Modeling COVID-19 Incidence

Interim Presentation for Stat 222 (Spring 2023)

Background and movitation

- By mid-summer, 2021, vaccination eligibility for COVID-19 was widespread and preventive public health measures were significantly loosened
- Return to normalcy in the presence of vaccination led to concerns of the emergence of a vaccine-resistant strain
- In July 2021, Rella et al. (2021) published simulations of outbreak trajectories under various emergence probabilities
  - Resistant strains never established during periods of preventive public health measured
- On November 30, 2021, the first case of the Omicron variant (B.1.1.529) in the US was confirmed (CDC 2021)

Insights from Rella et al. (2021)

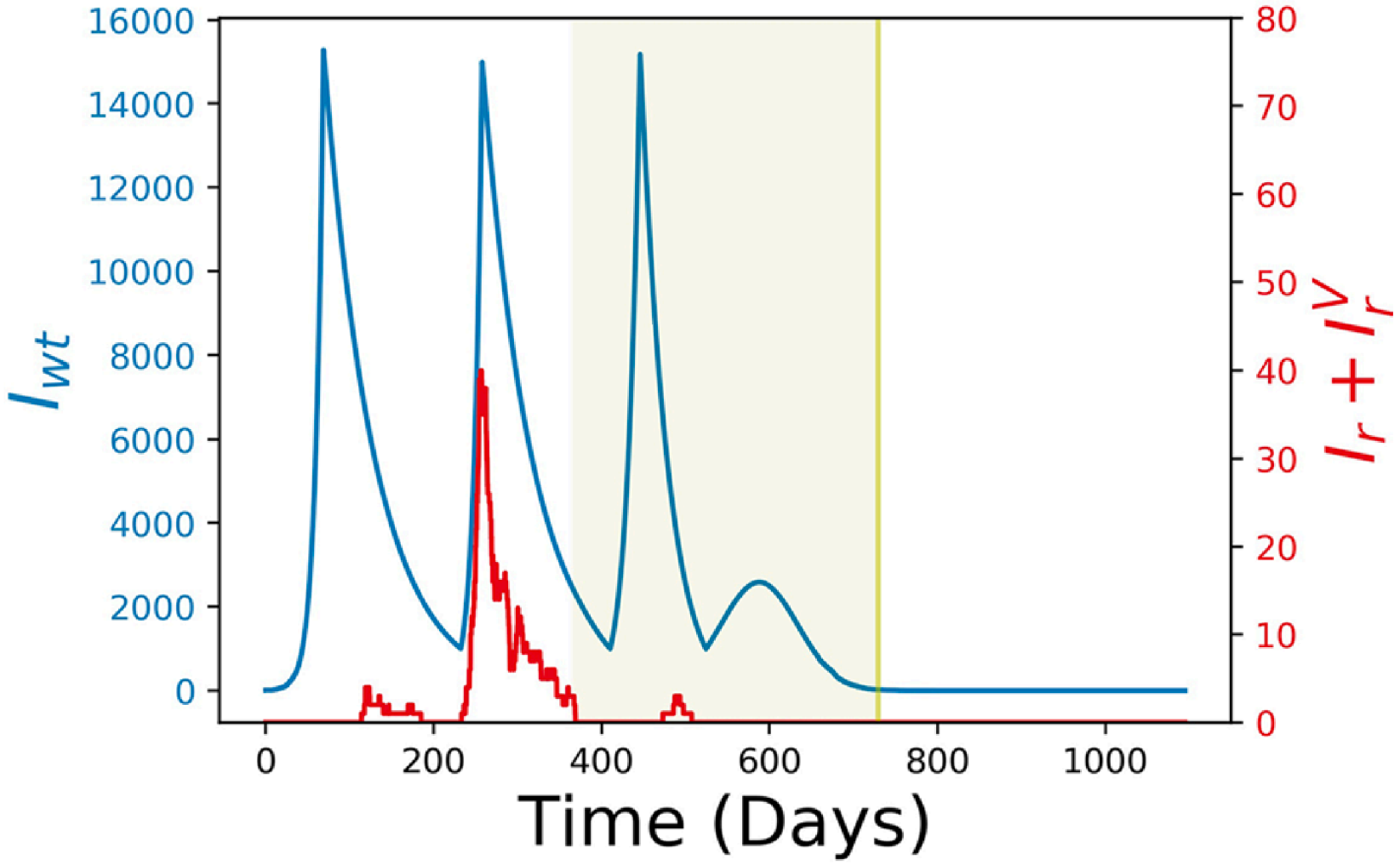


Figure 1: Low emergence probaility

Insights from Rella et al. (2021)

