Using City Simulator to Prepare for COVID19

city simulator

http://atkinsglobal.com/citysimulator

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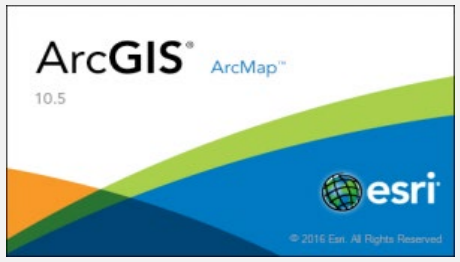
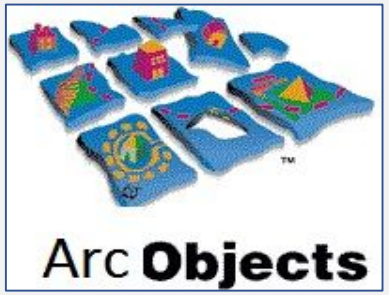
What is City Simulator?

A map-based decision support tool that helps communities understand their vulnerabilities to future disasters and find the most effective mitigation and adaptation actions.



Esri ArcMap Extension

Microsoft Visual Studio 2017, C#, Vb.net



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How does City Simulator Work?

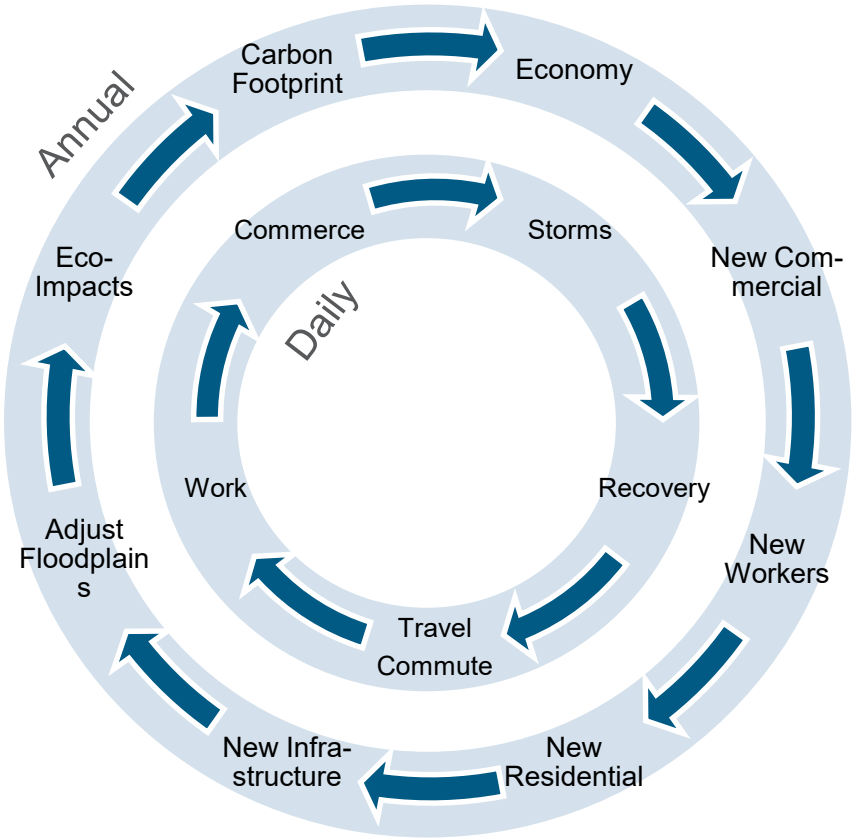
Build a digital twin using existing data & models

System Users
- Agents
- Non Residents
- Tourists

System Infrastructure
- Parcels and Buildings
- Roads and rail
- Stormwater, Wastewater, Water Supply, Telecom, Power
- Rivers, Soils

System Control
- Political Boundaries
- Zoning
- Building Code
- Policies

Simulate Scenario daily from 2020-2050



Evaluate Key Performance Metrics for Decision Making

Economy
- Productivity
- Storm Damage
- Losses Avoided
- ROI
- Investment made

People
- Trips Disrupted/ Lost Wages
- Accessibility (shelters, critical facilities, education)
- LMI population Impacted
- Heat Exposure

Environment
- Carbon Footprint (travel, buildings)
- Pollutant Loadings
- Water Quality

Untitled - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:59,035

Editor

Table Of Contents

Base Year System | Driver Forecasts | Scenario Builder | Simulation | Scenario Comparison

BaseScenario

Load Base Model | Run Scenario Simulation | Stop Run | Publish Results

Loaded

Model Loading | Simulation Dashboard | Results | Old Controls

Status: Idle - Run the scenario to see simulation progress.

2017

2017 09/20

Rain (in.)

Workforce Engaged

Simulation Progress - Annual

10 8 6 4 2 0

2016 2017 2018 2019 2020

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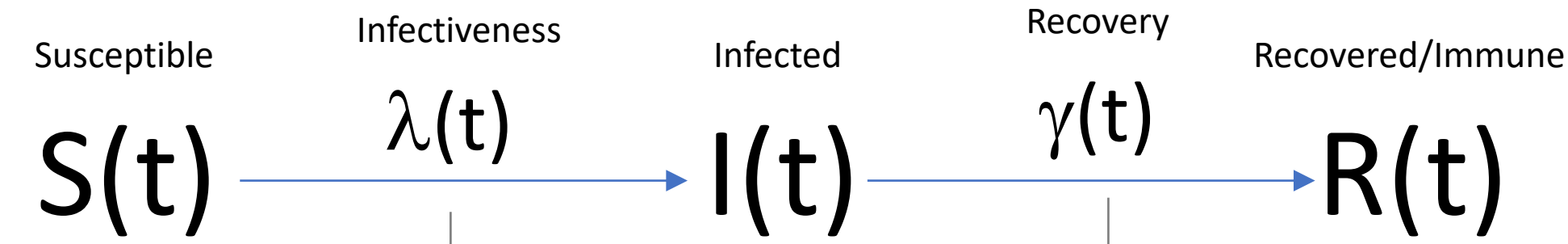
Simulating Storms

