



# Artificial Intelligence at NASA

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DATAWORKS 2025



# AI at NASA

**Artificial Intelligence drives how NASA explores our universe, revolutionizes air transportation and sends humans to the Moon, Mars, and beyond.**

**The Chief AI Officer (CAIO) enables mission by setting conditions for success:**



## **Driving AI Innovation**

Enhancing mission success, operational efficiency, and scientific breakthroughs by accelerating data analysis, optimizing mission planning, and enabling autonomous systems for deep-space exploration.



## **Advancing AI Applications for Sustained Exploration**

Developing solutions that expand human knowledge beyond Earth, optimizing resources and supporting long-duration missions, ultimately paving the way for a sustained presence in deep space.



## **Fostering a Culture of Excellence**

Streamlining AI integration across NASA's programs to maximize innovation, ensuring that all advancements uphold NASA's longstanding commitment to safety and integrity.



## **Strengthening AI Talent and Partnerships.**

Investing in AI expertise and collaborations with industry, academia, and government agencies, cultivating the next generation of AI and space pioneers and leveraging collective knowledge to support mission goals.

**Through these efforts, we solidify America's leadership in both AI and aerospace, opening new frontiers for discovery and human progress.**

# Perseverance Rover

**AI enables the Perseverance rover to explore Mars, collect samples, and make autonomous decisions.**

## CHALLENGE

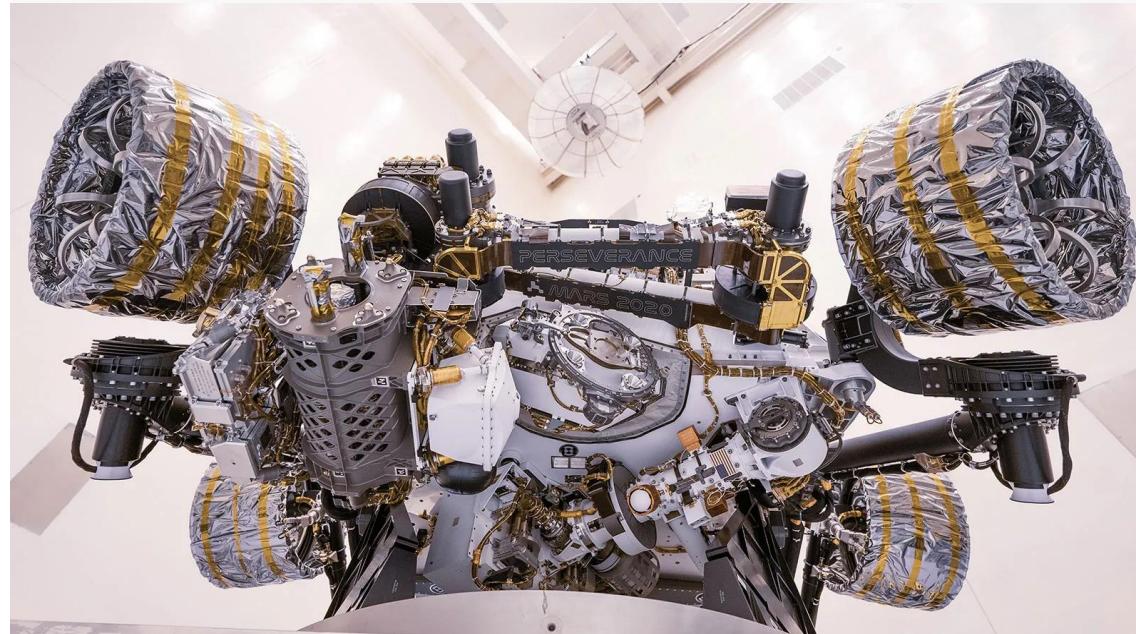
- In a harsh, remote environment with limited communication to Earth, the rover must operate safely to maximize science return and protect billions in mission investment.

AI schedules tasks, monitors resources to optimize performance, and chooses valuable targets for sampling.

