

Neurosymbolic Customized and Compact Copilots

[Tutorial Paper](#) (100 minutes, Hands-on and Lecture Style Tutorial)

@International Semantic Web Conference,
Date.

Kaushik Roy, Megha Chakraborty, Yuxin Zi, Manas Gaur, Amit Sheth

AI Institute of South Carolina, University of South Carolina

University of Maryland, Baltimore County





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

How Current Language Models Work



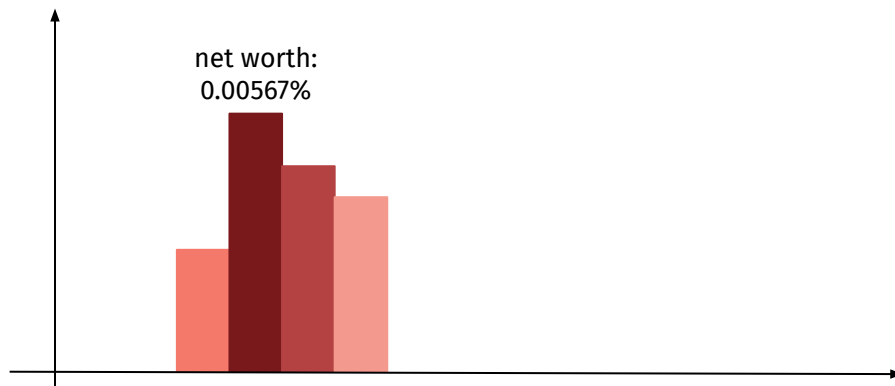
Prediction Context

What is Mark Zuckerberg's net worth?

Did you mean: net worth

Did you mean: salary

Did you mean: rich for



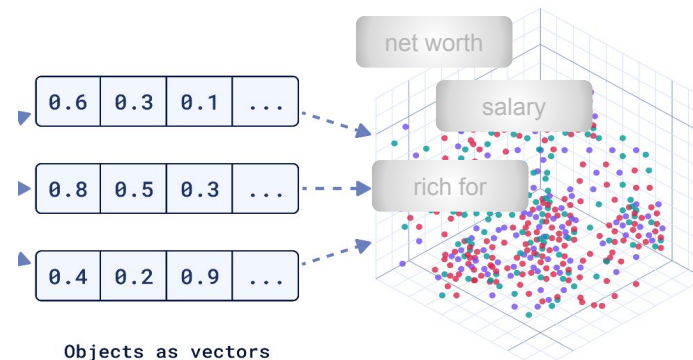
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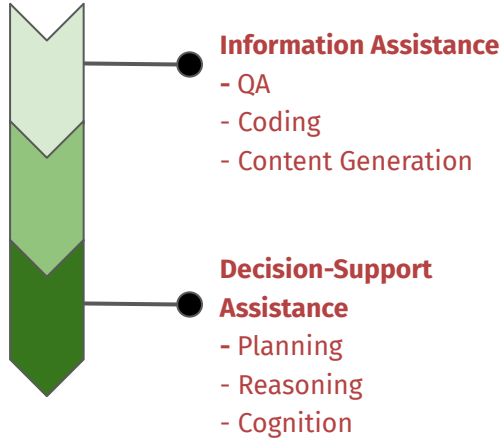
[Image Source](#)



