ARTIFICIAL INTELLIGENCE/ MACHINE LEARNING

Artificial intelligence-based machines can quickly learn to identify specific criteria, present multiple scenarios for action, make decisions, and learn from them. Due in large part to the revolution of cloud computing over the past 20 years, data processing speeds have increased exponentially. Leveraging artificial intelligence techniques for space systems requires both understanding these tools and testing them with different types of data sets. It is essential to have the ability to identify positive or negative/potentially dangerous results reliably and effectively, including pattern recognition in images, anomaly detection across sensors and measurement predictions, and time series data analysis.

Accuracy and Availability Are Essential for Space Systems

All artificial intelligence tools rely on readily available and accurate data. For space systems, where there is virtually zero tolerance for error, the issues of properly shepherding data and data integrity take on greater significance. As spacecraft and payloads become miniaturized and more robust and begin operating in different configurations and orbits, space applications will increasingly rely on artificial intelligence to enhance operations. Aerospace surveys techniques about how data is being processed and which data sets are used for training to ensure that conclusions drawn from the data lead to accurate results.

Aerospace is leveraging artificial intelligence in myriad ways to support customer missions. It has had transformative effects for traditional tasks, such as using machine learning to help our customers better manage programs that consider cost, schedule and risk variables to predict outcomes, as well as for cutting-edge applications where artificial intelligence has been used to detect abnormal conditions in large data sources (including signatures of impending failure or adversarial activity) that other tools find difficult or impossible to detect. Our tools have produced faster processing of telemetry data for launch systems, enabled the ability for data to be interpreted and downselected on a satellite before transmission, and facilitated the processing and interpretation of massive amounts of systems engineering text, pictures, and other data to accelerate customer programs. Additionally, in order to speed development of artificial intelligence and analytics tools for space, Aerospace is leveraging our rapid prototyping capabilities to develop and test new techniques and get them on orbit quickly.

Artificial intelligence and machine learning have myriad applications for space including:

› Enhanced telemetry analysis

› Pattern recognition in large data sets

› Anomaly detection

› Cost/schedule/risk analyses

Current Artificial Intelligence Projects

ENHANCED TELEMETRY ANALYSIS

Using artificial intelligence, Aerospace has enhanced traditional telemetry analysis to help us identify patterns, help predict outcomes and identify problems when data doesn't go down a predicted path. Launch analysis requires data analysis from every part of the vehicle. Integrating artificial intelligence with human insight enhances our role as the unbiased advisor for the space enterprise by enabling faster analyses and a more rapid launch cadence.

CATALINA SKY SURVEY

Aerospace partnered with NASA Planetary Defense to develop a fast artificial intelligence prototype to increase the detection of near-earth objects (NEOs) for the Catalina Sky Survey, which identifies NEOs from data of moving objects observed by telescopes. Possible NEOs had a high false positive rate; the application of the initial prototype to the existing metadata improved observer performance by 10 percent. As this was done without a need for upgrades to existing systems, it has the potential to scale for implementation at all observatories worldwide.

PROJECT SPACE CLOUD

Aerospace engineers have combined several commercially available or open-source tools, including an Intel Movidius chip to reduce processing resource demands, Google Kubernetes for cloud and ground application deployment, and a custom geospatial temporal cloud scheduler to move data processing onto a satellite. The combination of these tools on a LEO satellite can enable the observation and identification of key data to be done at the right time in the right place while downloading only the relevant results. This matching of the best of existing artificial intelligence technology with space systems can speed the delivery of actionable intelligence to the end user. The first prototype of Project Space Cloud is expected to launch on an Aerospace cubesat in July 2019.

THE ARMY RAPID CAPABILITIES OFFICE (RCO) BLIND SIGNAL CLASSIFICATION CHALLENGE

In 2018, a team of Aerospace engineers participated in the Army RCO Challenge, in which contestants were asked to find innovative approaches to conducting analysis of previously unknown or 'blind' radio frequency signals using artificial intelligence and machine learning. The team surpassed 48 other competitors to win first place by correctly detecting and classifying the greatest number of radio frequency signals using artificial intelligence and machine learning methods. This could eventually expedite and improve ways of identifying signals within the electromagnetic spectrum, resulting in technological advancements to assist electronic warfare officers on the battlefield.

Cloud Computing to Perform Launch Trajectory Analysis

THEN

| 24 hrs | 24 hrs | 24 hrs | 24 hrs | 24 hrs |
| 24 hrs | 24 hrs | 24 hrs | 24 hrs | 24 hrs |

Process took seven to 10 days.

NOW

15 hrs

Process completed in about 15 hours.
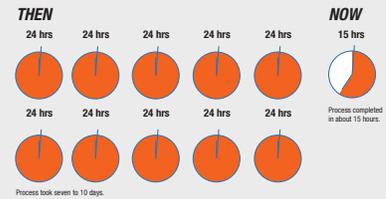
Catalina Sky Survey's 60-inch telescope atop Mount Lemmon. Credit: Catalina Sky Survey/UA

To cut through the noise and increase the speed at which electronic warfare officers can identify and react to signals on the battlefield, the Army's Rapid Capabilities Office (RCO) sought new technologies that apply artificial intelligence and machine learning to paint a picture of the electromagnetic spectrum for the Army Signal Classification Challenge. Credit: U.S. Army Research Laboratory

The Aerospace Corporation

The Aerospace Corporation is a national nonprofit corporation that operates a federally funded research and development center (FFRDC) and has approximately 4,000 employees. The Aerospace FFRDC is aligned to support the most critical programs of the Department of Defense and the nation, and to serve as its customers' innovation partner across the space enterprise. Consistent with the competencies outlined in our sponsoring agreement, Aerospace provides strategic value through independent, intellectually rigorous, relevant, and timely products and services. With three major locations in El Segundo, Calif.; Colorado Springs, Colo.; and Washington, D.C., Aerospace addresses complex problems across the space enterprise and other areas of national significance.