Dynamic and Social Network Analysis

Lecture 11

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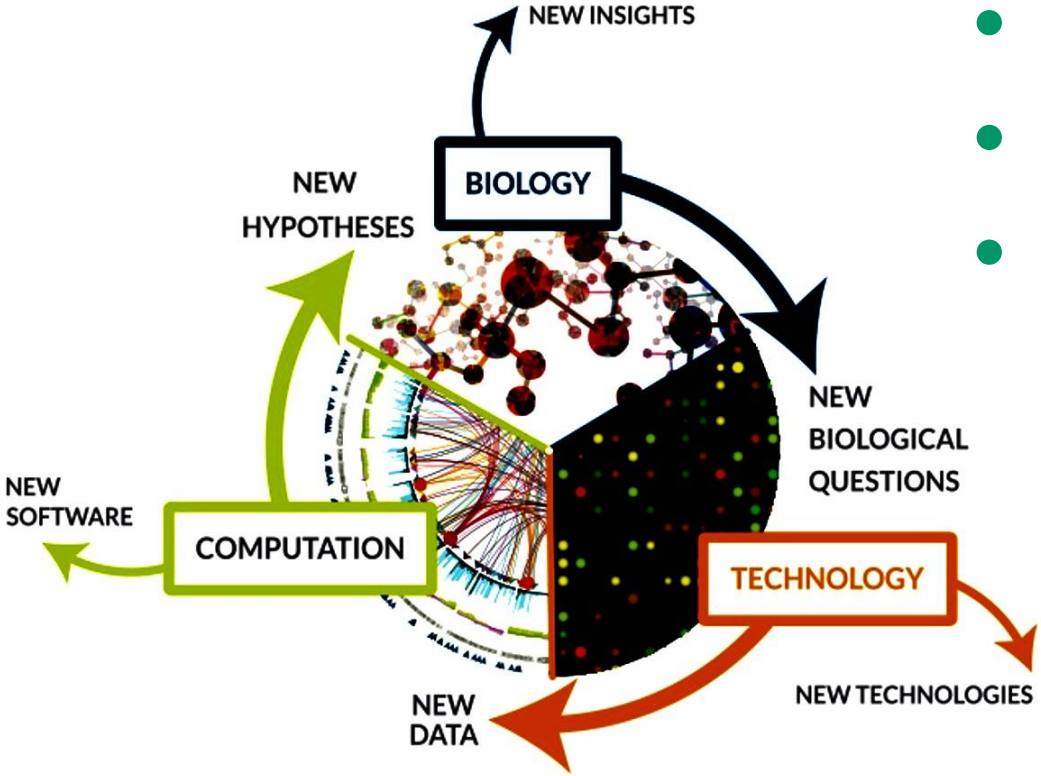
Computational Modeling in Health Care

Computational Modeling in Different Areas of Science

- **Weather forecasting models** make predictions based on numerous atmospheric factors. Accurate weather predictions can protect life and property and help utility companies plan for power increases that occur with extreme climate shifts.
- **Flight simulators** use complex equations that govern how aircraft fly and react to factors such as turbulence, air density, and precipitation. Simulators are used to train pilots, design aircraft, and study how aircraft are affected as conditions change.
- **Earthquake simulations** aim to save lives, buildings, and infrastructure. Computational models predict how the composition, and motion of structures interact with the underlying surfaces to affect what happens during an earthquake

Computational Modeling in Health Care



- Tracking infectious diseases
- Clinical decision support
- Predicting drug side effects

https://www.nibib.nih.gov/science-education/science-topics/computational-modeling

Computational Modeling in Health Care

- **Tracking infectious diseases** Track infectious diseases in populations, identify the most effective interventions, and monitor and adjust interventions to reduce the spread of disease. Identifying and implementing interventions that curb the spread of disease are critical for saving lives and reducing stress on the healthcare system during infectious disease pandemics.
- **Clinical decision support** Intelligently gather, filter, analyze and present health information to provide guidance to doctors for disease treatment based on detailed characteristics of each patient. The systems help to provide informed and consistent care of a patient as they transfer to appropriate hospital facilities and departments and receive various tests during their course of treatment.
- **Predicting drug side effects** Design drugs that will be the safest for patients and least likely to have side effects. The approach can reduce the many years needed to develop a safe and effective medication.

