Neurosymbolic Customized and Compact Copilots

Tutorial Paper (100 minutes, Hands-on and Lecture Style Tutorial)
@International Semantic Web Conference,
Date.

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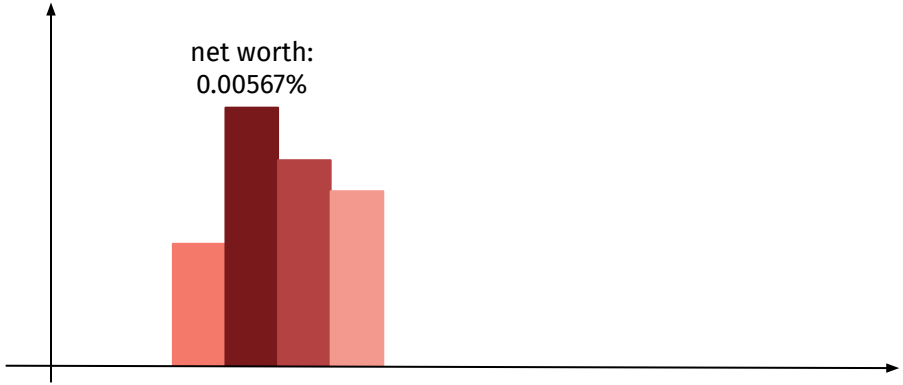
Part 1 (20 Mins) - **Neurosymbolic Customized and Compact Copilots**

How Current Language Models Work

Prediction Context

What is Mark Zuckerberg's net worth?

Did you mean: net worth
Did you mean: salary
Did you mean: rich for



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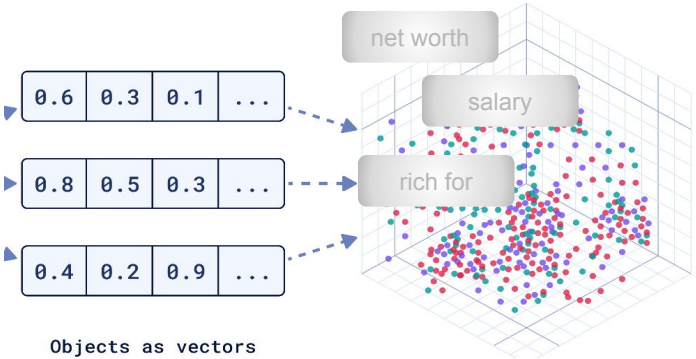
Language Models Predict based on Context-Specific Distributional Mappings



Good Successes, but ....

Information Assistance
- QA
- Coding
- Content Generation

Decision-Support Assistance
- Planning
- Reasoning
- Cognition

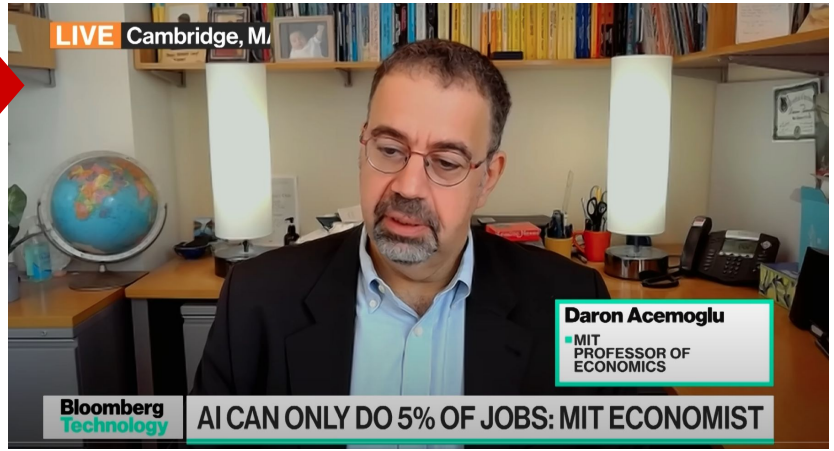
Are these high-value business/industry use cases that impact productivity?

Generative Ai In Content Creation Market Exploring Projected Size and Trends for 2033

Trending Market Research News
349 followers

May 16, 2024

Market.us reports that the Generative AI in content creation market was valued at USD 11.6 Billion in 2023. It is expected to reach USD 163.8 Billion by 2033, with a CAGR of 31.20% during the forecast period from 2024 to 2033.



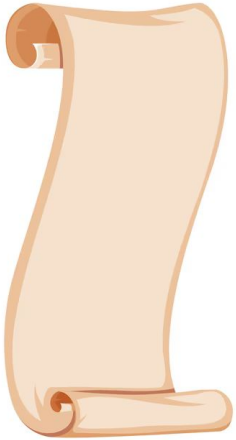
Longer list of Failures ...

For Decision-Support Assistance

? Data - Why train on Voluminous open web data?