Identify | Create Features

Epidemic/Pandemic Modeling – Simple Model



Number of Contacts

Person-to-person infectiveness

$$\lambda(t) = c\chi\frac{I(t)}{N(t)}$$

Infected Popn. / Total Popn. = Probability contacted individual is infected.

$$\gamma(t) = \gamma = \frac{1}{\tau}$$

Average duration of infection

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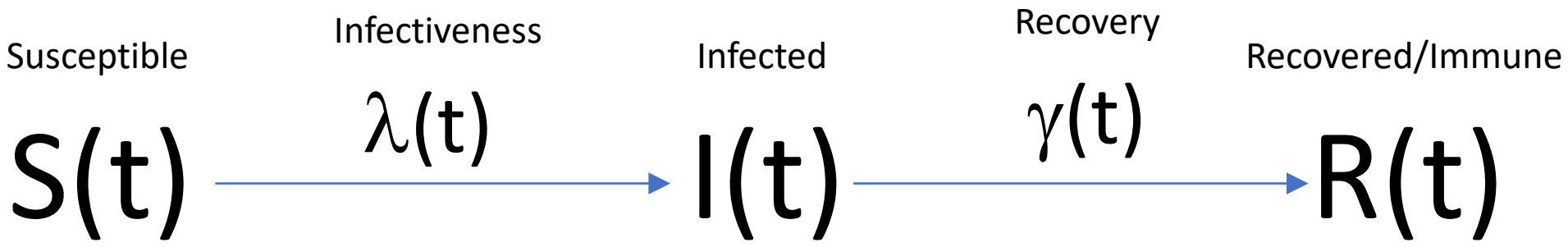
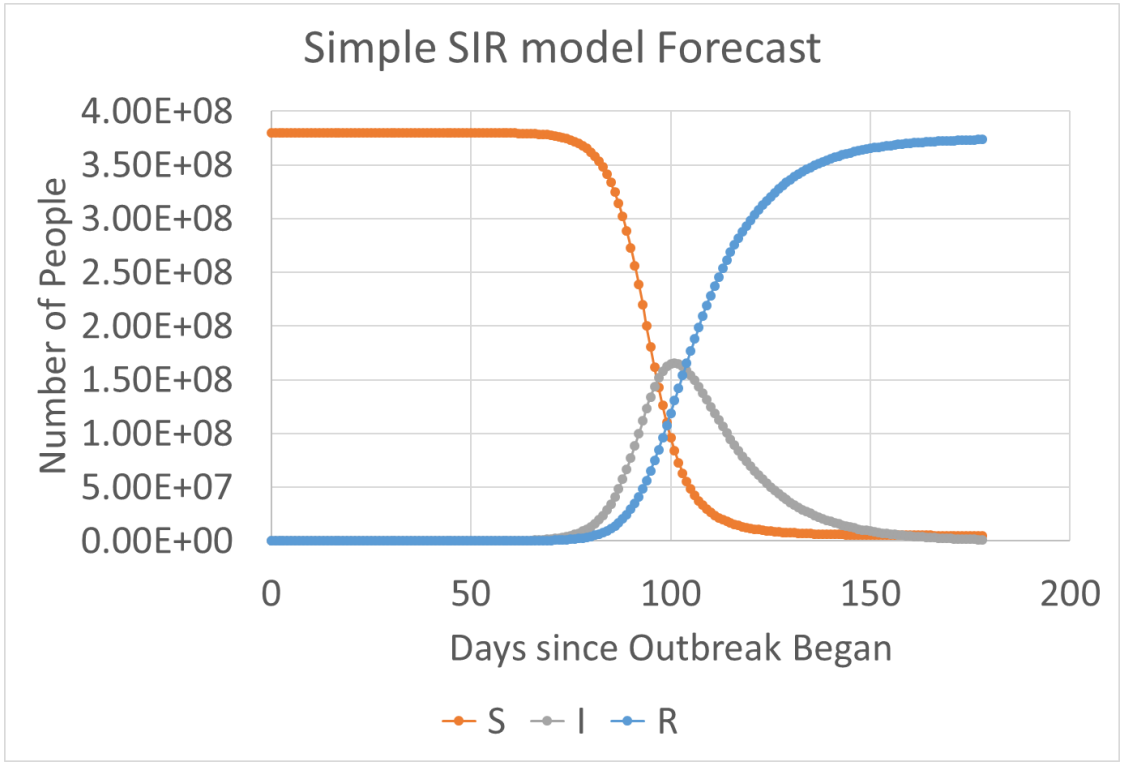
Epidemic/Pandemic Modeling – Simple Model





C = 3 people contacted per day
χ = 0.1 person-to-person infection
τ = 14 days average recovery
S(0) = 380M
I(0) = 1
R(0) = 0

