



We Are Modelers, Pressing Our Models



We Are Modelers, Pressing Our Models

How do we model?



We Are Modelers, Pressing Our Models

How do we model?

To what extent
can we model?





We Are Modelers, Pressing Our Models

How do we model?

To what extent
can we model?

Why do we model?





We Are Modelers, Pressing Our Models

How do we model?

To what extent
can we model?

Why do we model?

What are the ***long-term consequences***
of our modeling?



The First Modelers





The First Modelers

Goal: Food!





The First Modelers

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- Where will deer be given current conditions?





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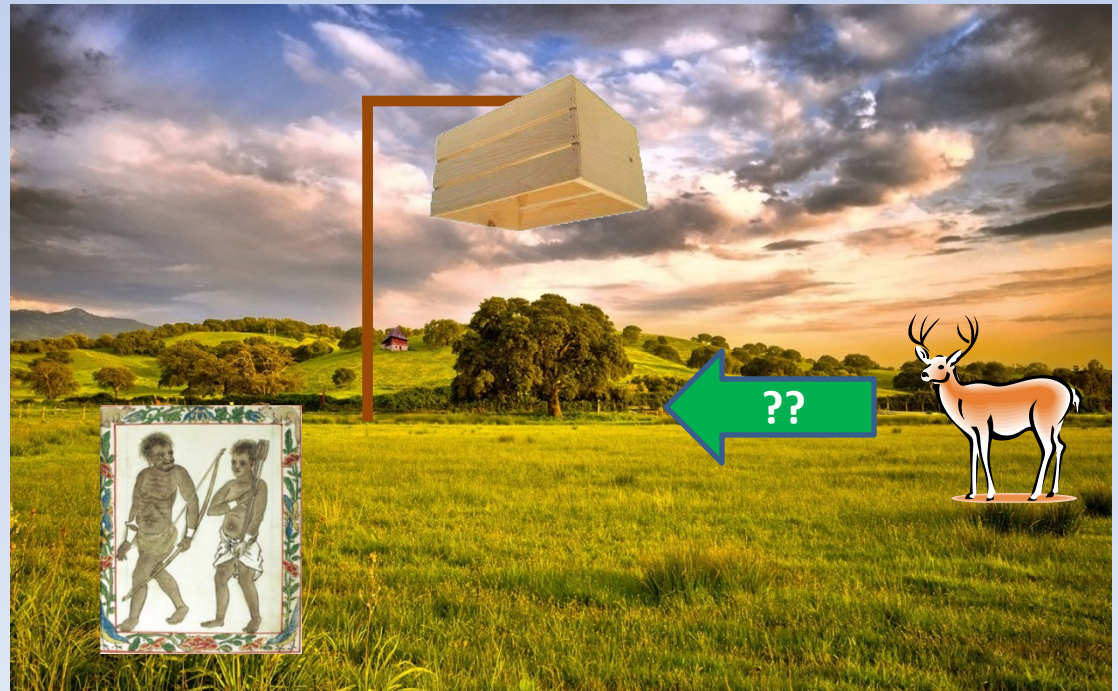




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Goal: Food!

- Where will deer be given current conditions?
- What conditions will make deer most likely move under the trap?





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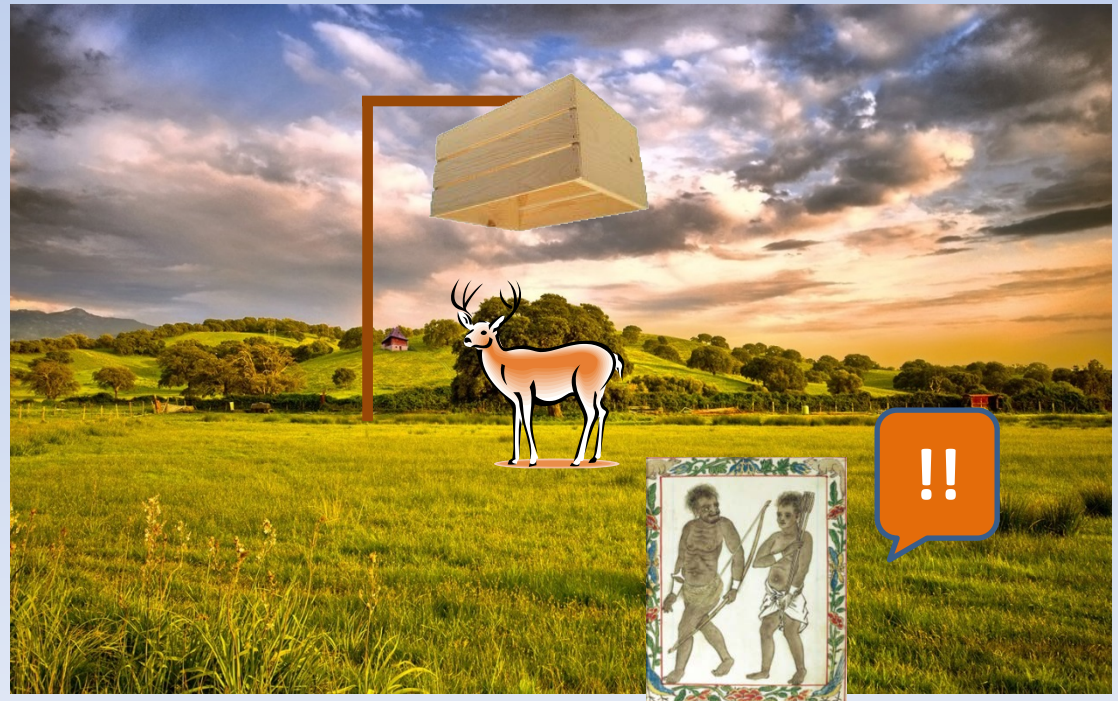




