

A world map with a dark background and white outlines of continents. Numerous red circles of varying sizes are scattered across the map, representing data points. The circles are most densely clustered in Europe and North America. Some labels like 'EUROPE', 'AFRICA', and 'North Atlantic Ocean' are visible in a light blue font. A white mouse cursor arrow is positioned over a red circle in the Atlantic Ocean region.

Towards Health Surveillance with Online Media

Luca Maria Aiello



Mobility + Connectivity

Pandemics

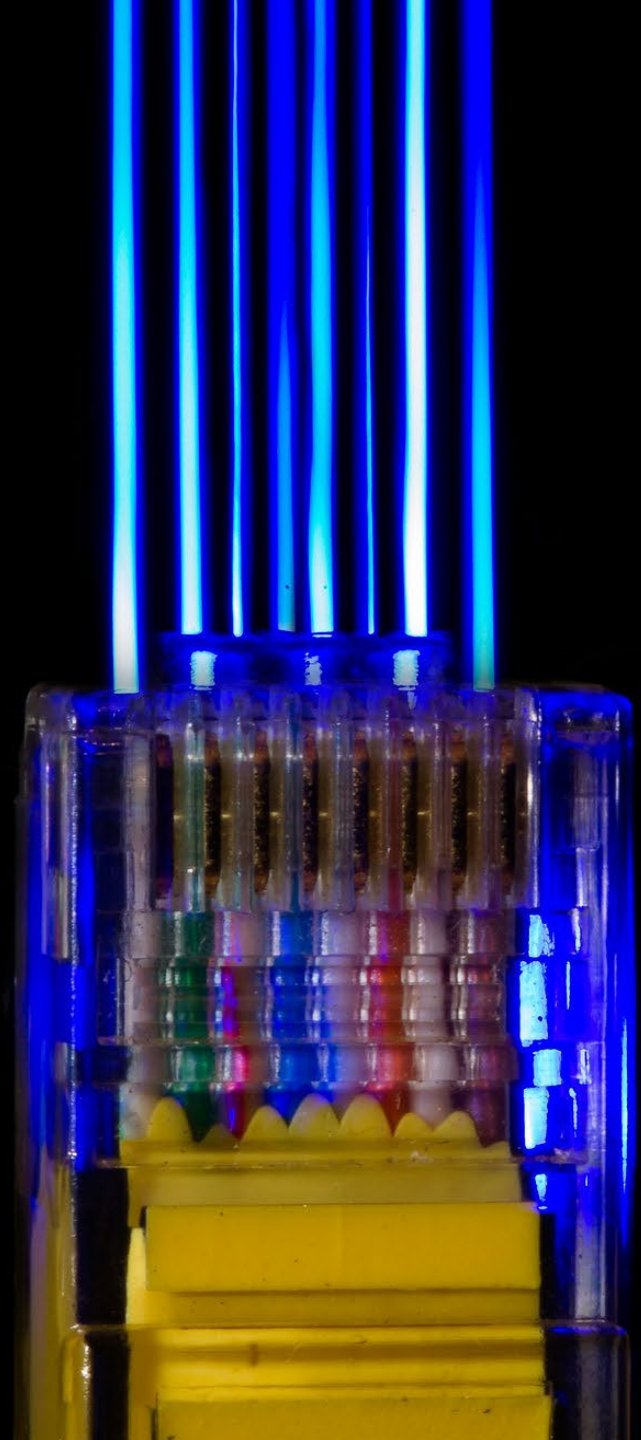
Obesity

Opioid crisis

Depression

WHO

“Ten years in public health 2007-2017”



Next-generation health surveillance systems

1. Near real-time
2. Work at the scale of nations
3. Cheap
4. Unintrusive
5. Adaptive to new types of health crises
6. Capture the whole bio-psycho-social sphere of health



Digital data

PROJECT I:
Obesity



PROJECT II:
All diseases



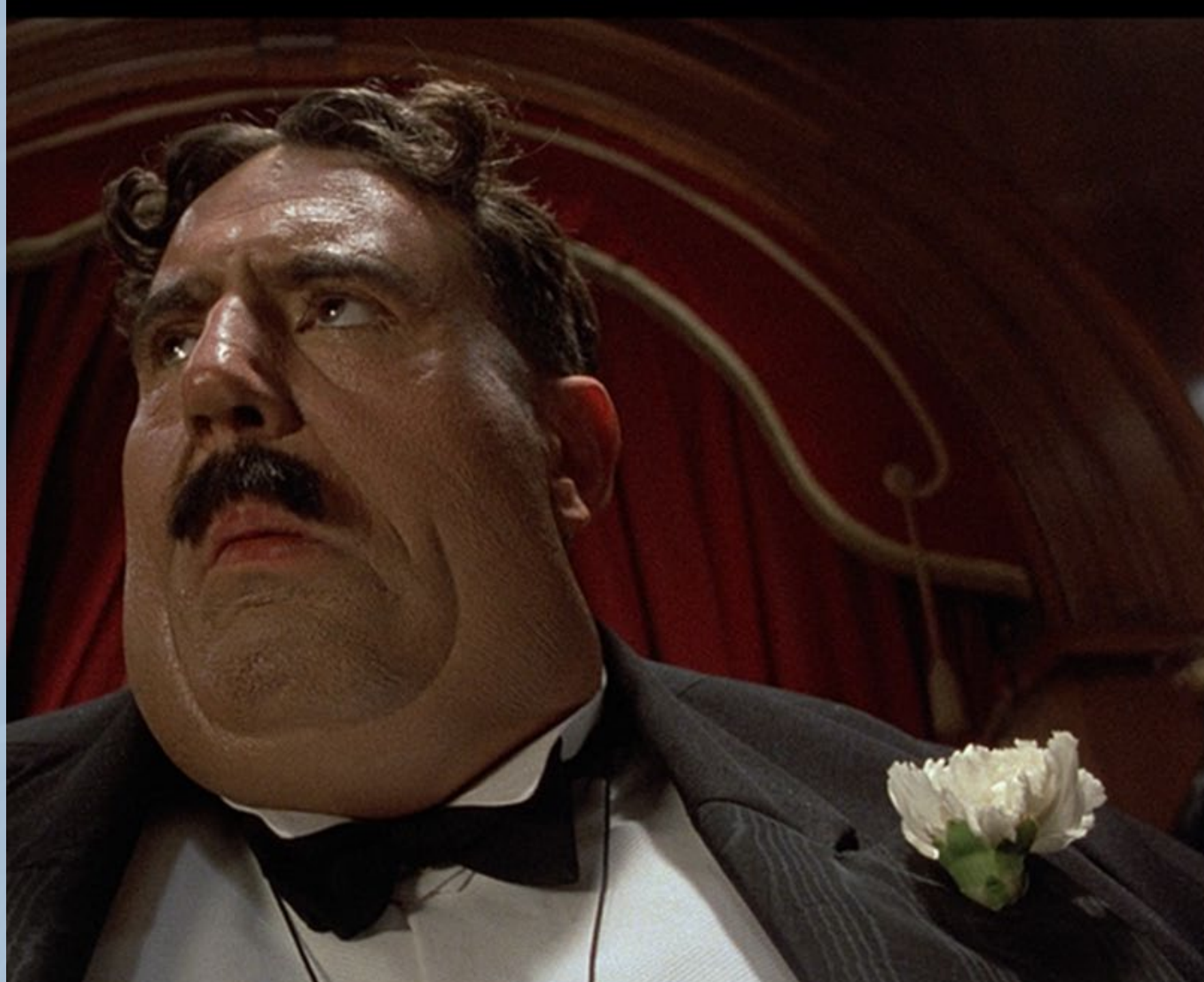
Metabolic diseases

In the UK:

26% adults are obese

31k excess deaths
connected to obesity

£58B yearly spending

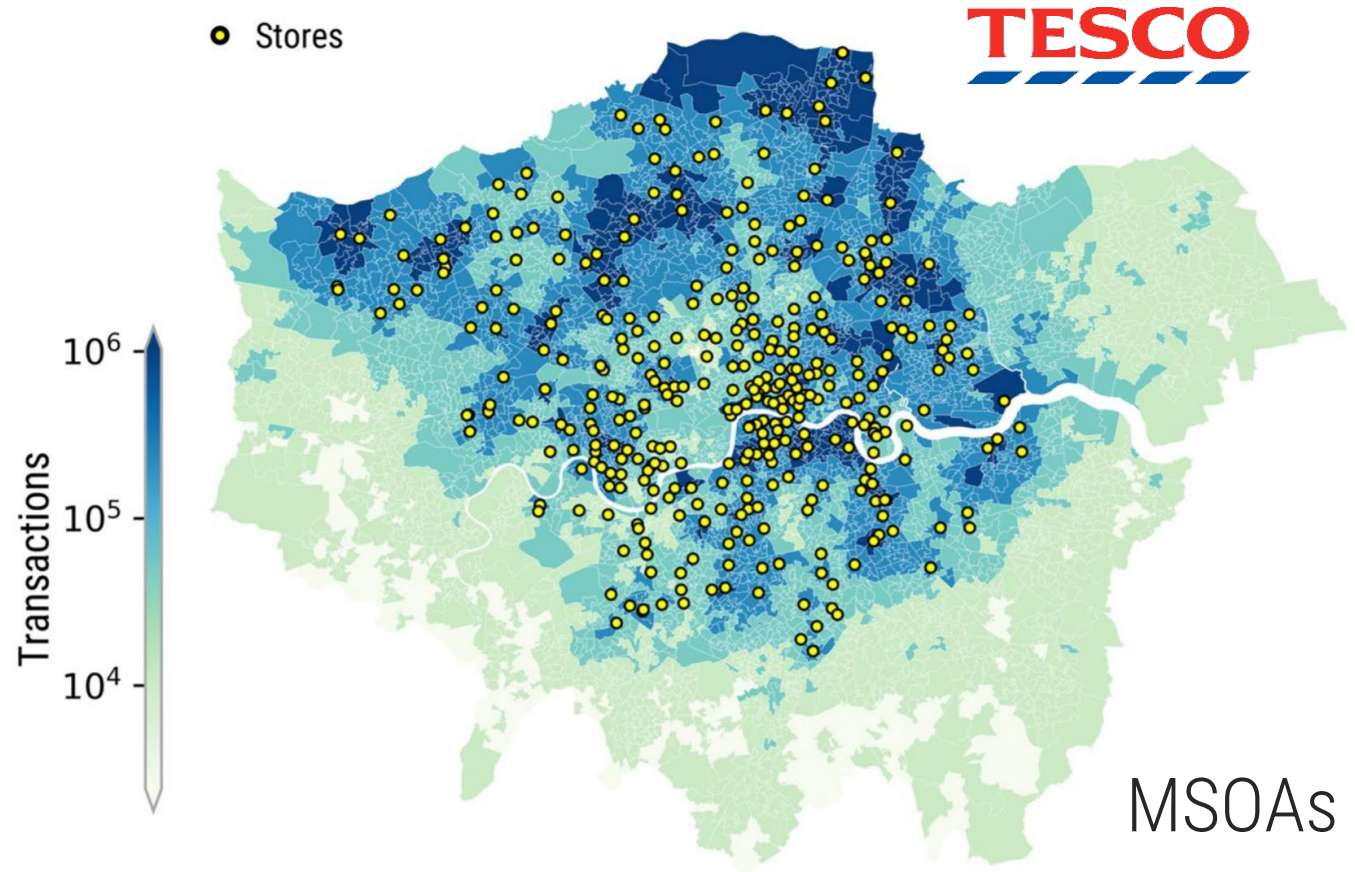


No Large-scale
data



Grocery purchases data

- Tesco, the largest food retailer in UK (30% of the market)
- 411 stores in greater London
- 1.6B products purchased by 1.6M customers in 2015 (zip code)
- 77k unique products
- Nutritional info and ingredients



Dataset: <https://doi.org/10.6084/m9.figshare.c.4769354.v2>

Example records

Transactions

transaction_time	clubcard_number	storeID	productID	quantity
2015-04-12-16:45	ggC...e/sSog==	5561	72294267	2

Customers

clubcard_number	Postcode
ggC...e/sSog==	NW11NU

Products

productID	name	ingredients	weight	energy	fat	saturate	salt	sugar	protein	carbs	fibre	category
72294267	Finest Belgian Choc. Nut	Dark Chocolate Coated Brazil Nuts (30%) ...	225g	629	53	12	0.1	18	13	21	7.8	Sweets

