
Uncertainty in epidemiological models of the Ebola epidemic

Scott Janzwood

PhD Candidate, Balsillie School of International Affairs, University of Waterloo
Research Fellow, Waterloo Institute for Complexity & Innovation (WICI)



1918-1920 Influenza Pandemic

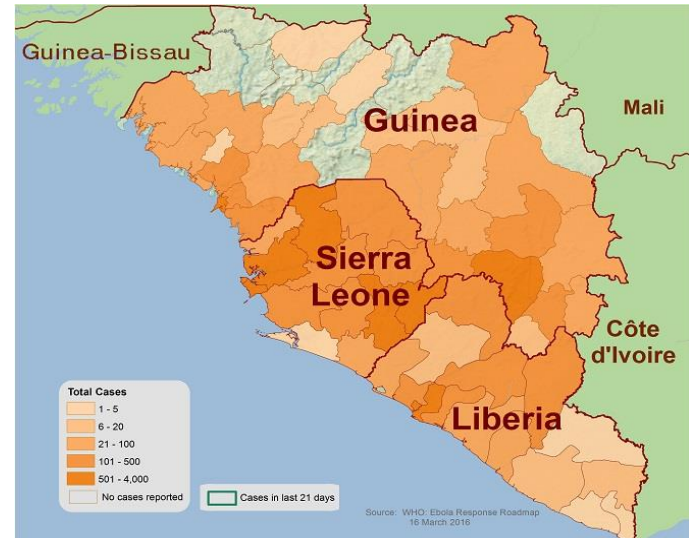
500 million infected. 50-100 million deaths



Wikimedia Commons

2014-2015 Ebola Epidemic

28 thousand infected. 11 thousand deaths



Wikimedia Commons

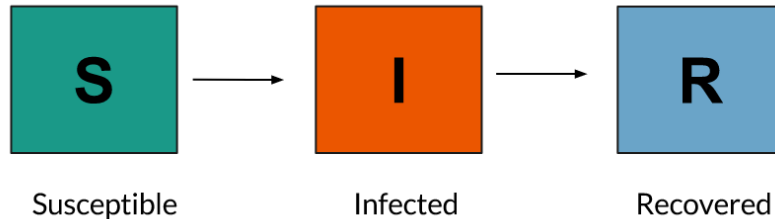


Purpose

- Describe the role played by (real-time) model-based decision support during the Ebola response
 - Mapping out the types of uncertainty confronting modelers & decision makers (highlighting “human dimensions”)

Mathematical epidemic models

- Phenomenological models (linear regression models)
- Compartmental models (Variations of SIR model)
- Network models (Agent-based models)

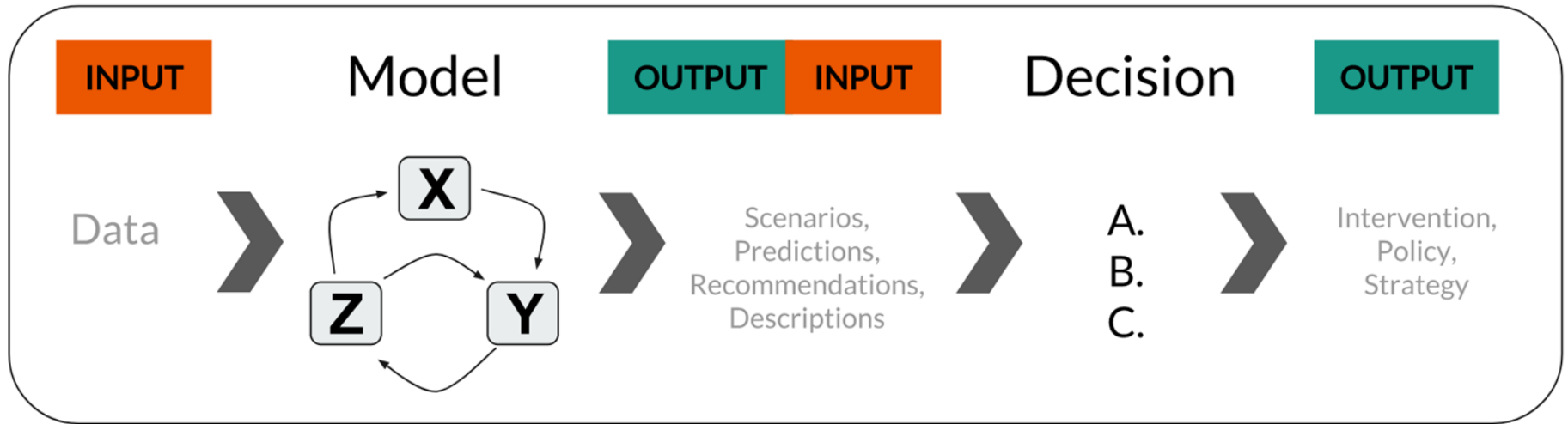




Reducing 3 big uncertainties

- Transmissibility of the pathogen (basic reproduction rate)
- Effectiveness of interventions
- Scope and magnitude of the outbreak

