# SPREAD OF AN SIS EPIDEMIC IN A NETWORK


Aminath Shausan

School of Mathematics and Physics, University of Queensland, Brisbane, Australia

a.shausan@uq.edu.au

The University Of Queensland AUSTRALIA

Australian Research Council Centre of Excellence for Mathematics and Statistics of Complex Systems


## INTRODUCTION

An epidemic occurs when a disease rapidly spreads through a population so that a significantly large proportion of that population becomes infected during a given period of time.

**Aim**: To describe the spread of SIS type epidemic in a closed population which is divided into groups, incorporating mobility of individuals between the groups.

## THE MODEL

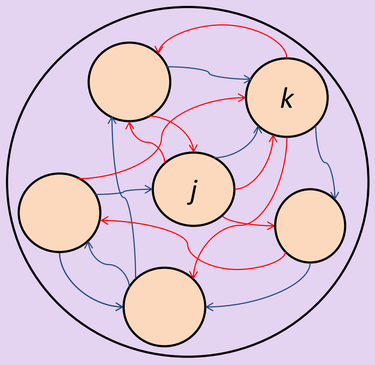
For $j = 1, 2, \dots, J$ let

- $m_j(t)$ := number of susceptibles at node $j$ at time $t$.
- $n_j(t)$ := number of infectives at node $j$ at time $t$.

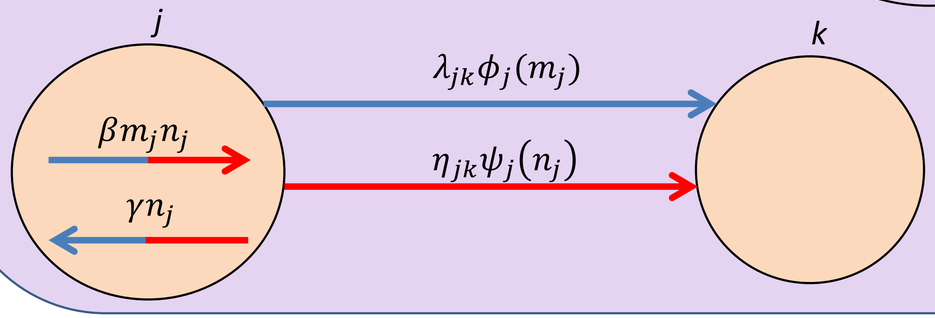
Then, $\{(\boldsymbol{m}(t), \boldsymbol{n}(t)) = (m_j(t), n_j(t));\ t \geq 0\}$

is a $2J$-dimensional Markov process constrained by

$$\sum_{j=1}^{J} (m_j + n_j) = N,$$

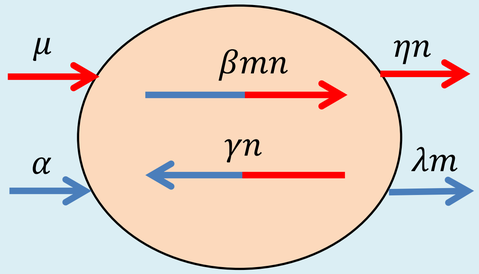



with rates:

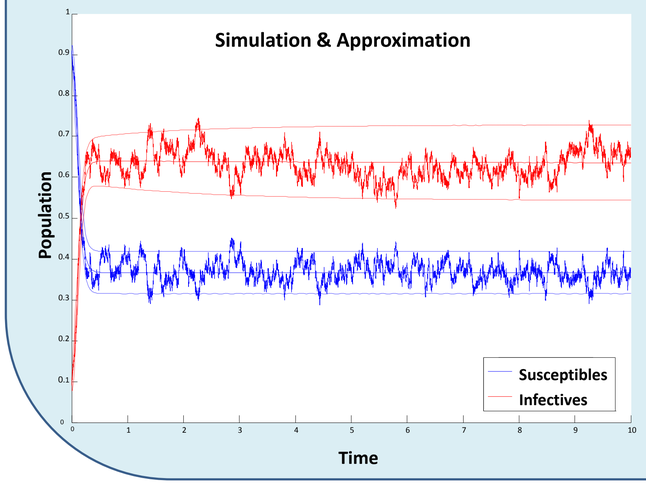



## ANALYSIS & RESULTS

**Behaviour of a single node**




$\alpha$




**Method:** Diffusion Approximation

**Step 1**: Check if the rates are dependent on the current state only through the density

$$x_\nu = \left(\frac{m}{\nu}, \frac{n}{\nu}\right) = (\mathrm{u}, \mathrm{v}),$$

$\nu$ := total initial population size. ✓

**Step 2**: Approximate the density process to

$$\frac{du}{dt} = \alpha' - \beta' uv + \gamma v - \lambda u,$$
$$\frac{dv}{dt} = \mu' + \beta' uv - \gamma v - \eta v. \quad ✓$$

**Step 3**: Use a central limit theorem to model the fluctuations around the deterministic path. ✓

## CONCLUSIONS & FUTURE WORK

- Formulated a model to spread SIS type epidemic in a mobility network.
- Analysed the behaviour of a single node using a diffusion approximation.
- Will apply this method to determine a limit theorem that allows me to predict the behaviour of the entire network