The “average” food product

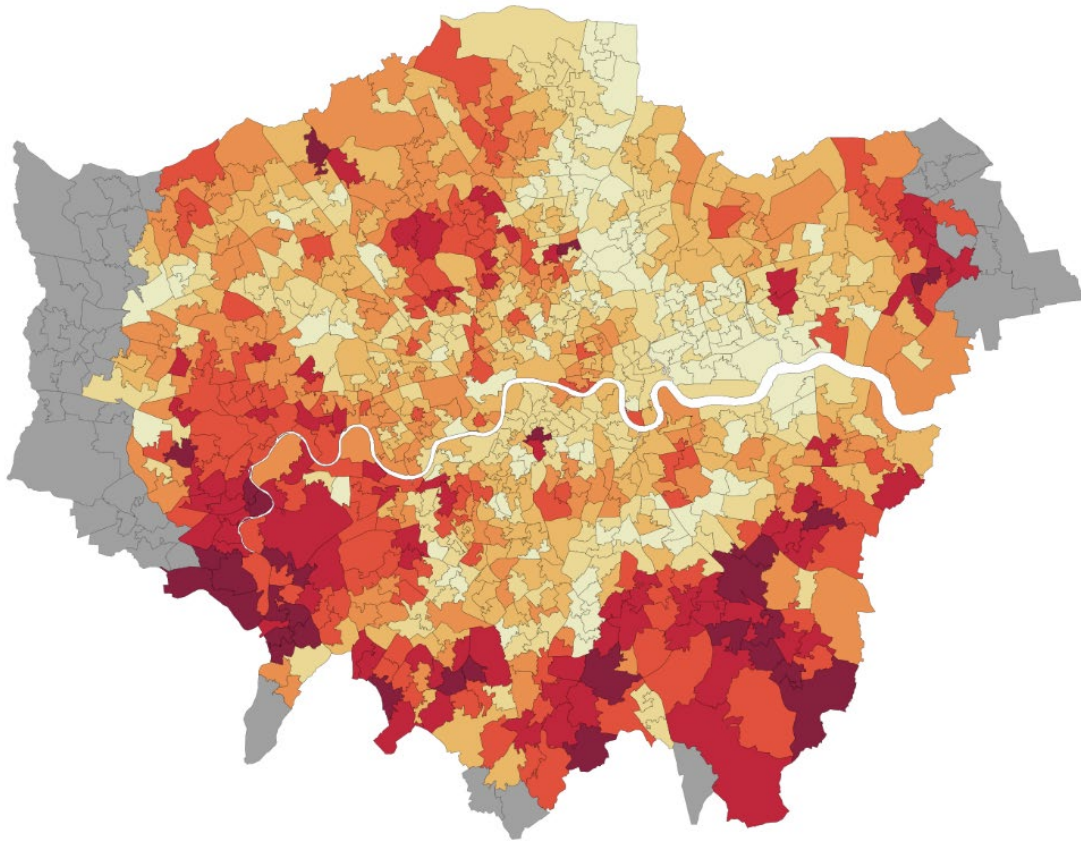


MSOA

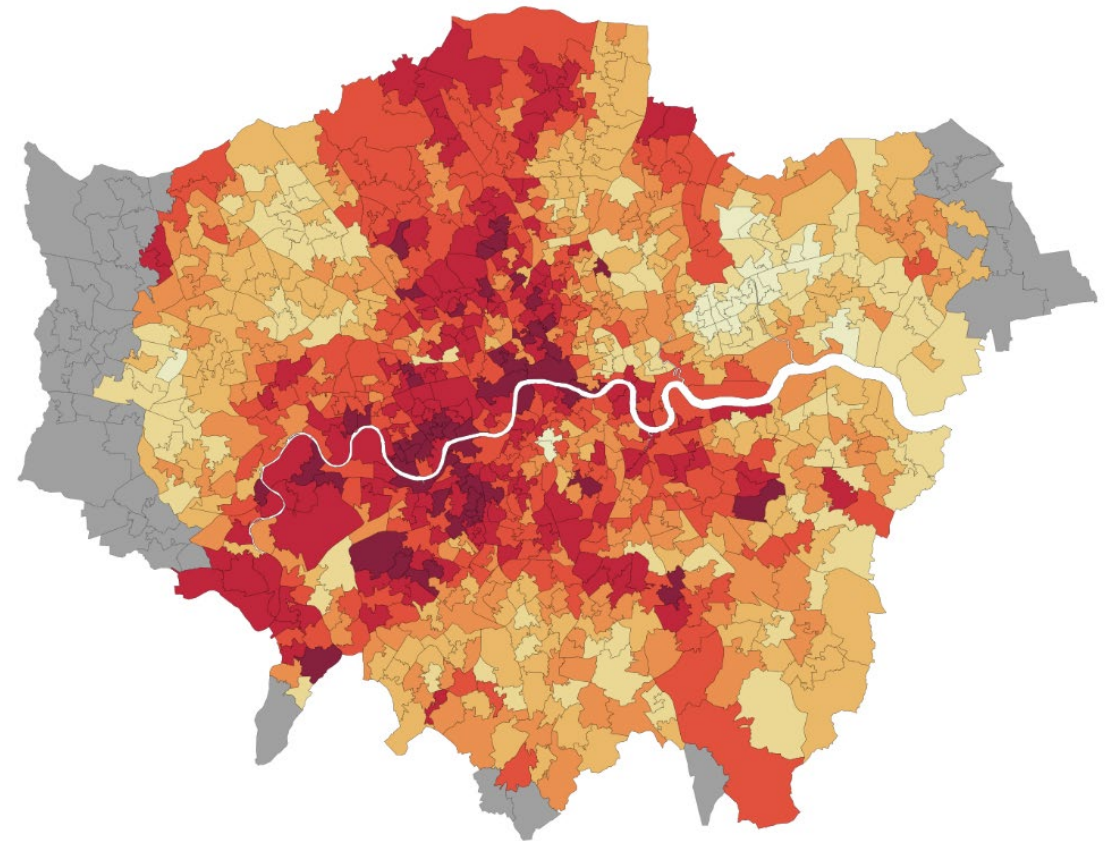


Consumption in space

Fibers



Nutrient diversity



Prescription data

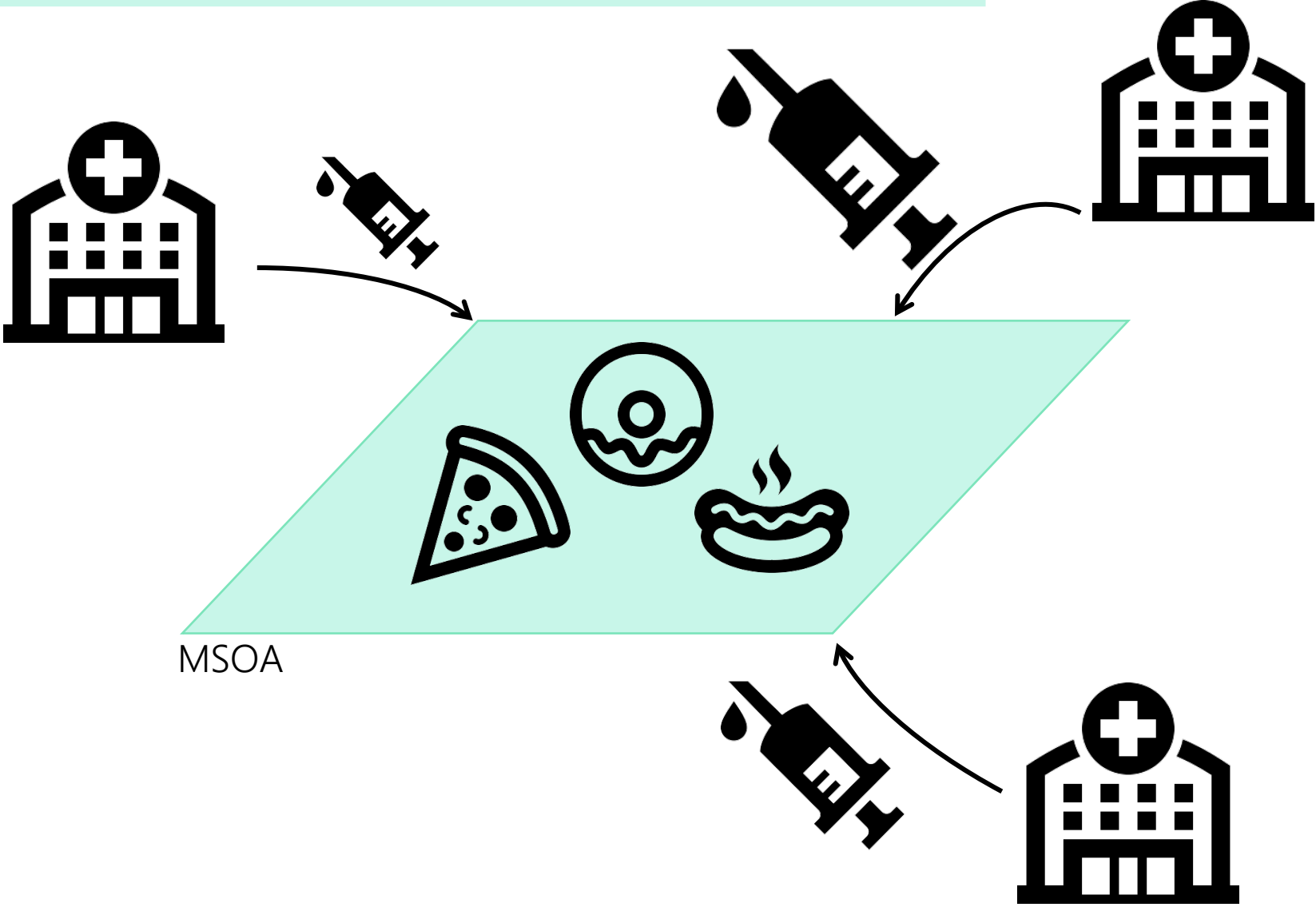
NHS dataset on GP medicine prescriptions

1,174 practices in Greater London

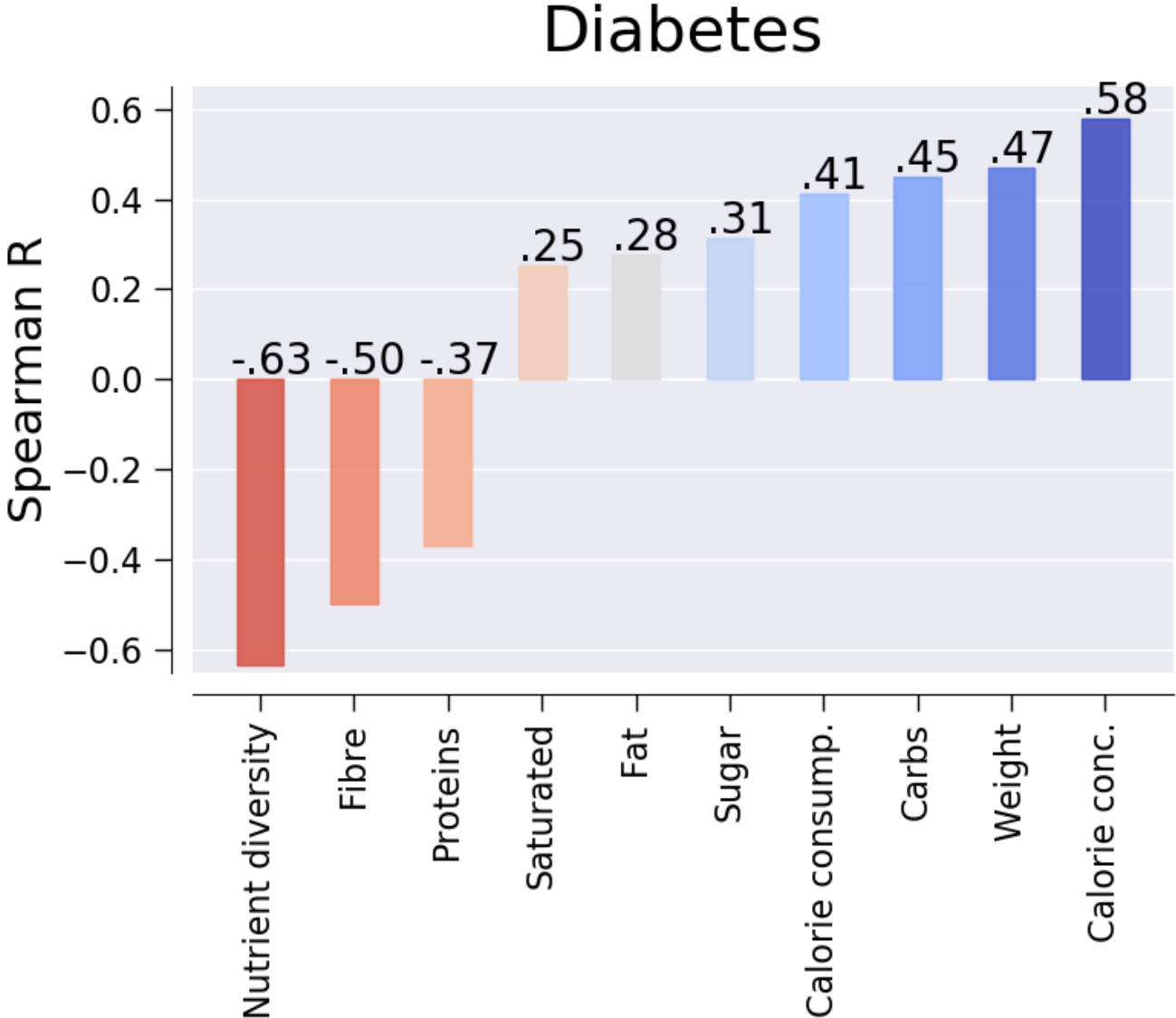
1.1B prescriptions in 2016, at area level