Language Models Predict based on Context-Specific Distributional Mappings



Good Successes, but



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



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

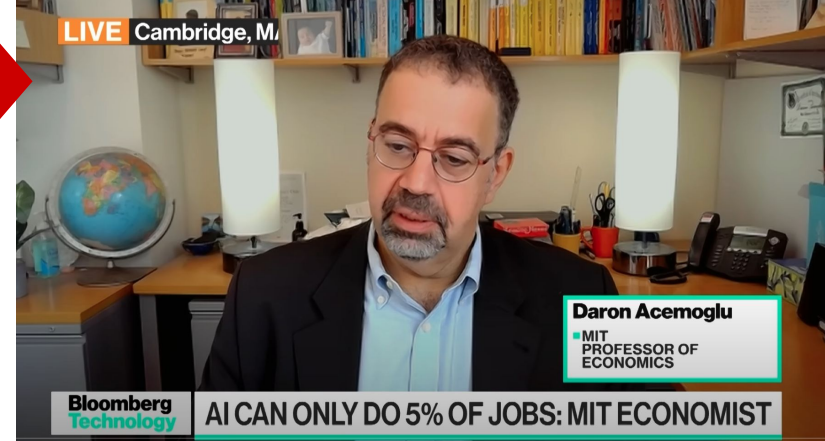


Trending Market Research News
349 followers



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

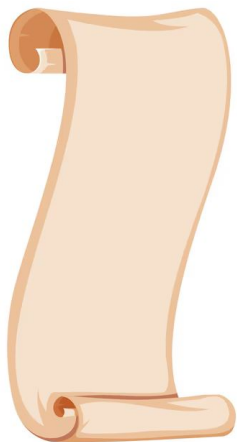
? Data - Why train on Voluminous open web data?

? 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.

