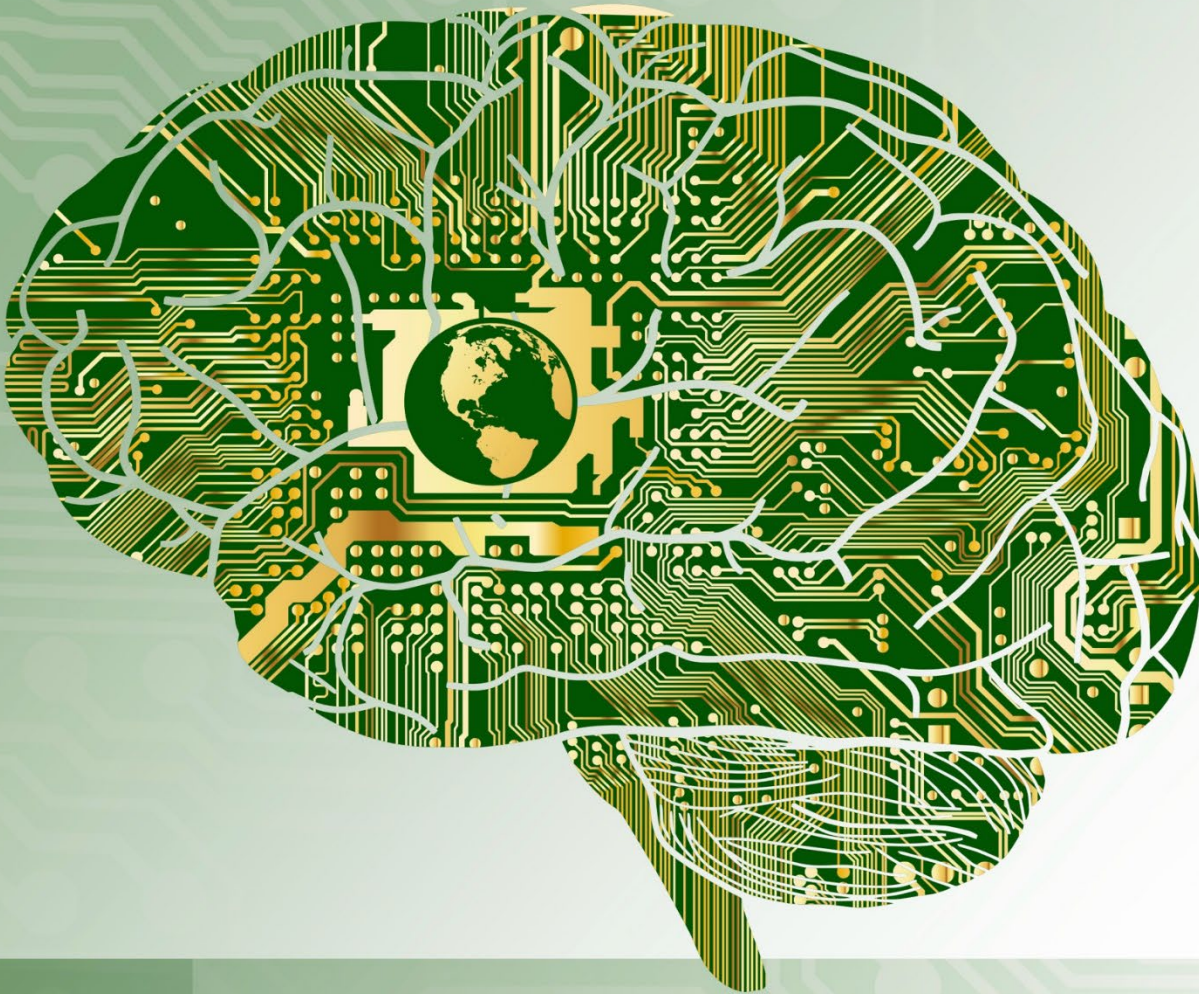National Aeronautics and Space Administration

NASA

2022 NASA'S RESPONSIBLE AI PLAN

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OCS
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NASA's Response Plan: Executive Order 13960 - Promoting the Use of Trustworthy Artificial Intelligence (AI) in the Federal Government

Foreword

Artificial Intelligence (AI) is an integral part of today's process of conducting science and technology development. At NASA, AI has become an integral and important tool for researchers, engineers, data scientists, and technologists in pursuing the ground-breaking discoveries that we are known for, including the command and controlling of our spacecraft and other supporting infrastructures. Consequently, research and engineering efforts incorporating AI have permeated almost every area of our work. It is contributing to NASA's drive toward the future, not just of space science, but for society here at home. We are dedicated to continuing the use of AI in a safe and fully transparent approach so that the public can have high confidence in the outcomes and benefits. We believe that the plan outlined here will be responsive and contribute to the call for openness across the federal government.

