Introduction

- Intelligent tutor systems (ITS) are effective for improving students’ learning outcomes
- These systems provide students with personalized hints, practice problems, and feedback
- Despite these benefits, ITS have been difficult to produce at scale because they require programming expertise and substantial development time
- We propose the use of teachable AI and machine teaching technology to support efficient authoring of new ITS content at scale

Apprentice Tutor Platform

- As a first step, we have created the Apprentice Tutor platform: https://tutor.apprentice.ai
- This system supports the Learning Tools Interoperability (LTI) protocol, so it can be easily integrated within popular LMS systems, such as BlackBoard, Canvas, and Piazza
- Each tutor leverages a rule-based AI model to trace student's problem solving and provide contextualized hints and feedback
- Each tutor also leverages Bayesian Knowledge Tracing to track what students know and do not know and to provide personalized next problem recommendation
- Every student transaction is logged, so that we can provide teachers/student with estimates of learning
- System can export anonymous data for sharing across the NSF AI-ALOE institute

Preliminary Deployment

- For cycle 1, our research team manually created a polynomial factoring tutor for TCSG’s MATH 1111 course (college algebra, see Figure 2)
- This technology was deployed to support one instructor with three class sections; the tutor was provided as optional, supplemental support
- During our deployment, 22 students used our tutor to produce 892 transactions
- The average student performed 40 steps within the tutor (std=83.5; min=1; max=357)
- A learning curve analysis of this tutor data shows preliminary evidence for learning (see Figure 3)

Discussion & Future Work

- We are currently manually constructing a second MATH 1111 tutor to teach exponent rules
- For cycle 2, we will deploy our factoring and exponent tutors to 265 students across 30 sections
- We have started initial development of our Apprentice agents that will support tutor authoring via teaching
- We have started exploring novel ways to visualize data from Apprentice tutors to support the needs of stakeholders (students/teachers/administrators)