



Clarity in Every Orbit, powering Safer Space

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ABOUT

What it is:

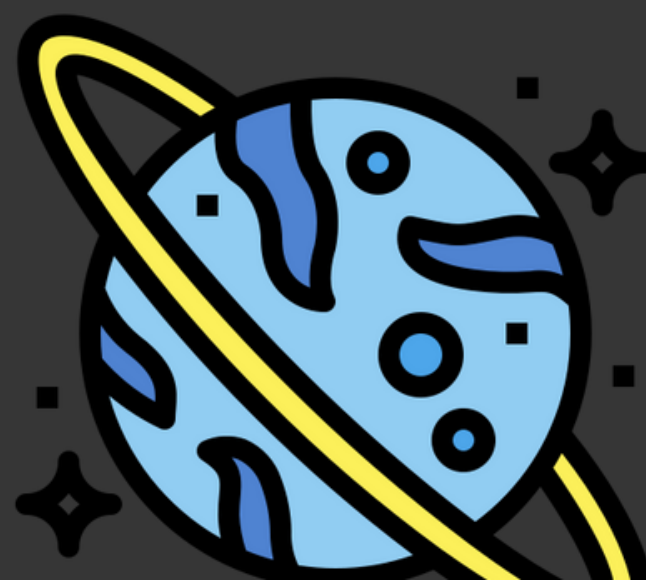
- Orryx is a cloud-native space intelligence platform, built on Microsoft Azure. Its mission is to automate the entire satellite collision prevention lifecycle: from threat detection and precise trajectory prediction to recommending optimized avoidance maneuvers, all presented in an intuitive dashboard for space operators.

Technology:

- Azure Functions
- Azure Blob Storage
- Azure Cosmos DB
- Azure Machine Learning
- Azure OpenAI Service

Data and Knowledge Sources:

- CelesTrak / Space-Track
- ESA DISCOS Web API
- NASA & ESA Debris Offices:



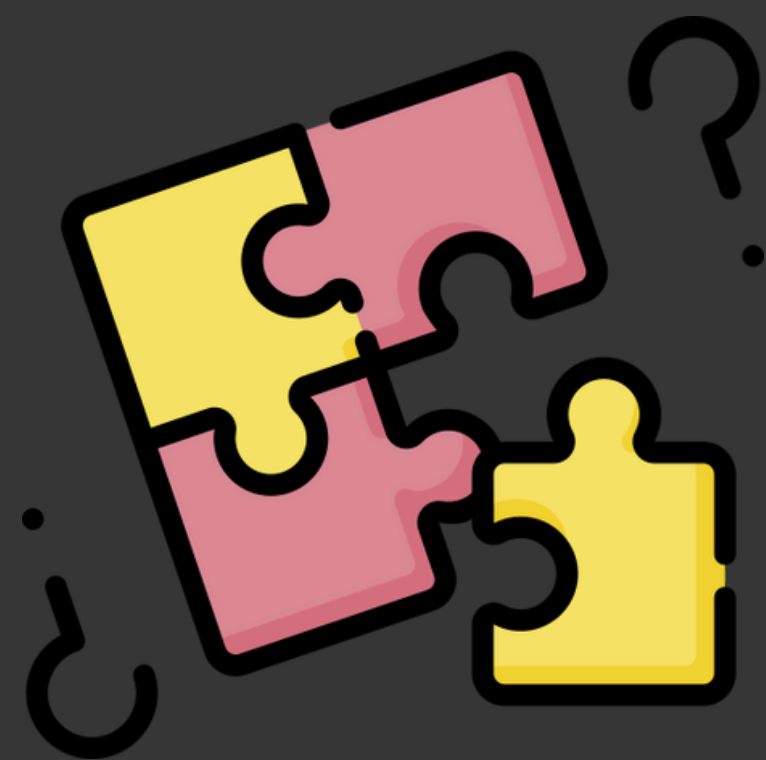
THE PROBLEM TO SOLVE

Problem Description:

- Earth's orbit is a finite and increasingly congested resource. Over 900,000 hazardous debris objects travel at hypersonic speeds, threatening the satellite infrastructure our daily lives depend on—from communications and GPS to financial transactions and emergency response.

Current Limitations:

- Current space traffic management relies heavily on the manual analysis of thousands of daily conjunction alerts, a slow, expensive process that doesn't scale with the exponential growth of mega-constellations.
- Uncertainty in trajectory predictions, especially due to atmospheric drag, forces costly avoidance maneuvers that shorten the lifespan of satellites.



