Advancing AI for Defense and National Security

ARTIFICIAL INTELLIGENCE HOLDS INCREDIBLE PROMISE for transforming U.S. Department of Defense (DoD) mission capabilities. As a federally funded research and development center (FFRDC) dedicated to advancing software for national security, the Carnegie Mellon University Software Engineering Institute (SEI) enables the DoD to rapidly and effectively adopt, develop, and deploy artificial intelligence (AI) for national defense and security.

Carnegie Mellon University: Connecting Leading-Edge Research with AI Mission Challenges

As a research institute operated by Carnegie Mellon University, the SEI has strong collaborative relationships with researchers who are making rapid advances in the field. These collaborations draw on the deep expertise of faculty and researchers in AI and machine learning (ML) as well as electrical and computer engineering, computer science, and robotics.

Our Capabilities

AI for Mission: The SEI develops and prototypes real-world AI capabilities to identify leading practices and critical gaps. SEI teams perform operational experimentation, co-evolution of mission and technology, and technology demonstration.

AI Engineering: The SEI conducts high-impact applied research to advance the discipline of AI Engineering based on rapid progress in the field. Through research, study, and application, the SEI identifies challenges and opportunities on the frontier of AI.

AI for Autonomy: The SEI advances the capability of autonomous systems in the multi-domain world. In engagements with DoD partners and customers, the SEI team performs simulation (including prototyping in simulation), counter autonomy, command and control (C2), architecture design, and test and evaluation.

Advanced Computing: The SEI identifies, evaluates, and applies the latest AI computing technologies. Specific SEI capabilities in this area include high-performance edge computing, radio frequency battlefield situational awareness, aided threat recognition, and physics-inspired neural networks.

Secure AI: The SEI works to make AI as secure as possible for the DoD and U.S. Intelligence Community (IC). Attacking ML, defending against counter-AI, and implementing security-by-design for AI are key ways the SEI advances secure AI.

Success Stories

Accelerating Commercial AI Innovation and Adoption for the Warfighter

In partnership with the U.S. Defense Innovation Unit (DIU), the SEI helps to accelerate the adoption of commercial and dual-use technology to solve operational challenges at speed and scale for the DoD. The SEI helps operationalize AI for the warfighter across multiple DIU portfolios by measuring the needs and requirements for acquiring and applying AI. From increasing the effectiveness of current AI systems, to managing increasingly complex data and ML workflows, to deploying emerging technology with mission relevance, the SEI ensures AI's usability. During DIU's Commercial Solutions Opening (CSO) process, the SEI also helps advance the best AI and advanced technological concepts by working with government teams to ensure that proposed solutions for warfighting systems meet mission needs. Our experts conduct rigorous test and evaluation, partnering with all levels of DoD stakeholders, including Service branches, Office of the Secretary of Defense (OSD) organizations, and U.S. Combatant Commands (CCMDs).

Engineering Large Language Models for Intelligence
The SEI is exploring use cases for large language models (LLMs) within the IC. The SEI engineered a baseline LLM for intelligence analysis, providing valuable recommendations for setting up, customizing, and evaluating the trustworthiness of LLMs for IC use cases. In follow-on research, the SEI is developing metrics to assess the mission impact of LLMs and guidelines for their proper use in mission systems.

Co-Design for Edge AI
Hardware inefficiencies pose major limitations to DoD applications; current processors simply cannot keep up with the large and complex ML workloads needed to perform their missions. The SEI used co-design—the concurrent design of electronic system hardware and software components—to provide tools to overcome these limitations and yield practical results that increase battery life, reduce the weight warfighters must carry, increase the maneuverability of forces, and reduce time from sensor to shooter.

Applied Research and Prototype Development: Optimizing Flights for Fuel Savings
Small changes to aircraft can save the U.S. Department of the Air Force (DAF) millions of gallons of fuel, but voluminous and variable data from in-service sorties make those savings difficult to estimate. At the DIU's suggestion, the DAF asked the SEI to apply ML to flight data and derive fuel savings from aircraft interventions. An SEI team built and trained ML models and developed a prototype tool the DAF can use to specify aircraft type, input data from flights with and without aircraft intervention, and output the intervention's estimated fuel savings. Along the way, the team dealt with the challenges of collecting clean flight data; processing it into a usable format; overcoming data noise; and controlling for confounding hardware, software, and operational variables.

Workforce Development for an AI-Ready Space Force
At the request of the U.S. Space Force, the SEI developed and delivered a custom AI Engineering course to Space Force staff whose roles include data analysis, acquisitions, and program management. The course, which used a combination of lectures, discussions, and hands-on virtual labs, covered topics such as an introduction to AI Engineering, assured AI, LLMs in-depth, and object detection using convolutional neural networks (CNNs).

Assurance of ML-Enabled Warfighting Systems
In support of the DoD Research and Engineering Center for Calibrated Trust Measurement and Evaluation (CaTE) effort, the SEI conducted user studies, performed research, and evaluated testing practices. The team delivered recommendations for a reference architecture of a conduct assurance governor; a prototype test experimentation and evaluation platform; and tools and metrics for test, evaluation, verification, and validation at the ML component, subsystem, and system level.

About the SEI

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