

# Ashtekar Frontiers of Science



Scan the QR code to subscribe to our mailing list.

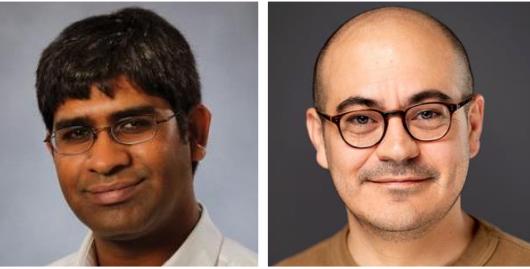


The lecture series was founded by Abhay Ashtekar, founding director of the Institute for Gravitation and the Cosmos and a member of the National Academy of Sciences. It owes its success to Barbara Kennedy, who presided over the series during its first 25 years, making it one of the most successful science outreach events in central Pennsylvania.

The 2026 Ashtekar Frontiers of Science lecture series will explore how researchers in the Eberly College of Science approach some of today's biggest societal questions using different approaches. The 2026 lecture series brings together researchers from disparate disciplines to showcase how faculty from across the college's seven departments leverage wide-ranging methodologies and theoretical approaches to tackle pressing scientific issues and help shape the future of science, health, and humanity.

# 001 Chemical and Biomedical Engineering Building

**"Origins"**  
January 24, 2026



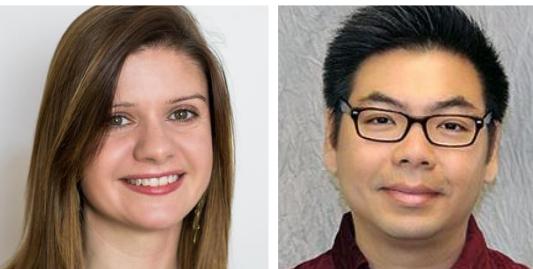
Suvrath  
Mahadevan      Tom Stewart

**"Medicine"**  
January 31, 2026



Santhosh  
Girirajan      Wenrui Hao

**"Climate"**  
February 7, 2026



Helen  
Greatrex      John Harlim

**"Materials"**  
February 14, 2026



Bryce  
Gadway      Danielle  
Hickey

**"Resources"**  
February 21, 2026



Charlie  
Anderson      Joey Cotruvo

**"Education"**  
February 28, 2026



Jennelle  
Malcos      Matthew  
Beckman



# AI Support for Teaching and Learning (at scale)

Matthew D. Beckman  
Department of Statistics

Resource Page



February 28, 2026



# The learning environment *matters*



## Claude's new constitution

Jan 22, 2026

[Read the constitution](#)

## Artificial and the Teaching

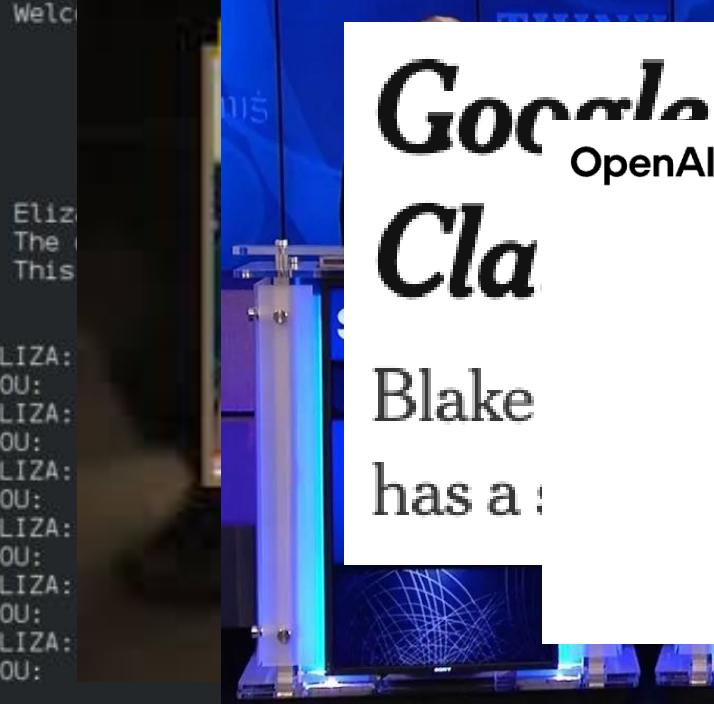
Insights and Recom

May 2023

### Recommendations .....

Insight: Aligning AI to Policy Ob  
Calling Education Leaders to A  
Recommendation #1: Emphas...  
Recommendation #2: Align AI I  
Recommendation #3: Design U  
Recommendation #4: Prioritize  
Recommendation #5: Inform ai  
Recommendation #6: Focus R  
Recommendation #7: Develop  
Next Steps.....