## OUTCOME

- **Safely landed on Mars** on February 18, 2021, enabled by advanced AI landing guidance system.
- **88% fully autonomous rover driving** over >18.65 miles (30 kilometers).
- **24 rock and dust samples** collected as of late 2024 for NASA's Mars Sample Return campaign.
- **Sets the standard** for responsible, high-integrity AI use in mission-critical systems.

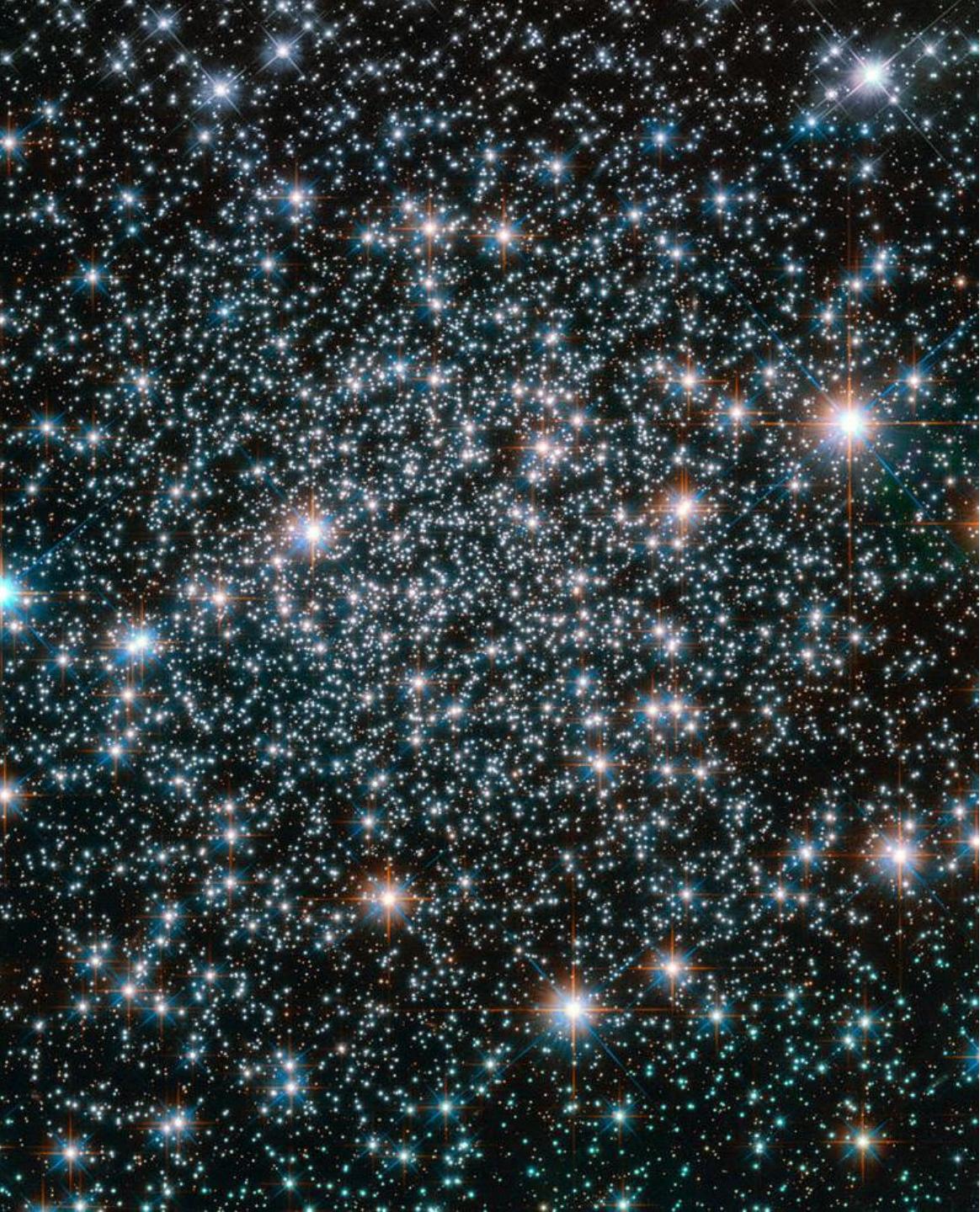
*This image of the Perseverance Mars rover was taken at NASA's Kennedy Space Center on April 7, 2020, during a test of the vehicle's mass properties.*



