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Analysis of Environmental Data

What is a model?

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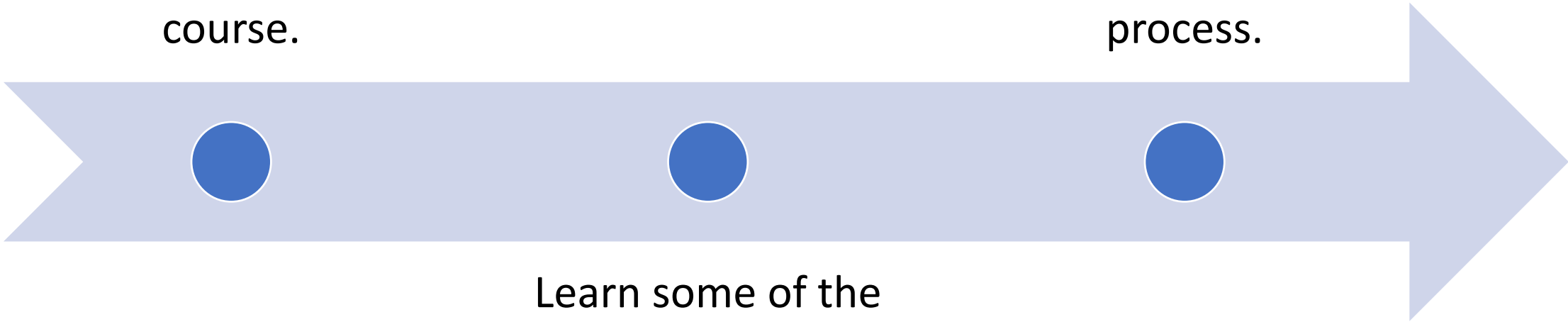
Objectives

Understand what **model** means in the context of this course.

Learn some of the important classes of models.

Understand the basics of model thinking and the model building process.



What is a model?

Here's a (very) simple, but effective definition:

- A model is a simplified version of reality.

We use models every day

- Can you think of any that you have already used today?

