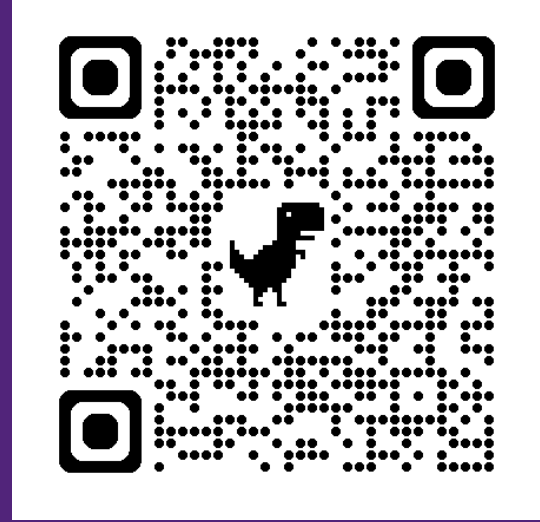
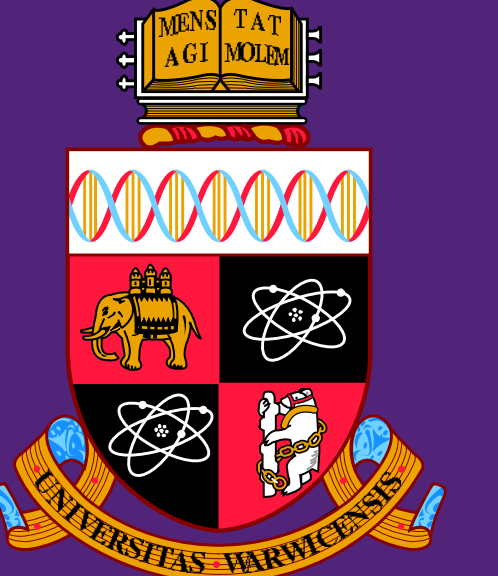


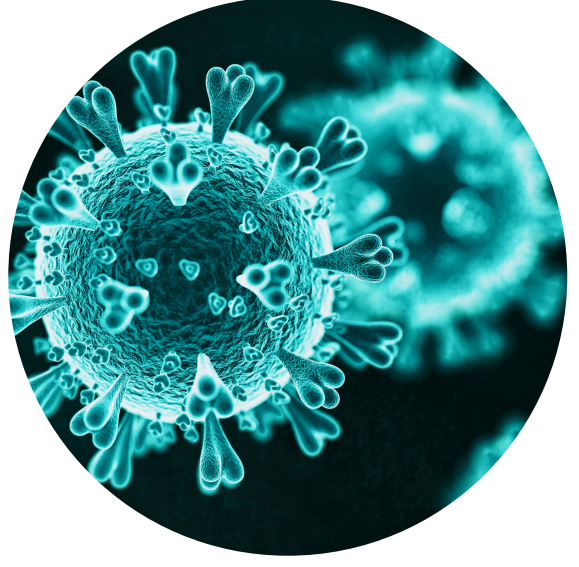
# Spatio-temporal Modelling for Infectious Disease Outbreak Detection



