Behavioral Change Modeling in Infectious Diseases: A Review of Reviews

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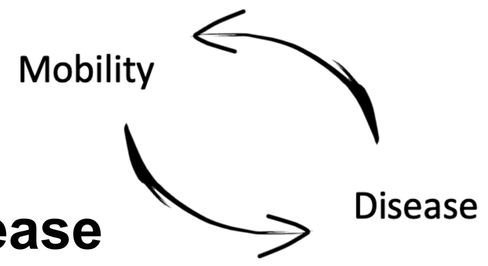
Motivation

- **Challenges in incorporating human behavior and response in infectious diseases**
- **The missing feedback loop of behavior and disease**

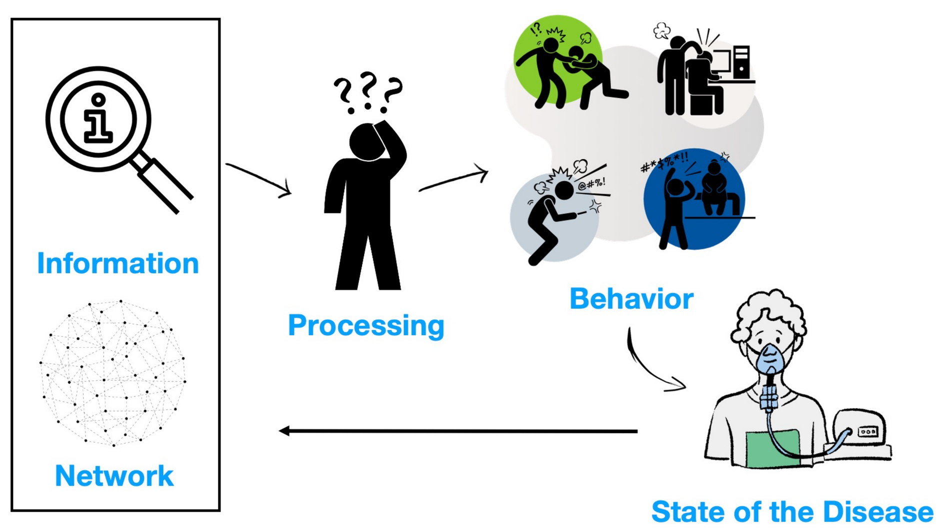


Objective

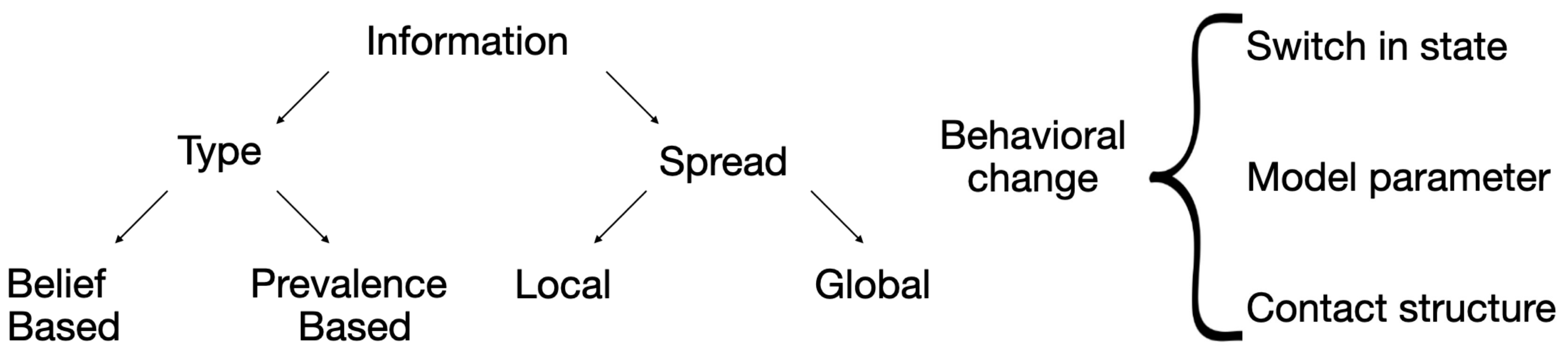
- **Examine different mathematical formulations of behavioral change in infectious diseases**
- **Provide a new classification based on behavioral response**

