AI for Missions PhD Project Proposals

October 2022

Contents

AI4M-PHD-11_Identification of environmental risk factors for antimicrobial resistance using spatio-temporal statistical models

Description

Antimicrobial resistance (AMR) poses a global threat (O'Neill, Welcome Trust 2016). Understanding the drivers and risk factors of AMR prevalence and spread is critical in the fight to maintain society's ability to combat infection using existing antibiotics. The least-well understood component of the one-health perspective to AMR is the role that the environmental component plays in eventual clinical presentations of AMR (Ott et al., 2021). This is due in large part to the complexity of the environmental processes at play, inconsistent observation methods and relatively sparse datasets. This project proposes a statistical approach that will be applied to a specific freshwater case, but in a way that can be readily generalised to other marine or freshwater applications or case studies. In particular, the project will identify generalisable (surrogate) AMR markers and use them as response variable(s) in a spatio-temporal model that can identify the effect of environmental covariates using observations with point (such as water quality) or areal (such as land use) characteristics. The complexity of the environmental process involved and the consequent non-linearities suggest that classical statistical frameworks will be unlikely to succeed. To overcome this, we propose to use some of the most recently developed deep learning algorithms, known for their ability to capture patterns in environmental setups (see for example, Amato et al, 2020 and Kuhnleinet al, 2014). The model will also integrate specific catchment features and demonstrate an approach to tackle the classical change-of-support problem often encountered in ecological and environmental modelling, wherein observations at point locations are related to environmental characteristics defined over areal locations. The three key steps in the project are:1. In collaboration with our UniSA collaborators, identify an appropriate AMR surrogate that is appropriate for freshwater ecosystems but generalisable to other (e.g.marine) contexts. 2.Propose (and code) a spatio-temporal model able to capture the spatio-temporal variations in an observed time series of the AMR surrogate and infer the impact of relevant risk factors. 3.Explore the limitations of the proposed model in terms of data requirements, model choice and the effects of uncertainty on decisions regarding the most efficient risk mitigation strategies.

Relevant publications

- Ickowicz, A., Ford, J. & Hayes, K. A Mixture Model Approach for Compositional Data: Inferring Land-Use Influence on Point-Referenced Water Quality Measurements.JABES.24,719–739 (2019).

Skillset required

- Strong theoretical background in data science / AI / statistics
- Strong interest environmental sciences, acknowledged by previous activities or experience
- Strong computer skills including in programming environment (R, Python)

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