



ACQUISITION INNOVATION
RESEARCH CENTER

Cognitive Assistant for Training Cost Estimators

EXECUTIVE SUMMARY
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The goal of this research project is to develop a cognitive assistant to support training of new cost estimators in the Department of Defense (DoD). A Cognitive Assistant (CA) is defined here as an Artificial Intelligence (AI) tool, usually with a natural language interface, that augments human intellect in a specific task by retrieving and processing relevant information from multiple information sources and providing it to the user at the right time. It also has the capability to learn and adapt to the user and problem at hand.

Cost estimation is a complex iterative process consisting of various steps: gathering the required information, selecting an overall strategy and one or more existing models, developing new models if needed (including calibration and validation), performing the estimate, and conducting sensitivity analyses as appropriate. There are challenges for beginner cost estimators in each of those steps, including dealing with incomplete datasets, appropriately assessing the performance of new models, projecting beyond historical ranges of validity, adequately reporting the level of uncertainty around a point estimate, understanding how to use joint cost-schedule distributions, etc.

Currently, the training of new cost estimators is done primarily through traditional instruction in live classrooms, and thus it is a time-consuming process. Traditional instruction typically implies reduced opportunities for hands-on learning opportunities, which are known to improve learning. This type of instruction is also not tailored to each individual, so the pace can be too fast for some trainees and too slow for others. The use of CAs can allow for more interactive and tailored instruction for each individual and area, as demonstrated with intelligent tutoring systems in other areas of education (Corbett et al., 1997).

The idea of using AI tools to enhance the learning of trainees is not new and has been studied for decades (Ong & Ramachandran, 2003). However, in the DoD Acquisition context, we are still in the early stages of incorporating advanced AI tools into workflows and, in particular, CAs have not been adopted yet as training tools. Previous attempts to adopt this technology in the workplace failed because of a combination of insufficient performance of the underlying machine learning (ML) models and lack of familiarity of the users with this mode of interaction. With CAs now being ubiquitous in our daily lives, and the significant recent advances we have seen in machine learning, the time is now ripe for infusion of this technology in the workplace.

In an Incubate Phase I of this project (\$100k, Sep 2021—Jun 2022), the research team worked with the sponsor and other stakeholders to define the use case for the CA. We decided to focus on a user that is already familiar with cost estimation methods, but wants to learn a new commodity, namely space systems. The tool was to help the user learn the new material in an individualized way. We developed an initial version of the CA based on an existing agent developed by the team called Daphne. This allowed us to make fast progress as some of the software infrastructure was reused. In addition, we demonstrated the ability to do individualized training in the context of selecting questions for the various learning assessments and learning opportunities that best address the user's needs (e.g., reinforcing weaker areas). An initial estimate of the resources that would be needed to develop and maintain such a tool in the DoD was provided.

The project was approved for a Phase II with the goal of further developing the agent and validating it with real users. This document reports on the results of the first year of Phase II (\$134k, Sep 2022—Sep 2023). In this time, we have developed a second version of the agent that leverages Large Language Models (LLMs) to make the system more flexible, extensible, and easier to maintain. In addition, we developed a 3-module online course on Space Systems with slides, example questions, and quizzes and we have started thorough testing of the effectiveness of the tool at Texas A&M University (TAMU).

Future research plans include delivering a longer 5-module version of the online course and testing it with real users at the Office of Cost Assessment and Program Evaluation (CAPE). In addition, the research team will refine our estimates of the development and maintenance costs.

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