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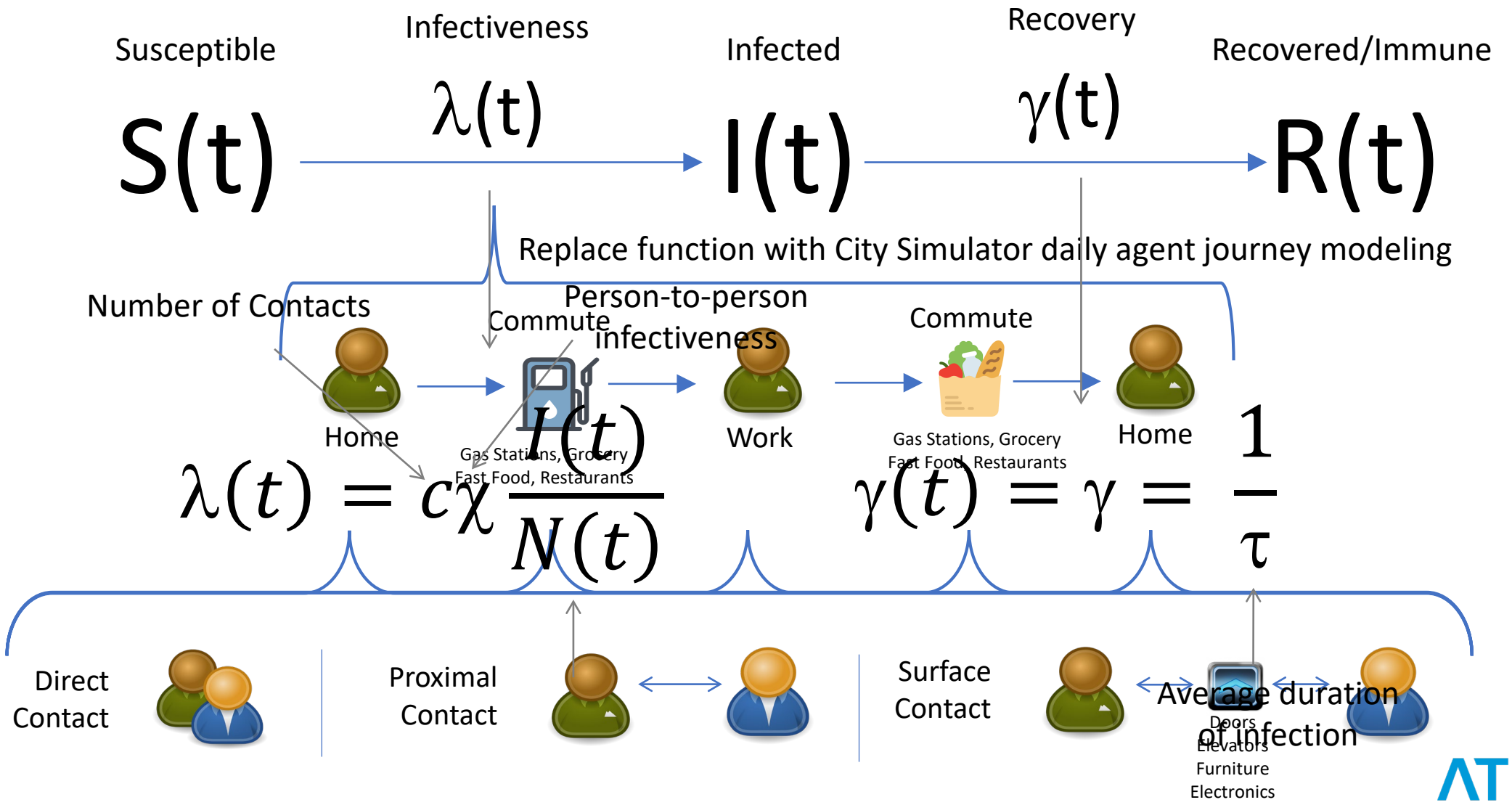
Epidemic/Pandemic Modeling – Agent-based



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Epidemic/Pandemic Modeling – Advantages of Agent-based

- Removes averaging effect of using bulk infection model – much higher detail.
- Automated contact tracing within the simulation at the level of the individual
- Pinpoint hot spots across the community
- Estimate impact of potential measures (eg. gas stations cleaning pumps hourly)

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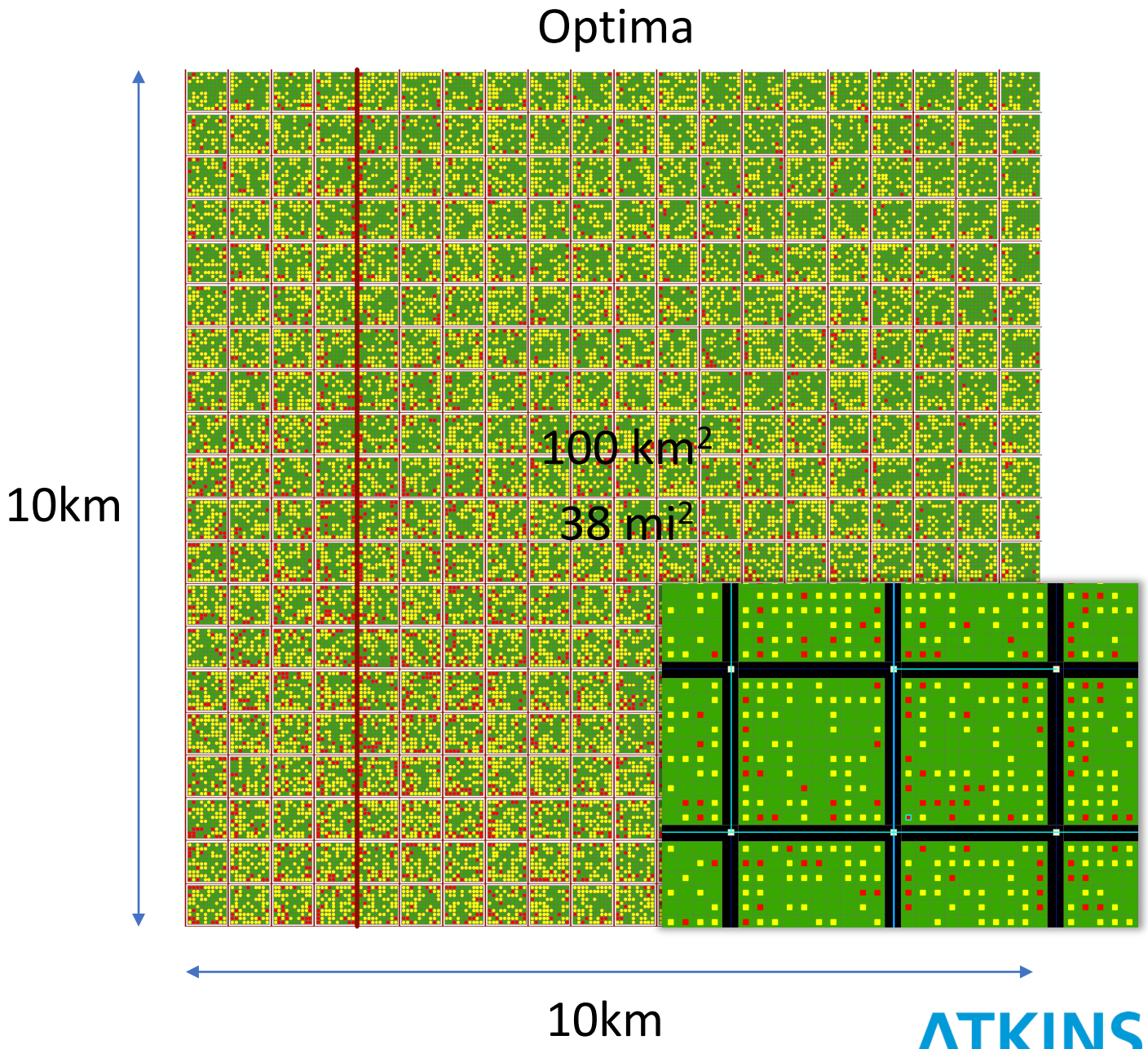
Optima – A virtual City

