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| **Comparing two models for restricted growth**  [Dr Matt Roberts](https://researchportal.bath.ac.uk/en/persons/matthew-roberts)  Imagine a collection of cells growing in one dimension: we begin with a cell at 0, which after some random time splits into two, its “child” moving to either 1 or -1, each with probability ½. As time goes on, each cell continues to try to split into two, subject to the condition that there can be at most one cell at each site; if there is no space next to a cell for its child to move to, then the splitting does not happen.  Now consider a different model, where there is no limit on the number of cells at each site, and each cell continues to produce children forever. However, if two cells share a site they get smaller, so that the total mass at each site is always at most 1.  We are interested in comparing these two models (which have not been fully specified yet - for example, how exactly does the mass of cells change when two cells are at the same site? What if there are more than two cells at a site?) via both computer simulations and rigorous mathematical bounds. The student should have a background in probability and/or analysis, and interest in computer programming (enthusiasm is more important than experience for this part of the project). |
| **Mathematical modelling of infectious disease dynamics within the body**  [Dr Ruth Bowness](https://researchportal.bath.ac.uk/en/persons/ruth-bowness)  The COVID-19 pandemic has highlighted the importance of understanding infectious disease dynamics. Often the focus is solely on the population spread of an infection but what happens at an individual level is also important as it helps us gain insight into why certain subsets of people respond differently to disease, and can guide future treatment.  This project would involve modelling pathogen spread and resulting immune response within a human body. We will create simple target cell model simulations using MATLAB, where these models use ODEs to describe viral dynamics. We will then progress to other modelling techniques, including individual-based models, and compare model outputs. You will not be expected to have any previous biological knowledge but some experience of coding in MATLAB would be desirable. |
| **Mathematical aspects of landslides**  [Dr Tristan Pryer](https://researchportal.bath.ac.uk/en/persons/tristan-pryer)  This project focusses on understanding elements of predictive models for landslides. Landslides are a devastating natural disaster in many areas of the world. Our focus is on the states of São Paulo and Rio de Janeiro. The reason is that the National Centre for Early Warning of Natural Disasters in São Paulo (CEMADEN) is able to provide up-to-date data, and, ultimately, generate important feedback for the development of new models.  CEMADEN monitors underground water content in high-risk areas. They use a pluviometer station coupled to sensors measuring underground moisture content. Stations have been operating in Campos do Jordo for the last 2 years, providing a rich set of historical data to calibrate our models with. Geophysical properties are determined using resistivity and electromagnetic methods giving a picture of subsurface structures.  Mathematically, the aim of this project is to examine some of the intricacies of the geophysical data inversion. This is an inverse problem whereby the global resistivity of the underlying soil is determined. We will examine the physical setup, the mathematical translation into an inverse problem as well as current methodologies to solve it. This project involves some coding which can be done in either MATLAB or Python |
| **Modelling the relationship between armed conflict and civilian safety, security and hunger in South Sudan.**  Supervisors: [Naomi Pendle](https://researchportal.bath.ac.uk/en/persons/naomi-pendle) and [Thomas Burnett](https://researchportal.bath.ac.uk/en/persons/thomas-burnett)  So that humanitarians can better support people facing crisis because of armed conflict, there is a need to better understand how humanitarian programmes, conflict, food insecurity, and other factors intersect, and to appreciate under what conditions people actual feel safer.  There has been a tendency to assess security based on standardised measures, but there is a growing appetite to consider people's different understandings and priorities when it comes to safety and security. This work is currently being developed in South Sudan by some of the world's largest humanitarian actors.  South Sudan has had decades of conflict and humanitarian assistance, as well as multiple famines.  It is clearly important to measure the safety and security of the civilian population in the setting of armed conflict. Current research effort is being made to define such models that prioritise communities’ own indicators of safety and security. The method aims to develop these indicators through the use of qualitative research, such as surveying local populations. An additional benefit being that these surveys also allow a measure of changing priorities over time. The student could contribute to the development of these surveys.  Beyond the survey design there are large amounts of existing humanitarian data relating to the relationship between armed conflict and food insecurity. Much of these data are gathered to inform immediate assessments of humanitarian need; there is rarely analyses of longer-term patterns across subsequent data sets. However, there is a lot of information potentially contained within these data about long term patterns with the potential to be able to predict crises before they are immediately apparent. The student could investigate what long term patterns may be available in such data, discovering what it might be feasible to learn from such data sources and how this might influence current practice.  This project will involve a large amount of data analysis (likely in R but this may be guided by the student’s preference) to gain an understanding of the data already collected. The project would be best suited to a student with an interest in statistics or data science. |