Uncertainty in Behavioural models

Insights from the HERoS project

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HERoS

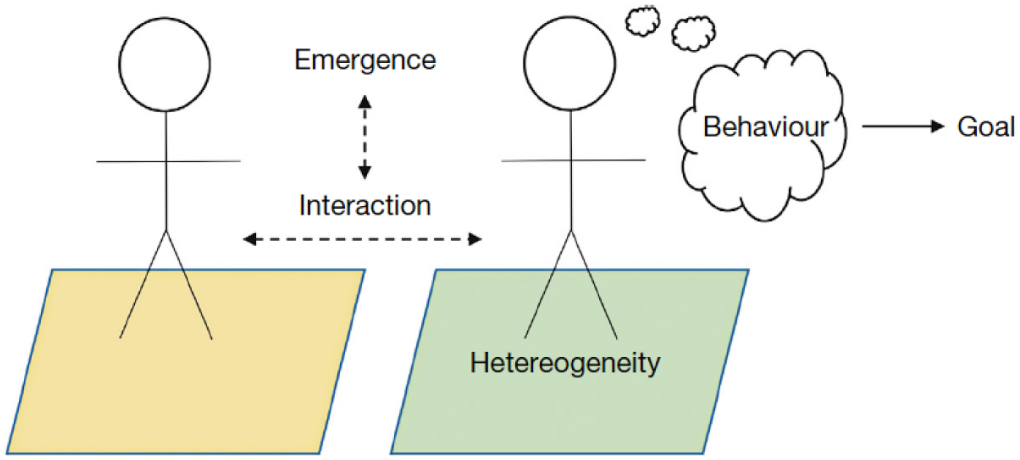
Health Emergency Response in Interconnected Systems

The Corona-virus outbreak is continuing to spread. **By beginning of February, the number of infected people surpasses 42,000 infections**, and the death toll continues to rise. As authorities and responders are struggling to contain the spread, news about mass quarantine camps or shortages of personal protective equipment threaten the health systems globally, fuelled by rumours and mis-information.

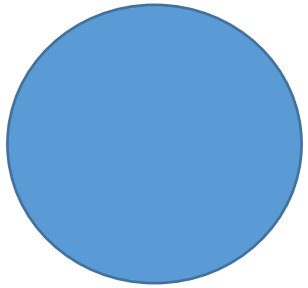
Behavioural modelling objectives

Epidemics essentially spread through contact networks. To consider impact of **behaviour from the bottom up,** we will develop an Agent-based model.

This model will be combined and coupled with a **network model** based on system dynamics to model the spread across globalised networks.

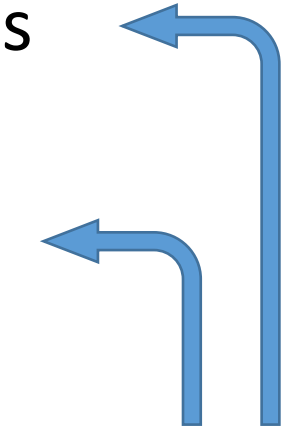


A city?



Understanding behavioural change - drivers

- Personal or individual: beliefs, knowledge, attitudes
- Social: interaction with other actors
- Environmental: economy (incl. prices), technology, ***pandemics***