- 95,099 people
  - 31,129 workers
- 20,030 buildings
  - Commercial – 3,125 buildings(single and multi-business)
  - Residential – 16,905 buildings (single and multi-family)
- Central Business District in SW Quadrant
- Daily Commutes to work



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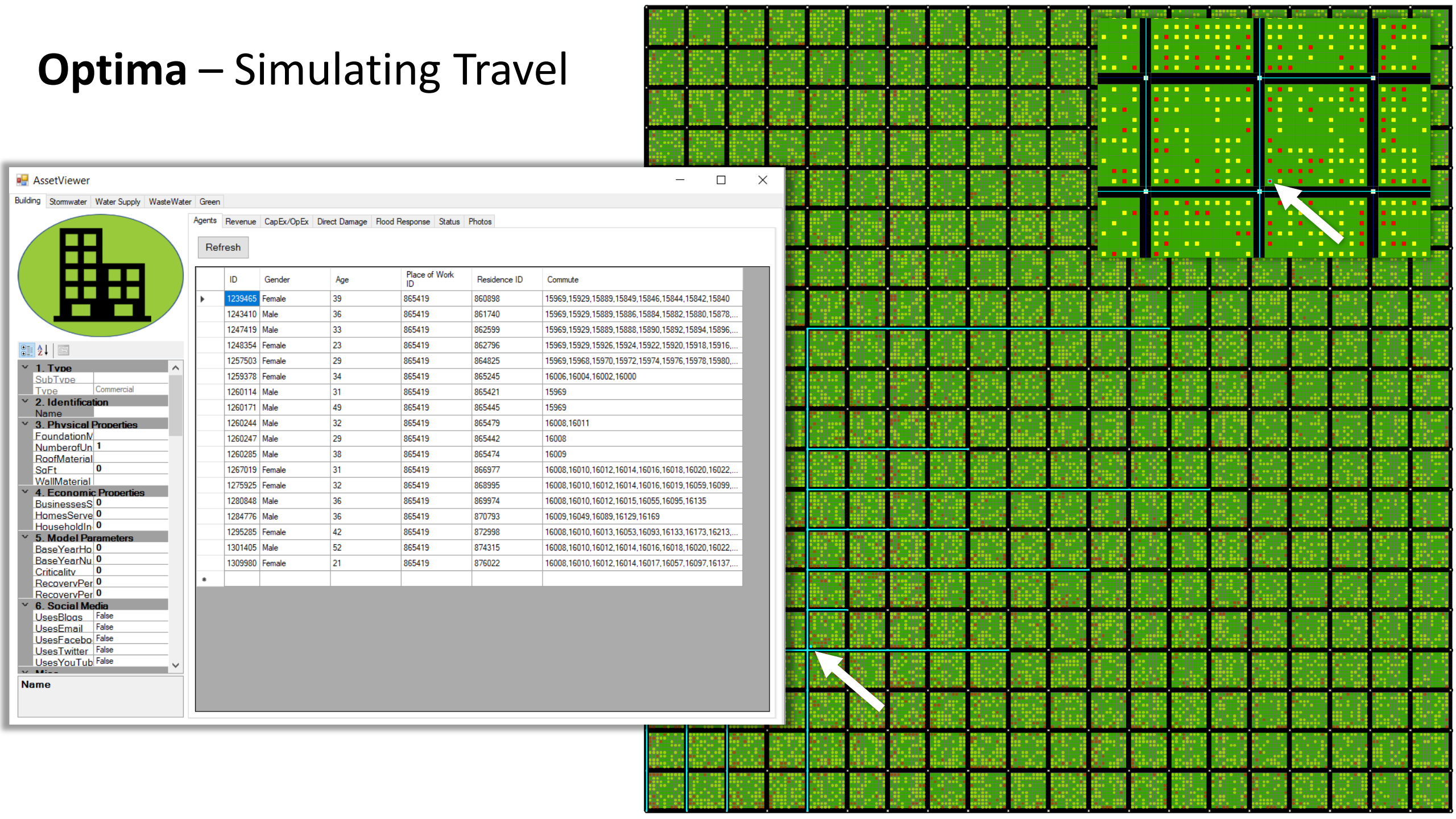
Optima – Simulating Travel