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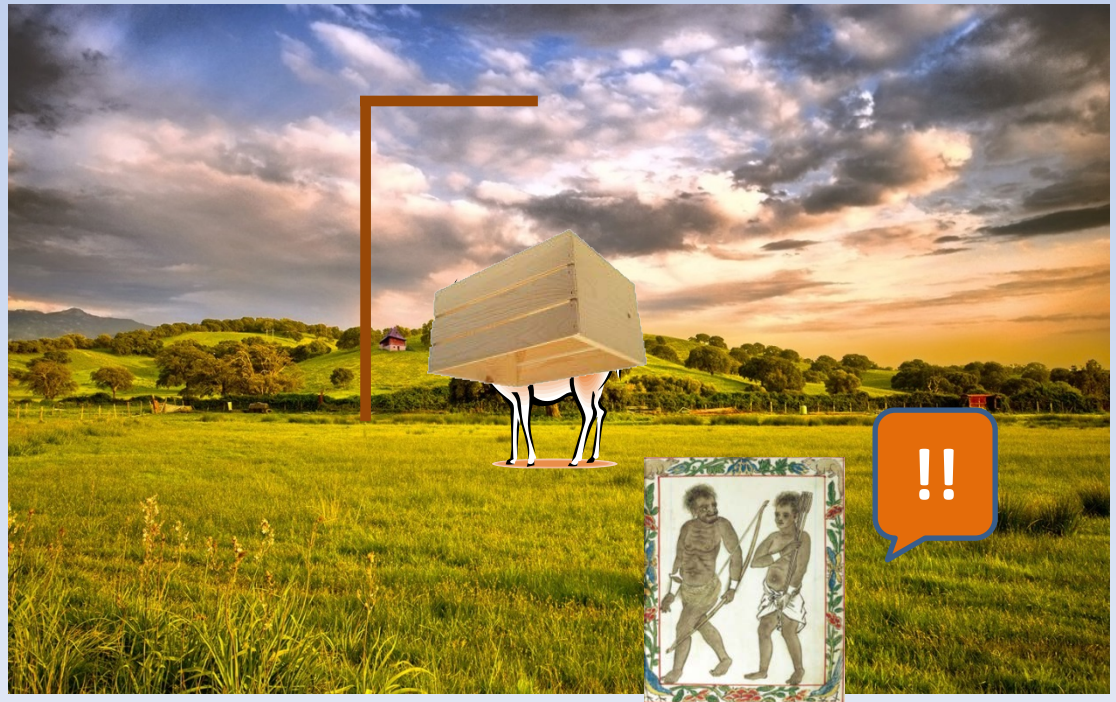




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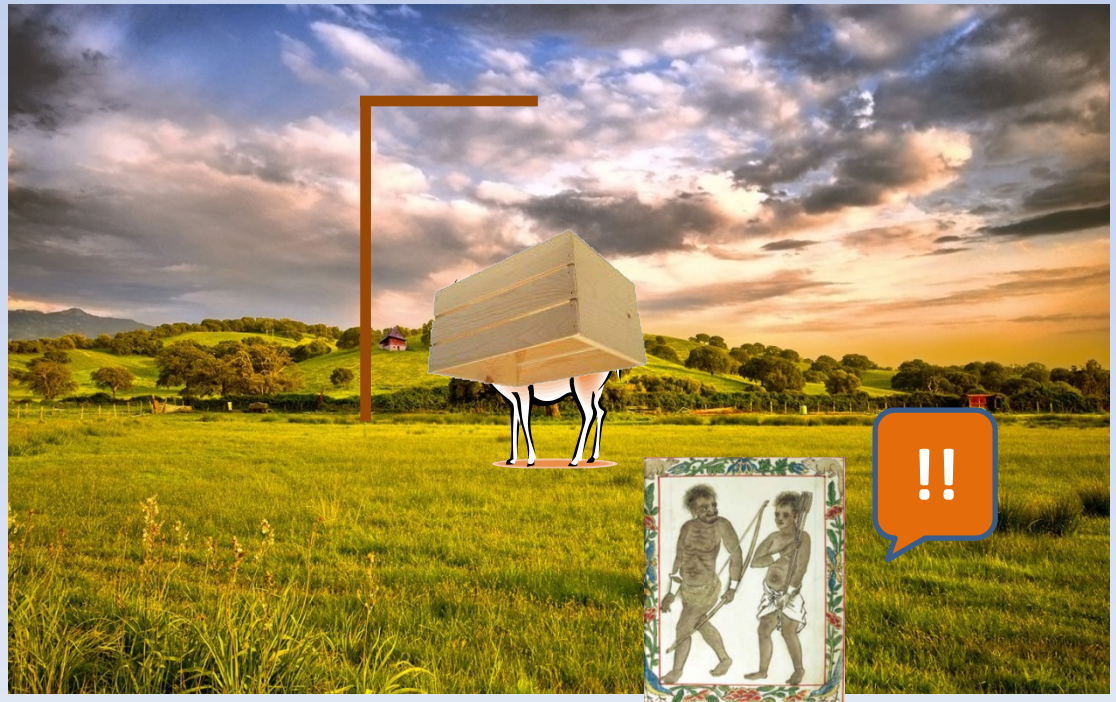
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➤ **Prediction**

