Welcome to Syntharion!

Team Members:

Ayaulym Tauyekel (Year 10 Student of NIS Kyzylorda)
Kaussar Kuanar (Year 10 Student of NIS Kyzylorda)

THE UNSEEN THREAT: Why We Miss 99% of Small NEOs

>1 km

19-44 m

2013, Chelyabinsk meteorite

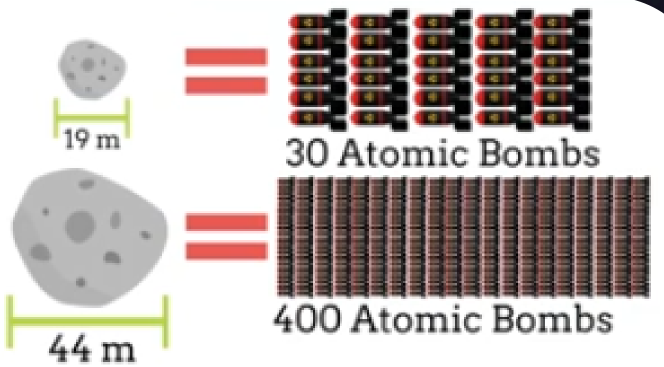
(19 m) the collision of a celestial body with the Earth caused a devastating wave, causing 1,500 people to be injured.

In 2005

NASA setted the goal: to detect 90% of asteroids with a diameter of more than 140 meters by 2020.

In 2020

The result: billions were spent on telescopes, but only 30% of asteroids in this category were found. And the detection of 19-44 meters is even only 0.1%!



19 m: Collision w/ Earth every **10-60 years**

The Hazard by the Numbers

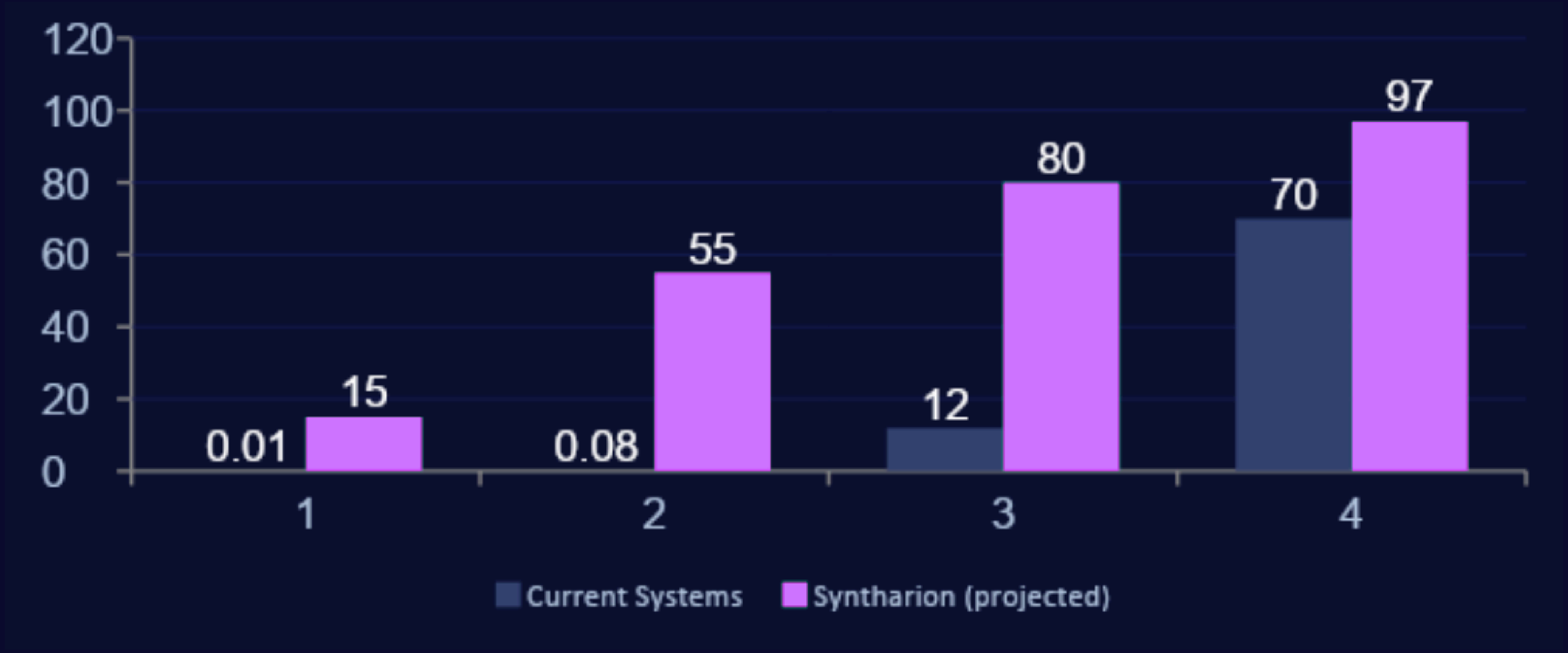
How Big?	10 meters	50 meters	140 meters
How Often?	~1 per decade	~1 per 1000 years	~1 per 20,000 years
How Many?	~45 million	~230,000	~25,000
% Discovered	0.03%	7%	40%

