math 390: dim(output) = 1

# Models - Approximations &/or abstractions to reality/abs truth/systems/phenomena

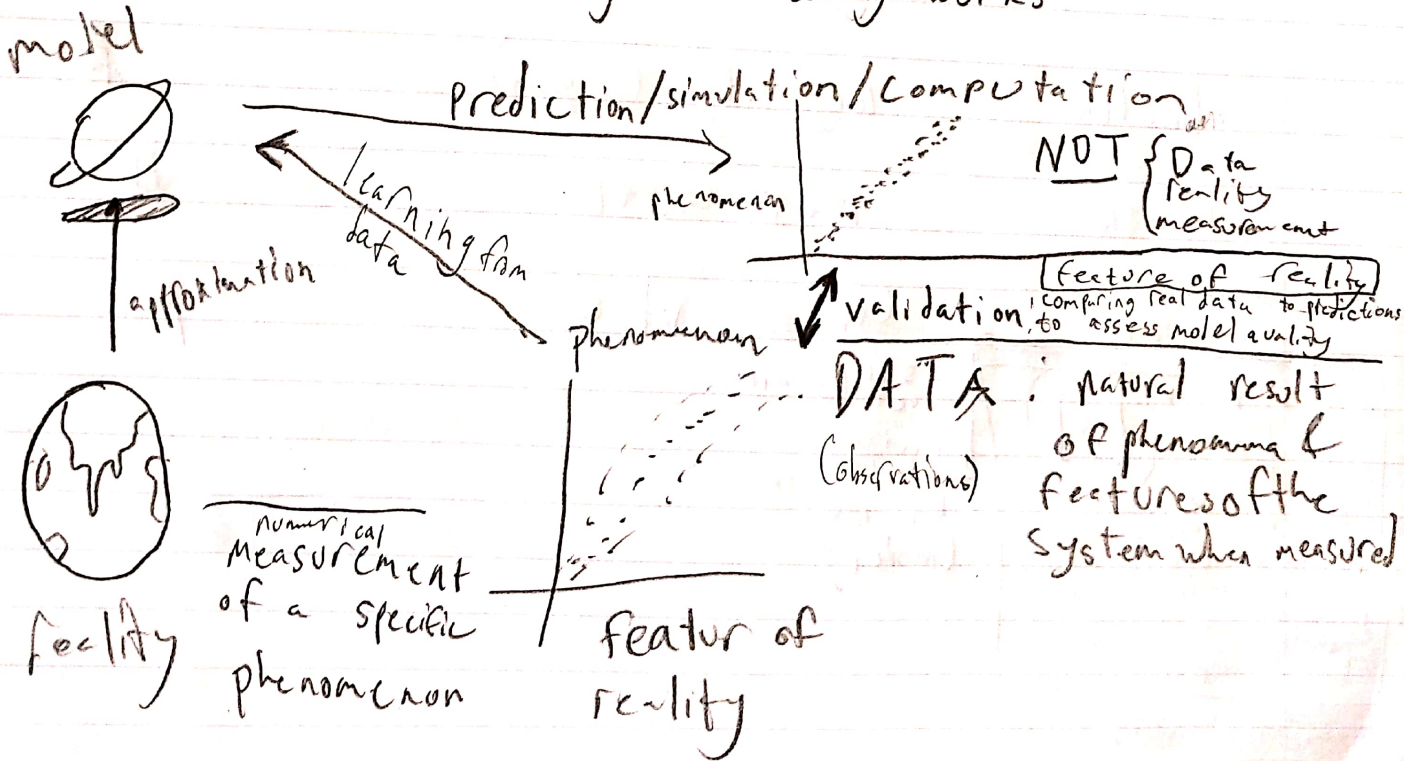
| Model | Approx. |
|---|---|
| model plane | real plane |
| Streetmap | road sys |
| wind tunnel | fast moving air |
| "early to bed... wise" | human success |

"All models are wrong, but some are useful" - George Box
(approximations are always wrong)
They can serve purposes

## Two main Goals of models -

1) Prediction: the model will tell us what will happen to a certain phenomenon in a certain setting (TELLING THE FUTURE)

2) Explanation: understanding how reality works



Structure of scientific revolutions by Coon

## Mathematical Models: functional relationship b/w numerical i/o

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

model for human success in phenomena health, wealth, wisdom

This is a non-mathematical model, which is inexact

To make this a mathematical model, quantify everything

"Early to bed, early to rise } features of the system
makes
a man healthy, wealthy, & wise" } phenomena

| Variables | metrics | Symbol |
|---|---|---|
| early to bed | avg bedtime as measured by # mins after 6 pm (268 vs 363) | b |
| early to rise | avg waketime as .... .... .... 4 am | w |
| health | longevity (in years) | l |
| wealth | net worth | n |
| Wisdom | Connor v1.0 | p |

$$\begin{bmatrix} l \\ n \\ p \end{bmatrix} = f\left(\begin{bmatrix} B \\ W \end{bmatrix}\right)$$

Is this really true? functional relationship b/w i/o (model)

phenomena: outputs, responses, endpoints, dep variables

features, attributes, characteristics, (indpt) variables, covariates, regressors, inputs

mathematical models

Assume reality can be explained by mathematical models, which means

$$y = t(\underbrace{z_1, z_2, \ldots, z_t}_{\text{Causal inputs}})$$

- $y$: One-dim phenomenon we are modelling
- $t$: the true function that "nature" uses to create the measurement of the phenomenon

Phenomenon: Payback loan

$y = \{$ pay back, not pay back $\}$

$y = \{0, 1\}$ — encoding

$= $ output space $\mathcal{Y}$

$z_1$: has sufficient funds $\in \{0, 1\}$

$z_2$: criminal intent $\in \{0, 1\}$

$z_3$: access to branch

$$y = z_1 (1 - z_2) z_3$$

Big Problem: Total ignorant about $z_3$! furthermore, we may not know $t(\,)$

Next best thing... Obtain features that approximate the causal information in $z_1, z_2, \ldots, z_t$. Denote these features $x_1, x_2, \ldots, x_p$

e.g.

$x_1$: income / bank acct. balance

$x_2$: prior criminal record

$x_3$: have internet

$x_4$: credit score