Learning²: Machine Learning to Improve Human Learning

Allen Nie, Emma Brunskill (w/many additional collaborators)

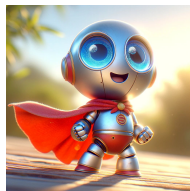Stanford ARTIFICIAL INTELLIGENCE

HAI FIVE

Motivation

- Education enables opportunity & reduces poverty
- Many students lack access to quality education
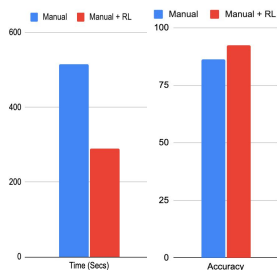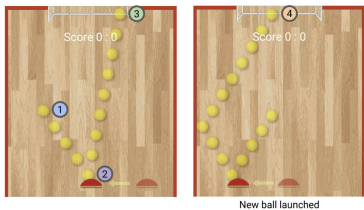- Teachers are under-resourced and over burdened

Research Vision

- Reinforcement learning (RL) involves learning from data to make high-outcome decisions
- Use RL to augment and amplify teaching ecosystem
- Doing so yields novel RL advances

1. RL for Grading: Grading Interactive Coding HW with RL

Error type: Does hitting the ball into the goal increment the score?

New ball launched

Nie, Brunskill, Piech NeurIPS 2021; Liu et al. NeurIPS 2022; Liu et al. SIGCSE 2024

2. RL for Tutoring: Create personalized tutoring companion for students
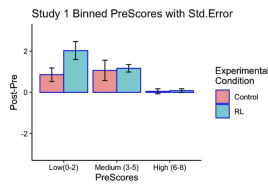

Pre-Tutoring Exam (Pre-Test) → Post-Tutoring Exam (Pre-Test)

Acknowledgement
Encourage
Guided Prompt
Direct Hint

"I think I have some ideas! But I won't spoil it. Just let me know if you need a hint."

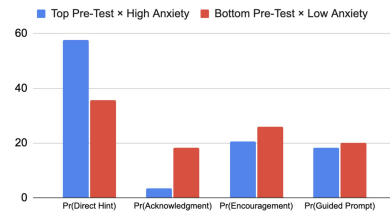"Hm... I suggest thinking about the concept of a unit cube and the volume of a unit cube."

"You can fit 3 chocolates along the height, 5 chocolates along the width, and 6 chocolates along the length of the box."

Study 1 Binned PreScores with Std.Error

RL policy is **helpful** for **initially low performers** in a randomized control trial (RCT) study.

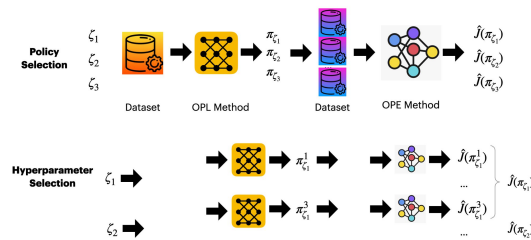*Ruan, Nie, et al. Machine Learning 2024.*

3. RL for Science of Teaching: What is the optimal tutoring strategy?

Nie, Reuel, Brunskill AI in Education 2023

4. Novel RL Advances

To Support **data efficient** RL policy for education, developed new **end-to-end robust** RL pipeline.

Nie, Flet-Berliac, Jordan, Steenbergen, Brunskill NeurIPS 2023