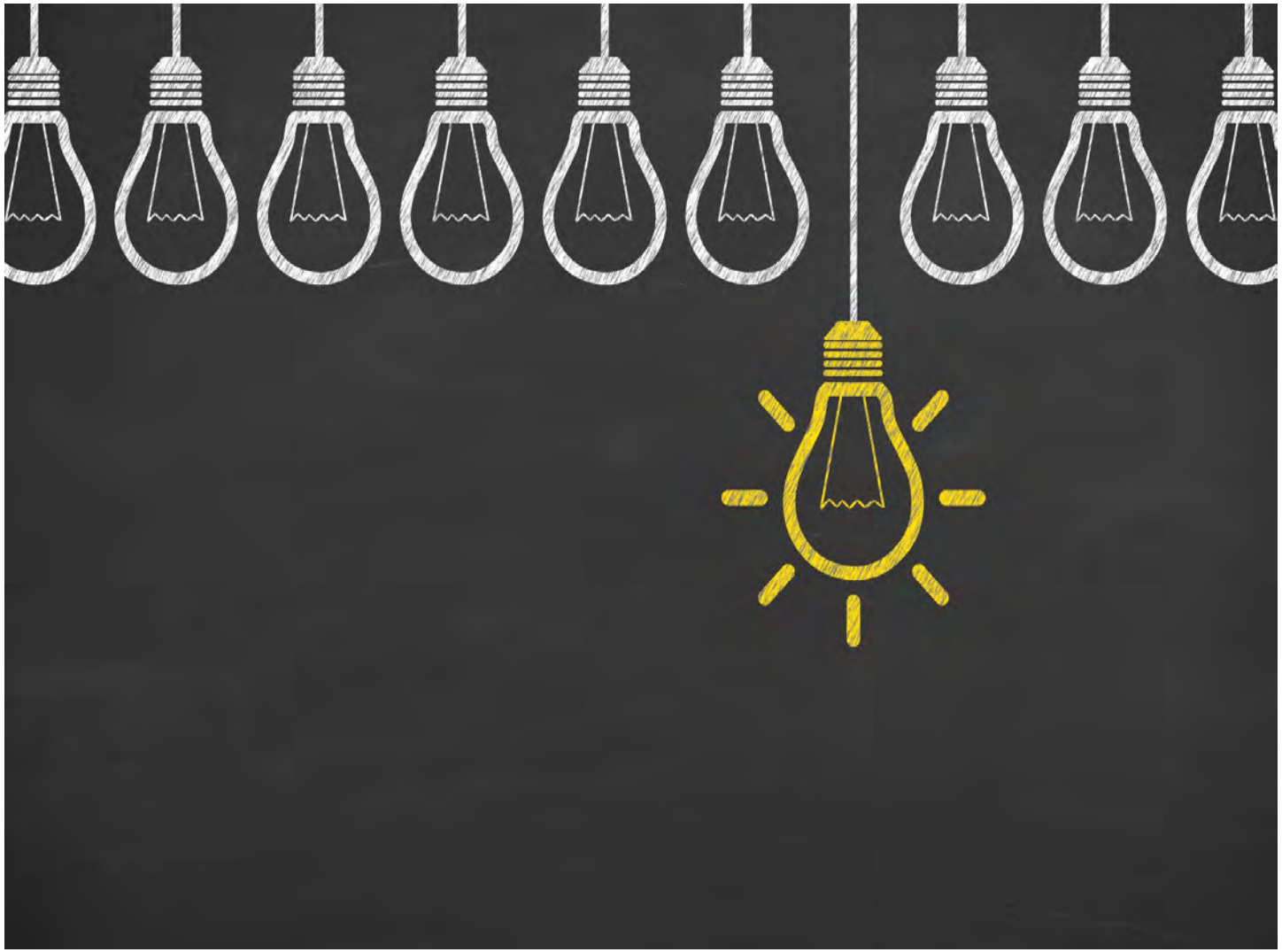
We might take these for granted, but they are all models:

- Sunrise/sunset times
- Seasons: expected phenology
- Tides and moon phase predictions
- Weather forecasts
- Mental geospatial models:
  - The layout of your house/apartment
  - The streets of your hometown
- Social cues
- Language?

