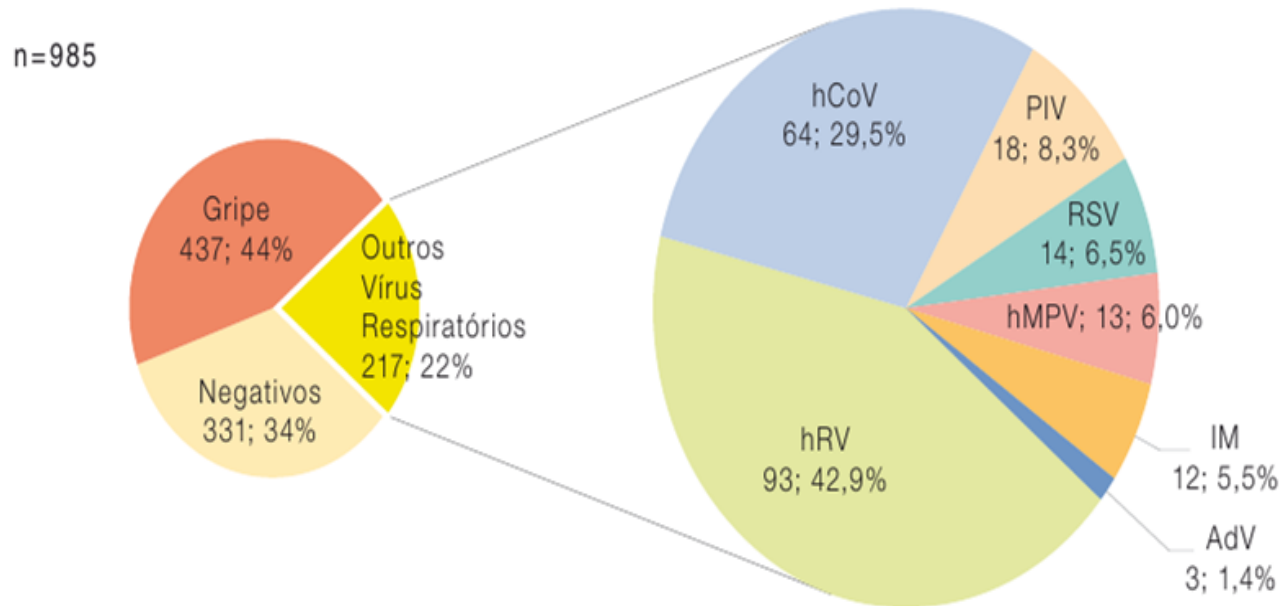


Curating the data improves forecasting, over using all data



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# Flu season & NIRVs



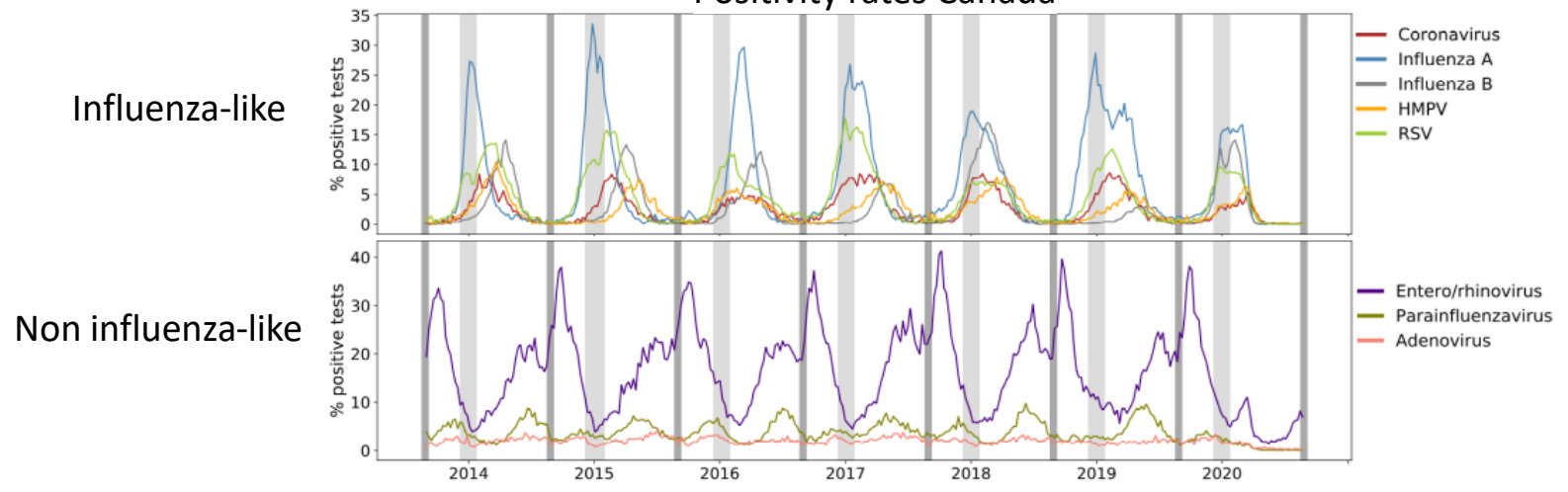
INSA National flu surveillance program. Season 2018/2019