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Epidemics: Similar to information spreading

- Spread of an epidemic depends on the pathogen carrying it
  - As well as the “contagion” network structure
- Goal of studying epidemics
  - Understand how to outbreaks happen
  - Use it to design intervention to curb / prevent the outbreak
- Similar to “information spreading”
  - Spread of opinions in society - Will a YouTube video go viral?
  - Adoption of new technology/product - Who should I market my product for better penetration?

https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-022-introduction-to-network-models-fall-2018/lecture-notes/MIT1_022F18_lec20.pdf

Similar to information spreading: Will a YouTube video go viral?

- Under what conditions will an initial outbreak spread to a nontrivial portion of the population?
- What %age of the population will eventually become infected?
- What is the effect of immunization policies?
- How do contagions spread in populations?
- Will a disease become an epidemic?
- Who are the best people to vaccinate?
- What individuals should we market to for maximizing product penetration?

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Epidemiology: Models of Diffusion

- **SIS (Susceptible, Infected and Susceptible):**
  - Nodes can become infected and then recover in such a way that they become susceptible again

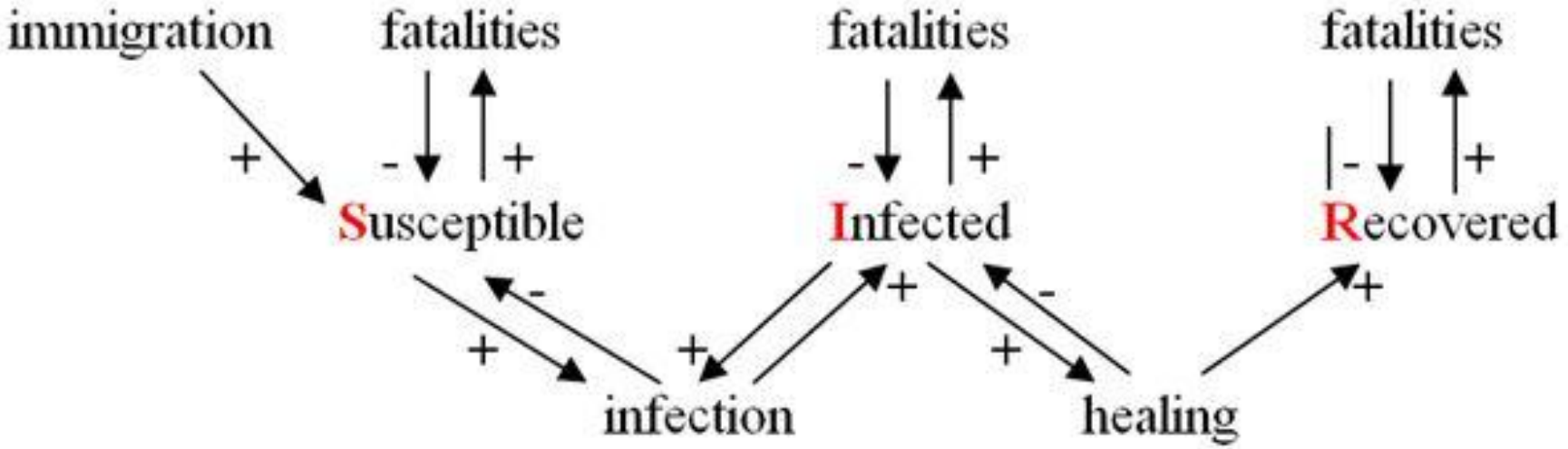
- **SIR (Susceptible, Infected and Recovered) - or Removed:**
  - The diffusion takes place between infected nodes and susceptible nodes. Once a node reaches the “removed” state, it has either recovered and is no longer susceptible or contagious, or it has died.

An example SIR model

- The size of this population grows with immigration and declines with natural deaths.
- Infection depends on contact of infected with not yet infected and not yet immune, i.e. with susceptible members of the population.
- The decease is not really dangerous. It does not increase mortality.
- The number of infected has no influence on migration and on the healing rate of infected.
- Infected can be healed, and once they are healed they are immune against the decease.
- The risk of contagion is equal for all members of the population.
- Newly immigrated are neither infected nor immune.

http://systems-sciences.uni-graz.at/etextbook/sw2/sir.html

An example SIR model



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Next Week:

Scientific Networks