CSE 482 B

Lecture 04

Global Covid Data and Modeling

Announcements

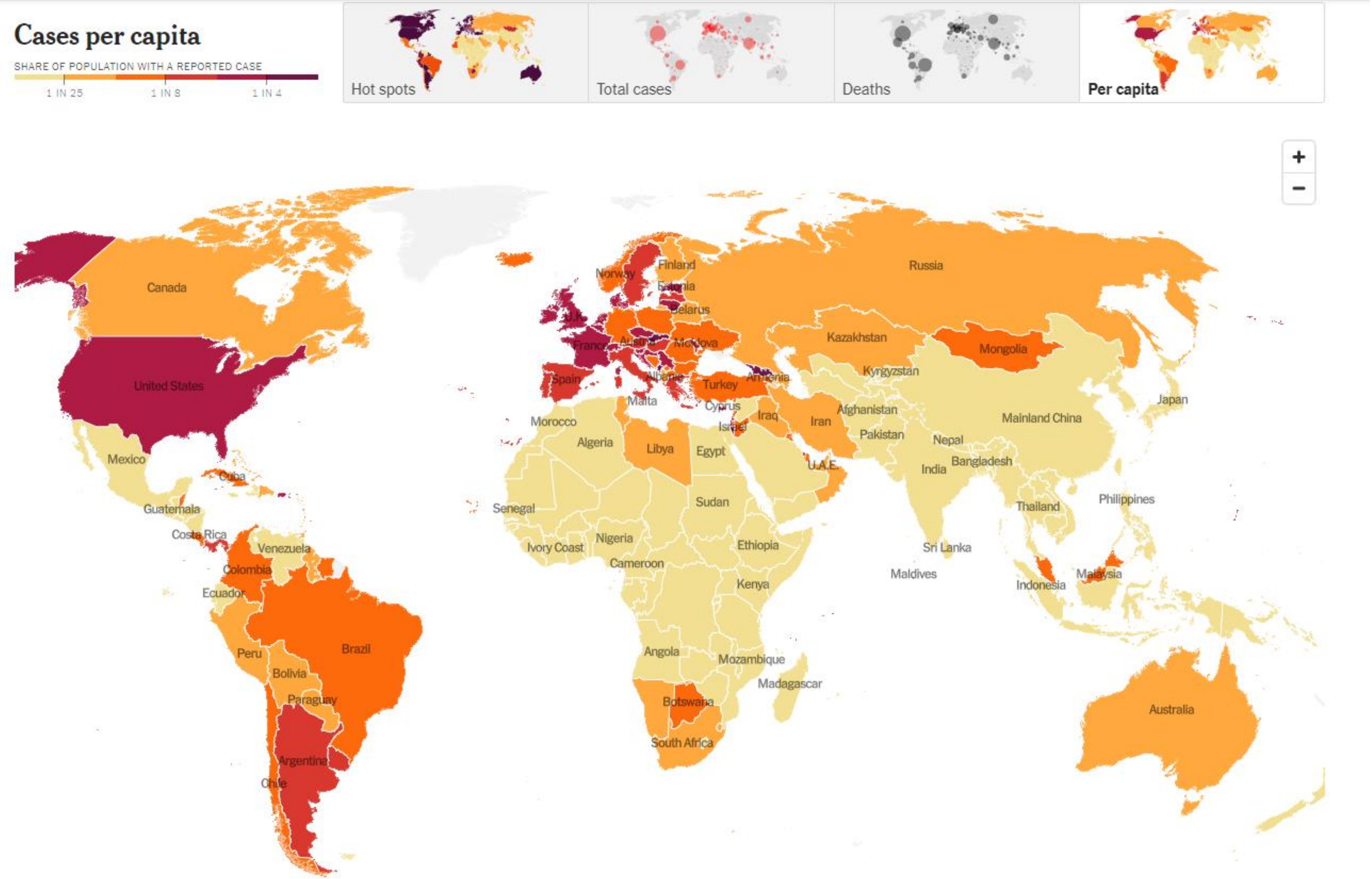
Covid Pandemic

Global Cases

New reported cases

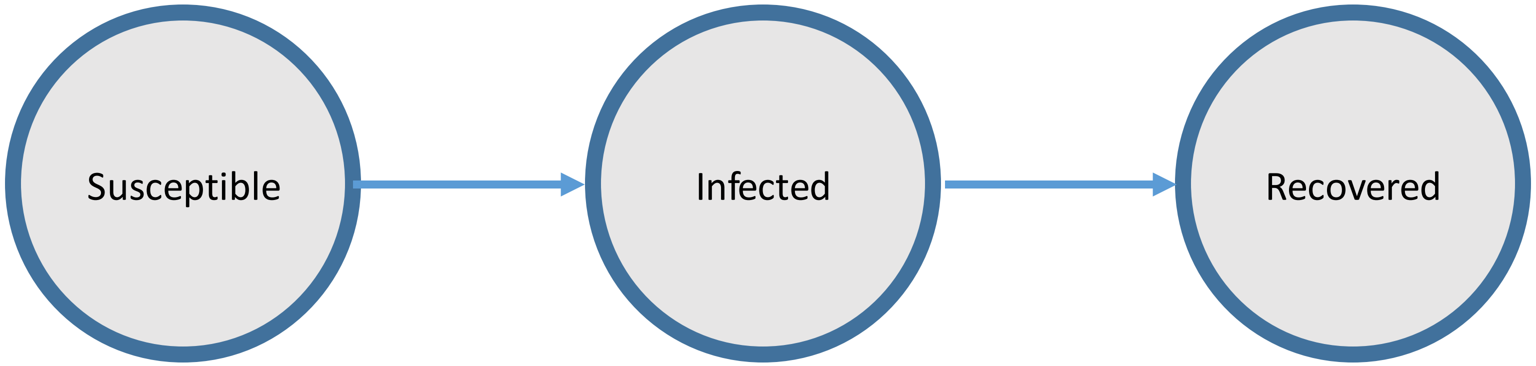
All time | Last 90 days

	DAILY AVG. ON JAN. 11	14-DAY CHANGE	TOTAL REPORTED
Cases	2,615,566	+180%	313,620,083
Deaths	6,647	+3%	5,502,949


Cases per capita
SHARE OF POPULATION WITH A REPORTED CASE
1 IN 25
1 IN 8
1 IN 4
Hot spots
Total cases
Deaths
Per capita
Canada
United States
Mexico
Cuba
Guatemala
Costa Rica
Venezuela
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Argentina
Chile
Norway
Finland
Estonia
Belarus
U.K.
France
Austria
Moldova
Spain
Albania