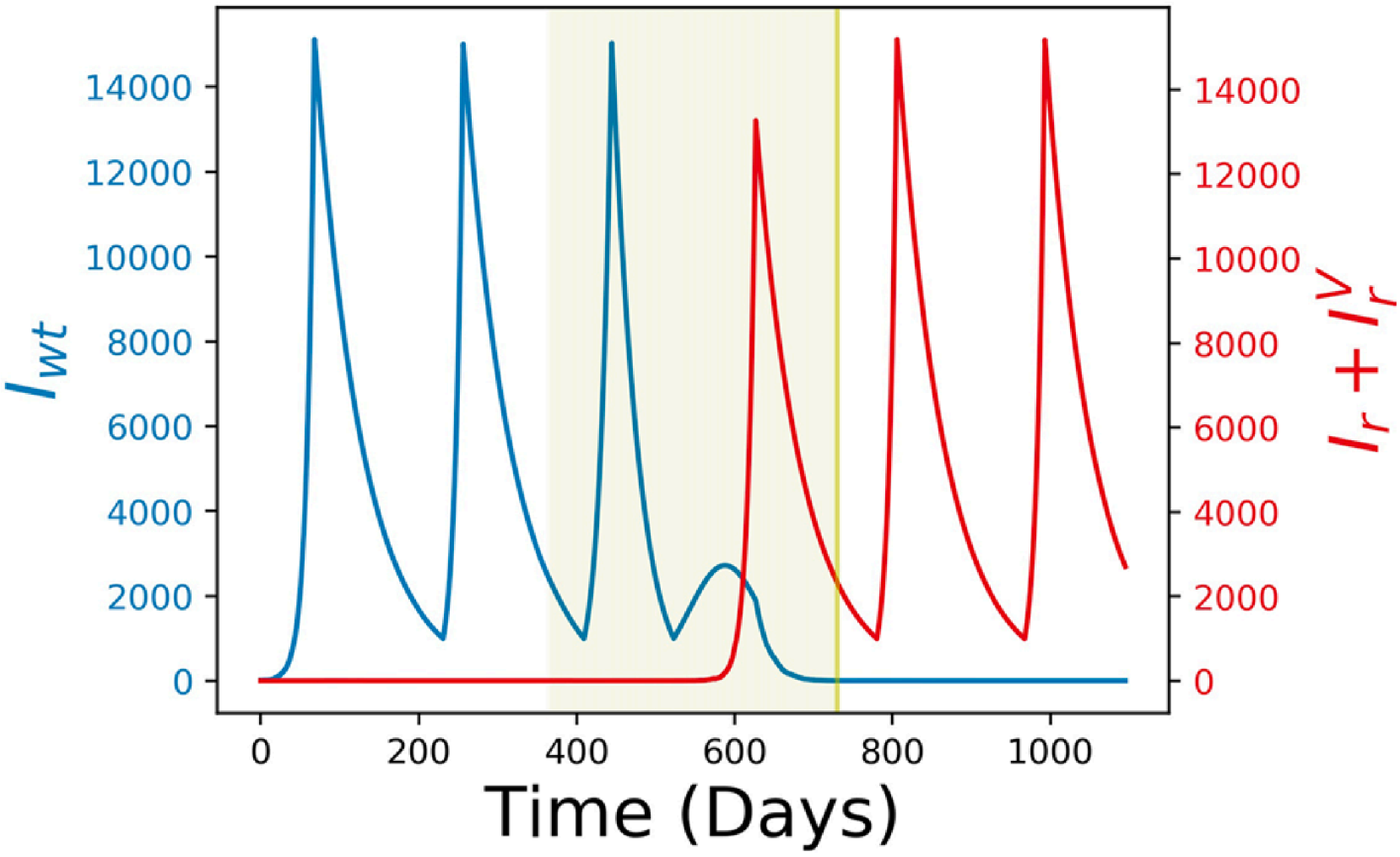
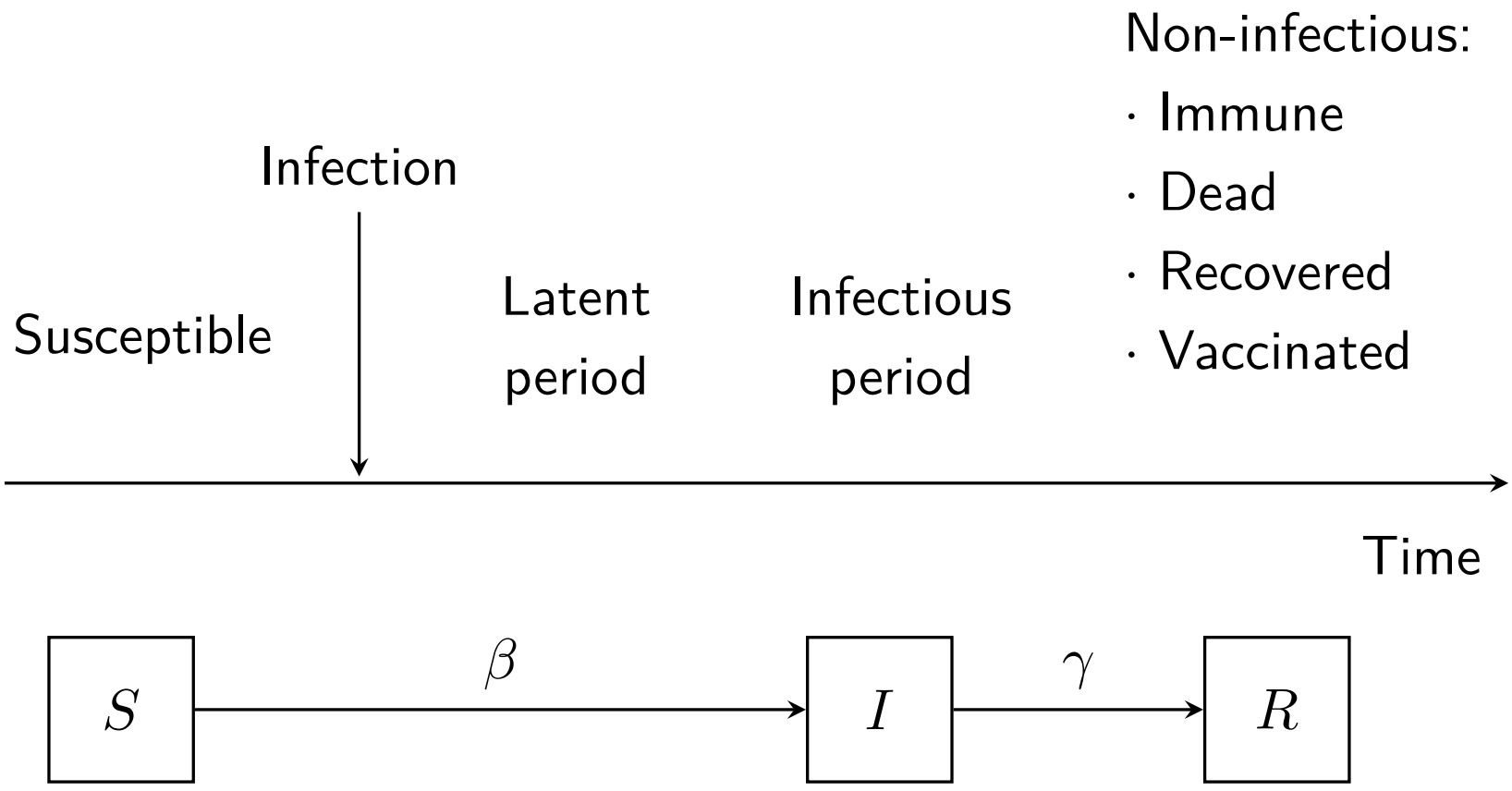


