COVID-19 Epidemic Modeling

May 1 2020

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- Research
- MVP
- Problems
- Future

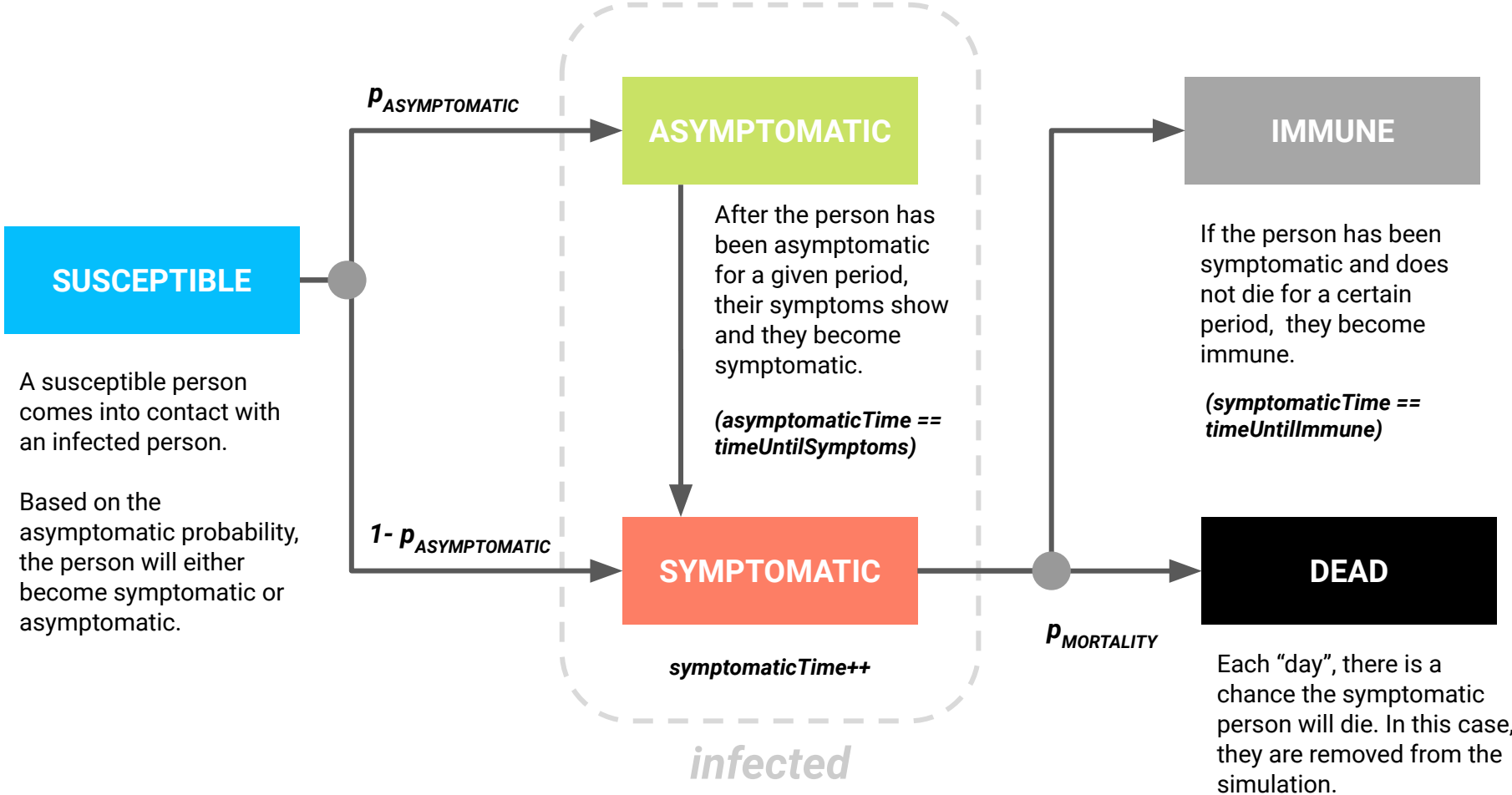
Research

Concepts

- The basics of SIR models
- Multi-level agent-based models for epidemics
- Infectious disease epidemiology
- The COVID-19 virus
- Different SIR models used for pandemics
- Research modeling tools (eg. GAMA, REPAST)
- Agent-based pandemic models on github
- The COVID-19 situation in the Netherlands

