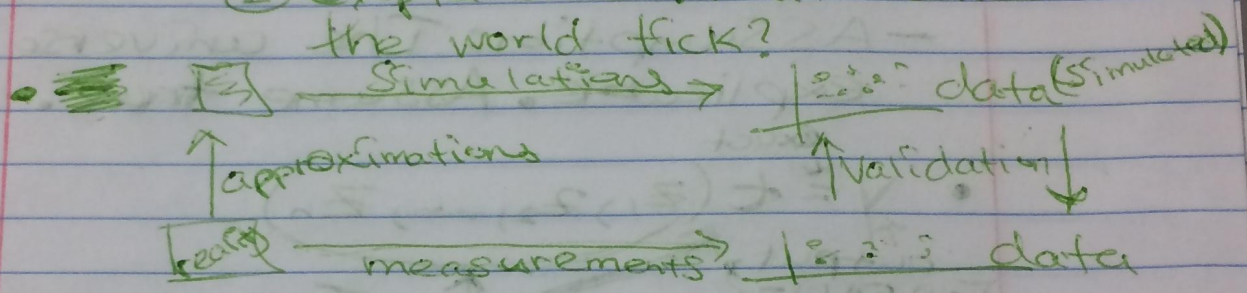


- \* "Models" are abstractions/approximations to reality/absolute truth/system/phenomenon.  
e.g. model airplane → airplane  
City street map → City Streets  
Wind tunnel → air flow

— "All models are wrong [not reality] but some are useful" — George Box  
→ Useful meaning: ① predictions: What happens in a certain situation?

② Explanation: What makes the world tick?



— data: Results of a system which is measured.

— Validation: Comparison of the measured data to the predictions. If they're "close" → the model is "good." If not, we can rebuild the model, and get close.

• Example: "Early to bed, Early to rise, makes a man healthy, wealthy and wise."

$$\begin{bmatrix} \text{Health} \\ \text{Wealth} \\ \text{Wisdom} \end{bmatrix} = f(\text{bedtime}, \text{wake time})$$

outputs inputs

— This model is "imprecise"; we need #'s and numerical measurements.



→ bed time: Avg. 24-hour time.

→ Wake time: "0".

→ health: "0".

→ wealth:  $\text{IDK} \dots$

→ wisdom:

- Mathematical models ~~models~~  $\mathcal{C}$  models have numeric inputs/outputs related by an equal sign

— Familiar examples:

$$\begin{array}{ccc} \uparrow & & \uparrow \uparrow \\ F = ma = f(m, a) \\ \text{output} & & \text{inputs} \end{array}$$

$$\rightarrow E = mc^2$$

— Assumption: The universe is explicable. Assume true.

<sup>exact</sup>  
•  $Y = t(z_1, z_2, \dots, z_n)$

$\uparrow$   
output,  
[:: REALITY

that's hopefully  
~~close~~  $\approx$  to  
ACTUAL  $\uparrow$

response, outcome  
endpoint, dependent  
variable.

True relationship between  
the causal inputs and  
the outputs.

"True" causal inputs  
information.

— Example: Creditworthiness.

$$Y \in \{\text{creditworthy, uncreditworthy}\}$$

→ Not a mathematical model.

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

→ True Causal Inputs

$Z_1$ : has enough money in the bank.  $\in \{0, 1\}$ .

$Z_2$ : Unforseen  $\in \{0, 1\}$ .

$Z_3$ : Criminal intent.



$$\rightarrow y = t(z_1, z_2, z_3) = z_1(1 - z_2)(1 - z_3).$$

$\rightarrow$  Biggest Problem here:  
 $\{z_1, z_2, z_3\}$  are undesirable,  
not able to be measured.