$$P(y|x) = ?$$

$$P(\text{DeerPos}_{t+1} | \text{state}_t) = ?$$



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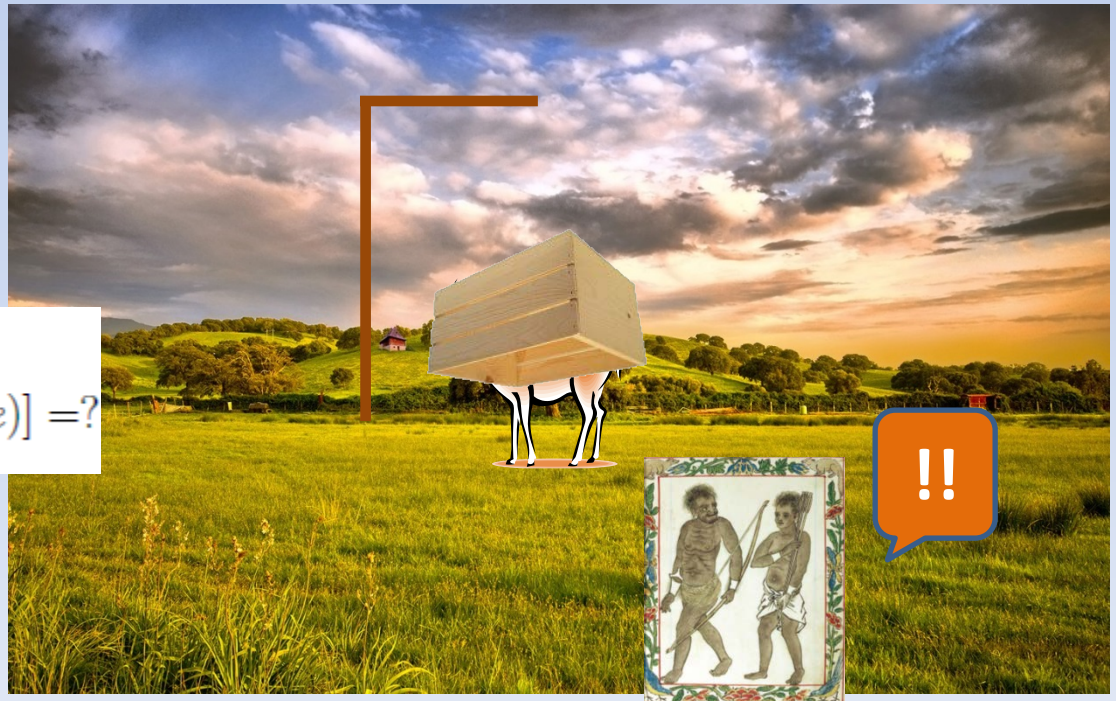
- **Prediction**
- **Explanation**

$$P(y|x) = ?$$

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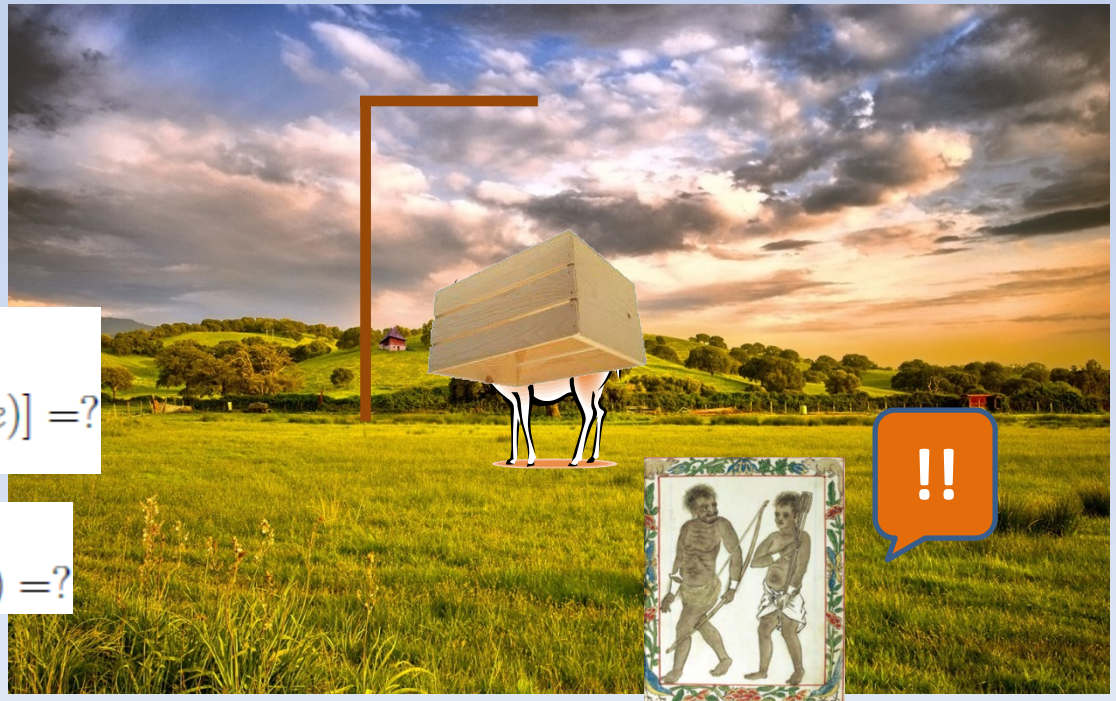
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Inference Queries