MVP

Demo


SUSCEPTIBLE
A susceptible person comes into contact with an infected person.
Based on the asymptomatic probability, the person will either become symptomatic or asymptomatic.
$p_{ASYMPTOMATIC}$
$1 - p_{ASYMPTOMATIC}$
ASYMPTOMATIC
After the person has been asymptomatic for a given period, their symptoms show and they become symptomatic.
(asymptomaticTime == timeUntilSymptoms)
SYMPTOMATIC
symptomaticTime++
infected
IMMUNE
If the person has been symptomatic and does not die for a certain period, they become immune.
(symptomaticTime == timeUntilImmune)
$p_{MORTALITY}$
DEAD
Each "day", there is a chance the symptomatic person will die. In this case, they are removed from the simulation.

Parameters

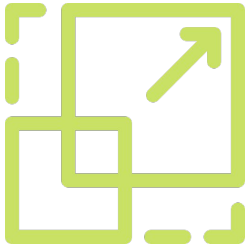
Name	Role in Model	Fallbacks	Initial Value
Person Radius	Size of a person		Range: 0-10 Initial value: 5
Infection Radius	How many people one person can infect at once	Find a solution with basic reproductive numbers.	1-20 range Initial = PERSON_RADIUS + (PERSON_RADIUS / 3);
Time Until Symptoms	How long you can stay asymptomatic. If a person is asymptomatic, they become symptomatic when this value is reached.	Not all people have the same symptom development time. Some people never develop symptoms.	Range: 7-14 Initial value: 10
Asymptomatic Time	Time that someone has been asymptomatic.		(just a counter)

Parameters

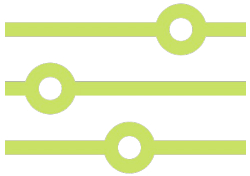
Name	Role in Model	Fallbacks	Initial Value
Mortality Rate	For a symptomatic person, each day a number is randomly generated and if it is less than the mortality rate, they die.		11.6% (most current NL value)
Time Until Immune	The length of time someone is symptomatic until they are declared immune.	Can people have the virus twice?	Range: 5-10 Initial value: 7
Symptomatic Time	Time that someone has shown symptoms. If it equals TimeUntilImmune, then we know the person has become immune.	Random range? (people have different symptomatic times based on their immune system)	(just a counter)
Asymptomatic Probability	Probability that someone will be asymptomatic. If someone is infected, there is a chance they will not show symptoms.	Everyone is asymptomatic for a period of time. Everyone has an incubation period, which is not reflected in this model.	25%

Problems

Speed



Scalability



Simplicity

Speed

- Draw a smaller proportion of agents (suppress the amount we render)
- Look into using a canvas that can be parallelizable (webGL)
- Use observables to only update visuals when the data changes
- Delete or compress old graph data
- Use async await (js)
- Convert performance critical code into modules and load into WebAssembly
  eg. for meetings between agents

Scalability

- Interface different models into a multi-level agent-based model
- Speed dependent, so once speed issues are resolved test the limits of scaling

Simplicity

- Setting standard deviations for certain parameters (eg. asymptomatic and symptomatic time periods)
- Social-distancing and repulsion between agents
- Community/central hubs/household interactions
- Hospital/ICU capacity
- Testing (how long until people quarantined, how many people are tested)
- Asymptomatic and symptomatic time periods and division (incubation class?)
- Account for human characteristics like age

