

Epidemic dynamics in complex populations

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Motivation

Infectious disease is, worldwide, the main thing that kills people. Systematic, mathematical thinking about patterns of disease – in other words, epidemiology – is essential in optimising the public health response to novel and established pathogens. Increasing levels of mathematical sophistication and model complexity are used in infectious disease epidemiology. Of particular interest is complex population structure, most generally conceptualised as a network.

Objectives

There remain many unanswered questions about the impact of network structure on epidemic dynamics, and so there are several research questions that could be posed during a miniproject that could be answered within the three-month timeframe. A non-exhaustive set of options, for which the route to interesting results is reasonably clear, includes:

- The interface between network models and available contact-network and socio-demographic data
- The relationship between disease prevalence, behaviour and social network structure
- Analytic approaches to contact tracing

Methodology

The project should be accessible to any Complexity student; particular methods can include:

- Analytic manipulation of equations (through e.g. integral transforms, application of probability theory ...)
- Numerical integration of ODEs
- Stochastic simulation
- Statistical Inference
- Data visualisation and analysis

Deliverables and Impact

The primary outcome from the project will be theoretical insight; however, some relatively immediate consequences of the work can be:

- Optimisation of contact-tracing strategy
- Which features of contact networks need to be measured to enable accurate epidemic prediction?
- How can appropriate health behaviours be promoted?

Further Directions

Any of the broad directions outlined here could be significantly extended as part of a PhD project. For any further information, email T.A.House@warwick.ac.uk

Preliminary Reading

The best modern reference book is: “Modeling Infectious Diseases in Humans and Animals” by Matt J. Keeling & Pejman Rohani. Website for the book is at: <http://www.modelinginfectiousdiseases.org/>