MARKET ANALYSIS

Planetary Defense is a High-Stakes, High-Growth Sector

$1.4B Global Space Surveillance Market (2024)	**$6.2B** Projected Market Size by 2032 (CAGR 18%)	**>70%** Hazardous Asteroids >140m Still Undetected	**~44K** Objects Tracked by NASA NEOWISE

Detection Rate Gap by Asteroid Size (Current vs. Syntharion)

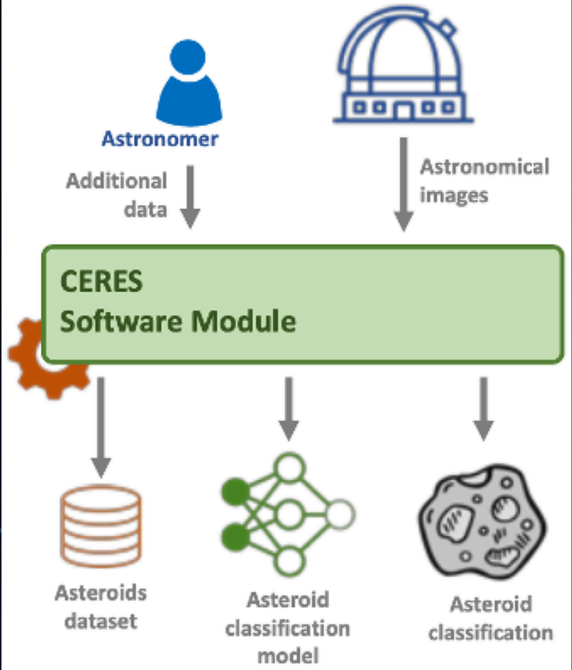


Key Market Drivers

🌍 International asteroid treaties & IAWN mandates
🚀 NASA PDCO increasing detection funding annually
📡 New telescope networks (Vera Rubin, ATLAS) generating TB/night
🏛️ Government contracts in planetary defense rising
🛰️ Growing private sector interest in space situational awareness

INTRODUCING THE SOLUTION

Imagine a world where we can detect every asteroid heading toward Earth before it becomes a threat...



Concept Example:
Assessment of Asteroid Classification Using Deep Convolutional Neural Networks

- **OBJECTIVE:**

To develop a deep learning model to detect asteroids quickly and accurately.

- **HYPOTHESIS:**

Convolutional Neural Networks (CNNs) can detect features invisible to the human eye, outperforming traditional software.

Difficulties in finding small asteroids:

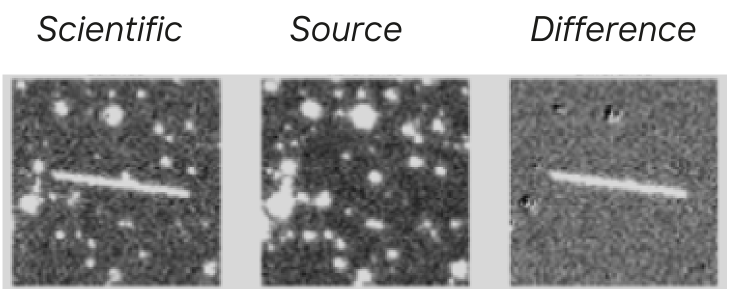
invisibility *high speed* *technical limit*

Cons of the traditional manual dataset:

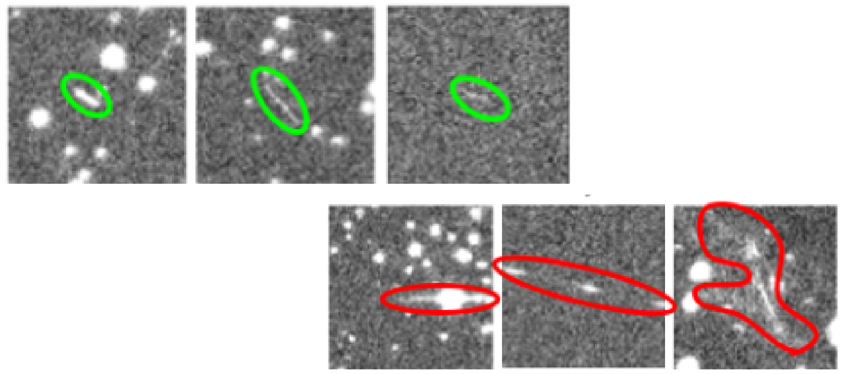
time pressure *dataset limit* *one-sidedness*

SYNTHARION is a planetary defense algorithmical project that utilizes deep learning and a novel synthetic data approach to drastically improve the detection of small, fast-moving Near-Earth Objects (NEOs). Its primary goal is to achieve near-perfect accuracy (99.8%), thereby eliminating the vast majority of false alarms that currently burden human analysts in major astronomical surveys.