*This image shows the remains of an ancient delta in Mars' Jezero Crater, which NASA's Perseverance Mars rover will explore for signs of fossilized microbial life.*



**NASA leverages AI to push the boundaries of exploration—but unlike in most commercial settings, our missions operate in extreme environments where failure isn't an option. Rigorous testing and evaluation are as important to our mission success as innovation.**



MEMO M-25-21

# What is High-Impact AI?

**High-impact AI is any AI system whose output serves as a principal basis for decisions or actions that have a legal, material, or significant effect on:**

- Civil rights, liberties, or privacy
- Access to education, housing, credit, benefits, or healthcare
- Human health, safety, or critical infrastructure
- Government programs, employment, or strategic assets

## Examples:

- Medical diagnosis or treatment recommendations
- Law enforcement risk assessments
- Government benefits determinations
- AI-controlling physical systems (e.g., vehicles, robotics)

# GenAI and open data didn't get off to a great start

ChatGPT

Experiment conducted in February 2023 by Zach Whitman, PhD

zw Tell me about the demographics of suitland md

< 2 / 2 >

Suitland is an unincorporated community in Prince George's County, Maryland, United States. According to the United States Census Bureau, the Suitland census-designated place (CDP) has a total area of 4.2 square miles (10.8 km<sup>2</sup>), all of it land. As of the 2020 census, the population of the Suitland CDP was 27,568.

In terms of demographics, the population of Suitland is predominantly African American, with African Americans comprising over 95% of the population. The remaining 5% is made up of people of other races, including White, Hispanic/Latino, Asian, and Native American. The median age in Suitland is 37.4 years, which is slightly younger than the median age of Maryland as a whole.

In terms of income, the median household income in Suitland is \$60,620, which is lower than the median household income for Prince George's County as a whole, but higher than the median household income for the state of Maryland. The poverty rate in Suitland is 13.9%, which is higher than the national average but lower than the poverty rate for Prince George's County.

**true**

**wrong**

**wrong**

**wrong**

**wrong<sup>2</sup>**

**wrong**

**wrong**

**wrong**

**true**

**wrong**

**true**

Z Tell me about suitland md demographics

View other drafts

Suitland is a town in Prince George's County, Maryland, United States. The population was 26,375 at the 2020 census. Suitland is part of the Washington metropolitan area.

The town is named after the Suitland Federal Research Center, which was established in 1939. The center is home to a number of federal agencies, including the National Archives and Records Administration, the United States Department of Agriculture, and the United States Department of Commerce.

Suitland is a diverse community with a population that is 89% African American, 6% Hispanic, and 2% white. The median household income is \$64,652.

The town is home to a number of parks and recreation areas, including Suitland Park, which is home to a swimming pool, a playground, and a picnic area. The town is also home to the Suitland Library, which offers a variety of services for residents of all ages.

Suitland is a convenient location for commuters to Washington, D.C. The town is served by the

