Phân tích dữ liệu thông minh

Infectious Disease Modelling

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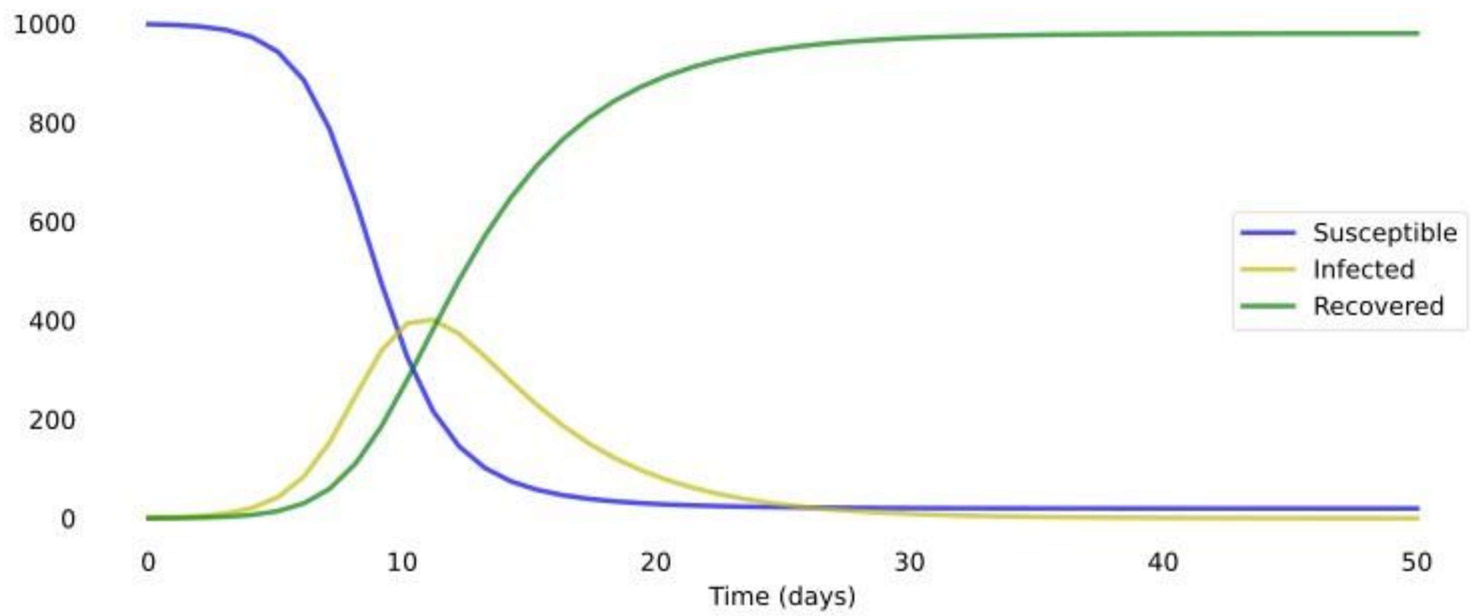
Infectious Disease Modelling - SIR



SIR model

- **N:** total population
- **S(t):** number of people susceptible on day t
- **I(t):** number of people infected on day t
- **R(t):** number of people recovered on day t
- **β:** expected amount of people an infected person infects per day
- **D:** number of days an infected person has and can spread the disease
- **γ:** the proportion of infected recovering per day ($\gamma = 1/D$)
- **R_0:** the total number of people an infected person infects ($R_0 = \beta / \gamma$)