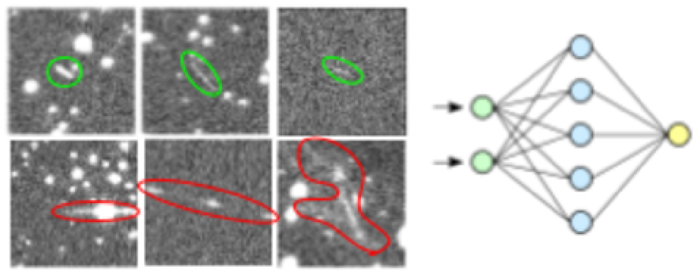
METHODOLOGY: RESEARCH STEPS



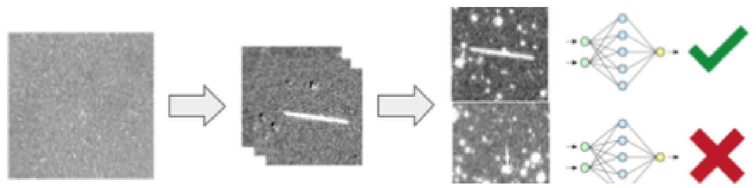
1) data collection
Zwicky Transient Facility; NASA Near Earth Objects Dataset



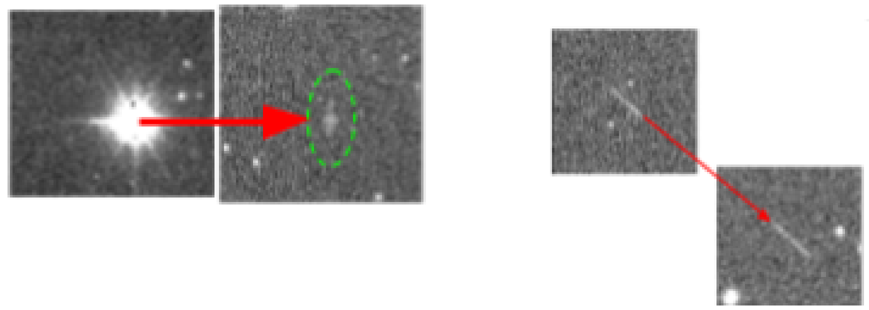
2) Creating a data set
On the example of negative and positive images



3) neural network training
Using the EfficientNetB1 model



4) checking the algorithm
Extracting transients from all difference images

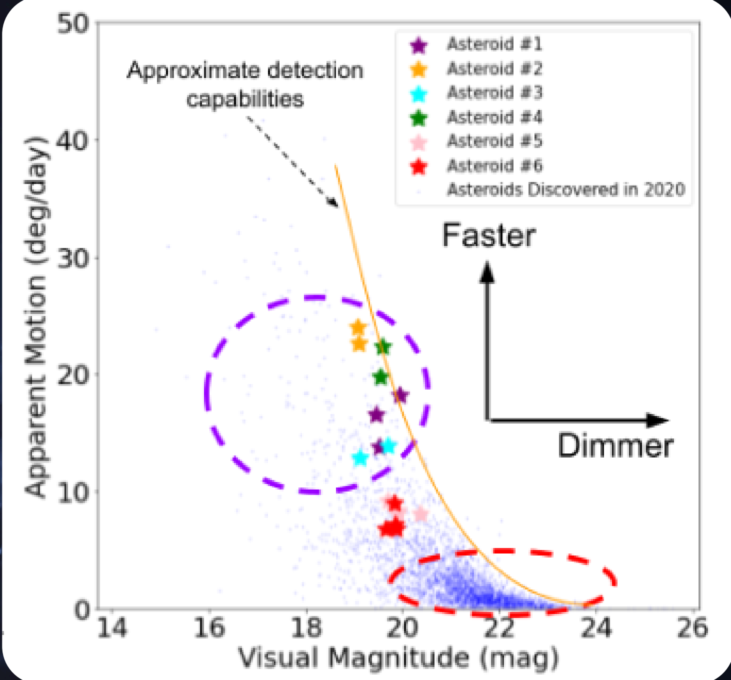


5) filtering results
Removing false positives

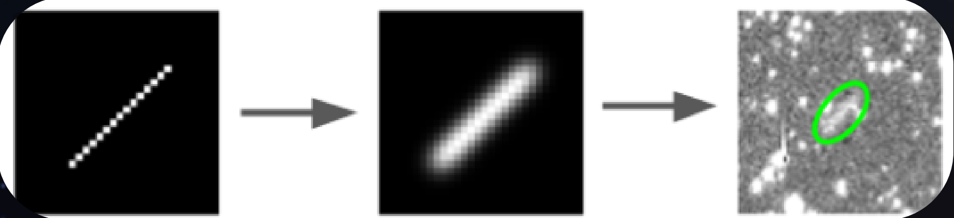
$$m = -2.5\log_{10}\left(\sum F_{ij}\right) + \mathrm{MAG}_{ZP}$$

$$\omega = \frac{\theta}{\mathrm{EXP\_TIME}}$$

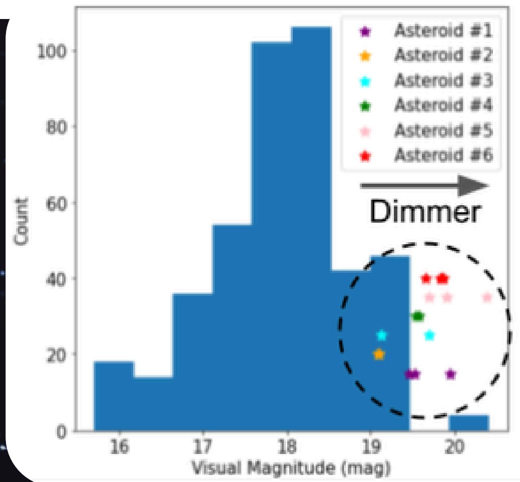
6) description of definitions
by Equation



- 🔴 Red zone: large, distant, slow-moving asteroids → easy to find.
- 🟣 Purple zone of purple: weak light, fast moving asteroids → difficult to find.
- Newly discovered asteroids (#1, #2, #4) located in this area.
- Diameters: 1-50 m, distance from Earth: ≈20 lunar distance units.
- Result: the algorithm identified objects that traditional methods cannot find.