PROJECT GOALS

Main Objective:

- To develop a functional prototype of "Orryx" capable of ingesting orbital data, identifying the 100 highest-risk conjunctions within a 72-hour window, and proposing an optimal avoidance maneuver for the most critical events.

Key Modules:

- **Conjunction Prediction Engine:** Process the CelesTrak catalog to autonomously generate conjunction data messages (CDMs).
- **AI-Powered Risk Assessment:** Assign a precise collision probability to each CDM using a hybrid model (Physics + Machine Learning).
- **Maneuver Planner:** Recommend the most efficient avoidance maneuver in terms of safety and fuel consumption using Reinforcement Learning.

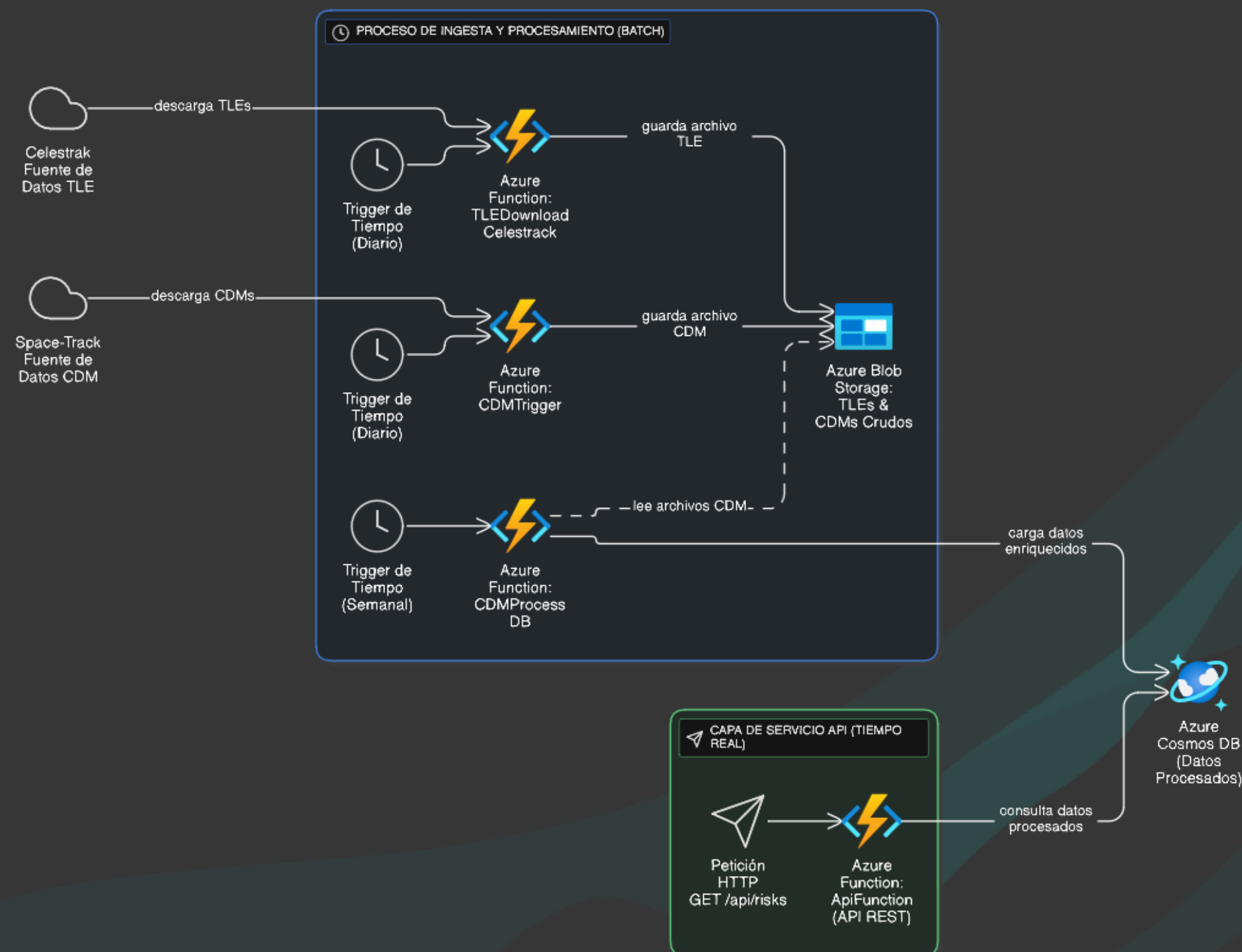


SOLUTION COMPONENTS AND ARCHITECTURE

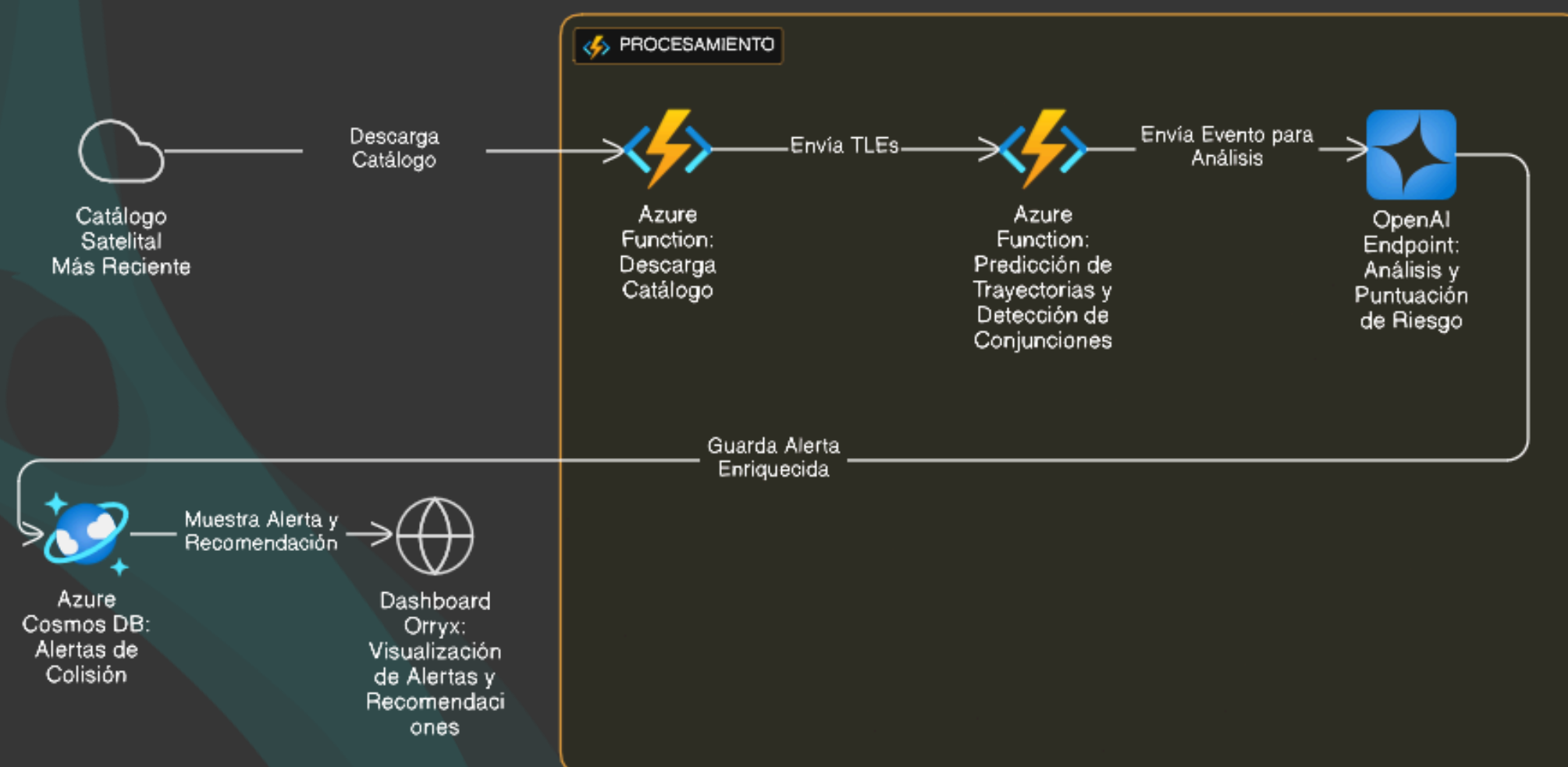
Key Modules:

Overall Architecture:

- A modular, event-driven system that combines a powerful batch processing engine for massive analysis with a real-time API to serve results instantly.