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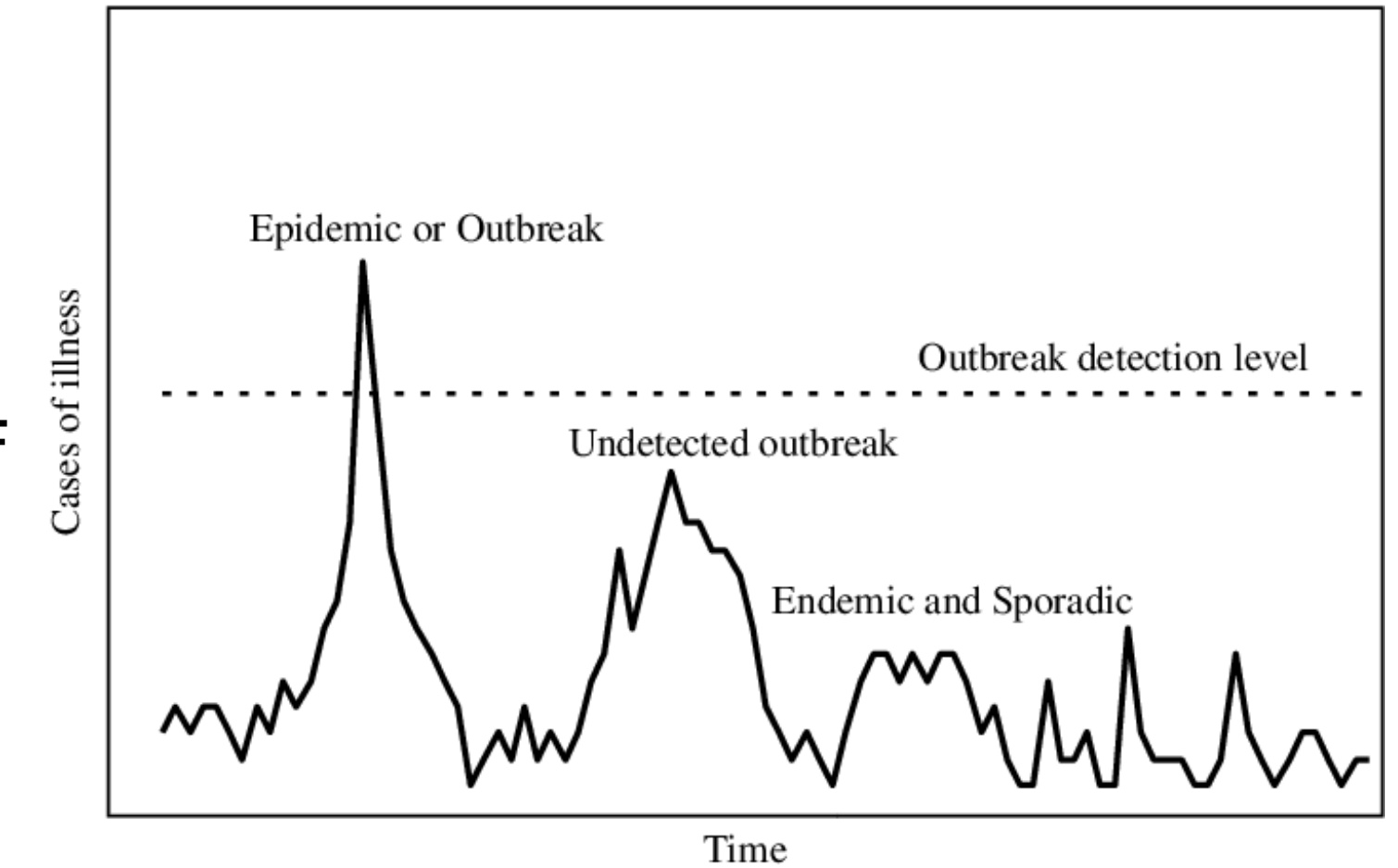
## The context



- The **health** and **economic** impacts of infectious disease outbreaks are **disastrous**.
- Majority of **epidemic outbreaks are recurring**.
- 19.8%** fall in UK's **GDP** between April and June **2020**.
- About **£310 billion** to **£410 billion** public spending due to the COVID-19 pandemic.
- 3.5%** fall in global **GDP** in 2020.
- About **\$77 billion** to **\$2.7 trillion** global economic burden in 2019 due to COVID outbreak.

## The challenge

- Identifying **outbreaks** from **sporadic** cases is difficult.
- Carefully designed **outbreak detection tools**: an excess of **false positive detections** may **overwhelm public health resources**.
- Dearth in **parametric/model-based** outbreak detection tools.
- Can we **forecast** future outbreaks?