Background

- **Early uses of compartmental modeling for spread of disease in Suseptible-Infected-Recoverd (SIR) model**
- **Balance of complexity and computational boundaries in considering levels of heterogeneity: Agent base and game theory modeling**



- **Networks and node modeling is another approach to analyzing the interaction of different popolation levels with one another**
- **Previous classifications based on information diffusion and behavioral response**



Methodology

- **Conducted a scoping literature review of previous literature reviews**

Results

- **Identified components within human behavior that require a distinctive form of modeling:**

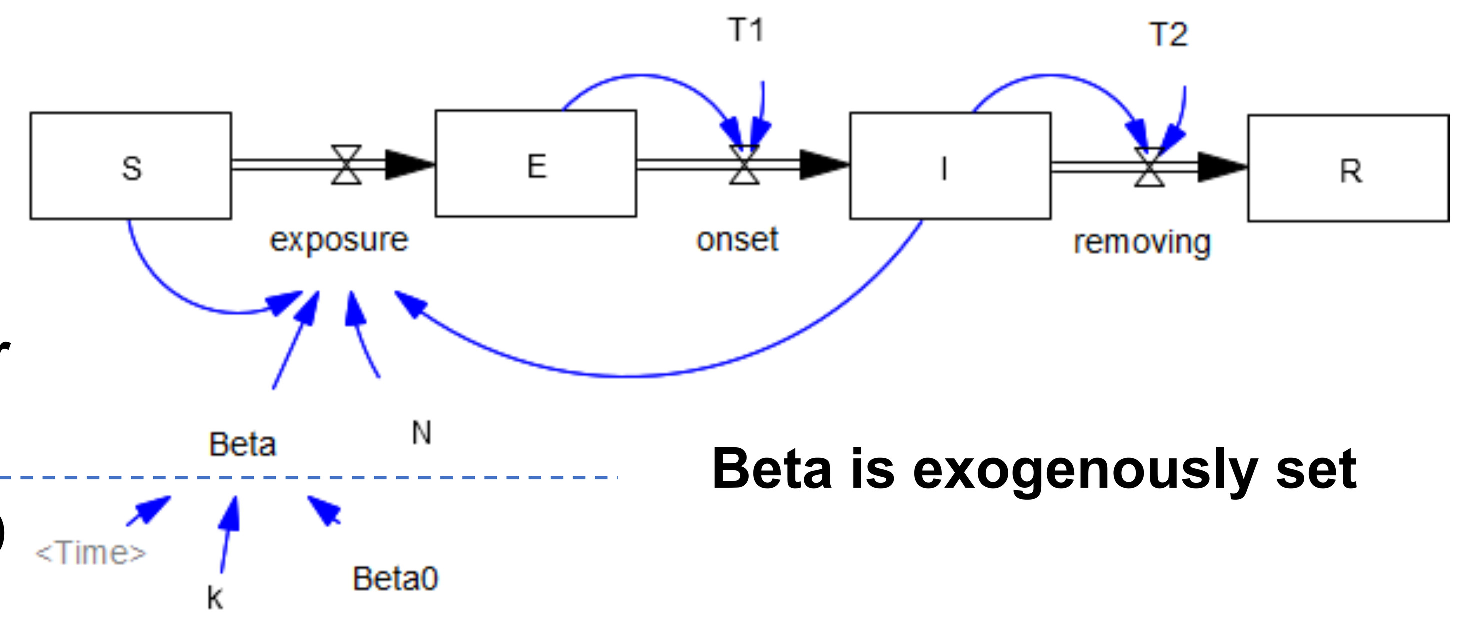
1) Risk perception 2) Adherence Fatigue 3) Complience with measures 4) Mobility 5) Willingness to vaccinate

- **Classification of modeling approaches based on the way behavioral response is incorporated:**

1) Exogenoues:

1.1) Constant contact rate (conventional SEIR)

$$\frac{dS}{dt} = -\frac{\beta SI}{N}; \quad \frac{dE}{dt} = \frac{\beta SI}{N} - \frac{E}{\tau_1}; \quad \frac{dI}{dt} = \frac{E}{\tau_1} - \frac{I}{\tau_2}; \quad \frac{dR}{dt} = \frac{I}{\tau_2}$$



Beta is exogenously set

1.2) Variable parameters or reproduction number
This could be as a function of time $\beta = \mathrm{f}(\mathrm{t})$ Or estimaion of time series data $\beta = \mathrm{f}(\text{mobiliy data})$