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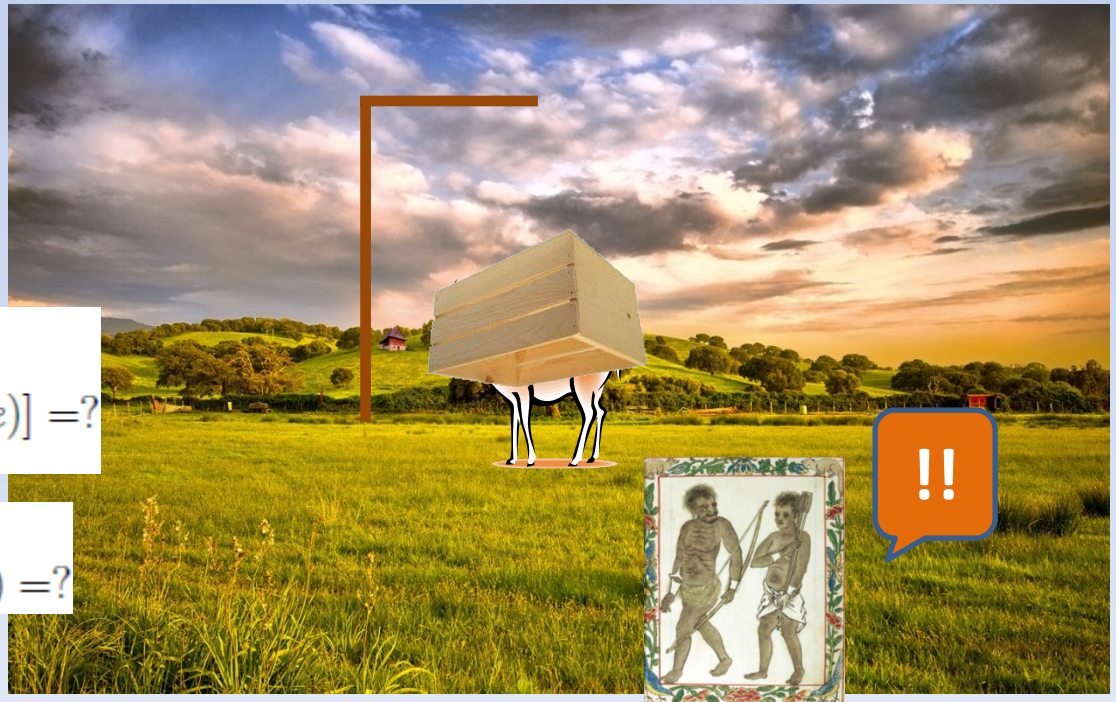
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Inference Queries

Computable!

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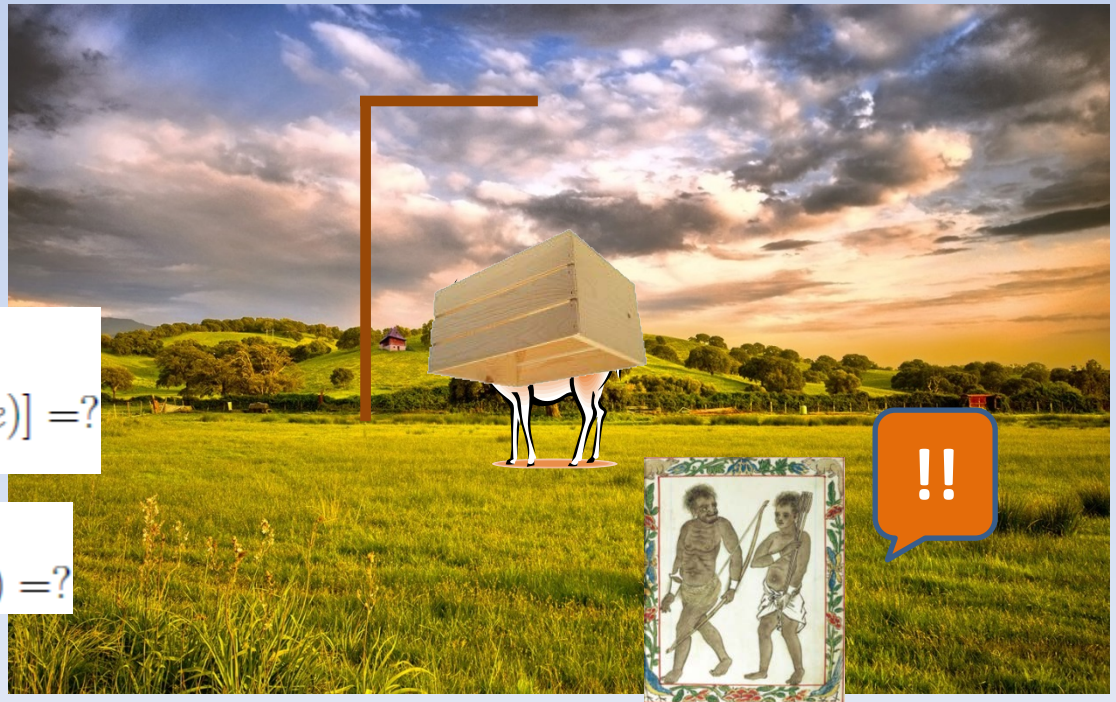
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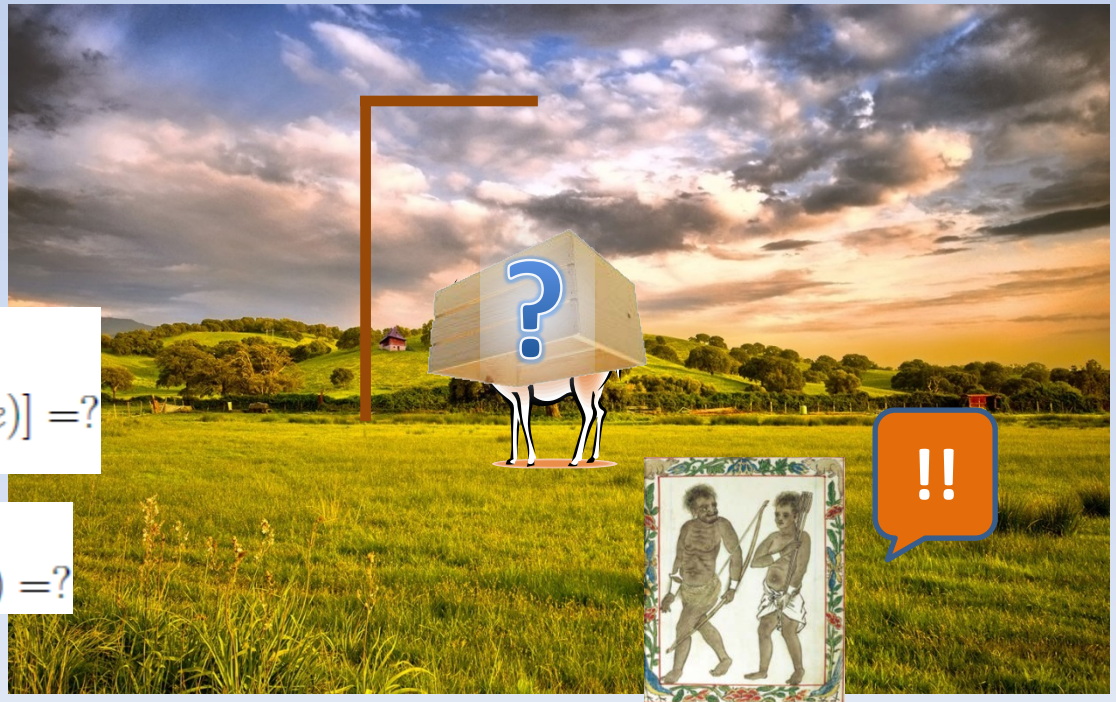
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Limits