Executive Summary

NASA is committed to responsible use of AI in all of its activities and in all phases of development and deployment of its space and terrestrial programs missions. NASA does not deliberately focus on "AI Research" as a separate field (we have no single "AI office" or "AI program"), rather NASA uses AI to build tools for its programs. This plan, being put forward, adheres to the Responsible AI (RAI) principles set and laid down by the White House in its Presidential Executive Order 13960. Our research, engineering and technical communities have been made aware of these guidelines and we are committed to an on-going process of educating and monitoring its implementation to ensure adherence to those principles. The vast majority of NASA's use cases, which number almost 75 today, are geared toward analyzing the petabytes of data that NASA collects from its fleet of spacecraft across all disciplines, in human space exploration, and in aeronautics, etc.

Overview

This plan outlines how NASA intends to implement the Executive Order 13960. This plan will guide NASA and all its Centers.

According to the President's Executive Order 13960 - *Promoting the Use of Trustworthy Artificial Intelligence (AI) in the Federal Government* promises to drive the growth of the United States economy and improve the quality of life of all Americans. The order further expects that, in alignment with Executive Order 13859 of February 11, 2019 - *Maintaining American Leadership in Artificial Intelligence,* executive departments and agencies have recognized the power of AI to improve their operations, processes, and procedures; meet strategic goals; reduce costs; enhance oversight of the use of taxpayer funds; increase efficiency and mission effectiveness; improve quality of services; improve safety; train workforces; and support decision making by the Federal workforce, among other positive developments. Given the broad applicability of AI, nearly every agency and those served by those agencies can benefit from the safe and appropriate use of AI.

For the purposes of this plan, NASA uses the definition of Responsible AI from EO 13960. Namely, the term ''artificial intelligence'' includes the following:

(1) Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets;

(2) An artificial system developed in computer software, physical hardware, or other context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action;

(3) An artificial system designed to think or act like a human, including cognitive architectures and neural networks;

(4) A set of techniques, including machine learning, that is designed to approximate a cognitive task; and

(5) An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting.

Dr. Bhavya Lal, Associate Administrator for Office of Technology, Policy, and Strategy (OTPS) and Dr. Katherine Calvin, NASA Chief Scientist are the Responsible AI Officials for the agency.

Details of Plan

The following steps outlines or provides high-level details on how NASA intends to execute its response to the Presidents Executive Order 13960 - Responsible Artificial Intelligence (AI). This plan consists of NASA's approach to developing an Inventory of AI Use Cases, Oversight applied to AI applications, Education of the researcher community, Transparency of the results, and Reporting.

- **Inventory of NASA's AI Activities – AI Use Cases**

NASA will identify, capture, and document all relevant NASA AI use cases and release descriptions to the public. This will be accomplished by leveraging our AI Community of Practice (CoP) which has ~300+ members, our Autonomous Systems Software team (ASST), and Digital Transformation team (DT), Center representatives and through internal discussions with NASA Directorate leaders. We have reviewed the use of AI at a leadership retreat as well. AI researchers have or will report their activities to the RAI leaders for inclusion in our database of activities which will be maintained within the agency.

As stated earlier, NASA does not deliberately focus on developing better AI techniques. NASA uses known AI techniques/applications to build tools for its programs and projects, for example, for managing spacecraft autonomy or airline ground operations, image processing, etc. This makes NASA more of a user of AI, not an "AI developer" per se.

Examples of the types of work NASA carries out with AI are shown in the following table.

Mission Operations and Planning	Vehicle Navigation	Data Communications Management	Trust and Trustworthiness (Validation and Verification)
Anomaly detection and Avoidance	Human-System Interaction	Crew and System Health Management	Materials Discovery
Hazard detection and Avoidance	Weather Predictions	Test and Evaluation	In-Situ Resource Utilization

- **Oversight**

NASA will implement a tiered approach to focus more oversight on the more critical / matured AI projects, while providing initial guidance to immature projects in low-threat / early incubation stages. NASA will sort out its AI use cases by the NASA Technology Readiness Levels (TRL)[1] ranges:

- TRL 1 - 4 (Early Incubation)
- TRL 5 - 7 (Mid Maturity)
- TRL 8 - 9 (High Maturity/Currently Deployed)

The high maturity AI cases are subjected to more scrutiny (more frequent assessments) while the other cases receive less oversight. Assessments will most likely be conducted annually. Oversight will include a review by experts to confirm adherence to the nine EO AI principles set forth by the White House. NASA will follow its established software / safety processes (in particular NPR 7150.2, NASA-STD-8739.8[2]) in all AI applications. NASA's NPR 7150.2, Software Engineering Requirements, includes detailed requirements for all software products. NASA STD 8739.8 - Software Assurance and Safety Standards, will also be applied per our usual processes.

