POISSON COKRIGING: A GEOSTATISTICAL MODEL FOR MULTIVARIATE HEALTH RATE DATA

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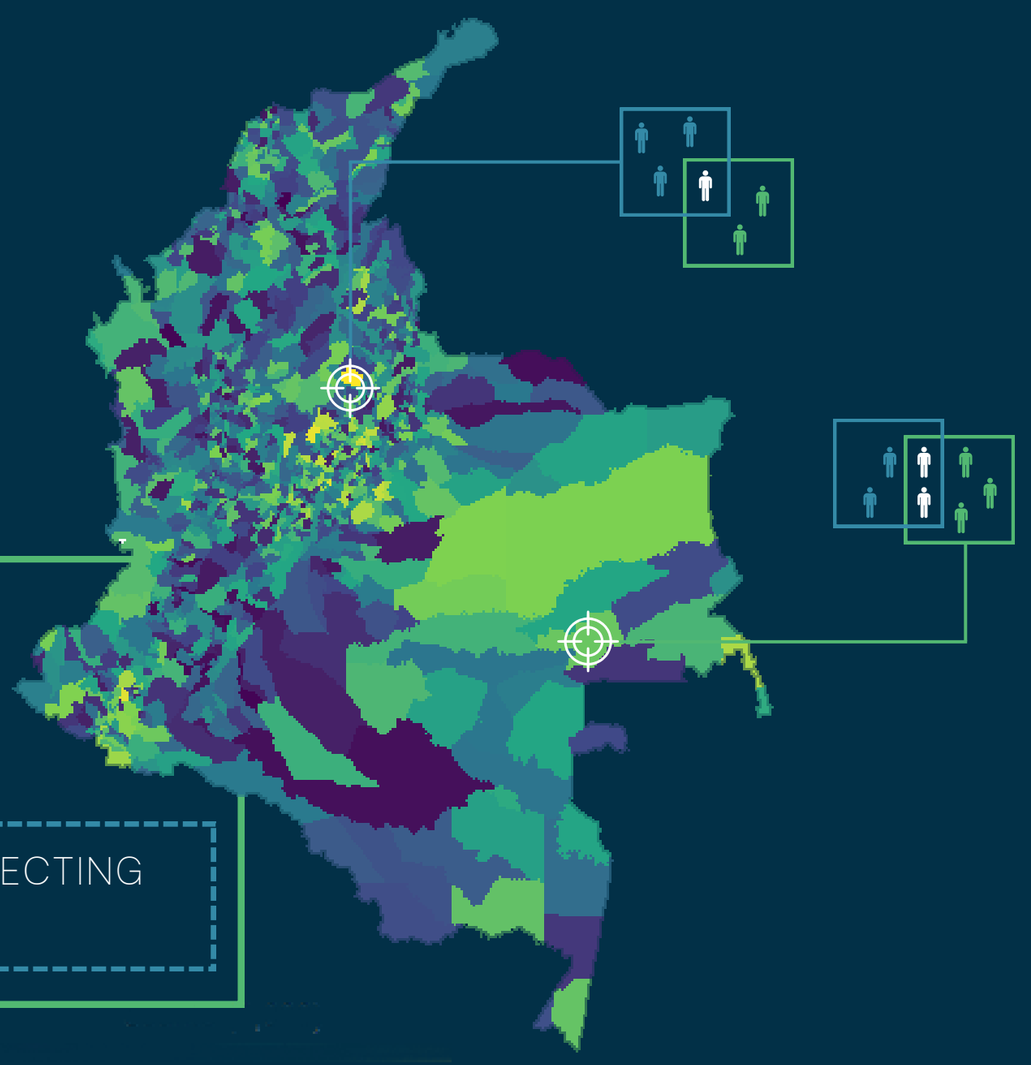
INTRODUCTION

- **Co-occurrence of diseases** is a commonly observed pattern
- Some diseases **spatially influence and depend on** each other
- **Health data** often comes aggregated
- Current methods are hard to **interpret** and **implement**