60



# Google Sidel

OpenAI

# Cla

Blake  
has a :

E  
@

Replying to

It's a n

4:03 AM ·



Welc

Eliz  
The  
ThisELIZA:  
YOU:  
ELIZA:  
YOU:  
ELIZA:  
YOU:  
ELIZA:  
YOU:  
ELIZA:  
YOU:

1966

1991

2011

2022

2023

2026

Today

# How AI Impacts Skill Formation

Judy Hanwen Shen\*

Alex Tamkin†

February 3, 2026

## Abstract

AI assistance produces significant productivity gains across professional domains, particularly for novice workers. Yet how this assistance affects the development of skills required to effectively supervise AI remains unclear. Novice workers who rely heavily on AI to complete unfamiliar tasks may compromise their own skill acquisition in the process. We conduct randomized experiments to study how developers gained mastery of a new asynchronous programming library with and without the assistance of AI. We find that AI use impairs conceptual understanding, code reading, and debugging abilities, without delivering significant efficiency gains on average. Participants who fully delegated coding tasks showed some productivity improvements, but at the cost of learning the library. We identify six distinct AI interaction patterns, three of which involve cognitive engagement and preserve learning outcomes even when participants receive AI assistance. Our findings suggest that AI-enhanced productivity is not a shortcut to competence and AI assistance should be carefully adopted into workflows to preserve skill formation – particularly in safety-critical domains.

