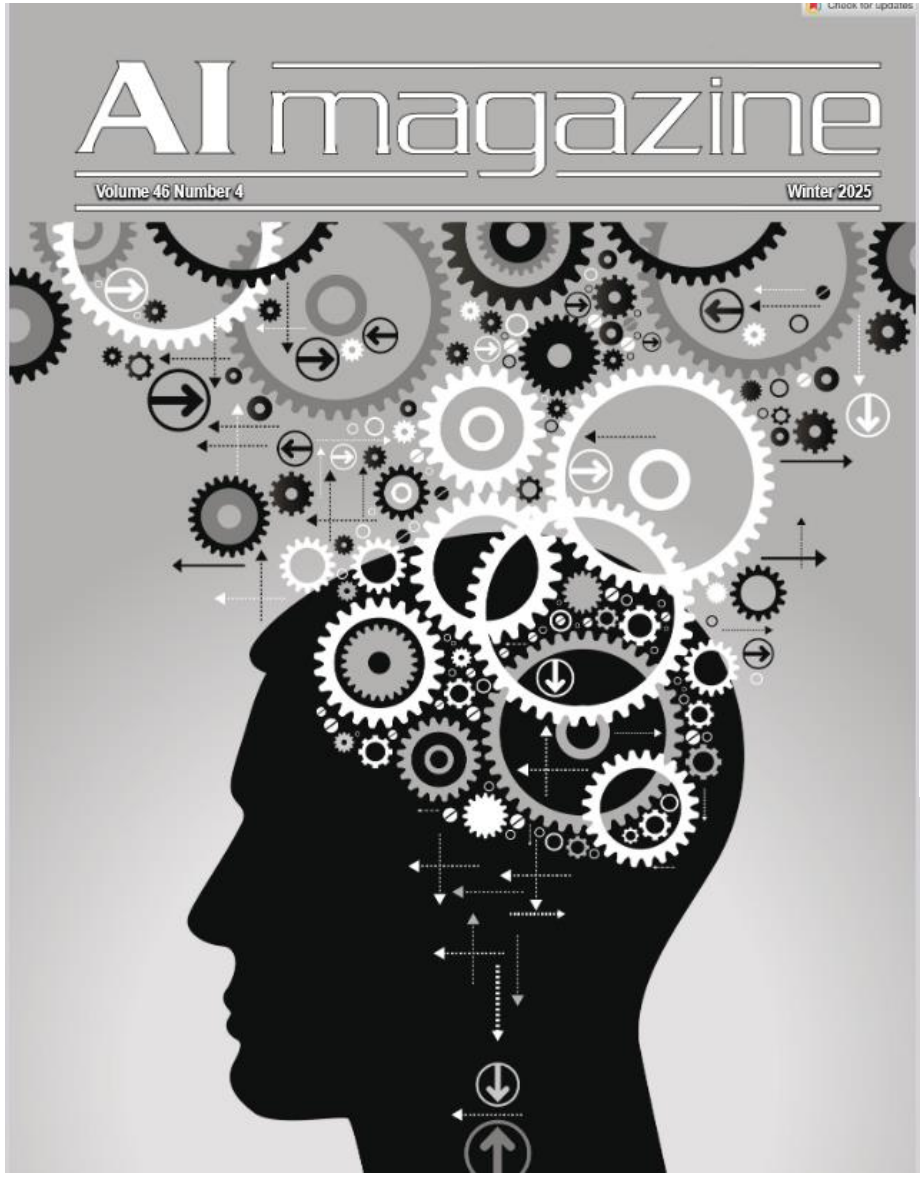


A community-driven vision for a new knowledge resource for AI

Vinay K Chaudhri[1] | Chaitan Baru[2] | Brandon Bennett[3] | Mehul Bhatt[4] | Darion Cassel[5] | Anthony G Cohn[6] | Rina Dechter[7] | Esra Erdem[8] | Dave Ferrucci[9] | Ken Forbus[10] | Gregory Gelfond[11] | Michael Genesereth[12] | Andrew S. Gordon[13] | Benjamin Grosof[14] | Gopal Gupta[15] | Jim Hendler[16] | Sharat Israni[17] | Tyler R. Josephson[18] | Patrick Kyllonen[19] | Yuliya Lierler[20] | Vladimir Lifschitz[21] | Clifton McFate[22] | Hande Küçük McGinty[23] | Leora Morgenstern[24] | Alessandro Oltramari[25] | Praveen Paritosh[26] | Dan Roth[27] | Blake Shepard[28] | Cogan Shimizu[29] | Denny Vrandečić[30] | Mark Whiting[31] | Michael Witbrock[32]

Based on the AAAI 2025 Workshop on
Translational Institute for Knowledge Axiomatization

Presenter: Vinay K Chaudhri
December 9, 2025

This work has been supported by the National Science Foundation under Awards No 2514820 and 2537485.