Future

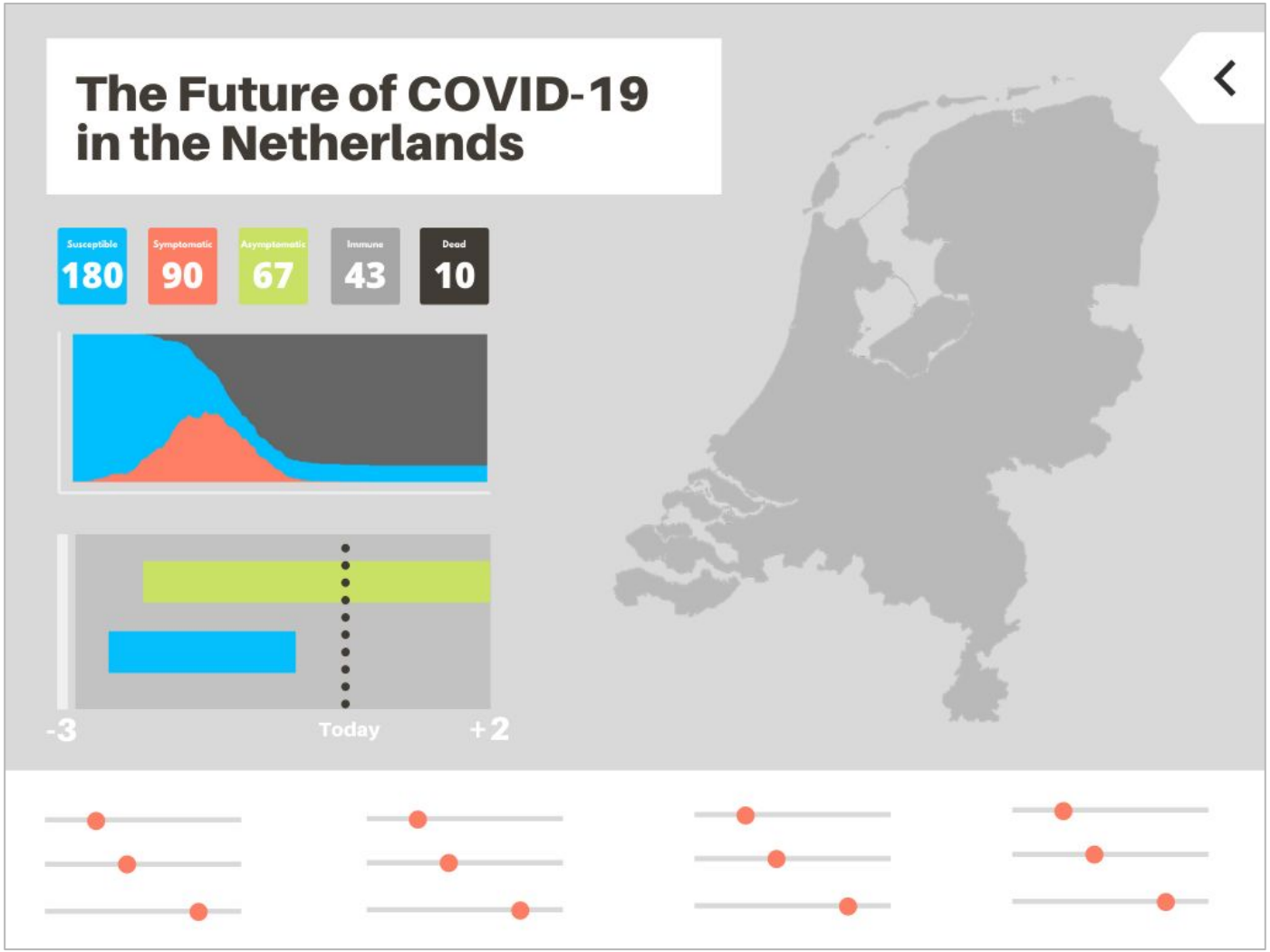
Priorities

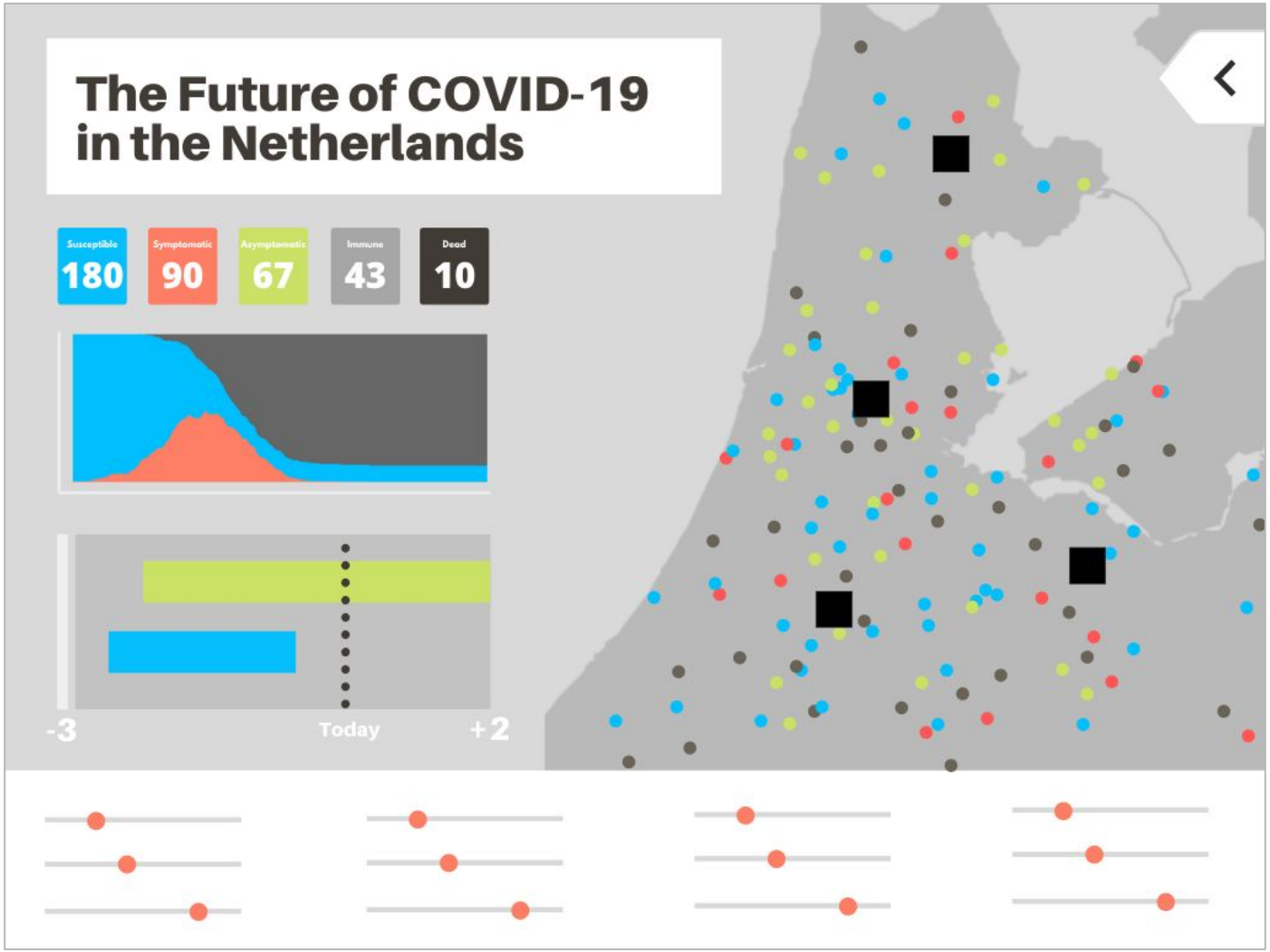
- Addressing the stated problems
- Integrating current data API
  - Test our model against current data
  - Set initial parameters to most current values and use sliders to manipulate
- Testing

Final Product

We want to develop a tool that can be used by civilians or politicians to investigate the future of the virus in the Netherlands

- **Relatable visuals**
  - Overlaying map data
  - Multi-Level Agent-Based Modeling (multiple cities with interaction)
- **Accessible to other countries**
  - Make it easy to swap data
  - Clear documentation, minimal use of data API
- **Easy to investigate the future**
  - Have a timeline for parameters


The Future of COVID-19 in the Netherlands
Susceptible
180
Symptomatic
90
Asymptomatic
67
Immune
43
Dead
10
-3
Today
+2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Thank you for your attention.

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