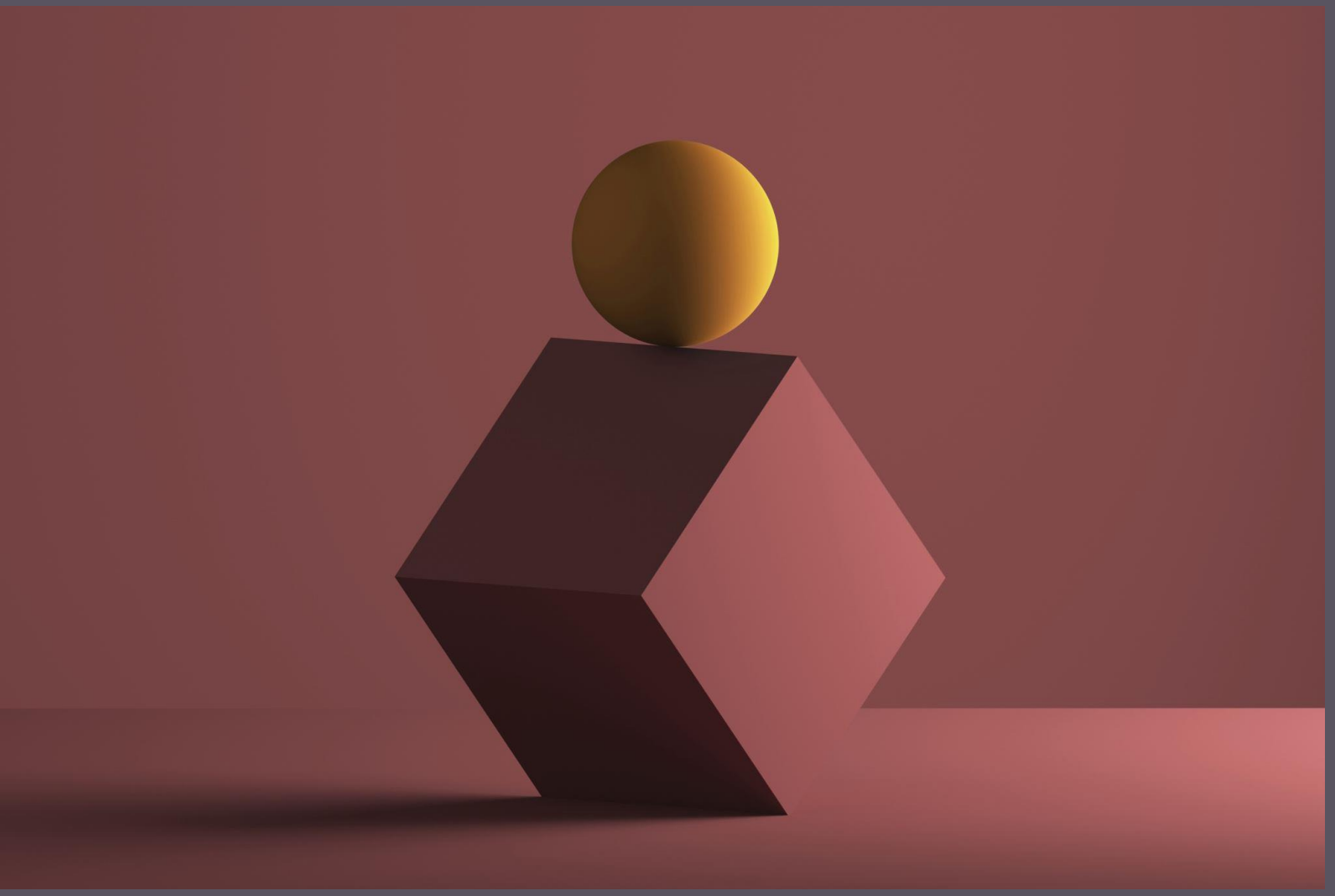


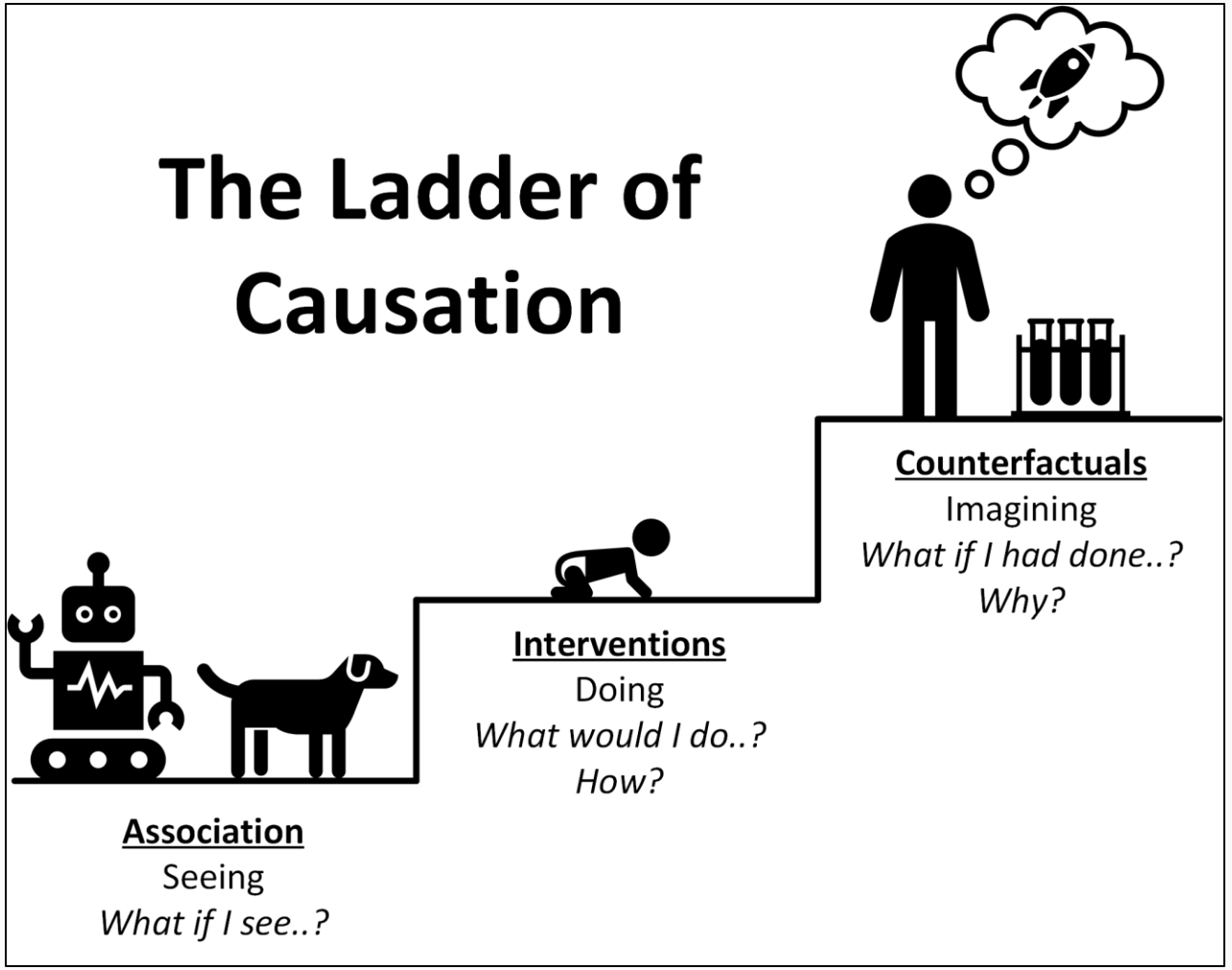
MACHINE CAUSATION

AI-Driven Hypothesis