Welcome to Syntharion!

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

>1 km

19-44 m

2013, Chelyabinsk meteorite

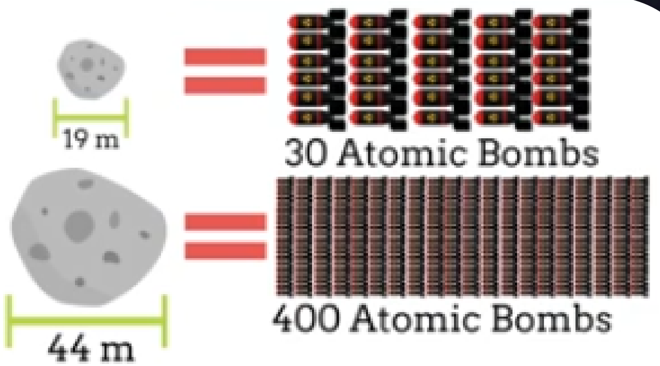
(19 m) the collision of a celestial body with the Earth caused a devastating wave, causing 1,500 people to be injured.

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%!



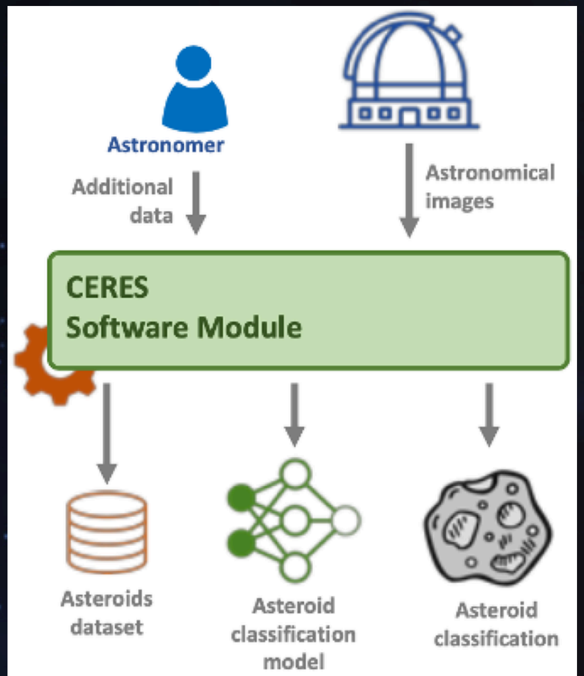
19 m: Collision w/ Earth every **10-60 years**

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%

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:

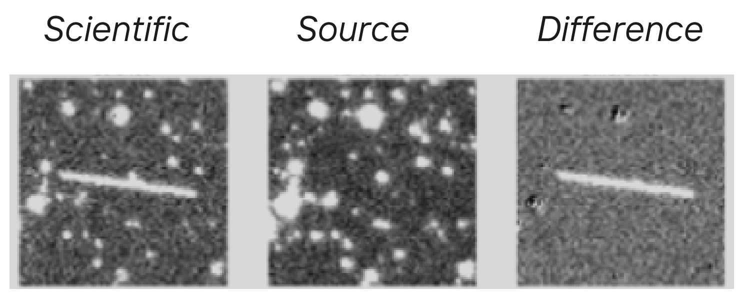
invisibility *high speed* *technical limit*

Cons of the traditional manual dataset:

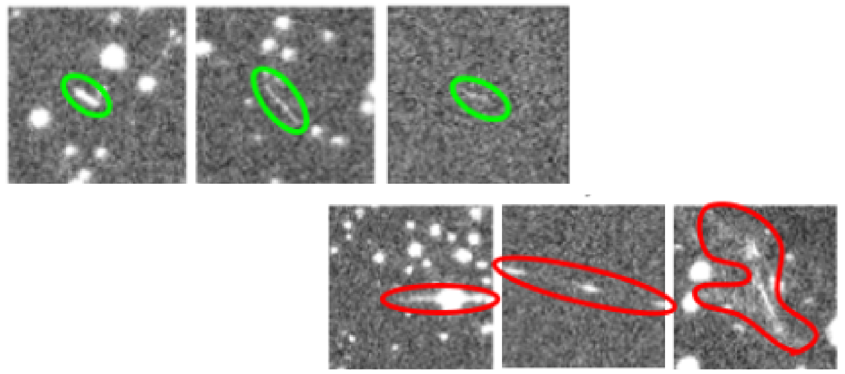
time pressure *dataset limit* *one-sidedness*

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.