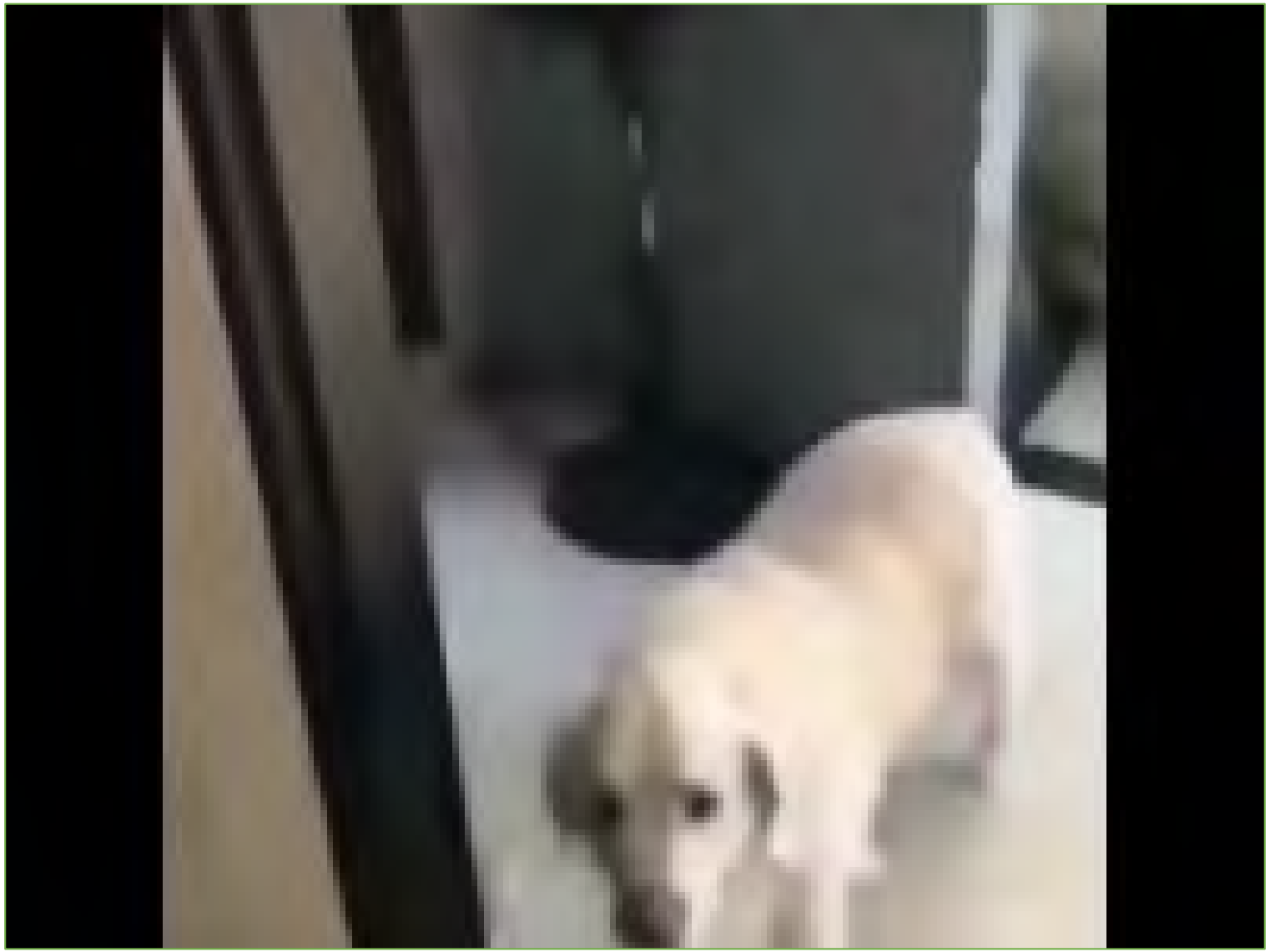
What is model thinking?

Model thinking means:

- Learning to see potential models everywhere.
- Being aware of models we already use.
- Recognizing benefits, pitfalls, and limitations of a model.
- Considering multiple models.
- Thinking **iteratively.** Updating your model



A very cute example



Clarification: What is a system?

A definition of system from Merriam-Webster:

1. a group of interacting bodies under the influence of related forces

2. a group of body organs that together perform one or more vital functions

3. a group of related natural objects or forces

Model Thinking: How to think like a modeler

A model thinker would first consider:	Then they might:
• What do I already know about this system? • What are some of the important parts of a system? • What are some of the important interactions? • What questions are important?	• ponder • draw some sketches • write down their ideas • discuss with friends or colleagues… • Give up and try again tomorrow

Model Thinking: How to think like a modeler

Modeling is Iterative

In the second round the model thinker might consider questions like:

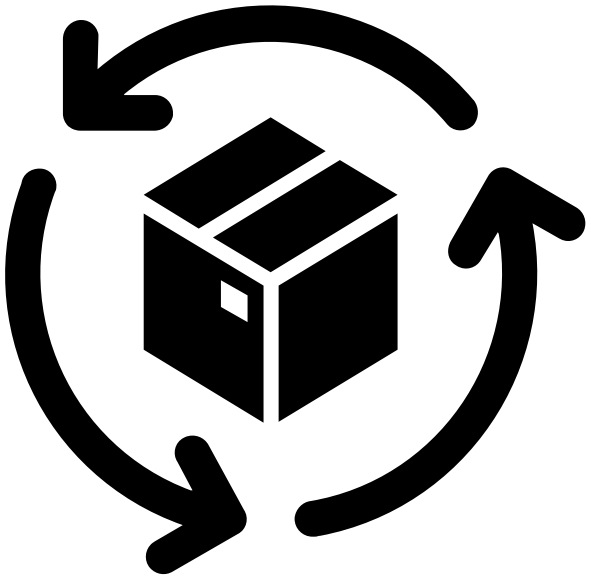
- What components are vital, and which could I ignore?
- Can I identify knowledge gaps and known unknowns?
- How could I create a computer simulation?
- What if my model is wrong?
  - Can I hypothesize a competing model?
- Can I identify biases in my model?
  - Cultural
  - Species
  - My personal background and training