**ANTHROPIC**

# Lessons for Education

- Not an “end of homework”
- Teaching shifts emphasis
- Access and Scale Improve
- Caution: “ELIZA Effect”

```
Welcome to
EEEEE LL     IIII    ZZZZZZ  AAAAA
EE      LL     II     ZZ  AA  AA
EEEEE LL     II     ZZZ  AAAAAAA
EE      LL     II     ZZ  AA  AA
EEEEE LLLLLL IIII ZZZZZZ  AA  AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU: Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU: Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU: It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```



Unexpected Pairings  
Addressing  
Big Questions



PennState  
Eberly College of Science

Ashtekar  
Frontiers of Science

# Personalized Practice / Tutoring

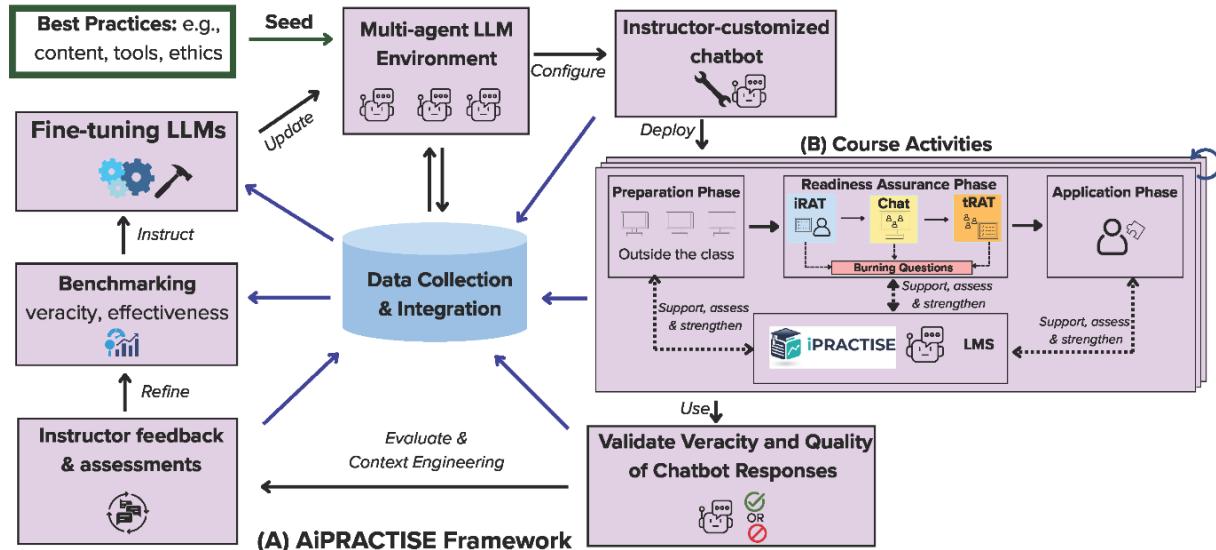


Fig. Schematic representation of Ai-Practise Project related technologies.

- **Ai-Practise** PennState
  - SSRI AI Seed Grant; Sy-Miin Chow, PI
  - Extends iPractise & T-Practise NSF Grants
- **SPARK Self-Regulated Learning** PennState
  - Rayne Sperling, PI
- **Context-aware Chatbots for Education**
  - Khan Academy's Khanmigo
  - Pearson's AI-Powered Chat Bot
  - NSF-Funded HaLLMos Tool (<https://hallmos.com>)

# Initial Schematic of LLM support for formative assessment at scale



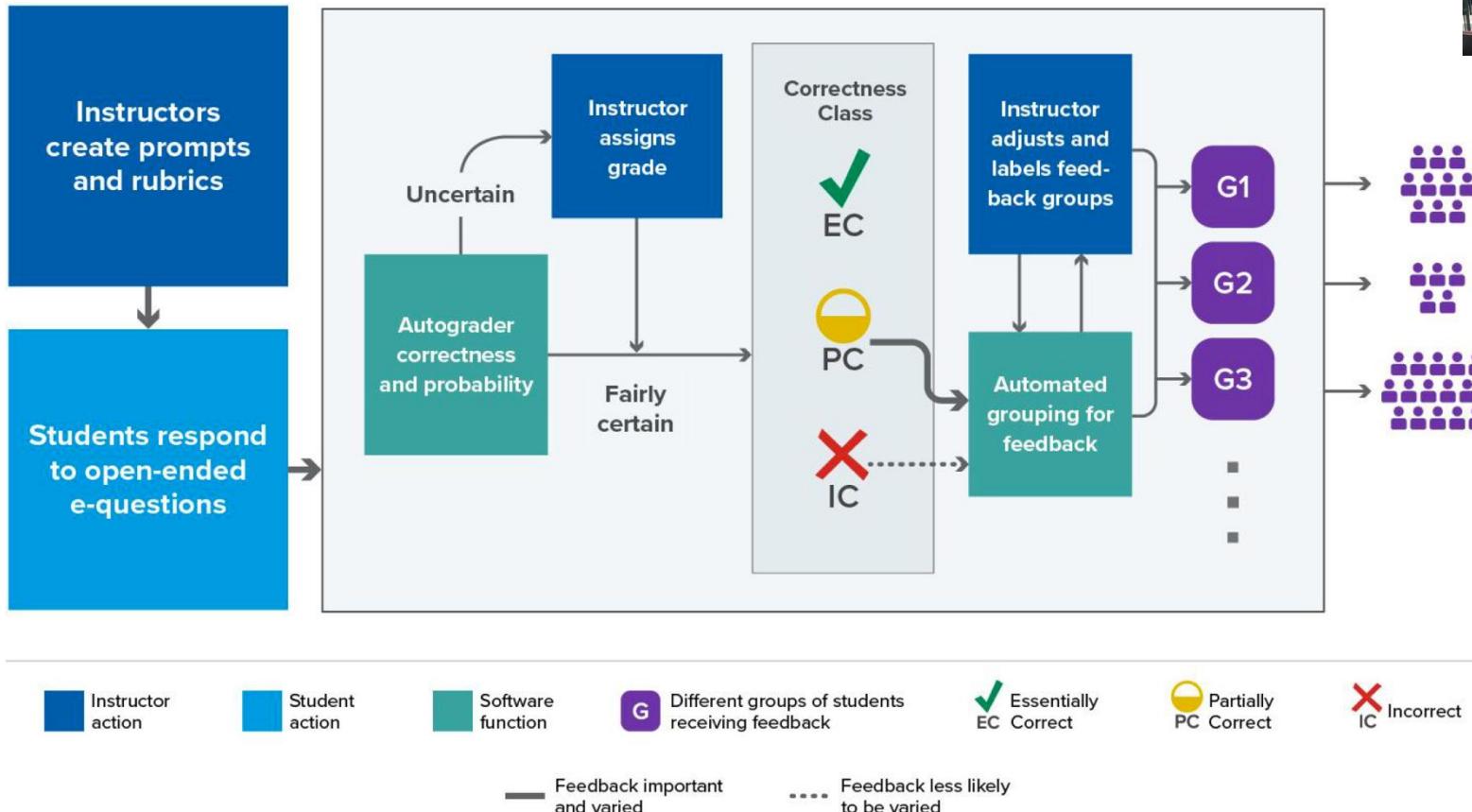