? Knowledge
- Representing Domain-Specific Information
- Representing Relevant Facts about the World
- Representing Domain-relevant Decision Processes

? Human Expertise
- How to Ensure Knowledge and data are Leveraged correctly?



Limited accuracy in complex decision-support requests

ChatGPT showed only *56% accuracy* in medical queries (Wei et al., 2023), raising concerns about trustworthiness in clinical use.

Lack of domain-specific expertise

General-purpose LLMs struggle with specialized medical knowledge, leading to errors in diagnosis and treatment recommendations.

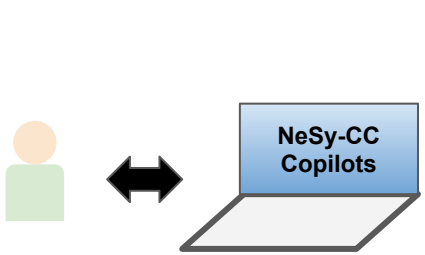
Inability to handle & Follow guidelines

LLMs often rely on outdated or incomplete information, failing to incorporate the latest medical research or evolving clinical guidelines.

Potential for generating harmful or biased content

LLMs can provide inaccurate or harmful suggestions, particularly if the input data is biased or not representative of diverse patient populations.

Neurosymbolic Customized and Compact (NeSy-CC) Copilots



Engineering Benefits

- Reduced Parameters
- Lower Computational Costs
- Energy Efficiency

Business Benefits

- Targeted Use Cases
- Ease of Deployment

For Solving Decision-Support Assistance

? Data: Customized training on a Compact/Right-sized set of Curated Task and Domain-Specific Data

