LIFE DATA EPIDEMIOLOGY

Lecture 1: Preliminaries

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Lecturers

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Exam: two parts

- Written test (max grade 27)
  - first opportunity to pass will be Dec 20
  - for “non attendees” → only option

- Optional (but highly recommended) project
  - performed by a group of 1-3 people

- Final grade is the sum

Calendar

- Official exam dates for this semester
  - Jan 23 – Feb 14
  - written exam in the morning,
    project discussions in the afternoon

Prerequisites

- Differential equations
  - the course itself is based on a mathematical background of system modeling
- Attitude towards computer simulation
  - not necessarily Matlab (but can be useful)
- Interest towards interdisciplinary topics and collaborations

Related courses

- “Network science” for the MSc Degrees of
  - ICT for Internet and multimedia
  - Physics of data
  - Data science
- “Game theory” for the same degrees and
  - Computer engineering
  - Computer science

What to expect from this course

- See a prime example of exact methodologies applied elsewhere
  - use your technical capability for a cause
- To get a open window to other subjects
  - possible mixture of data analytics, society, communications, technology, economics
- To find something new and interesting

Epidemics

and relationships to our programs

Motivation

- Infectious diseases kill millions of people
  - main death cause in some world regions
  - new diseases make headlines for their sudden outbreak (and panic phenomena)

Definition attempts

- From Wikipedia:
  - epidemic (from Greek ἐπί "upon or above" and δῆμος "people") = rapid spread of an infectious phenomenon to a large number of people within a short period of time

- Think of a disease carried by a virus
  - but it is also commonly heard of a “computer virus” or “viral trends” → correct?

Compare this

- A real pathogen exhibits these traits:
  - living being (or has some characteristics)
  - affects the host behavior
  - causes slower responses
  - creates something extra → usual symptoms
  - eventually may halt functions

- This description holds true for...?

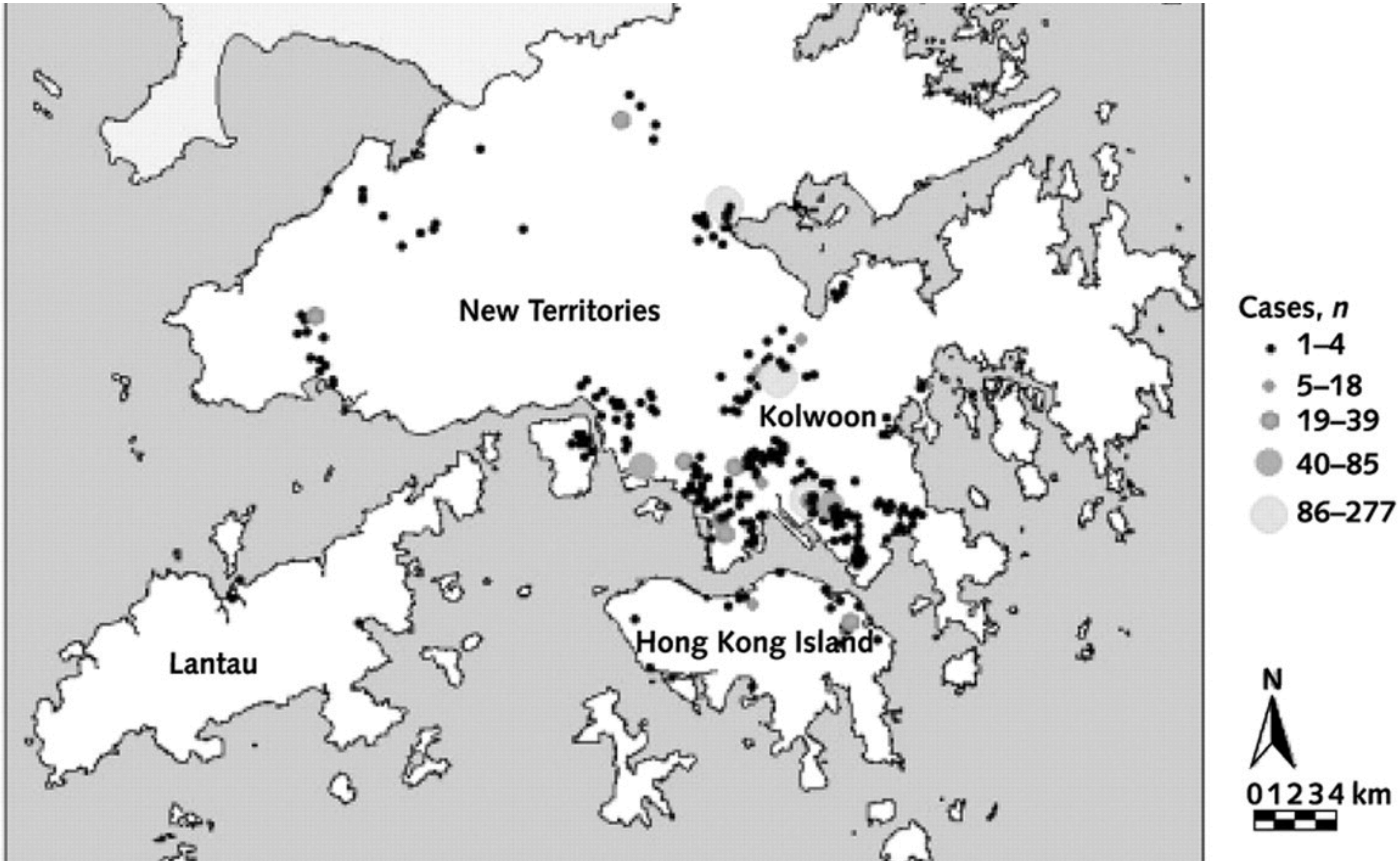
3 fields of application

- **Biological.** Disease networks for airborne (flu, SARS, TB) or body-fluid-related (Ebola, HIV, virus-related tumors) diseases
- **Digital.** Computer viruses: self-replicating programs with similar spreading patterns – now they even affect smartphones
- **Social**. Networks carry innovative ideas, practices, rumors, and memes; even more so in the digital era! (Twitter, fake news)

Why do **we** study it

- Strong mathematical characterization
  - real application of hard science to medicine
  - actually transcends the "local treatment" aspects that are a matter for physicians
- It involves a networking pattern
  - good job to involve the expertise of network engineers / scientists
- Heavily data driven
  - not only based on abstract conjectures

Diseases and epidemics



SARS epidemic map, 2003

Epidemics = spreading

- And does so over an underlying **network**

Applications of our studies

- Prediction
  - general modeling
  - understanding emergency
- Control
  - surveillance (vaccinations)
  - adopting countermeasures
- Clinical implications
  - pathogen characterization
  - effectiveness assessment of a prevention or treatment therapy (large scale analysis)

Problem setup

- Simplest model for an infective disease involves a pathogen carried by individuals
  - some more complicated model may include multiple carrier-pathogen interactions
- The individuals contracting the pathogen are also able to spread it to others
  - dynamics may also include latent periods, or different phases: for now, we focus on a simple model where sick = infectious

Problem setup

- Consider an **isolated** system (e.g. island / university campus) where an epidemics is sighted and you want to monitor its spread
  - people start to get diagnosed and influence others by some contact means

- Most basic model for this scenario:
  SIR (Susceptible – Infected – Recovered) by Kermack and McKendrick (1927)

Compartmental models

- We partition individuals into classes, e.g.:
  - susceptible (S): sane but without immunity
  - infected (I): have the disease and spread it
  - recovered (R): the disease ended and they are immune to it (or they are dead)
- We define transitions diagrams

- Only count aggregate size of each class!