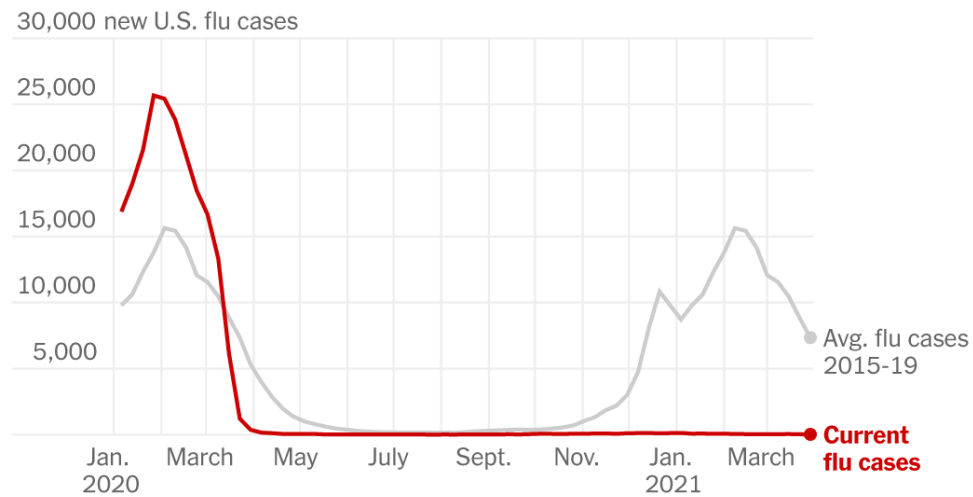
## Data:

- Epidemiological data: NIRVs positivity rates.
- Climate data (weighted for population).
- Symptoms data: Twitter, Google, Influenza Net.

Country	Epidemiological data					
	Frequency	From	Seasons	National data	Regional data	Format
USA	Weekly	16/17	4	hCoVs	hCoVs	% Positive test
				hMPV	hMPV	
				RSV	RSV	
				Adenovirus		
				Parainfluenza		
Canada	Weekly	13/14	7	hCoV	hCoV	% Positive test
				hMPV	hMPV	
				RSV	RSV	
				Adenovirus	Adenovirus	
				Parainfluenza	Parainfluenza	
				Enterorhino virus	Enterorhino virus	

Positivity rates Canada





## “Avalanches” nas urgências pediátricas, com gripe fora de época. Os “velhos” vírus estão de volta

Dois dos maiores serviços de urgências pediátricas do país estão receber mais cerca de 100 crianças por dia, em média, do que em Março de 2019. Médicos lembram que a maior parte dos casos de gripe e outras infecções respiratórias podem ser tratados em casa.

