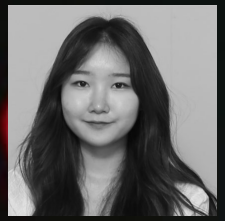
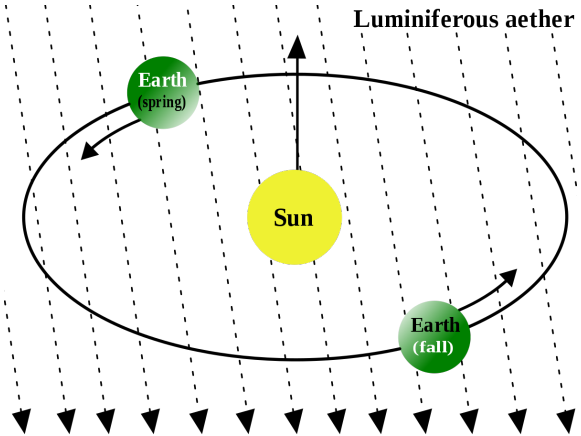


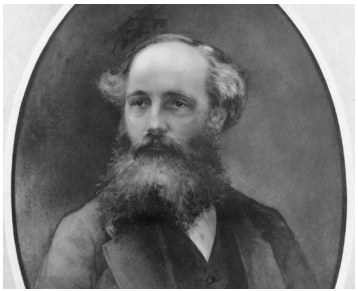
Reconstructing Ground Truth

Estelle, MJ, and Omar

Does science bring us closer to the Truth?

Science believed aether





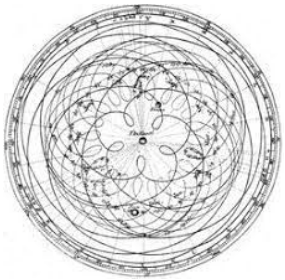
James Clerk Maxwell

"light propagate through aether"

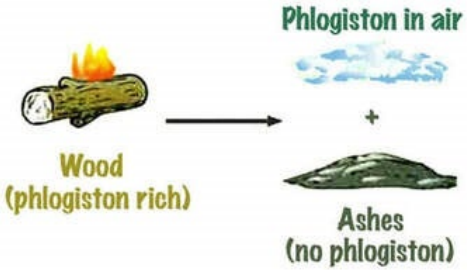
It had to be ***a fluid*** in order to fill space, but one that was millions of times ***more rigid than steal*** in order to support high frequencies of light waves. It also had to be ***massless and without viscosity***, otherwise it would visblty affect the orbits of planets. Additionally it appeared it had to be completely ***transparent, non-dispersive, incompressible, and continuous*** at a very small scale.

