Teaching Artificial Intelligence (AI) with AI for AI applications

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Abstract

The emergence of widely-used artificial intelligence (AI) has created a critical need for AI expertise, not just as a research area but for workers in the wide variety of careers and roles that AI disrupts. While AI is still an area of research for new processing, application, and development – it continues to partially automate, augment, or replace many of the tasks which are performed through active use of human hands. While recently publicized items such as ChatGPT and MidJourney have made press in their adjustment to writing and image generation technology, the basic workflow of copyeditors and digital artists was completely transformed, inside of the year, to a combination of partially automated or fully automated AI tasks. While some blame AI as part of the "problem", it is naturally part of the "solution" – AI tools to help workers develop AI competencies. The paper describes an array of strategies which the DoD and its ICT UARC are using to address the fundamental problem of quickly upskilling the DoD workforce of over 2 million adult learners.

Introduction

Artificial intelligence is increasingly critical to modern operations. However, shortages in the number of AI professors and trainers mean that growing AI competencies in the military is not simply a matter of putting Soldiers in classrooms, and despite progress in areas such as intelligent tutoring systems, AI-driven tutoring for learning AI competencies has not been fully realized. The Government Accountability Office has directly criticized the Department of Defense (DoD) for their lack of guidance, agreements, responsibilities, and decision-making regarding a technology area which is critical to national security (GAO, 2022). This is a challenging problem: despite well-considered workforce strategies (JAIC, 2020), limited training pipelines and strong competition for AI specialists inherently constrains not only finding experts but also training more limited sets of AI skills to existing DoD service members and public servants.

The DoD's Institute for Creative Technologies (ICT) University Affiliated Research Center (UARC) is building on our research on AI education for youth and the general public, and our research on explainable AI for human-AI teaming, studying the development of an integrated, scenario-based AI training with personalized-feedback that leverages the trainees existing knowledge. The research is part of a long-range vision of DoD for AI-driven training solutions which build AI competency. This work takes a variety of AI-based approaches detailed in future sections.

AI for AI Training: High-Level Concept

In this paper, AI for AI training means to increase AI competencies and expand AI skills in the workforce more effectively with advanced learning technologies such as: a) AI systems for decision-making (e.g., recommenders, decision-support), b) machine-learning (ML) tools that help improve instruction by leveraging data from usage (e.g., ML-driven dashboards, tutoring dialog classifiers, resource-discovery for training on emerging AI topics), and training systems which simulate AI code or algorithms to assist with learning such skills. While not focused on in this paper due to its relatively lower maturity level as a technology, generative AI for co-developing AI training activities will eventually also be relevant and valuable.

AI can be leveraged for pedagogical in ways that are both general (e.g., useful to many training domains, AI being one of them) and specialized (e.g., tools and approaches that are unique to AI). This distinction is common for training tools in other STEM fields such as electronics, where general intelligent tutoring systems (ITS) were adapted to the domain but other systems were built around specialized tools (e.g., circuit simulators). AI likewise has a variety of knowledge to train: generalizable concepts well-suited for discourse, applied programming skills, qualitative understanding of relative risk, recognizing patterns in AI behavior or results, etc. As a result, different tools should aim to accomplish complementary goals for AI training:

- Personalized Upskilling: Reducing training time and increasing relevance by training skills actually needed for a learner's goals and role.
- Improved Mastery or Skill Retention: Increasing speed to acquire skills, such as through intelligent resource recommendations (adaptive learning) and/or personalized support during learning activities (ITS). This may also be designed to reduce decay of skills needed infrequently or after gaps.
- Broader Engagement: Outreach and training of AI competencies with groups who might not traditionally seek out AI skills, but who would benefit from them.
- Improved Transition to Utility: AI training optimized to produce and support useful tools to apply AI in schoolhouses, training, and operations.

Below, a number of ICT initiatives are highlighted which focus on different parts of this overarching goal to expand AI competencies and practices.

