ABS25

The Applied Bayesian Statistics summer school

SPATIO-TEMPORAL METHODS IN

ENVIRONMENTAL EPIDEMIOLOGY

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Abstracts

Participants' presentations

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Causal Mediation Analysis with Spatial Interference

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Abstract: Drawing causal conclusions from the analysis of observational data requires specific, sometimes untestable assumptions. One of the most common is the so-called Stable Unit Treatment Value Assumption (SUTVA), which requires that the response variable of a subject depends only on their own treatment assignment, not on those of other units, or, in other words, there is no interference between units. This assumption is unlikely to hold in many real-world settings, especially in the context of spatial data, where the impact of a subject's variable on other subjects is called spillover effect. Indeed, the treatment assigned to some units may affect also units which did not receive it: for example, in environmental studies, the pollution levels in one area may affect the health outcomes of individuals in adjacent areas, or in the case of environmental policies, regions close to the one where the policy is actually implemented may benefit from it as well. Causal inference in spatial settings has recently received the attention of some scholars, who proposed new estimands to address the complexities connected to spatial data. However, to the best of our knowledge, no one has considered the issue of mediation with spatial interference. In this work, we propose estimands for the direct and the indirect effects, taking into account the distance between units. We discuss the assumptions necessary for the identification of such effects and show the impact of ignoring spatial patterns on estimates. Finally, we provide an application to real data.

Spatio-temporal Modeling of Obesity Rates in Italy: A Bayesian Perspective

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Abstract: In this talk I will present some preliminary results from my PhD research, in which we study how obesity rates have evolved across Italian regions between 2010 and 2022. The aim is to uncover spatial and temporal trends and better understand macro-level drivers of obesity prevalence. Given that obesity is measured as a proportion, we adopt a Bayesian hierarchical Beta regression model. The response is assumed to follow a Beta distribution parameterized by $\mu\phi$ and $(1-\mu)\phi$, with μ linked to both covariates and random effects via a logit function. Our model builds on existing Beta regression literature, extending it by incorporating structured spatio-temporal and gender-specific random effects. Spatial correlation is captured through an Intrinsic Conditional Auto-Regressive (ICAR) prior, while temporal dependence is modeled using a first-order autoregressive process (AR(1)). The autoregressive coefficient is assigned either a Beta(1, 1) prior or a weakly informative normal prior, allowing us to compare different temporal specifications. To account for systematic gender differences, we consider both fixed and random effects for gender. These modeling choices result in four alternative specifications, which we compare to assess the most suitable structure. The additive combination of spatial, temporal, and gender components offers a flexible yet interpretable framework for capturing regional-level variation over time. To address covariate selection and avoid overfitting, we adopt the Stochastic Search Variable Selection (SSVS) approach. This Bayesian regularization technique enables the identification of the most relevant predictors while promoting sparsity in the model. Our findings highlight the dominant role of spatial, temporal, and gender-related structure in explaining regional obesity trends. Exogenous covariates, though considered, play a secondary role. The work is ongoing and aims to contribute to the statistical modeling of complex public health data by integrating Bayesian tools with spatio-temporal analysis.

The Effect of Multi-Pollutant Exposure on the Risk of Small for Gestational Age Births: A Spatial Analysis in Milan

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Abstract: In the literature there are several studies showing the adverse effect of air pollution on health outcomes. Specifically, a connection has been established between small for gestational age (SGA) babies (i.e. babies whose weight at birth is below the 10th percentile compared to other babies of the same gestational age) and mother exposure to PM2.5 during pregnancy. However, determining the health outcome considering only one specific pollutant is often limiting: a more comprehensive analysis should consider the diverse effect on health produced by numerous exposures.
In our work, we aim to apply this type of study to the city of Milan, where, given the specific geographic conformation of the territory, air pollution is a recurrent concern. We adopted an areal model by dividing the municipality into a grid and studying the health outcome in each area, while accounting for spatial correlations among neighboring zones. Furthermore, to increase the flexibility of our model, we estimate exposure effects nonparametrically, assessing both the impact of individual pollutants and their interactions. We also incorporate in the analysis confounding factors related to the socio-economic status of the specific area and the presence or absence of green spaces, measured through the Normalized Difference Vegetation Index (NDVI).