



NASA SBIR 2020 Phase I Solicitation

S5.03 Accelerating NASA Science and Engineering through the Application of Artificial Intelligence

Lead Center: GSFC

Participating Center(s): ARC, JPL, LaRC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

Scope Title

Accelerating NASA Science and Engineering through the Application of Artificial Intelligence

Scope Description

NASA researchers are increasingly using Artificial Intelligence (AI) technologies across science and engineering to address questions that previously could not be studied, in order to open up new insights. While many problems can be addressed with AI, the adoption of these techniques and technologies has been slow due to the large learning curve associated with the application of these technologies, the applicability of commercial tools to specific problems of interest for NASA, and the high level of effort to create training sets. The goal of this subtopic is to overcome these challenges and accelerate NASA science and engineering through the development and/or application of tools and technologies that use AI, including Machine Learning (ML), Deep Learning (DL), and more. The expected outcomes of this subtopic are tools and technologies that use AI that lead to improved science and engineering, and that lead to advancements in operational capabilities for remote sensing instruments and platforms.

The specific objectives of this subtopic include the following. Innovative proposals using AI are being sought to solve these unique problems across NASA science. Proposals MUST be in alignment with existing and/or future NASA programs and address or extend a specific need or question for those programs. Examples of AI solutions to NASA problems include:

- Mission Operations with long latency communications in deep space environments where the models of the destinations are not well known. Examples of these missions include rovers/instruments on Mars2020 and the Europa Lander.
 - Advanced autonomy with the ability for instruments to learn at the edge
 - Fault detection and recovery
 - Anomaly detection for instruments or platforms
 - Onboard/embedded machine learning for remote sensing platforms
- Data fusion and predictions across multiple data sets using AI, examples include
 - Enhanced geoeffective space-weather predictions
 - Creation of a global product from the fusion of multiple satellite inputs for areas such as carbon science or aerosols

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- Downscaling lower-resolution images to higher resolutions, either from previous missions or through combination of multiple data sets and in-situ data
 - Augmenting automatic image analysis, including registration, classification, segmentation, and/or change detection. Examples include
 - Identification of spatial patterns to better determine calibration factors across multiple instruments or for detecting instrument degradation
 - The detection of transient events in astronomical imagery
 - The detection of burned areas from Earth imagery

Research proposed to this subtopic should demonstrate technical feasibility during Phase I, and in partnership with scientists and/or engineers, show a path toward a Phase II prototype demonstration, with significant communication with missions and programs to later plan a potential Phase III infusion. It is highly desirable that the proposed projects lead to solutions that will be infused into NASA programs and projects.

Tools and products developed under this subtopic may be developed for broad public dissemination or used within a narrow community. These tools can be plug-ins or enhancements to existing software, on-line data/computing services, or new stand-alone applications or web services, provided that they promote interoperability and use standard protocols, file formats, and Application Programming Interfaces (APIs).

References

Most Recent Decadal Surveys: <https://science.nasa.gov/about-us/science-strategy/decadal-surveys>

Mission to Europa - Europa Lander: <https://www.jpl.nasa.gov/missions/europa-lander/>

Mars 2020 Mission: <https://mars.nasa.gov/mars2020/>

Global Modeling and Assimilation Office: <https://gmao.gsfc.nasa.gov/>

NASA Goddard Institute for Space Studies: <https://www.giss.nasa.gov/>

NASA Earth Science Data: <https://earthdata.nasa.gov/>

NASA Center for Climate Simulation: <https://www.nccs.nasa.gov/>

NASA High-End Computing (HEC) Program: <https://www.hec.nasa.gov/>

Expected TRL or TRL range at completion of the project: 4 to 6

Desired Deliverables of Phase II

Prototype, Software, Research

Desired Deliverables Description

Tools and products developed under this subtopic may be developed for broad public dissemination or used within a narrow scientific community. These tools can be plug-ins or enhancements to existing software, on-line data/computing services, or new stand-alone applications or web services, provided that they promote interoperability and use standard protocols, file formats, and Application Programming Interfaces (APIs).

The desired outcomes for this subtopic include: (1) new or accelerated science and engineering products, (2) training data sets and trained models specifically for a given problem but that can also be used as a basis for furthering other science and engineering research and development, and (3) software algorithms and capabilities developed during the SBIR work would be used and infused in NASA science projects and potentially used to develop new missions.

State of the Art and Critical Gaps

NASA science and engineering have only just begun making use of Artificial Intelligence (AI) technologies (which

includes both machine learning and deep learning). Emerging computational platforms now provide significant improvements in computing capabilities to enable AI to be applied to a wide variety of applications in science and engineering. These emerging computational capabilities have the potential to dramatically speed up AI calculations, and these systems are even being used as the reference architecture for Exascale high performance computing systems.

The current applications of AI across NASA science and engineering are just beginning, and the technologies are difficult to use with significant barriers to entry. This has dramatically slowed the adoption of AI across NASA.

Relevance / Science Traceability

Broad applicability across throughout the decadal surveys

Specific missions include the Europa Lander, Mars2020, and more:

- Global Modeling and Assimilation Office (GMAO) Assimilation - Augment Earth system modeling or data assimilation
- Carbon Cycle Ecosystems Office (CCOE) - Wide variety of applications given the diversity of data sets from sparse in-situ to global satellite measurements
- Earth Observing System Data and Information System (EOSDIS)/ Distributed Active Archive Centers (DAACs) - Harnessing the potential for new discoveries across the wide array of observation data
- Earth Science Technology Office (ESTO/AIST) - New technology and services to exploit NASA and non-NASA data
- Computational and Information Sciences and Technology Office (CISTO - Code 606) - Technologies used for new data science
- NASA Center for Climate Simulation (NCCS - Code 606.2) - Building applications toward exascale computing