U.S. National Science Foundation
Directorate for Technology, Innovation and Partnerships

Outline

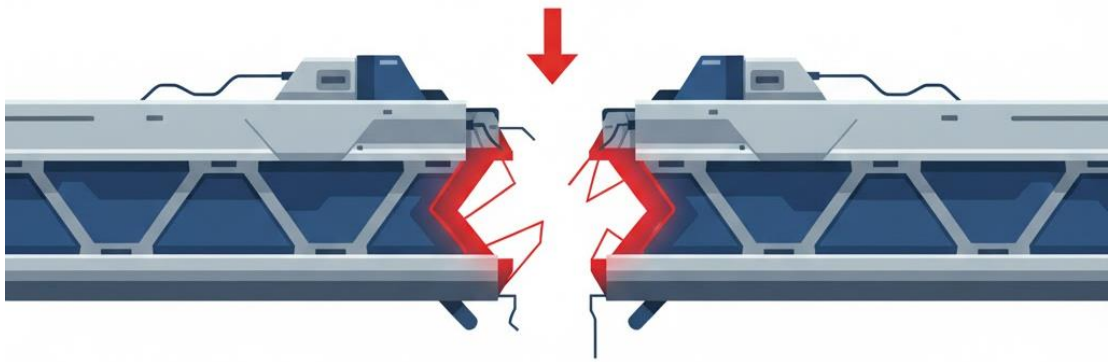
- Motivation
- Community Vision
- Building a knowledge resource
- Path Forward
  - Proof of concept
  - Additional Workshops

Motivation: The Knowledge Principle

A system exhibits intelligent understanding and action at a high level of competence primarily because of the specific knowledge that it can bring to bear: the concepts, facts, representations, methods, models, metaphors, and heuristics about its domain of endeavor (Lenat & Feigenbaum 1987)

- AI needs a large body of knowledge that can be extended by natural language processing and machine learning
- The Cyc project aspired to test this empirically, but we do not have a conclusive result

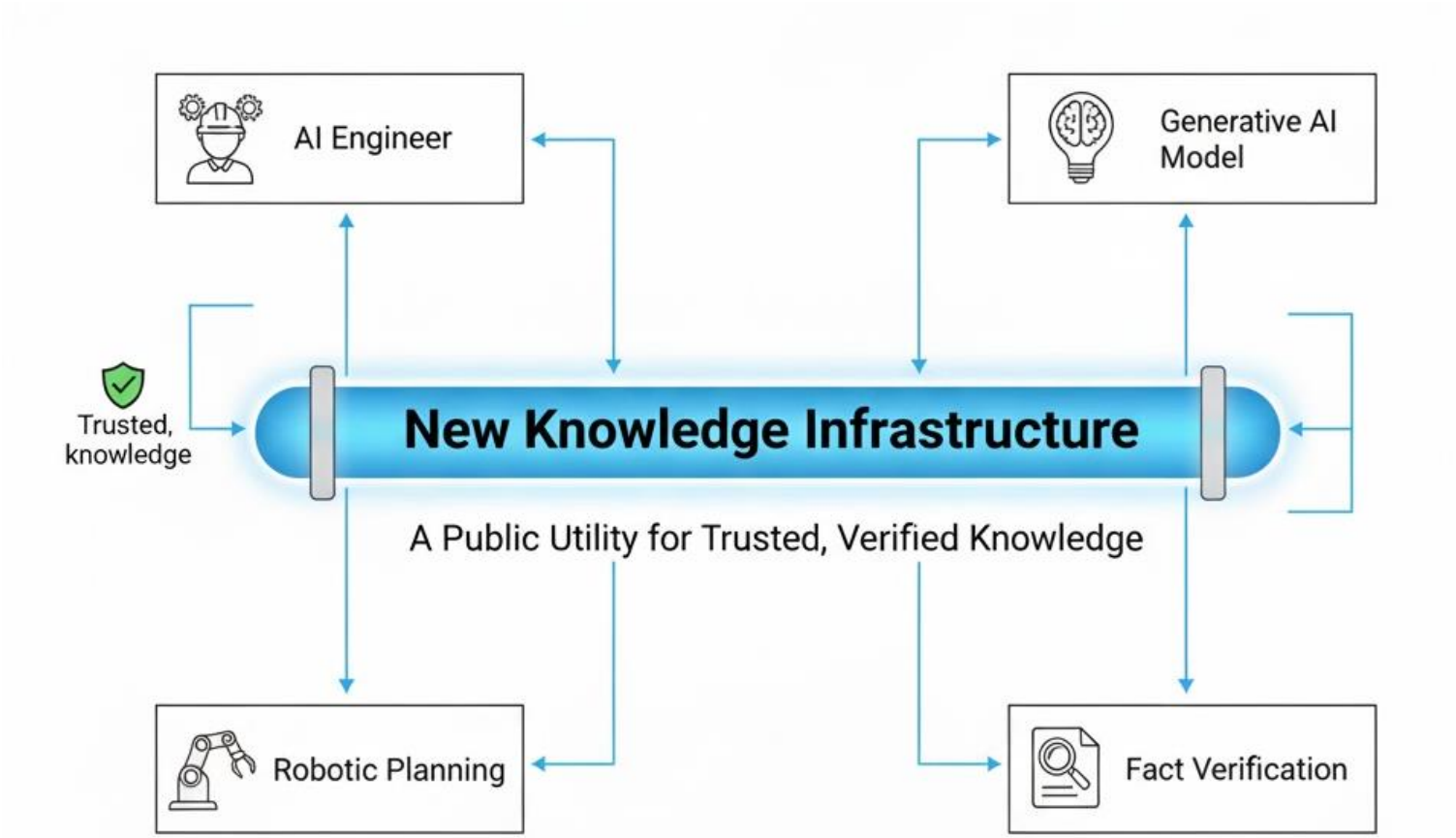
Motivation: Verifiable General Knowledge



Resource	Expressiveness	Real-World Data	Common sense	License	Guarantees
Cyc	High	Some	Yes	Restricted	Some
Wolfram|Alpha	High	Yes	No	Restricted	Yes
ConceptNet	Limited	Some	Yes	Open	Yes
WikiData	Limited	Yes	No	Open	Yes
LLMs	Text	Yes	Yes	Mixed	No