Figure 2: High emergence probaility

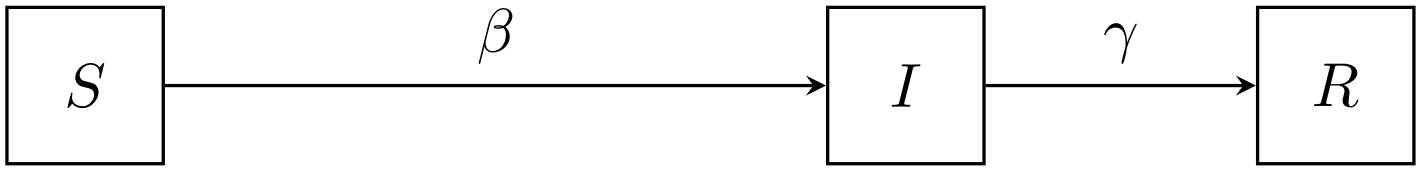
Basic concepts in infectious disease epidemiology

- *Infectious agent:* biological causal locus of an infectious disease
- *Contact:* interaction between potential hosts and the infectious agent
- *Infection:* entry of the infectious agent into the host
- *Latent period:* time between infection and infectiousness
- *Infectious period:* the period of time during which contact with hosts means contact with the infectious agent
- These periods make up the *natural history timeline* for infectious disease