Generation and Testing

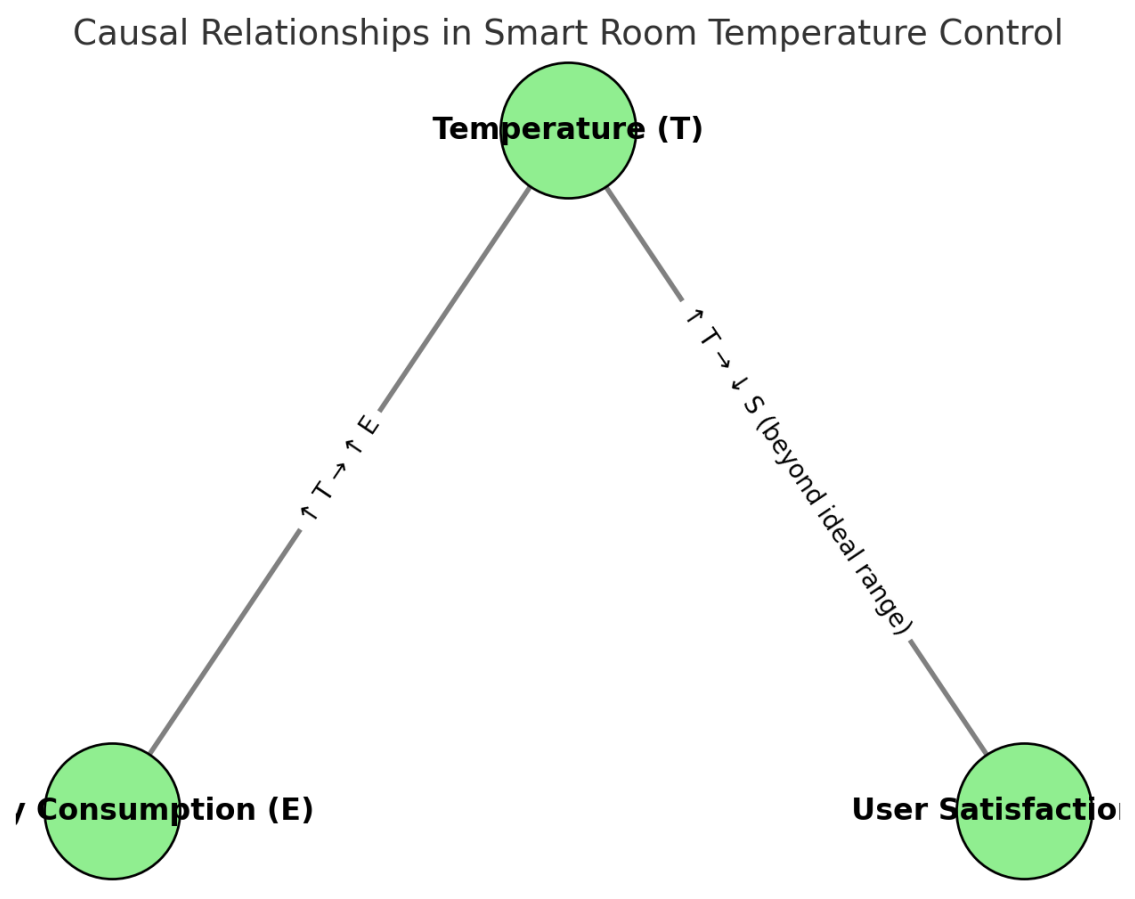
Taqiya Ehsan

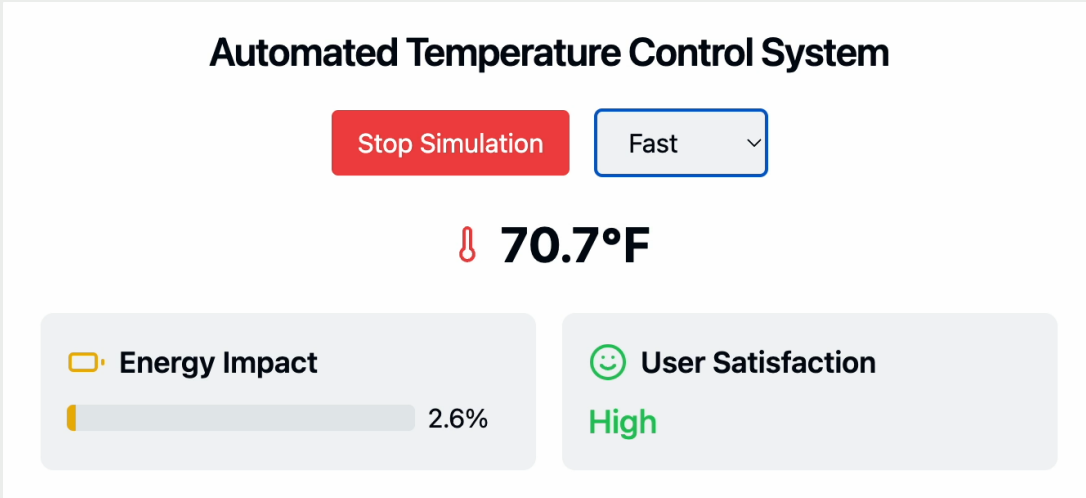
What is Causal Reasoning?

Causal reasoning is the ability to uncover cause-and-effect relationships to explain events and predict outcomes.