- Maxwell

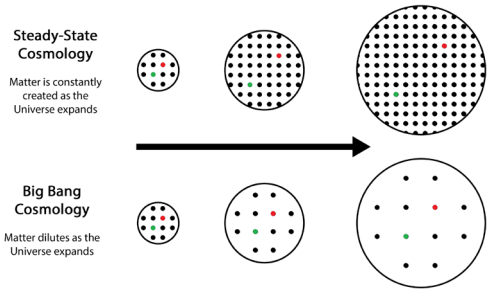
Many superseded theories in science



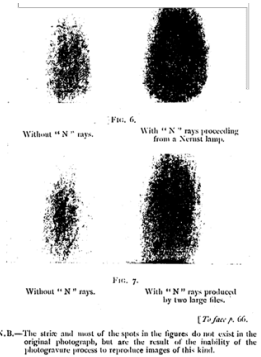
Geocentrism



Philogiston theory

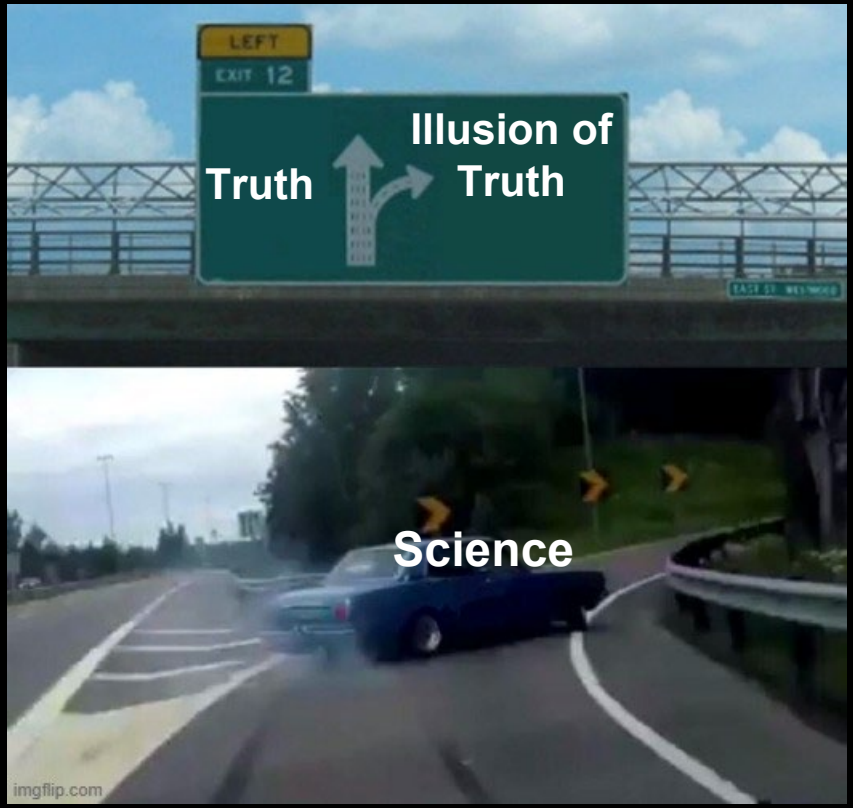


Steady-state cosmology



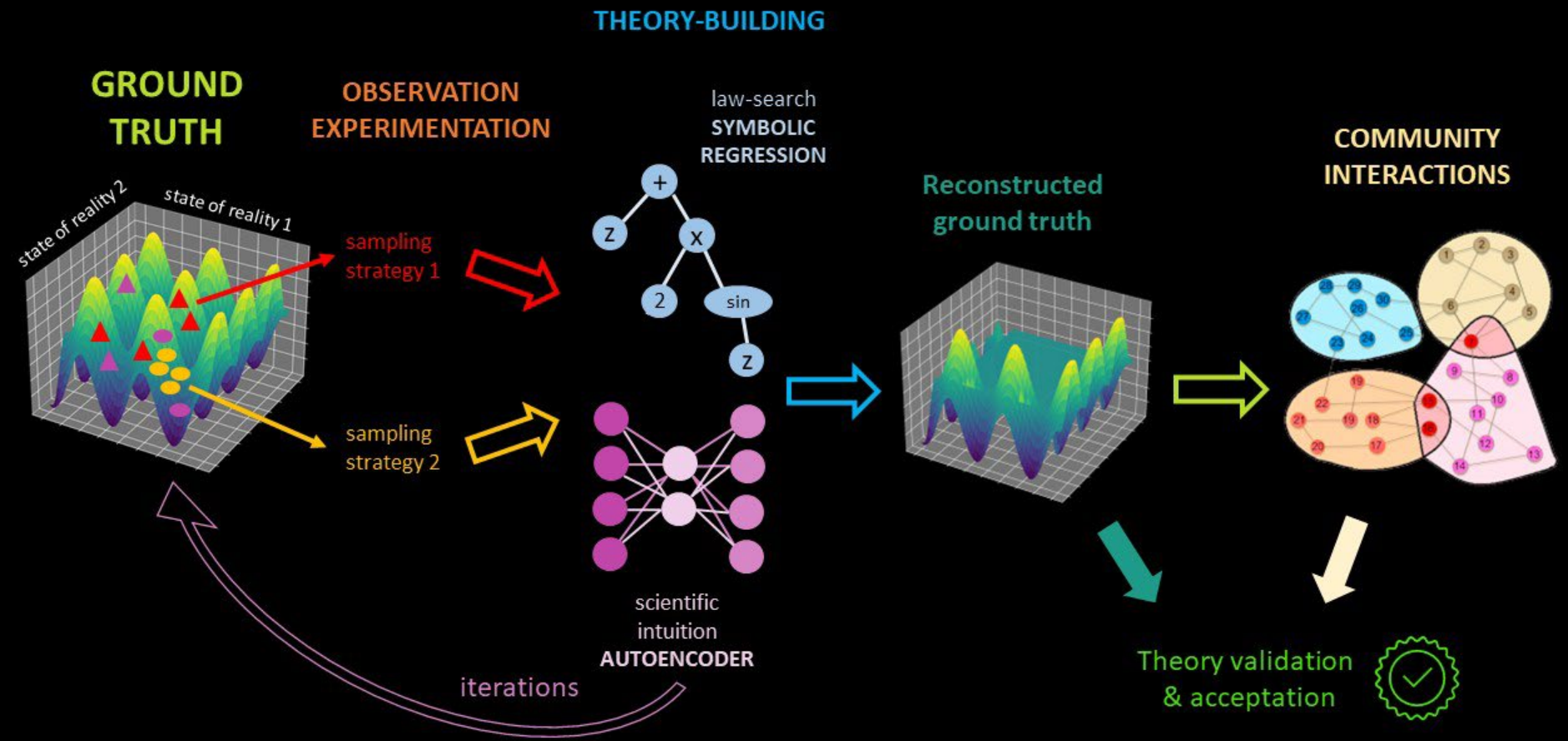
N-rays

Falsifiability does not garantee that science reaches the truth


LEFT
EXIT 12
Truth
Illusion of Truth
Science
imgflip.com

