"Models" are abstractions/approximations to reality/absolute truth/system/phenomenon

Examples of Models

Model Airplane → airplane

Street Map → city streets

Wind Tunnel → airflow

"All Models are wrong but some are useful." - George Box

↓ not reality

↓
① predictions: what happens in a certain situation?
② Explanations
↳ what makes the world tick?

Data via Simulation
(Validate ↑)
Data via Direct Measurements

Why not just go w/ data via Direct Measurements?
There is more control w/ simulation rather than in reality.

Definition

Validation: comparison of the measured data to the prediction if they are "close", then the model is real. If not, we can rebuild the model, iterate and go closer

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Model

"Early to bed
Early to rise
Makes a man
healthy, wealthy,
and wise"

Let's take this aphorism and see if it's a valid model

output inputs

$$\begin{bmatrix} \text{healthy} \\ \text{wealthy} \\ \text{wise} \end{bmatrix} = f(\text{bedtime}, \text{waketime})$$

The previous model is "imprecise", we need numbers and numerical measurements.

Let's take our parameters and outputs to see if there is a way to acquire numerical measurements:

- bedtime: average of 24 hr. time
- waketime: average of 24 hr. time
- health: longetivity
- wealth: net worth
- wisdom:

(MM)
Mathematical Model $\subset$ Models

- MMs have numeric inputs and outputs
- MMs are related by an equal sign

Famous Examples:

$F = ma = f(m, a)$ $\quad E = mc^2 = f(m, c)$

F: output; m, a: 2 inputs

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

y: output / response / outcome / endpoint / dependent variable

$(z_1, z_2, \ldots z_t)$: "true" causal input information

t: "true" relationship between the causal inputs and the output.

=: Exact

An Example of this relationship is w/ Creditworthiness:

where $y \in \{\text{creditworthy}, \text{uncreditworthy}\}$

$\therefore Y = \{0, 1\}$ w/ y being our outputspace.

True Causal Inputs

z_1: has enough money at the time the loan is due $\in \{0,1\}$

z_2: unforeseen emergency $\in \{0,1\}$

z_3: criminal intent

Bigger Problem

$\{z_1, z_2, z_3\}$ are unobservable; not able to be measured; unaccessable

Smaller Problem

we don't know t

End of Theory. For practice w/ R, look at the Repo.