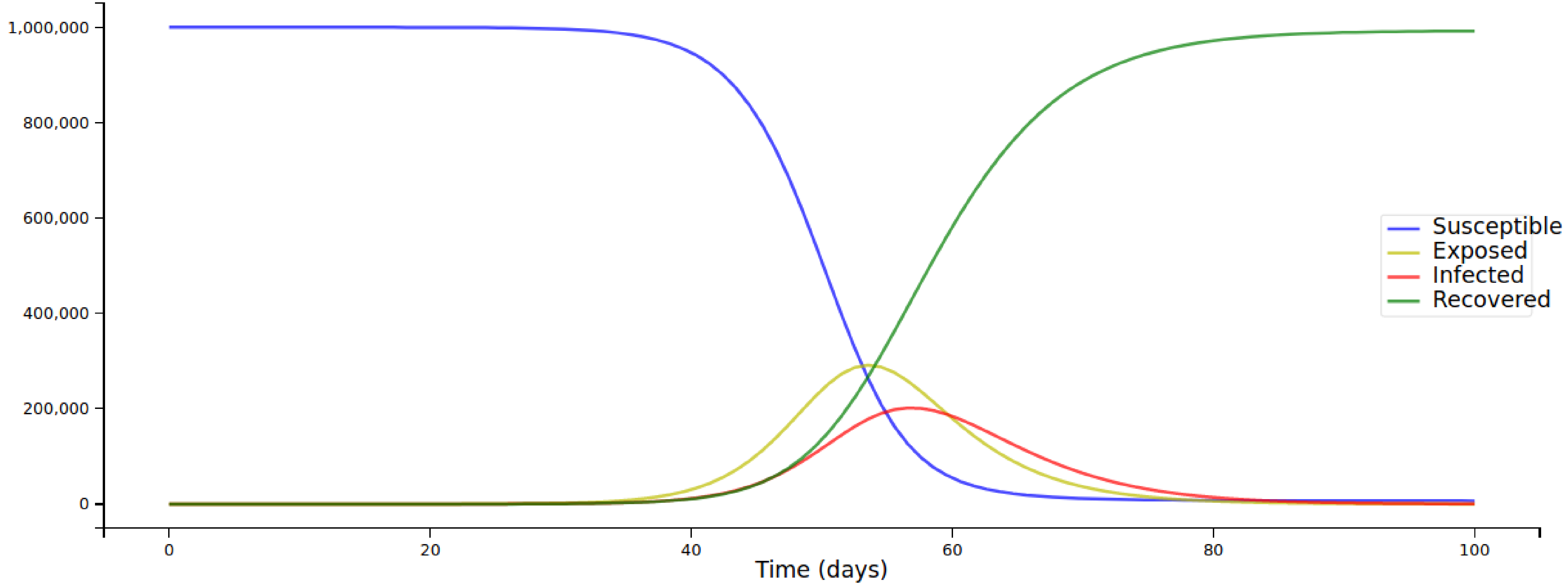
SIR model

- $N = 100$
- $\beta=1$, $D=7$ and $\gamma=1/7$
- Let's say that on day t, 60 people are infected (so $I(t)=60$), and 30 people are still susceptible (so $S(t)=30$ and $R(t)=100–60–30=10$).
- Now, how do S(t) and I(t) and R(t) change to the next day?
  - Change of S(t) to the next day $S'(t) = - \beta \cdot I(t) \cdot S(t) / N$.
  - $I'(t) = \beta \cdot I(t) \cdot S(t) / N - \gamma \cdot I(t)$
  - $R'(t) = \gamma \cdot I(t)$

SIR model - *ordinary differential equations*

$$\frac{dS}{dt} = -\beta \cdot I \cdot \frac{S}{N}$$
$$\frac{dI}{dt} = \beta \cdot I \cdot \frac{S}{N} - \gamma \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I$$

Beyond the basic SIR



Models as State Transitions

$$\boxed{S} \xrightarrow{1 \cdot \frac{S}{N} \cdot \beta I} \boxed{I} \xrightarrow{\gamma \cdot 1 \cdot I} \boxed{R}$$

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$$\frac{dS}{dt} = -\beta \cdot I \cdot \frac{S}{N}$$
$$\frac{dI}{dt} = \beta \cdot I \cdot \frac{S}{N} - \gamma \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I$$