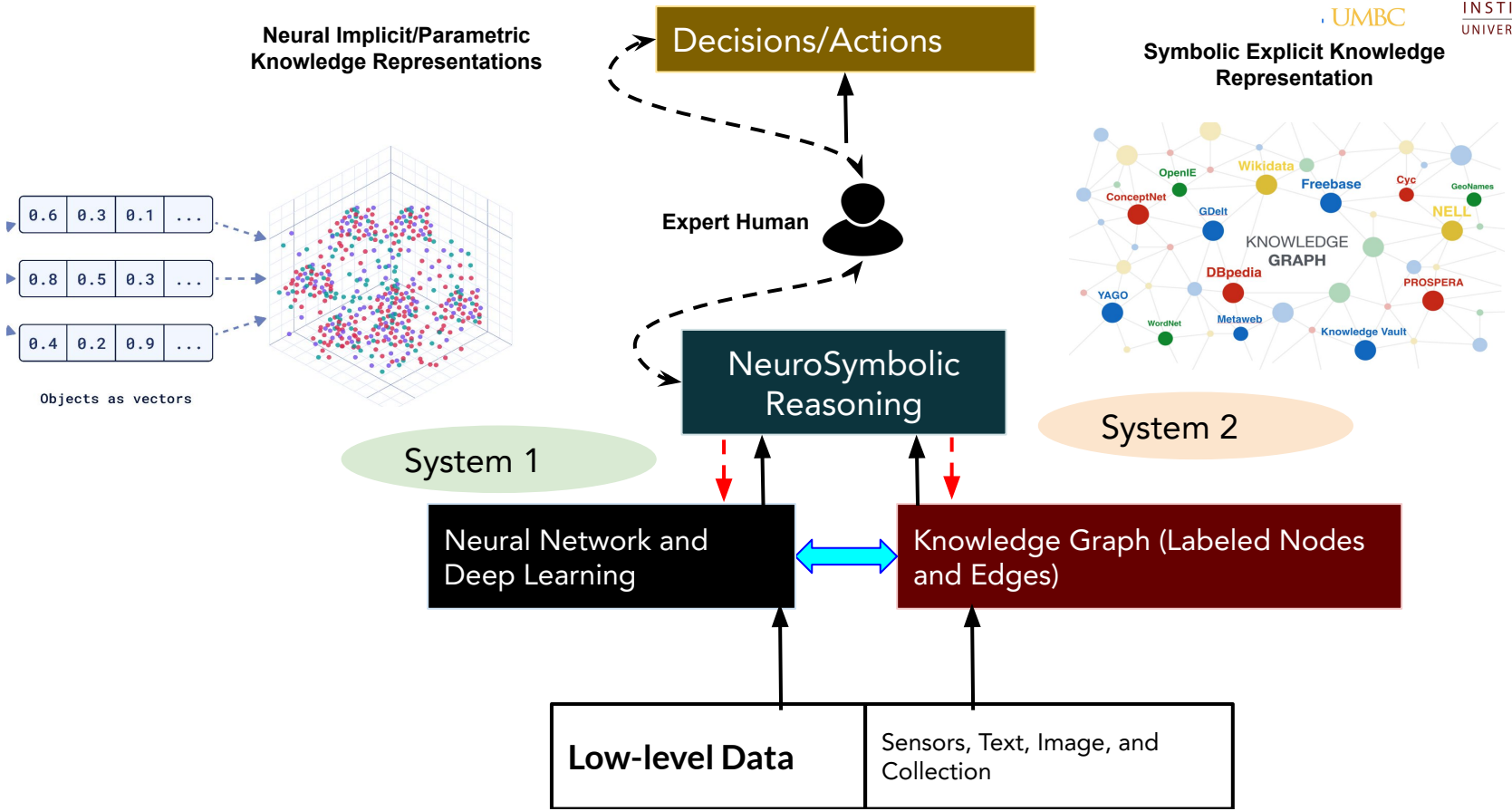
? Knowledge

- **For Accuracy and Unambiguous Knowledge Capture**
- Symbolically Represent Domain-Specific Information
- Symbolically Represent Facts about the World
- Symbolically Represent Decision Processes

? Human Expertise

- **How to Ensure Knowledge and data are Leveraged correctly?**
- Employ Neurosymbolic approaches to **correctly** leverage knowledge and data
- **Correctness** involves: *Robust, Transparent and Flexible Reasoning with Grounding in Knowledge*

Neurosymbolic Customized and Compact (NeSy-CC) Copilots

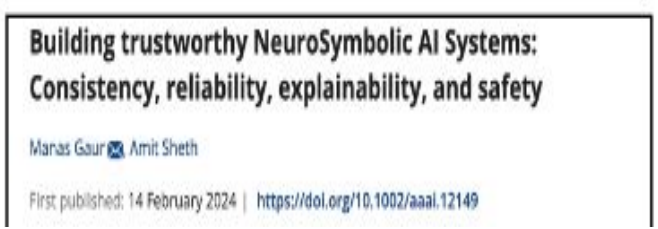


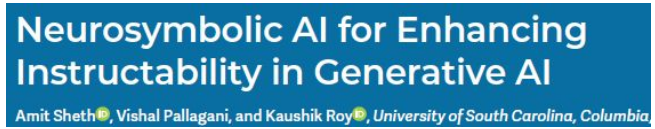
Amit Sheth, Kaushik Roy, Manas Gaur, Neurosymbolic Artificial Intelligence (Why, What, and How), IEEE Intelligent Systems, 38 (3), May-June 2023

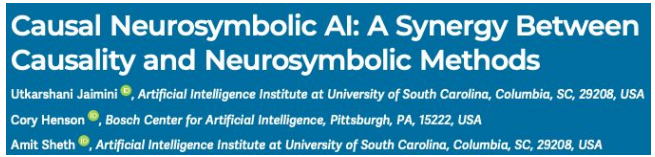
Neurosymbolic Customized and Compact (NeSy-CC) Copilots

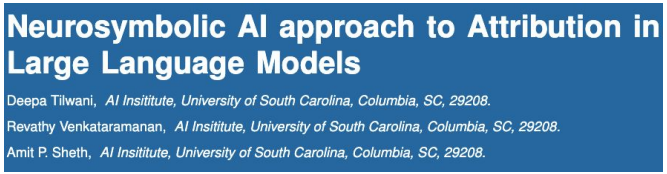
A Granular Look at The Features of a NeSy-CC Systems

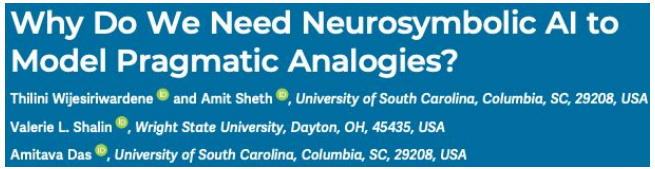
#Grounding
#Instructability
#*Alignment*
#Explainability
#Intrepretability
#Safety
#Causality
#Attribution
#*Abstraction*
#Analogy
#Reliability
#Consistency



