

Intro to Models and Modeling

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August 29, 2016

“To try to make a model of an atom by studying its spectrum is like trying to make a model of a grand piano by listening to the noise it makes when thrown downstairs.”

- Anonymous

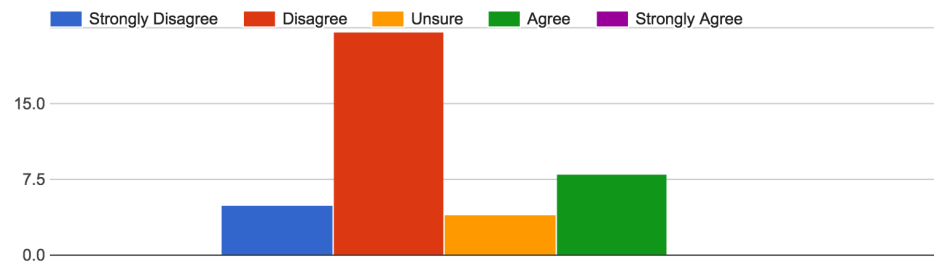
Introduction to Quantitative Biology, Fall 2016

Class announcements

- Office hours (ISC 3252)
 - Mondays, 2-3 pm
 - Fridays, 9:30-10:30 am
- Homework due dates changed to **Monday, 11:59 pm**
- Reading assignment for Wednesday: **OpenIntro Stats, Chapter 4: Foundations for Inference**

Science misconceptions

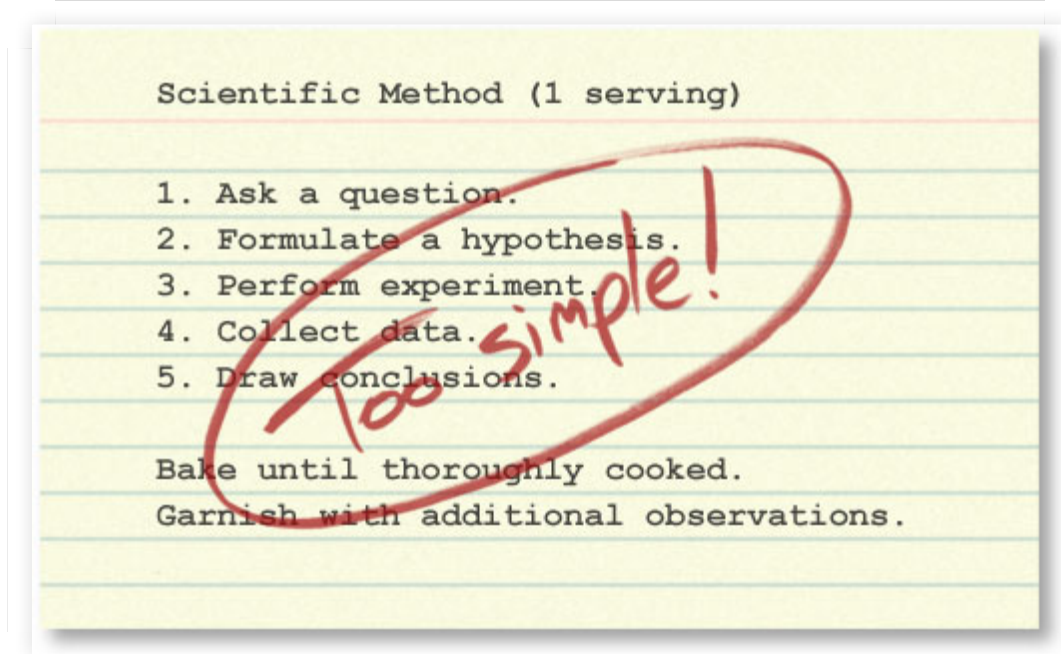
Scientists always follow the same step-by-step scientific method.



“In fact, the Scientific Method represents how scientists usually write up the results of their studies (and how a few investigations are actually done), but it is a grossly oversimplified representation of how scientists generally build knowledge.”