STRIP SIMULATION PROCESS



	Diameter (Meters)	Distance to Earth (Lunar Distances)
Asteroid #1	1.1 - 8.4	18.3 ± 9.0
Asteroid #2	1.2 - 9.2	21.5 ± 12.1
Asteroid #3	4.5 - 35	20.3 ± 12.9
Asteroid #4	1.1 - 8.4	5.52 ± 3.87
Asteroid #5	6.0 - 46	61.4 ± 30.1
Asteroid #6	6.5 - 51	19.9 ± 6.9

AI TECHNOLOGIES

Syntharion's Deep Learning Core

CNN Architecture

EfficientNet-B1 trained on 1M+ synthetic samples. Detects asteroids in 30-sec ZTF exposures in milliseconds.

Synthetic Data Engine

PSF-based streak injection into real sky images — eliminates bias toward bright/slow objects. 500K+ positive samples generated.

1.3σ Detection Threshold

Lower than industry-standard 1.5σ, enabling detection of faint NEAs missed by traditional pipelines (NEOWISE, ZTF).

Difference Imaging

Background subtraction boosts SNR. Consistent motion filter removes false positives to 0.02% false positive rate.

70% Faster than Traditional Methods

6 New Asteroids Discovered

0.02% False Positive Rate

COMPARATIVE PERFORMANCE

- **Accuracy (Validation Accuracy): 99.8%**
- **True Positive Rate (recall): 97%**
- **False Positive Rate: 0.02%**
- **Practical discovery: 6 new asteroids (ZTF, 3 Night analysis)**
- **Brightness(m): 19.0 – 20.3 for asteroids found**
- **Angular velocity: 6.8-24 °/day**

КерсеткішДастурı in My Drive

	A	B	C	D	E
1	Metric	Traditional Meth	SYNTHERION (Your Model)	Improvement	
2	Accuracy	84.80%	99.83%	+15.0 p.p. (≈17.7% increase)	
3	True Positive Ra	80.00%	97.00%	+17.0 p.p. (≈21.3% increase)	
4	False Positive R	15.00%	0.02%	99.9% Reduction	
5	Precision	21.90%	99.60%	4.5× Higher	
6	Processing Time	10 hours	3 hours	70% Reduction	

EFFICENCY

	A	B	C
1	***Section***	**Metric**	**Formula / Validation Calculation**
2	I. Scientific Validation (Target Population)		
3		Apparent Magnitude (m - Faintness)	m=−2.5·log10(∑F)+MAGZP (Example: ∑F=158)
4		Angular Velocity (ω - Speed)	ωdeg/day≈EXPTIMELpix×Factor (Example: 30 pix/30 sec)
5	II. Machine Learning Performance (Validation Set: 100,000)		
6		Accuracy (Overall Correctness)	TotalTP+TN=100,0004,850+94,981
7		Precision (Trustworthiness)	TP+FPTP=4,850+194,850
8		False Positive Rate (FPR)	NFP=95,00019
9		True Positive Rate (TPR/Recall) (No Miss	0.97·Positives=0.97·5,000
10	III. Operational Efficiency		
11		Processing Time Reduction	Tnew=(1−Reduction)·Told (Example: Told=10 hrs)
12			
13			
14	**SYNTHERION Result**	**Key Impact on Planetary Defense**	
15	m≈19.50	ASTRA NOVA proves capability to detect the most challenging, unseen threats (faint and fast).	
16	24∘/day	Confirms objects detected are very faint; traditionally missed by automated and human review.	
17		Confirms objects are fast-moving; typically fail existing tracking and linking algorithms.	
18	99.83%	Model delivers near-perfect trust and minimal false alarms.	
19	≈99.61%	+15.0 p.p. increase over Traditional Methods, nearly eliminating missed detection.	
20	0.02%	4.5× higher than Traditional Precision, confirming detections are highly reliable.	
21	97.0% (4,850 TP)	99.9% reduction in false alarms, freeing up human analysts for critical orbital work.	
22		Confirms minimal False Negatives (150 FN), maximizing detection coverage.	
23	**3 hours**	Enables mission-critical speed for early warning alerts.	
24		70% reduction in data processing time, directly enabling faster alerts and follow-up.	
25			

SYNTHARION algorithm
is 3 hours faster!

BUSINESS CANVAS MODEL: *USE OF PRIZ GURU*

PRIZ.GURU
Think different, think inventive...

Syntharion

Home › Projects & Tools › Project › Tools list › EBS

Effective Brainstorming (EBS)

KEY PARTNERS:

1. Major Observatories (ZTF, LSST): Access to raw, real-time data streams for testing and deployment.

2. Space Agencies (NASA/ESA): Grant funding, regulatory support, and pilot program endorsement.

3. Academic & Research Institutions: Peer review, independent validation, and next-generation R&D for orbital linking.

KEY RESOURCES:

1. Intellectual Property (IP): The proprietary SYNTHARION synthetic data generator and the custom-trained EfficientNet model.

2. Deep Learning Expertise: The core team's specialized knowledge in CNN architecture, PSF modeling, and scientific computing.