Hypertension, Diabetes, Cholesterol

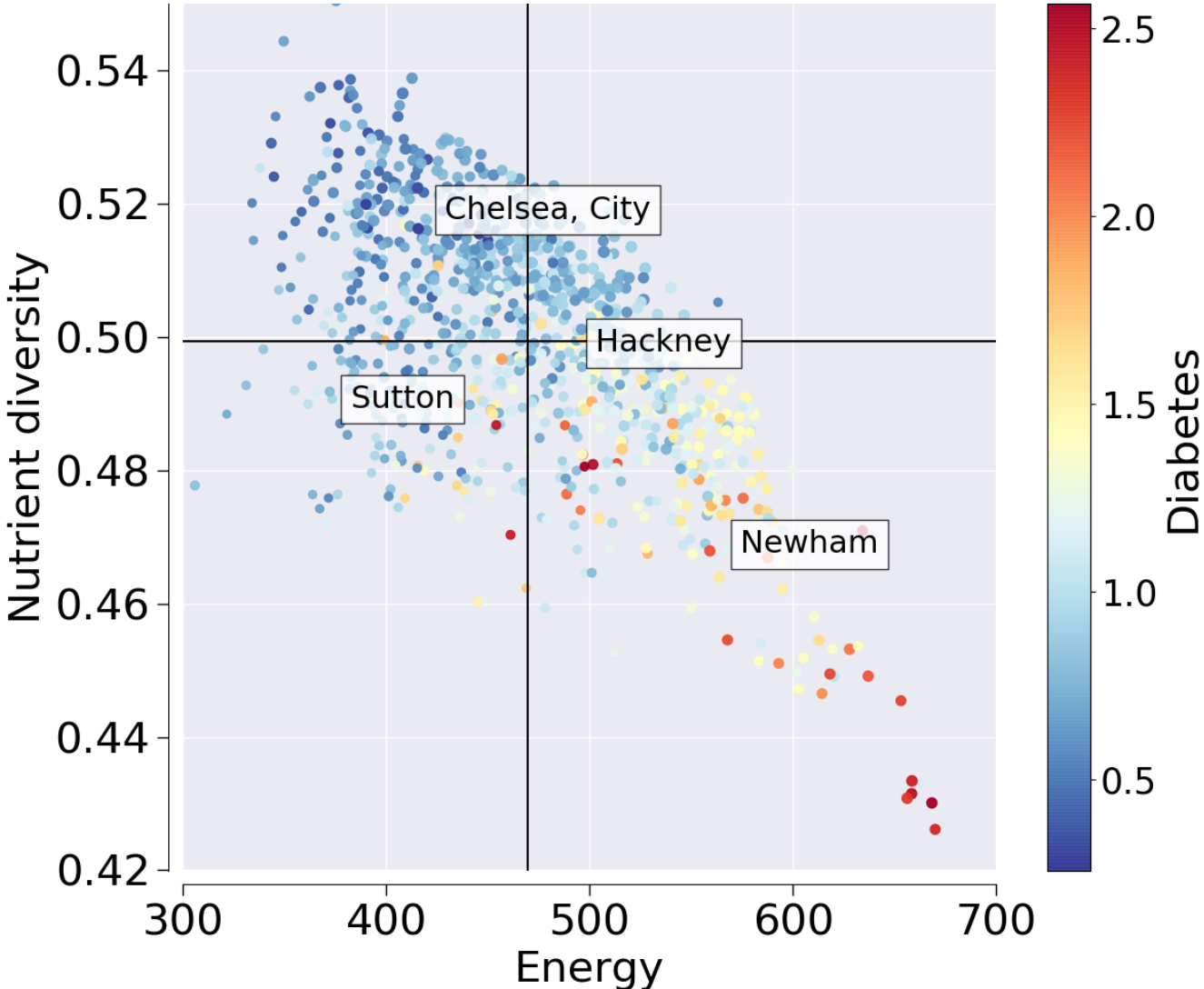
Matching food and prescriptions



Food consumption and diseases



Diversity & energy predict diabetes



Limitations

1. Near real-time ✓
2. Work at the scale of nations
3. Cheap
4. Unintrusive
5. Adaptive to new types of health crises
6. Capture the whole bio-psycho-social sphere of health

Idea



Gather health-related information from social media*

Most data-mining techniques are disease-specific and keyword-based

One algorithm to rule them all?

* Chancellor and De Choudhury: "Methods in predictive techniques for mental health status on social media: a critical review" npj Digital Medicine, 2020

2 My allergies are ruining my life. Please help! (Can't sleep. Nasal conge... Advice

r/Allergies · Posted by u/CrispChum New Sufferer 1 day ago

My allergies are ruining my life. Please help! (Can't sleep. Nasal congestion)

Advice

This is gonna be long. I'll include a TLDR at bottom.

After allergy testing, I'm allergic to mostly everything. Molds, dust mites, pollens, cat, etc.

My major (and only) symptom is nasal congestion at night.

This started as soon as I moved I to my apartment in June. Before this, my allergies would just consist of itchy, watery eyes and runny nose during the spring and fall. I have not gotten any of these symptoms since I moved. Only congestion at night.

Right before I moved in, I was sitting at a fire pit with friends, and the smoke went directly into my face, and hit my face face mask where I continued to breathe in the smoke all night.

My congestion started the day after, but was minor.

I moved into my apartment, and immediately got a sinus infection. Since I moved in, I cleaned the radiators and bathroom fan that was full of dust. I also installed a new window AC because the previous one was full of mold. I installed an air purifier (HEPA) and bought a heavy duty vac (HEPA). I have low pile carpet that I vac at least once a week. (All within the first 3 months of moving in)

I have searched every crevice of the apartment for mold, and found no signs.

Medications I have tried:

- Flonase
- Nasacort (both have similar effect and work to an extent but does not last through