- Understanding Science

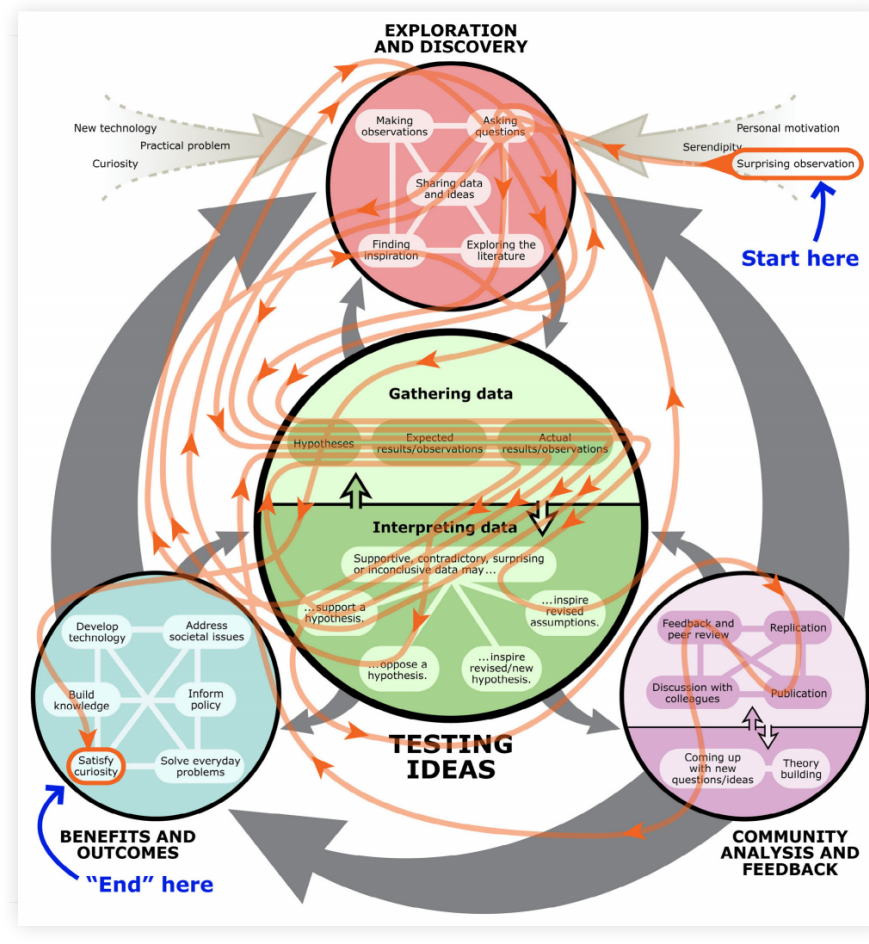
Misconception #1: Rigid Workflow



University of California Museum of Paleontology's Understanding Science (<http://www.understandingscience.org>)

Difference is between how **how science is done** versus **how science is reported**.

Misconception #1: Rigid Workflow



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Misconception #1: Rigid Workflow

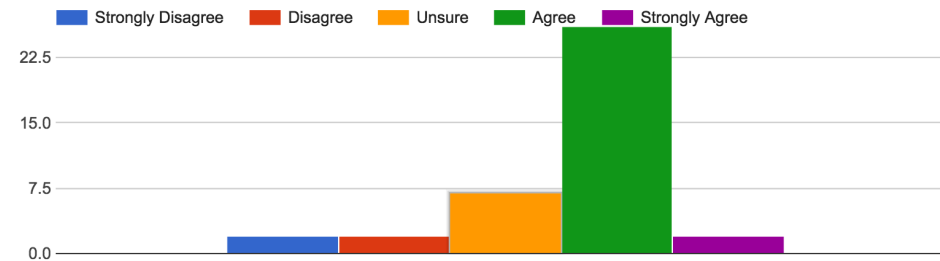
Asteroids and dinosaurs: Unexpected twists and an unfinished story
(PDF version)



University of California Museum of Paleontology's Understanding Science (<http://www.understandingscience.org>)

Misconception #2: Hypothesis vs Theory

Well-supported hypotheses become theories, and well-supported theories become laws.