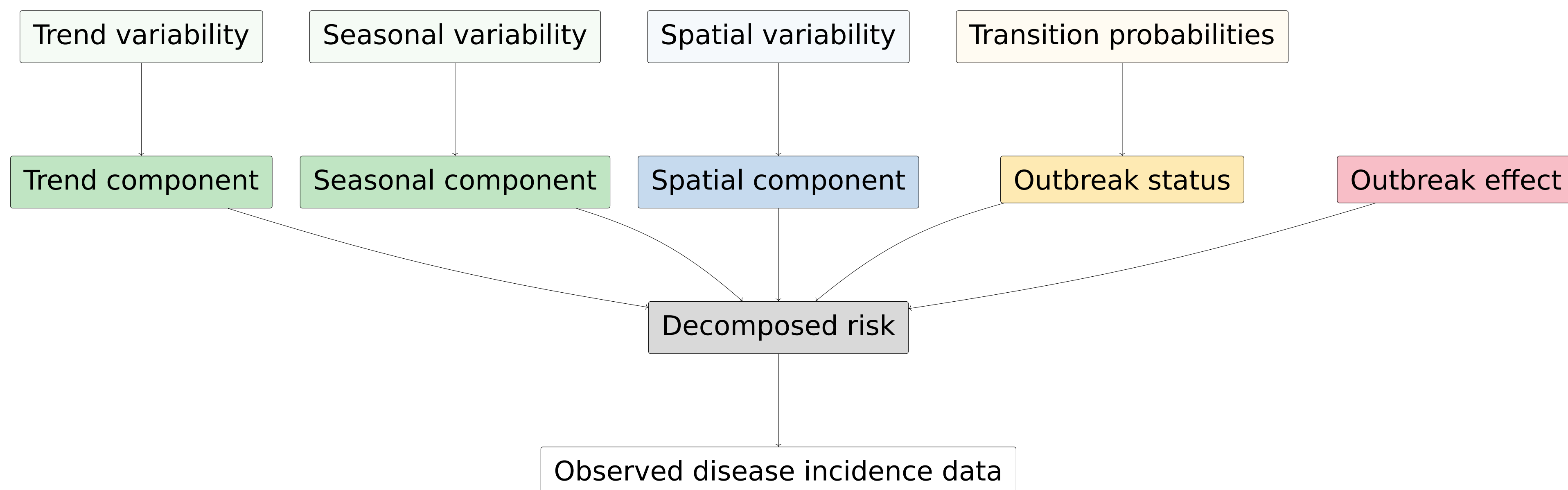


## Our method: a computationally efficient statistical model

### INPUTS

- Incidence counts**
- Population sizes**
- Connectivity of geographic locations**