Matt Beckman  
(Statistics)



Becky Passonneau  
(Computer Science)



Dennis Pearl  
(Statistics)



Anna Fergusson



Liza Bolton



Anne Patel



Lars Thompson



Emma Lehrke



Matt Beckman

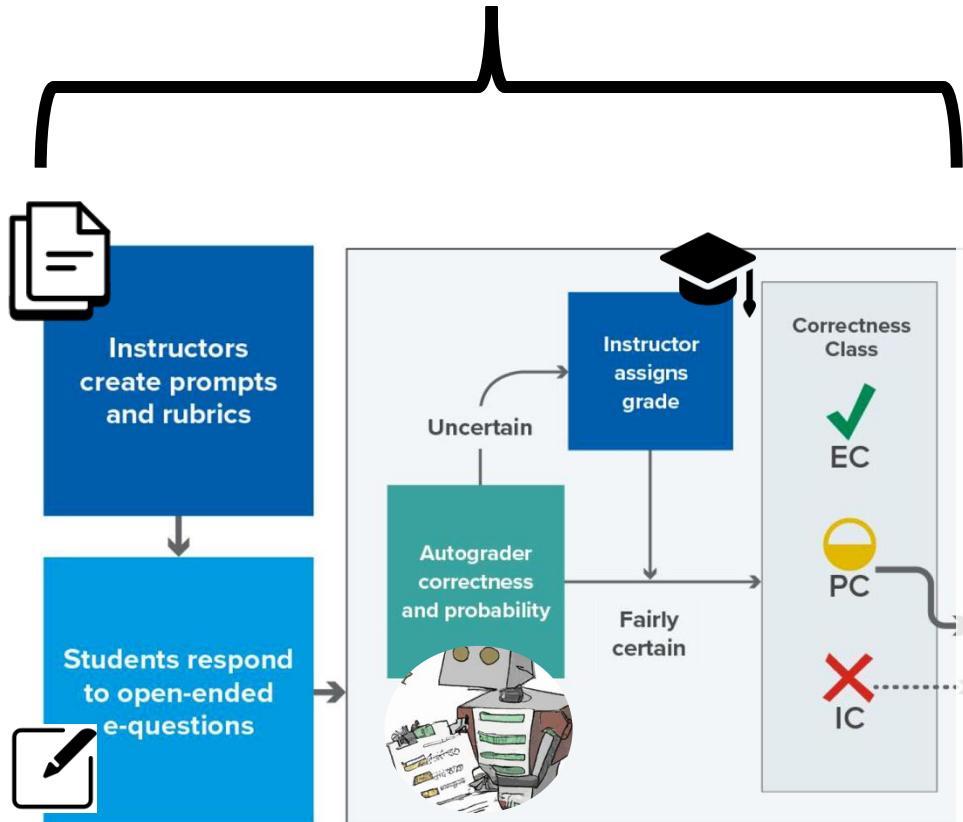


# Quick, Write!

**Question:** How would you describe the value of this kind of formative assessment? For students? For Instructors?

(Seriously, just share whatever comes to mind; we'll use them in a moment)

# Does it... work?



## "Scoring" Agreement:

- Instructors  $\approx 0.7 - 0.8$
- TA's  $\approx 0.6 - 0.7$
- Our custom AI  $\approx 0.7$

## Human-in-the-Loop Combination:

- $0.85 - 0.9$  *with deferral control*

Threshold	Deferral Rate	Simulated HIL Accuracy
0.68	9.5%	0.855
0.75	13.2%	0.861
0.80	16.0%	0.871
0.85	20.2%	0.884
0.90	25.6%	0.899

# Students: “*What’s in it for me??*”

(translation: I thought he said formative assessment)



- Comparative Judgments (CJ)
- Evaluate other responses
- Give (& get) feedback

*p.s. it's the same QR code as “Quick, Write!” so you can either scan OR just refresh the page.*

Prototype: Dr. Anna Fergusson (University of Auckland, NZ)



Matt Beckman



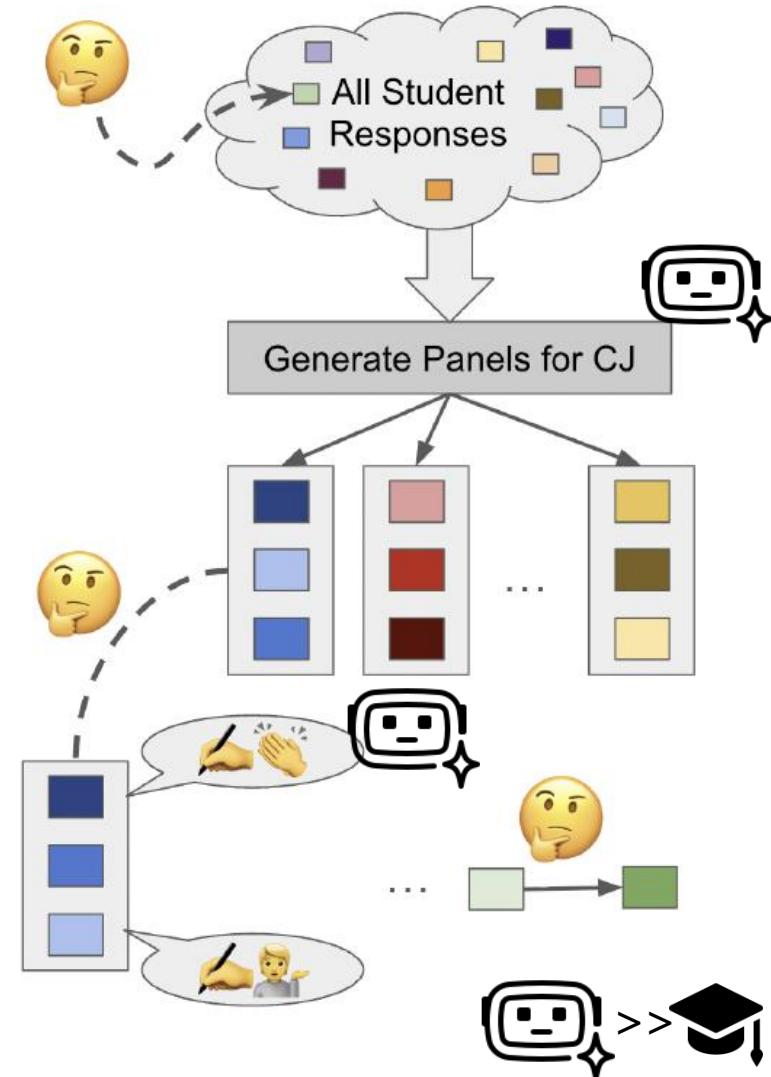
Wenpeng Yin



ChanMin Kim



Neil Hatfield Anna Fergusson