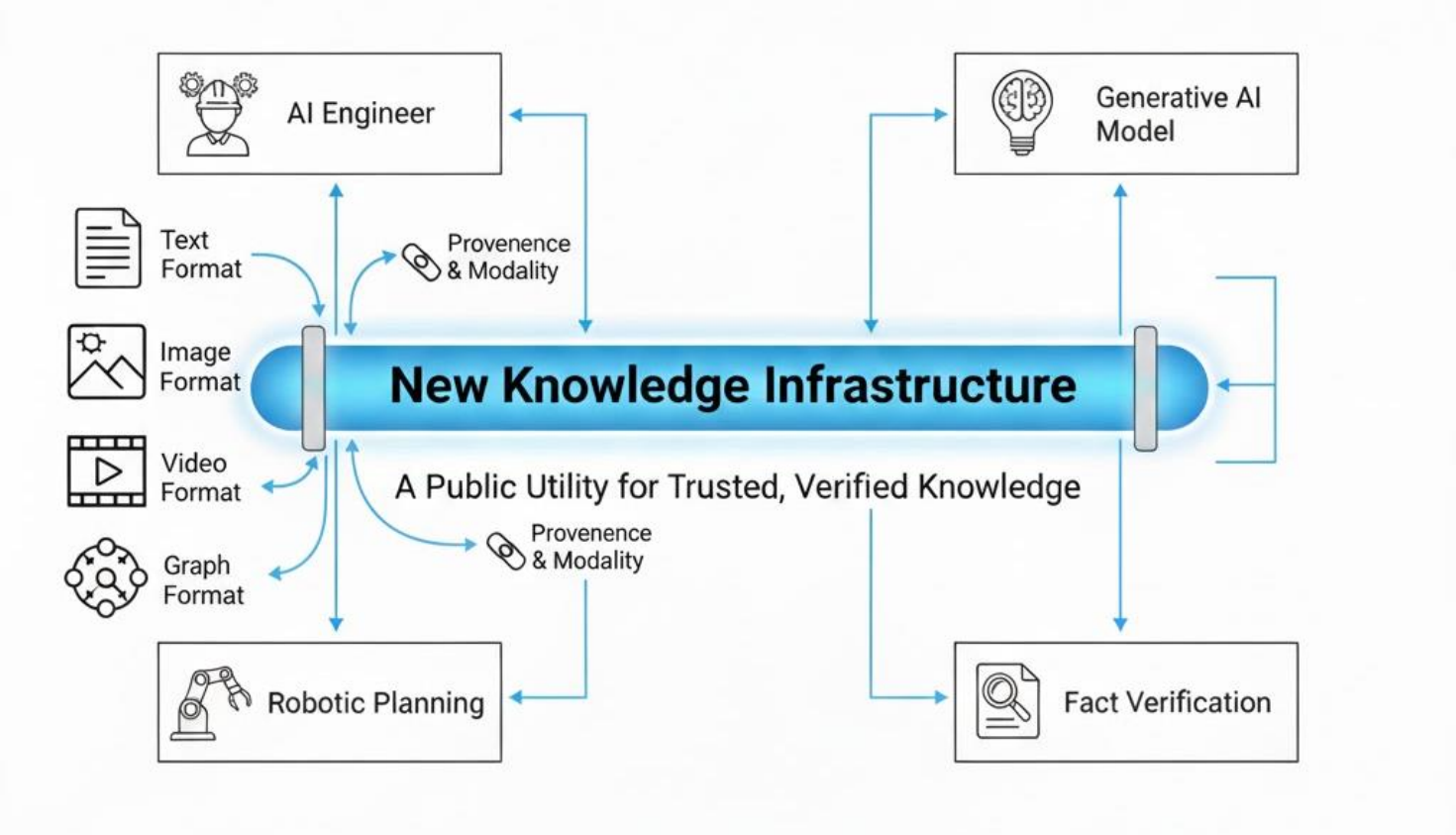
Community Vision

- A public utility like knowledge infrastructure



Community Vision

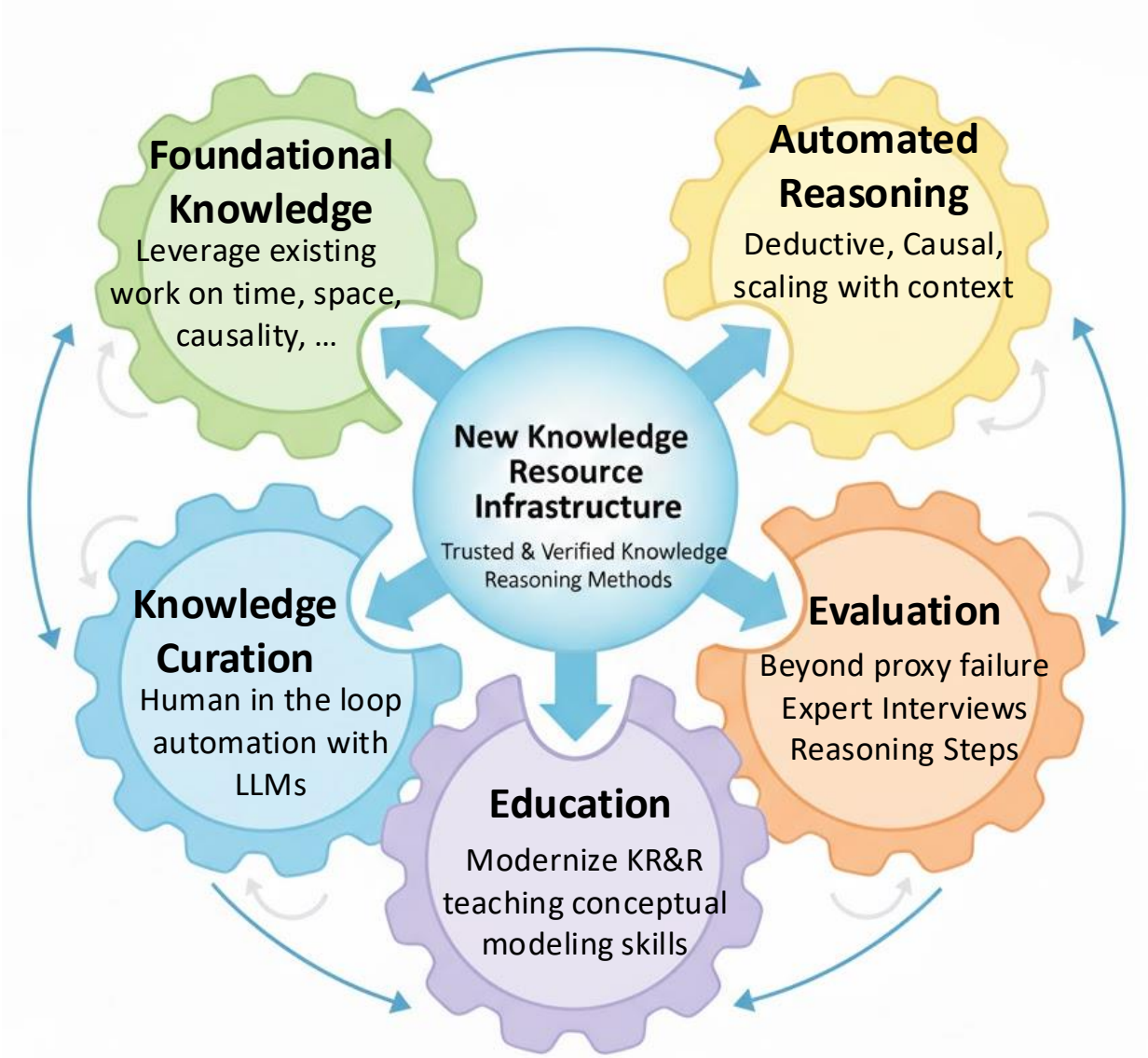
- Multimodal with complete provenance



Outline

- Motivation
- Community Vision
- Building a knowledge resource
- Path Forward
  - Proof of concept
  - Additional Workshops

Building the Knowledge Infrastructure



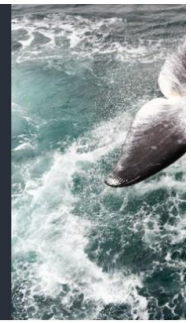
Need better ways to measure AI Knowledge

nature

Explore content | About the journal | Publish with us | Subscribe

This whale lives for centuries: its secret could help extend human lifespan

A cold-activated protein that mends damaged DNA could play a part in keeping the bowhead whale in tip-top shape.

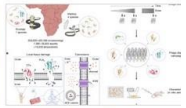


Single antivenom protects against 17 different snakebites

Researchers immunized an alpaca and a llama with snake venoms, and combined some of the antibodies produced into a potent cocktail.

World's smallest 3D bioprinter could help surgeons repair vocal cords

Flexible device inspired by an elephant's trunk can deliver healing hydrogels after surgery.



Nanobody-based recombinant antivenom for cobra, mamba and rinkhal bites

A recombinant antivenom composed of eight nanobodies provides broad protection against venom-induced lethality and dermonecrosis in mice challenged with venoms from cobras, mambas and rinkhals snakes

News & Comment ›