**wrong**

Bard

# Minimum Testing & Risk Management Practices

## Before Deployment (Pre-Launch)

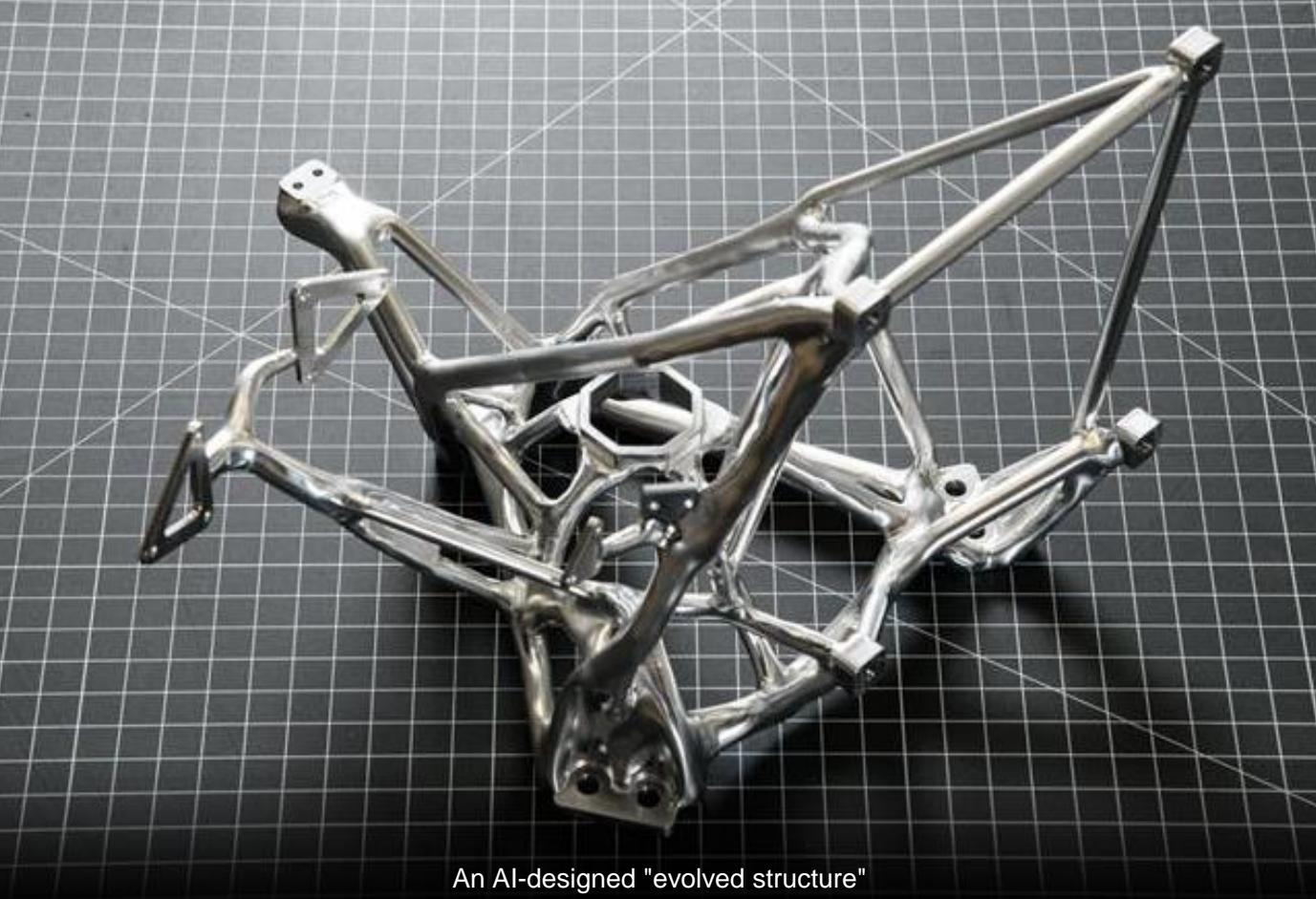
- Pre-deployment testing that simulates real-world use
- AI Impact Assessment, including:
  - Intended purpose, data quality, and benefit analysis
  - Risk to civil rights, privacy, safety
  - Independent review and approval by a designated official

## After Deployment (Ongoing)

- Performance monitoring & human review
- Training for human operators to interpret and manage AI outputs
- Human oversight & fail-safes for high-risk decisions
- Appeals process for individuals negatively impacted
- User & public feedback integration into system evaluation

**Non-compliant high-impact AI must be discontinued until aligned with policy requirements.**

**Waivers must be justified, reported to OMB, tracked, and re-certified annually by the Chief AI Officer (CAIO).**



An AI-designed "evolved structure"

## Powered by the best in space and tech.

### Industry collaborations:

Autodesk, Protolabs, ZeroHour, Rennscot, Synera, Celedon Solutions, Hexagon, Infinitiform.

