MIT LINCOLN LABORATORY

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Accelerating Fielding of Artificial Intelligence Programs with the DAF-MIT AI Accelerator

Division 9: Space Systems and Technology

A Laboratory team led by staff in Groups 01 and 93 is working with MIT campus to operationalize artificial intelligence using the DAF-MIT AI Accelerator.

The Department of the Air Force-Massachusetts Institute of Technology Artificial Intelligence Accelerator (DAF-MIT AI Accelerator) is a collaboration between multiple organizations, and aims to leverage the capabilities of academia, government, and industry to make progress in the field of artificial intelligence. Staff from the Laboratory work closely with scientists in government and across MIT campus on the Automation in Space Domain Awareness project—the first and currently only—U.S. Space Force AI accelerator project.

The MIT campus team consists of Dr. Richard Linares, Dr. Jonathan How, and Dr. Victor Rodriguez-Fernandez—along with their graduate students Miles Lifson, Joana Nikolova, William Parker, Thomas Roberts, Tory Smith, and Liz Solera (who also works at the Laboratory)—and postdoctoral researchers Dr. Peng Mun Siew, Dr. Giovanni Lavezzi, and Dr. Di Wu. The team is currently working on a three-year funded project to look at different mission areas for space domain awareness that they can apply to artificial intelligence, solutions that are expected to be useful two to four years from now.

Group 93—specifically technical staff members Brian Knoth, Zach Folcik, and Kallai Hokanson—is leading the effort to operationalize artificial intelligence and machine learning. They are focusing on the question of how they can adapt AI technology that campus builds or other AI solutions to those problems that the accelerator is trying to address, operationalize them, and figure out what future challenges will be. The driving mission behind AI involves building and using it to solve problems. However, putting it into operation can be challenging, and there are multiple things to consider.

"The motivation for these studies is in reducing Space Force operator workload. Often, space operators are using decades-old systems, which require much care and feeding in order to maintain accurate orbital knowledge of satellite positions," said Folcik. "Our prototype systems and our use of AI and machine-learning (ML) models reduce operator workload by automating mundane tasks and generating high-quality indications and alerts to provide operators with relevant, actionable information."

The Laboratory team's main focus is on adaptive AI—AI that learns from data and uses that learned model to make predictions or recommendations, or identify patterns, in operations. As the environment of AI changes—such as in the space domain, where new sensors and new satellites are appearing—these new entities often have behaviors that change over time and differ from established patterns. As the data environment evolves, the AI models begin to degrade in performance. What the Laboratory is trying to do is look at how to monitor that performance in an operational setting. One of the problems the team is facing is a lack of labelled, ground-truth data during operations, so their question is, "how do we acquire live ground-truth data to continually assess how the AI is doing?"

"Some of the most difficult tasks in producing accurate models are in generating high-quality ground truth in sufficient quantities," said Folcik. "Although we have been collecting thousands of cases by hand, we are also developing tools so that users can generate new cases through their existing workflows, with little extra effort. These tools should also help to prevent drift. Drift occurs when static machine-learning models no longer perform well because the training data used to produce the model are old and no longer agree well with current data."

To help address these issues, the Laboratory team has defined the Space AI Launchpad (SAIL). Consisting of a framework of commercial-off-the-shelf tools, human workflows, gap analysis, and an AI-informed data strategy, SAIL provides a live working environment within which to address these problems of operationalizing AI. To figure out how to train AI in different situations, they need AI to run it on to see if it's being done correctly and figure out how to assess the AI, how to improve it, and what challenges they'll face. While Group 01 is working on foundational and future-looking AI architectural solutions to SDA problems, the Group 93 team wants to start applying AI solutions now for addressing SDA mission needs so they know how to deal with them in the future.

Staff are leveraging previous AI work, such as Folcik's work on detecting satellite maneuvers to prepare the SAIL framework so they can use AI for future assessment and continue improving operations. The team is currently a year and a half into the project. Their goal is to demonstrate their framework and be vocal about it. "Constant assessment and continuous learning for mission-critical AI and ML applications is an area the Space Force needs to be thinking about," said Knoth.

The team has a good working relationship in the accelerator and are trying to influence the strategic guidance that might come out of the Space Force's Chief Technology Innovation Office so that everyone starts thinking about these things. They're trying to position SAIL as a reference architecture in which agile adaptive AI can be tested. In addition, they plan to explore ways in which AI and ML techniques can be used to address current Space Force problems such as detecting satellite breakups and collisions, organizing satellite launch information using natural language models, and detecting changes in satellite behavior.

In addition to this work, the Laboratory team is working on other tasks with the AI accelerator project, namely releasing data. They're assisting the Space Force with releasing satellite information and sorting it into different classes, such as debris and rockets.

"For space applications of AI methods, the Laboratory has a great deal of real observations of satellite positions," said Folcik. "We also maintain prototype systems, which include post-processed orbital and maneuver data. All of these real data sources are used to develop, train, and test models of satellite motion and behavior. We also have many staff members with years of experience in tracking satellites and analyzing observation and orbital data."

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