God?



Limits



Limits



“What are the limits of our models?”



Limits



“What are the limits of our models?”
“How do we acquire knowledge?”



Limits



“What are the limits of our models?”
“How do we acquire knowledge?”

→ *Epistemology*



Limits



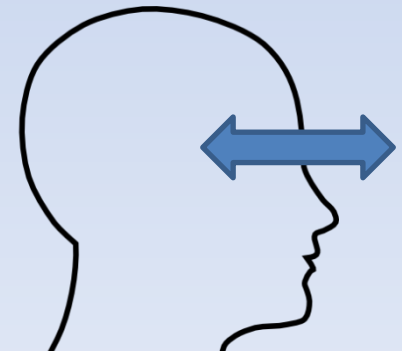
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Empiricists

Senses

Knowledge ← **Environment**



Limits



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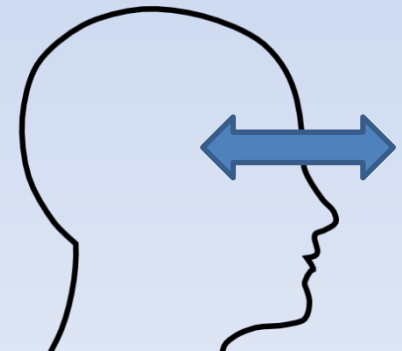
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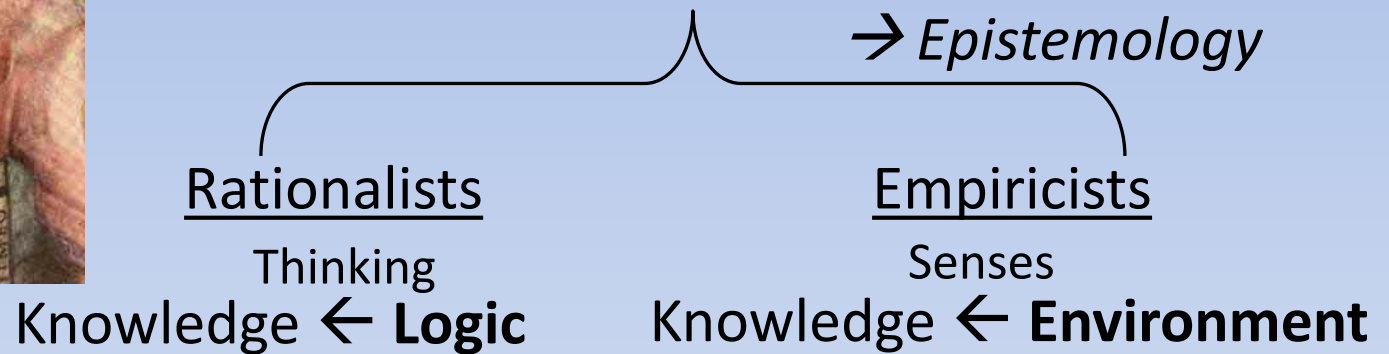
Observe Everything → Know Everything



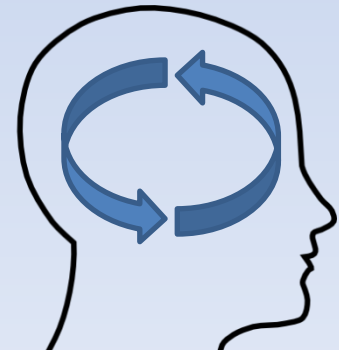
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Limits



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Rationalists

Thinking

Knowledge ← **Logic**

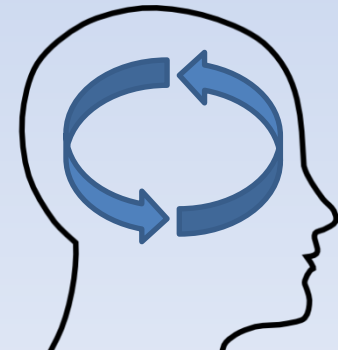
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Compute Everything → Know Everything

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Limits



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Empiricists

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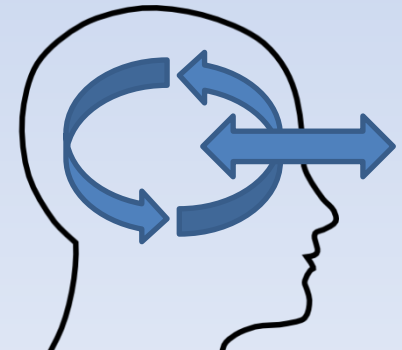
Observe Everything → Know Everything

God-Machine?