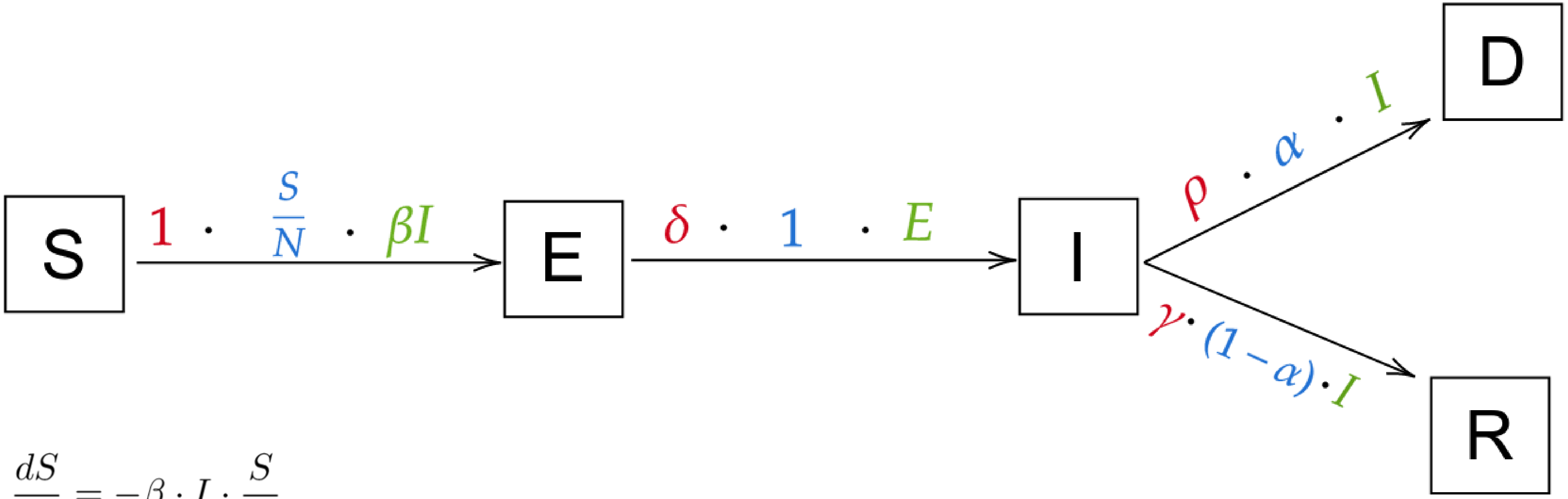
$$\xrightarrow{\textit{rate} \cdot \textit{probability} \cdot \textit{population}}$$

SEIR

$$\boxed{S} \xrightarrow{1 \cdot \frac{S}{N} \cdot \beta I} \boxed{E} \xrightarrow{\delta \cdot 1 \cdot E} \boxed{I} \xrightarrow{\gamma \cdot 1 \cdot I} \boxed{R}$$

$$\frac{dS}{dt} = -\beta \cdot I \cdot \frac{S}{N}$$
$$\frac{dE}{dt} = \beta \cdot I \cdot \frac{S}{N} - \delta \cdot E$$
$$\frac{dI}{dt} = \delta \cdot E - \gamma \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I$$

Deriving the Dead-Compartment



$$\frac{dS}{dt} = -\beta \cdot I \cdot \frac{S}{N}$$
$$\frac{dE}{dt} = \beta \cdot I \cdot \frac{S}{N} - \delta \cdot E$$
$$\frac{dI}{dt} = \delta \cdot E - (1-\alpha) \cdot \gamma \cdot I - \alpha \cdot \rho \cdot I$$
$$\frac{dR}{dt} = (1-\alpha) \cdot \gamma \cdot I$$
$$\frac{dD}{dt} = \alpha \cdot \rho \cdot I$$

Time-Dependent Variables

- On day *L*, a strict “lockdown” is enforced => pushing R_0 to 0.9

```
def R_0(t):
    return 5.0 if t < L else 0.9
```

```
def beta(t):
    return R_0(t) * gamma
```

Colab

- https://colab.research.google.com/drive/16uL8ASmEnBxUqmQX4-aSfNPlR0Rp8-Eh?usp=sharing

Cảm ơn đã theo dõi!