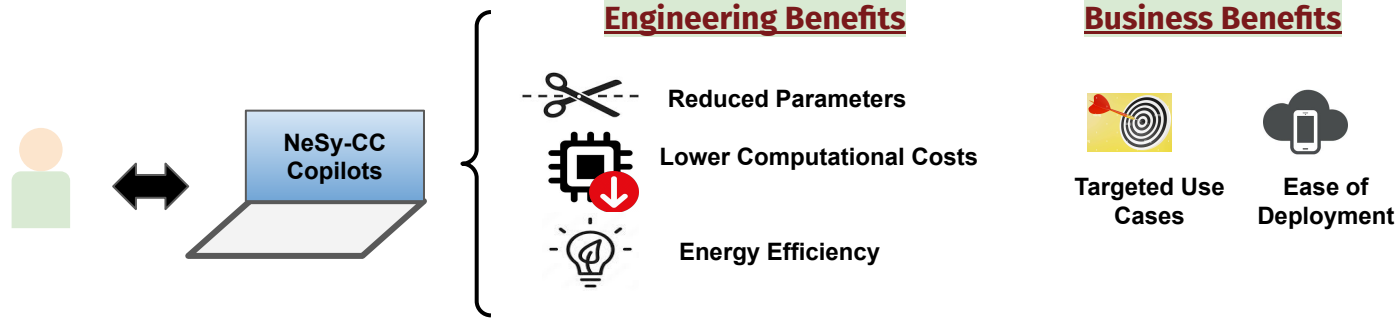
Inability to handle & Follow guidelines

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



For Solving Decision-Support Assistance

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

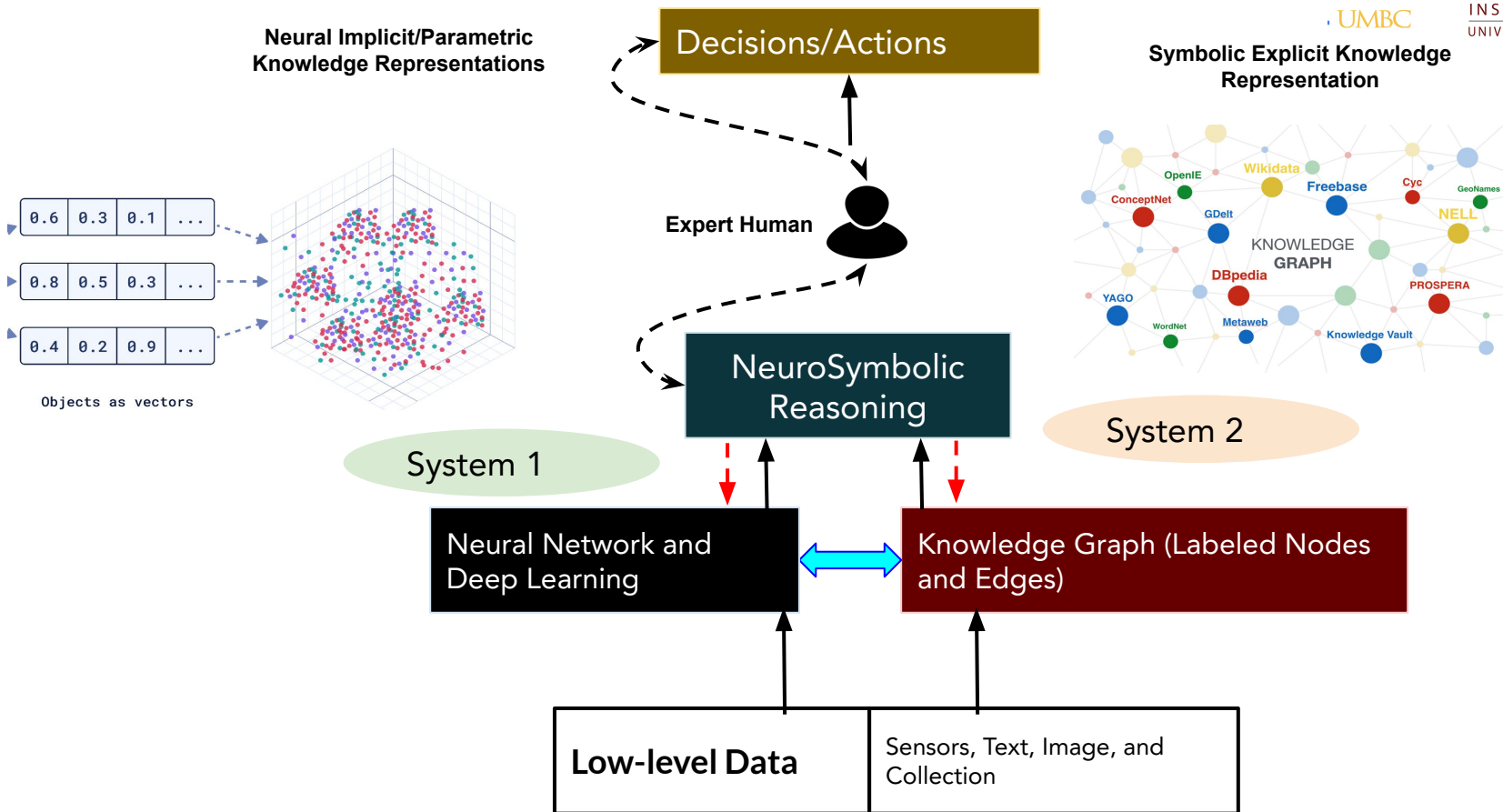
? **Knowledge**

- **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



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

Building trustworthy NeuroSymbolic AI Systems: Consistency, reliability, explainability, and safety

Manas Gaur, Amit Sheth

First published: 14 February 2024 | <https://doi.org/10.1002/aaai.12149>

Process Knowledge-Infused AI: Toward User-Level Explainability, Interpretability, and Safety

Amit Sheth, Manas Gaur, Kaushik Roy, Revathy Venkataraman, and Vedant Khandelwal, University of South Carolina, Columbia, SC, 29201, USA

Knowledge-Intensive Language Understanding for Explainable AI

Amit Sheth, Manas Gaur, and Kaushik Roy, University of South Carolina, Columbia, SC, 29208, USA
Keyur Faldu, Embibe, Inc., Bengaluru, 560002, India

Neurosymbolic AI approach to Attribution in Large Language Models

Deepa Tilwani, AI Institute, University of South Carolina, Columbia, SC, 29208.
Revathy Venkataramanan, AI Institute, University of South Carolina, Columbia, SC, 29208.
Amit P. Sheth, AI Institute, University of South Carolina, Columbia, SC, 29208.

Grounding From an AI and Cognitive Science Lens

Goonmeet Bajaj, The Ohio State University, Columbus, OH, 43210, USA
Valerie L. Shalin, Wright State University, Dayton, OH, 45435, USA
Srinivasan Parthasarathy, The Ohio State University, Columbus, OH, USA
Amit Sheth, University of South Carolina, Columbia, SC, 29208, USA

Neurosymbolic AI for Enhancing Instructability in Generative AI

Amit Sheth, Vishal Pallagani, and Kaushik Roy, University of South Carolina, Columbia