Model Thinking: How to think like a modeler

As the model thinker refines their model, further questions they might consider are:

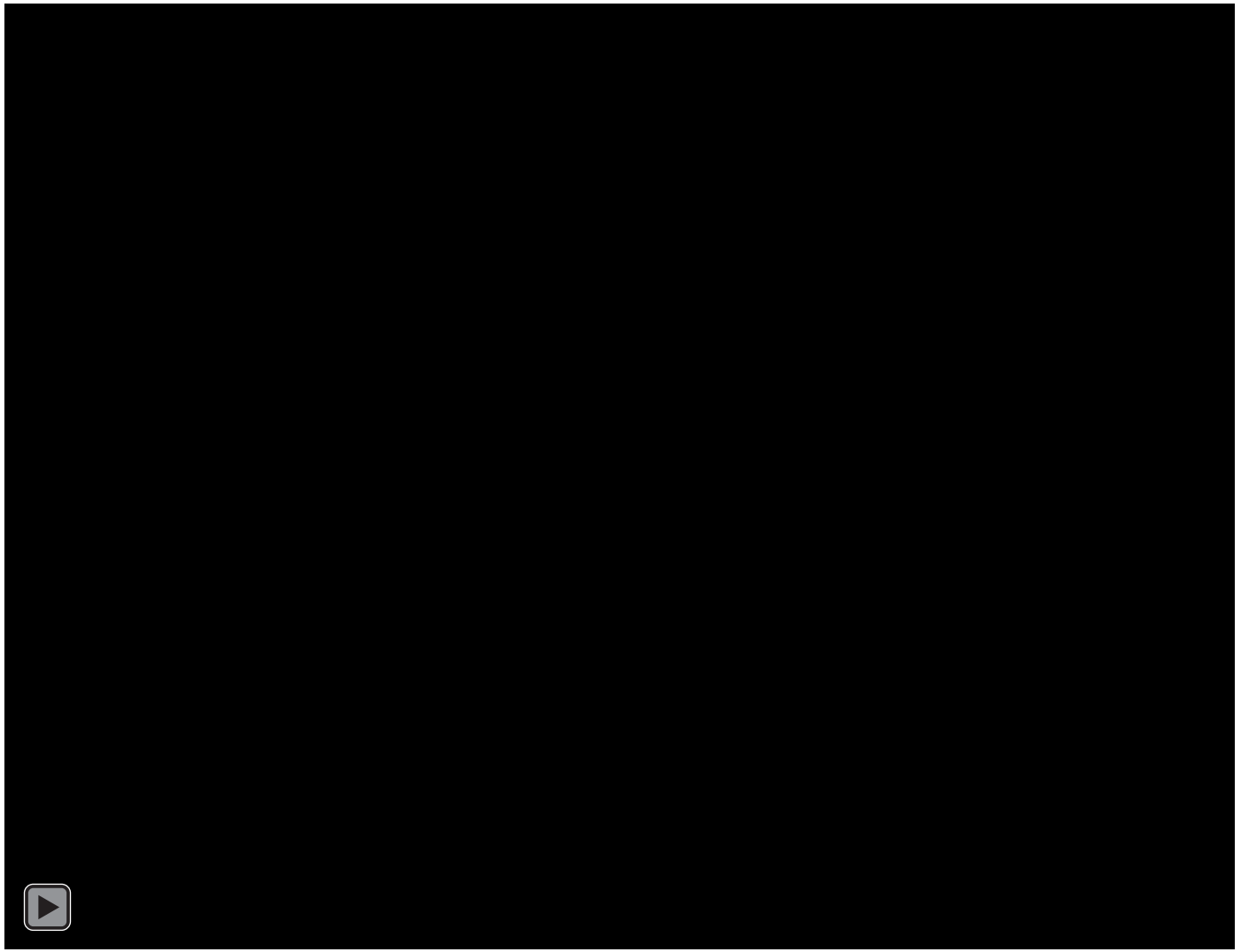
- Why do I want to build a model?
- What will I use the model for?
  - Prediction? Understanding? Experimenting?
- What data could I use to calibrate or validate my model?
- What are the sources of uncertainty and randomness?
- What if I discover my model is wrong?