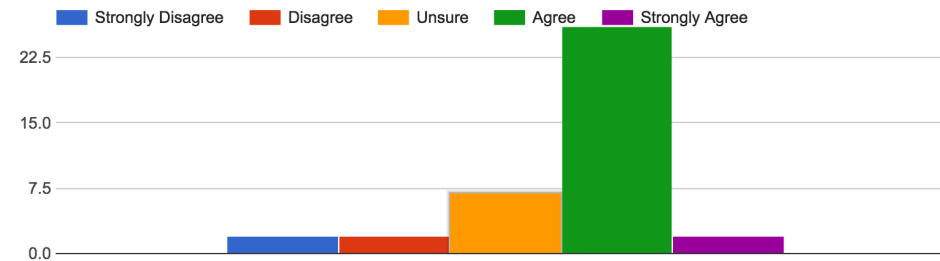


“...hypotheses, theories, and laws are rather like apples, oranges, and kumquats: one cannot grow into another, no matter how much fertilizer and water are offered.”

- Understanding Science

Misconception #2: Hypothesis vs Theory

Well-supported hypotheses become theories, and well-supported theories become laws.



“Hypotheses, theories, and laws are all scientific explanations that differ in breadth — not in level of support.”

- Understanding Science

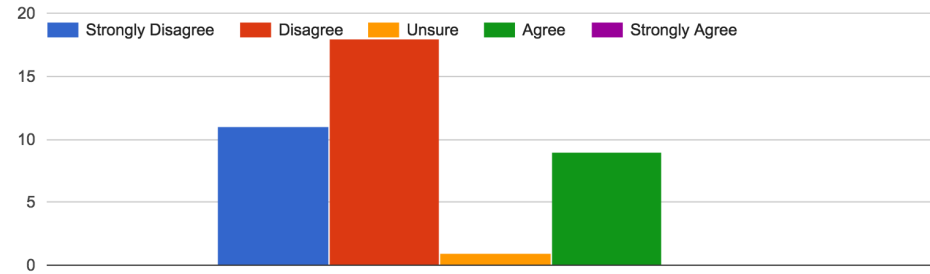
Misconception #2: Hypothesis vs Theory

Hypothesis: Hypotheses are explanations that are limited in scope, applying to fairly narrow range of phenomena.

Theory: Theories are deep explanations that apply to a broad range of phenomena and that may integrate many hypotheses and laws.

Misconception #3: Scientific "proof"

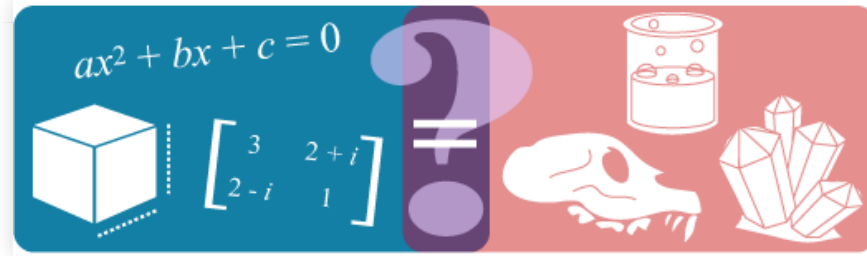
The aim of scientific testing is to prove a hypothesis correct.



“Science is based on the principle that any idea, no matter how widely accepted today, could be overturned tomorrow if the evidence warranted it. Science accepts or rejects ideas based on the evidence; it does not prove or disprove them.”

- Understanding Science

Is math science?