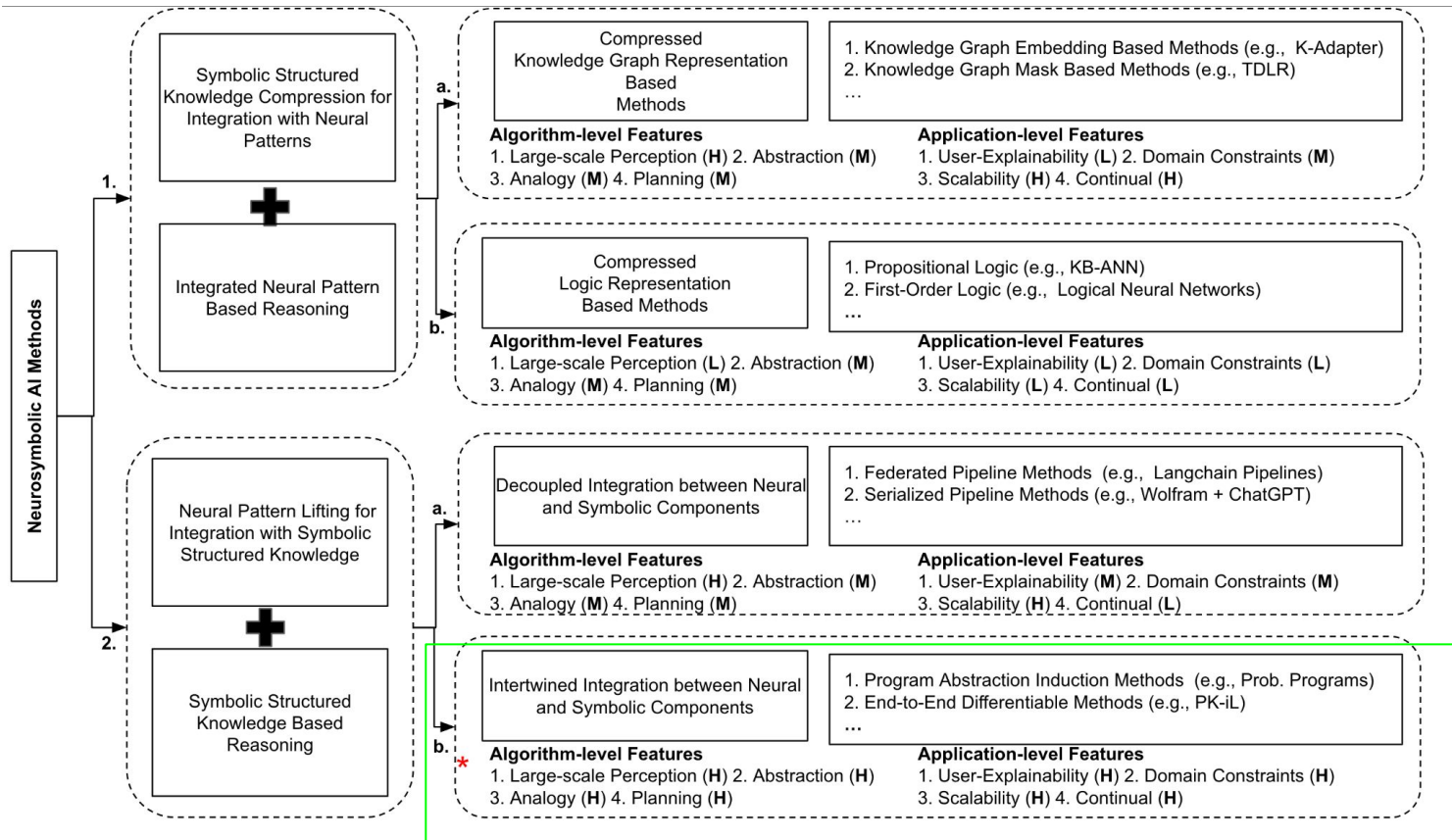
Causal Neurosymbolic AI: A Synergy Between Causality and Neurosymbolic Methods

Utkarshani Jaimini, Artificial Intelligence Institute at University of South Carolina, Columbia, SC, 29208, USA
Cory Henson, Bosch Center for Artificial Intelligence, Pittsburgh, PA, 15222, USA
Amit Sheth, Artificial Intelligence Institute at University of South Carolina, Columbia, SC, 29208, USA

Why Do We Need Neurosymbolic AI to Model Pragmatic Analogies?

