**SHORT COURSE**

**Spatial and Spatio-temporal data analysis using R and INLA**

**September 26th-30th, 2022 – University of São Paulo**

This short course will provide a comprehensive introduction to concepts, methods, and R tools that can be used to analyse spatial and spatio-temporal data. Specific focus will be given to Bayesian Inference through the *Integrated Nested Laplace Approximation (INLA)* approach.

We will first go through the basic of INLA for Bayesian inference and will then see how to model hierarchical structures. We will then focus on area level data and present how to model spatially structured random effects through conditional autoregressive specifications; following that, we will extend the approach to include temporal dependency and touch briefly on spatio-temporal interactions. Moving on to point-referenced data we will introduce the stochastic partial differential equation (SPDE) approach, used for spatial modelling on a continuous field. We will then extend this to deal with spatio-temporal data. Finally, we will describe how to use R-INLA for more advanced problems in the spatio-temporal realm, for instance how to deal with misaligned data or how to model two outcomes jointly.

Throughout the course there will be practical examples from epidemiology, public health, environmental and social sciences.

The module will be delivered by lectures and computer-based practical sessions, while reproducible reporting will be ensured with R-Markdown.

**Course Contents**

***Monday (9am-1pm) – September 26***

Session 1.1: Introduction to Bayesian thinking (1hr)

Session 1.2: INLA and R-INLA (1hr)

*Break (30min)*

Practical1 (1hr)

Session 1.3: Introduction to spatial data (30min) Metterlo in xaringan

***Tuesday (9am-1pm) – September 27***

Session 1.3: Hierarchical models, prediction, prior specification (1.30hr) (aggiungere expected – lecture 6)

Practical 2a (45min)

Practical 2b (15min)

*Break (30min)*

Session 2.1: Models for small area data (1hr)

Practical 3 (1hr)

***Wednesday (9am-1pm) – September 28***

Session 3.1: Introduction to temporal modelling (1hr)

Session 3.2: Spatio-temporal modeling for small area data (1hr) (togliere slide 8-9 e sistemare slide 10 con Gamma)

*Break (30min)*

Practical 4 (1.30hr)

***Thursday (9am-1pm) – September 29***

Session 4.1: Models for geostatistical data and introduction to SPDE (1.5hr)

Session 4.2: inlabru (30min)

*Break (30 min)*

Session 4.3: Practical session (1.5hr)

***Friday (9am-1pm) – September 30***

Session 5.1: Spatio-temporal model for geostatistical data (1.5 hr)

Session 5.2: Practical session (1 hr)

*Break (30 min)*

Final Exam (1 hr)

**Pre-requisites**

It is recommended that people attending are familiar with R (https://www.r-project.org/) and with the basic of the Bayesian approach.