Ingesting AI Curricula into an AI Learning Coach

Perhaps the most obvious approach to leveraging AI to teach AI is to apply existing intelligent tutors and adaptive systems to AI content, particularly systems that were designed to be domain-general (e.g., Swartout et al, 2016; Sottilare et all, 2017). While AI has distinct pedagogical needs, substantial portions of AI curricula are structurally similar to other STEM domains (e.g., conceptual explanations, qualitative reasoning, recognizing classes of problems). In recently-started work, the previously studied PAL3 framework is being adapted for AI upskilling: letting learners select a goal and then adaptively learn the content through personalized recommendations for topics and lessons inside each topic (Swartout et al., 2016). PAL3 previously showed benefits in self-directed use for electronics concepts (Hampton et al., 2018), which provided intuitions that varied types of learning resources should be used: a library of curated training resources containing both custom activities, pre-existing tutoring system artifacts, tutorial videos, and web pages.

When applying PAL3 to build AI skills, many intelligent capabilities can be directly re-used for the new domain, such as its capabilities for: an embodied pedagogical agent that acts as a guide and can lead an adaptive interview to survey learner characteristics and preferences; a persistent learner model to track what students have done and estimates both mastery and expected decay of skills; a content library that allows registering both built-in resources and external resources (e.g., web pages) to rapidly register varied content; a recommendation engine that suggests topics and resources for based on the student's learner model, metadata about the resources (e.g., improve specific skill deficits), the learner's choices (e.g., they can skip or override recommendations), and open-response tutoring dialogs built-in to the system. PAL3 can also enable optional game-like mechanisms that create engagement (such as teams, leaderboards, and system capabilities that unlock after gaining experience). In addition to existing resources, PAL3 activities are being expanded to include short game-like programming activities, which will be implemented as a web-based resource which can be presented within PAL3's built-in web browser or used separately.

Such a system can integrate content about teaching AI itself – from which will be most-strongly informed by USC approaches to AI instruction and Artificial Intelligence Integration Center (AI2C) curriculum for officers and enlisted members within the DoD. It is intended to address issues of personalized upskilling, by using PAL3's capabilities for learner goal-setting and the coach agent's adaptive surveys to determine what skills are most relevant to prioritize first. It should also help improve mastery and skill retention, by recommending resources based on mastery of knowledge components, giving open-learner models to help learners study more effectively, and suggesting spaced practice if skill decay is expected.

Additionally, this application of PAL3 to AI competencies also offers long-term advantages for AI pedagogy. First, by tracking learning activities in an xAPI learning record store, data is collected that could help train models and optimize recommendations for different learner paths. Second, due to an ethos that allows self-directed learners to override recommendations (e.g., switch to a different topic to complete first; skip a recommended lesson; exit a lesson in progress), the system can collect data about both learning and engagement with recommended resources. This should enable training models (e.g., reinforcement learning) to understand and adapt to optimize for how different learners can be best-assisted by an adaptive learning coach.

Broader Engagement in AI Applications

The critical role of AI in the future of work has been recognized around the globe. Today's youth will become the future AI workforce that uses, implements, and researches AI. It is critical to prepare future generations with basic knowledge of AI beginning with childhood learning. However, there has been little research into how pre-college students construct an understanding of and gain practice with core ideas in AI. As a result, there is yet little evidence-based accounts of how youth learn AI concepts.

AI is about using algorithms to solve problems. Problem-solving skills are challenging to teach effectively through textbooks (Jonassen, 2006). In contrast, games simulate real-world complexity and fast-paced processing provide a complex decision-making context (Squire, 2006). As such, games are often viewed as potential tools for learning problem-solving skills (Spires et al, 2011) and generally an effective tool to promote student learning (Plass, Mayer, & Homer, 2020).

Recently, there is research into utilizing educational games to help elementary (Lee et al., 2021) and high school students (Leitner et al, 2022) learn about AI. One of such pioneering effort is the ARIN-561 game developed at USC ICT (Leitner et al, 2022). ARIN-561 is a 3D role-playing game designed to teach high-school students AI concepts, prompt them to apply their math knowledge, and develop their AI problem-solving skills. In the game, students play as a space-faring scientist who has crash landed on an alien planet, named ARIN-561. The activities for survival and for exploration form the basis for students to learn and apply AI algorithms to solve problems. In-game challenges, such as searching for missing spaceship parts or cracking passwords, serve as natural opportunities for the introduction of search algorithms as a topic.