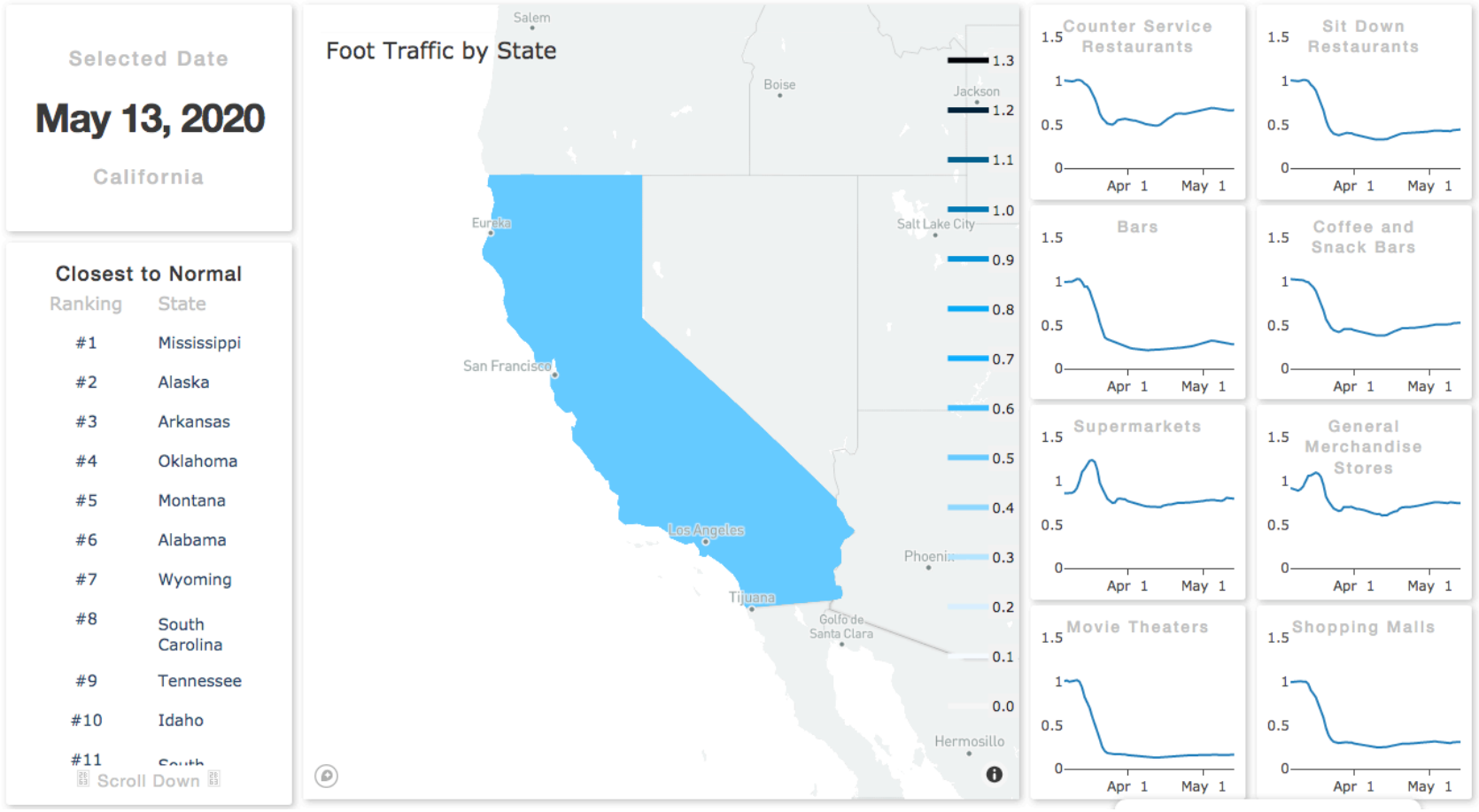


Theories

- *Social Cognitive Theory:* observing and learning from others; effects of positive and negative reinforcement

- *Theory of Planned Behaviour:* people's behaviour is determined by intention, predicted by attitudes, subjective norm (beliefs about whether other people approve or disapprove), and perceived behavioural control (beliefs about whether it is easy or difficult to do).