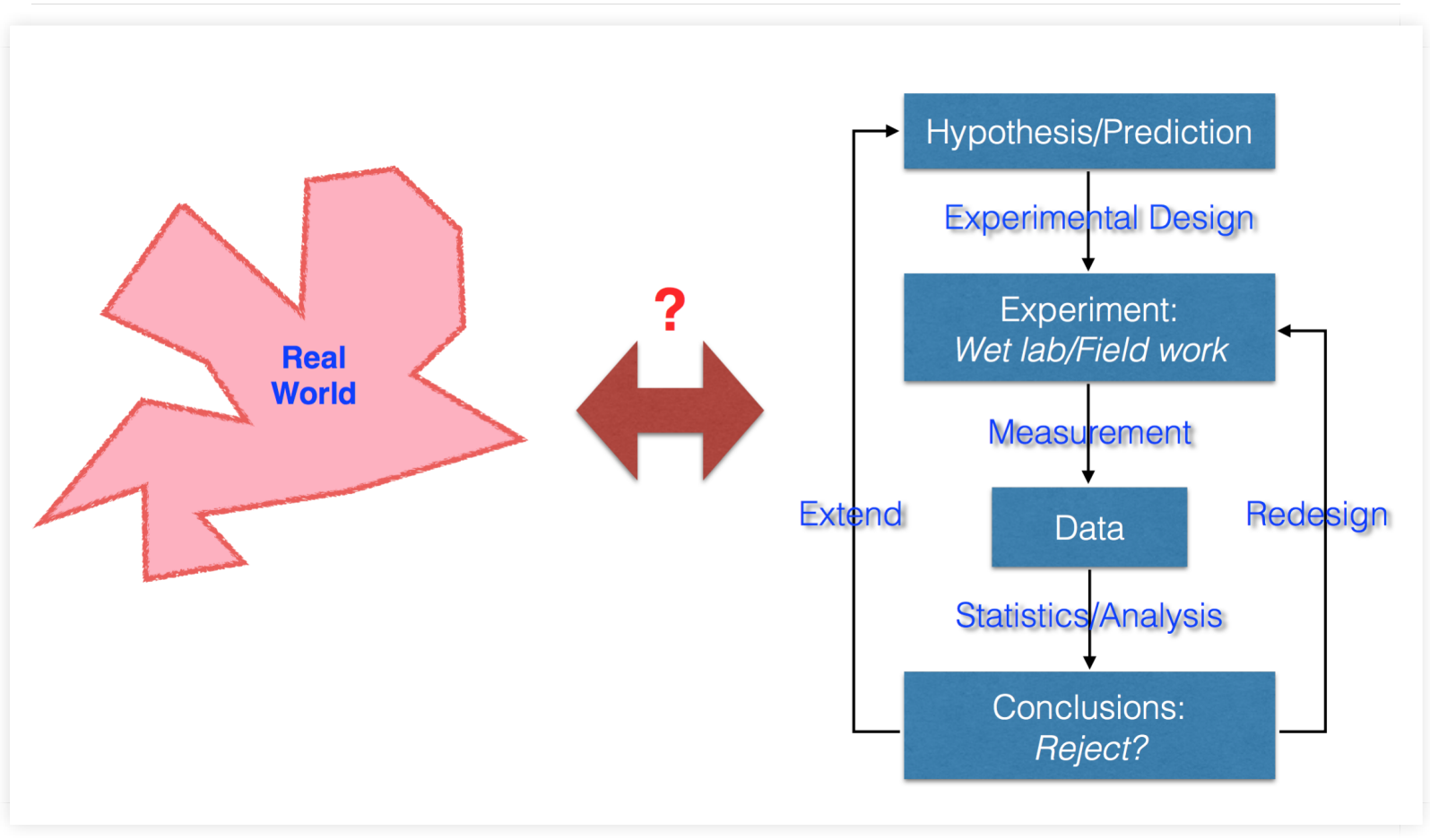


Science checklist:

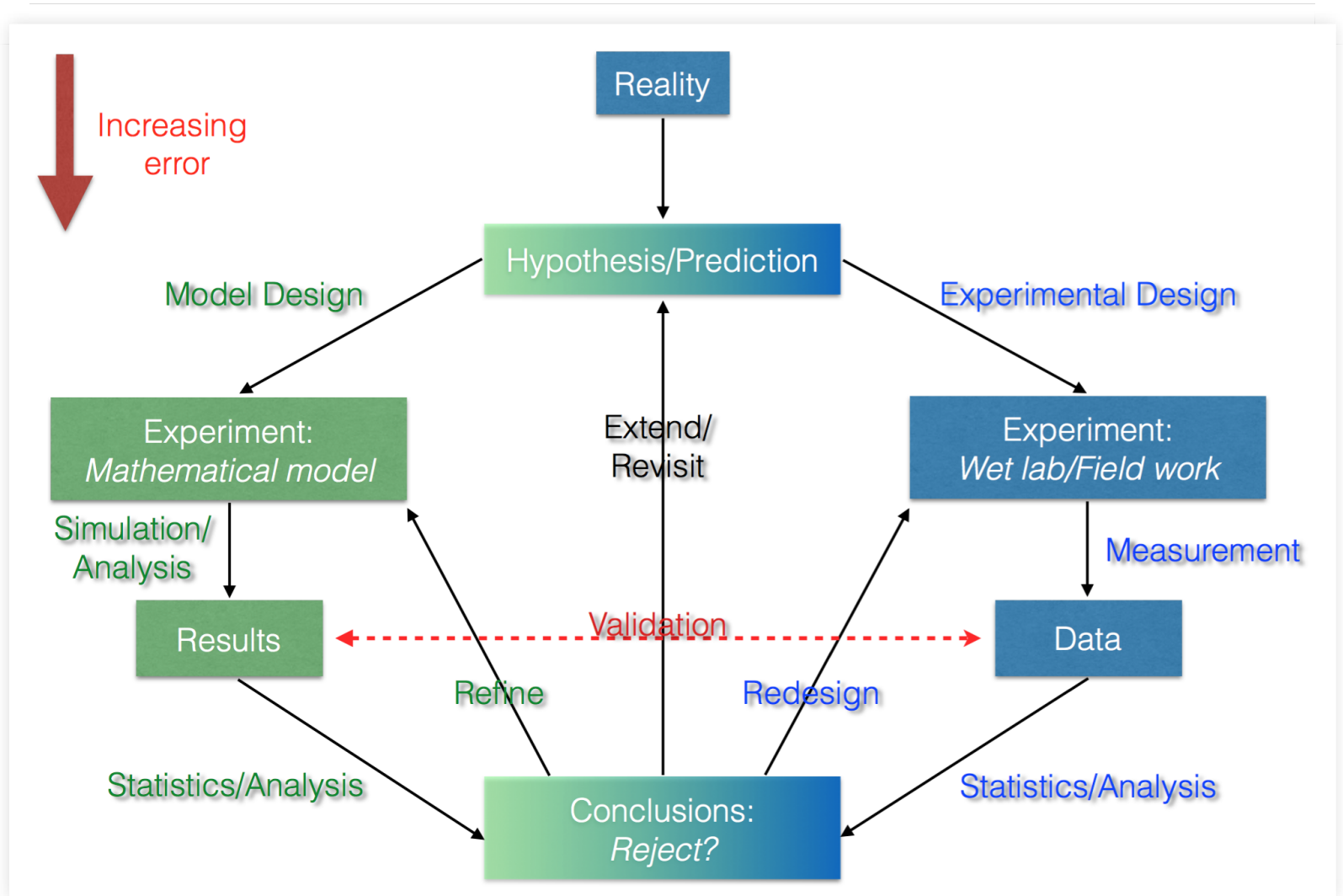
How scientific is it?

- ☐ Focuses on the natural world
- ☐ Aims to explain the natural world
- ☐ Uses testable ideas
- ☐ Relies on evidence
- ☐ Involves the scientific community
- ☐ Leads to ongoing research
- ☐ Benefits from scientific behavior

Science



POS vs POMM



Class Activity: What's in the box?



Models and Modeling

Discuss: What is a model?

Models and Modeling

Question: Is this a model?



Models and Modeling

Question: Is this a model?