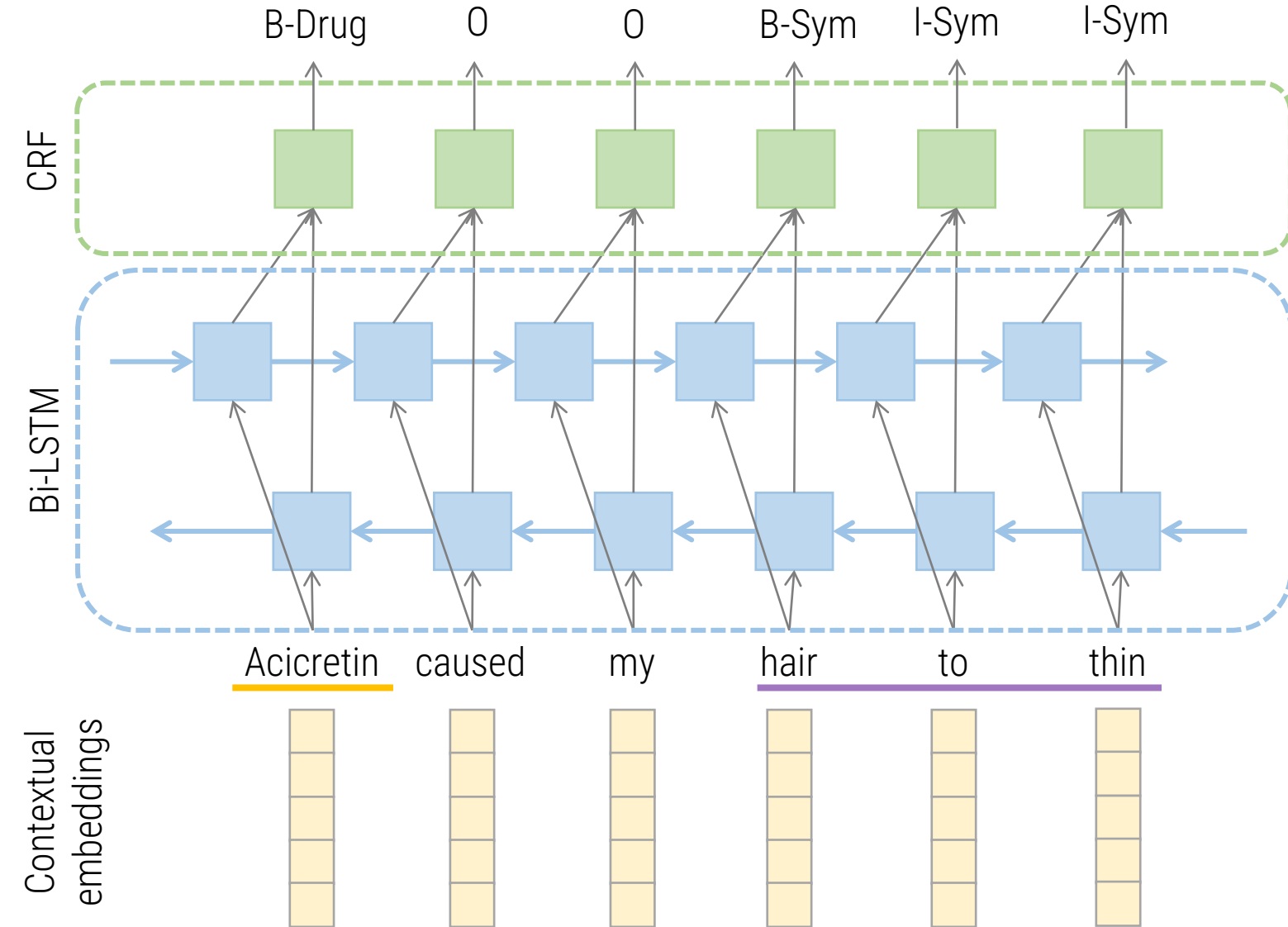
Medical conditions from text

Conditions

Symptoms

Drugs

Medical entity extraction



Training on 2000 Reddit posts labeled via Mturk

F1 score in [0.71, 0.78] on three benchmarks

Discovering medical conditions at country level



0.5M users
7M submissions
130M comments

↑ 20 ↓
 Posted by u/This_Muffin 12 months ago

Anyone already experiencing bad allergies? Or is this a cold?

I've had horrible Spring time allergies since moving to Bloomington. It's very much like having a cold and I thought I did have one the first time I got them. Right now my **throat hurts**, I'm **exhausted** & I have a **runny nose**. But it doesn't feel like a full blown cold. Anyone else?

Edit: Thanks for the responses. I've concluded that it's allergies again. I've been less congested tonight and my throat isn't as sore. My nose isn't pouring like crazy either.

Edit #2: Yep. Allergies. Bad again today and fenofexadine 2x a day is no match for it.

38 Comments Give Award Share Save Hide Report 88% Upvoted

Co-occurrence network

↑ 2 ↓
 r/Allergies · Posted by u/CrispChum **New Sufferer** 1 day ago

My allergies are ruining my life. Please help! (Can't sleep. Nasal congestion)

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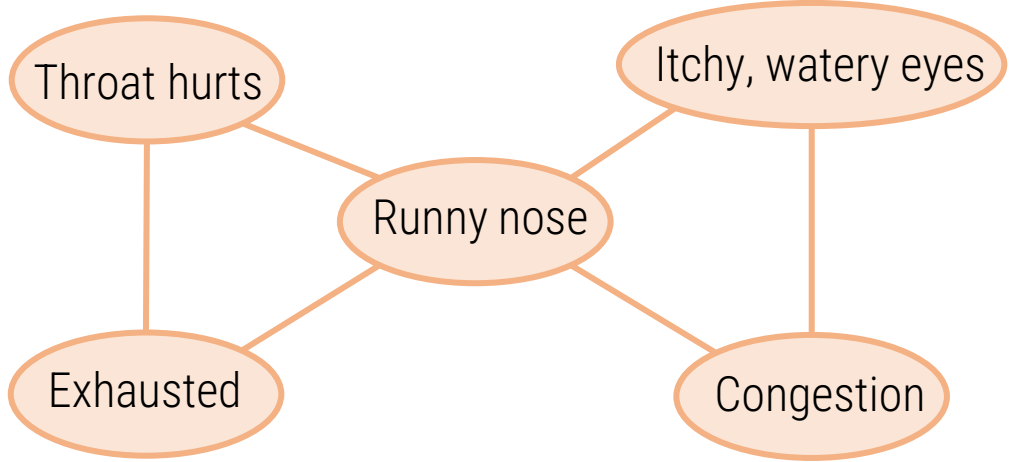
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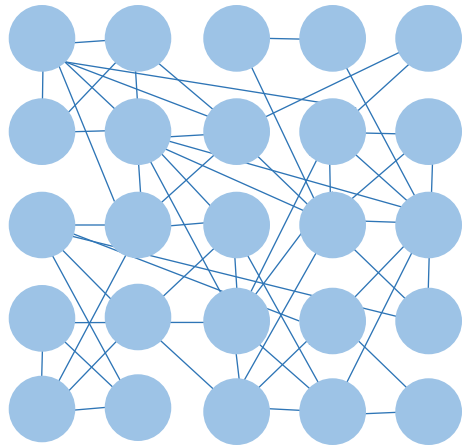
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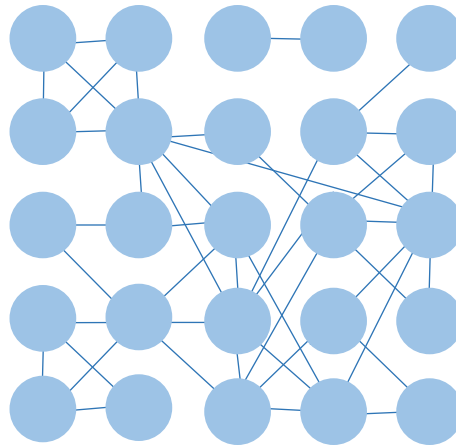