### BAYESIAN STATISTICAL MODEL

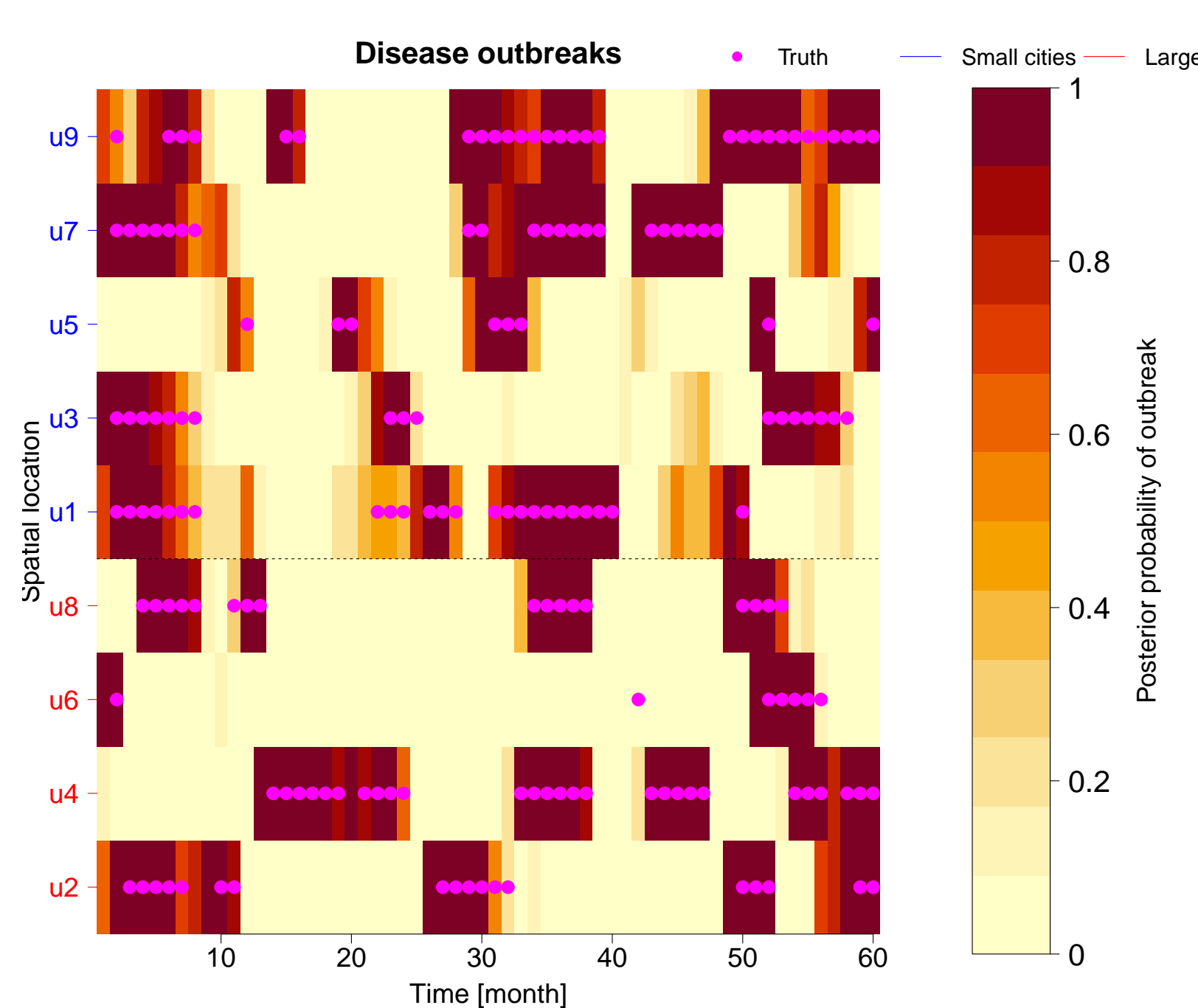