We need a new Turing test to assess AI's real-world knowledge

A fresh set of benchmarks could help specialists to better understand artificial intelligence.

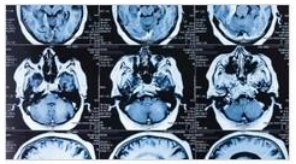
Vinay K. Chaudhri
World View | 29 Oct 2025

Single antivenom protects against 17 different snakebites

Mohana Basu
News | 29 Oct 2025

7 basic science discoveries that changed the world

Michael Marshall
News Feature | 29 Oct 2025



From MRI to Ozempic: breakthroughs that show why fundamental research must be protected

Editorial | 29 Oct 2025

World's smallest 3D bioprinter could help surgeons repair vocal cords

Jenna Ahart
News | 29 Oct 2025

This whale lives for centuries: its secret could help extend human lifespan

Heidi Ledford
News | 29 Oct 2025

Fighting dengue with lactic acid bacterium

Advertisement Feature

Latest Reviews & Analysis ›

Ultrasound-driven artificial muscles can grasp, flex and swim

Electronic paper could enable virtual reality with human-eye resolution

Need Better Ways to Measure Knowledge

- AIs can do well on standardized exams but fail in real-world
  - Proxy-Failure
- Expert interacting with an AI over an extended period of time
  - Panel of Experts
- Set up a system to conduct expert interviews on scale

JUNE 16, 2025 | 4 MIN READ

Truly Intelligent AI Could Play by the Rules, No Matter How Strange

To build safe but powerful AI models, start by testing their ability to play games on the fly