∞ processing

∞ memory

∞ bandwidth



Limits



“What are the limits of our models?”
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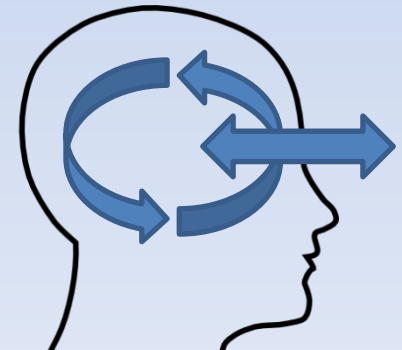
Compute Everything → Know Everything

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God-Machine?

∞ processing
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**Can we reach the
God Machine?**





Reality Check: Hard Limits

lim

lim

lim



Reality Check: Hard Limits

Physical
Measurements

Heisenberg

$$\sigma_x \sigma_p \geq \frac{\hbar}{2}$$

lim

lim



Reality Check: Hard Limits

Physical
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lim

Knowledge

Gödel
Incompleteness

Complete \oplus Consistent



Reality Check: Hard Limits

Physical
Measurements

Heisenberg

$$\sigma_x \sigma_p \geq \frac{\hbar}{2}$$

Physical
Manipulation

Thermodynamics

$$\Delta S \geq 0$$

Knowledge

**Gödel
Incompleteness**

Complete \oplus Consistent



Reality Check: Hard Limits

Physical Measurements	Physical Manipulation	Knowledge
Heisenberg $\sigma_x \sigma_p \geq \frac{\hbar}{2}$	Thermodynamics $\Delta S \geq 0$	Gödel Incompleteness Complete \oplus Consistent

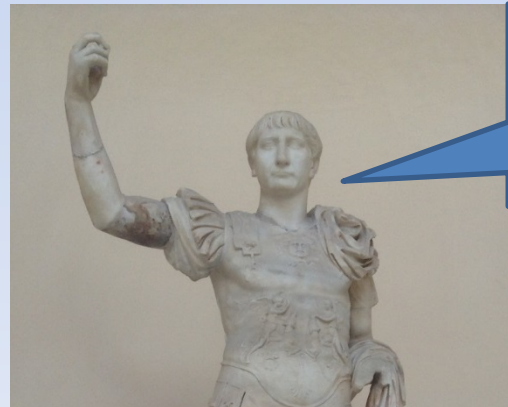
PERFECTION



Reality Check: Hard Limits

Physical Measurements	Physical Manipulation	Knowledge
Heisenberg $\sigma_x \sigma_p \geq \frac{\hbar}{2}$	Thermodynamics $\Delta S \geq 0$	Gödel Incompleteness Complete \oplus Consistent

PERFECTION



But we can
get closer!

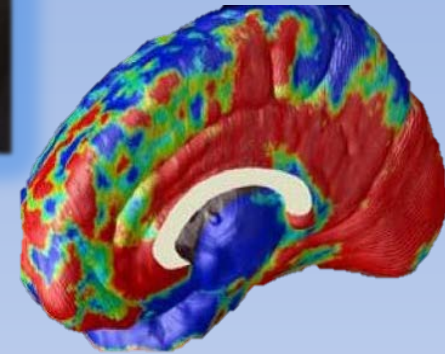


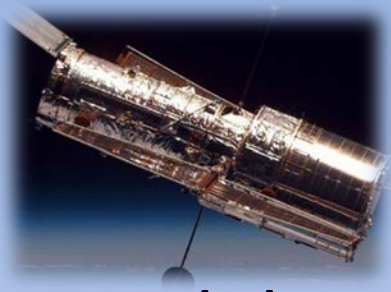
Push the Limits



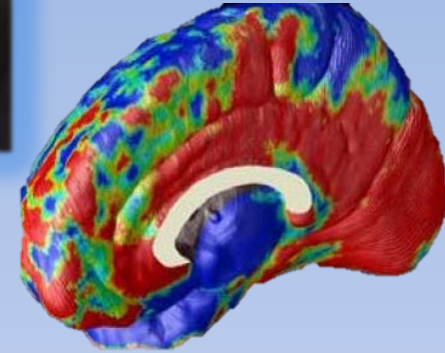
Push the Limits

- Push bandwidth (I/O)
 - More Data, More *Relevant* Data



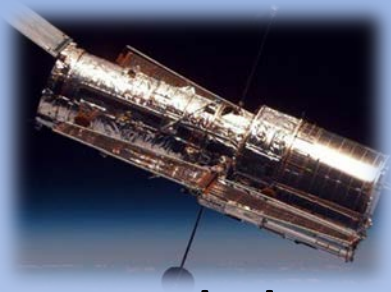


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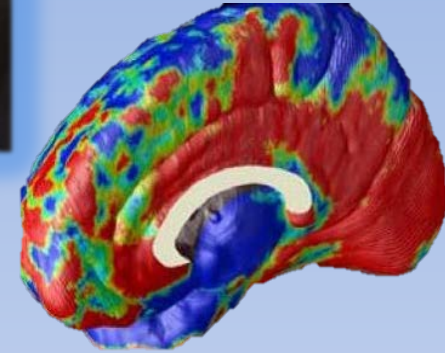