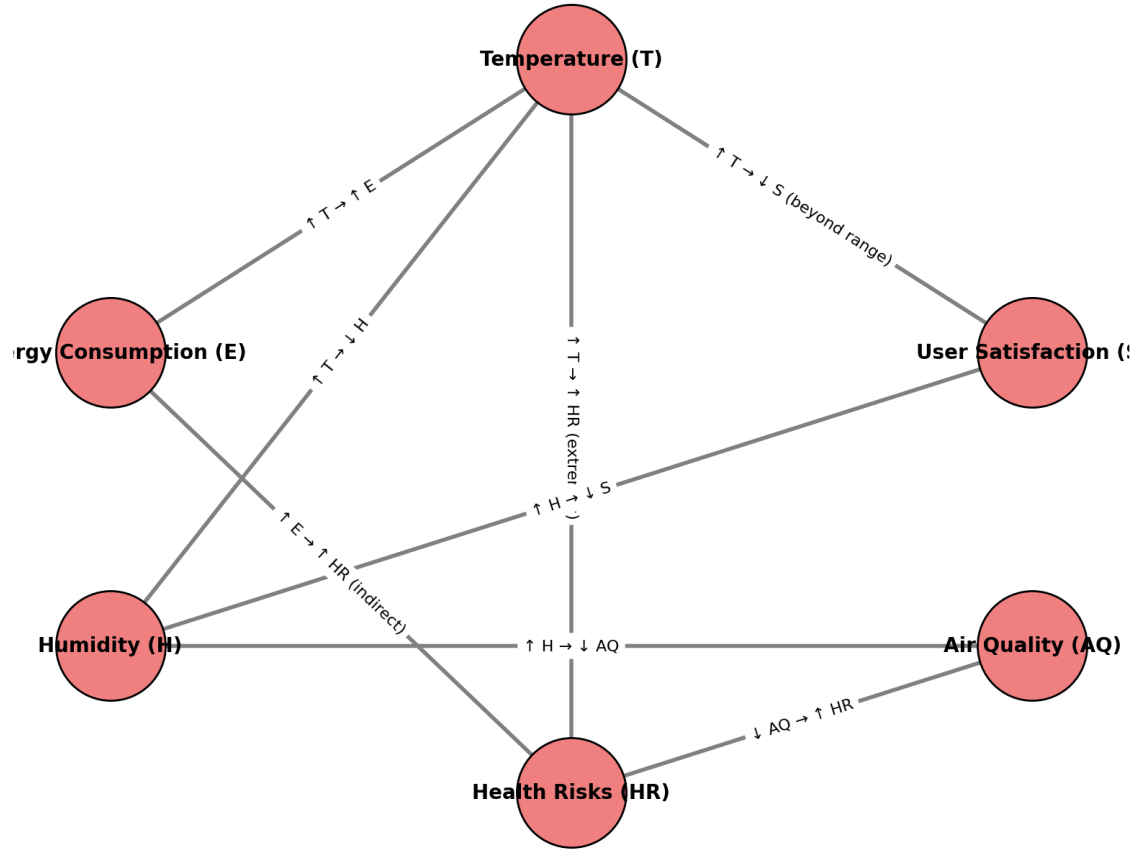


Pearl, Judea. "*Models, reasoning and inference*." Cambridge, UK: Cambridge University Press 19.2 (2000): 3.
Pearl, Judea, and Dana Mackenzie. "*The book of why: the new science of cause and effect*." Basic books, 2018.


Causal Relationships in Smart Room Temperature Control
Temperature (T)
↑ T → ↑ E
↑ T → ↓ S (beyond ideal range)