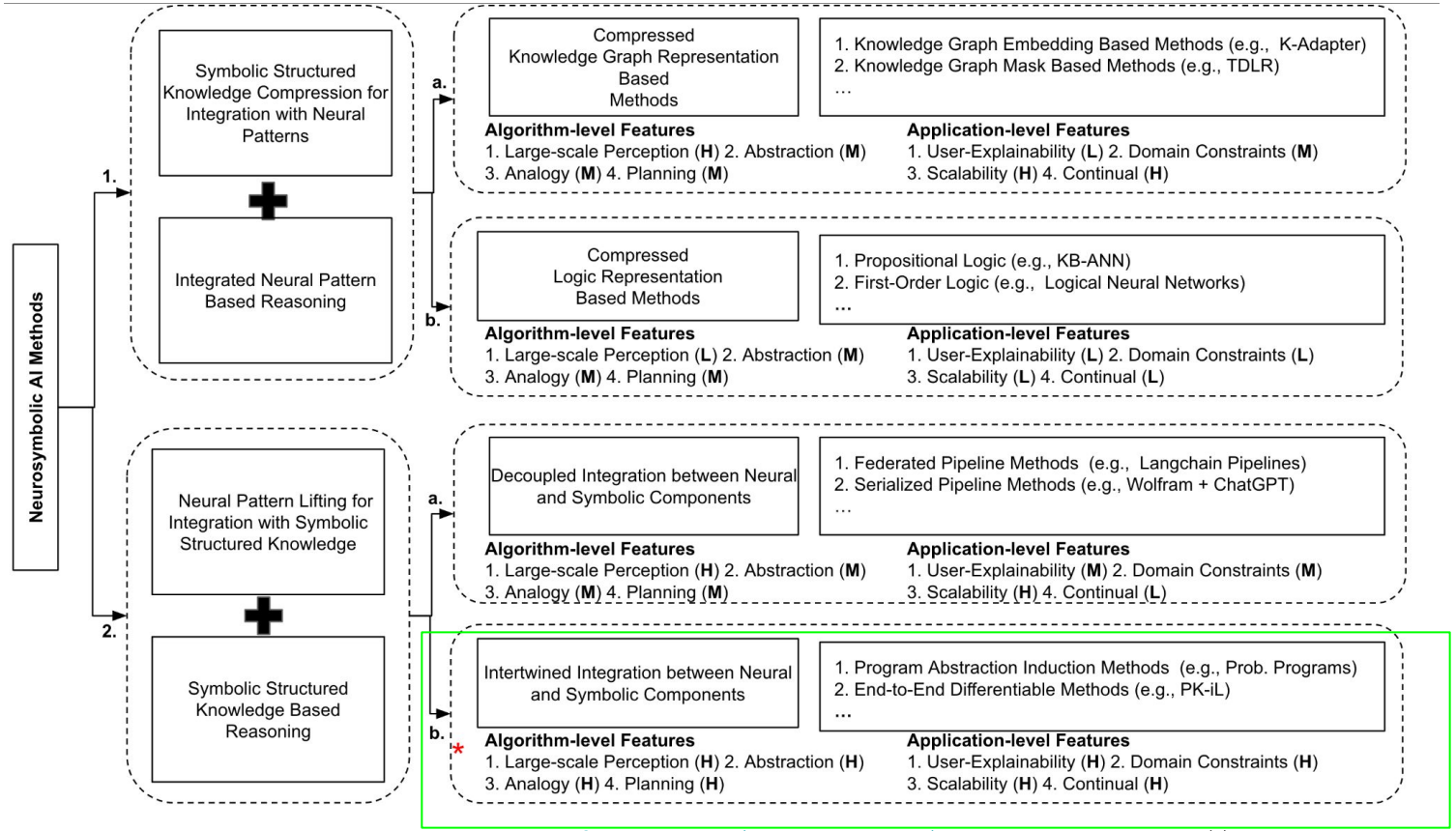








Neurosymbolic Customized and Compact (NeSy-CC) Copilots



We want to get to this stage

Amit Sheth, Kaushik Roy, Manas Gaur, Neurosymbolic Artificial Intelligence (Why, What, and How), IEEE Intelligent Systems, 38 (3), May-June 2023

Part 2 (20 Mins) - **Use Case Example: Multi Tiered System of Supports (MTSS)**

Decision-Support Example: Behavioral Health

Multi Tiered System of Supports

What is the MTSS?

A Tested and Proven State Mandated Framework for Providing Behavioral Health Assistance to School Students with the Aid of a Support Network of:

School Counselors

School Administrator

Parents

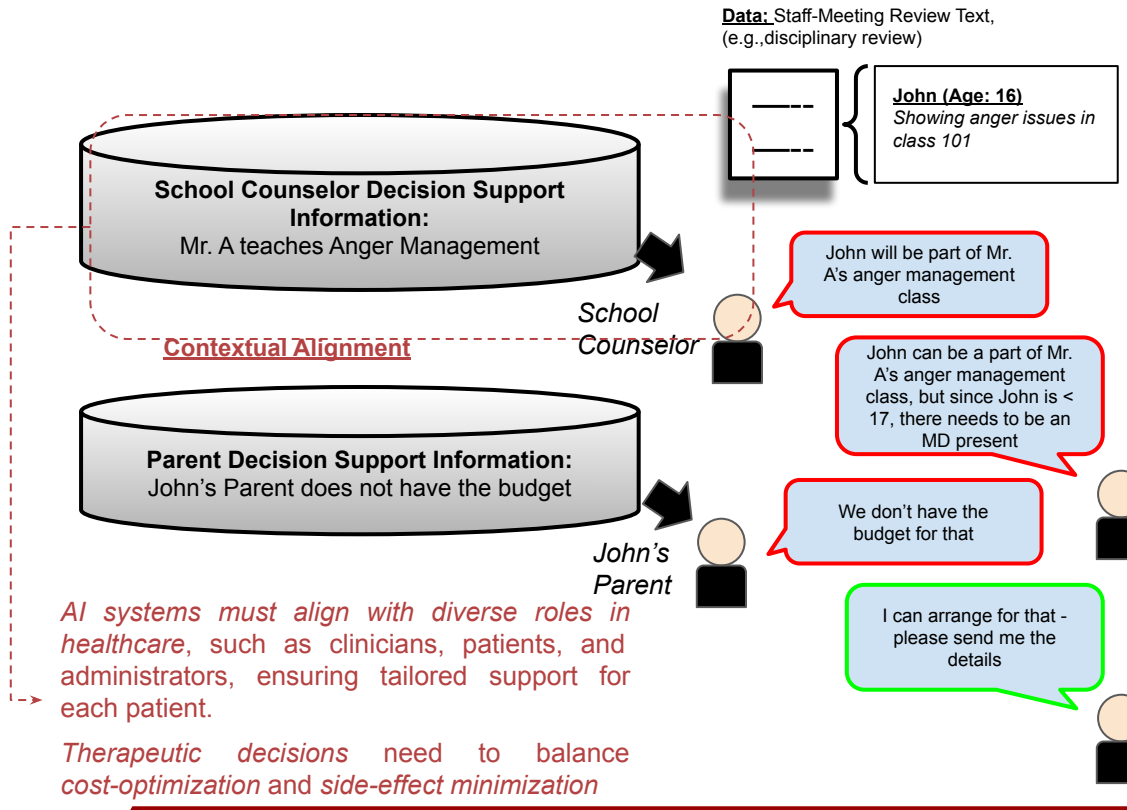
Where AI can help?

Conversations between Members of The Support Network takes several turns and involves complex decision-making before a Satisfactory Resolution is arrived at for action on a Student's case

Decision-Support Example: Behavioral Health

Multi Tiered System of Supports

Example Case: *John is a student showing anger Issues in Class*



AI systems must align with diverse roles in healthcare, such as clinicians, patients, and administrators, ensuring tailored support for each patient.

Therapeutic decisions need to balance *cost-optimization* and *side-effect minimization*

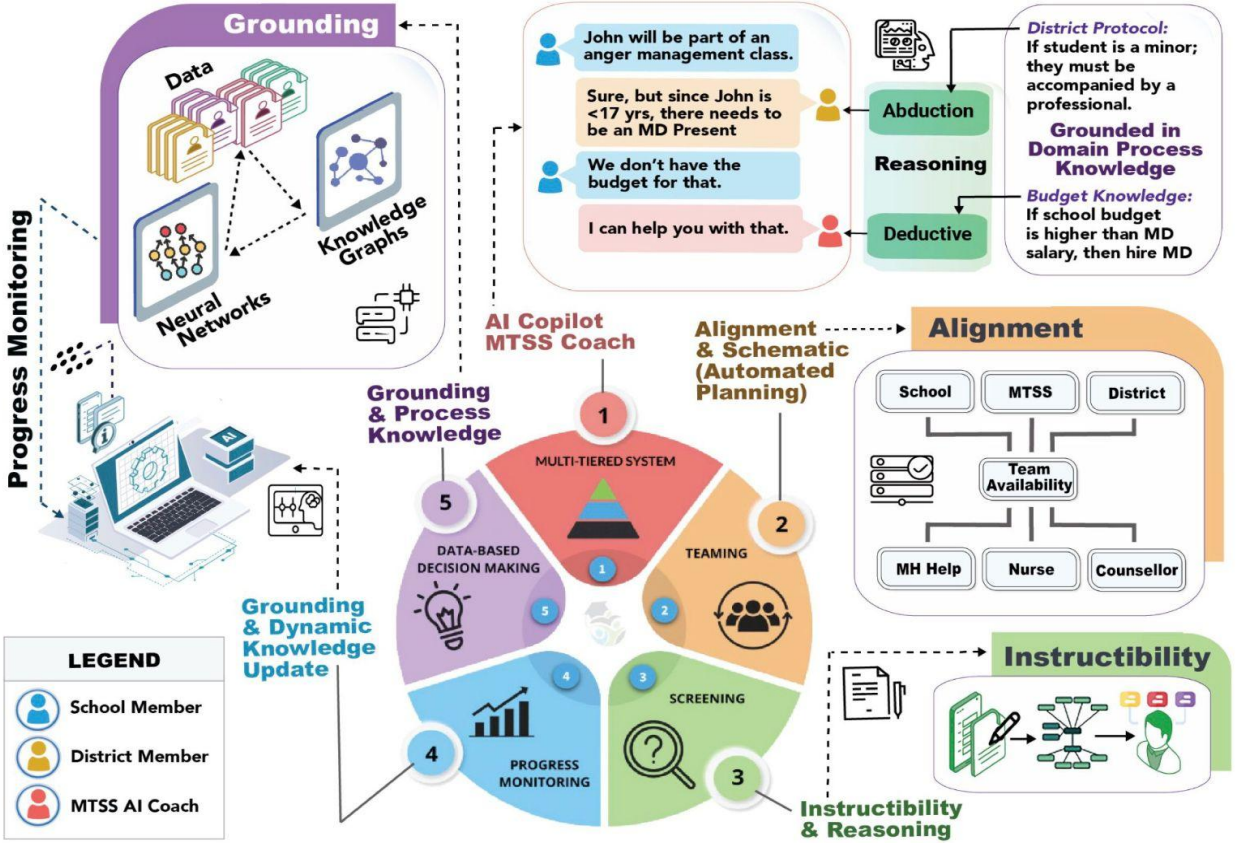
Where AI can help?