# Stay tuned!

- How do LLM / AI models handle linguistic diversity?
- How best to cluster LLM representations of student responses?
- New learning theory for formative comparative judgement (CJ)?
- How does choice of responses for CJ influence critical thinking?
- How does AI-supported CJ influence critical thinking?
- Are there constraints on task & rubric implementation?
- And many other interesting questions

# Acknowledgments

- US National Science Foundation (NSF DUE-2236150; DUE-2417294)
- Penn State Center for Socially Responsible Artificial Intelligence
- Penn State Social Science Research Institute (SSRI) Seed Grant
- Strategic partnership between University of Auckland and Penn State University
- Students, instructors, and institutional partners that contributed data and permitted us to use it for our research (Penn State IRB: Study 00022615)

# References

- Anthropic. (2026, January 22). Claude's new constitution. <https://www.anthropic.com/news/clause-new-constitution>
- Beckman, Burke, Fiochetta, Fry, Lloyd, Patterson, Tang (2024). Developing Consistency Among Undergraduate Graders Scoring Open-Ended Statistics Tasks. Preprint URL: <https://arxiv.org/abs/2410.18062>
- Brooks, D. (2022, February 2). Opinion: In the age of A.I., major in being human. The New York Times. <https://www.nytimes.com/2023/02/02/opinion/ai-human-education.html>