Consumption (E)
User Satisfactio


Automated Temperature Control System
Stop Simulation
Fast
70.7°F
Energy Impact
2.6%
User Satisfaction
High

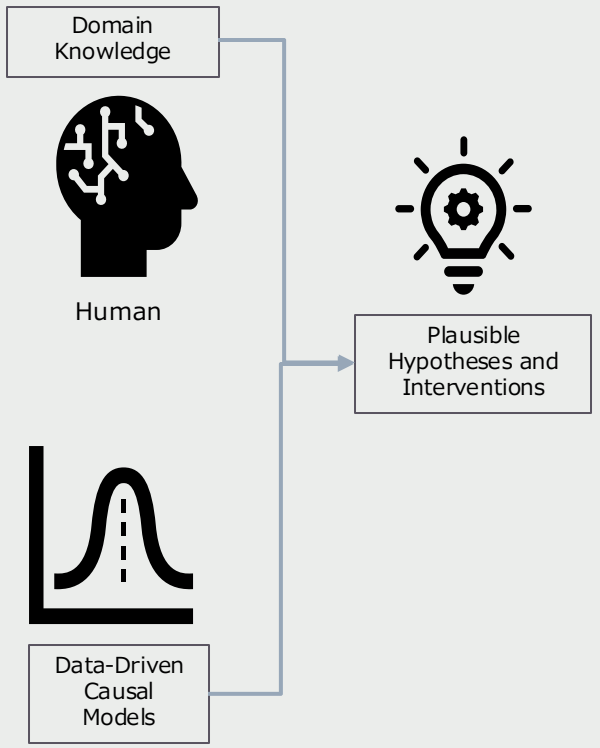
Problem Landscape



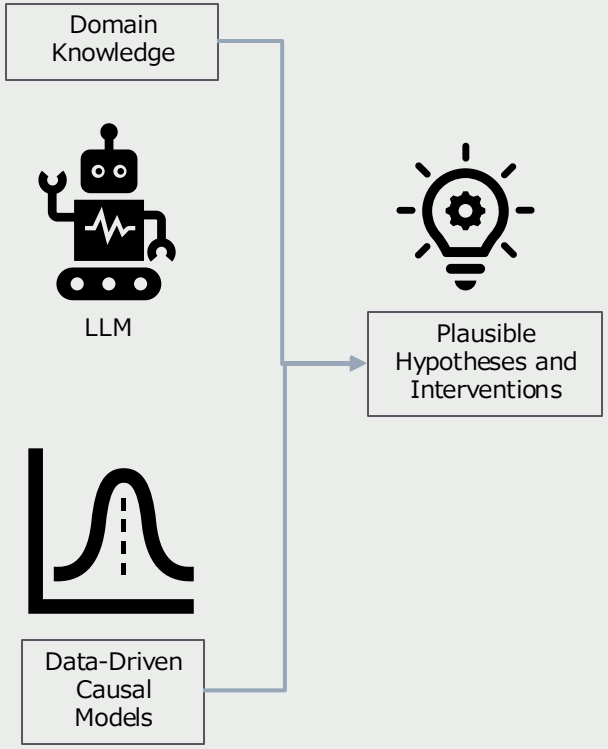
- Hypotheses in complex systems are expensive and risky to test.
- Simulations help but are limited.
- Human oversight slows scalability.

