Model-building in scientific research

(1) What is a **model**? What are some examples of models in science?

(a) A model is an abstract* explanatory device that captures structure in the data

*'Abstract' because it exists in the minds of the explainers

(b) Examples of models in science include: models of planetary motion, the Law of Supply and Demand, ...

(2) What does having a model allow us to do, with respect to facts about the world?

(a) In many cases, the very act of **describing** a phenomenon is impossible without our (perhaps implicitly) constructing a model of it

(b) Once we have a model of a phenomenon, we can **make predictions** about the domain that the model addresses

(c) A model is an attempt to **explain** why phenomena occur the way they do

(3) When we propose a model, what are some of the characteristics we have to give it?

(a) We have to propose **entities** that exist in the model

(b) We have to propose ways in which those entities **behave** or **interact**

(c) We have to carefully **define** those elements or entities and their relations, so that it is clear what the model allows, or requires, them to do

(4) How do we tell when a model is a good or useful one for understanding the world?

(a) Goodness of fit — does it **accurately** describe, and predict, phenomena?

(b) Simplicity/elegance ("Occam's Razor") — In comparing two models that have the same, or nearly the same, goodness of fit, we prefer the **simpler** one

(c) Falsifiability — A good model predicts that certain things should ***not*** **happen**, so that there *would* be a way to show that it was wrong *if it were*

(5) Models are never "true" or "perfectly correct". Why is it still worth building them? That is, what are some advantages to understanding the world through model-building?

(a) Using a model allows us to **classify** phenomena into subgroups — possibly including a subgroup of phenomena for which the model makes some wrong prediction!

(b) Building a model and being **explicit** about how its parts function may cause us to make new discoveries about how entities behave or are related

(c) Models can be taken apart or modified in specific ways, and the **consequences** of those changes can be explicitly explored

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This handout is largely based on points raised in Ch 1 of:

Lewandowsky, Stephan, and Simon Farrell. 2011. *Computational modeling in cognition: Principles and practice*. Los Angeles: SAGE Publications.