BY VINAY K. CHAUDHRI EDITED BY DAN VERGANO

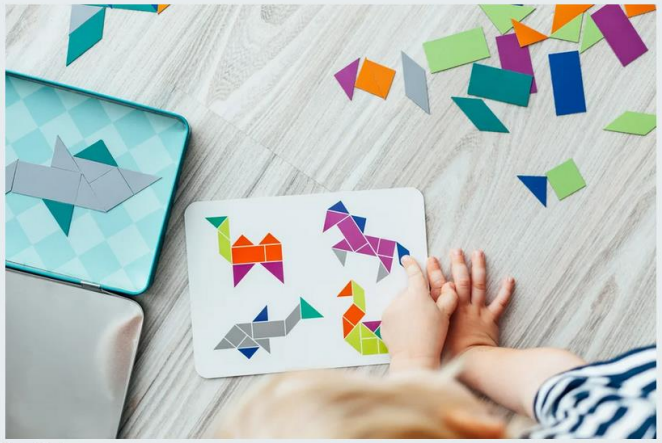
OPINION

SEPTEMBER 5, 2024 | 6 MIN READ

Kids Should Be Taught to Think Logically

Training in symbolic logic is critical in many careers, for responsible citizenship and better lives. It is also an underexploited antidote to today's bizarre conspiracy thinking

BY VINAY K. CHAUDHRI

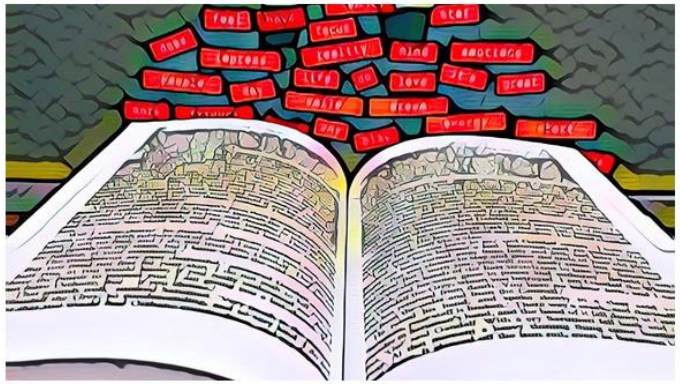


Manico/Getty Images

PERSPECTIVE

Should the AI Race Be About Bigger Models, or the Search for Meaning?

VINAY K. CHAUDHRI / OCT 13, 2025



Teresa Berndtsson / Letter Word Text Taxonomy / CC 4.0

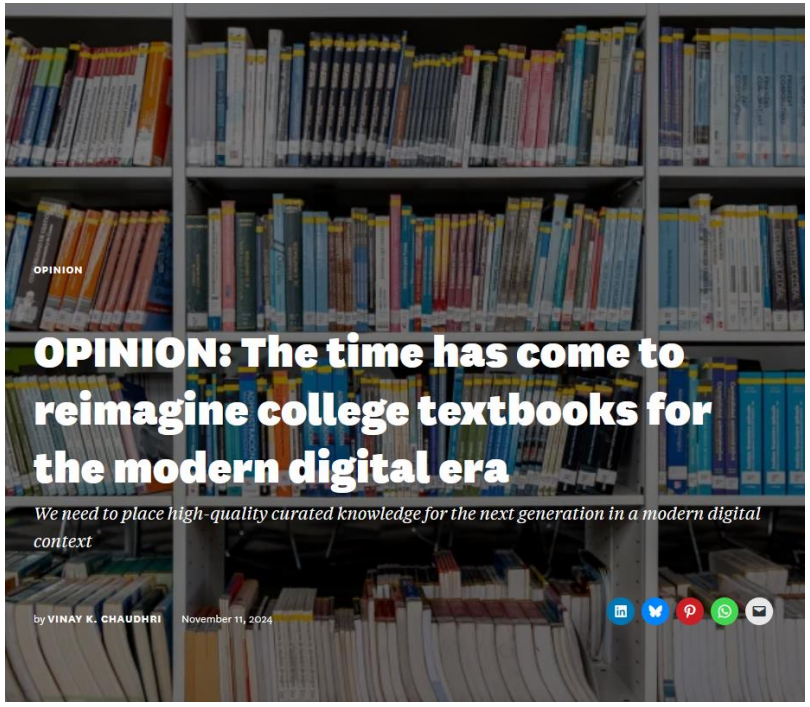
Home > Media & Technology

When Rules Can Be Code, They Should Be!

Achieving safe, scalable efficiencies requires a new approach to rule making.

OPINION

Shahadat Rahman on Unsplash



nature > correspondence > article

CORRESPONDENCE | 04 March 2025

AI must be taught concepts, not just patterns in raw data

By Vinay K. Chaudhri

Data-driven learning is central to modern artificial intelligence (AI). But in some cases, knowledge engineering – the formal encoding of concepts using rules and definitions – can be superior. For example, in basic arithmetic, people easily outcompete chatbots such as ChatGPT because they learn how to add numbers using rules rather than by looking at many examples (V. Cheng & Z. Yu *Proc. 35th Conf. Comput. Linguist. Speech Process.* 188–193; 2023) .

How do we modernize KRR Education?