### Extending "description to design" from parts to entire missions using:

LLMs, AI agents, generative design AI, surrogate models, & reinforcement learning.

### Global Recognition:

Featured in Fast Company, NBC News, The New York Times, Aviation Week, and more.

MISSION OBJECTIVES →  
EVOLVED STRUCTURES

# Text-to-Structure

**AI-powered design reshaping the way we turn mission objectives into hardware.**

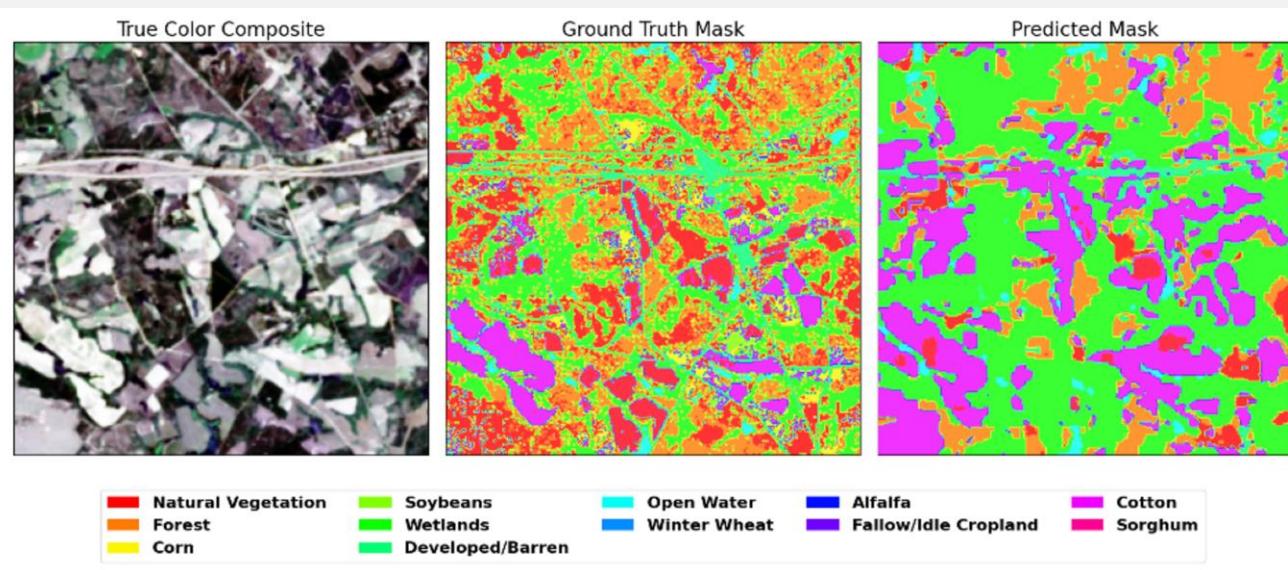
### CHALLENGE

- Developing hardware is slow and expensive.
- Manual iteration across large teams = long development cycles, high costs, and non-optimal designs.

AI enables rapid iterations for optimized designs. The resulting "evolved structures" are more reliable and higher-performing in extreme space environments.

### OUTCOME

- **10x faster and cheaper** than traditional design processes.
- **3x superior strength, stiffness, and weight efficiency** for AI-optimized designs.
- **~10x lower stress factors** and potential points of failure based on NASA-standard validation processes.
- **60+ NASA mission applications**, including EXCITE, HWO, and Mars Sample Return.
- **Spin-offs in development:** Text-to-Spaceship, Text-to-Circuit, Text-to-Telescope.



It's like having a powerful assistant that leverages NASA's knowledge to help make faster, more informed decisions, leading to economic and societal benefits.



True-color HLS image of northwest Iceland acquired on July 11, 2023

AI TRAINED ON GLOBAL DATA

# Prithvi Geospatial Foundation Model

A milestone foundation model developed by NASA and IBM for Earth observation data and Earth science applications.

## CHALLENGE

- NASA needs a way to make its vast scientific datasets more accessible and usable for things like land use tracking, disaster response, and agricultural monitoring.