Turkey
Armenia
Malta
Cyprus
Israel
Iraq
Iran
Morocco
Algeria
Libya
Egypt
U.A.E.
Senegal
Sudan
Nigeria
Ivory Coast
Cameroon
Ethiopia
Kenya
Angola
Mozambique
Madagascar
Botswana
South Africa
Russia
Kazakhstan
Mongolia
Kyrgyzstan
Afghanistan
Pakistan
Nepal
India
Bangladesh
Mainland China
Japan
Sri Lanka
Maldives
Thailand
Philippines
Malaysia
Indonesia
Australia

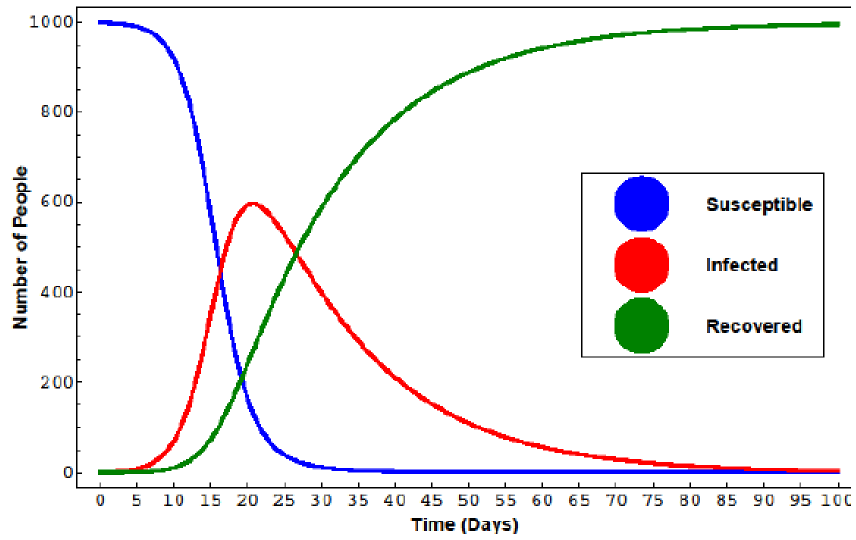
Disease Modelling

- Naïve Assumptions
  - Uniform Population
  - Three types of people: Susceptible, Infected, Recovered
  - Disease lasts one unit of time
  - Each Infected exposes r other people
  - A person Susceptible person that is exposed becomes infected