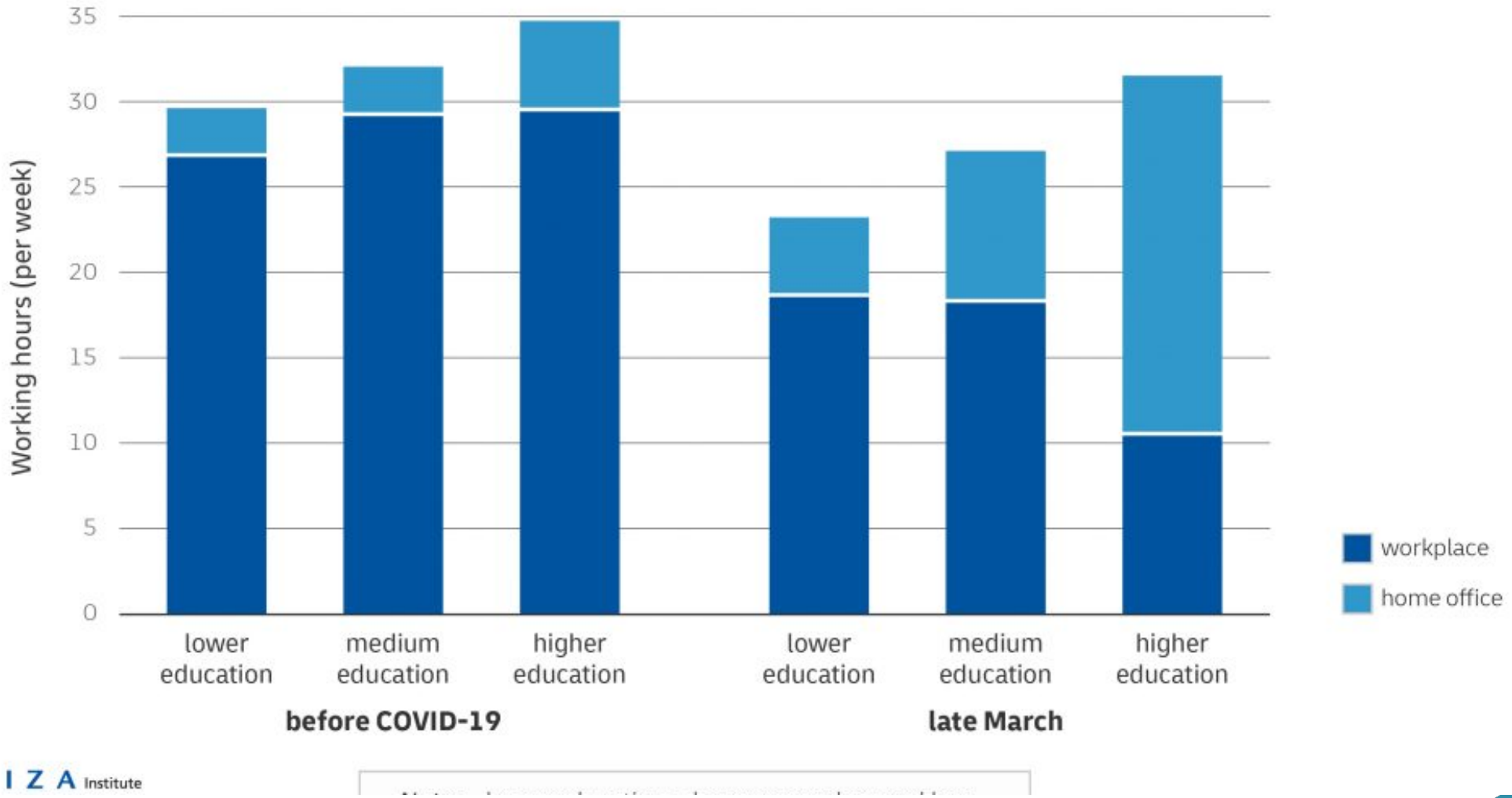
Drastic behavioural shifts



essential

not essential

https://www.safegraph.com/dashboard/reopening-the-economy-foot-traffic?s=CA&d=05-13-2020&i=all



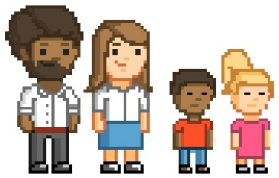
[Labour Supply in the Early Stages of the COVID-19 Pandemic: Empirical Evidence on Hours, Home Office, and Expectations](#) Hans-Martin von Gaudecker, Radost Holler, Lena Janys, Bettina M. Siflinger, Christian Zimpelmann

