Lecture 1

"Models" are approximations / abstractions to reality / absolute truth / systems / phenomena

| Model | Phenomena |
| --- | --- |
| Model airplane | real airplane |
| Street map | actual roads |
| "early to bed, early to rise makes a man healthy, wealthy and wise" -Ben Franklin | human health, human wealth, and human wisdom |

"All models are wrong but some are useful"

-George Box

By definition approximations are close but not reality

are good enough for a practical purpose

Models can be considered Good if they are close enough to reality

ex. Pi to the 20th decimal place gets us pretty close to the actual "real" solution

Models are generally used for two goals

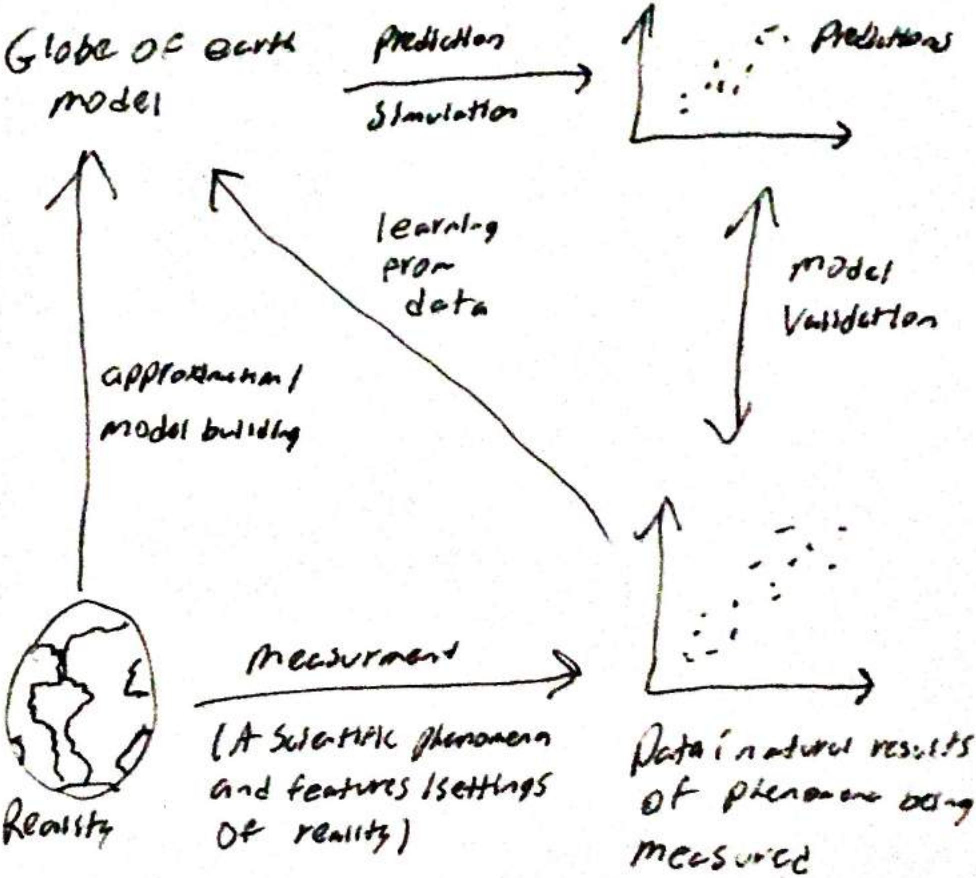
(1) Prediction: Can the model tell us what will happen in a certain phenomenola in a certain setting

* What we will be focusing on in class

(2) Expllnation: How does reality really work? What causes phenomena to manifest

dlagram

next page →


Globe of earth model
Prediction
Simulation
Predictions
learning from data
model Validation
approximation / model building
Measurment
(A Scientific phenomena and features / settings of reality)
Reality
Data; natural results of phenomena being measured

Pre steps to modelling

(1) Identify a phenomenon/a You wish to predict/explain
    This is the target of the modelling procedure

(2) Figure out a way to measure it

(3) measure features/settings of the system/reality

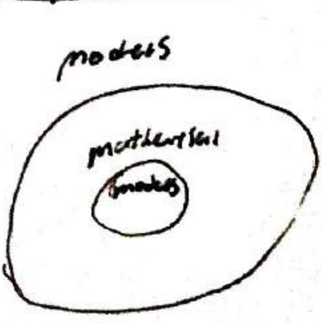
"Early to bed, early to rise makes a man healthy, wealthy and wise"

Phenomena: human health, wealth and wisdom (3)
Features/settings: bedtime, waketime (2)

This model is ambiguous! we don't know how to measure the setting and phenomena. In order to make this model unambiguous, we need to establish "metrics". Metrics are well-defined ways to numerically gauge phenomena/settings

| Features/ Phenomena | Metric | Symbol |
|---|---|---|
| bedtime | average daily bedtime between ages 18-60 measured in hours past 5 pm | $b$ |
| waketime | average waketime measured in hours past 4 Am | $w$ |

| Features / Phenomena | Metric | Symbol |
| --- | --- | --- |
| health | longevity / lifespan, QOL metric | l |
| wisdom | take a test about situations and what you would do in situations and have a panel of old people provide answers | S |
| wealth | net/worth at time of death | n |




$$f\left(\begin{bmatrix} b \\ w \end{bmatrix}\right) = \begin{bmatrix} l \\ h \\ S \end{bmatrix}$$

model — two settings (input) — three phenomena (outputs)

Since the inputs / outputs are numerical, f is called a "mathematical model"

* In this class we only build models with one output

Mathematical models are not physical.
They are themselves ideas and abstractions.
But they are extremely useful!

ex $a = F/m$

$E = mc^2$

Assume: a phenomenon denoted $y$, can be expressed as:

$$y = t(z_1, z_2, \ldots, z_t)$$

phenomenon, response, outcome, endpoint, dependent, variable

causal inputs: the true drivers of the phenomenon. In reality we don't know them

Let's examine the phenomenon $y$ = pays back loan on time

$$y \in \{0, 1\} = y$$ output space

did not pay back on time

paid back on time
1 = positive / true

models with output spaces of cardinality 2 are called "binary classification models"