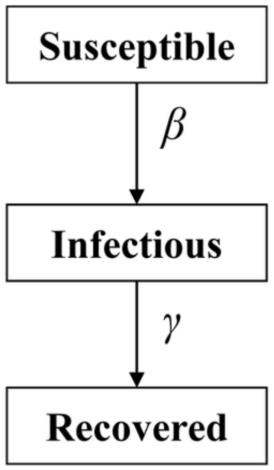
Model predictions

- Exponential growth for r > 1
- Decline in cases when r < 1
- New cases: r ×|I| × (|S| / n)
- Effective r value decreases as susceptible population decreases
- Decline starts when r = (n / |S|)



Making the model continuous

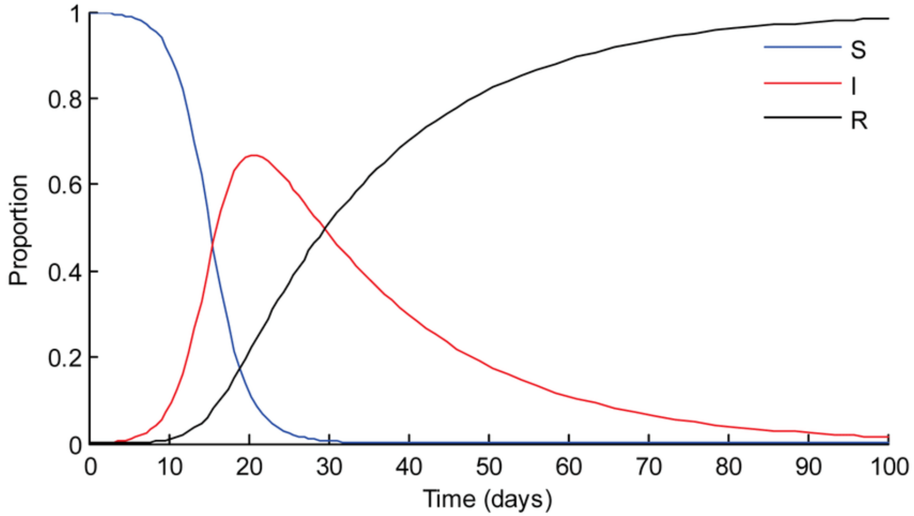
- Shrink the time interval and allow multiple time periods in I
- Parameters β and γ for transition from S to I and from I to R
- Time step to zero to make a differential equation



$$\frac{dS}{dt} = -\beta SI$$

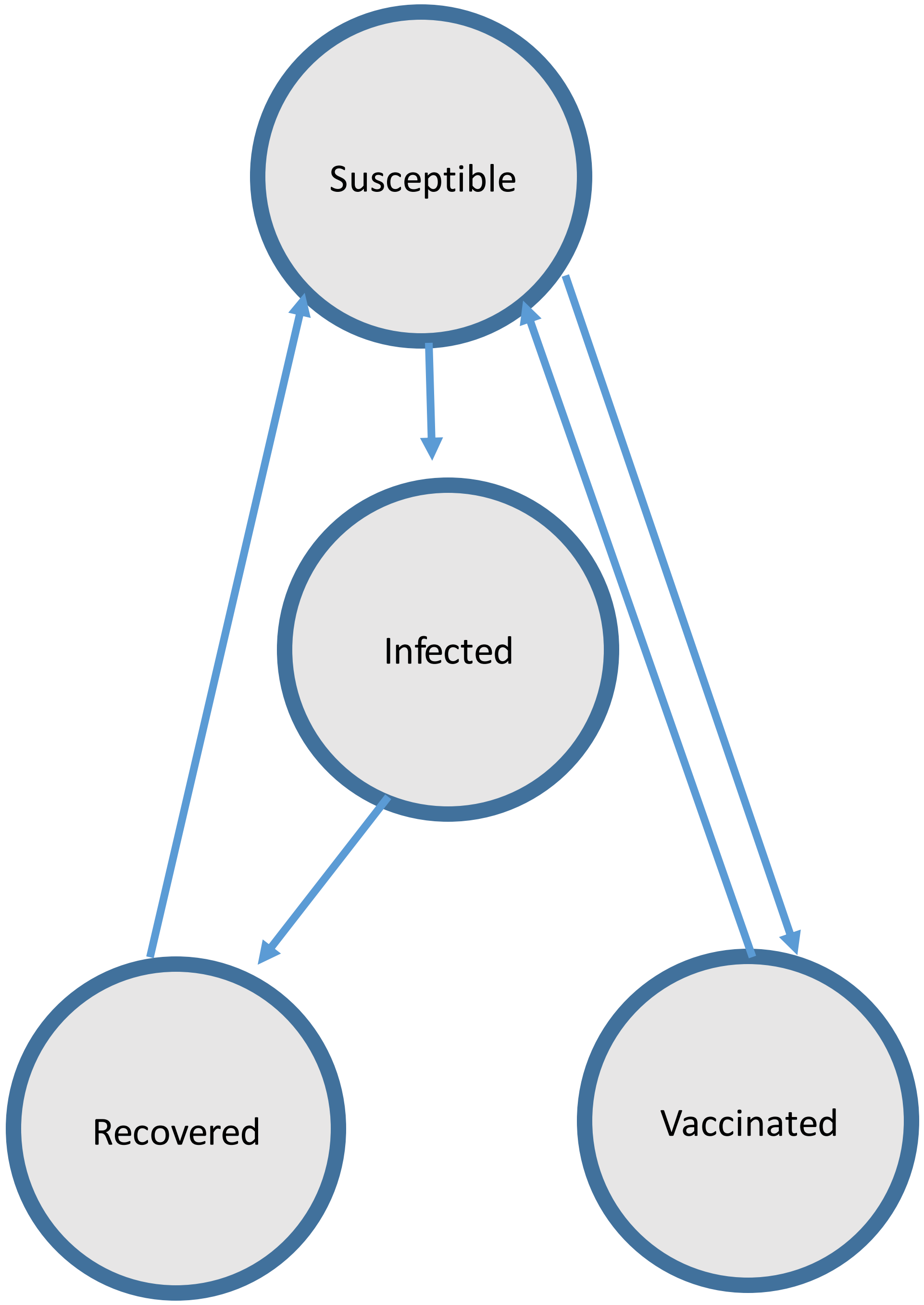
$$\frac{dI}{dt} = \beta SI - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