Zooming in

Understanding the behaviour of different profiles and groups in a city

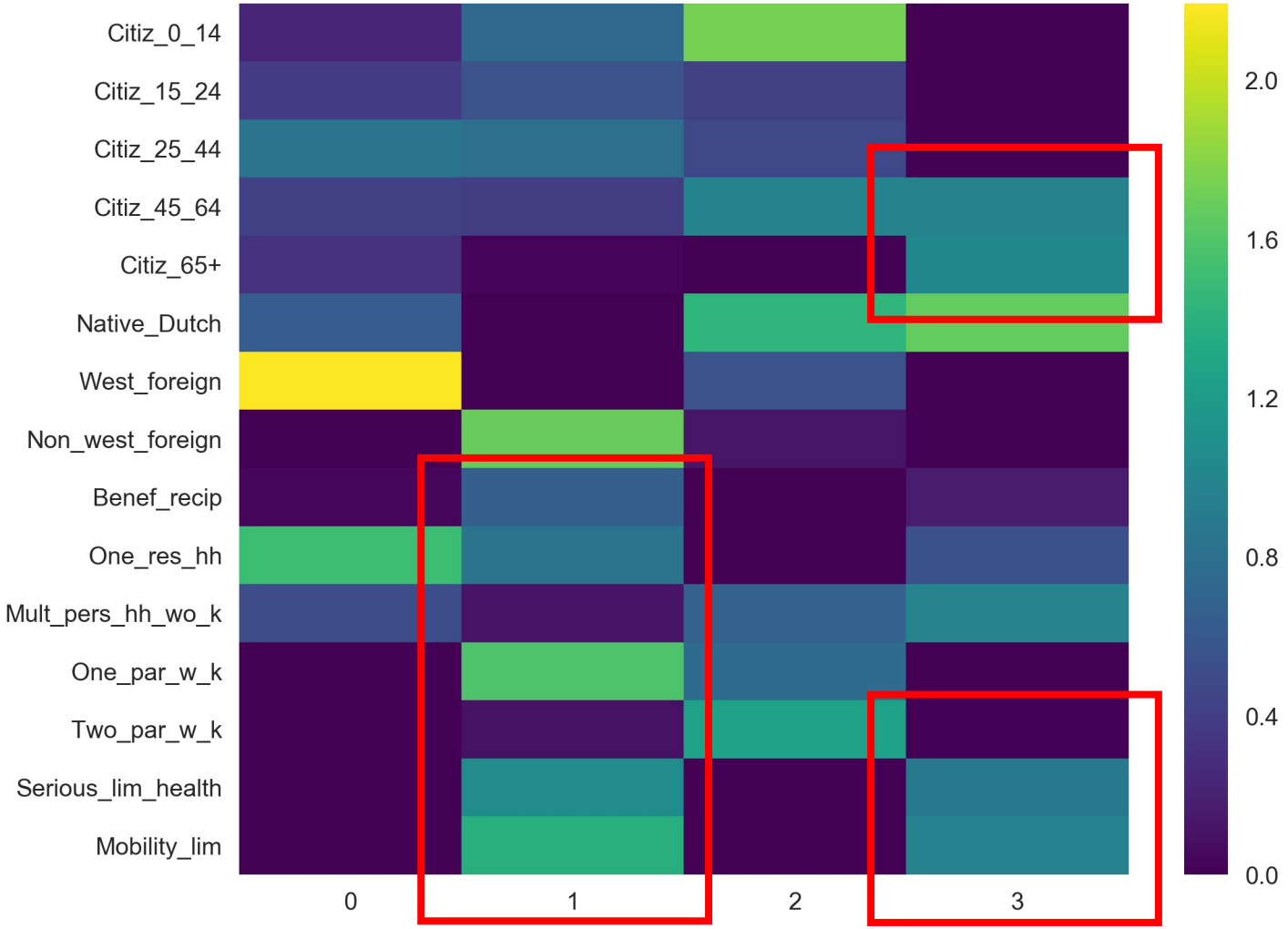
Work by Mikhail Sirenko (m.sirenko@tudelft.nl)

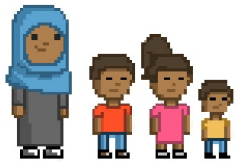
“Profiling” of the citizens via Non-negative Matrix Factorization