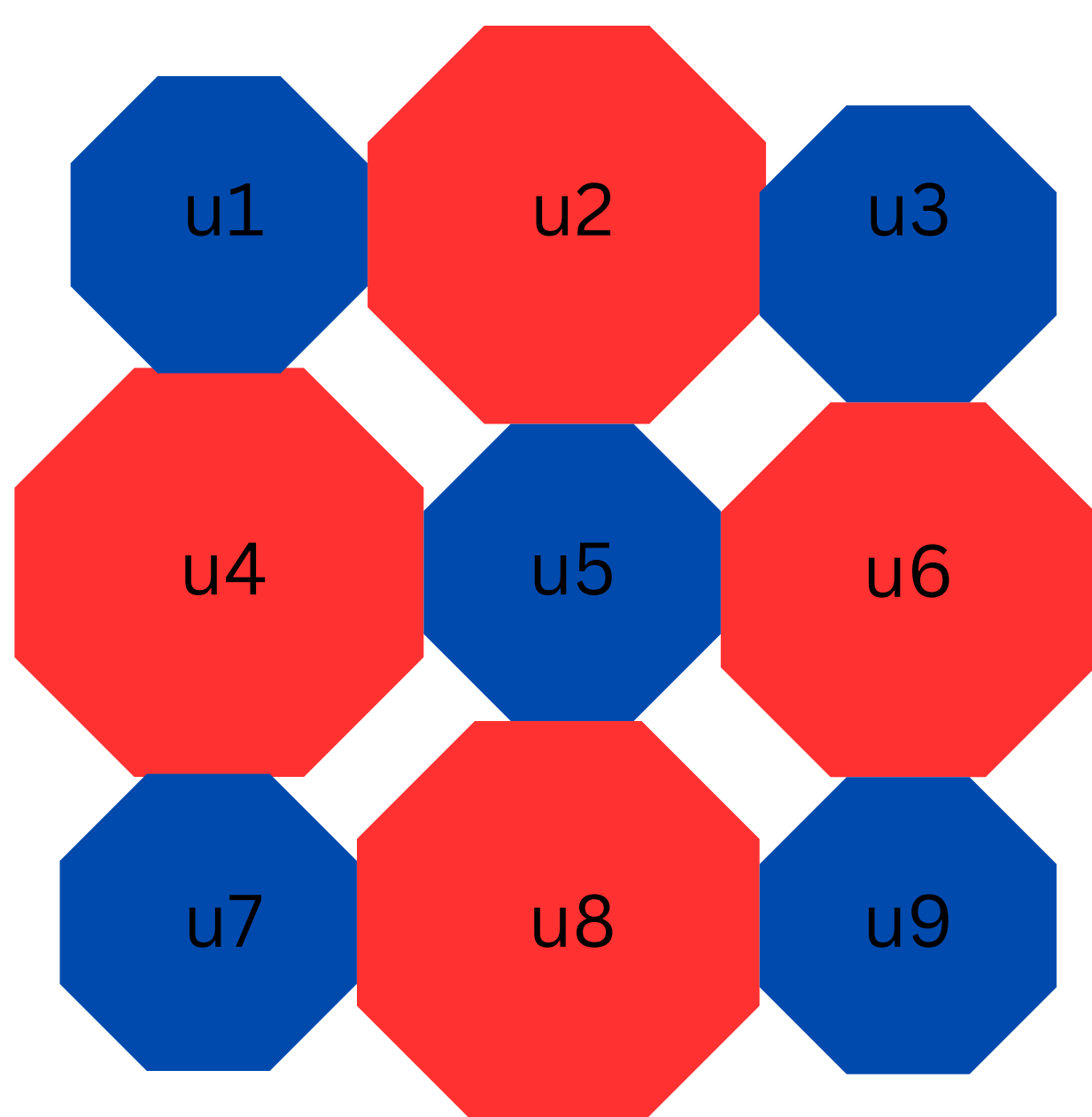


