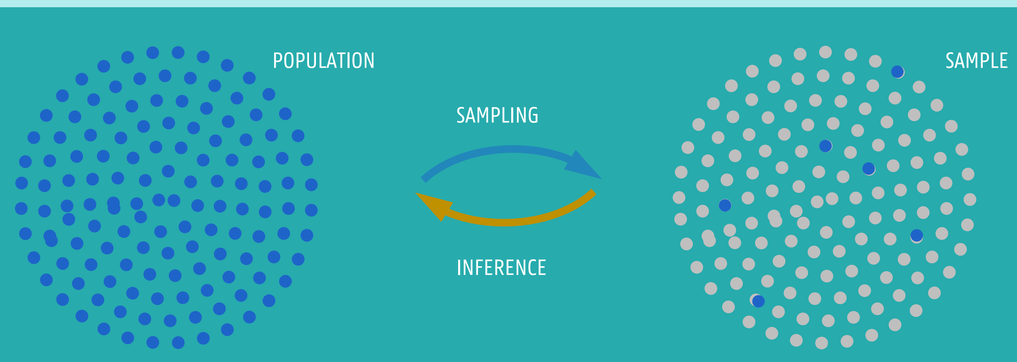
FACULTY OF BIOSCIENCE ENGINEERING

BIOSTAT

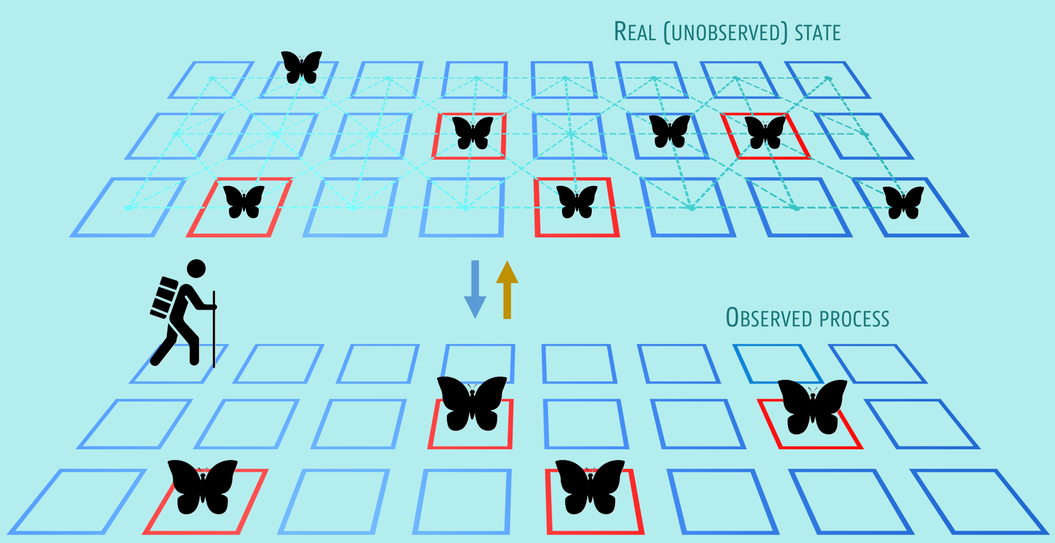
From data to discovery: Modern statistics to study hidden patterns in spatio-temporal data

Mission

Statistics is a key tool for extracting knowledge from data. At its core lies the principle of inference, where insights are drawn from a sample of measurements to make broader conclusions about a population while accounting for inherent uncertainty. Our mission at BIOSTAT is to push the boundaries of statistical science in order to better understand and explore the complexities in environmental & biological applications.



THE PRINCIPLE OF STATISTICAL INFERENCE



SPECIES DISTRIBUTION MODELLING, Guillera-Arroita (2017) & Van Eupen (2022)