This conversation between Members of The Support Network took several turns and complex decision-making before a Satisfactory Resolution was Arrived at for Action on John's case

Can we build an Decision Support CoPilot that facilitates this conversation smoothly by providing decision-support assistance?

Decision-Support Example: Behavioral Health

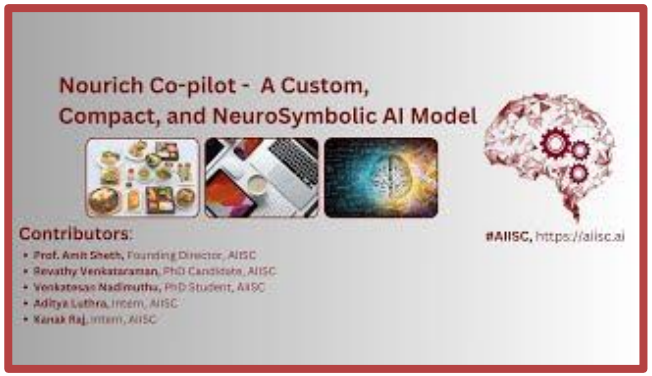
Multi Tiered System of Supports



Neurosymbolic Customized and Compact (NeSy-CC) Copilots

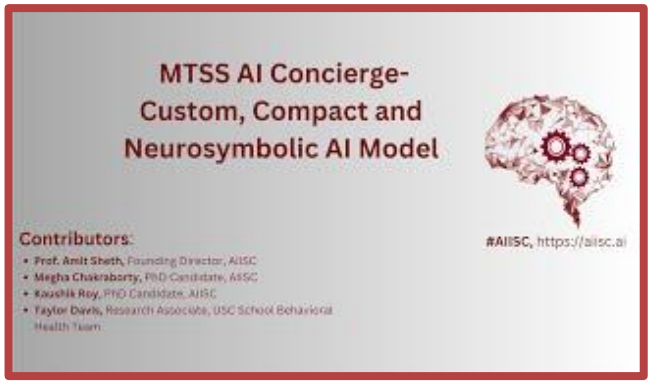
Demonstration Videos

Nourish Co-pilot: A Custom, Compact and NeuroSymbolic Diet AI Model



Short-form Video (< 2 minutes)
Long-form Video

MTSS AI Concierge- Custom, Compact and NeuroSymbolic AI Model

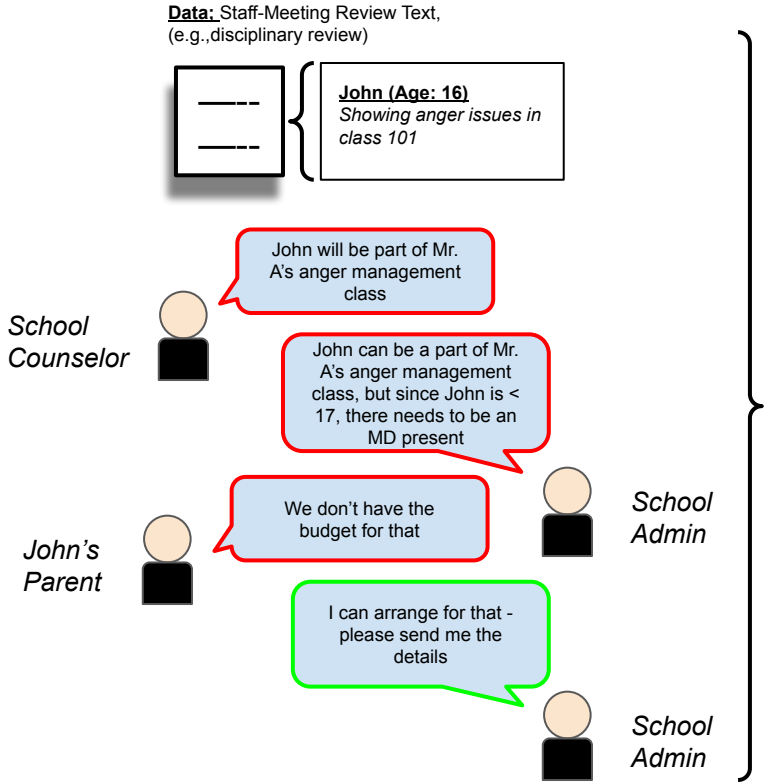


Short-form Video (< 2 minutes)
Long-form Video

Please play on Youtube

Part 3 (40 Mins) - **Demonstrating Preliminary NeSy-CC Copilots (MTSS)**

Can we use Retrieval-augmented Generation?