### OUTPUTS

- Trend effects**
- Seasonal effects**
- Spatial effects**
- Probability of an outbreak**
- Effect of an outbreak**
- Future outbreak forecasts**

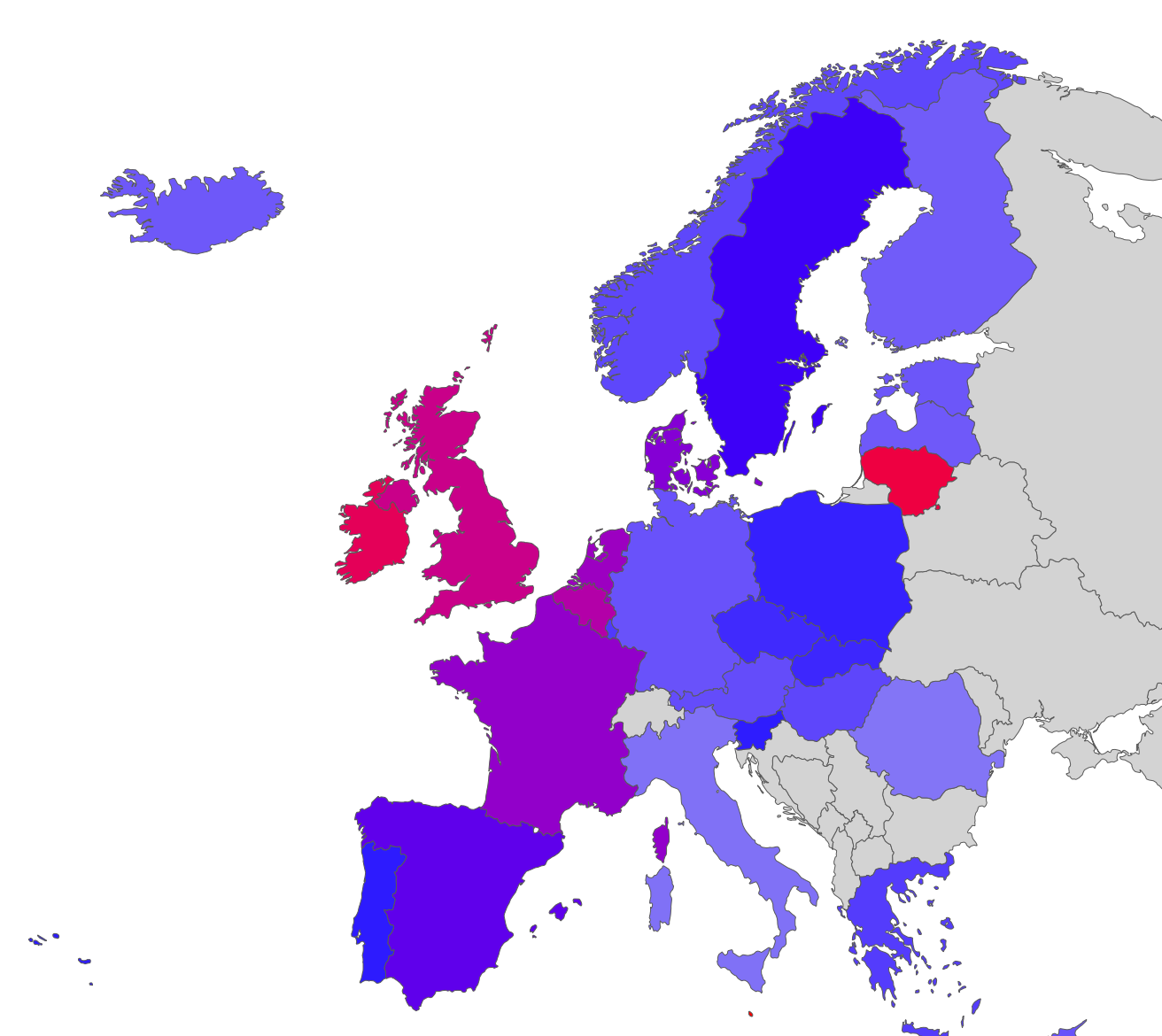
## Toy example

Adjacency structure of spatial locations

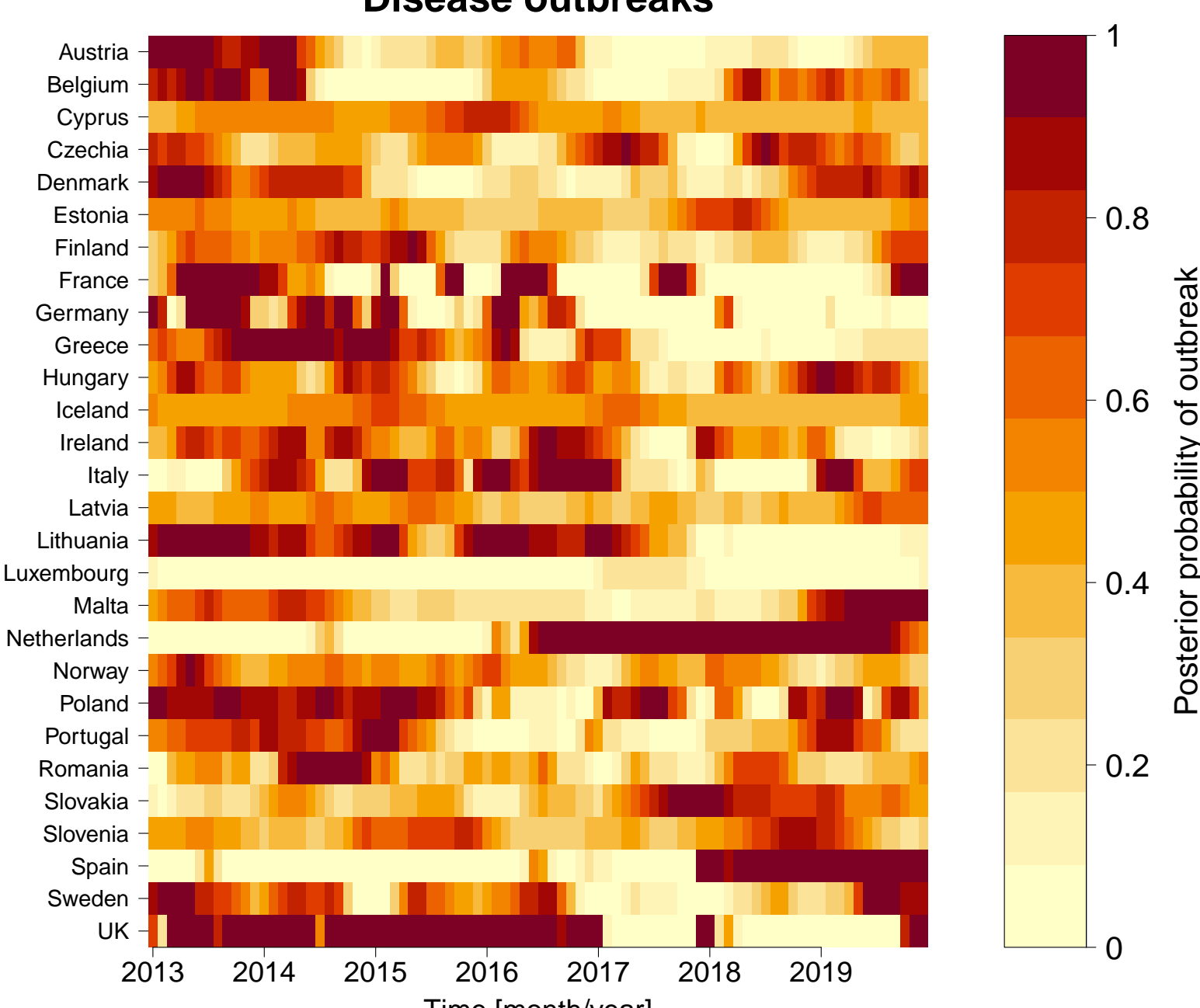


## Real-world application

Relative risks (RR) of Meningitis across Europe

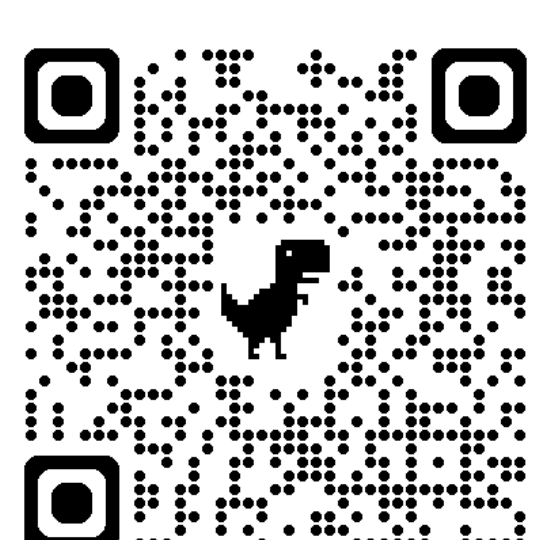
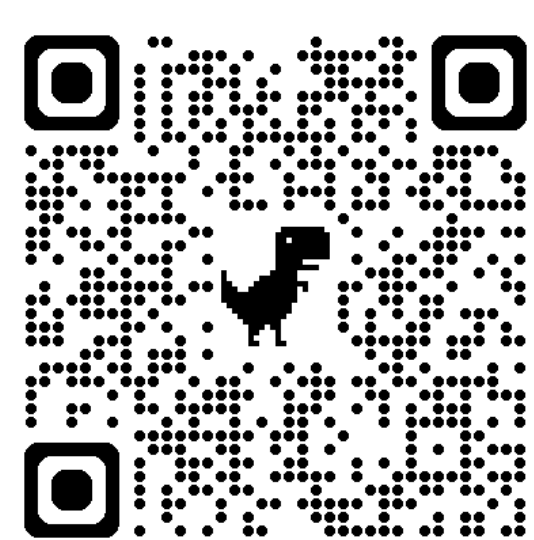


Disease outbreaks



## Achievements

- An open-source software with rigorous probabilistic tools for **early outbreak detection**.
- An application to **meningitis** data from **the UK** and 27 other **European** countries.
- A **methodological peer-reviewed paper** on outbreak detection for public health agencies.



## Advantages

- Applicable to many pathogens** in epidemiological studies.
- Significant computational **efficiency and flexibility** for practical applications.
- Model-based**: control for spatial and temporal factors.
- Forecasting** future outbreaks