Unravelling the complexities of environmental systems with big data

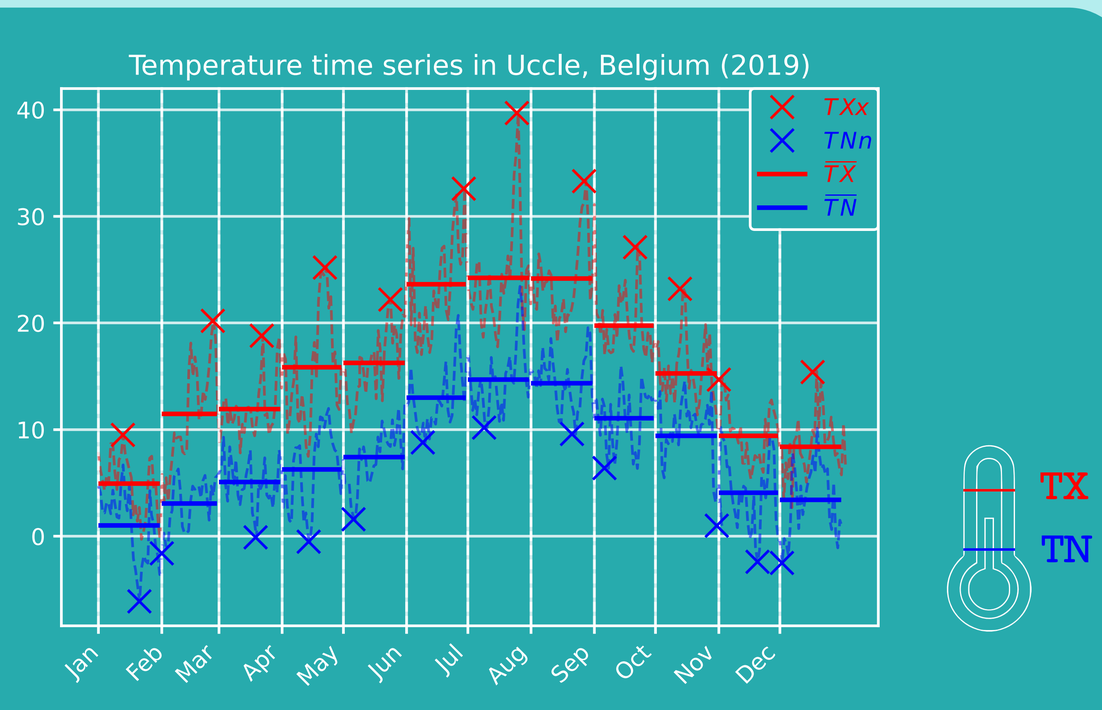
Current sensor technology enables the collection of massive data sets. It so happens that this data are often spatio-temporal and/or multivariate. At the core of our work we use and develop so-called (Bayesian) hierarchical models. These models unravel the complex relationships that exists in data in layers, each layer offering a better understanding of how things connect and influence each other.

The applications in research are very diverse: studying the nature crisis through biodiversity modelling, studying the effect of climate change on environmental parameters, studying the variation of plant or food parameters, or what about studying the mysteries of the universe itself?

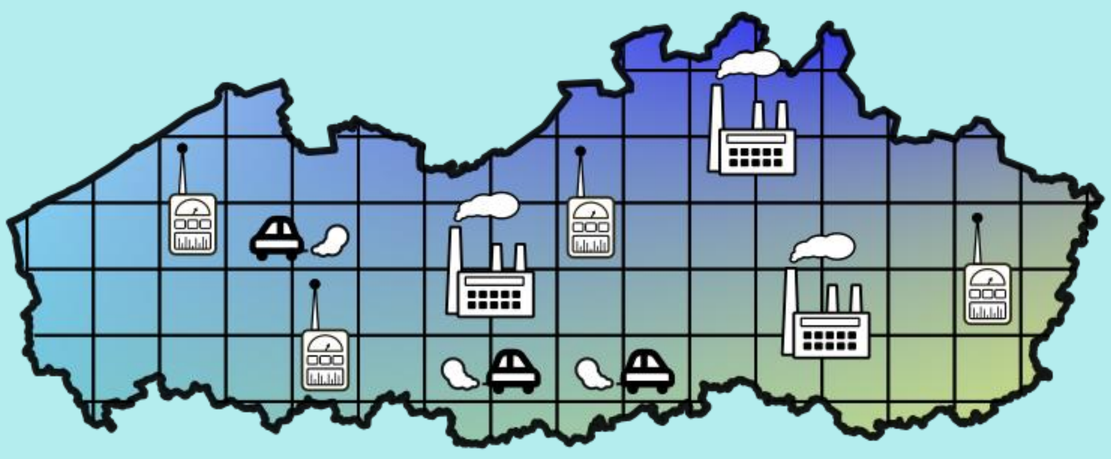
To the extreme and beyond

This research line deals with a data-driven study of extreme events and is situated in the field of extreme value statistics while exploring links with computational and machine learning methods. Assessing the probability of extreme events is of great importance in various life science applications given their potential for catastrophic impacts, e.g. tsunamis, floods or heat waves can cause significant economic and human losses.

Classical models for multivariate extremes often lead to complex analyses that don't scale well when the number of variables increases and are hard to interpret or visualise. In our work we study sparse dependency structures and latent variable approaches to increase the applicability and interpretability of extreme value models. Applications are being explored in the broad context of climate change issues and anomaly detection among others.



EXTREME TEMPERATURES IN UCCLE, Belgium , Aelbrecht & Luca (2025)



SAMPLE DESIGNS TO MONITOR AIR POLLUTION, Savery & Luca (2025)

An experiment is a question put to nature in the hope of discovering some secret (E.J. Russel, 1926)

In various life science applications, the acquisition of data can be labor intensive or costly such that in practice one is interested in an efficient design for data collection, e.g. for the acquisition of environmental parameters an efficient field survey can save costs.

Although a rich literature is available on spatial survey designs, less is known on how to develop optimum designs for integrating field surveys with modern acquisition techniques such as citizen science where data is collected by volunteers with different levels of expertise and in an unstandardized manner or remote sensing techniques where a parameter of interest is inferred from high-dimensional data.

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