

Reaction-diffusion spatial modeling of COVID-19 in Chicago

Trent Gerew

Illinois Institute of Technology

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- ① The COVID Problem
- ② Project Context and Objectives
- ③ Current Work
- ④ Future Goals



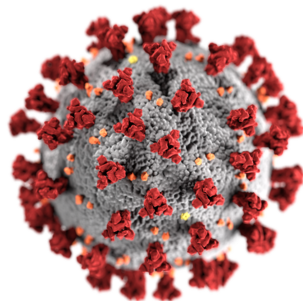
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Identified in Wuhan, China in December 2019.
Caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

In the United States alone, we currently have

- **37,768,911** total cases
- **626,833** total deaths



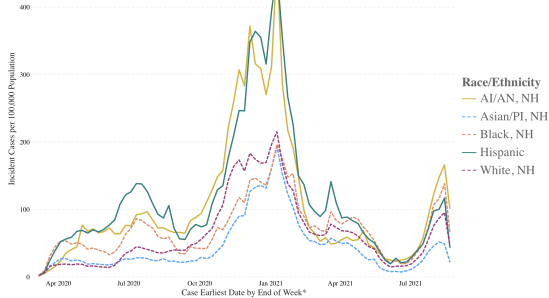


Transmission by exposure to infectious respiratory fluids:

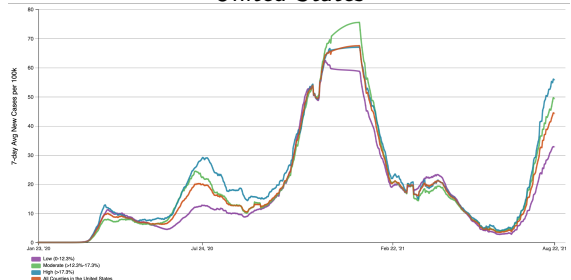
1. Inhalation of virus
2. Deposition of virus on exposed mucus membranes
3. Touching mucous membranes with soiled hands contaminated with virus



COVID-19 weekly cases per 100,000 population by race/ethnicity, United States



COVID-19 weekly case rate per 100,000 population by percentage of county population in poverty, United States





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Why make a mathematical study of COVID-19?

An epidemic model provides . . .

- a convenient summary of the data
- insight into the underlying processes of the disease spread
- a testing ground for assessing control procedures

Models of infectious diseases are usually variations on the **Kermack-McKendrick model** (1927).



Usual assumptions:

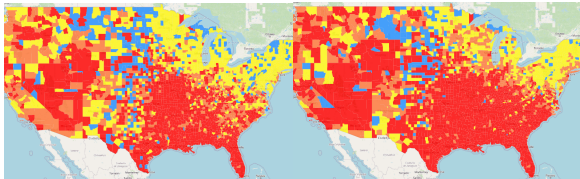
- Population is *homogeneous*
- Transmission is spatially independent

Project Context and Objectives



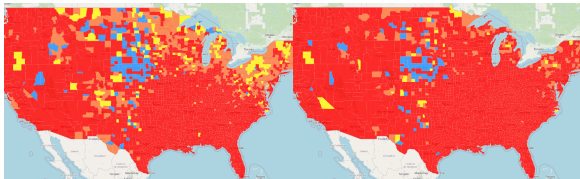
These assumptions don't match reality!

Level of community transmission by county



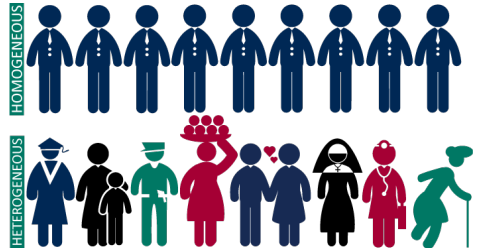
(a) 7/22/2021

(b) 7/29/2021



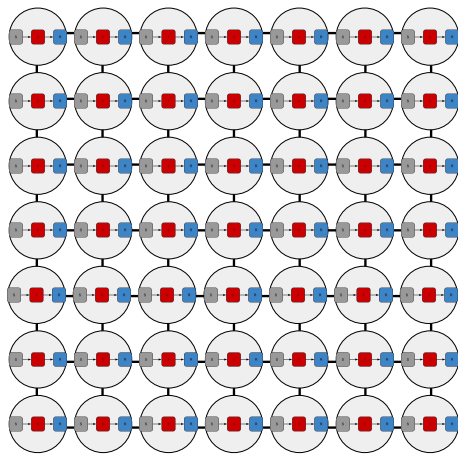
(c) 8/8/2021

(d) 8/21/2021



Idea: Use reaction-diffusion to build a spatially explicit model.

- The data clearly shows a diffusive pattern
- Spatial dependence can approximate demographic differences
- Spatially dependent data exists for many scales and regions





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Working over the summer with Prof. Chun Liu and Prof. Yiwei Wang.

1. Start with a population of *susceptibles* (S)
2. Some of the population may become *infected* (I) upon emergence of the virus
3. Infected individuals interact with susceptibles at rate β to draw new members into I



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