Final Thoughts and Caveats

Brian Hunt
University of Maryland
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General Thoughts: Model Validity

- An important part of interpreting the results of a model is recognizing the limitations of of the model.
- Ideally a model, or at least parts thereof, can be validated against data. With enough data, one can (at least partially) quantify the accuracy of the model.
- A modeler should acknowledge and discuss assumptions made in the model, especially those that are not verifiable from data.
- Assumptions that greatly simplify reality are not a fatal flaw. They give some indication of how appropriate the model is for a given scenario, and of circumstances under which the model may need improvement.

General Thoughts: Parameters

- Often a model involves parameters for which calibration data is not available, or control parameters that can be chosen by the user of the model.
- Even if model parameters can be calibrated well from data, one may want to apply the model to other scenarios for which data is not (yet) available.
- Even if one is only interested in a particular scenario, there is usually some nontrivial uncertainty in the appropriate parameter values.
- For all of these reasons, the modeler should explore a range of plausible parameter values in order to quantify the range of possibilities the model predicts.

General Thoughts: Goals and Interpretation

- Having tested a range of parameters, an useful goal is to try to extract general principles that apply over a range of the unknown parameter(s).
- As we have done in this course, one can study how to optimize control parameters. This, of course, requires a quantitative formulation of what should be optimized.
- Especially for parameters that are not easily calibrated and cannot be controlled, it is important to understand how sensitive the results of the model are to the values of these parameters. This indicates how much effort the user of the model should make to determine accurate values for the parameters, as well as how to interpret the model results when parameter uncertainty remains.

Modeling Epidemics

- This semester we have discussed and used variants of the SIR model for the spread of an epidemic. We have discussed some of its limitations.
- Despite vastly simplifying the dynamics of an actual epidemic, the models can fit data from the HIV/AIDS epidemic reasonably well.
- However, it would be difficult in practice to estimate, from data known at the beginning of an outbreak, parameter values that can predict accurately how the outbreak will unfold.

Modeling Epidemics: Interventions

- We have modeled interventions in a way that has not been calibrated against data.
- On the other hand, any intervention that removes people from the susceptible and/or infectious population could be modeled as we did, perhaps replacing the intervention parameters a_1, a_2, b_1, b_2 with functions of time and or the variables $S_1, \mathcal{I}_1, S_2, \mathcal{I}_2$.
- If we could collect data on the number of people reached by an intervention and how they react, we could calibrate the intervention-related removals in the model.

Modeling Epidemics: Cost Function

- We have discussed that our use of a linear cost function has the flaw that it doesn't exhibit the "diminishing returns" observed in real life.
- Another limitation of this part of the model is that it would be hard in practice to make an accurate estimate in advance of how many removals will be achieved by a given expenditure of resources.
- In real life, pilot programs are used to estimate effectiveness and decide on a long-term strategy.