Reaction-diffusion spatial modeling of COVID-19 in Chicago

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Outline

1. The COVID Problem
2. Project Context and Objectives
3. Social and Community Connections
4. Current Work

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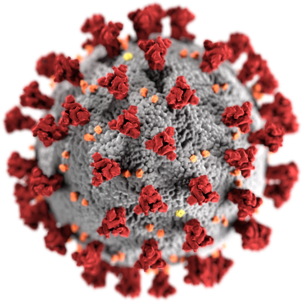
The COVID Problem

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



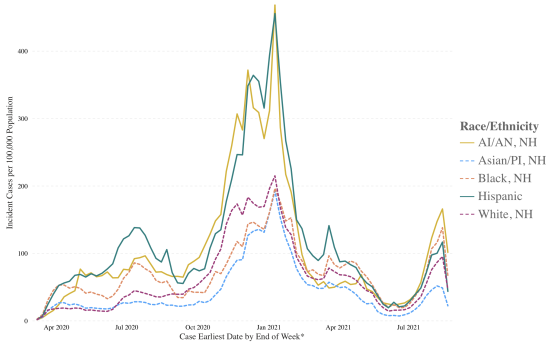
The COVID Problem

Transmission by exposure to infectious respiratory fluids:

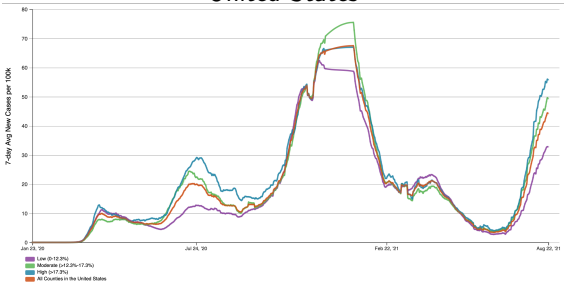
1. Inhalation of virus
2. Deposition of virus on exposed mucus membranes
3. Touching mucous membranes with soiled hands contaminated with virus

The COVID Problem

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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Project Context and Objectives

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

Project Context and Objectives

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

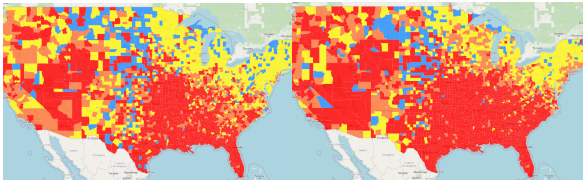
Usual assumptions:

- Population is *homogeneous*
- Transmission is spatially independent

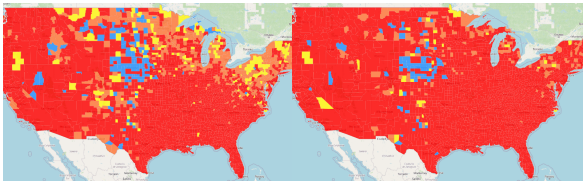
Project Context and Objectives

These assumptions don't match reality!

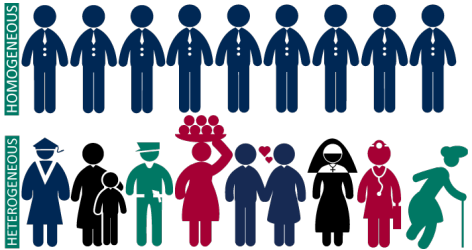
Level of community transmission by county



(a) 7/22/2021 (b) 7/29/2021



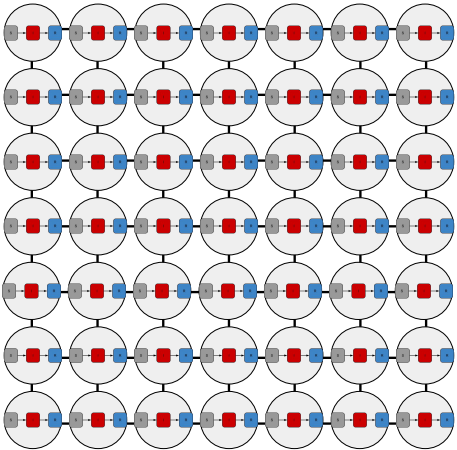
(c) 8/8/2021 (d) 8/21/2021



Project Context and Objectives

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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Social and Community Connections

Original context: Working with David Eads (NPR) to identify *demographic trends* in COVID-19.

How does the impact of COVID-19 (in Chicago) depend on **age** and **race/ethnicity**?

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