- Push bandwidth (I/O)
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 - Summarize and condense (Hash)





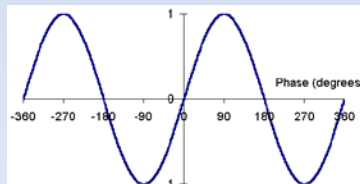
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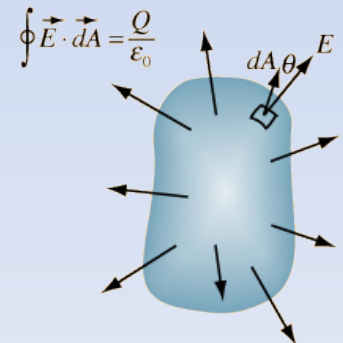
- Push bandwidth (I/O)
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- Push Computation (Processor)
 - New ways of thinking → Theories
 - Classical to Probabilistic



123

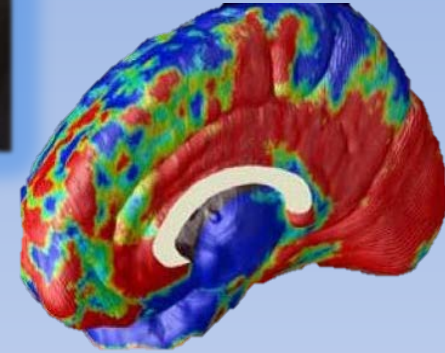


xyz

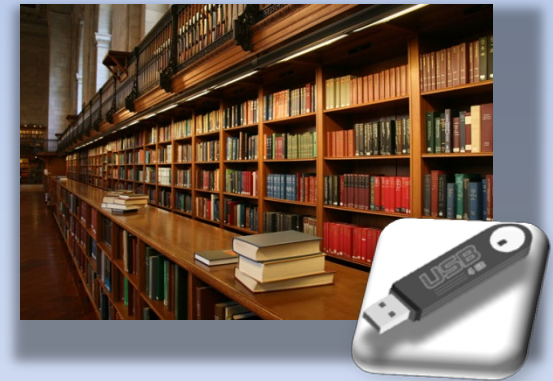




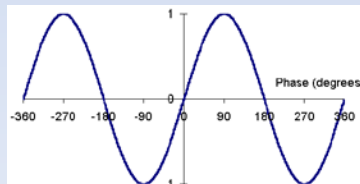
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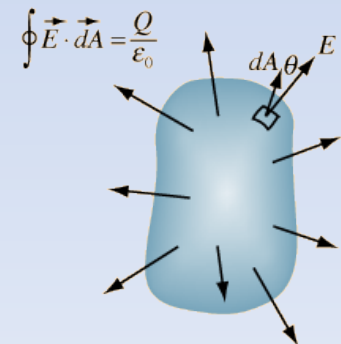
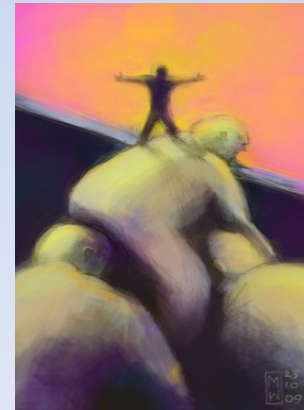
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 - Classical to Probabilistic
 - Increase thinking efficiency



123



XYZ





Taking Models to the Next Level



Taking Models to the Next Level


- Accuracy & Precision ↗
 - Assumptions ↘
 - Minimize error
- Compatibility w/ other models ↗ (Unification)
- Computability ↗
- Simplicity ↗ (*Language*)



Taking Models to the Next Level

- Accuracy & Precision ↗

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Scientists: expand knowledge via ↗ models

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The Bottom Line:

Within limitations, make *most likely* inferences

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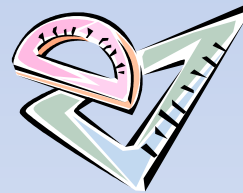
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Engineering: leverage all knowledge & Solve problems

The Bottom Line:

Within limitations, make *most likely* inferences



For what purpose?





For what purpose?

- 1) Advance humanity toward *your future vision*
➔ Your meaning of life



For what purpose?

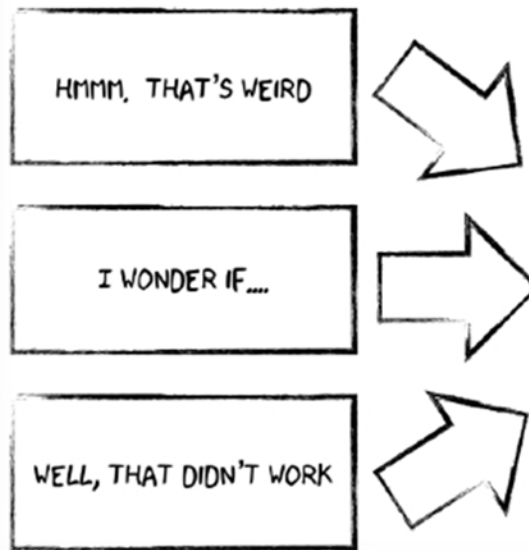
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 - ➔ Your meaning of life
- 2) **FUN!** Enjoy everything...
 - ➔ Creation process, outcome, camaraderie

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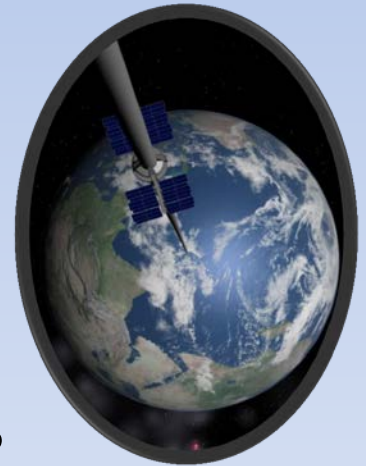