Profile 0

Profile 2



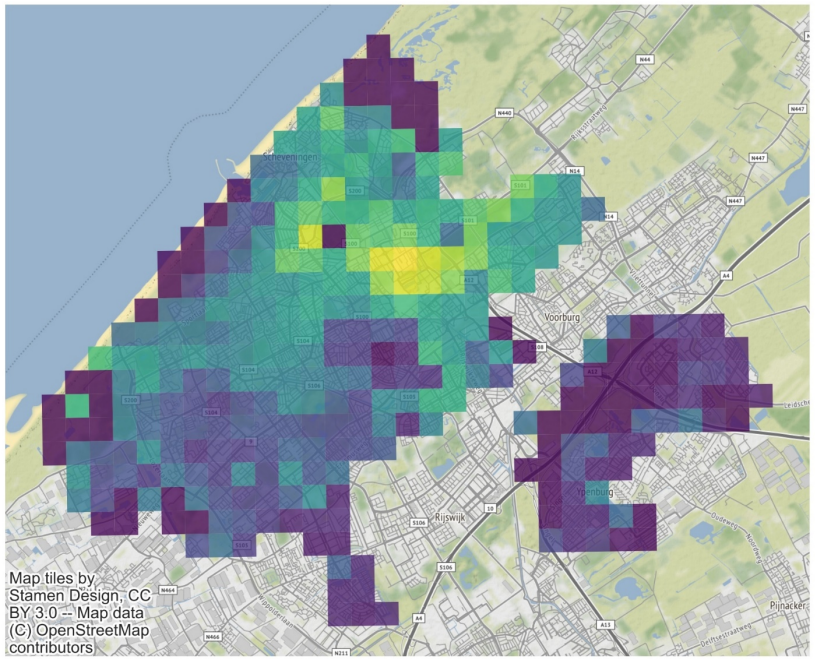


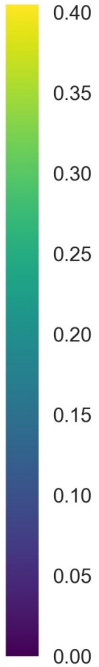
Profile 1

Profile 3

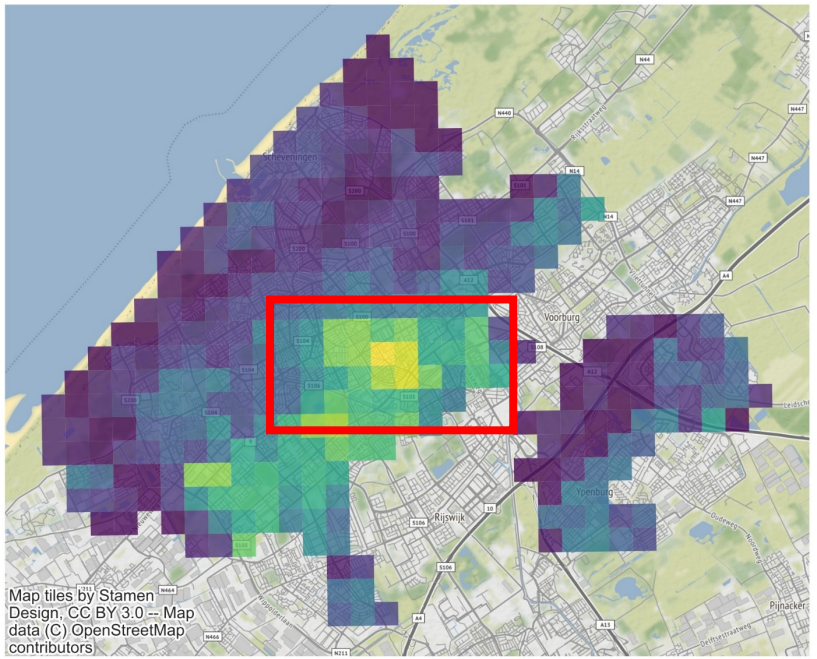
(c) Mikhail Sirenko

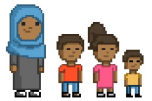
0





1





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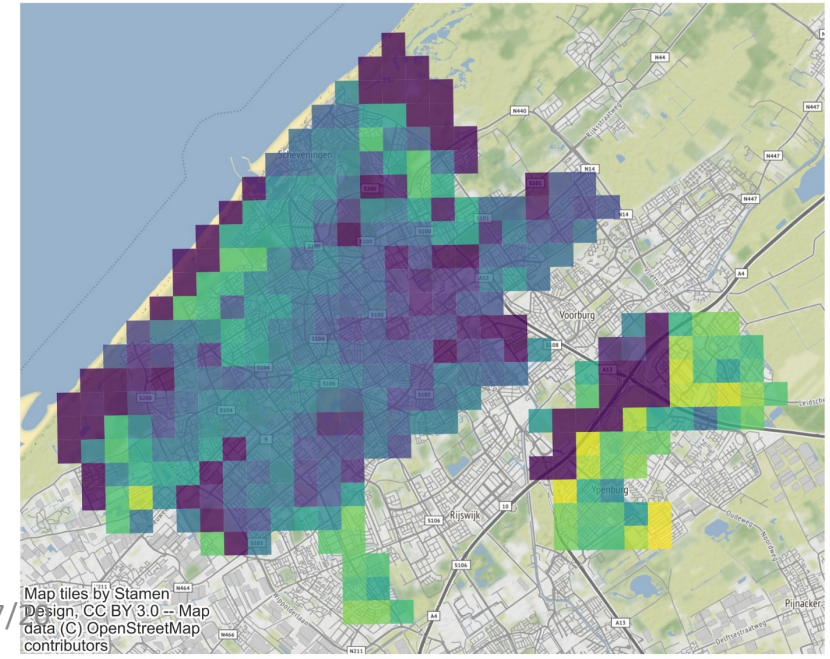