- Grant, N., & Metz, C. (2022, June 12). Google engineer claims chatbot AI is sentient. The New York Times. <https://www.nytimes.com/2022/06/12/technology/google-chatbot-ai-blake-lemoine.html>
- Li, Lloyd, Beckman, & Passonneau (2023). Answer-state Recurrent Relational Network (AsRRN) for Constructed Response Assessment and Feedback Grouping. Findings of the Association for Computational Linguistics: EMNLP 2023. <https://doi.org/10.18653/v1/2023.findings-emnlp.254>
- Lloyd, Beckman, Pearl, Passonneau, Li, & Wang (2022). Foundations for AI-Assisted Formative Assessment Feedback for Short-Answer Tasks in Large-Enrollment Classes. In Proceedings of the eleventh international conference on teaching statistics. Rosario, Argentina.
- Shen, J.H. & Tamkin, A. (2026). How AI Impacts Skill Formation. Preprint URL: <https://doi.org/10.48550/arXiv.2601.20245>
- U.S. Department of Education, Office of Educational Technology. (2023). Artificial intelligence and the future of teaching and learning: Insights and recommendations. U.S. Department of Education. <https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf>
- Wei, Beckman, Pearl, & Passonneau (in review). Concept-based Rubrics Improve LLM Formative Assessment and Data Synthesis. <https://arxiv.org/pdf/2504.03877>