3. High-Fidelity Synthetic Data Library: The constantly growing library of perfectly labeled synthetic streaks, which serves as the core asset.

KEY ACTIVITIES:

1. Algorithm Maintenance & Optimization: Continuous refinement of the EfficientNet CNN and the SYNTHARION PSF model fidelity.

2. Synthetic Data Generation: Scaling the synthetic dataset to adapt to new telescope hardware/noise profiles.

3. Orbital Linking Integration: Developing the feature to track objects across multiple nights and calculate definitive trajectories (Red Zone alerts).

CHANNELS:

1. Direct API Integration: The primary channel for real-time delivery to observatory data pipelines (e.g., streaming alert service).

2. Enterprise Licensing (SaaS): Annual subscription fees for the fully trained, high-performance ASTRA NOVA model and its updates.

3. Scientific Publications & Conferences: The channel for communicating results and engaging key stakeholders (e.g., IAU, Planetary Defense Conference).

VALUE PROPOSITITIONS:

1. Near-Perfect Accuracy (99.8%): Eliminates the risk of missing small, fast-moving threats (15% absolute improvement).

2. Noise Elimination: Reduces the False Positive Rate (FPR) from ~78% to 0.02%, saving hundreds of hours of analyst time.

3. Scalable, Unbiased Training: The SYNTHARION method eliminates data scarcity and training bias, making the model future-proof.

COST STRUCTURE:

1. R&D Salaries: Compensation for specialized AI/Deep Learning engineers and scientific researchers.

2. High-Performance Computing (HPC): Costs associated with cloud infrastructure (GPUs) for model training and high-volume data inference.

3. Validation & Testing: Costs for securing and processing archival telescope data for continuous model validation and discovery (6 new asteroids found).

CUSTOMER RELATIONSHIPS:

1. High-Touch Strategic Partnership: Co-development and direct scientific collaboration for integration and calibration.

2. Scientific Validation: Publishing results in peer-reviewed journals to build credibility and trust.

3. Dedicated Technical Support: Providing specialized astronomical and AI expertise for system integration.

REVENUE STREAMS:

1. Government R&D Grants: Primary funding source from space agencies (NASA/ESA) and scientific foundations.

2. Data/System Integration Fees: Fees charged for customizing the SYNTHARION model and calibrating it for a specific telescope's unique noise characteristics.

3. Academic & Non-Profit Use (Freemium Model): Basic model/API access may be provided at low cost or free to academic groups to encourage research and broader adoption.

CUSTOMER SEGMENTS:

1. Planetary Defense Organizations (PDOs): NASA PDO, ESA PDC, UNOOSA.

2. Astronomical Survey Observatories: Zwicky Transient Facility (ZTF), Vera Rubin Observatory (LSST), Pan-STARRS, ATLAS.

3. Government/Defense Ministries: Agencies focused on Space Situational Awareness (SSA) and early warning systems.

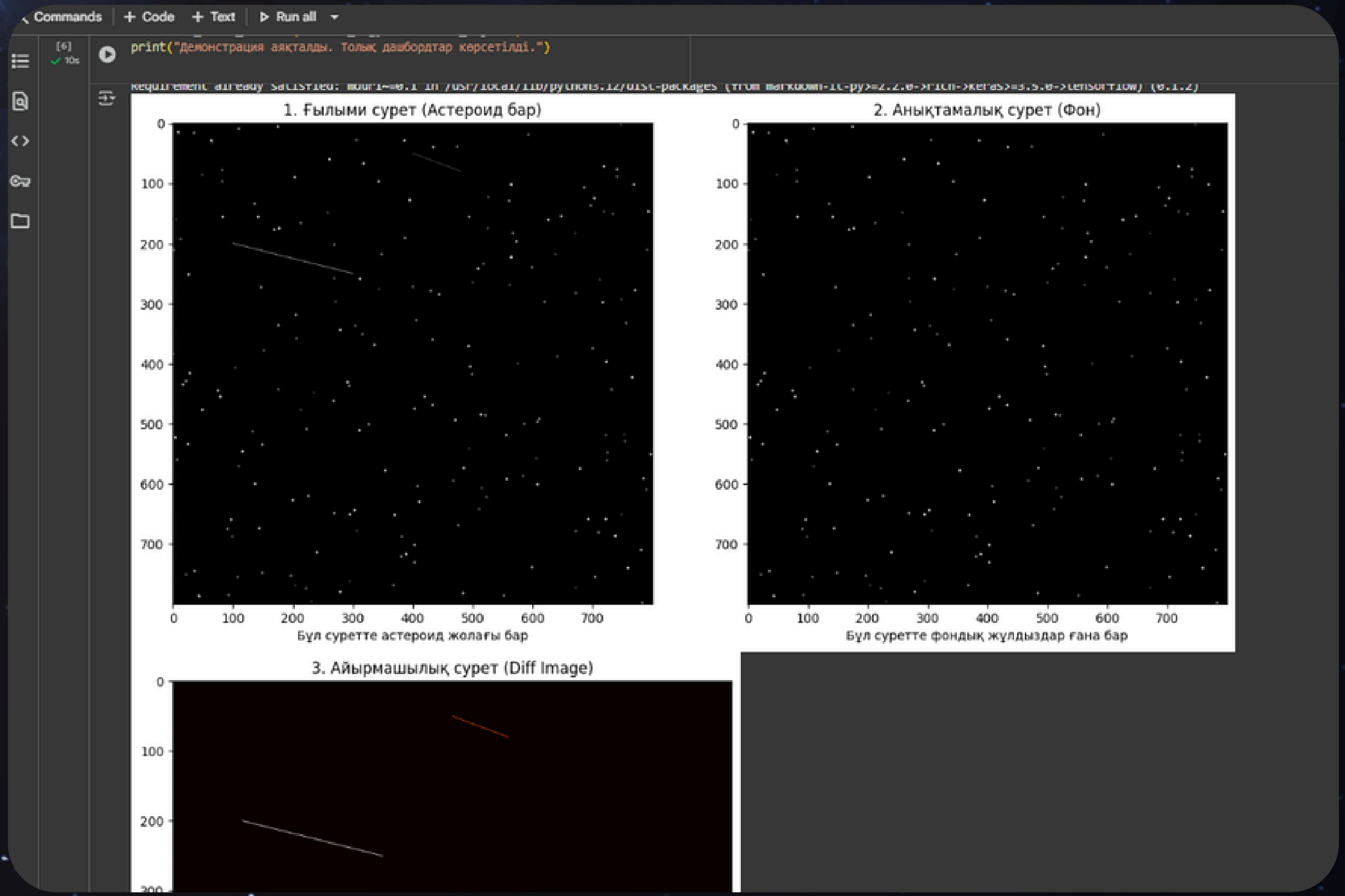
Export to Sheets

Project solves this problem by applying the **PRIZ Principle 17 (Moving to a New Dimension),** shifting the entire training process from the expensive, limited "Real Data Dimension" to the unlimited, zero-cost "Synthetic Data Dimension."

Why SYNTHARION is Essential?

Traditional asteroid detection systems fail on two fronts:

1. ***Data Scarcity:*** Real astronomical data is limited and contains insufficient examples of the most challenging objects—the faint, fast-moving, smaller NEOs (Near-Earth Objects) that pose an immediate, regional threat (like the Chelyabinsk meteor).
2. ***Observational Bias:*** The few labeled real-world streaks are biased toward brighter, slower objects. This results in AI models that are poor at generalizing to the critical, fast-moving, unseen population.



COMPETITIVE LANDSCAPE

Syntharion Outperforms Legacy Systems Across All Key Metrics

Feature	NEOWISE	ZTF / ZStreak	Pan-STARRS	SYNTHARION ✦
Core Approach	Infrared Survey	Rule-Based	Optical Survey	**Deep Learning CNN**
Detection Threshold	1.5σ	1.5σ	1.5σ	**1.3σ**
Fast-Mover Detection	Limited	Partial	Moderate	**Full Coverage**
Data Volume / Night	Limited	2 TB	1 TB	**Scalable**
False Positive Rate	High	Moderate	Moderate	**0.02%**
Accuracy	~60–70%	~75%	~80%	**99.8%**
Synthetic Training Data	✗	✗	✗	**✓ (1M+ samples)**
Real-time GPU Processing	✗	Partial	✗	**✓**

✦ Syntharion is the only solution combining synthetic training data, sub-threshold detection, and GPU-accelerated real-time analysis.

FUTURE WORK: GLOBAL DEPLOYMENT FOR PLANETARY SECURITY

SCALABILITY

GPU-Native: The model utilizes GPU parallelism, enabling rapid processing of the daily terabytes of data from observatories (ZTF, ATLAS, LSST).

NEXT STEP

Orbital Linking: Develop the final module to link the detected streak coordinates across multiple nights, automatically calculate the preliminary orbit, and generate a definitive Red Zone alert.

INTEGRATION

Universal Pipeline: The SYNTHARION output (a trained model) can be immediately integrated into the data pipelines of any major survey telescope globally.

From Simulation to Security: Training the Technology to See the Unseen!