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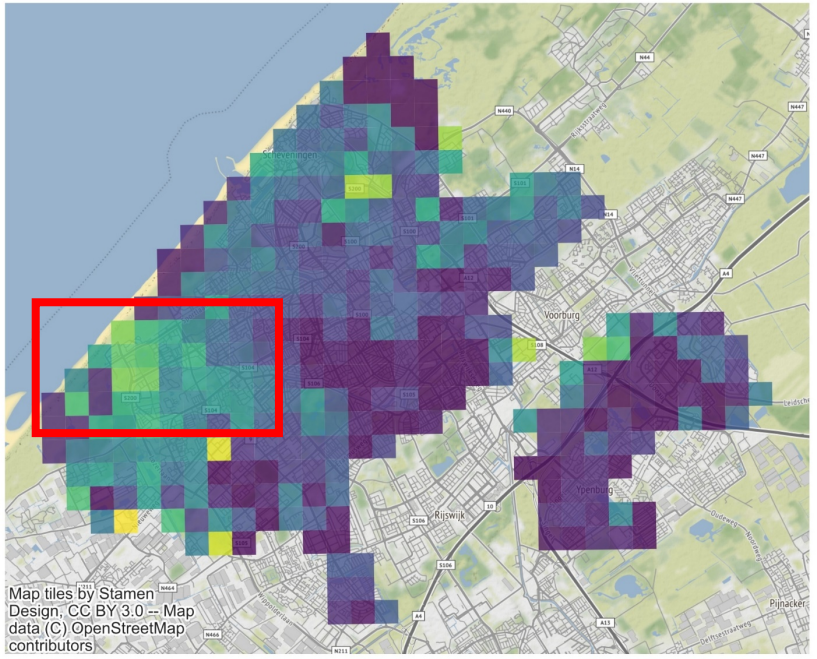

(c) Mikhail Sirenko 5/27/

hift2Rail

Challenges - Data

Wuhan

Helsinki

Data Needed	Data Obtained	Data year	Next
Geodemographic			
Population Size and Density	1x1km grids	Current	
Age	By district and sub-districts	2019	
Gender			
Ethnicity	City level primary language spoken	2019	
Existing health problems	Number of patients who previously received healthcare, by district	2018	
Preferred mode of transportation			
Car ownership	Regional-level	2018	
	By industry and district	2018	
Occupation	250x250m grids (industry type and job numbers)	2017	
Mobility			
Pedestrian flows			
Car flows	Major bridges	2018	
Public transportation travel volume	Spatial	Current	
Bus, tram, metro stops	Spatial	Current	
Bicycle stations and volumes	Spatial	Current	
Car park zones	Spatial	Current	
Amenities			
Working and closed businesses			
Educational institutions	Locations	2017	
Number of visitors at grocery stores			
Number of GP's and patients			
Hospitals	Addresses		
Hospital capacities			

The long read

‘We can’t go back to normal’: how will coronavirus change the world?

https://www.theguardian.com/world/2020/mar/31/how-will-the-world-emerge-from-the-coronavirus-crisis

Challenges II – predictions in a phase of fundamental shifts & transformation

TPB - predicted by attitudes, subjective norms, perceived behavioural control – all of which are subject to massive changes

What is the baseline? What are we converging to? For how long?

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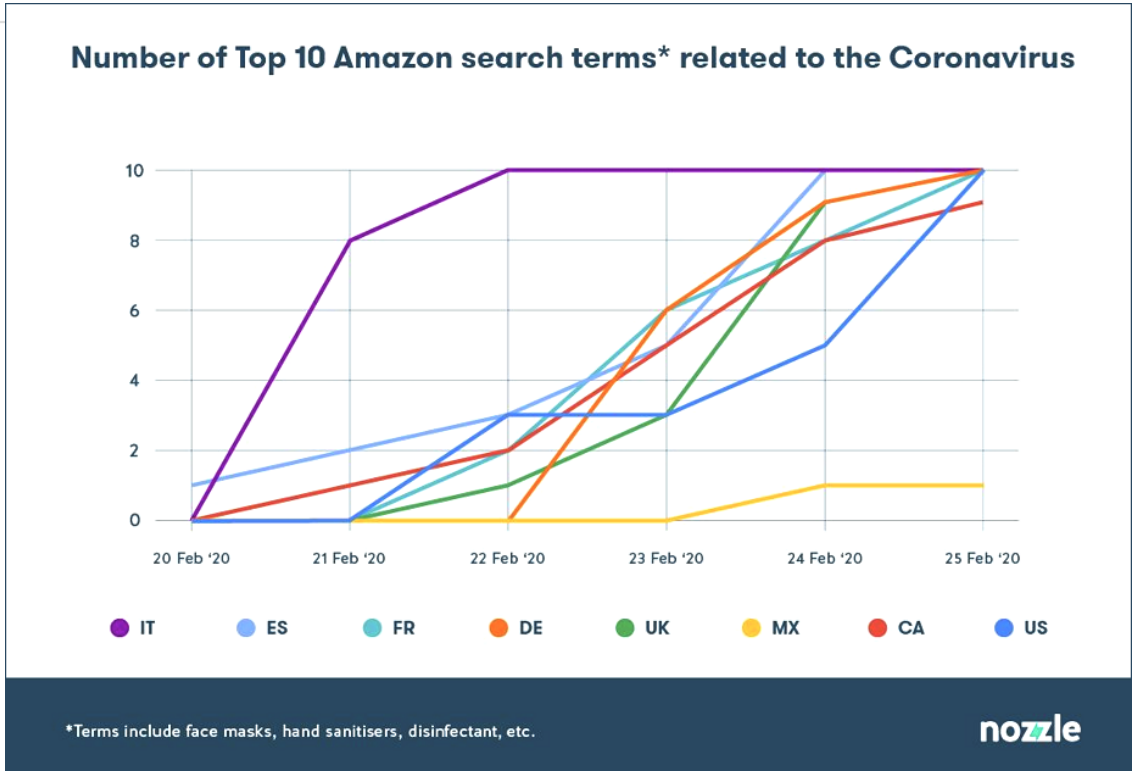
Artificial intelligence / Machine learning