Foundation models are powerful AI systems that can learn from vast datasets and detect complex patterns and processes.

## OUTCOME

- **Successful use cases** in flood mapping and burn scar identification, supporting natural disaster monitoring, management, and recovery.
- **Demonstrated value** for tracking land use, predicting crop yields, and improving agricultural monitoring and resource management.
- **Versatile downstream applications** for measuring biomass and ecosystem health, detecting landslides, and estimating wildfire severity.

# 2101: A Parking Space Odyssey

A deep learning model with limitless applications—from the parking lot of Building 2101 to the moons of Jupiter and Saturn.



Langley Building 2101



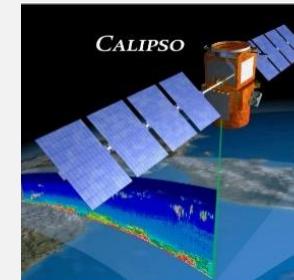
NSA



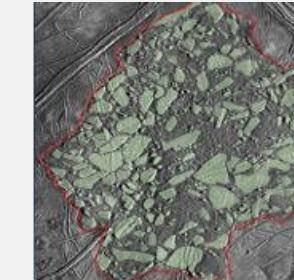
CERTAIN Range



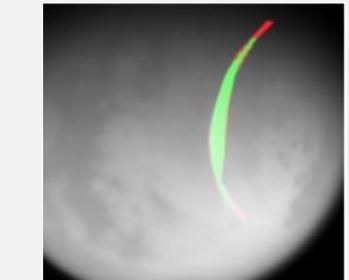
Badge &amp; Pass Office



Low Earth Orbit



Europa Ice



Titan Methane

In 2019, a team of Langley interns combined a convolutional neural network (Mask R-CNN) with security cameras to detect vehicles and report open parking spaces.

## MISSION VALUE :

- **Real-World Positioning:** object detection and localization with pixel-level accuracy, using only a single camera per parking lot.
- **Driving Productivity:** LaRC Park mobile app shows open parking spots and saves time for employees across Langley's huge campus.
- **Scalable and Flexible Technology:** This AIML approach proved highly accurate, flexible, and scalable. The solution was shared with the NSA at Ft. Meade, Maryland to address even greater parking challenges.

When parking issues disappeared during COVID, the technology transferred to Langley's CERTAIN range for UAS flight testing.

## The AIML adapted, launching an odyssey across new use cases.

### O U T C O M E S :

- **CERTAIN Range:** Instead of detecting cars in lots, the model now detects people near Vertipads to ensure safety during UAS arrival/departure.
- **Badge & Pass Office:** Model is repurposed to detect and count people in BPO waiting area, optimizing on-demand staffing assistance and visit timing for employees.

- **Low Earth Orbit:** Model extended to analyze LIDAR imagery from CALIPSO satellite and monitor worldwide coral reef health. NASA partnered with the NIA, Georgia Tech, University of Rochester, and Coral Vita.
- **Ice Floes of Europa:** Model retrained through "Transfer Learning" to recognize and map ice blocks in the chaos region of Jupiter's moon, accelerating discovery of its subterranean ocean—which has the best chance of hosting other life in our solar system.
- **Methane Clouds of Titan:** Model trained to recognize methane cloud migration on Saturn's largest moon, the only other place in our solar system with an Earth-like evaporation/precipitation cycle. This will be the keynote lead story at NVIDIA's 2025 GTC conference, with a reach of 25 million viewers