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[1] https://www.nasa.gov/directorates/heo/scan/engineering/technology/technology_readiness_level
[2] https://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7150&s=2B,
https://standards.nasa.gov/standard/NASA/NASA-STD-87398

NASA is moving forward with a plan to produce a draft strategy and appropriate guidance for its researchers, with both a short-term and a long-term component. NASA intends to roll out this in the upcoming fiscal year.

- **Education**

NASA is already engaged in Ethical AI training and has conducted workshops on ethical AI in 2021. Ethical AI is a part of Responsible AI, and we will continue, and if needed, to expand these Ethical AI discussions.

NASA will develop educational materials for the NASA community of researchers, engineers, technologist, etc. based around the nine pieces of responsible AI principles and practices. NASA will organize workshop(s) on RAI within next 12 months. Training will be arranged around existing scientific meetings where AI is presented, such as the AGU 2022 Fall meeting, where three workshops are being planned for AI practitioners. If practical, NASA would like to partner with other government agencies to share educational materials, participate and co-host workshops, including the materials developed for the Transform to Open Science (TOPS) initiative[3].

- **Transparency**

NASA will promote transparency of its RAI activities to the public by posting its RAI inventory on an Agency website. In addition, by promoting its RAI inventory, the agency will bring visibility to participants, users, innovator, researchers, etc. for the work they've already done via status reporting to the White House EOP and to the NASA leadership. NASA plans to publicize use cases with high interest.

Proper training of AI applications is crucial for transparency, including the selection of training data. Data Scientists and AI/ML practitioners at NASA actively employ the best practices of assessing all data for bias and mitigating as much bias as possible, and using separate data sets for training models, testing models, and validating models. NASA will continue to encourage these practices, to include continuing education in data handling and including data handling checks / balances in relevant processes.

- **Reporting**

Each organization within NASA (including those using AI techniques) will follow its standard procedures and guidelines for allocating and tracking resources, including AI activities. This data will be available to the RAI Officials.

A final report will be presented to the Administrator and the entire agency leadership on the Agency's Responsible AI activities and plans for continuous oversight and improvements. The public AI Use Case inventory will be updated annually.

- **Roles and Responsibilities**

The Responsible AI Officials at NASA carry out the following responsibilities:

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[3] https://science.nasa.gov/open-science/transform-to-open-science

- Respond to Executive Orders (EOs) regarding Responsible AI
- Collect AI Use cases from across the Agency
- Develop Responsible AI Policy and promote Responsible AI within NASA
- Provide training on Responsible AI Use within NASA
- Report as required on NASA's Responsible AI activities
- Respond to audits (e.g., GAO)

- **Deliverables and Timeline.**

The following is a notional time-line of activities to be carried out.

- **August 2022:** Publicly posted AI inventory (removing non-releasable items).
- **August 2022:** NASA's Responsible AI Principles Application Plan.
- **TBD:** Review Responsible AI Principles and determine how they apply to NASA's AI portfolio.
- **October 15th, 2022:** Triage NASA's use cases and choose high-maturity projects for early focus and greater attention, leveraging existing processes as much as possible, and adding new AI ethics mechanisms only as-needed.
- **December 2022**: Carry out workshops at the Fall AGU meeting.
- **December 2022:** Investigate and initiate the development of an appropriate tool to assess use cases with respect to the Responsible AI principles.
- **FY2023:** Develop a strategy for Responsible AI use.
- **December 2022/Annually**: Educate the community via discussion sessions, FAQ, examples, etc. and encourage low and mid TRL Responsible AI principles as part of their profession and with their existing mechanisms.
- **Annually:** Track progress and report to the Responsible AI Officers and other interested stakeholders**.**
- **16 January 2023:** RAI Principles Application Plan completion.

Summary

NASA has robust communities of practice for data science, engineering and system design, AI/ML, and autonomous systems, all of which are actively employing AI in their solution space and identifying and promulgating emerging best practices. These communities will support the guidance efforts of the Responsible AI Officials. In addition to governance and guidance, including possibly an AI governance board, NASA is encouraging widespread AI workforce development, which will assist in embedding best practices into use of AI.

NASA will continue to foster open community debate regarding AI ethics, which not only evolves best practices, but also encourages participants to employ AI ethics in their emerging work.

AI is an exciting growth area with potential to amplify and impact nearly all aspects of NASA's work. This growth process will be governed by existing policies and processes. The unique aspects of AI, for example,

possible autonomy and self-learning capabilities, make it a powerful tool. NASA is carefully tracking the unique aspects of AI in our applications.

NASA will continue to practice Responsible AI and apply the nine principles set down in the EO 13960. The agency has been engaged in ethical AI already and will increase our transparency by making our AI Use Cases public and providing annual updates.