QAZCOSMOS

KAZAKHSTAN SMART SPACE

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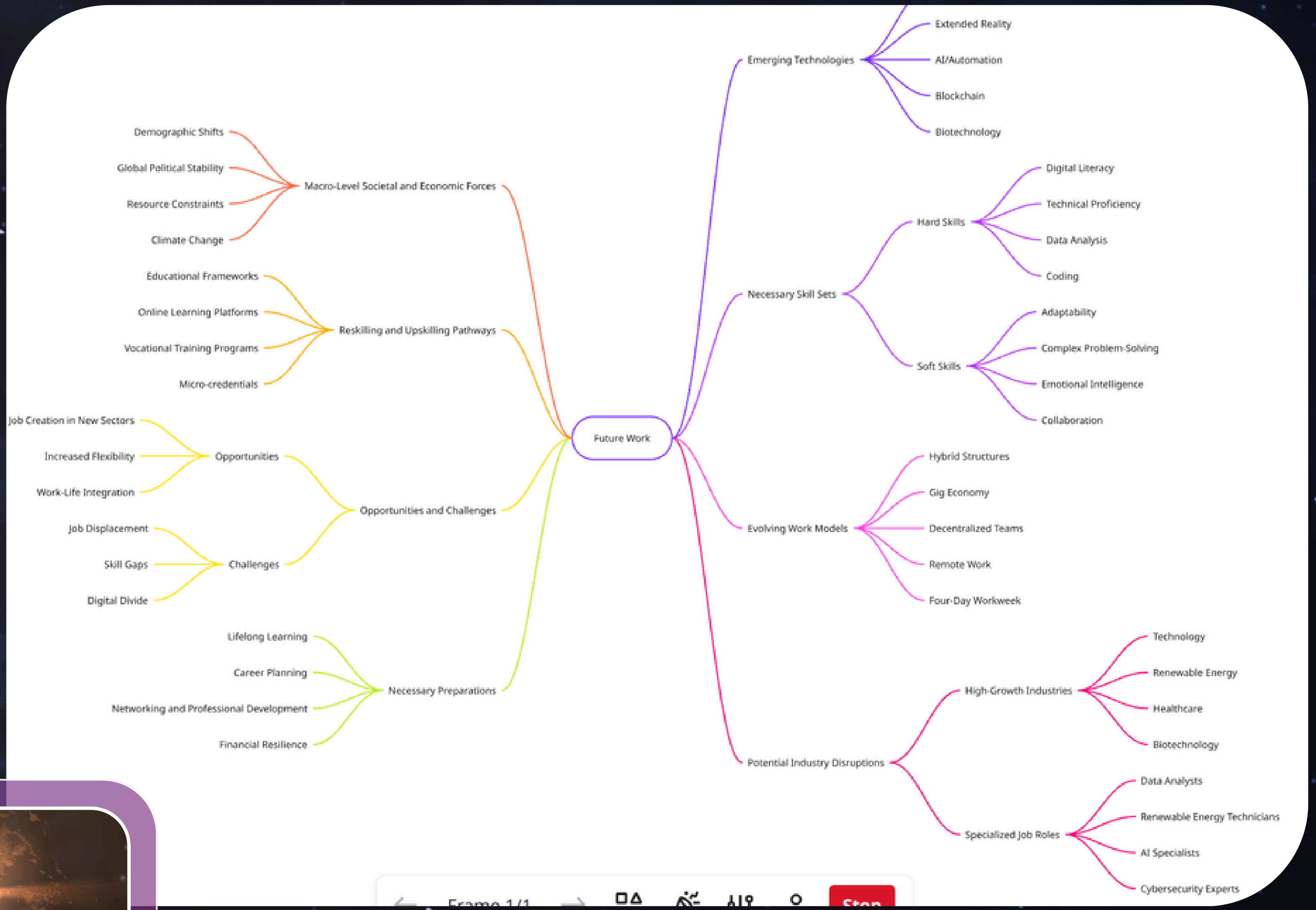
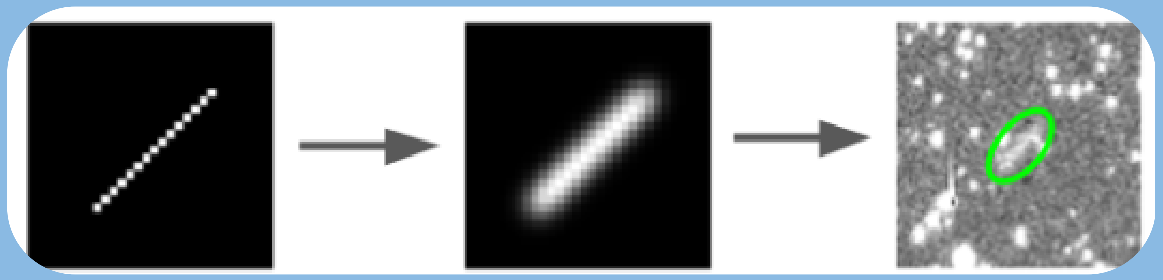
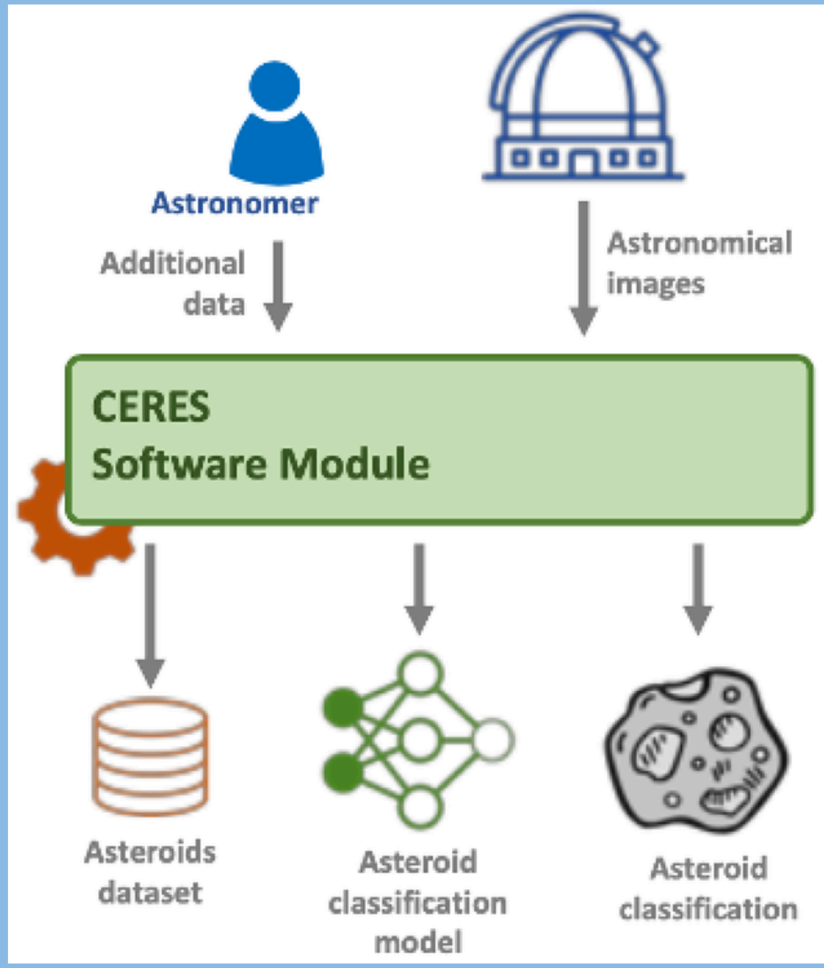