Experiment Assumptions – Rates, Durations, Probabilities

Every 10 days

New Infected Resident
For duration of simulation

14 days

Recovered and Immune
Returns to work

5 days

Infectious, No Symptoms
Continues working

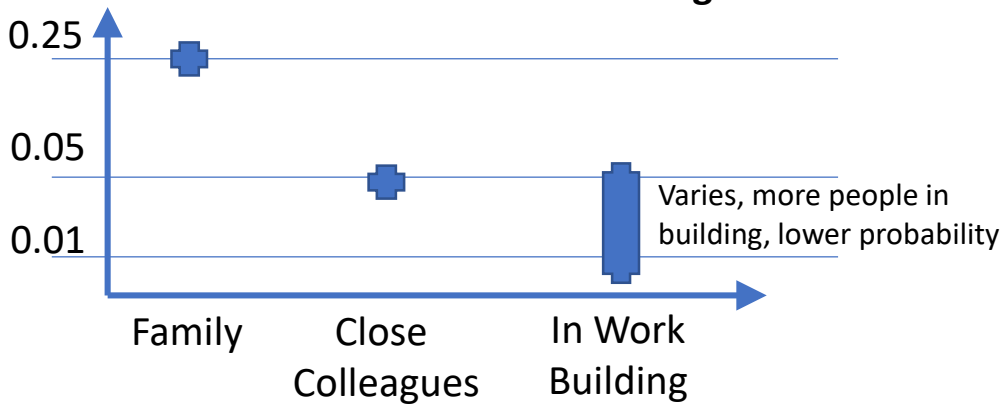
50%

Days 6-14, Sick
Not able to work

50%

Asymptomatic
Continues to Spread Virus

Probability of Contact & Transmission within building



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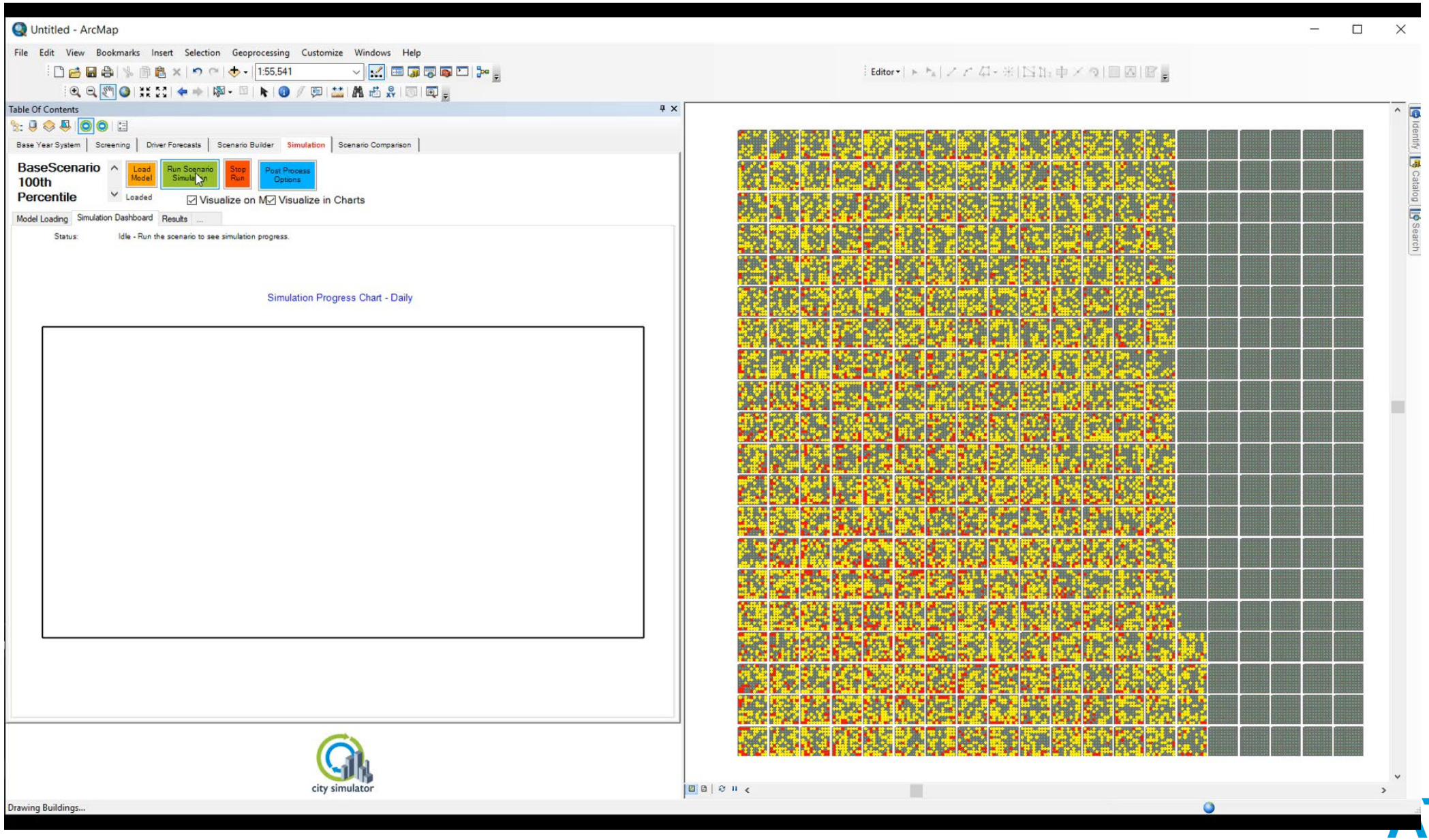
Base Run – No Mitigation