Thilini Wijesiriwardene and Amit Sheth, University of South Carolina, Columbia, SC, 29208, USA
Valerie L. Shalin, Wright State University, Dayton, OH, 45435, USA
Amitava Das, University of South Carolina, Columbia, SC, 29208, USA

Neurosymbolic Customized and Compact (NeSy-CC) Copilots



We want to get to this stage



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:

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



School Counselors



School Administrator



Parents

Decision-Support Example: Behavioral Health

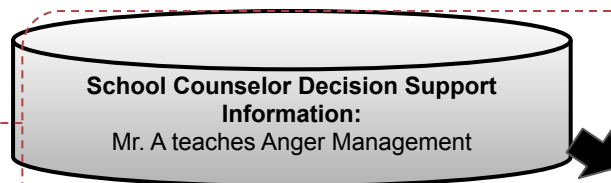
Multi Tiered System of Supports



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

Data: Staff-Meeting Review Text,
(e.g.,disciplinary review)

John (Age: 16)
Showing anger issues in
class 101



Contextual Alignment



School
Counselor



John will be part of Mr.
A's anger management
class

John can be a part of Mr.
A's anger management
class, but since John is <
17, there needs to be an
MD present

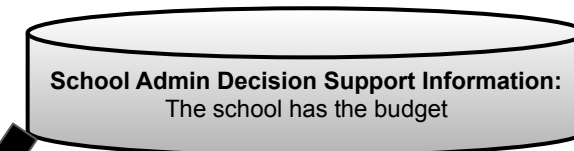
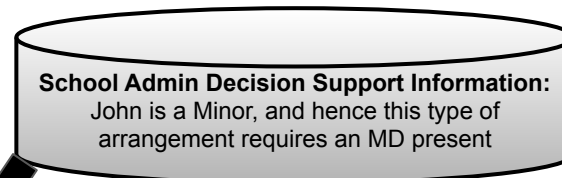
We don't have the
budget for that

I can arrange for that -
please send me the
details

John's
Parent



School
Admin



School
Admin



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

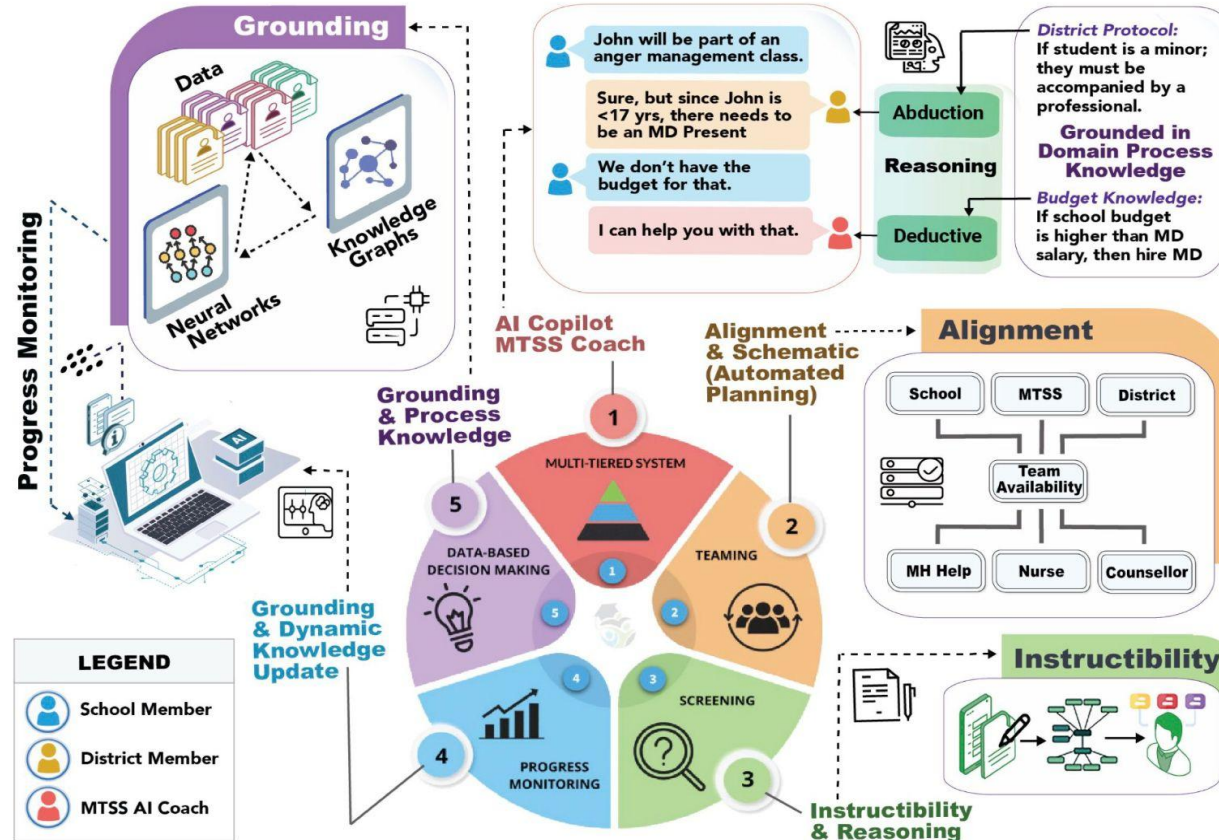
Where AI can help?