Query

Information Stored in a Vector Database

- **Parent Decision Support Information:** John's Parent does not have the budget
- **School Admin Decision Support Information:** John is a Minor, and hence this type of arrangement requires an MD present
- **School Admin Decision Support Information:** The school has the budget
- **School Counselor Decision Support Information:** Mr. A teaches Anger Management

Vector-similarity (Sim)-based Information Retrieval

Sim > θ?

Relevant Information

Irrelevant Information

Issues

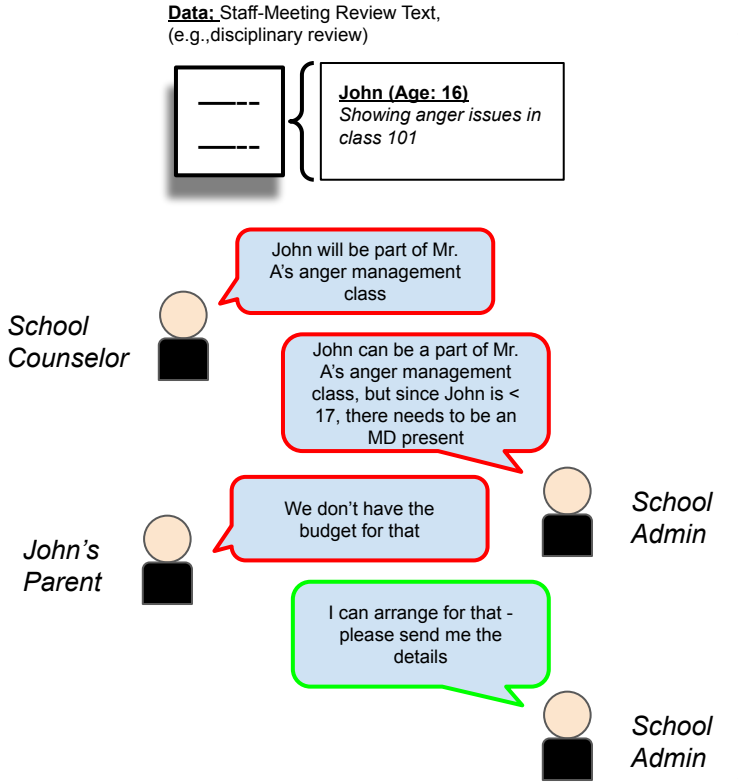
Information Retrieval Mechanism is Black-box

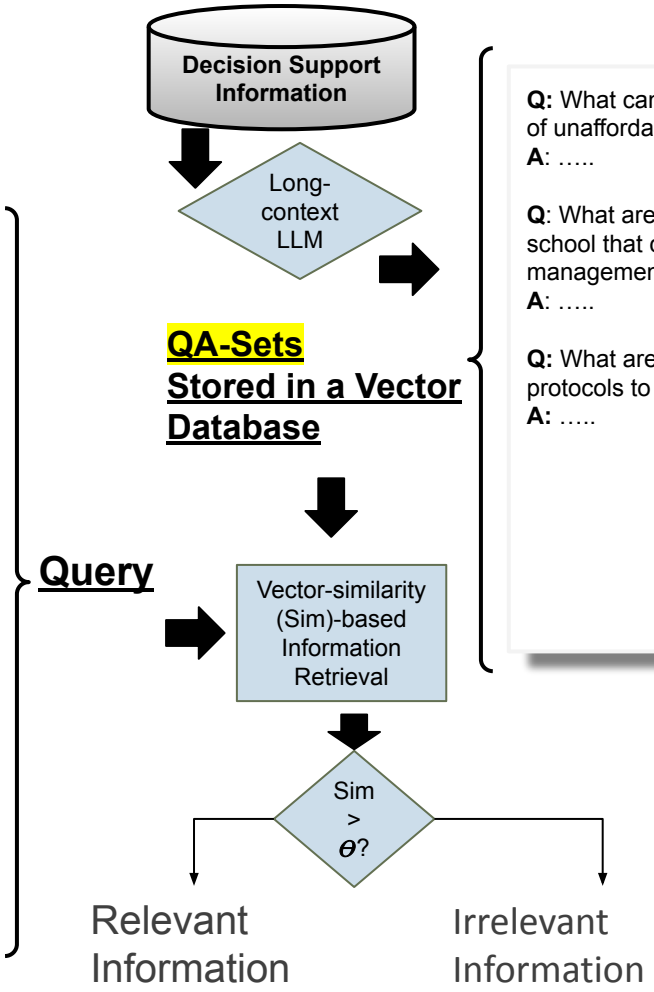
Arbitrary chunking of information

Arbitrary thresholds, no user customization, and No Robustness checks

High consequences!!