QUESTION AND AIM

CAN WE SPATIALLY PREDICT A **DISEASE RATE** BASED ON THE RATES OF **ANOTHER CORRELATED DISEASE?**

WE AIM TO JOINTLY ANALYSE **TWO DISEASES** AFFECTING THE **SAME POPULATION.**

MATERIALS AND METHODS

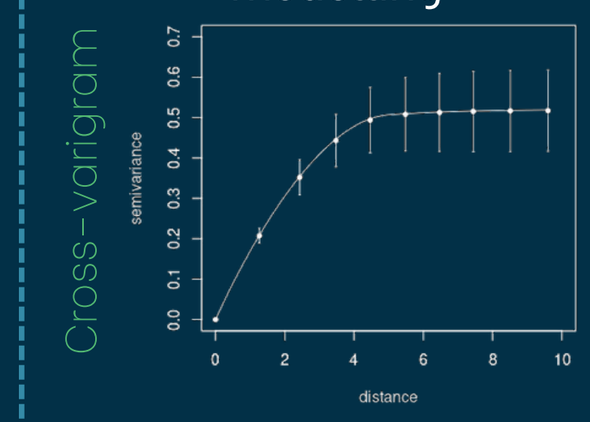
Model

$$Y_{\alpha i} \mid \mathcal{R}_{\alpha i} \sim Poisson(n_{\alpha i} \cdot \mathcal{R}_{\alpha i})$$

$$Y_{\beta i} \mid \mathcal{R}_{\beta i} \sim Poisson(n_{\beta i} \cdot \mathcal{R}_{\beta i})$$

Our model considers the **effect population size** have on the variance. We introduced a **share risk** to model the dependence between diseases.

Spatial dependence modelling



Prediction

$$\mathcal{R}^*_{\alpha 0} = \sum_{i=1}^{k_\alpha} \lambda_{\alpha i} \frac{Y_{\alpha i}}{n_{\alpha i}} + \sum_{i=1}^{k_\beta} \lambda_{\beta i} \frac{Y_{\beta i}}{n_{\beta i}}$$

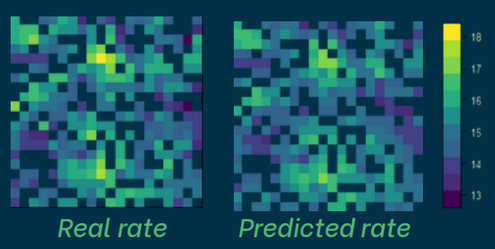
Variance of the error

$$\sigma^2_{PCK} = (\sigma^2_\alpha + \sigma^2_{\alpha\beta}) - \sum_{i=1}^{n} \lambda_{\alpha i} C^{\mathcal{R}}_{\alpha\alpha i 0} - \sum_{i=1}^{n} \lambda_{\beta i} C^{\mathcal{R}}_{\beta\alpha i 0} - \mu_\alpha$$

Prediction and error depend on the **rate data** and the **spatial interdependence** between diseases.

RESULTS AND DISCUSSION

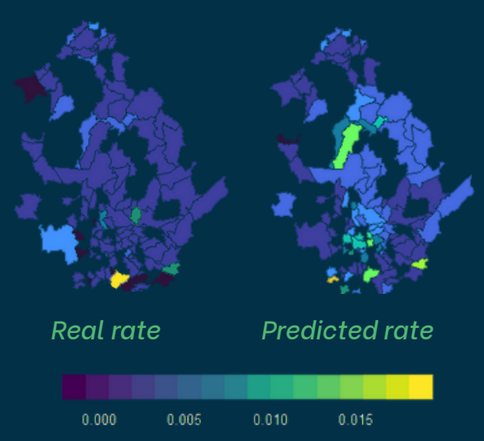
Simulation study



Simulations demonstrate that our model can **accurately model and predict** correlated disease rates.

Against ordinary cokriging, **Poisson cokriging** is a better choice for rate prediction.

Real data application



Our method sucessfully predicted **Zika rates** based on **Chikungunya rates.** The two mosquito-borne diseases are spatially correlated.

- Poisson cokriging is superior against other geostatistical methods.
- The method is robust against population size variations and different correlations.
- Our method is easy to interpret and implement to non-statisticians.

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