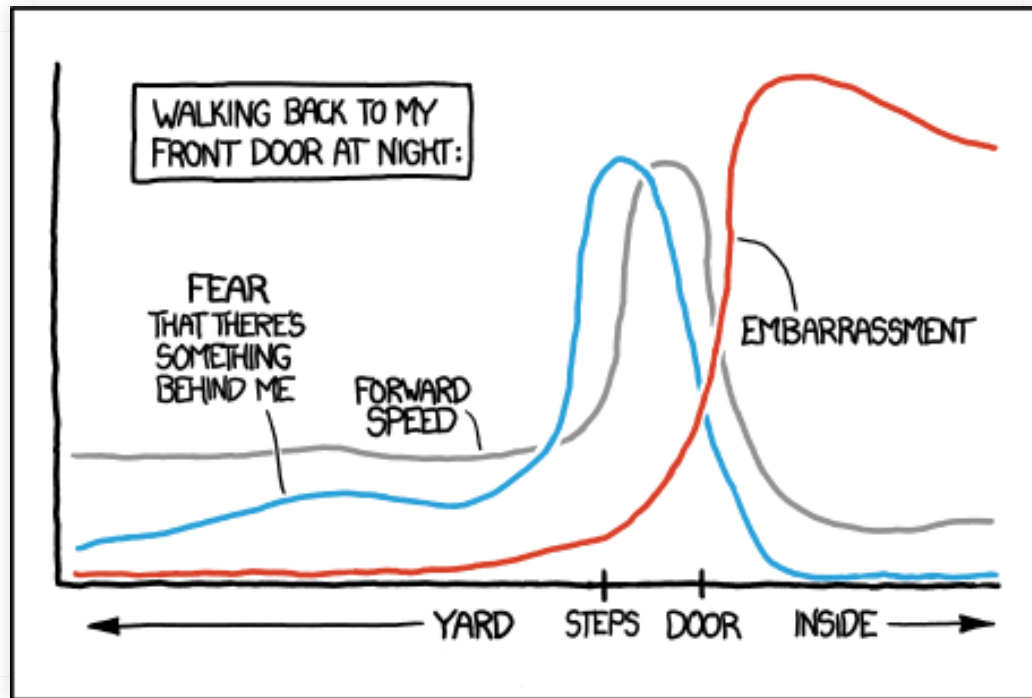
Models and Modeling

Question: Is this a model?

$$F = ma$$

Models and Modeling

Question: Is this a model?



<http://www.xkcd.com/>

Models and Modeling

Question: Is this a model?

	A	B	C	D	E	F
1		Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
2	1	5.1	3.5	1.4	0.2	setosa
3	2	4.9	3	1.4	0.2	setosa
4	3	4.7	3.2	1.3	0.2	setosa
5	4	4.6	3.1	1.5	0.2	setosa
6	5	5	3.6	1.4	0.2	setosa
7	6	5.4	3.9	1.7	0.4	setosa
8	7	4.6	3.4	1.4	0.3	setosa
9	8	5	3.4	1.5	0.2	setosa
10	9	4.4	2.9	1.4	0.2	setosa
11	10	4.9	3.1	1.5	0.1	setosa
12	11	5.4	3.7	1.5	0.2	setosa
13	12	4.8	3.4	1.6	0.2	setosa
14	13	4.8	3	1.4	0.1	setosa
15	14	4.3	3	1.1	0.1	setosa
16	15	5.8	4	1.2	0.2	setosa
17	16	5.7	4.4	1.5	0.4	setosa
18	17	5.4	3.9	1.3	0.4	setosa
19	18	5.1	3.5	1.4	0.3	setosa
20	19	5.7	3.8	1.7	0.3	setosa
21	20	5.1	3.8	1.5	0.3	setosa
22	21	5.4	3.4	1.7	0.2	setosa
23	22	5.1	3.7	1.5	0.4	setosa

Models and Modeling

Discuss: What are the components of a model?

Answer:

- Objects (*nouns*)
- Processes or relationships (*verbs*)
- Simplified, abstract/concrete (*adjectives*)
- **Function** (*use case*) - Not strictly necessary for the definition of a model. This answers the “Why model?” question.

Definition: A *model* is a simplified, abstract (or concrete) representation of objects and their relationships and/or processes in the real world.