Introducing the MTSS QA Copilot





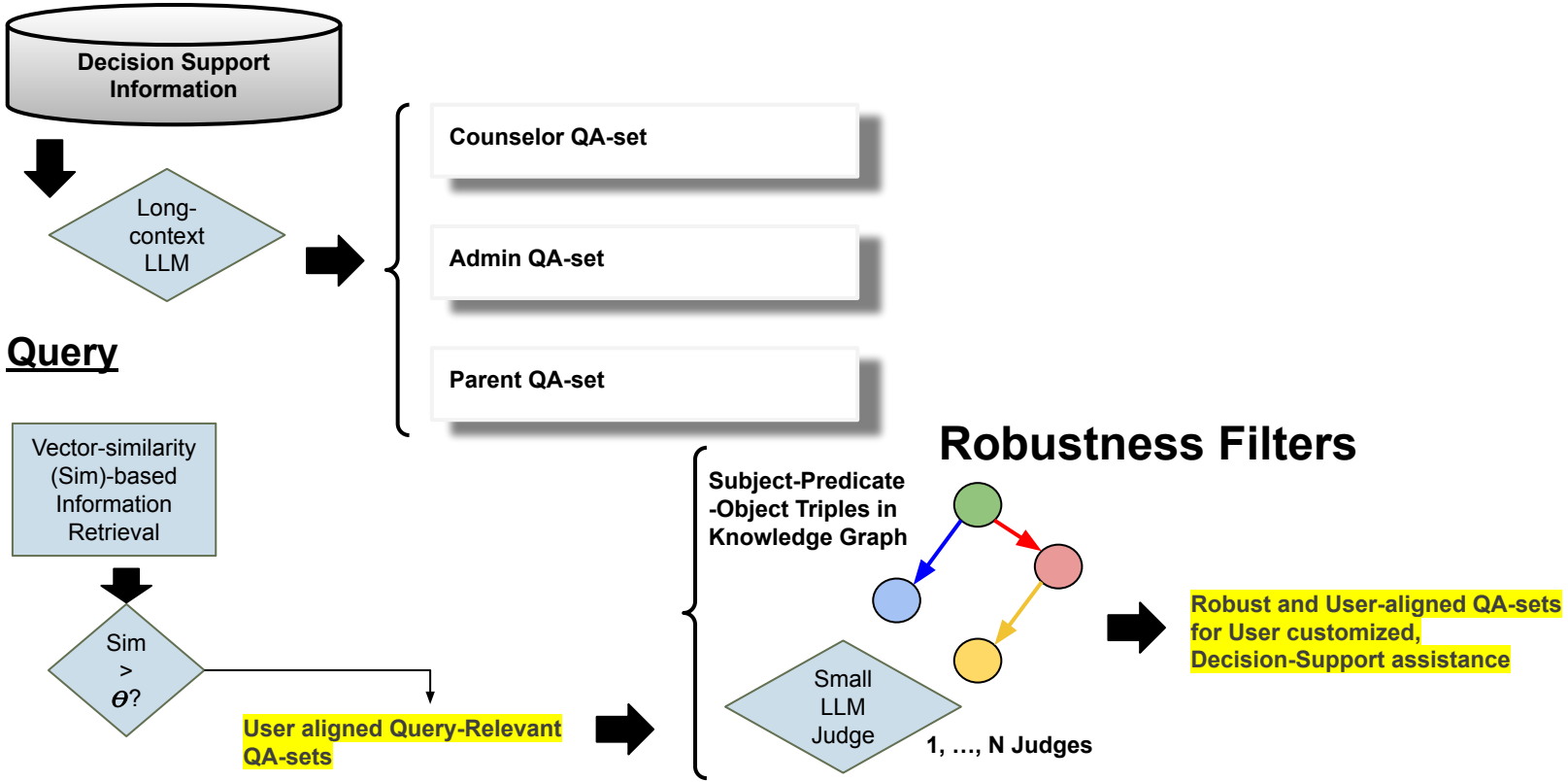
Issue Fixes

We can trace back to the Question-answer block

Long-context LLMs can preserve information properly during conversation to QA-sets

What about Thresholds, User customization, and Robustness Checks?

Introducing the User-aligned QA sets for User Customization, and Leveraging Knowledge-Graphs and LLM-Judge-Averaging for Robustness Checks



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Part 4 (20 Mins) - **Future Work and Vision (MTSS)**

Thank you!!