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

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



Contributors:

- Prof. Amit Sheeth, Founding Director, AIISC
- Revathy Venkataraman, PhD Candidate, AIISC
- Venkatesan Nadimurthy, PhD Student, AIISC
- Aditya Lathra, Intern, AIISC
- Karak Raj, Intern, AIISC

#AIISC, <https://aiisc.ai>

[Short-form Video](#) (< 2 minutes)

[Long-form Video](#)

MTSS AI Concierge- Custom, Compact and NeuroSymbolic AI Model

MTSS AI Concierge- Custom, Compact and Neurosymbolic AI Model



Contributors:

- Prof. Amit Sheeth, Founding Director, AIISC
- Megha Chakraborty, PhD Candidate, AIISC
- Raushik Roy, PhD Candidate, AIISC
- Taylor Davis, Research Associate, USC School Behavioral Health Team

#AIISC, <https://aiisc.ai>

[Short-form Video](#) (< 2 minutes)

[Long-form Video](#)

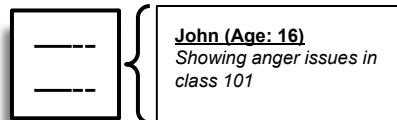
Please play on Youtube



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

Can we use Retrieval-augmented Generation?

Data: Staff-Meeting Review Text,
(e.g.,disciplinary review)



School
Counselor



John will be part of Mr.
A's anger management
class

John can be a part of Mr.
A's anger management
class, but since John is <
17, there needs to be an
MD present

We don't have the
budget for that

John's
Parent



I can arrange for that -
please send me the
details

School
Admin



School
Admin



Query

Information
Stored in a
Vector
Database



Vector-similarity
(Sim)-based
Information
Retrieval



Sim
>
 θ ?

Relevant
Information

Irrelevant
Information

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

Issues

Information Retrieval
Mechanism is Black-box

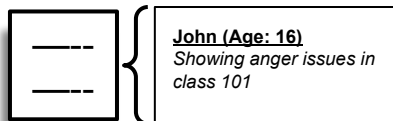
Arbitrary chunking of information

Arbitrary thresholds, no user
customization, and No
Robustness checks

High consequences!!

Introducing the MTSS QA Copilot

Data: Staff-Meeting Review Text,
(e.g.,disciplinary review)



School
Counselor



John will be part of Mr.
A's anger management
class

John's
Parent



We don't have the
budget for that

School
Admin

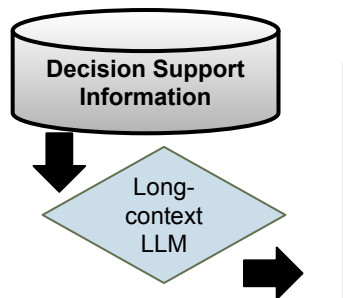


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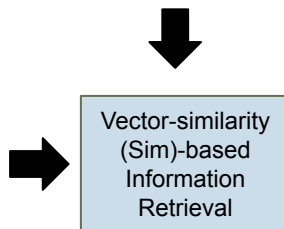
School
Admin



Query



QA-Sets
Stored in a Vector
Database



Relevant
Information

Irrelevant
Information

Q: What can a parent do in the case
of unaffordability

A:

Q: What are the teachers in the
school that currently teach anger
management?