- Problem: A field in decline
  - Current practice
  - Deficiencies
  - Call to action

Current Practice for teaching KRR

- Embedded as part of a larger course
- Advanced electives
  - KRR, Computational Logic, Logic Programming
- Innovative Practices
  - Northwestern, Cycorp, Wright State, UT Dallas

Image Credit: Nano Banana

Deficiencies in teaching KRR

- Outdated/negative textbook coverage
- Lack of real-world connection
- Missing conceptual modeling skills
- Philosophical framing

Image Credit: Nano Banana

Call to Action

- Provide modular teaching segments
  - Reusable with pedagogical support for tools, lectures, grading
- Address Practicality
  - Why care, linkage into other CS courses
- Broaden the scope
  - Engage with AI literacy efforts, KR body of knowledge, education at all levels

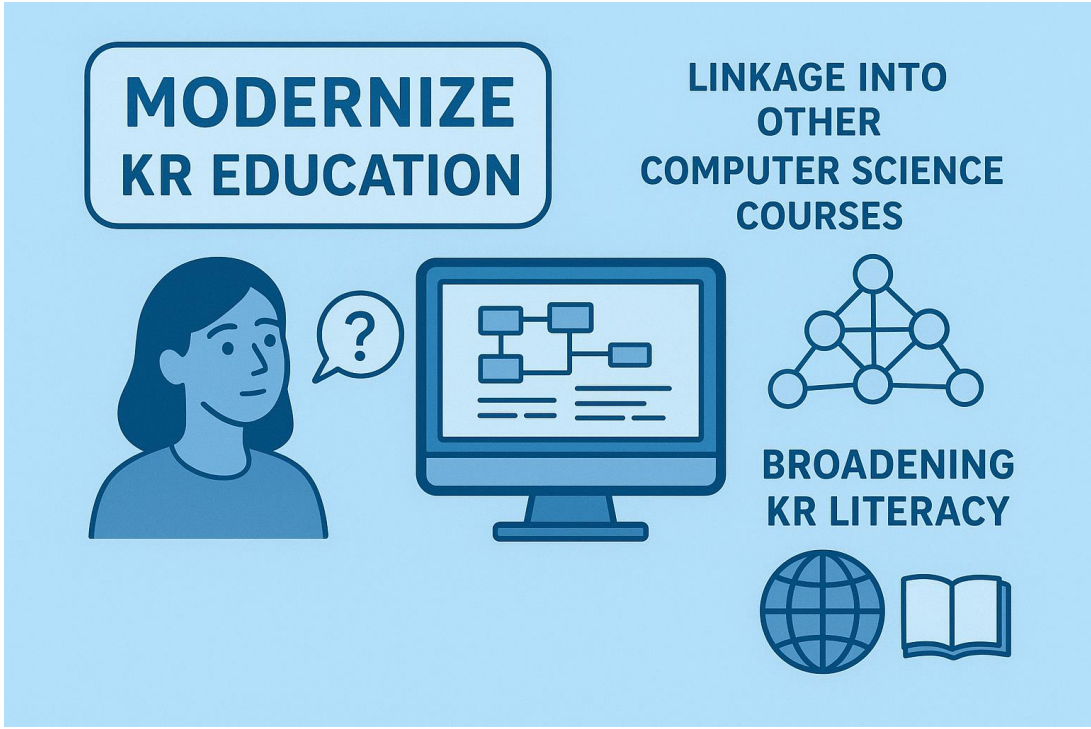


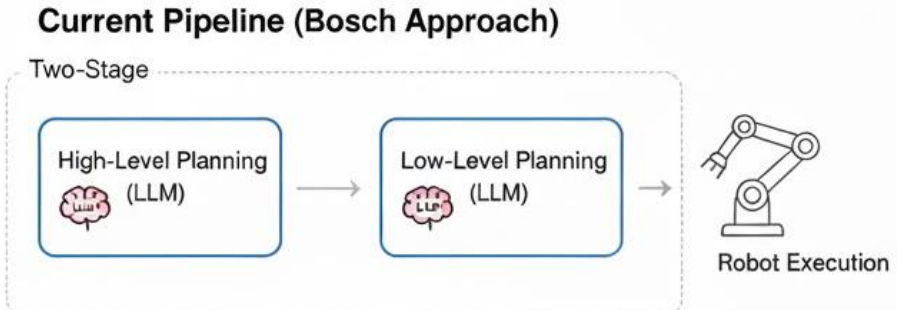
Image Credit: ChatGPT

Outline

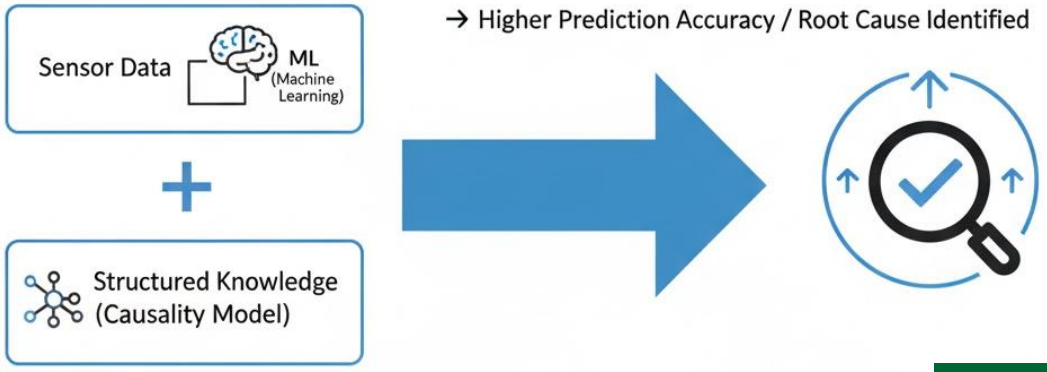
- Motivation
- Community Vision
- Building a knowledge resource
- Path Forward
  - Proof of concept
  - Additional Workshops