Alexandra Campos  
31 de Março de 2022, 6:31

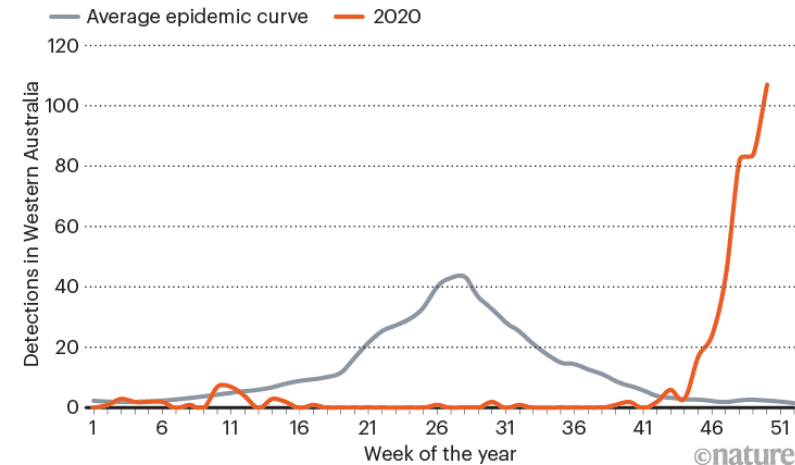


Urgências pediátricas registam números de casos acima do habitual NELSON GARRIDO?

<https://www.nytimes.com/interactive/2021/04/22/science/flu-season-coronavirus-pandemic.html>

### STRONG REBOUND

Infections with respiratory syncytial virus (RSV) reached historic lows in 2020 amid COVID restrictions. But they rebounded intensely in countries including Australia when these measures were eased.



<https://www.nature.com/articles/d41586-021-02817-8>

# SUM UP

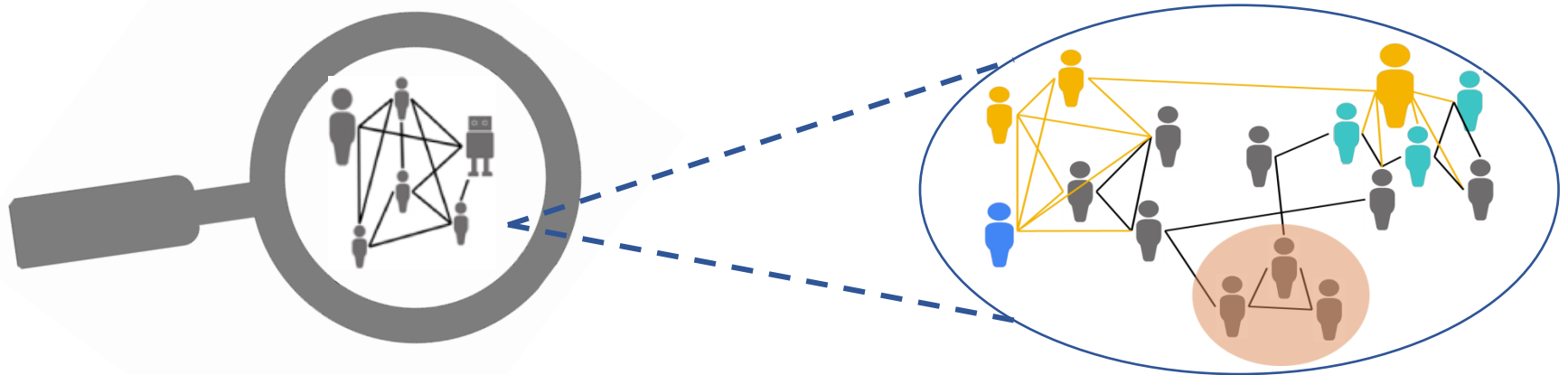
We are trying to use a combination of tools and datasets to study problems in public health

- Inferring diagnosis from prescription patterns
  - Learning from pandemics to improve seasonal forecasting
  - Understand viral competition and dynamics
- 
- We could significantly reduce AB prescription
  - More data is not always better
  - We might be experiencing epidemiological transition(s)