A model thinker knows that modeling is iterative…



What can we learn from the dog's model?

I want to hear your ideas!



Classes of Models

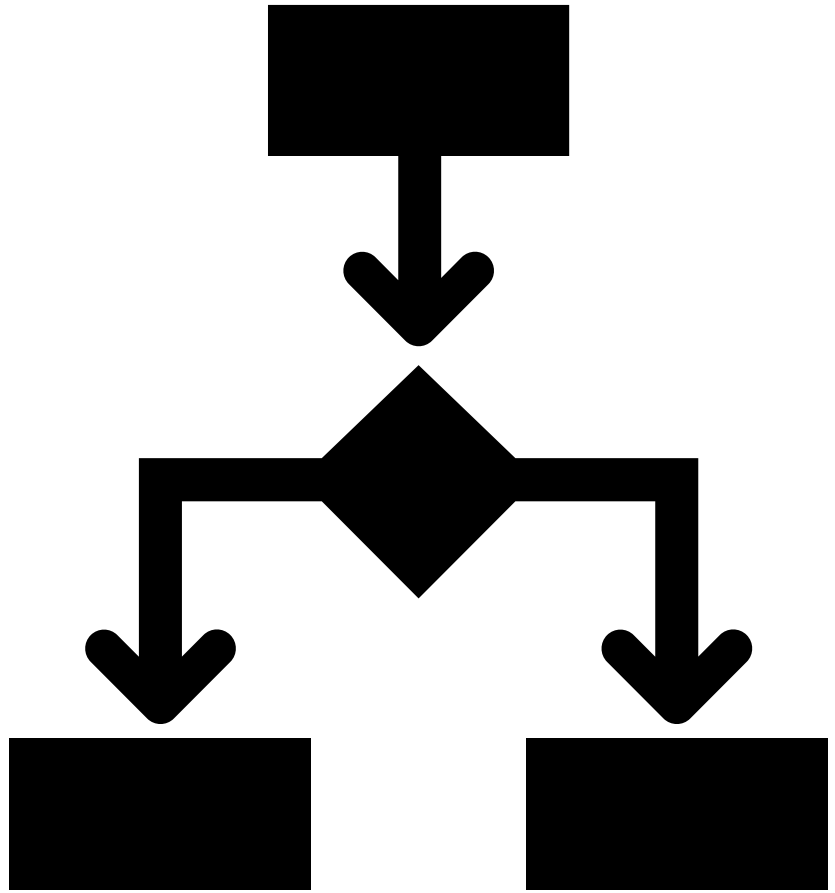
Modeling is a very broad concept.

The model we build depends on our purpose, what we already know, and the data we have!

Some categories of models include:	**These categories are not mutually exclusive.**
Conceptual Phenomenological Mechanistic	• Since modeling is iterative, you may use (for example) a conceptual model to inform an experiment. • You could then use a phenomenological model to explain patterns you observe in the results. • This may support or refute your conceptual model, or help you develop a mechanistic model.