Proof of Concept Study

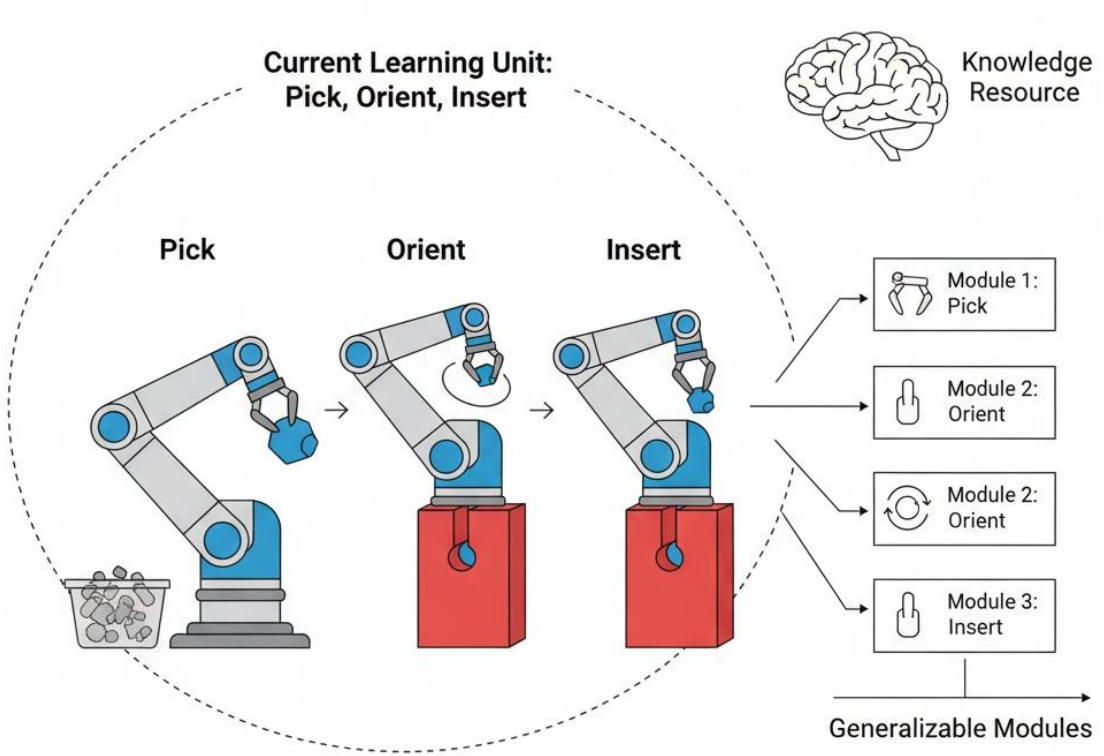
Improve robotic planning using a spatial reasoner



Structured knowledge for causal reasoning



Action Libraries for generalizable skill learning



WRIGHT STATE UNIVERSITY

BOSCH

CarnegieBosch INSTITUTE

Example POC: Action Libraries for Robots

- Manufacturing robots routinely use physical actions
  - Pickup, Grasp, Pour, Tilt, etc.
- Significant prior work exists in modeling actions
  - Answer set programming, Plan Description Language

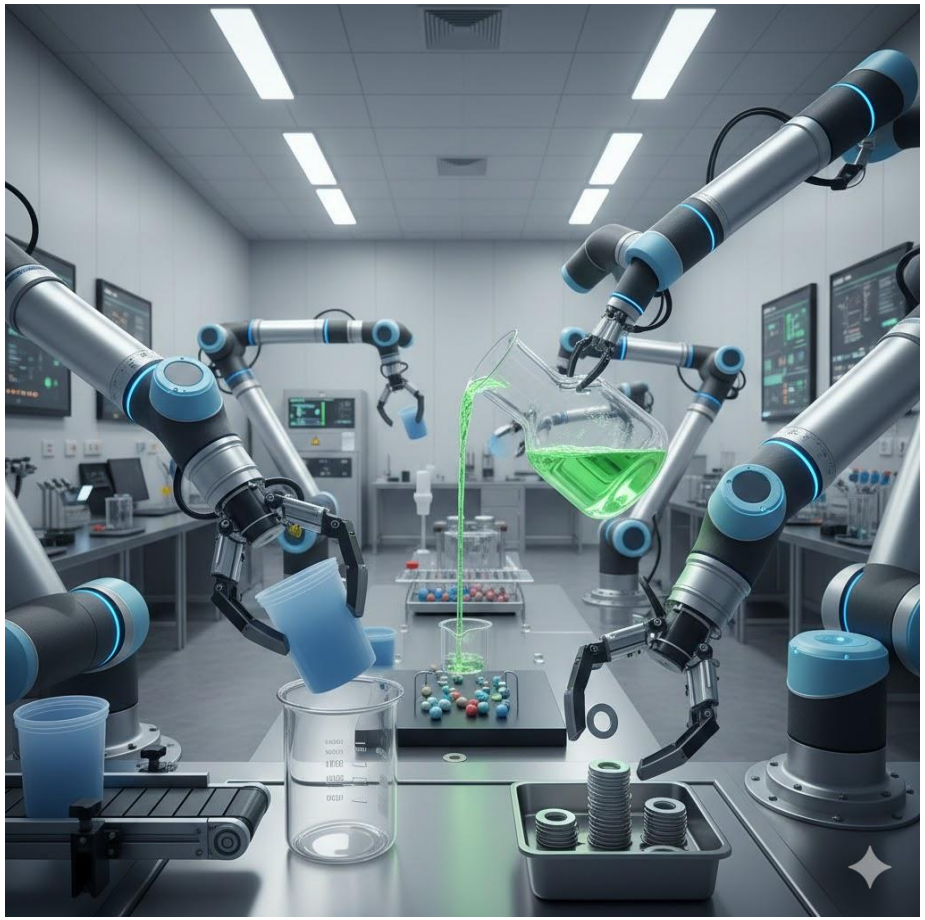
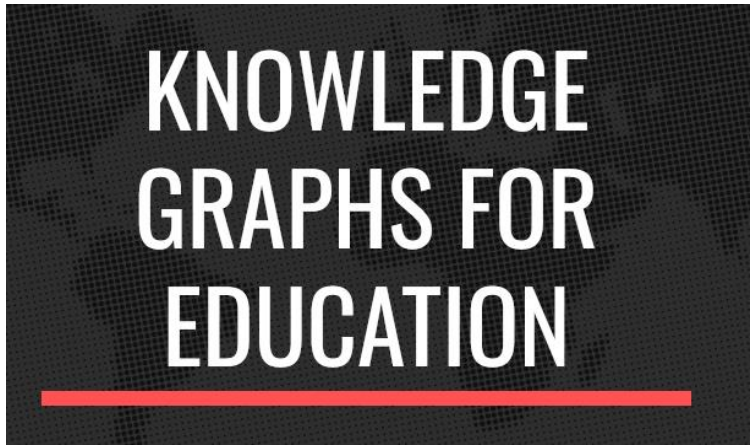


