# Introduction to spatial and spatio-temporal analysis

## Bayesian modelling for spatial and spatio-temporal data

MSc in Epidemiology

Week 6

## Goals for weeks 6-10

➔ Building on the theoretical concepts and tools studied in weeks 1-5, we will now learn the relevant statistical methods used in spatial and spatio-temporal analysis and we will apply them using computational tutorials and practicals/homeworks.

➔ By the end of these five weeks, we will gain and master the fundamental strategies to:

    ➔ manipulate

    ➔ explore

    ➔ visualize

    ➔ model

spatially and temporally-related data, and critically discuss and utilise the results.

## Topics

**Week 6**: Introduction to (i) spatial data types and coordinate reference systems, (ii) spatial autocorrelation, and (iii) disease mapping

**Week 7**: Areal data analysis and *discrete* spatial models that belong to the family of Conditional Autoregressive (CAR) distributions, also known as Gaussian Markov Random Fields (GMRF)

**Week 8**: Geostatistical data analysis and *continuous* spatial models with Gaussian process based smoothers

**Week 9**: Temporal processes and spatial-temporal analysis with focus on areal data

**Week 10**: Temporal processes and spatio-temporal analysis with focus on geostatistical data; datasets realise for mini-project reports

Waldo Tobler's first law of geography:

*Everything is related to everything else, but near things are more related than distant things (Tobler 1970)*

**Interpretation**:
Data that are close together in space (or time) are often more similar than those far apart (except when they aren't!)

## What is spatial analysis?

Spatial analysis represents a collection of techniques and models that explicitly use the spatial referencing associated with each data value or object that is specified within the system under study (Haining 2003).

| Non-Spatial Analysis | Spatial Analysis |
|---|---|
| Spatial data are analyzed using conventional statistical methods | Spatial data are analysed using spatial statistical methods |
| The geographical coordinates are excluded from the computational procedures | The geographical coordinates are included into the computational procedures |
| The results are independent of the spatial arrangement of the geographical entities | The results depend on the spatial arrangement of the geographical entities |
| The analysis can also include temporal dependence | The analysis can also include temporal dependence |

Haining, R. (2003), *Spatial Data Analysis: Theory and Practice*, Cambridge University Press.

Tobler, W. R. (1970), "A computer movie simulating urban growth in the Detroit Region," *Economic Geography*, 46, 234–240.