# Doc in a Box

**A prototype for leveraging AI to assess crew health and provide actionable recommendations.**

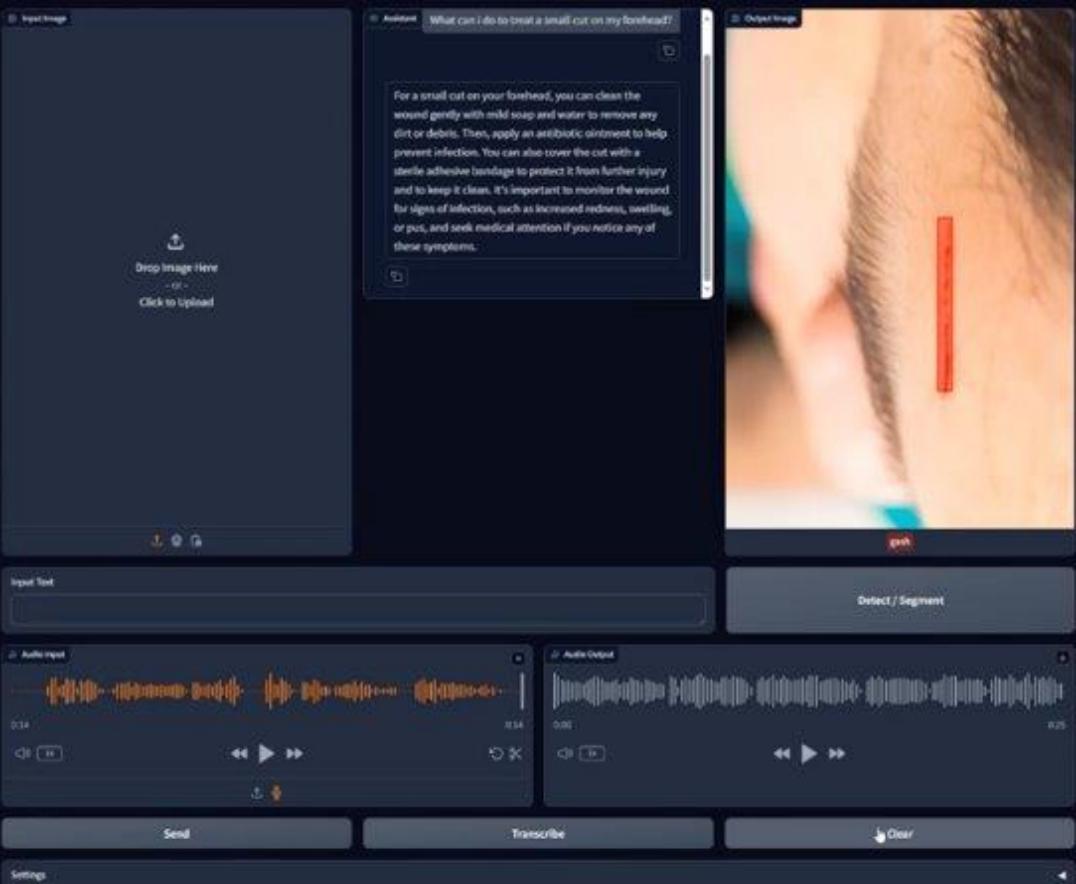
## CHALLENGE

- Astronauts aboard the International Space Station rely on constant communication with Earth for healthcare needs.
- Future astronauts heading to the Moon or Mars will need a different kind of medical support.

NASA leverages cutting-edge technology while ensuring robust standards, allowing us to venture deeper into space at reduced risk to our astronauts.

## OUTCOME

- **Successful deployment** of a robust AI model on an edge device.
- **Novel adaptation of the OSCE** (a benchmark evaluation for medical students/professionals) to test medical AI systems.
- **Models tested:** Google Gemma 2 (scored 75%), Llama 3.1 (scored 78.5%).
- **High accuracy** in diagnostic recommendations and decision support across various scenarios in preliminary tests.
- **Projected impact:** increased mission safety and crew performance, reduced mission risk and cost.



**In the future, Doc in a Box could give astronauts an AI medical partner that can support diagnosis, treatment, and decision making when Earth is out of reach.**



# Conclusion & Discussion

## OVERVIEW

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NASA has built significant momentum toward an AI-ready workforce and infrastructure.



The agency has a rich history of leveraging AI. This includes a history of rigorous testing and evaluation to meet incredibly high standards.



We're excited to share the innovative ways our workforce is developing novel frameworks for validating innovative, mission-enabling AI capabilities.

## QUESTIONS ?