"Models" are approximations and/or abstractions to reality/absolute truth/system/phenomena

Examples:

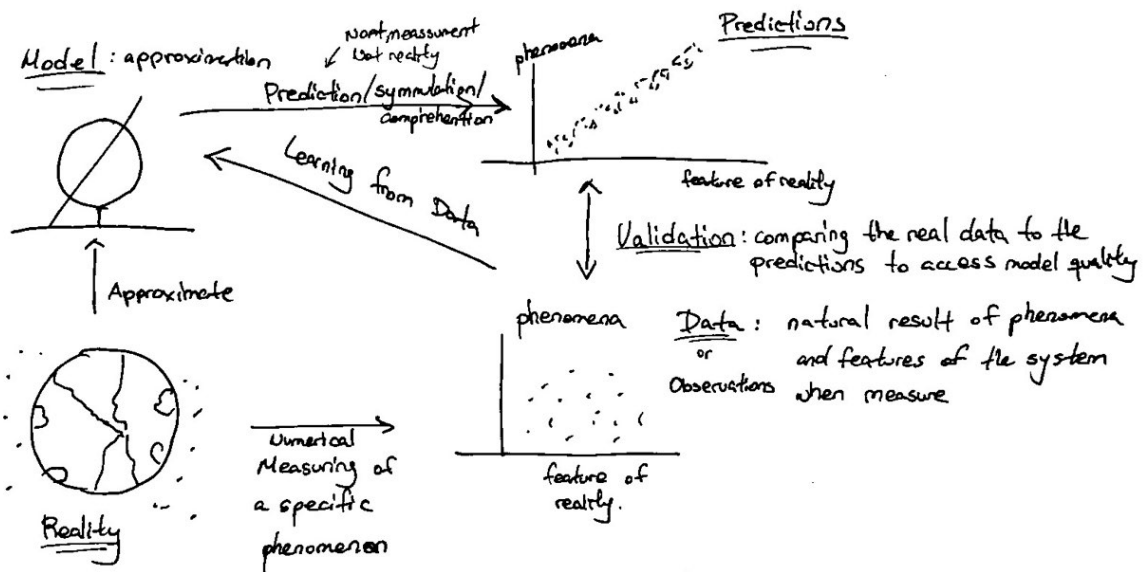| Model	Approx Reality
Model Airplane	Real Airplane
Street Map Wind Tunnel	Road system
Wind Tunnel	Fast Moving Air
"Early to bed Early to rise healthy and wise	Human Success

"All Models are _wrong_, but some are _useful_"
by definition   they serve useful - George Box.
                       function for us.
models are aproximation
which are technically wrong
$3.141593 \neq \pi$

Two main Goals of Models

① Prediction: Can the model will tell us what will happen to a certain phenomenon in a certain setting.
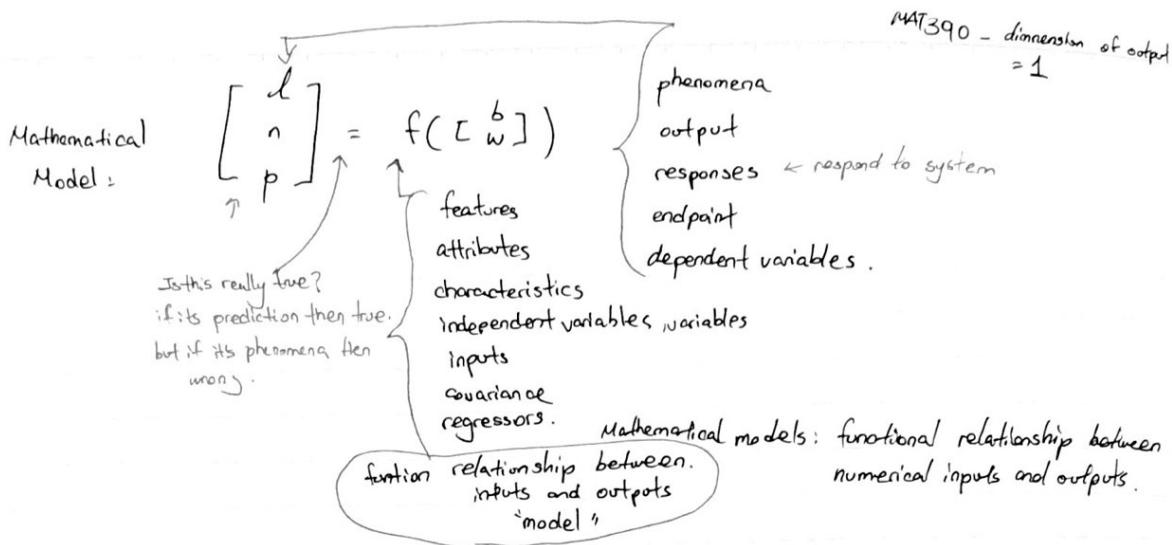
② Explanation: Understanding how the universe works.

Model: approximation
Noat/measurment ✓ bat reality
Prediction/symmulation/comprehention
phenomena   Predictions
feature of reality
Learning from Data
Approximate
Reality
Numerical Measuring of a specific phenomenon
phenomena
feature of reality.

Validation: comparing the real data to the predictions to access model quality

Data: natural result of phenomena
or   and features of the system
Observations   when measure

Mathematical Models

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

features of the system.

	Variables	Metrics	symbol
phenomena	ealy to rise	avg ——— 4AM.	w.
	heath	longavity (in years)	ℓ
	wealth	networth worth	n
	wisdom	cannor r/o	r

Variable	Metrics	symbol
Early to bed	Avg betw 10 24 hr tive	b
	Avg betw as measure by # min after 6pm eg. 368 vs 363	

Mathematical
Model :
$$\begin{bmatrix} l \\ n \\ p \end{bmatrix} = f(\begin{bmatrix} b \\ w \end{bmatrix})$$

phenomena
output
responses ← respond to system
endpoint
dependent variables .

features
attributes
characteristics
independent variables , variables
inputs
covariance
regressors .

Is this really true?
if its prediction then true.
but if its phenomena then
wrong .

function relationship between.
inputs and outputs
"model"

Mathematical models: functional relatilonship between
numerical inputs and outputs.

Assume reality can be explain by Mathematical Models which means:

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

one dimension
phenomena
we are modeling

that the function that "nature" uses
to create the measure as the
phenomena .

$\underbrace{}$ Casual inputs

Phenomenon : pay back loan

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

$$y = \{ 1 , 0 \} \quad \text{encoding}$$
$$\text{(output space)}$$

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

z_2 : criminal issue $\in \{0, 1\}$.

z_3 : access to branch $\in \{0, 1\}$

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

Big problem : we are totally ignorant of the z's and further we may not know
$f()$.

Next best thing.... Obtain features that approximates the casual 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 account balance

X_2 prior criminal record

X_3 internet access

X_4 credit scores