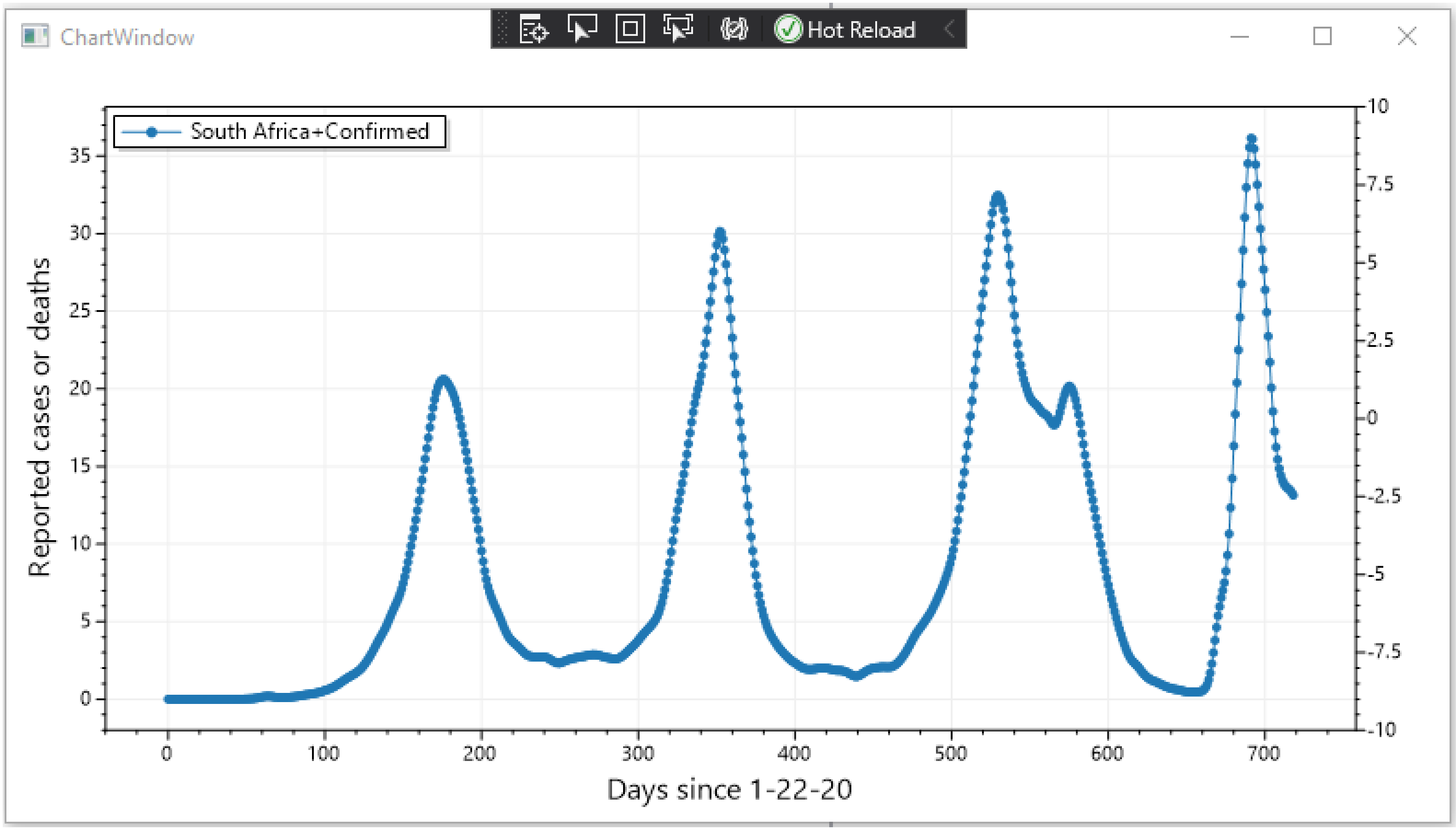


Expanding the models

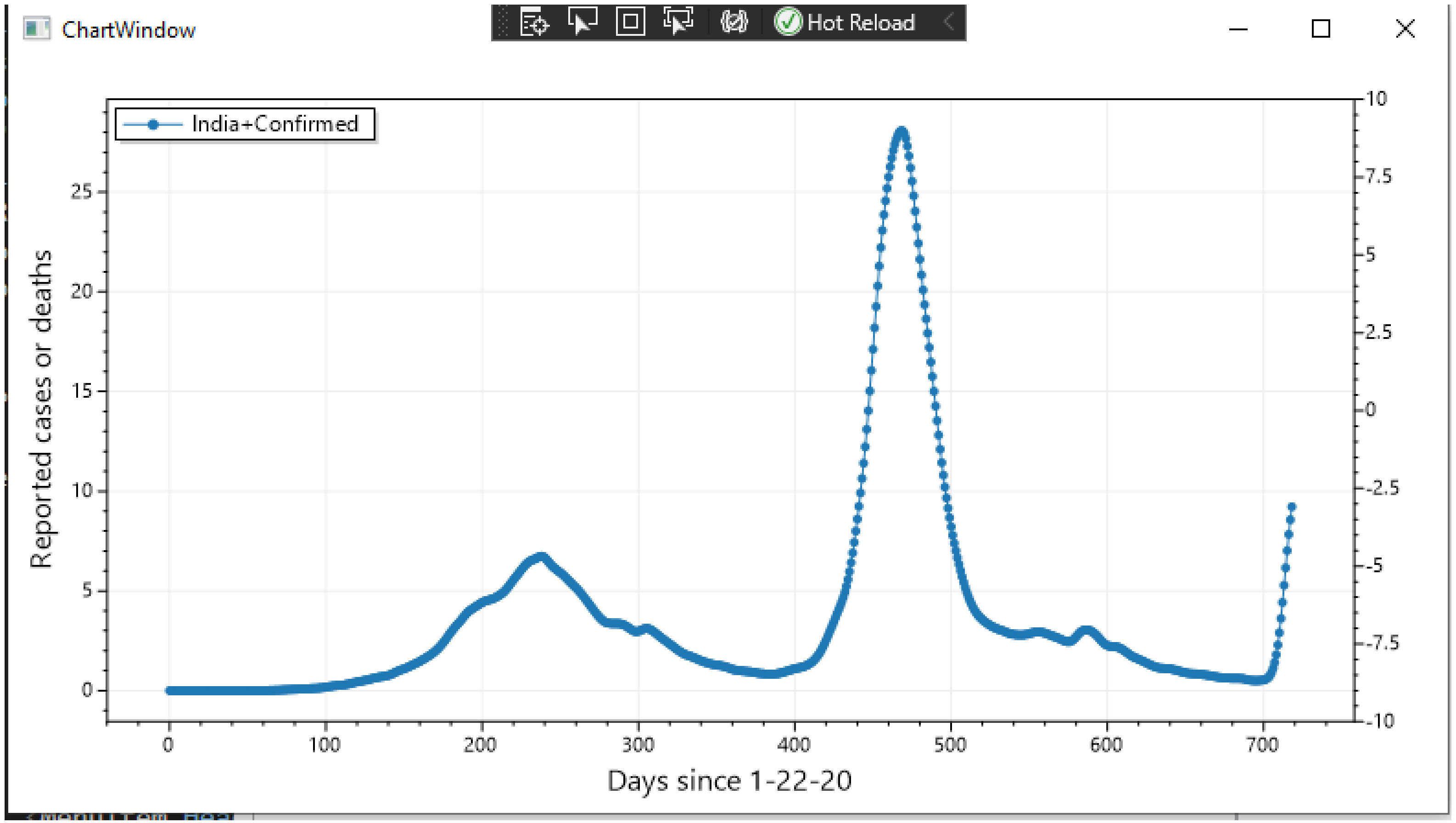
- SIRD – Susceptible, Infectious, Recovered, Dead
- SEIRD - Susceptible, Exposed, Infectious, Recovered, and Dead
- Adding Vaccines
- Adding Reinfection