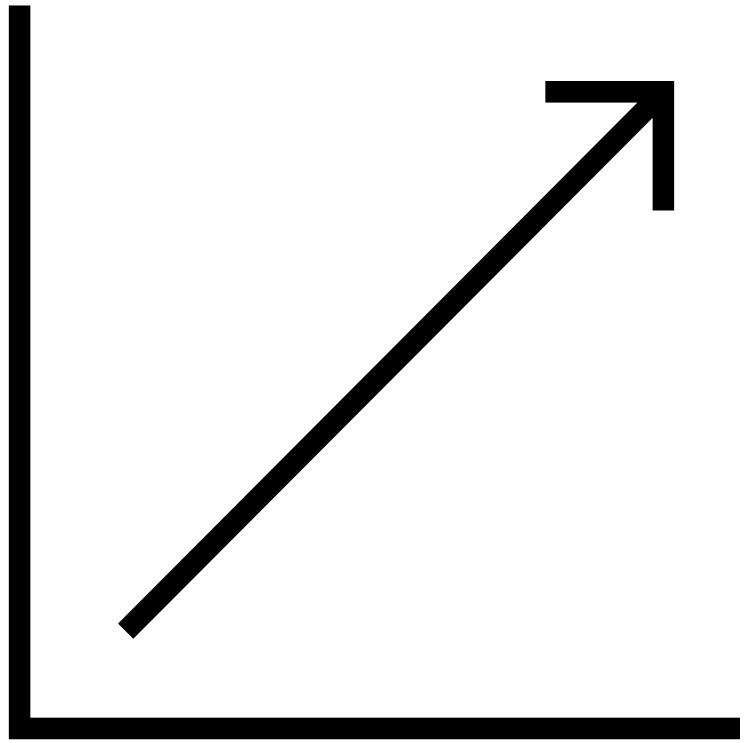
Conceptual Models

- Conceptual models are useful to identify important components and hypothesize interactions.
- Conceptual models don't have to be **quantitative**.
- A flow chart, or concept diagram can be a conceptual model.