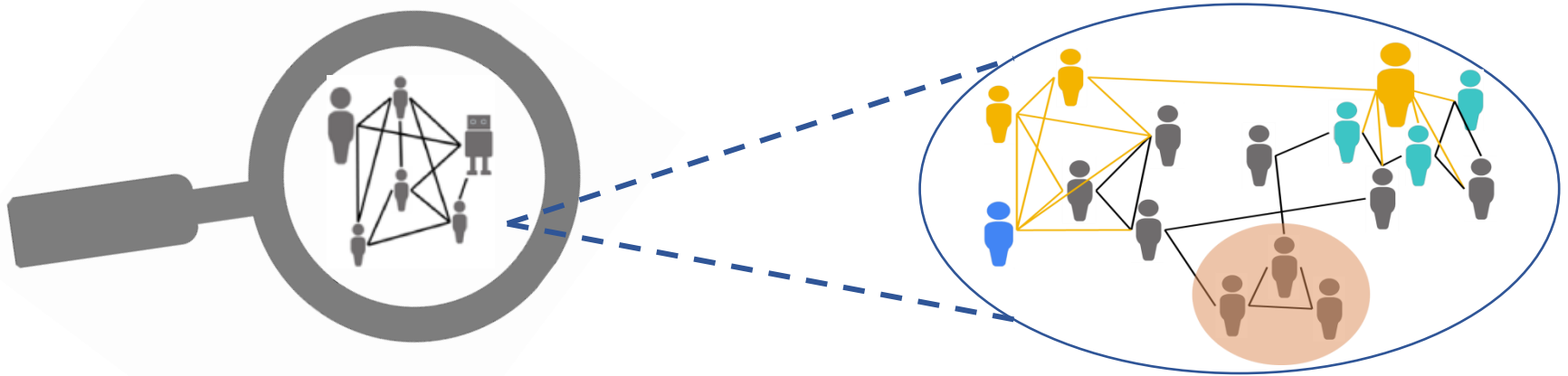
# ROADMAP

1. What is Digital Epidemiology?
2. Lessons from Flu
3. Lessons from Pandemics
4. Lessons from NIRVs
5. **Bias and Risks**

# WE CREATED A MACROSCOPE



## WE CREATED A MACROSCOPE

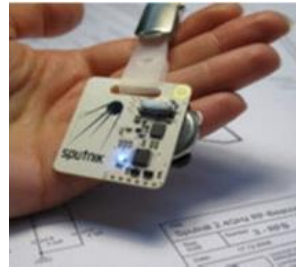
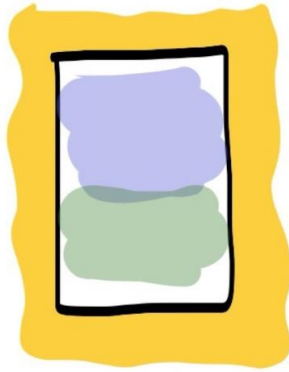