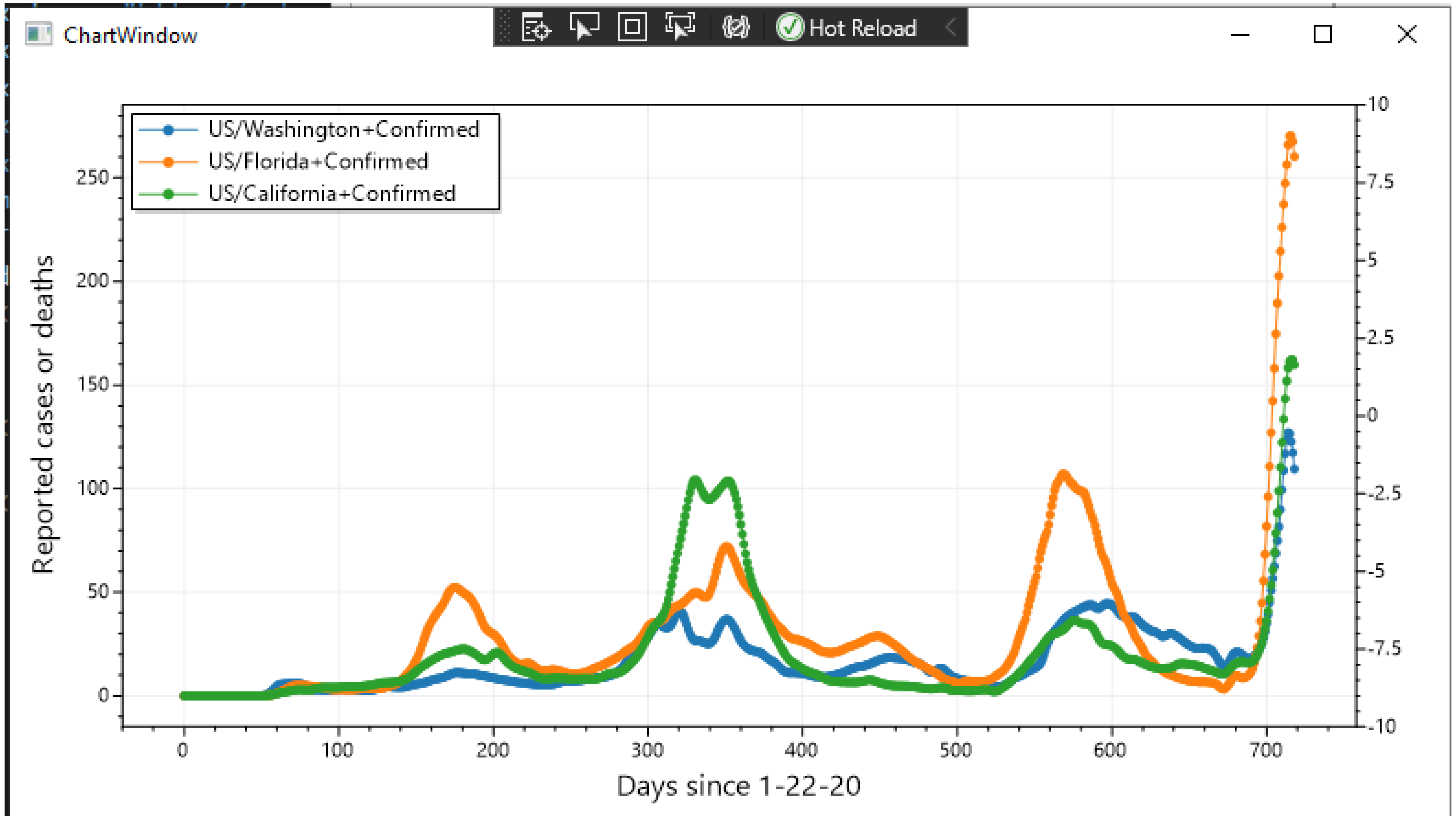
Covid Epidemic: South Africa

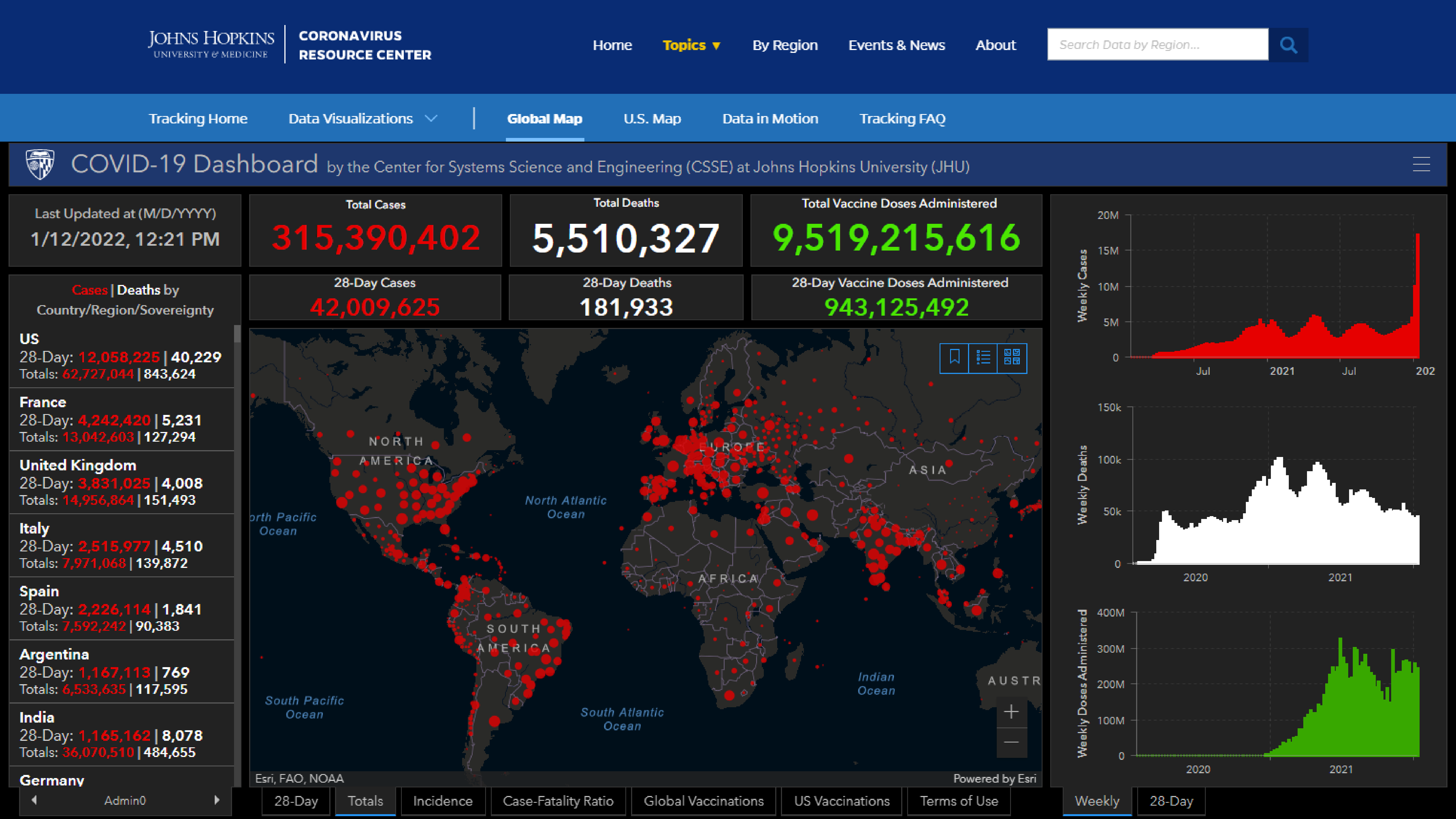


Covid Epidemic: India



Covid Epidemic – CA, FL, WA

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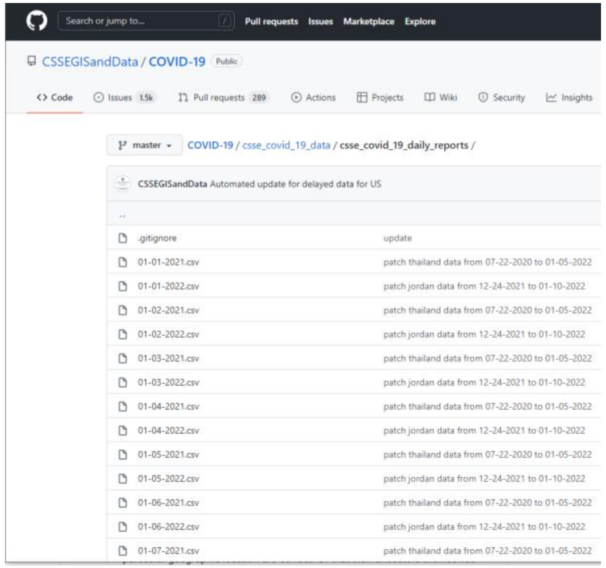
COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)
Last Updated at (M/D/YYYY)
1/12/2022, 12:21 PM
Total Cases
315,390,402
Total Deaths
5,510,327
Total Vaccine Doses Administered
9,519,215,616
Cases | Deaths by Country/Region/Sovereignty
28-Day Cases
42,009,625
28-Day Deaths
181,933
28-Day Vaccine Doses Administered
943,125,492
US
28-Day: 12,058,225 | 40,229
Totals: 62,727,044 | 843,624
France
28-Day: 4,242,420 | 5,231
Totals: 13,042,603 | 127,294
United Kingdom
28-Day: 3,831,025 | 4,008
Totals: 14,956,864 | 151,493
Italy
28-Day: 2,515,977 | 4,510
Totals: 7,971,068 | 139,872
Spain
28-Day: 2,226,114 | 1,841
Totals: 7,592,242 | 90,383
Argentina
28-Day: 1,167,113 | 769
Totals: 6,533,635 | 117,595
India
28-Day: 1,165,162 | 8,078
Totals: 36,070,510 | 484,655
Germany
Admin0
NORTH AMERICA
EUROPE
ASIA
AFRICA
SOUTH AMERICA
AUSTR
North Atlantic Ocean
orth Pacific Ocean
South Pacific Ocean
South Atlantic Ocean
Indian Ocean
Esri, FAO, NOAA
Powered by Esri
28-Day
Totals
Incidence
Case-Fatality Ratio
Global Vaccinations
US Vaccinations
Terms of Use
Weekly Cases
20M
15M
10M
5M
0
Jul
2021
Jul
202
Weekly Deaths
150k
100k
50k
0
2020
2021
Weekly Doses Administered
400M
300M
200M
100M
0
2020
2021
Weekly
28-Day

Where does this data come from

- Different country reporting strategies and aggregation
  - Tremendous variation on levels of accuracy and sources of case data