In which scenario, does science become an epistemic illusion?

Simulating the lifecycle of scientific theories: our pipeline



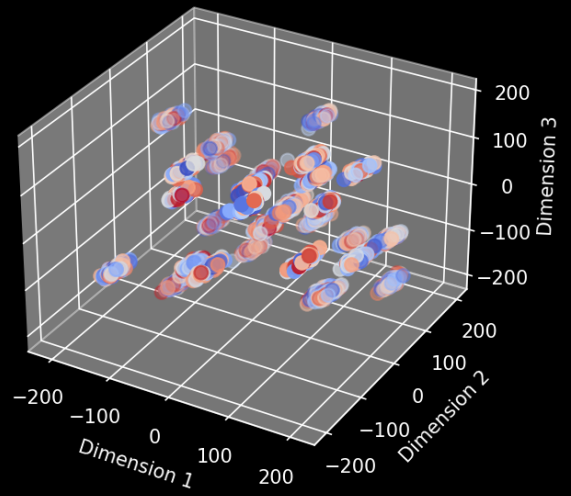
Defining Ground Truth

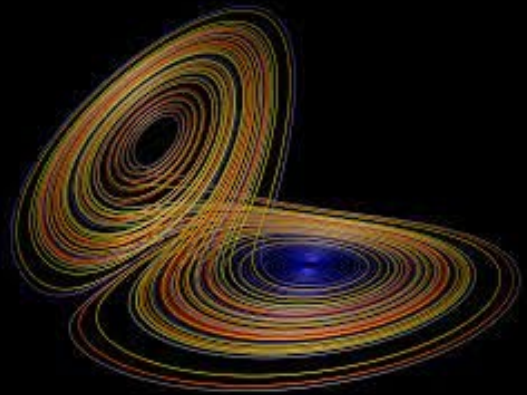
Fundamentally unknown
High-dimensional

<u>Two strategies:</u>

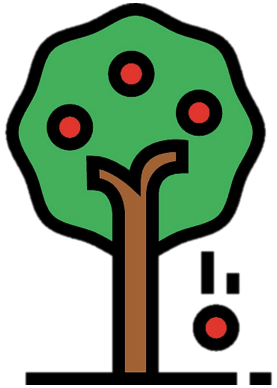
Random distributions
e.g., multivariate Gaussian distribution