Network processing

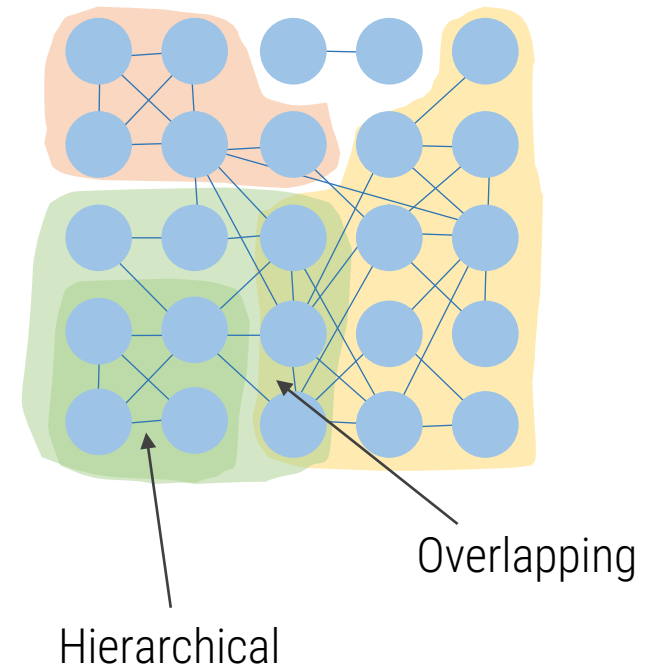
Original network



Backboning



Infomap clustering



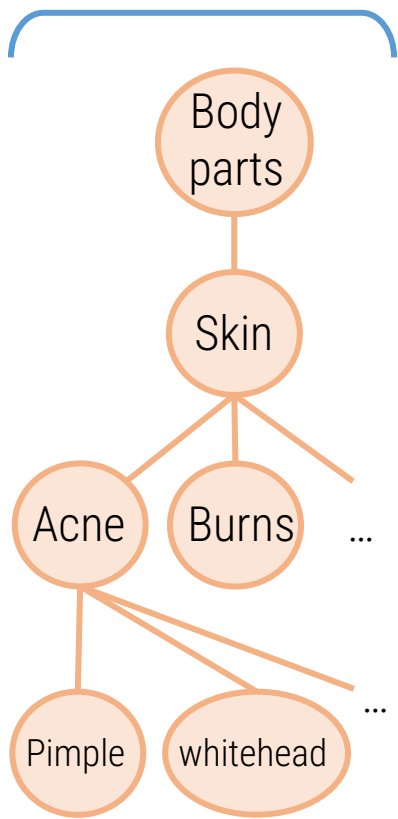
Reddit Health Taxonomy

(A) Level-1	Level-2	Example words
Mental		
mental [06]	isolation, autism, adhd, bipolar, psychosis, severe illness, anhedonia, stress, tic, paranoia, anguish, dyslexia, depression, personality disorder, impulsive behaviour, genetic, psych disorder, fatigue, misophonia, personality, light head, insecurity, dissociation	wobbly feel, dread, hypomania, autism, suicidal thought
anxiety [06]	anxiety	anxiety, anxious, panic attack
personality [06]	bpd, dysphoria, narcissistic, antisocial, schizotypal	lack of empathy, sociopathic, manipulative behaviour, abusive behaviour
Behaviour		
breathing [12]	asthma, fatigue, chest, heart, breathing, active breathing control, inflammations	trouble breathing, severe chest pain, esophagus spasm
vomit [21]	vomiting, emetophobia, bugs, pain, gagging	terrible fever, phobic, disgust
STDs [01]	stds, yeast, pregnancy, pain	hiv, syphilis, viral load, losing blood, testicular ache
obesity [05]	eating disorders, hunger, weight loss	obese, overweight, excessive fat, overeating
addiction [06]	drugs, porn, alcohol, symptoms	drinking problem, opiates, strong urge, abscess, irritable
sleep [07]	hallucinations, pain, traumas, nightmares, apnea, narcolepsia, insomnia, sleepwalking, lack	ptsd, flashback, apnea, snore, wake up every hour
Body parts		
skin [14]	acne, redness, wrinkles, hyperpigmentation, scalp, aging, dryness, spots, bleeding, burns, inflammation, rash, itching, eczema, allergies, bites, herpes, food allergies, soreness, bumps, psoriasis, vitamin, body hair, irritation, scab	pimple, whitehead, flaky, dark spot, ingrown hair, mango allergy
ear [10]	tinnitus, dementia, vertigo, vibrations, congestion, noise	ringing in my ear, dizzy, blowing nose constantly
eye [09]	vision distortion, blurry vision, gallstone, high pressure, eye alignment, blindness, glaucoma, sweating, light sensitivity, strain, hypertension, aneurysm, migraine	eye pressure, spatially aware, nearsighted
heart [11]	palpitations, irregular, tachycardia	irregular heartbeat, poor concentration
spine [08]	multiple sclerosis, neurodegenerative, hernia	tingling, lesion, difficult to lav

Level-1	Level-2	Example words
Conditions		
cancer [02]	cancer, gout, skin, lymphoma, lumps, genitals, digestive, lymphnodes, bones	discolored skin, swollen lymphnode, back ache, terminally ill, gnarly bruise
infective [01]	sepsi, heart, fever, overdose, pneumonia, mosquito-borne, measles, blood, pain, confusion	highly viral, dark mucus, sweating and cough, with knuckle, blood clot
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diabetes [05]	diabetes, cataract, metabolic syndrome, vision, brain	nebula, brain fog, low blood sugar, lost pigment
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Demographics		
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infants [18]	reflux, ppd, breast, teeth	spitting up, clogged duct, nipple damage, screaming, mentally drained
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Reddit Health Taxonomy

ICD-11 category #14



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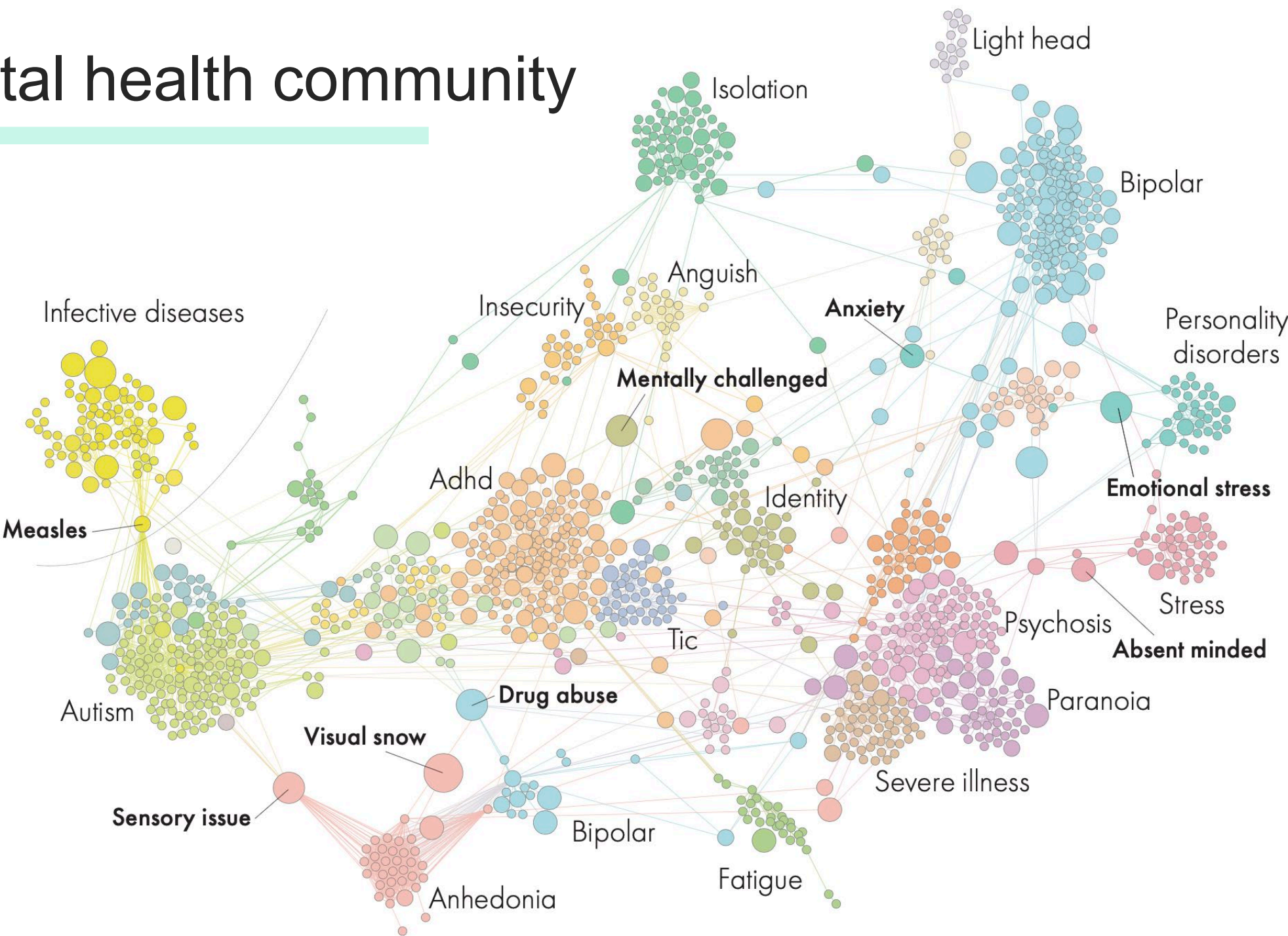
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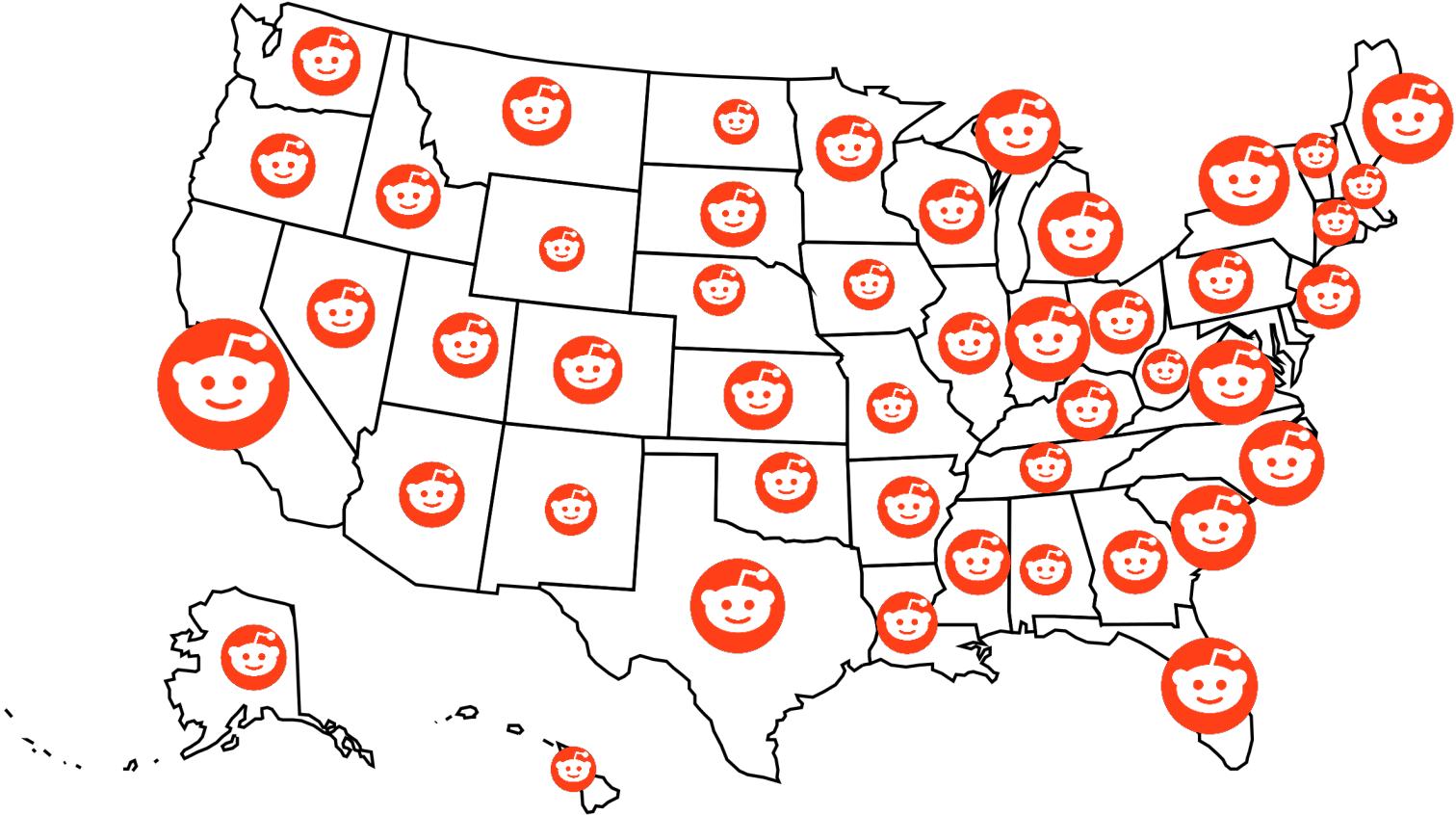
Mental health community