Analytical Framework

Combines **LLMs** with **causal models** to generate hypotheses and test interventions autonomously.



Traditional Approach

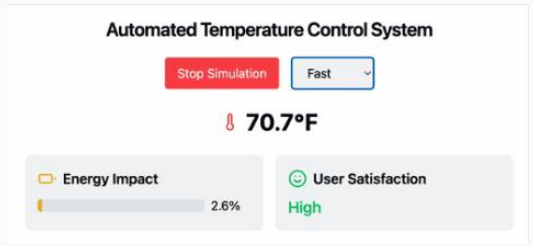


Machine Causation

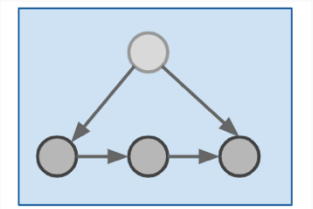
Smarter Decisions with Machine Causation

Goal: Integrate causal reasoning into LLMs for smarter hypothesis generation and safe intervention design.

Approach:



Data Collection



0	1	1	0
0	0	1	1
1	0	1	0
1	1	1	1
1	1	0	0

Causal DAG +
Counterfactual Analysis

$$Reward(I) = \alpha \cdot S(X) - \beta \cdot E(X)$$
$$Risk(I) = \sum \lambda_i \cdot (X_i - X_i^{ideal})^2$$

ChatGPT

LLM

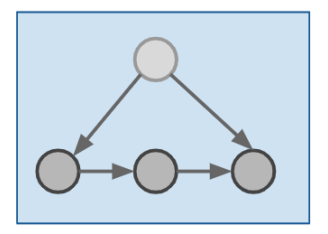
Hypothesis
&
Intervention

Testing

Smarter Decisions with Machine Causation

Goal: Integrate causal reasoning into LLMs for smarter hypothesis generation and safe intervention design.

Preliminary Insights:



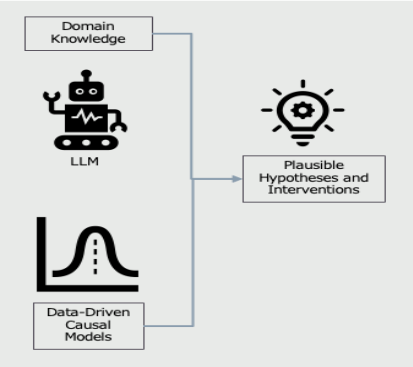
+ ChatGPT

Hypotheses are more precise and selective.

ChatGPT

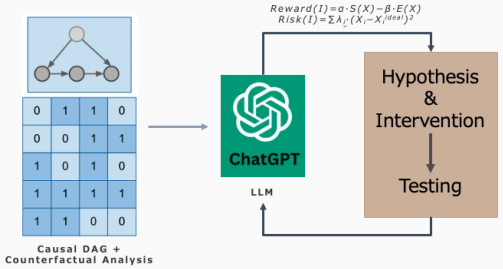
Hypotheses are diverse but lack focus.

Key Takeaways



Generate and test hypotheses **autonomously** across diverse scenarios.

Enhance **explainability** with minimal human involvement.



Enable ethical, reliable, and scalable machine causation **pipelines** for goal optimization.