- SECURITY BREACHES
- PRIVACY CONCERNS
- ETHICAL CONCERNS
- DATASET BIAS
- ALGORITHMIC BIAS
- INSTRUMENTATION BIAS



## EASY COLLECTION OF SENSITIVE DATA

Using  
sensors,  
apps &  
museums  
to enable  
wellbeing



**RSE**  
Registo de Saúde  
Eletrónico



**PEM**  
Prescrição Eletrónica  
Médica



And you will read this at the end



**You will read  
this first**

**And then you will read this**

**Then this one**

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

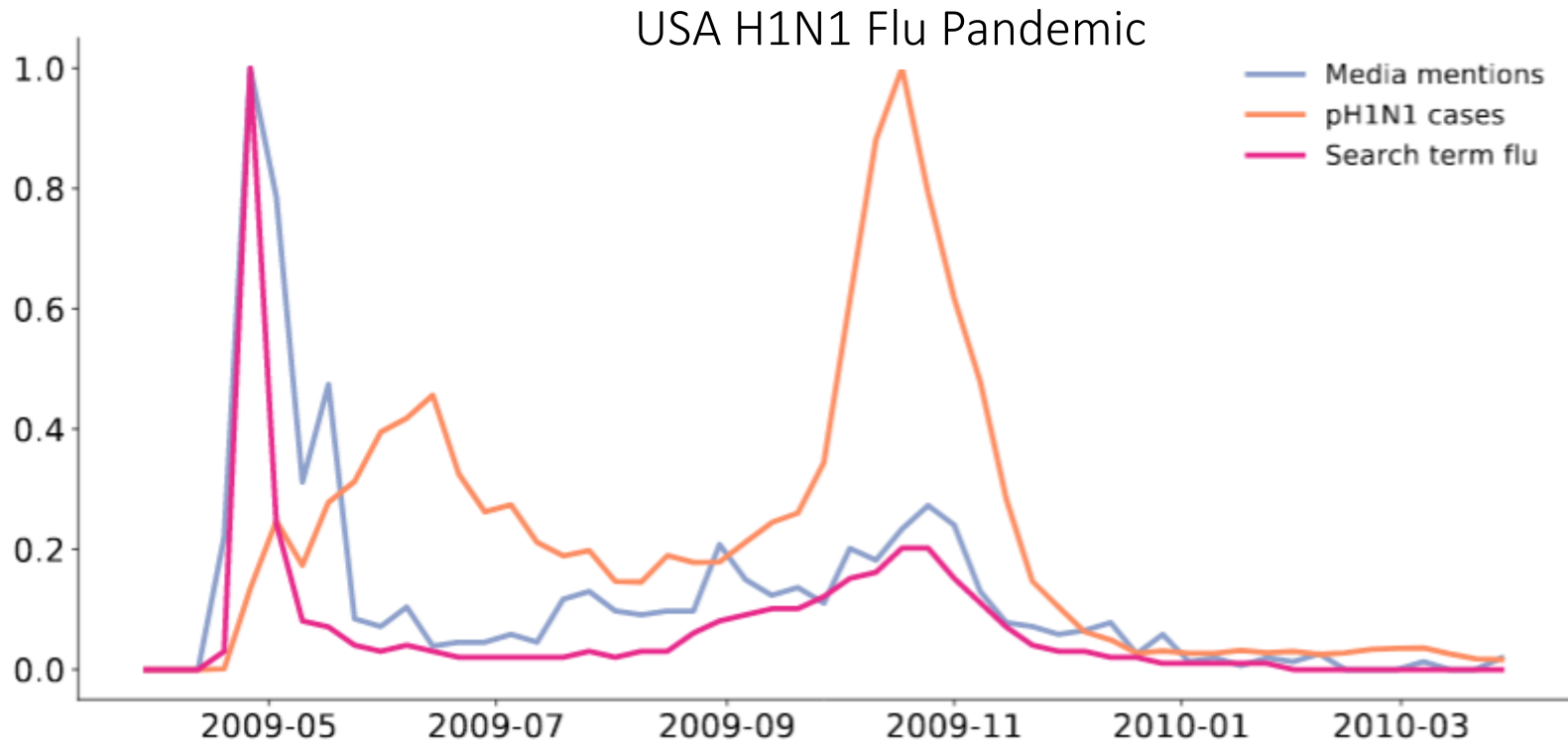
como é que se **beija**  
como é que se **diz eu te amo**  
como é que se **beija de lingua**  
como é que se **engravidar**  
como é que se **beija na boca**  
como é que se **escreve**  
como é que se **beija pela primeira vez**  
como é que se **faz um facebook**  
como é que se **faz um relatório**  
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 gâteau**  
comment faire **du caramel**  
comment faire **de la glue**  
comment faire **du pain**



Google searches for “flu” might be driven more by ~~the media~~ than by disease

Google searches for “flu” might be driven more by **fear/anxiety** than by disease

# THANK YOU

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