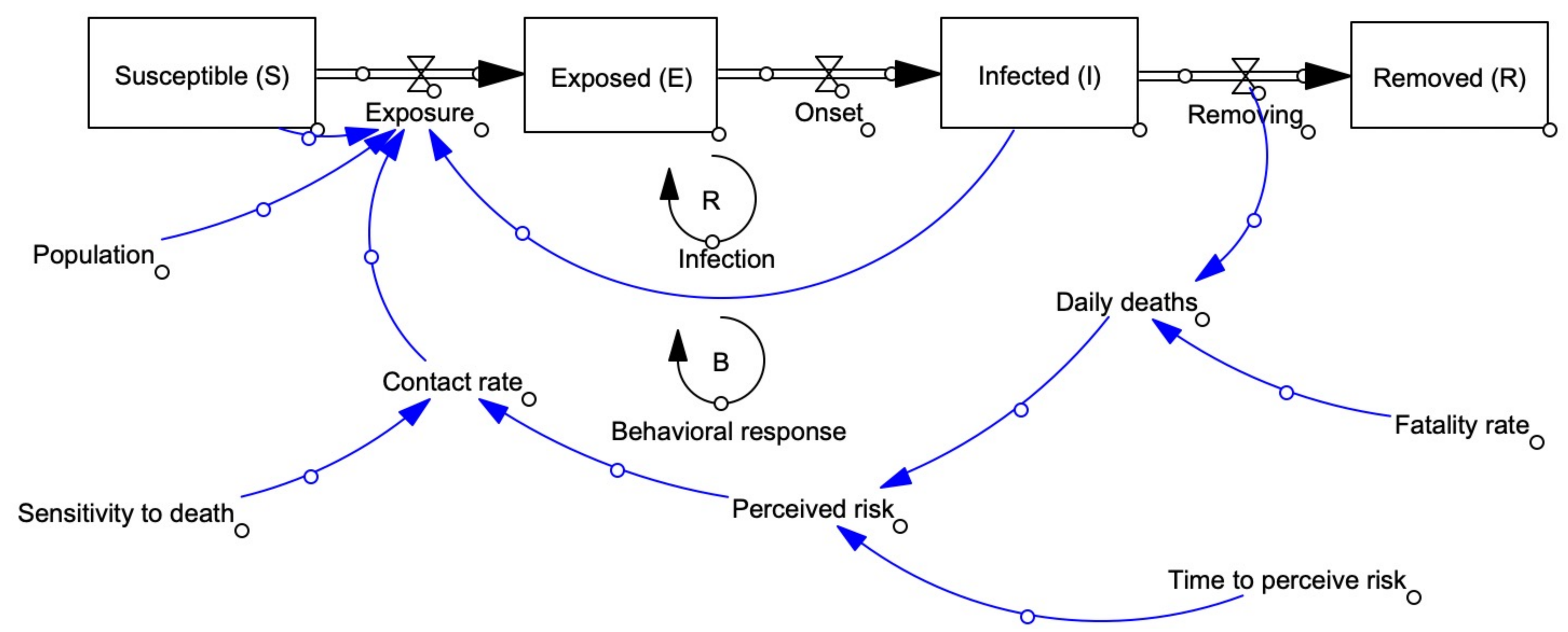
2) Endogenous:

2.1) Information threshold
Behavioral change that can occure due to either disease or belief prevelance based on passing a threshold

2.2) Direct dynamic disease information
Behavioral change is a result of changes to the disease state, such as deaths or cases. Can be a as a function of risk cue:
e.g., $\beta = \mathrm{f}(I)$ or a state transition:
e.g., ${}^{dC}/_{dt} = \mathrm{f}(I)$ this is an example for an extra state of people who stay home

2.3) Indirect dynamic disease information
These are models that explicitly model information diffusion.

This is simmilar to the spread of information as the spread of a disease



Examples for this category are modeling the percentage who self isolate: ${}^{dx}/_{dt} = \mathrm{x}(1-\mathrm{x})\mathrm{f}(I,c)$ or cases where norms may form, such as wearing masks: ${}^{dx}/_{dt} = \mathrm{x}(1-\mathrm{x})\mathrm{f}(I,c,x)$

Conclusion

- **While incorporating human behavior and its intertwined relationship with the disease is complex, it is vital to creating a realistic model. Bringing together different ideas and translating them into a mathematical language, opens to door to more insightful works.**

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