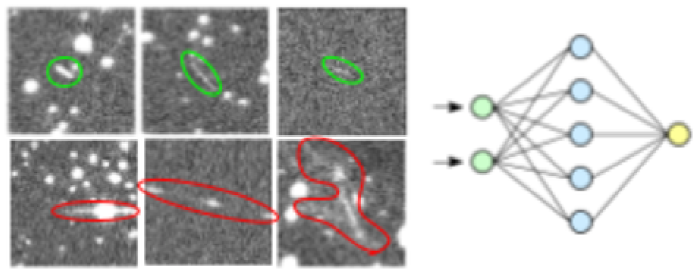
METHODOLOGY: RESEARCH STEPS



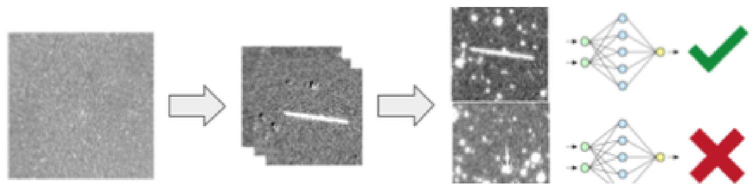
1) data collection
Zwicky Transient Facility; NASA Near Earth Objects Dataset



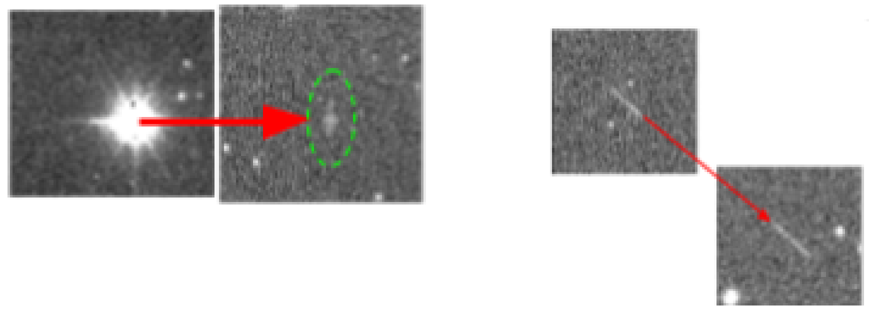
2) Creating a data set
On the example of negative and positive images