SOLUTION COMPONENTS AND ARCHITECTURE

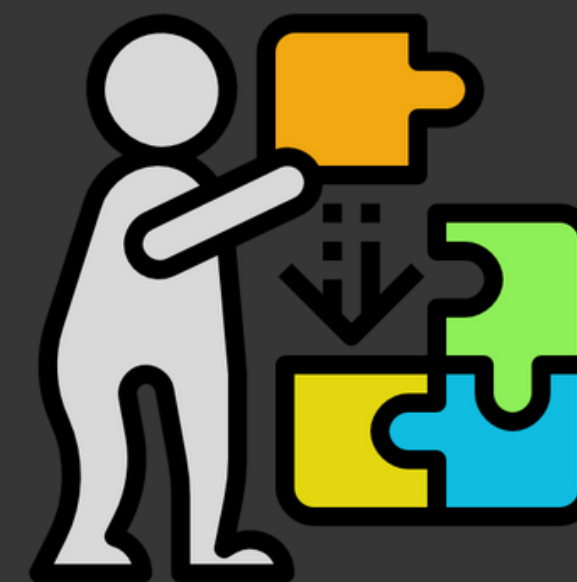


- **Ingest:** Azure Function downloads latest satellite catalog.
- **Processing:** TLEs are processed to predict trajectories and detect high-risk conjunctions.
- **AI Enrichment:** Event sent to Azure ML for analysis, assigns critical risk score.
- **Storage:** Result saved as new alert in Azure Cosmos DB.
- **Exposure:** Alert displayed on "Oryx" dashboard with avoidance recommendation.

SOLUTION OVERVIEW

Challenges and Insights:

- Challenge: Balancing the computational cost of batch processing with the need for up-to-date data.
- Insight: The hybrid architecture (batch + real-time) is the optimal solution, enabling deep analysis without sacrificing responsiveness.



USER INTERFACE FUNCTIONALITY

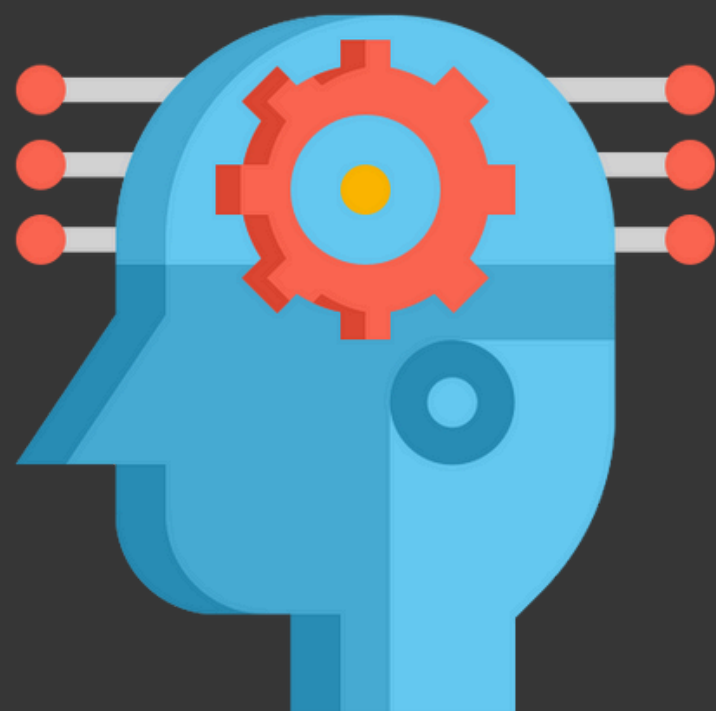
User Interface Functionality:

- A Global Dashboard with a 3D globe visualizing active alerts in real-time.
- A Prioritized Alert List that allows the operator to focus on what matters most.

Technology:

- An Alert Detail View showing the orbits, the AI's justification (SHAP), and the option to request an avoidance maneuver.
- An Assistance Chatbot to make queries in natural language.

KEY LEARNINGS



Our Core Strengths

- **High-Performance Analysis:** We leverage Azure's parallel processing capabilities to efficiently analyze the entire satellite catalog, delivering timely and comprehensive risk assessments.
- **Cutting-Edge Innovation:**
 - Our Hybrid AI Model combines proven physics with Machine Learning to achieve superior prediction accuracy.
 - We use Microsoft Planetary Computer data to uniquely improve atmospheric drag calculations.
 - A Reinforcement Learning agent autonomously plans the most efficient and safest avoidance maneuvers.
- **Responsible & Transparent AI:** Our system is built on trust. We use Azure's Responsible AI tools to ensure every prediction is explainable and fair, providing operators with full transparency into the AI's decision-making process.

FUTURE CHANGE

What's Next: The Future of Orryx

- Enhanced Intelligence: Integrating new data sources like private radars.
- Instantaneous Response: Deploying a real-time endpoint for on-demand risk analysis.
- Fleet-Scale Management: Expanding our AI to coordinate maneuvers for entire satellite constellations.