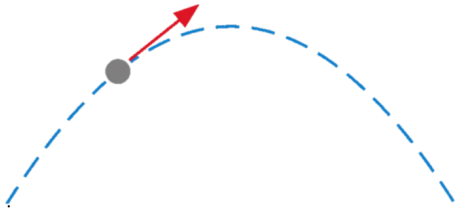
Physically-motivated ground truth
e.g., set of equations
(Lorenz equations, ubiquitous power laws…)

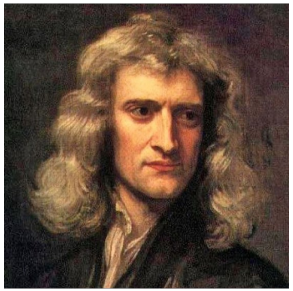




Observation and Intuition

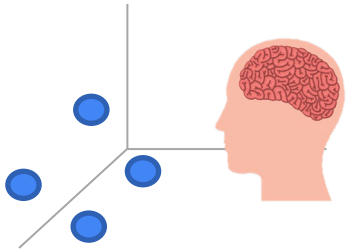




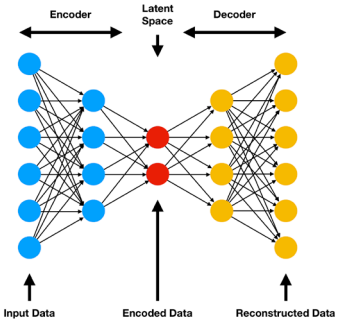


"A change in motion is proportional to the motive force impressed"