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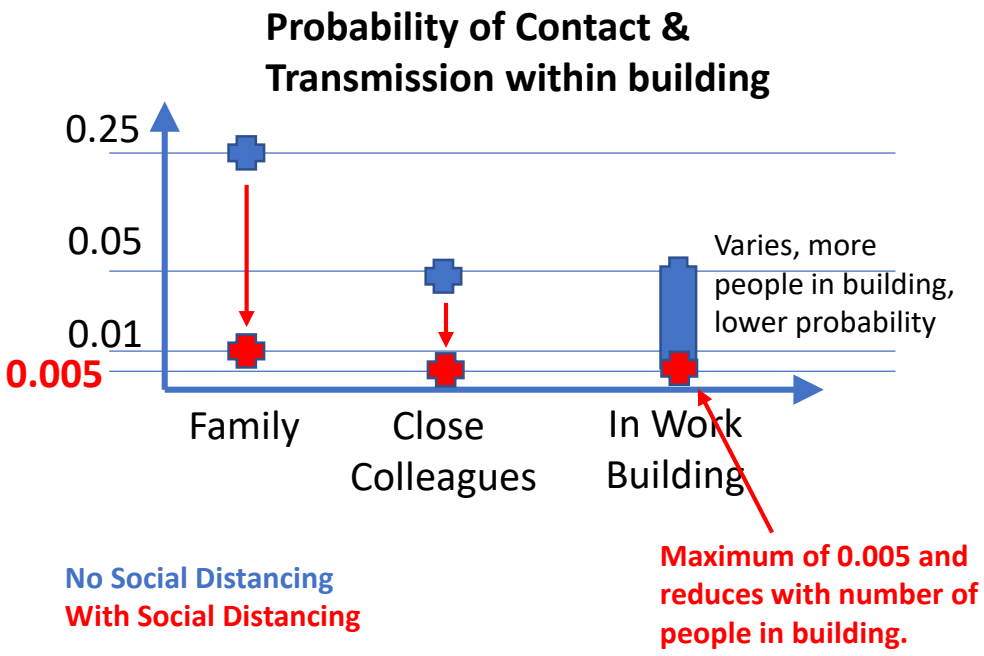
Mitigating with Social Distancing

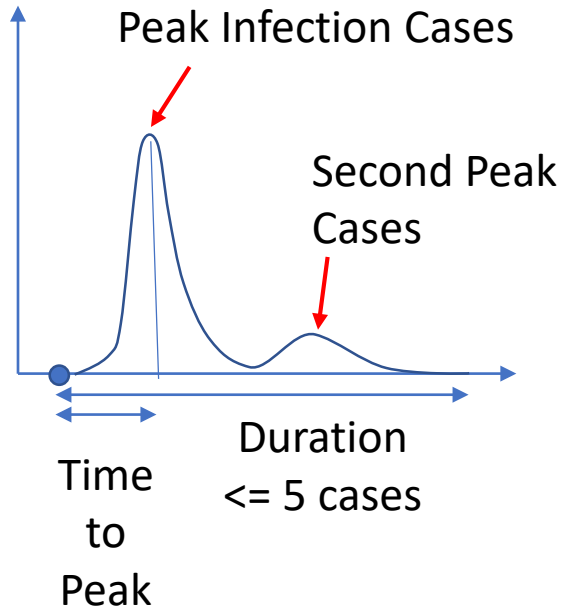
Assumed Impact on person-to-person Transmission



Explore Options

- Start Time
  - 10 cases, 50, 100
- Duration of Measure
  - 14 days, 28, 42, 56, 70, 84
- Compliance of Individuals
  - 50%, 75%, 100%

Metrics



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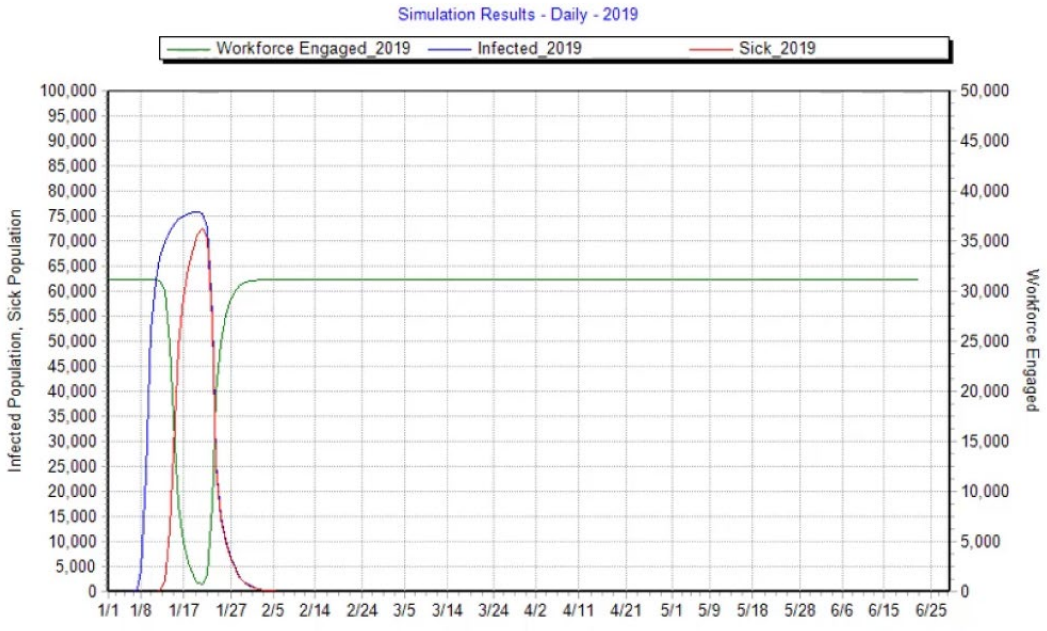
Mitigating with Social Distancing