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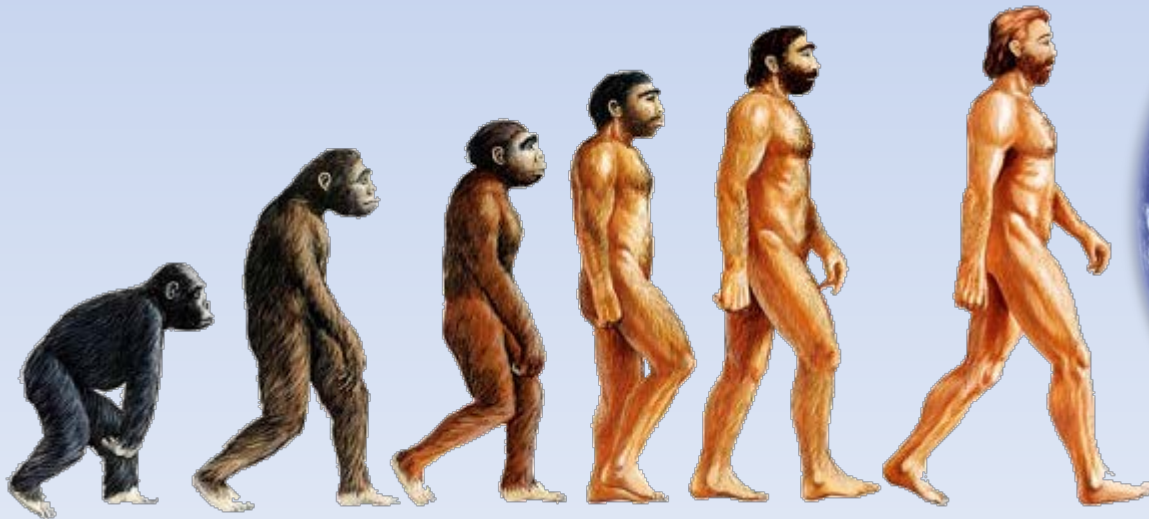
Better...

- Predictions
- Explanations
- Interventions

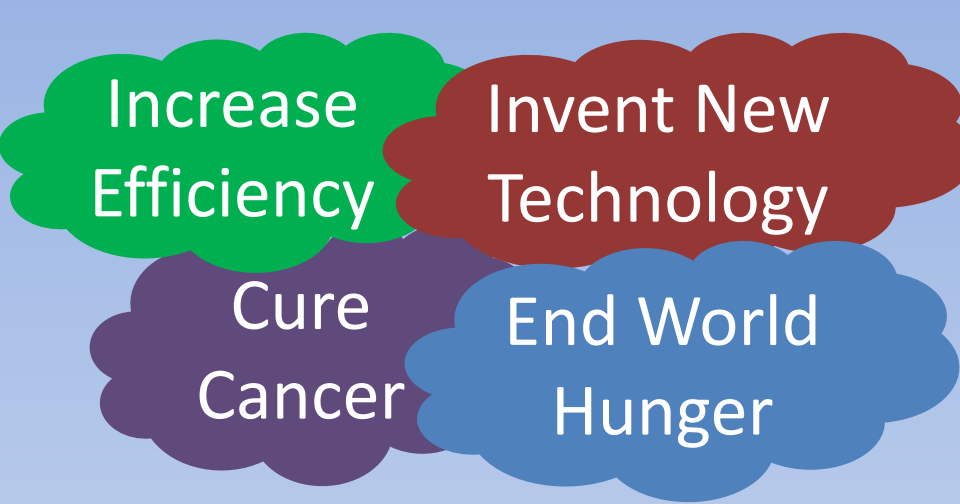


**APPROACH OUR
LIMITS AND PROSPER!**

PART II: CONSEQUENCES



Majority's Future Vision: "*Progress*"



Increase
Efficiency

Invent New
Technology

Cure
Cancer

End World
Hunger

Majority's Future
Vision: "*Progress*"

Increase
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**Increased Human
Quality of Life**

Majority's Future
Vision: "*Progress*"

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Majority's Future
Vision: "*Progress*"

Increased Human
Quality of Life

Human Population
Growth



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Majority's Future Vision: "*Progress*"

Increased Human
Quality of Life

Human Population
Growth



Crime &
Disease

Species
Elimination

Environmental
Terraforming

Resource
Scarcity

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Majority's Future Vision: "*Progress*"

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Quality of Life

Decreased Human
Quality of Life

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Crime &
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Environmental
Terraforming

Resource
Scarcity

Progress Cycle → ...?



1. Stop human population growth

- Redefine society's notions of ethics and “progress”

2. Colonize Space

- Infinite growth ok
in the infinite universe



3. Perish

- Humans kill themselves or Earth?
- Black swan event?



Backup!





Modern Models

- Physics
 - Prediction: What is the path of an electron?
 - Explanation: What causes gravity?
 - Intervention: If we build a rocket and ignite it, will it launch into orbit?
- Finance
 - What will the value of Apple be in 3 months?
 - What circumstances led to the 2008 crash?
 - If the Federal Reserve repurchases treasury bonds, will inflation decrease?
- Music
 - How will it sound if a violin plays A, a Flute plays B, a Cello plays C, ...
 - What leads an audience to most appreciate a sound? [psychology]
 - If we change the increase a tune's time signature, will it appear faster?
- Love, History, Biology, Mathematics, Engineering, Health,