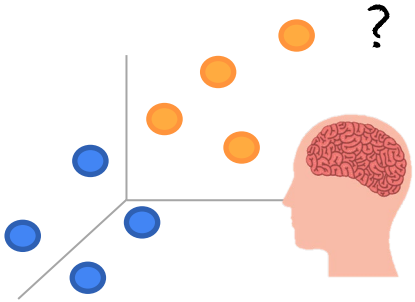
Observation and Intuition



Observing sparse data



Auto-encoder is trained

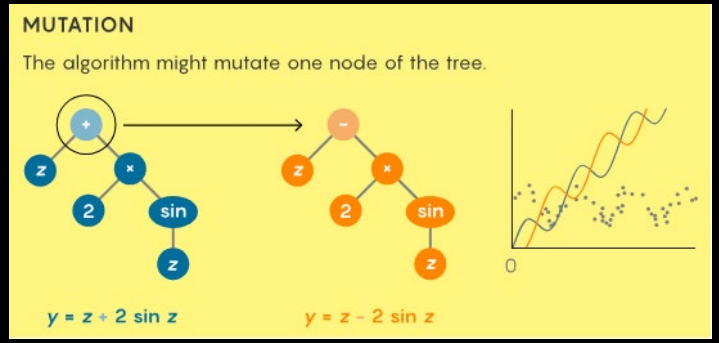


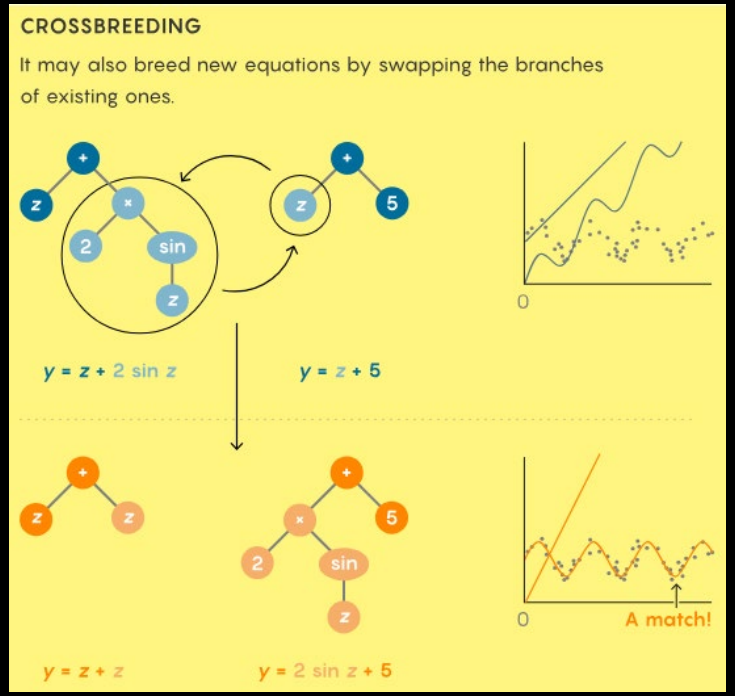
Find the data point showing the least reconstruction error (Thought experiment)