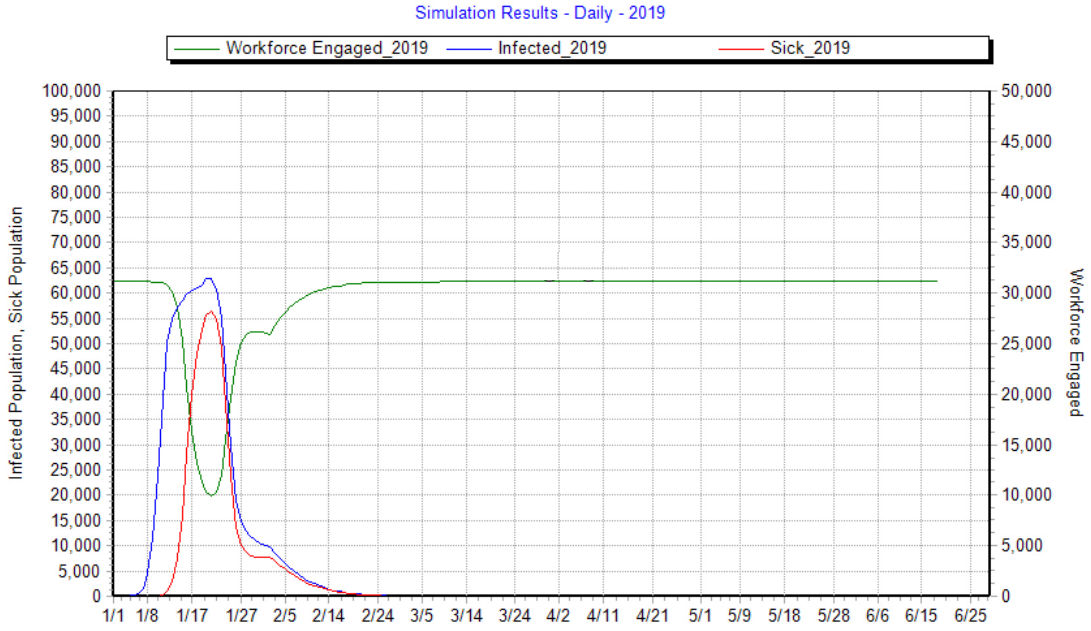
Base Run

No Mitigation Measures



Social Distancing

Start at 10 cases, Measure in Place 14 days,
50% Compliance



- Peak Significantly lower, still high percentage of city
- Engaged workforce minimum at 10,000
- Second peak starting to form

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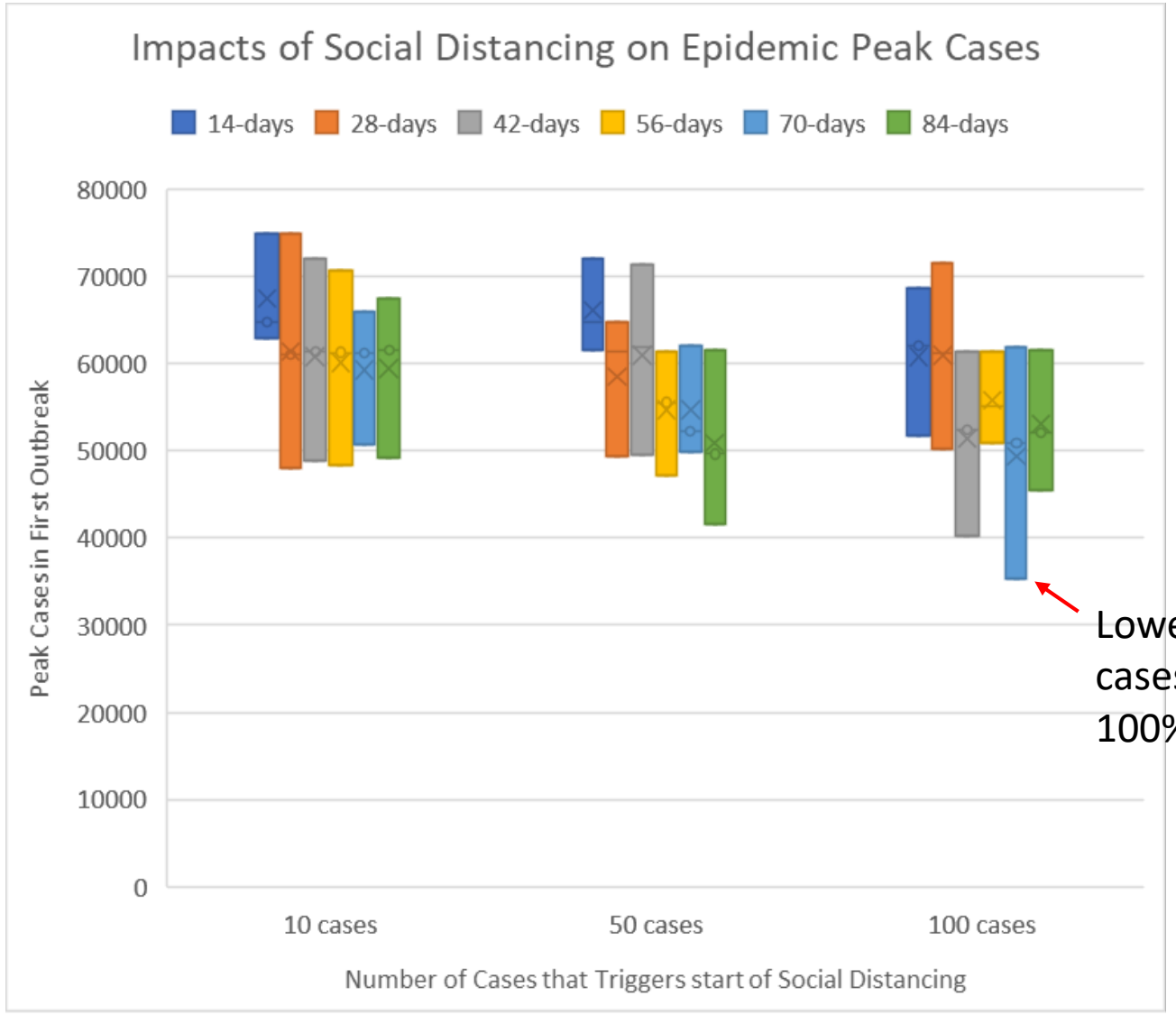
Social Distancing – Peak Cases Metric