# Additional Images

- [Ai-Practise Schematic] Sy-Miin Chow
- [Autograder Schematic] Becky Passonneau, Matthew Beckman, Dennis Pearl
- [ChatGPT] <https://openai.com/index/chatgpt/>
- [Chess] <https://www.facebook.com/WIONews/posts/todayinhistory-1997-ibms-deep-blue-defeats-garry-kasparov-in-chess-match/2358635227680432/>
- [Classroom Photos] Matthew Beckman
- [Comparative Judgment Schematic] Matthew Beckman, Anna Fergusson
- [ELIZA] <https://en.wikipedia.org/wiki/ELIZA>
- [Elon Musk Tweet] <https://www.bbc.co.uk/newsround/64210050.amp>
- [Google Photos Screenshot (& Adaptation)] Matthew Beckman
- [Grading Robot] Dall-E
- [History of eLearning] <https://elearningindustry.com/history-of-elearning-infographic-education-2012>
- [Jeopardy] <https://blog.ted.com/how-did-supercomputer-watson-beat-jeopardy-champion-ken-jennings-experts-discuss/>
- [Icons for “Edit” / “Documents” / “Graduation” / “Robot”] <https://icons8.com/icons>

# AI Support for Teaching and Learning (at scale)

Matthew D. Beckman  
Department of Statistics

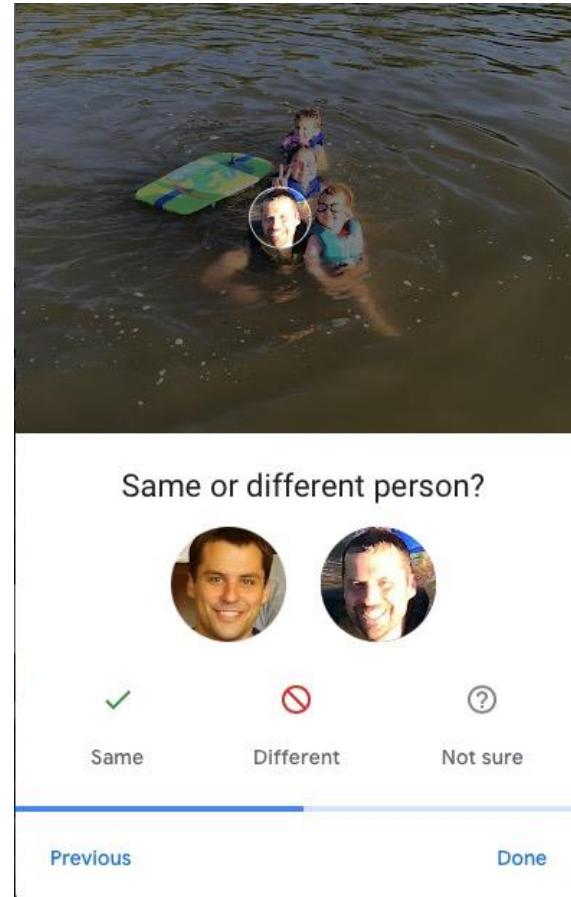
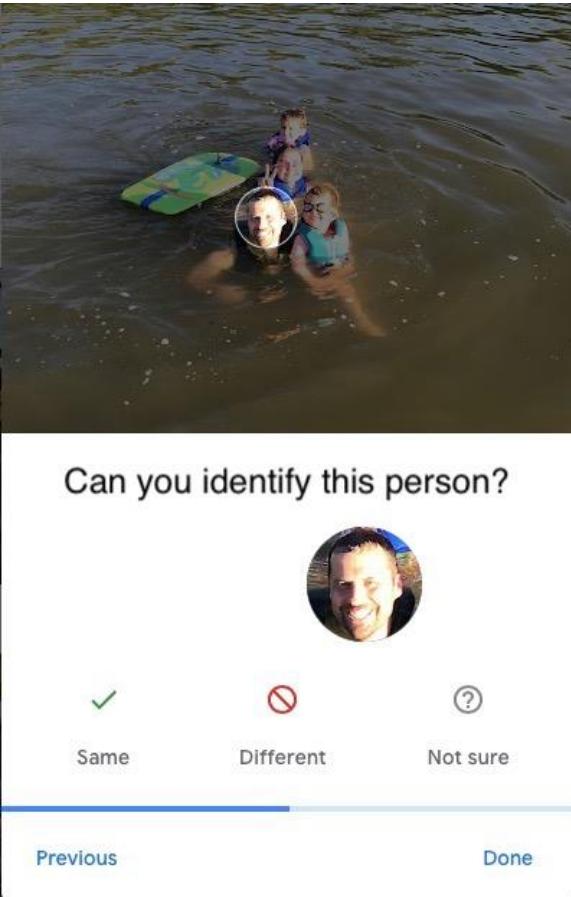
February 28, 2026

Resource Page



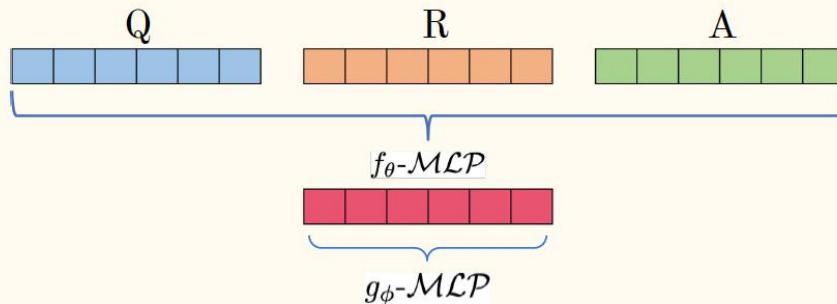