The essential concepts such as space and time complexity also lend opportunities to connect math knowledge familiar to high school students and these AI concepts that are usually taught in higher education. The integrated educational content in ARIN-561 leverages this opportunity by supporting the students' application of math knowledge to the evaluation of each algorithm as they progress through the game. The game's narrative is also deeply embedded in each interaction. It builds a game flow that keeps students engaged without distracting from the AI tasks at hand. In-game dialogue between the characters offers natural opportunity not just to advance the story but also to scaffold students through abstraction, automation, and analysis -- the three phases of computational thinking (Lee et al., 2011) that are critical AI problem-solving (Greenwald, Leitner, & Wang, 2021).

Real-life narratives shared using AI offer a complementary approach to game-based engagement. Conversational systems have been a long-standing research focus at ICT, including agents who were successful for sharing skills that were adjacent to AI, such as a pair of question-answering agents at a Boston Museum of Science exhibit (the "Twins" Ada and Grace; Traum et al., 2012) and sharing STEM careers with high school students as part of the MentorPal (Nye et al., 2021). A more recent expansion of MentorPal has developed a self-recording portal called MentorStduio for building AI-based conversational agents who respond to students' questions with the best video-recorded response by a real-life mentor. The goal of this effort is to expand engagement in STEM careers by making it efficient and scalable to develop a virtual STEM career fair where organizations can record and share their mentors. This technology is particularly beneficial when students lack familiarity with a career field, such as due to under-representation (e.g., their community lacks those careers) and for growing careers (e.g., few mentors available verus the demand). As work that is synergistic with applying PAL3 to AI, MentorPal will be leveraged to record panels of AI mentors from different backgrounds and areas of AI. The goal of this is to help students understand how AI is used in different types of jobs (e.g., corporate vs. government; computer vision vs.business decisions) and how they could get into those fields (e.g., education, skills, mindsets).

Transition to Utility

As part of the efforts to use AI-for-AI-for-people technologies, there is a partnership between three organizations. The first of these is the Army University. While little-known for its premier status outside of the Army, the Army University is the coordinating activity for a learning population of approximately 2M users. This includes institutions of higher learning in the popular consciousness, such as the United States Military Academy at WestPoint and the US Army Command and General Staff College, both of which have significant populations from other uniformed services and foreign nationals. This also includes lesser-known and perhaps more impactful organizations such as the Army Distance Learning Program (TADLP) and first-line-supervisor development course for the largest civilian workforce worldwide.

The second of these organization is the University of Southern California (USC). USC is regularly recognized at the national level for their exceptional educational programs and specific focus in the computational fields and educational fields. Recently, two USC Institutes – the Institute for Systems Intelligence (ISI) and Institute for Creative Technologies (ICT) have been organizationally aligned together, given auspices to double in size, and are located on a campus now-branded the [censored] campus; it is to be the largest organization of its type worldwide. [organizational partnership details censored; announcement will be made prior to conference].

The third organization is the DEVCOM-SC is the managing agency for the ICT UARC at USC, is in official partnership with Army University, and is the director of performing work at the UARC.

As part of the efforts of these three organizations, there is a management and transition, a performance of technical work, and an incredibly broad community of users to assist. Programs developed under the auspices of this partnership have aligned interests and built-in adopters.

Assessment of Utility

A portion of the partnership itself is set aside to analyze the impact on performance. This will occur primarily through two metrics: user data and performance data. The goal of the program is to intersperse the training of AI items in the 'in the chow line' situation. Swaths of the technology will be available in both in competition with YouTube and other resources and as redirected resources. Given the free-roaming environment of choice in this situation, the percentage of users actually using the software will be a primary metric of evaluation.

The secondary metric of evaluation will be the increases (hopefully) or changes in knowledge and performance of tasks. Several of the topics covered (list) are of the nature related directly to job performances, while others are related to broader technology knowledge better assessed via traditional testing or practice scenarios. All will be used.

Integrational Conclusion

This paper is submitted as a short paper, as the length requirements are insufficient to describe the wide variety of AI applications, content, development, and partnership. It was submitted with the intention to show how an integrated program of efforts on behalf of the [censored], its management, its technologies, and its institutions, and the available sources for information and data can be knitted together into a cohesive program in line with its goals. It has been relatively light on the technical details of implementations, but describes a full-scale development of a program from start to finish and assessment. If AI is part of the problem - it is part of the solution.

Author note – if selected as a short paper this statement will be removed; the intention here is to present a broad overview of institute-level AI-for-AI activities and partnerships, documenting the efforts, and providing direction to resources during the conference poster session.

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