MATH-342W
SPRING 2021

2/1/2021

"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"	human health, human wealth, and human wisdom

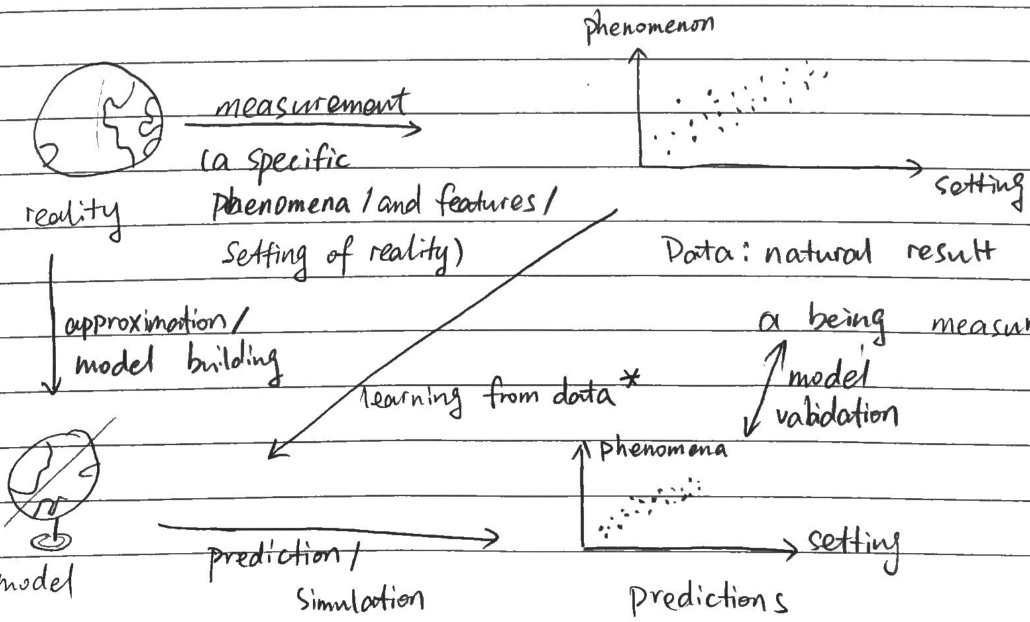
"All models are wrong but some are useful" George Box, 1984

*by definition approximations which are not reality.

* are good enough to be used for a practical purpose.

Models are generally used for two goals:

1) Prediction: can the model tell us what will happen in a certain phenomenon in a certain setting. ***
2) Explanation: how does reality really work? what causes phenomenon to manifest?



Data: natural result of phenomenon / a being measured.

Presteps to modeling:

1) Identify a phonamenon you wish to predict / explain.
   This is your target of the modeling procedure.
2) Figure out a way to measure it.
3) Measure features / setting to the system / reality.

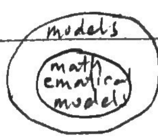
"Early to bed, early to rise makes a man healthy, wealthy and wise.
phenomenon: human health, wealth, and wisdom.
Features/settings: bedtime, waketime.
This model is ambiguous! we don't know how to measure the setting and phenomena. In order to make this model unambiguous, we need to establish "metrics". 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 5pm.	b
wake time	average daily waketime ... measured in hours past 4AM	w
health	longevity / lifespan / QOL metric	L
wealth	net worth at time of death	n
wisdom	take a test about situations and what you would do in situations and have a panel of old people provide answers	s

$$\underset{\text{model}}{f}\left(\underbrace{\begin{bmatrix} b \\ w \end{bmatrix}}_{\text{two settings}}\right) = \underbrace{\begin{bmatrix} l \\ n \\ s \end{bmatrix}}_{\text{three Phenomena}}$$

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

* In this class, we'll only build models with one output.



Mathematical models are not physical. They are themselves ideas and abstractions. But they are extremely useful! ex. $a = F/m$, $e = mc^2$.
We've been building them for ~ 4000 yr.

For the purposes of this class, we'll assume the university is mathematical:

Assume: a phenomenon denoted y can be expressed as:

$$y = t(\underbrace{z_1, z_2, \dots, z_t}_{})$$

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

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

0: didn't pay back on time

1: pay back on time (Convention: 1 is the "positive" event or the thing you want to happen).

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

The causal inputs are features or characteristics of the individual person. we don't know the causal model why people pay/don't pay back loans. We are going to make one up just as an illustration.