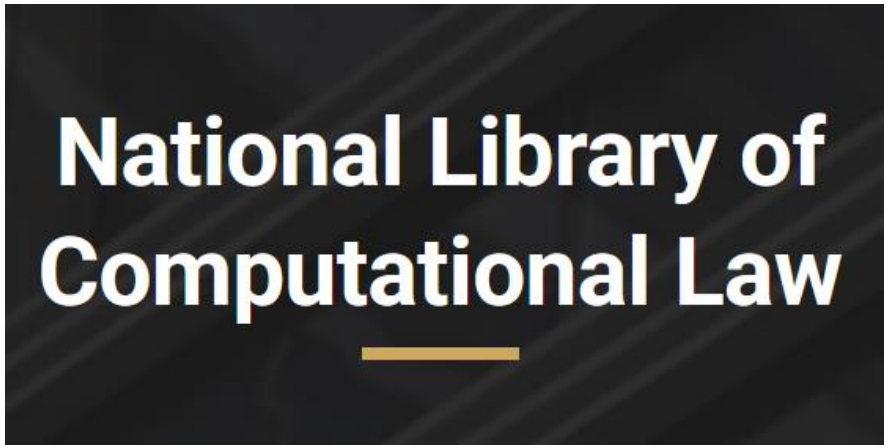
Image Credit: Nano Banana

Example POC: Action Libraries for Robots

- Research Question: How can an action library be plugged into the perception/action loop of a robot?
  - Semantic definitions of actions
  - A knowledge module that codifies actions and properties
  - Interfacing symbolic knowledge of actions with the neural layer of a robot

Three Additional Workshops





Knowledge Graphs for Education

- The Disruption
- The Paradox
- The Path Forward

The Disruption: A new breed of Edtech

Khanmigo

Khan Academy's AI tutor. Uses Socratic methods to prompt critical thinking rather than giving answers. Contextually aware with plans for better memory.

Google LearnLM

Partnership with OpenStax. Transforms static textbooks into interactive Notebooks. Generates overviews, mind maps, and quizzes automatically.

LeanTutor

A formal approach using the Lean theorem prover. Verifies mathematical proofs and offers guidance. High accuracy but limited scope for now.

The Paradox: Chatbot ≠ Better Learning

Khanmigo

Lacks diagram and visual support essential for complex topics

Google LearnLM

Can suffer from ambiguous, verbose, and sometimes erroneous answers

LeanTutor

Reconstructed correct proofs in about 57% of cases

Detected faulty reasoning in another 30%

The Path Forward: Infuse Knowledge

- Let us not curb LLMs, but ground them in structured knowledge
- By infusing knowledge, we can move from mimicry to genuine mentorship

What Knowledge?

Personalization Knowledge

Digital Promise's Learning Variability Navigator maps cognitive, social-emotional, and contextual factors to specific teaching strategies.

Knowledge of Standards

Learning Commons' Knowledge Graph provides a shared, semantic structure linking academic standards, curricula, and learning outcomes.

Knowledge Tracing

Knowledge to track if a student has learned/mastered a topic

Three Opportunities

Evaluate & Calibrate

Systematically assess LLM tools (like OpenStax Notebooks) for factual accuracy, instructional coherence, and personalization.

Expand Existing Education KGs

Develop a domain-specific KG for middle school biology. Link concepts and standards to allow conceptual navigation.

Scale for Higher Ed

Construct KGs for the entire OpenStax library using LLMs for drafting and experts for validation. Anchor active learning.

Summary

- Motivation
- Community Vision
- Building a knowledge resource
- Path Forward
  - Proof of concept
  - Additional Workshops

How can we work together?

- Map out a strategy for engaging the US2TS community
- Help co-design the Hugging Face for Knowledge
- Help co-create the knowledge resource