- Reported to centralized authorities
- Aggregators, such as JHU curate data sets
  - Labor intensive – group of research assistants collect daily data
- Data made available for download
  - Github or other sources



Data repositories

- Johns Hopkins University
  - Source for majority of dashboards
- Our World in Data (Our world in data)
- US Specific sources CDC
- Other countries
  - https://coronavirus.data.gov.uk/
  - https://sacoronavirus.co.za/

- Global data: WHO
  - https://covid19.who.int/

Data types

- Case counts and death counts
- Vaccine delivery
  - Quantity of vaccines delivered to countries is know
  - Reporting of number of immunizations is fairly good
- Covid variants – percent of different variants detected around the world
- Covid restrictions – time scale of restriction by geography
- Excess deaths
- Country demographics and maps

Many dashboards and studies are already available

- What is left to be done?
- How to compete against New York Times or Johns Hopkins University or Institute of Health Metrics and Evaluation
- Sources of data exist
  - Possible to build on top of existing data sets
  - Infrastructure exists to work with large data sets
- Identify specific directions that are not components of these existing tools
- Tools give very good overviews and summaries
  - Opportunity is doing deeper analysis: combining data sources and refining geographical analysis

Applications of modeling

- Obviously, predicting the future
  - When will Omicron peak in Seattle?
  - This quarter Omicron will sweep round the world
  - So tools would need to be designed for Omicron – but ready for Pi, Rho, and Sigma
