Math 390.4 01/29

"Models" are approximations & or abstractions to reality / absolute truth / System / phenomenon.

Model	~~Appro~~ Reality
Model Airplane	Real airplain
street map	road system
wind tunel	fast moving air
"early to bed early to raise makes man healthy & wise"	human success

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

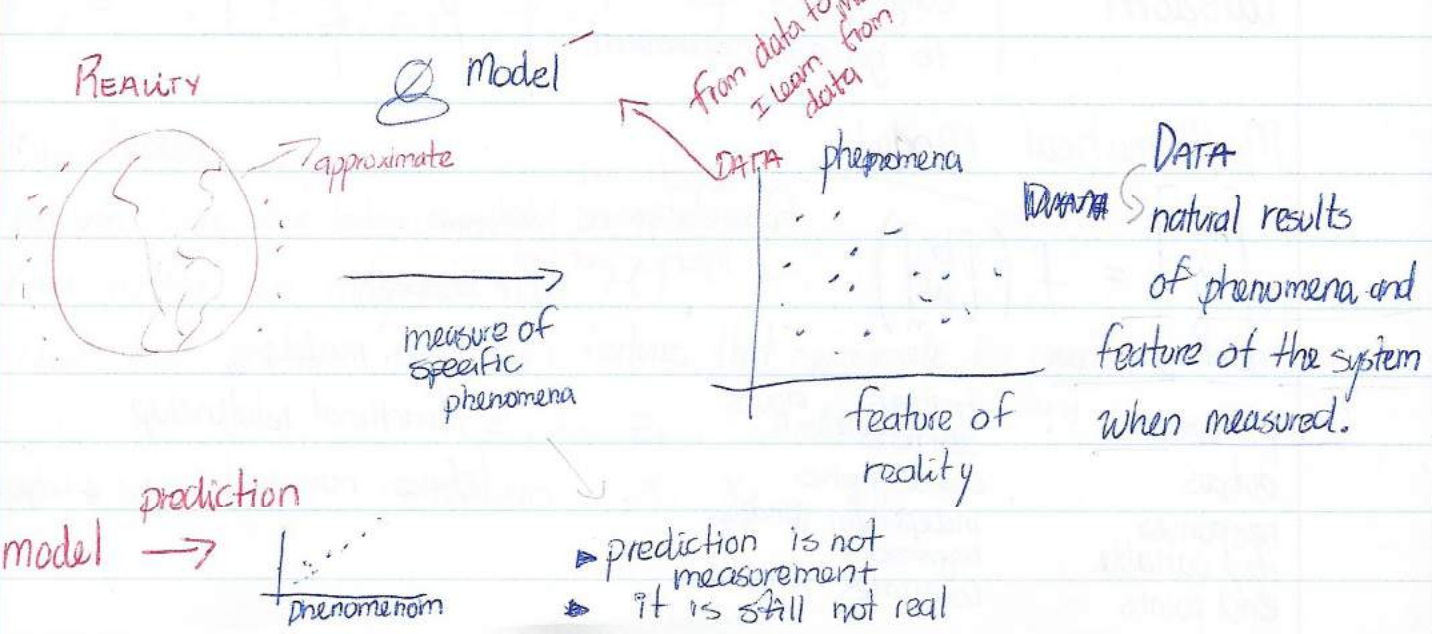
→ models by definition Approximations ~~which~~ which make them technicaly wrong. aproximation → $3.141513 \neq \pi$
→ they seem useful for us

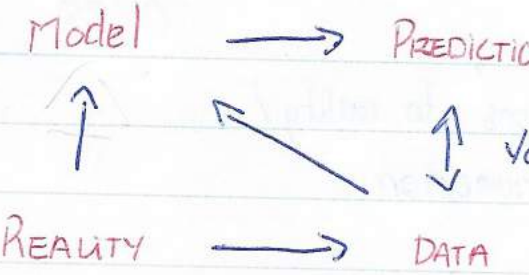
Goals & Models

Two main goals

① Prediction: ~~can~~ the model will tell us what will happen to a certain phenomenon, and external seting.

② Explanation: understanding how the world the universe works.





to check if real data match with predictions to assess model quality.

Mathematical Models

"Early to bed early to raise makes a man healthy & wise"

FEATURES OF SYSTEM → Variable: early bed → symbol: b

PHENOMENA.

Metrics: average bed time ~~24 hour~~ time ex, 22:20 — as measured by # after 6 pm

Variable	Metrics	symbol
early to rise	Average wake up as . . . 4AM	w
health	longevity in (years)	l
wealth	net worth	n
wisdom	Some kind of test to get a # measurement	p

Mathematical Model

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

f ⇒ functional relationship between inputs & outputs. ~~(Model)~~

Is this really true?

Math model: ↓
functional relationship between numerical input & output

phenomena
outpus
responses
dep variable
end points

features, inputs.
attributes
characteristics
independen Variables
regressors
covariates

"Assume that reality can be explained by mathematical models."

$$Y = t(Z_1, Z_2, \ldots Z_t)$$

Y: one dimention phenomena we are modeling

t: the function that "nature" uses to create the measure of phenomenon.

$Z_1, Z_2, \ldots Z_t$: Causal inputs

occurance
a fact

Phenomenon: pay back loan.

$Y = \{$pay back, no pay back$\}$

encoding.

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

Z_1: have sufficient funds day before $\in \{0,1\}$

Z_2: Criminal $\Rightarrow$ (if he wants to pay or not) $\in \{0,1\}$ $\rightarrow$ *

Z_3: access to branch $\in \{0,1\}$

(*) $Y = Z_1 (1 - Z_2) Z_3$ $\rightarrow$ ask why?

→ Big Problem

Problem ↘ we are totally ignorant of the Z's

And further, we may not know $t()$ $\rightarrow$ $t(Z_1, Z_2 \ldots Z_t)$

→ NEXT BEST THING. . . obtain features that approximate the causal information in Z_1, Z_2, Z_t. Denote these features $X_1, X_2 \ldots X_p$.

(ex)

X's features from people to match the Z's

X_1: income,

X_2: prior criminal record

X_3: have internet

X_4: credit score

" $f \rightarrow$ model "

" $t \rightarrow$ reality

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Assume

$Y = t(Z_1, \ldots Z_t)$

it is not the model, it is the reality.

find the Z's with X_i or something very close to Z