Lowest peak when start at 100 cases with 70-day duration and 100% compliance

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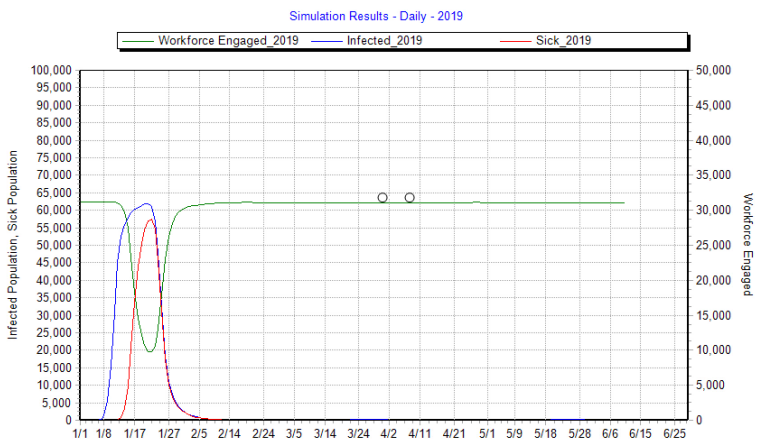
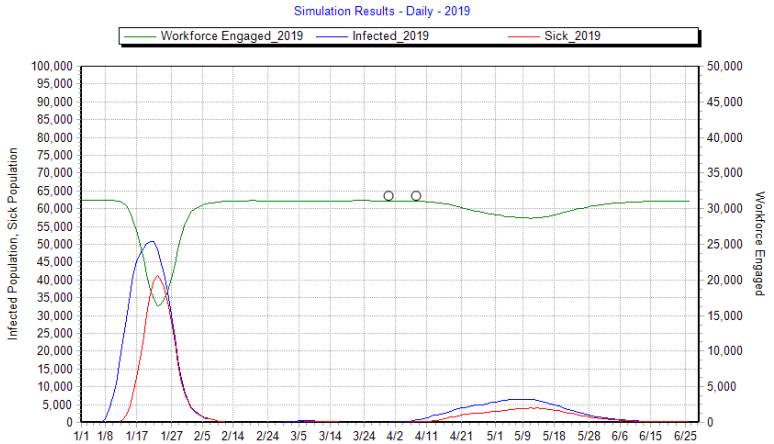
Social Distancing – Start at 100 Cases, 70 Day Duration

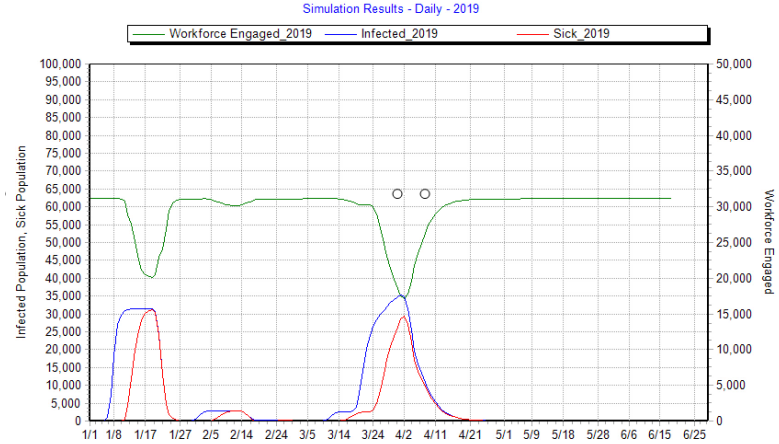
50% Compliance



75% Compliance



100% Compliance



- Compliance has large impact
- Flattens curve
- Introduces large second peak when 100% compliant

Take away, compliance is key but must be extended.

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Social Distancing – Longer Term

- Extending Social Distancing keeps peak cases lower
- Results in multiple peaks that diminish as immunity builds

- Regularity of peaks related to 10-day outside-City case clock
- Strong need to control new cases from outside city

On-going Modeling Enhancements

- **Multi-disaster**
  - **Hurricane + Pandemic impacts on shelter requirements**
  - **Forbes Article: https://tinyurl.com/y53blc97**

- **Uncertainty:**
  - Monte Carlo-type multi-run approach (1000 runs per simulation) to capture uncertainty in spread.
  - Allows us to estimate best and worst cases.
- **Place and Realism are Key:**
  - Real city modeling
  - Increase complexity of modeling
    - Calibrate to contract tracing data
    - Fomite spread
- **Other Measures are needed:**
  - Value of stay-at-home orders
  - Regular surface cleaning (eg. gas station pumps)
  - Many more.
- **Ability to string Measures in Series and Parallel**
  - Is there a 1 + 1 = 3 effect with multiple measures

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Thanks for watching!

For more detail:

Check out http://atkinsglobal.com/citysimulator

Contact Stephen Bourne at Atkins.

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