3) neural network training
Using the EfficientNetB1 model



4) checking the algorithm
Extracting transients from all difference images

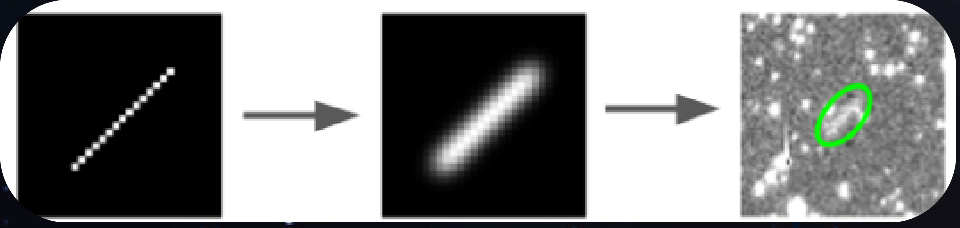


5) filtering results
Removing false positives

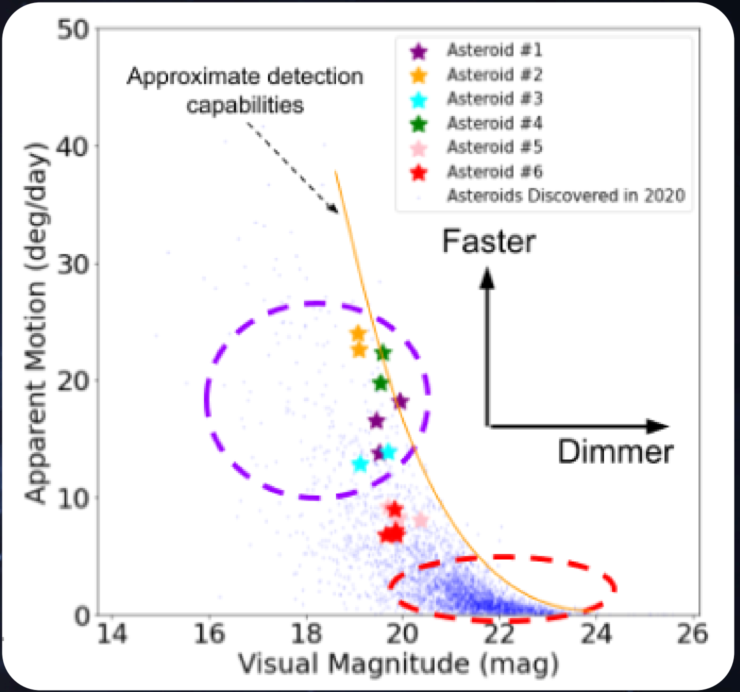
$$m = -2.5\log_{10}(\sum F_{ij}) + \mathrm{MAG}_{ZP}$$

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

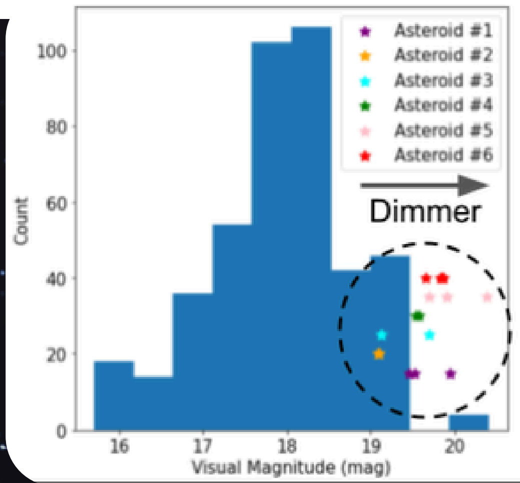
6) description of definitions
by Equation



STRIP SIMULATION PROCESS



- 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.



	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

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

КөрсеткішДəстүрі in My Drive

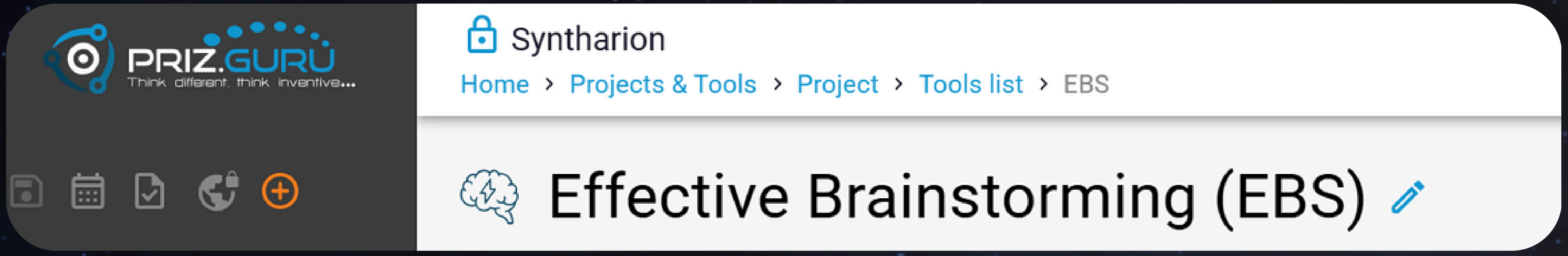
	A	B	C	D	E
1	Metric	Traditional Meth	SYNTHERION (Your Model)	Improvement	
2	Accuracy	84.80%	99.83%	+15.0 p.p. (≈17.7% increase)	
3	True Positive Ra	80.00%	97.00%	+17.0 p.p. (≈21.3% increase)	
4	False Positive R	15.00%	0.02%	99.9% Reduction	
5	Precision	21.90%	99.60%	4.5× Higher	
6	Processing Time	10 hours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

