

Module 9: Introduction 1 Notes

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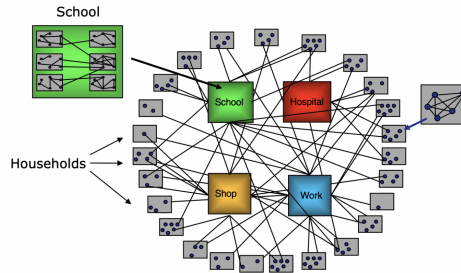
Introduction

- Networks used to capture host population contact heterogeneity and structure
- Process of building a contact network model
 - Define a realistic contact network
 - Predict the spread of disease through the network
 - Apply understanding of network structure and disease spread for public health questions
- Issues with traditional compartmental models:
 - Assumes homogeneous mixing (β)
 - * Know this is not true
- Basic description of a contact network model
 - Individual nodes connected through edges (contacts)
 - Degree = number of edges
 - Are specific to a population and disease class
 - * Different disease transmit via different methods in different populations!
- Contacts:
 - Summarizes
 - * Potential for individual to infect others
 - * Potential vulnerability

Defining a realistic contact network

- How to define a contact network (in decreasing realism)
 - Empirical networks
 - * Based on data from population
 - * Not feasible for large populations
 - Heuristic networks
 - * Tries to merge other two types

Data: census data, school attendance data, hospital bed occupancy data, employment data



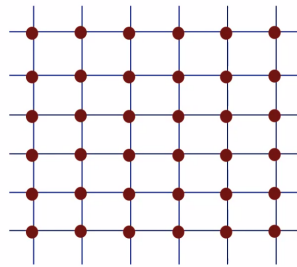
Contact Network for an Urban Area

Ref: Meyers et al,

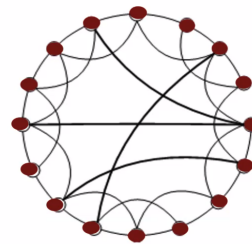
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– Idealized networks

- * Networks that are computationally generated/mathematically described
- * Depend on small pieces of information from data to generate
- * Fast as well described



Lattice



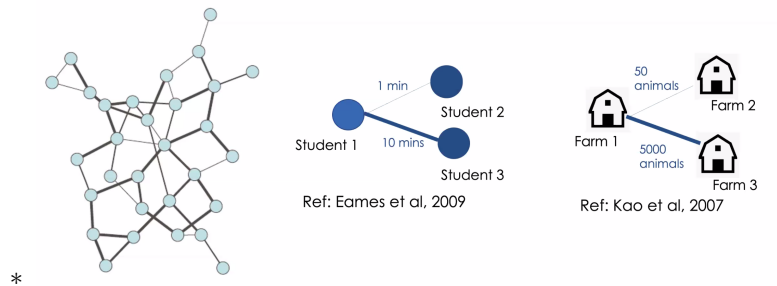
Small-world graph

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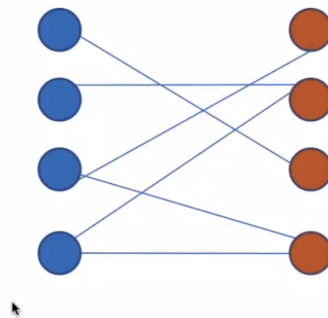
- Lattice may capture spatial structure
- Small world when most interactions with nearby individuals
- * Also includes random networks

Adding more information in contact networks

- Network across scales
 - Think about network where node represents location, not individuals
 - * E.g. livestock movement
- Weighted contacts
 - Instead of edge being binary, can be weighted edge/contact
 - * Represent strength of contact between individuals



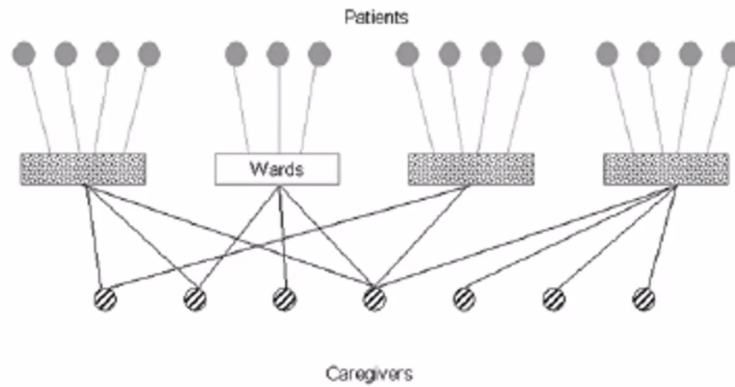
- Directed edges
 - Represent asymmetry in contact
 - Note always the best way to represent but sometimes useful e.g. city dweller to healthcare worker
- Bipartite network
 - Only transmission between certain nodes



Transmission of STD in heterosexual network

Ref: Gómez-Gardeñes et al, PNAS, 2008

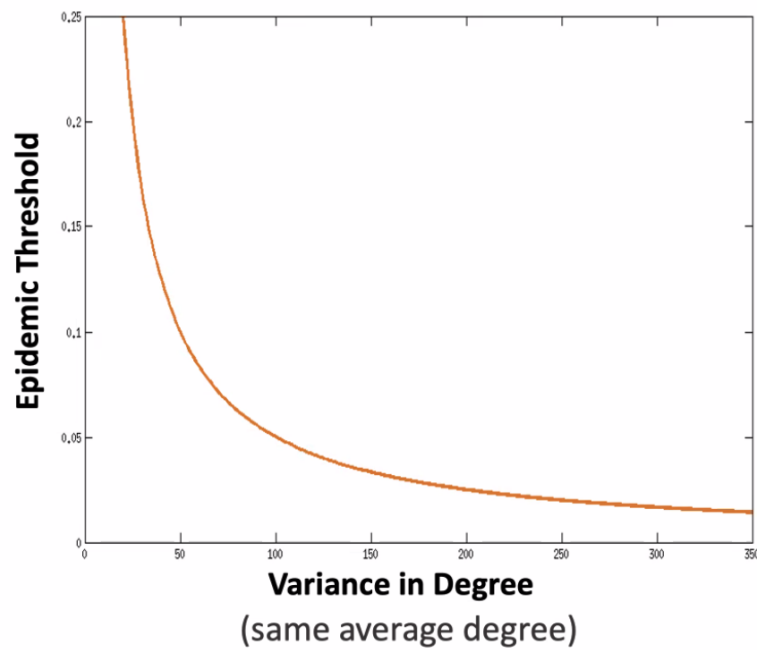
- Co-location network



Ref: Meyers et al, EID, 2003

Predict the spread of a disease through the network

- Network itself contains lots of information about how the disease will spread
- Degree distribution
 - Larger variance in degree decreases the epidemic threshold



- Network transitivity
 - Property that measures the propensity of triangles
 - Transitivity makes populations hard to invade and leads to smaller and longer epidemics
- Dynamic network
 - Contact networks are static in reality, so sometimes want to change throughout the model