Our weird behavior during the pandemic is messing with AI models

Machine-learning models trained on normal behavior are showing cracks — forcing humans to step in to set them straight.

by **Will Douglas Heaven** May 11, 2020



"The situation is so volatile," says Cline. "You're trying to optimize for toilet paper last week, and this week everyone wants to buy puzzles or gym equipment."

https://www.technologyreview.com/2020/05/11/1001563/covid-pandemic-broken-ai-machine-learning-amazon-retail-fraud-humans-in-the-loop/

Journal of Homeland Security and Emergency Management | Volume 2: Issue 1

Believe in the Model: Mishandle the Emergency

Simon French [1] and Carmen Niculae [2]

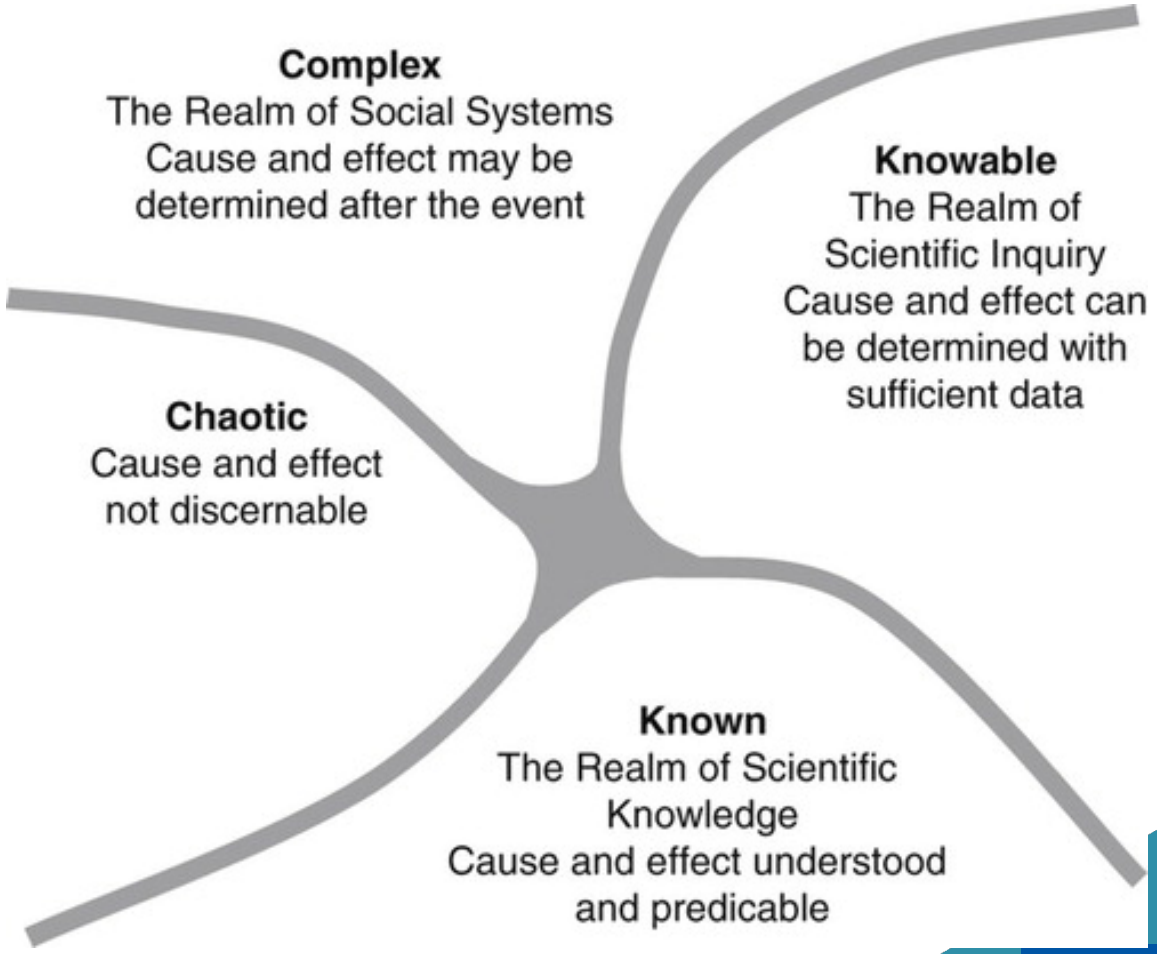
[1] University of Manchester [2] University of Manchester