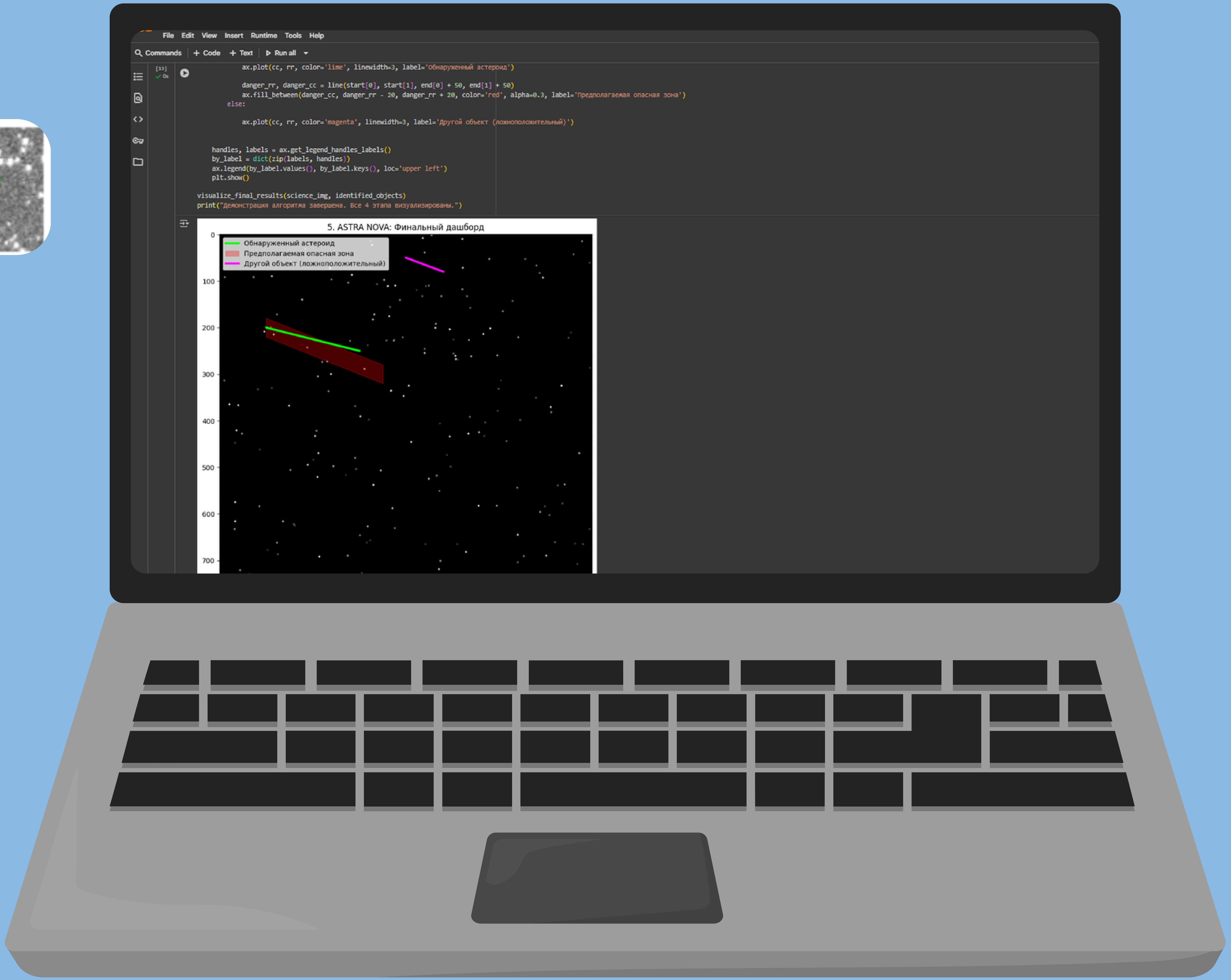
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

8 DECENT WORK AND ECONOMIC GROWTH





Astronomer
Additional data
Astronomical images
CERES
Software Module
Asteroids dataset
Asteroid classification model
Asteroid classification



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Commands + Code + Text Run all
visualize_final_results(science_img, identified_objects)
print("Демонстрация алгоритма завершена. Все 4 этапа визуализированы.")
5. ASTRA NOVA: Финальный дашборд
Обнаруженный астероид
Предполагаемая опасная зона
Другой объект (ложноположительный)

TEAM “NEIL’ED IT!”

Kaussar Kuanar

Researcher & Financial Strategist

Ayaulym Tauyekel

Systems Architect & Project Lead

> *From classrooms to space: Future Proficiency at the Confluence of Astronomy and AI*