Proposal for Complexity Science Mini-Project

Thomas House, Biological Sciences and Mathematics Institute.

Mathematical Models for Infectious Disease Epidemiology

What should we do in the event of an influenza pandemic, or a bio-terrorist release of an infectious agent such as smallpox? Purely experimental work cannot answer this question, since the controlled environment of the clinic or laboratory will not be reproduced when a disease is spreading through the human population. Only modelling using mathematics and computers is capable of integrating the large number of complex, interacting variables and parameters present into a framework capable of informing large-scale public health policy.

This mini-project involves the newly formed Infectious Disease Epidemiology Research Interest Group (website http://www2.warwick.ac.uk/fac/sci/bio/res/epidemiol/) which is an interdisciplinary group hosted by Biological Sciences but involving researchers from Biology, Mathematics, Statistics, Warwick HRI, Engineering, and Systems Biology.

A significant portion of work in this field concerns the development of ever more sophisticated and realistic computationally intensive epidemic models, and this forms the basis for the mini-project of the same title as this one offered in Systems Biology. Complexity science plays a vital role in putting such development on a mathematically sound footing, and also generating intuitively understandable insights from analytically and numerically tractable models in a way that can reduce concerns about the results of computer simulations.

The broad topic of the proposed mini-project is in the way that multiple, interacting heterogeneities in the human population can influence the progress of an infectious disease. As an example, the behaviour of many diseases depends on age. Children and adults mix within households, then either at school or work. This highly structured nature of the human population and its implications for disease spread and control is a classic example of a complex system.

Within this broad topic, there are many potential projects, including but not limited to: continuous age-structured models and geographic diversity; household structure and adult / child models; optimal vaccination schemes and implementable proxies for them; modelling the impact of a vaccination ‘shock’ (such as short-term public panic about safety of a vaccine) on disease control.

We are always happy to discuss potential mini-projects with interested students.