# Backup Slides

# Human-in-the-Loop Intuition



# Relation Network Intuition

## Motivation for a Relation Network



- Many short-answer datasets have triples
  - Question prompt
  - Rubric OR Reference answers
  - Answer from student
- Transformers are less practical
  - Datasets are often relatively small
  - Learning a single vector can efficiently capture relational structure

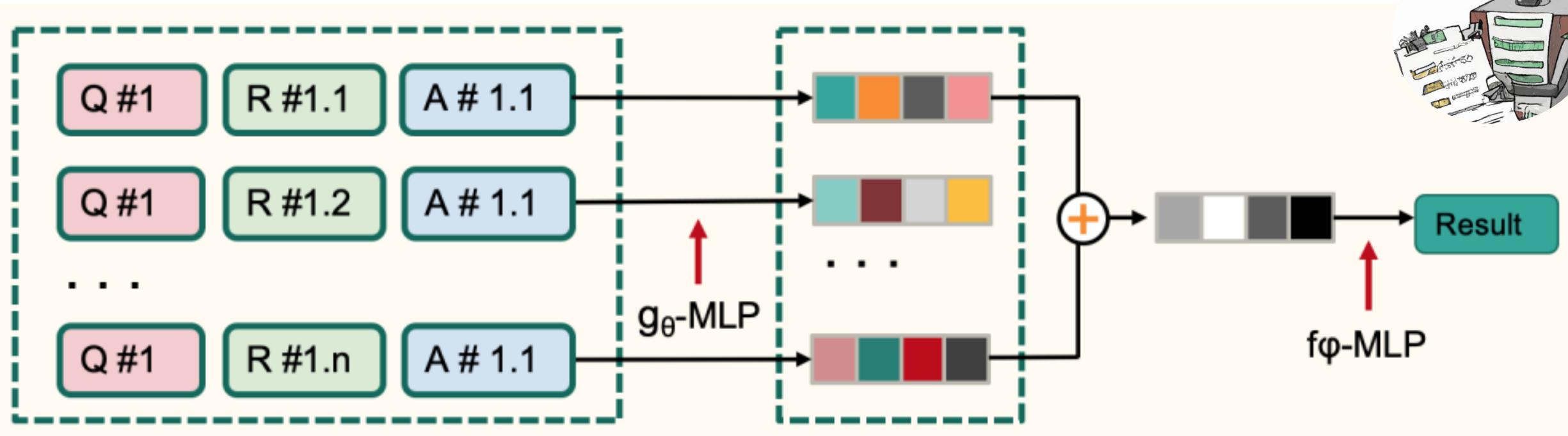
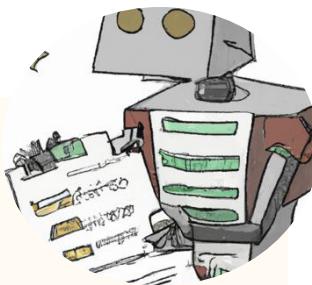
**Q:** Susan has samples of 5 different foods. Using only the results of her experiment, how will Susan know which food contains the most sugar? (Gas volume is evaluated by tube)

**R:** Susan should compare the amount of gas in each bag. The bag with the most gas contains the food with the most sugar.

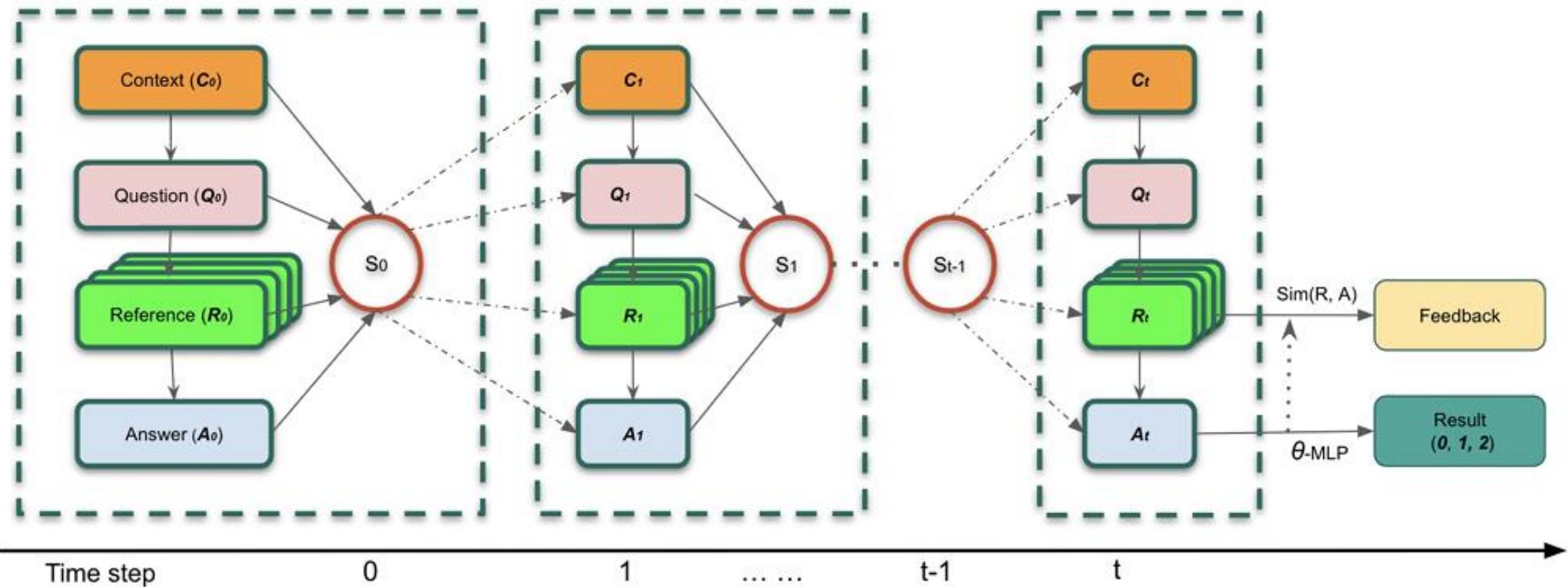
**A:** Susan will know how much sugar is in the foods by putting each bag in a volume tube. When her finder stops after pushing the top, the bottom of the part she pushes down will be on a number. That number is the milliliters of sugar in the food. Whichever number is the highest, that means that food has the most sugar.

Credit: Becky Passonneau

# Semantic Feature-wise Transformation Relation Network (SFRN)



# Answer-State Recurrent Relation Network



# We'd love your feedback!