- Matching SIR model against previous waves
  - Picking out previous waves is a start!
- Tying modeling to other data sets
  - Vaccination, Public Health Restrictions

Geographic refinement

- Predict and understand the epidemic across geographic areas using data from sub regions (e.g., county level data in the US)
- This is missing from the aggregation sources – which give good summaries but tend to be "one dimensional"
- Sub-national data is often not on aggregation sources (which was part of the motivation for one of the project areas)
    - There will be technical challenges in building appropriate data tools
- Reasons for paying attention to subnational data
    - Identify geographic structure in events
    - Correlations between different data can be stronger at the subnational level

Exploring the interaction of data sources

- Significant opportunities to investigate correlations between data sources
  - Rural-Urban vs impact
  - Cases vs death rate vs variant
  - Variant vs wave vs impact
  - Vaccine status vs public health intervention vs impact
  - Season vs climate vs wave
- Recommendation
  - Pick a subset of factors with plausible relations and build tools around good data sets
  - Option of emphasizing either tool building or data exploration
  - Map based tools or other visualizations could be included

Existing tools (from fall project)

- Available on local github, as csv files
  - Time series processing of JHU case count data
  - Decomposition of time series into waves with statistics
  - USA county adjacency map
  - CDC vaccination data (by county)
  - Co-variant data by country