Geo-referencing Reddit posts at US state level



List of US-based
Reddit users



Health indices

1. Fraction

%users in state mentioning symptoms of d

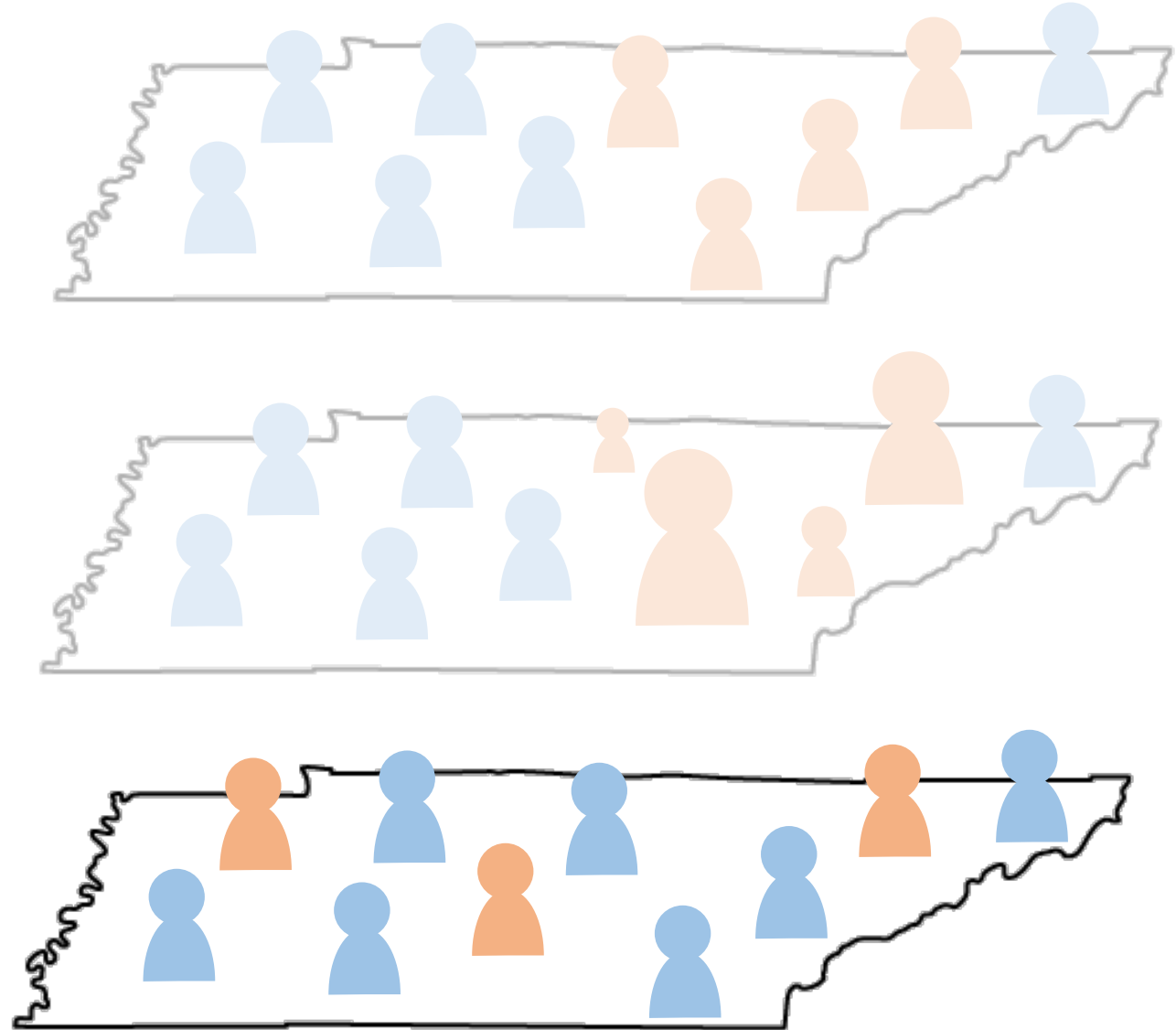
2. Centrality

%users in state mentioning symptoms of d ,
re-weighted by symptom's centrality on graph

3. Baseline

% users in state mentioning known symptoms from fixed
dictionary

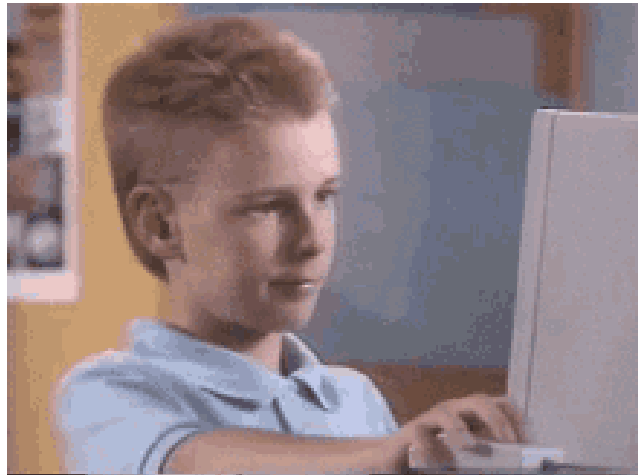
Hypothesis: the more symptoms of a disease d are
mentioned in a state, the more d is prevalent



Health indices

1. Fraction

NLP + Network science:



2. Centrality

3. Baseline

Health score	Official Statistic	Fraction	Centrality	Baseline
$H_{S_i}^l$	Mental Health			
mental	Mentally Unhealthy Days	-.31*	-.45**	-.06
mental	Mental Illness	-.23*	-.30*	-.01
$H_{S_i}^l$	Substance Abuse			
breathing	Cigarette Use	-.31*	-.29*	—
infections	Cocaine Use	-.25	-.29*	—
infections	Heroin Use	-.30*	-.43**	—
$H_{S_i}^l$	Metabolic syndrome			
obesity	High Cholesterol Prev.	-.29*	-.46***	-.12
obesity	High Blood Pressure	-.26	-.45***	—
obesity	Mortality Cardiovascular	-.19	-.39**	-.01
obesity	Mortality CHD	-.16	-.47***	-.03
obesity	Mortality Heart Disease	-.21	-.39**	-.02
obesity	Overweight	-.01	-.33*	—
obesity	Diabetes Prev.	-.25	-.45***	.02
$H_{S_i}^l$	Specific Diseases			
elderly	Arthritis	-.45**	-.47***	-.06
breathing	Asthma	-.33*	-.42**	-.13
$H_{S_i}^l$	STDs			
STDs	HIV prevalence	-.23	-.43**	.14
STDs	AIDS prevalence	-.22	-.41**	.11
STDs	Prim. and Sec. Syphilis	-.22	-.47***	.23
STDs	Early Latent Syphilis	-.28*	-.39**	.10
H_S^l	All Conditions			
all	Poor Self-rated Health	-.34**	-.33*	—
$H_{S_c}^l$	Most Central Conditions			
most central	Poor Self-rated Health	-.38**	-.39**	—

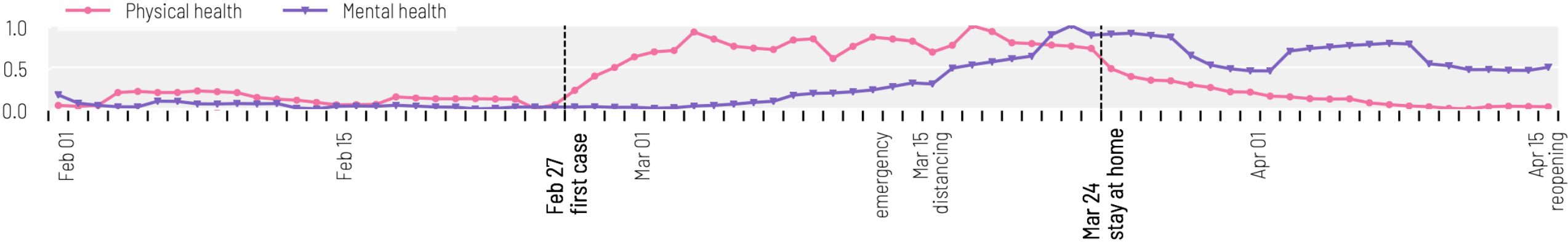
What conditions occupy people's minds




Conditions in COVID-19 tweets in USA



(USC collection)

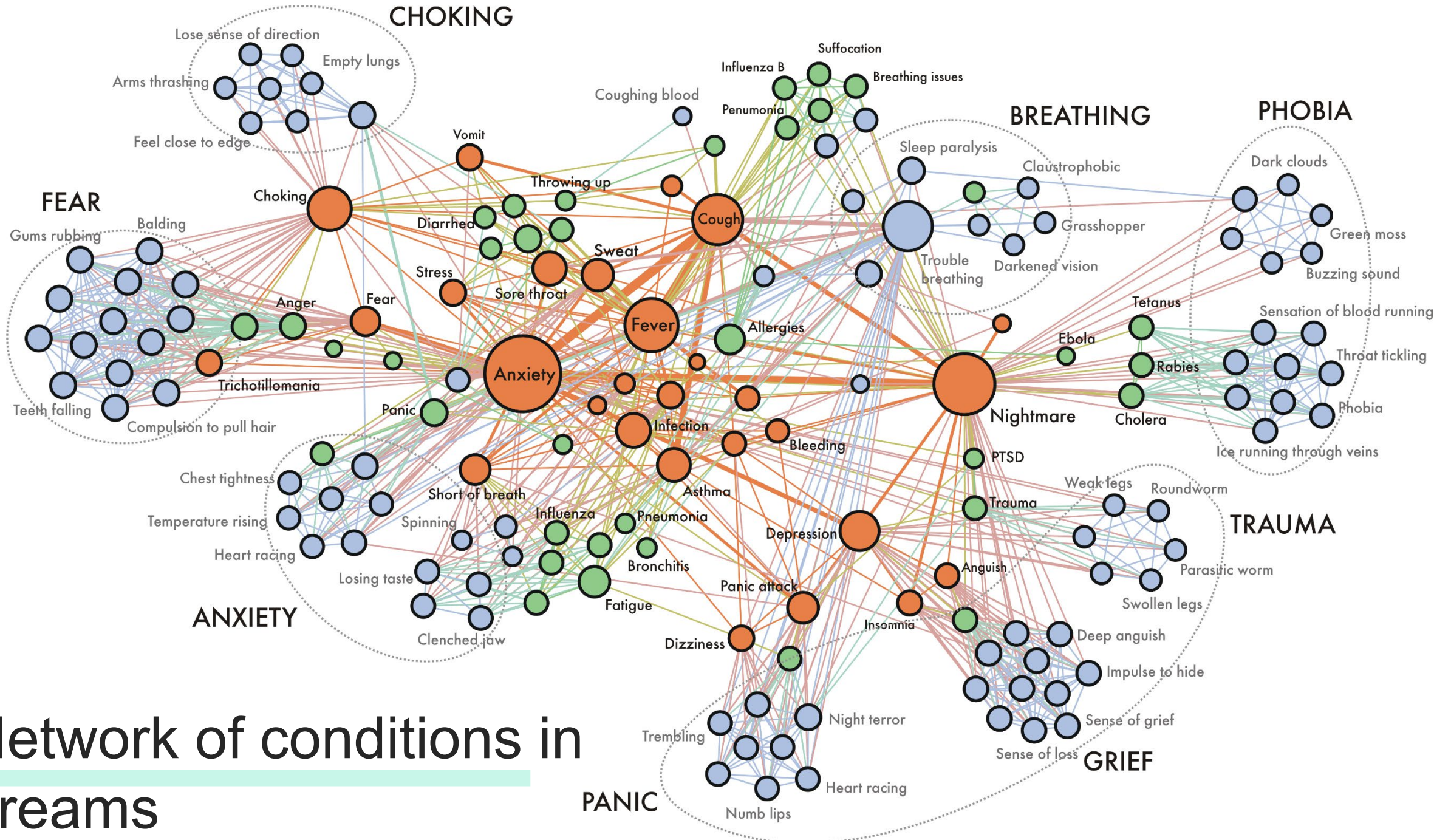


A close-up, low-angle shot of a person with long, dark hair tied up, sleeping peacefully in a bed. They are covered with a dark, textured blanket. In the background, a window with white horizontal blinds is visible, with soft light filtering through. The overall mood is calm and intimate.

What conditions occupy people's dreams

2000 covid-related dream reports from US residents

Network of conditions in dreams



Summary

NLP tool to discover medical conditions

Social media health taxonomy

Validity against official data

Health surveillance system properties

1. Near real-time
2. Work at the scale of nations
3. Cheap
4. Unintrusive
5. Adaptive to new types of health crises
6. Capture the whole bio-psycho-social sphere of health





I DON'T UNDERSTAND

WITH WILLIAM SHATNER



AVAILABLE ON



http://www.lajello.com/video/shatner_2021.mp4



Collaborators



Rossano
Schifanella



Lucia
Del
Prete



Deirdre
Barret



Tobias
Kauer



Daniele
Quercia



Sanja
Scepanovic



Ke "Adam"
Zhou



Marios
Constantinides



Sagar
Joglekar

Thank you!

@lajello 

www.lajello.com 

- Epidemic dreams: dreaming about health during the COVID-19 pandemic – Royal Society Open Science 2022
- The Healthy States of America: Creating a health taxonomy with social media – ICWSM 2021
- Extracting medical entities from social media – ACM CHIL 2020
- How Epidemic Psychology Works on Twitter – Nature Humanities & Social Sciences Communications, 2021
- Tesco Grocery 1.0, a large-scale dataset of grocery purchases in London – Nature Scientific Data 2020
- Large-scale and high-resolution analysis of food purchases and health outcomes – EPJ Data Science 2019

