Models – approximations / abstractions to reality / absolute truth / systems / phenomena.

Examples:

Model	Phenomenon
model airplane	airplane (real)
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

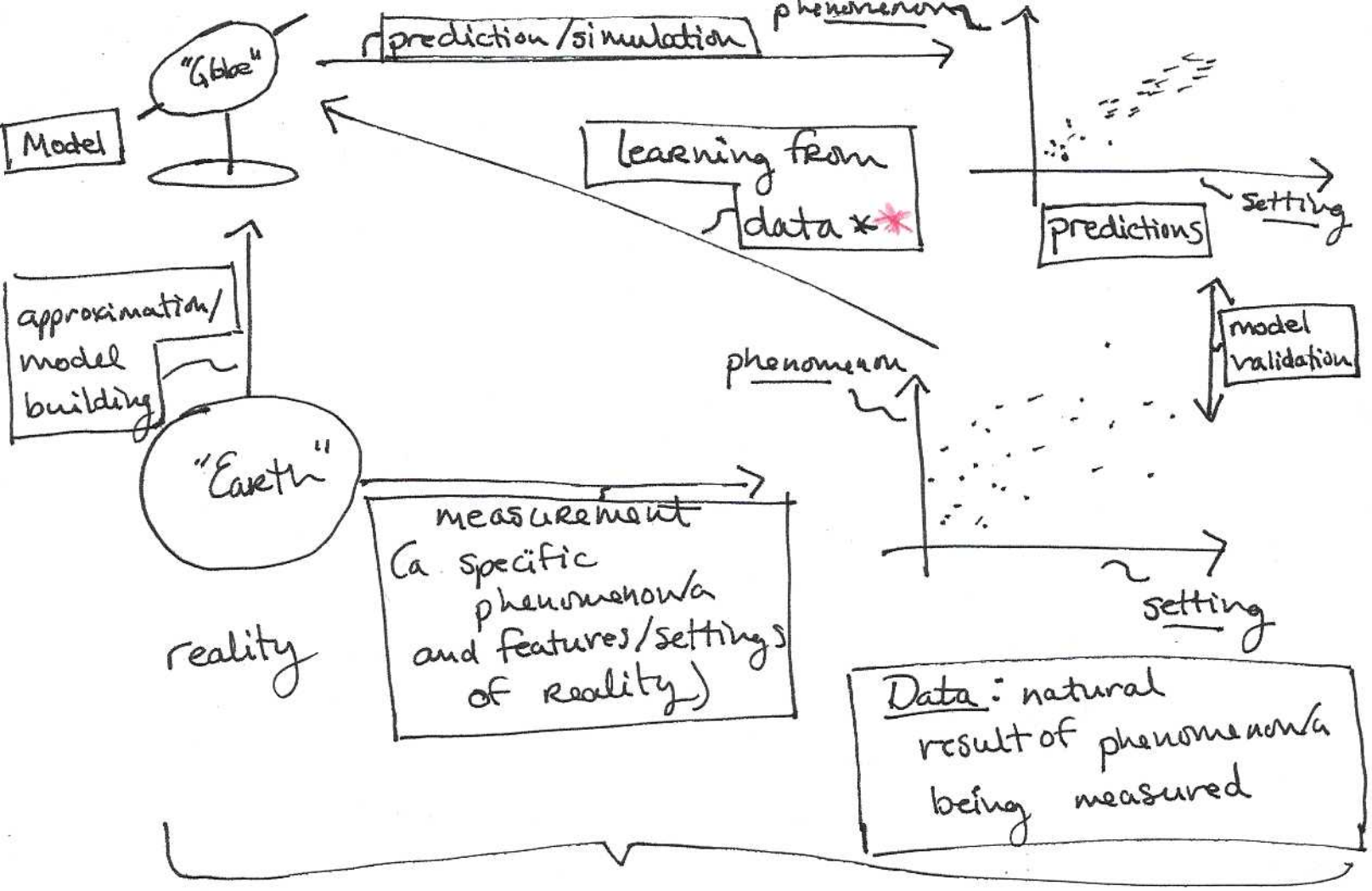
wrong → by def., approximations which are not reality

useful → good enough to be used for a practical purpose

Models are generally used for two goals:

~ prediction – can the model tell us what will happen in a certain phenomenon in a certain setting. ***
(focus of this class)

~ explanation – How does reality really work? What causes phenomena to manifest?
(other courses)



Real

** This class

Class schematic diagram

Presteps to modeling:

(1) Identify a phenomenon/a you wish to predict/explain.
This is your target of the modeling procedure.

(2) Figure out a way to measure it.

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

Model:

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

Phenomena: human health, wealth and wisdom.

Features/settings: bedtime, wake time

This model is ambiguous!

→ We don't know how to measure settings (2) and phenomena (3).

→ In order to make this model unambiguous, we need to establish "metrics". Metrics are well-defined ways to numerically gauge phenomena/settings.

Features/settings/phenomena	Metric	Symbol
Bedtime	Avg. bedtime between ages 18-60 measured in ~~24 hr time~~. hours past 5PM.	[redacted] b
Waketime	Avg. waketime btwn. ages 18-60 measured in hrs. past 4AM.	[redacted] w
Health	longevity/lifespan, QOL metric	h [redacted]

Chart Continued ...

Feature / phenom.	Metric	Symbol
wealth	net worth at time of death	n
wisdom	take a test about situations and what you would do in situations & have a panel of elderly people provide answers	s

ASK:

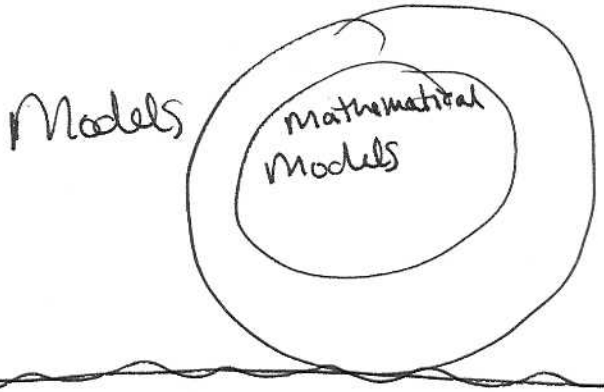
~~Would we not also need to quantify the "and"??~~

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

model | two setting (inputs) | three phenomena (outputs)

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

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



For the purposes of this class, the universe is mathematical.
(By Assumption.)
And, we will only have ONE output, called "y".

~~output, dependent variable~~

Assume: a phenomena, denoted y, can be expressed as:

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

y: "phenomenon, response, outcome, endpoint, dependent variable"

Causal inputs: the true drivers of the phenomenon. In reality, we don't know what these are.

Let's examine the phenomenon

y = pays back loan on time

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

y: 0 = did not pay back on time; 1 = paid back on time (Convention: 1 is "positive" event or the thing you are seeking to happen)

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

The causal inputs are features or characteristics of the individual person, but we will make one up! (Yay!)