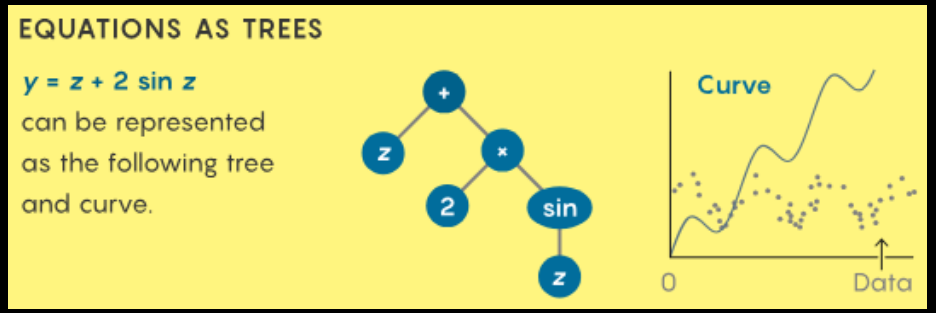
Modelling the theorization process

- Symbolic regression via Genetic Algorithms

1. Initialize
2. Evaluate
3. Select
4. Mutate
5. Crossbreed
6. Repeat!

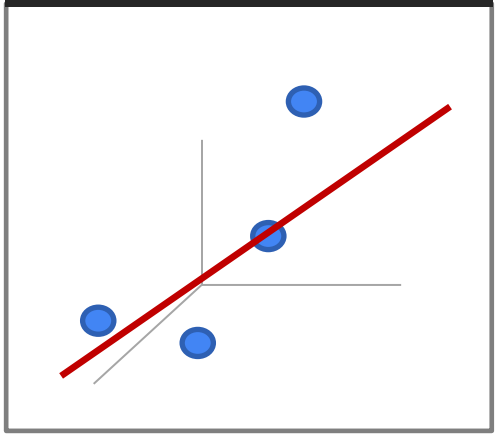




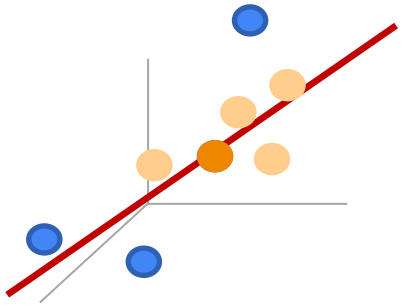


Experiment

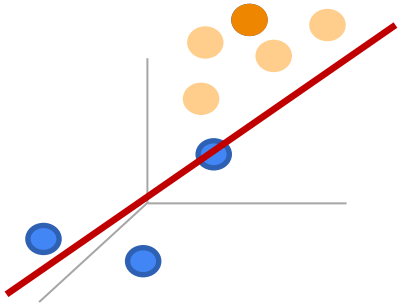
Chosen Formula



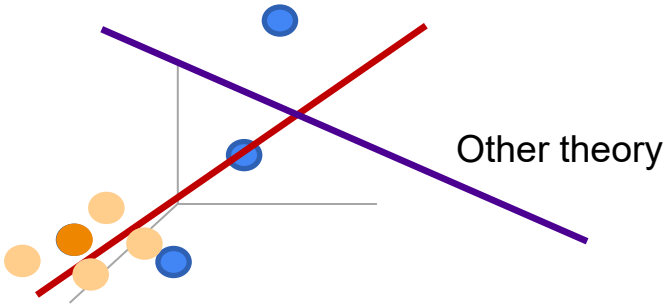
Confirmation



Falsification



Disagreement



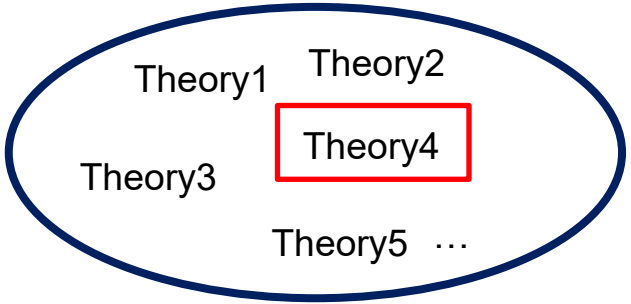
Social dynamics

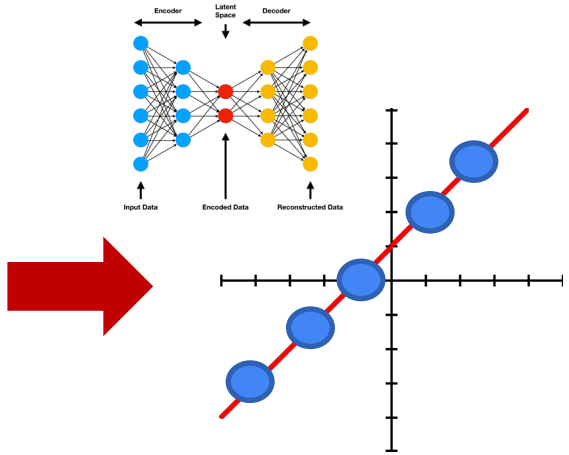
Students

Researchers

Social dynamics - training

Students

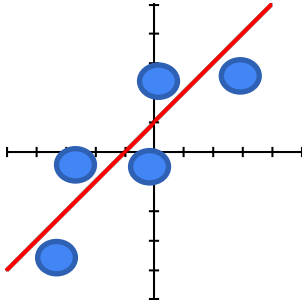




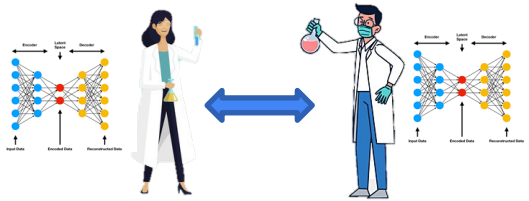
Auto-encoder is trained with the randomly selected data points which perfectly align with the best formula