Natural history timeline



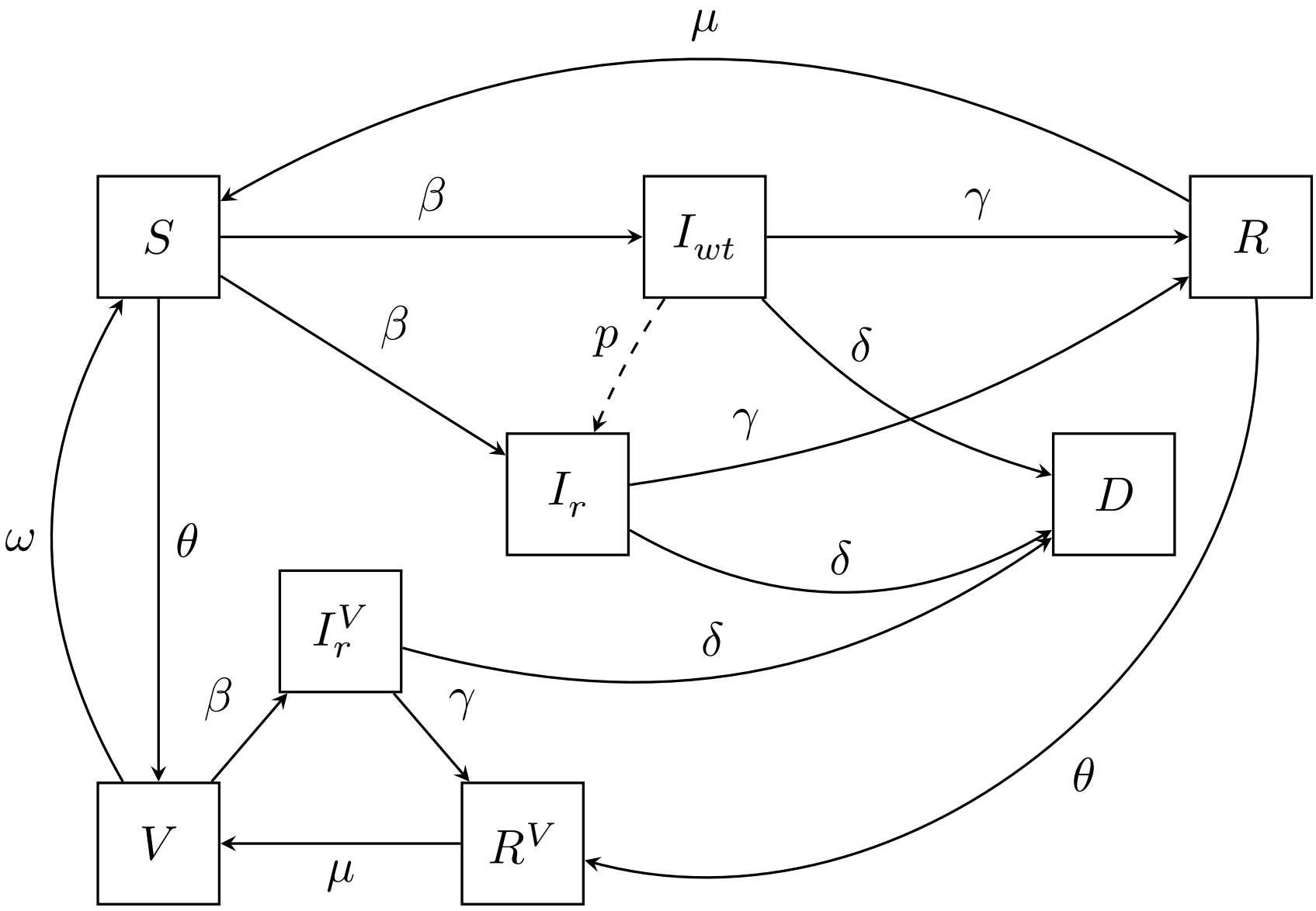
Compartmental modeling: simple SIR case



$$\begin{cases} \frac{d}{dt}S = -\frac{\beta}{N}IS \\ \frac{d}{dt}I = \frac{\beta}{N}IS - \gamma I \\ \frac{d}{dt}R = \gamma I \end{cases}$$

$$S + I + R = N$$

Compartmental modeling: theory of Rella et al. (2021)



References

CDC. 2021. "First Confirmed Case of Omicron Variant Detected in the United States." *First Confirmed Case of Omicron Variant Detected in the United States*. https://www.cdc.gov/media/releases/2021/s1201-omicron-variant.html.

Rella, Simon A, Yuliya A Kulikova, Emmanouil T Dermitzakis, and Fyodor A Kondrashov. 2021. "Rates of SARS-CoV-2 Transmission and Vaccination Impact the Fate of Vaccine-Resistant Strains." *Scientific Reports* 11 (1): 15729.