A:

Q: What are the state-mandated
protocols to follow for minors?

A:

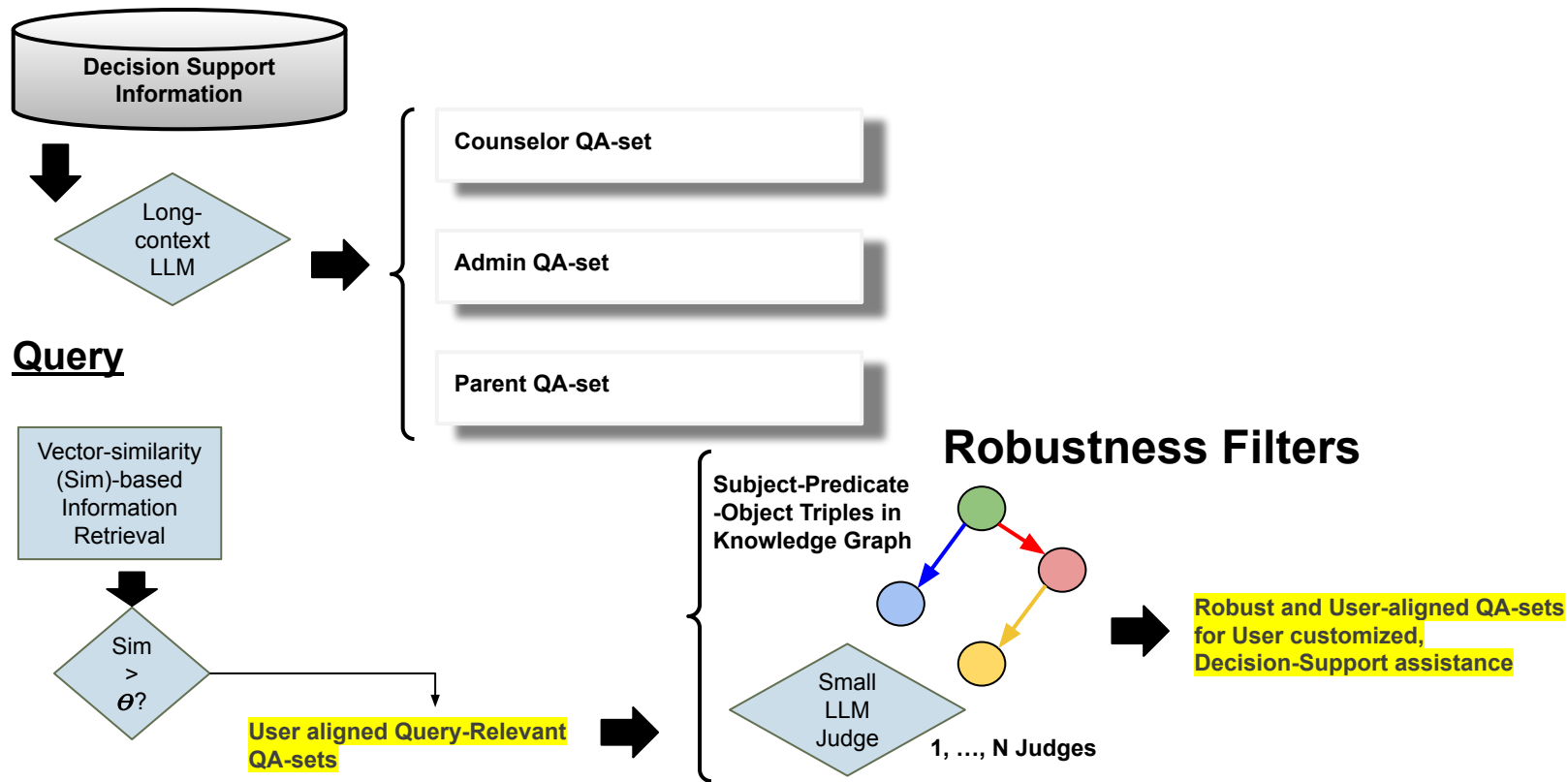
Issue Fixes

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





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



Thank you!!