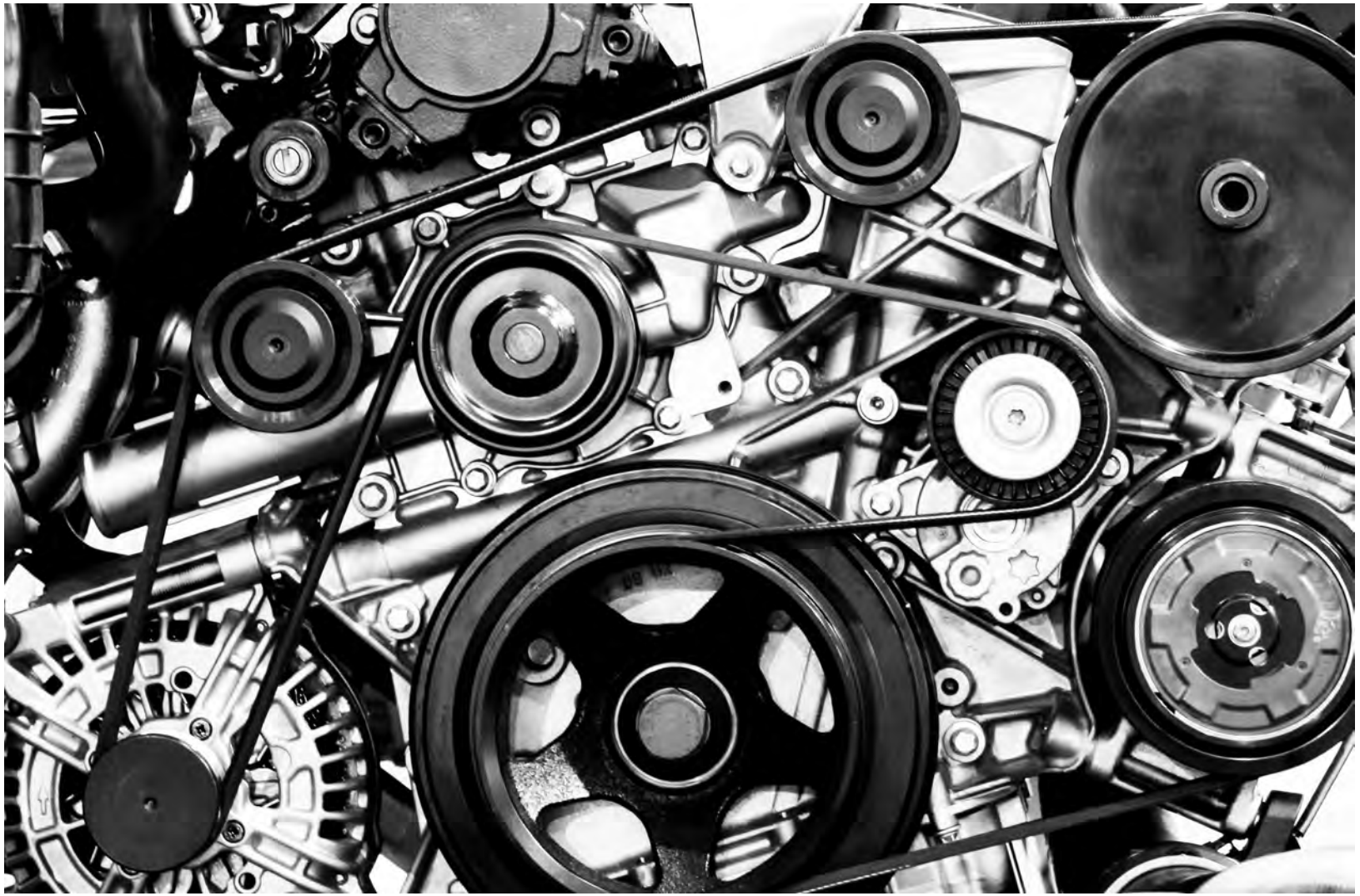
Phenomenological Models

- Phenomenological models use **quantitative tools** to *describe* observed patterns.
- The form of a phenomenological model doesn't have to reflect the structure of the underlying system.
- Note: *phenomenological* is incredibly hard to spell, and to pronounce so please be patient with me and each other!



Mechanistic Models

- Mechanistic models use **quantitative tools** to *describe* observed patterns.
- Mechanistic models use a known or hypothesized structure of the underlying system to specify the model form.



Some Model Examples

- What are the important components in a mangrove estuary in southern Florida, and how do they interact?
  - Davis et al (2005)
- What are the advantages and differences among fragmentation, variegation, and contour landscape models?
  - Fischer, Lindenmeyer, and Fazey (2004)
- What predictor variables best explain plant presence/absence and cover in vernal pools?
  - Ray and Colligne (2014)
- How well can models of of connectivity describe plant presence/absence and cover in vernal pools?
  - Ray and Colligne (2014)
- Do black bear responses to resource availability conform the Ideal-Free Distribution Model?
  - Beckmann and Berger (2003)

What is a model?

In the words of some famous model thinkers:

"All models are wrong, but some are useful" - George Box

Companion In-Class Modeling Activity

Let's Model!

Now that you have an idea of what I mean by model thinking, let's put our skills to work using some real ecological scenarios.

Click here to link to the assignment description.

You can also find it on the course github site under 'In-Class Activities'

Please make sure you read through the assignment instructions and the scenarios before you come to class.

References for the example models

- Beckmann, J.P., and Berger, J. (2003). Using Black Bears to Test Ideal-Free Distribution Models Experimentally. Journal of Mammalogy 84, 594–606.
- Davis, S.M., Childers, D.L., Lorenz, J.J., Wanless, H.R., and Hopkins, T.E. (2005). A conceptual model of ecological interactions in the mangrove estuaries of the Florida Everglades. Wetlands 25, 832.
- Fischer, J., Lindenmayer, D.B., and Fazey, I. (2004). Appreciating Ecological Complexity: Habitat Contours as a Conceptual Landscape Model. Conservation Biology 18, 1245–1253.
- Ray, C., and Collinge, S.K. (2014). Quantifying the dominance of local control and the sources of regional control in the assembly of a metacommunity. Ecology 95, 2096–2108.