# Peer-driven intervention for infectious diseases

### Background:

Mathematical models of infectious disease are being increasingly used to test and define appropriate responses to disease outbreaks. The dynamics of these models are highly dependent on the underlying structure of the social network. Amongst others1, one way of sampling this social network has been to use Respondent Driven Sampling2 (RDS), where individuals are given small incentives to recruit new individuals into the sample. This process forms chains of referrals which represent real social links between individuals, allowing us to reproduce certain aspects of the network. A corollary of this process is that highly connected individuals are found early in the chain of referrals.

### Objectives:

This project is designed to define a novel strategy for vaccinations and/or treatment of infected individuals taking advantage of social network structure and the properties of RDS. The questions we will aim to answer within the scope of the project are the following:

1) To what extent does the RDS process find highly connected nodes early, and under what assumptions of the underlying social network structure is this phenomenon most apparent?

2) Does targeting nodes found early on in the RDS process make a better-than-random choice for vaccination and/or treatment of disease?

The project is theoretical but has important applications to real-world situations. Examples of potential applications include improving treatment programmes for tuberculosis by targeting individuals most at risk, improving the effectiveness of local STD clinics by identifying individuals that are most likely to transmit disease, reducing the impact of epidemic outbreak by targeting individuals that contribute most to early spread of disease.

### What the student will do:

The student will develop models of infectious disease transmission and RDS processes. Depending on the interests of the student, there are a few directions that this project could take in the fields of dynamical systems and complex network theory. The student will learn to develop stochastic, agent-based models defined on networks of individuals. The project will be structured as follows:

1. Implement and test network models (3-4 weeks):
   1. Erdos-Renyi (random)
   2. Lattice and Small World (Watts-Strogatz type)
   3. Configuration model with arbitrary degree distributions
   4. Networks derived from real social network data
2. Implement and test a simple model of disease transmission (Susceptible Infected Susceptible) (3-4 weeks)
3. Implement and test a simple model of RDS (1-2 weeks, noting that RDS is very similar to an infection process).
4. Simulation of vaccine deployment and/or treatment and measuring changes in incidence and prevalence of disease for two cases (1-2 weeks):
   1. At random
   2. According to an individual’s rank in the RDS chain

With these tools at our disposal, we will be able to answer the questions set out in the objectives.

### Skills, techniques and follow on:

This project is ideally suited to a student with strong numerical/computational skills, basic knowledge of graph theory and stochastic processes. The student will have the opportunity to acquire the knowledge necessary to embark upon a PhD project on infectious disease modelling in complex social systems.

### References

1. <http://www.contactsurvey.org/>
2. Respondent-Driven Sampling: A New Approach to the Study for Hidden Populations, Heckathorn D.D., Social Problems, Vol 44, No. 2.
3. Danon L, House T, Keeling M.E.J Epidemics, 1:4, 250-258.