Social dynamics - communication

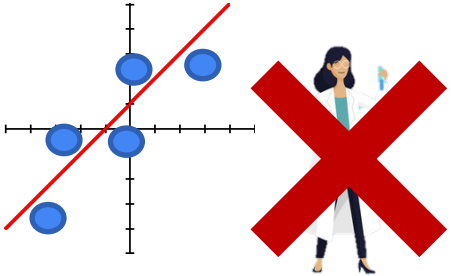
Researcher



Negative results are less shared than positive results



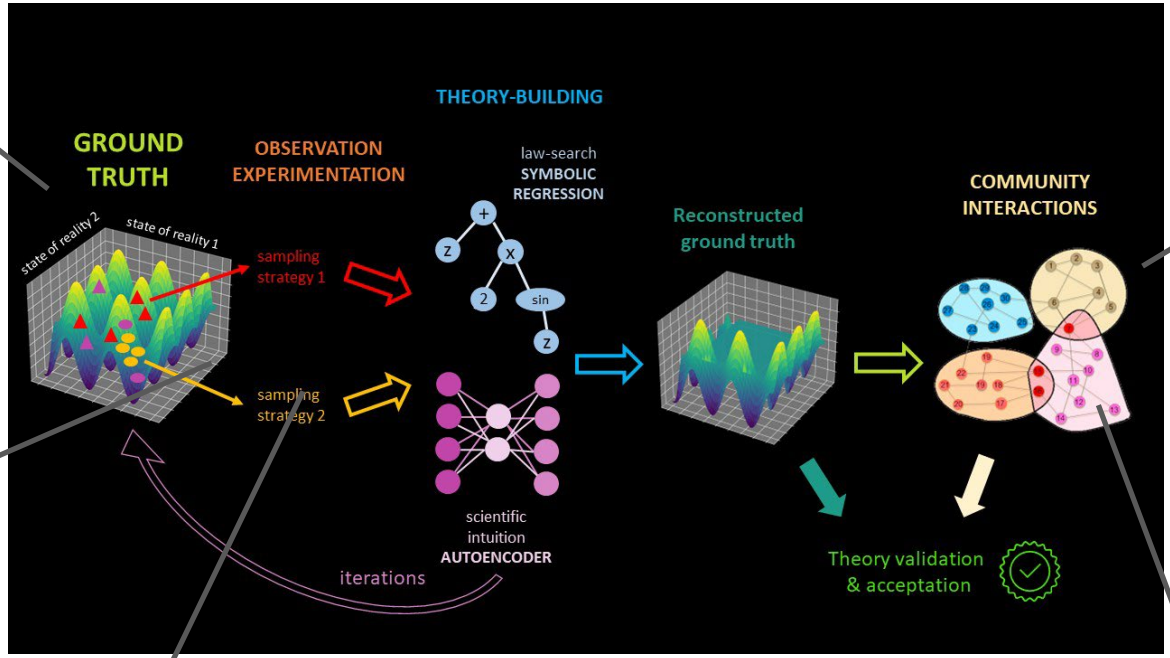
Two researchers (auto-encoders) average their weights



Agent is deleted if it fails to publish enough positive results

Simulation parameters

- Can we capture paradigm shifts?
- In which way, can we prevent the illusion?



Shape of ground truth

Dimension capacity to record

Sampling Strategies

Average weights based on prestige

Sharing of negative results

Future Plan

Against theory-motivated experimentation in science

Marina Dubova[1,2,3], Arseny Moskvichev[4], Kevin Zollman[2,3]

[1]Cognitive Science Program, Indiana University, Bloomington, IN USA

[2]Department of Philosophy, Carnegie Mellon University, Pittsburgh, PA USA

[3]Center for Formal Epistemology, Carnegie Mellon University, Pittsburgh, PA USA

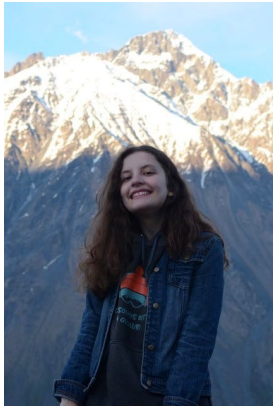
[4]Department of Cognitive Sciences, University of California, Irvine, CA USA

Contact: marina.dubova.97@gmail.com

An Evaluation of Experimental Sampling Strategies for Autonomous Empirical Research in Cognitive Science

Sebastian Musslick[1,2,3], Joshua T. S. Hewson[1], Benjamin Andrew[1], Younes Strittmatter[1,2], Chad C. Williams[1], George T. Dang[4], Marina Dubova[5], & John G. Holland[4]

[1]Carney Institute for Brain Science, Brown University; [2]Department of Cognitive, Linguistic, and Psychological Sciences, Brown University; [3]Institute of Cognitive Science, Osnabrück University; [4]Center for Computation and Visualization, Brown University; [5]Cognitive Science Program, Indiana University
Corresponding Author: sebastian@musslick.de