Model-based decision support: Input/Output



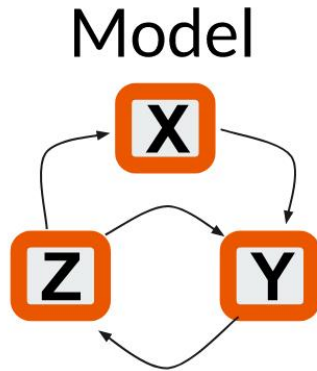


“Uncertainty Location” in model-based decision support

Adapted from 'Uncertainty Matrix,' (Walker et al. 2003)

Uncertainty Location
1. System-definition uncertainty
2. Model-structure uncertainty
3. Input uncertainty
4. Output uncertainty

System-definition uncertainty



- Air travel? National borders?
- SIR vs. SEIR vs. SEIS?
- Homogenous vs. heterogeneous mixing?

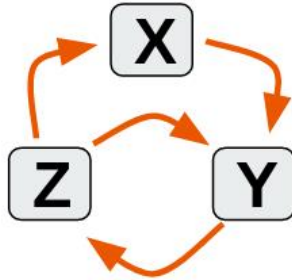
Solutions:

- Test model assumptions against real-world data
- Compare to other models

Model-structure / Parameter uncertainty



Model

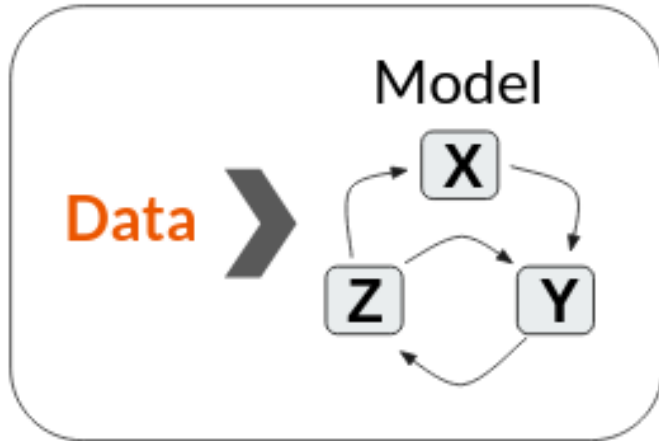


- Parameter values?
- Non-linear behaviour, feedback effects?

Solutions:

- Probabilities
- Sensitivity Analysis

Input uncertainty



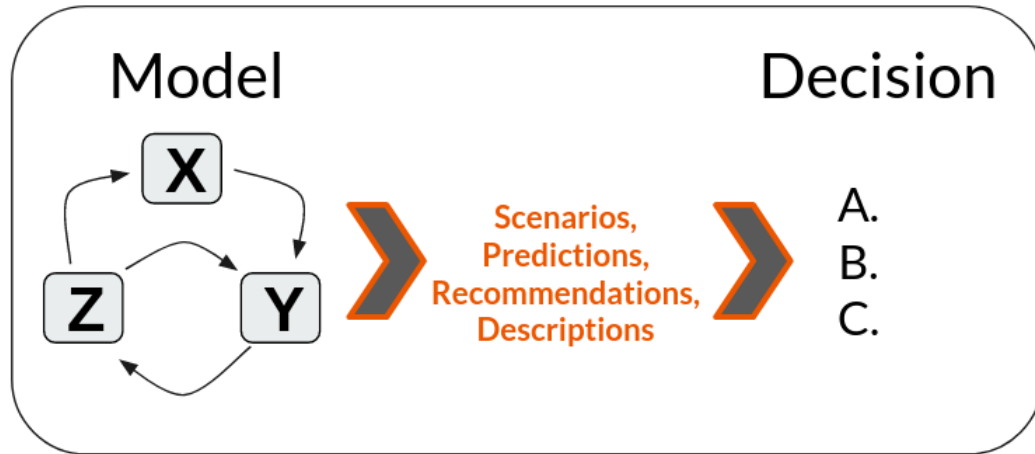
- Bad data
- Lack of data
- Contradictory data
- Model outputs as data inputs

Solutions:

- Better monitoring
- Information-sharing



Output uncertainty



- Communicating what we know
- Communicating what we don't know

Solutions:

- Communication frameworks



Ambiguity / “Interaction Uncertainty”

(Dewulf et al. 2005, Brugnach et al. 2008, Maier et al. 2016)

- **Normative/Value-based**
 - Divergent or oppositional worldviews, values, priorities
- **Epistemological**
 - e.g. Frequentist vs. Bayesian perspective
- **Linguistic**
 - Multiple meanings, inexactness



Tools for identifying ambiguities

- Mental Modeling (Concept Mapping)
- Discourse Analysis
- Interview Data