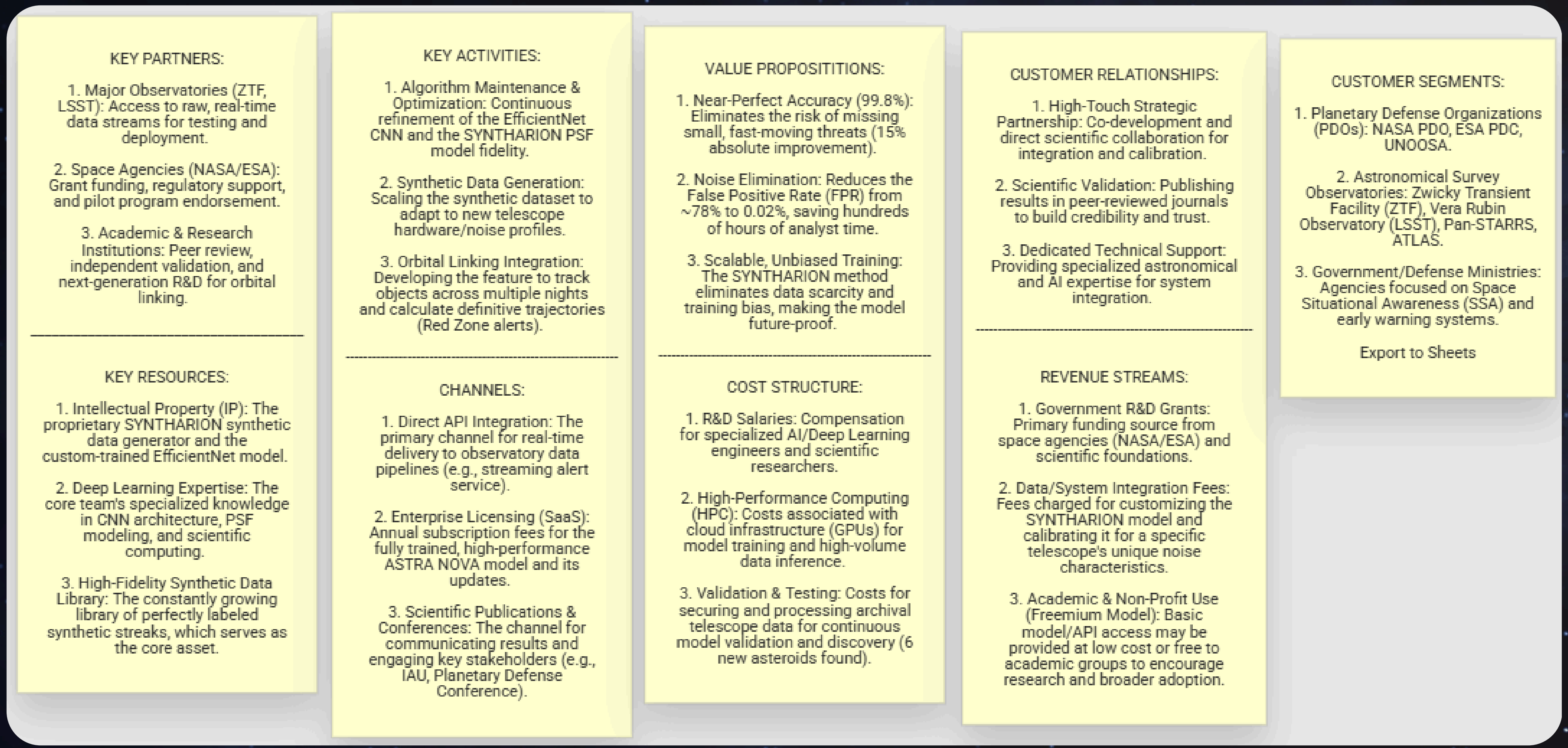
EFFICENCY

	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*



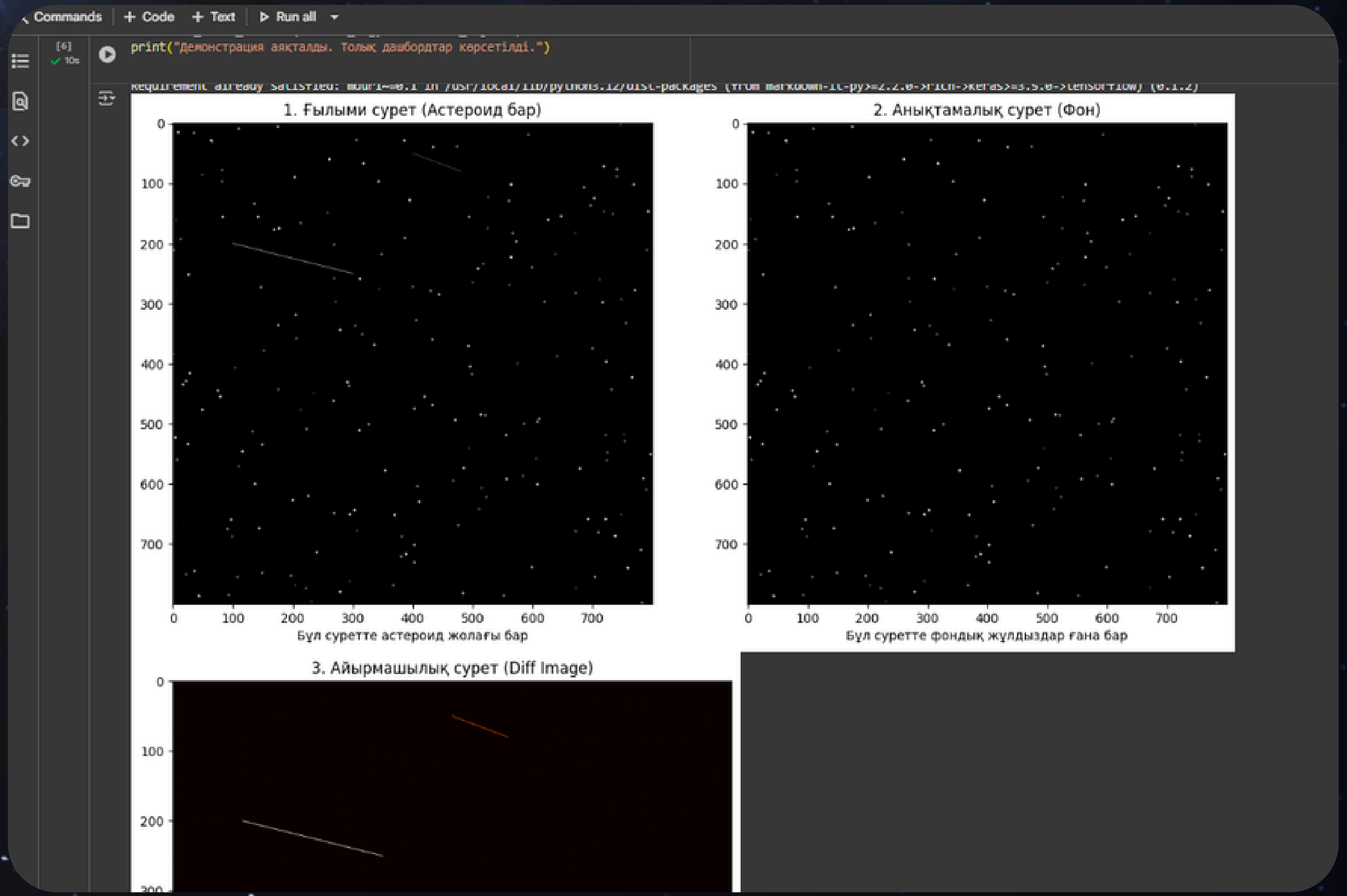


Project solves this problem by applying the **PRIZ Principle 17 (Moving to a New Dimension),** shifting the entire training process from the expensive, limited "Real Data Dimension" to the unlimited, zero-cost "Synthetic Data Dimension."