Marina Dubova

Arsney Moskvichev

- Make some concrete examples of ground truth shape
- Implementation of finding the data points with the smallest reconstruction error
- Implementation of symbolic regression and social dynamics





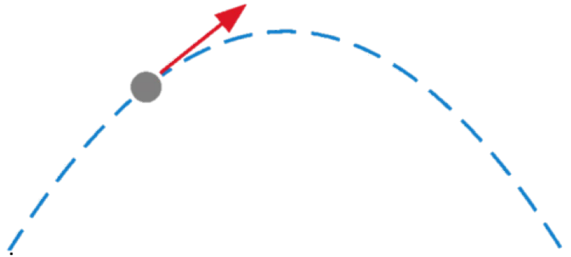
Thank you!

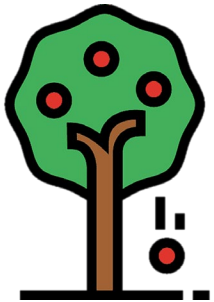

Experiment

Observation

Model

Observation

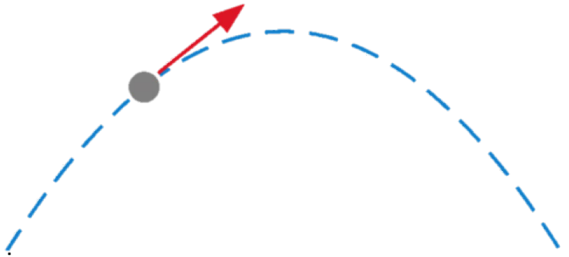




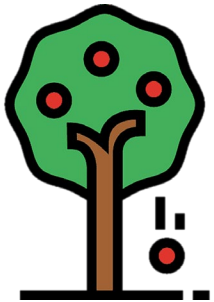
Model

A change in motion is proportional to the motive force impressed and takes place along the straight line in which that force is impressed

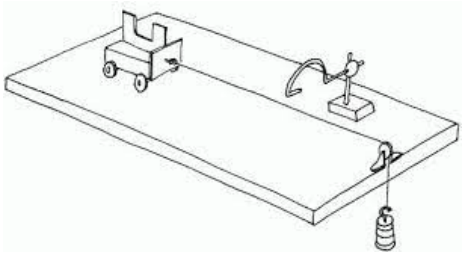
$$F = dp/dt$$



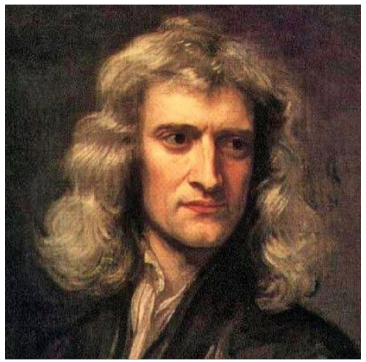
$$F \sim \frac{m_1 m_2}{r^2}$$

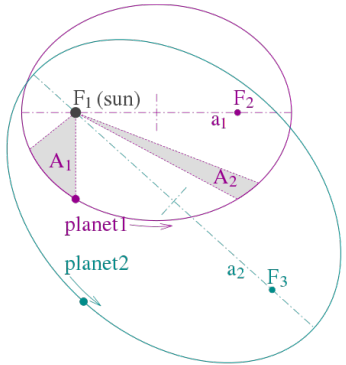


Experiment

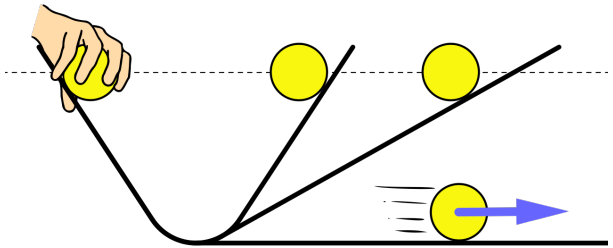


Social learnig





Kepler's law



Galileo's thought experiment