DOI: https://doi.org/10.2202/1547-7355.1108 | Published online: 02 Mar 2005

"During the past quarter century there have been many developments in scientific models […] to help predict the ongoing consequences in the aftermath of many types of emergency. […] But there are many pitfalls in the way of using these models effectively. Firstly, non-scientists and, sadly, many scientists **believe in the models' predictions** too much. The inherent uncertainties in the models are underestimated; sometimes almost unacknowledged. This means that initial strategies may later need to be revised in ways that **unsettle the public,** losing their trust in the emergency management process. Secondly, the output from these models form an extremely valuable input to the decision making process; **but only one such input**."

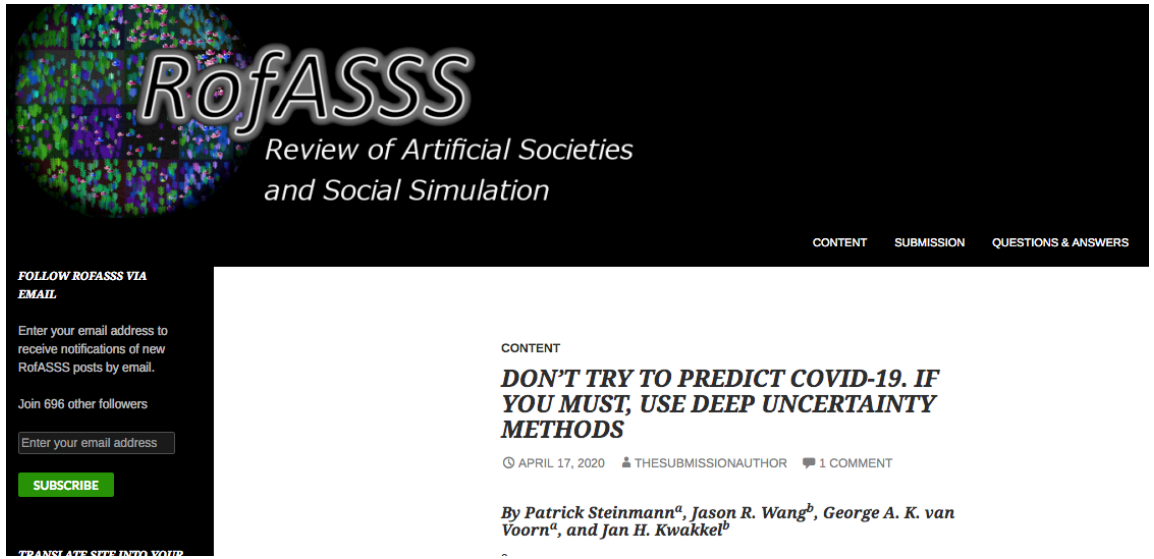
What can we know?

French, S. (2013). Cynefin, statistics and decision analysis. *Journal of the Operational Research Society*, *64*(4), 547-561.



Objectives & Data

To manage the tremendous **uncertainty** in the infectiousness and lethality, we will conduct **exploratory analysis** to test the impact of different policies. These analyses will allow us to identify robust policies that minimize the regret as well as critical scenarios.



https://rofasss.org/2020/04/17/deep-uncertainty/12

Objectives

The overall objective of HERoS is to improve the effectiveness and efficiency of the response to the Covid-19 outbreak. HERoS creates and provides policies and guidelines for improved crisis governance, with a core focus on responders to public health emergencies, and their needs to make informed decisions. This aim shall be achieved by enabling information-driven self-organisation and co-ordination that considers behaviour, as well as rapid adaptation to dynamically changing situations. To achieve this, HERoS will foster organisational and technical innovation during disasters for responders during critical scenarios from inaccurate, distrusted, and overhyped information. To this end, HERoS will provide them with accurate, validated, enriched, high quality, and actionable knowledge.

Contact

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https://www.heros-project.eu/