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.



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).

INTEGRATION

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

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.

QAZCOSMOS

KAZAKHSTAN SMART SPACE

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

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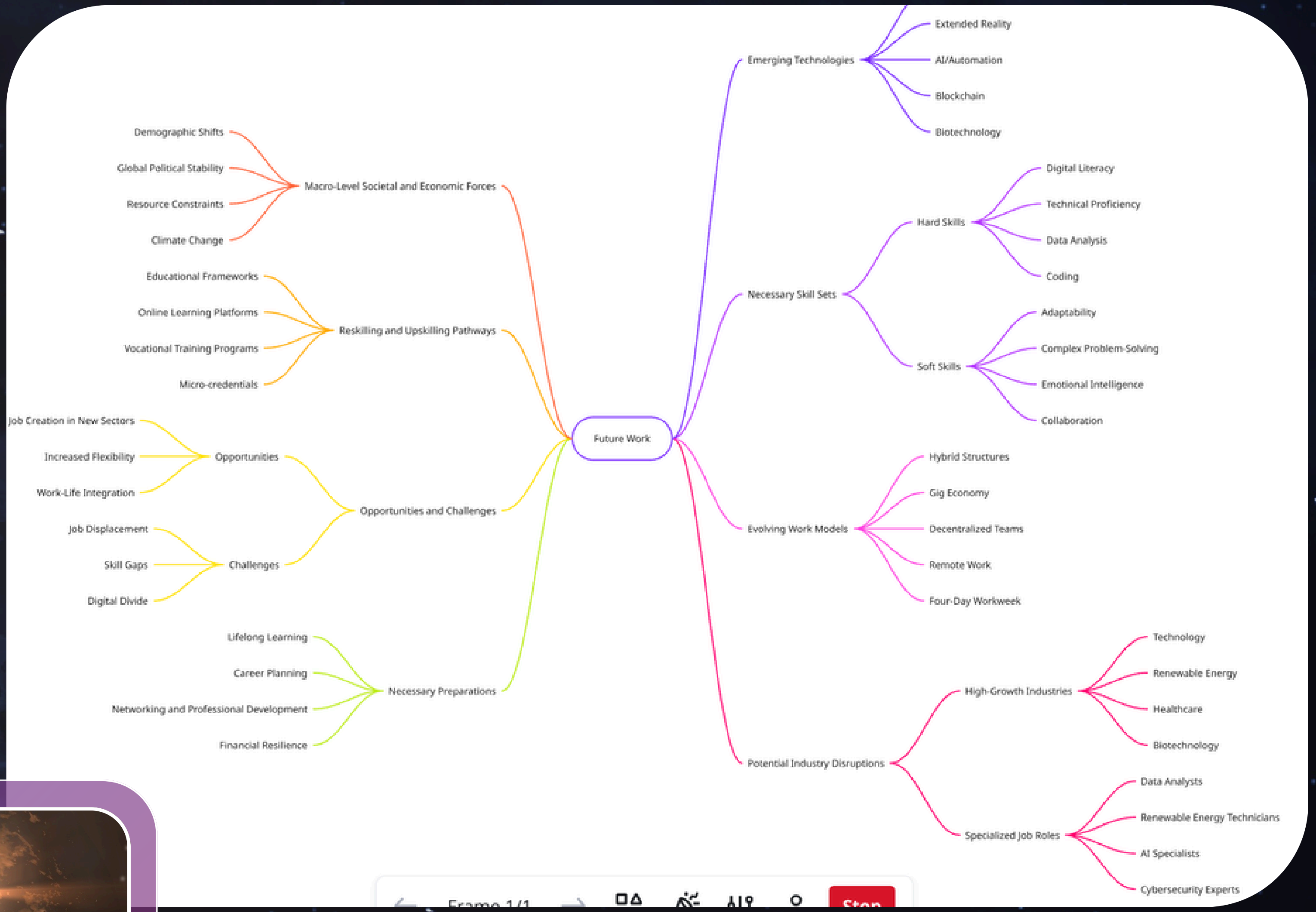
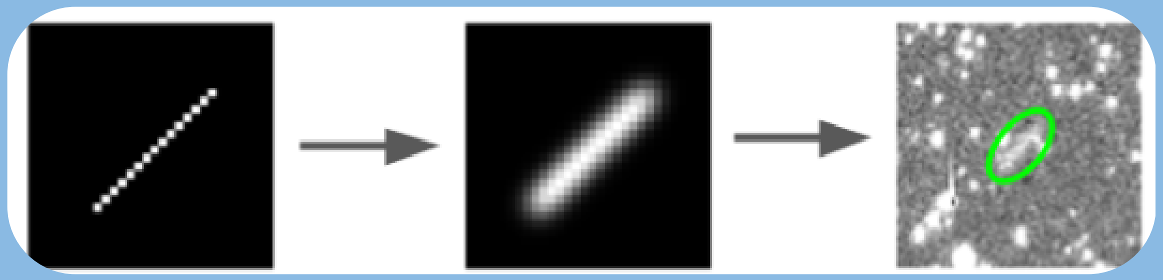
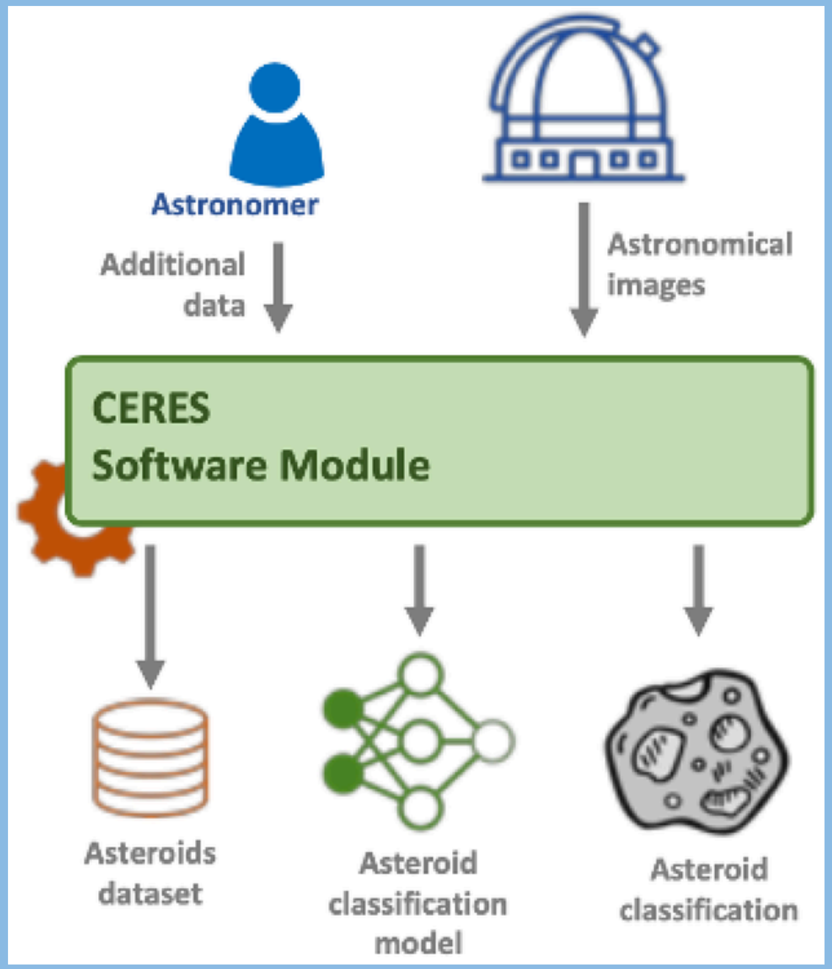
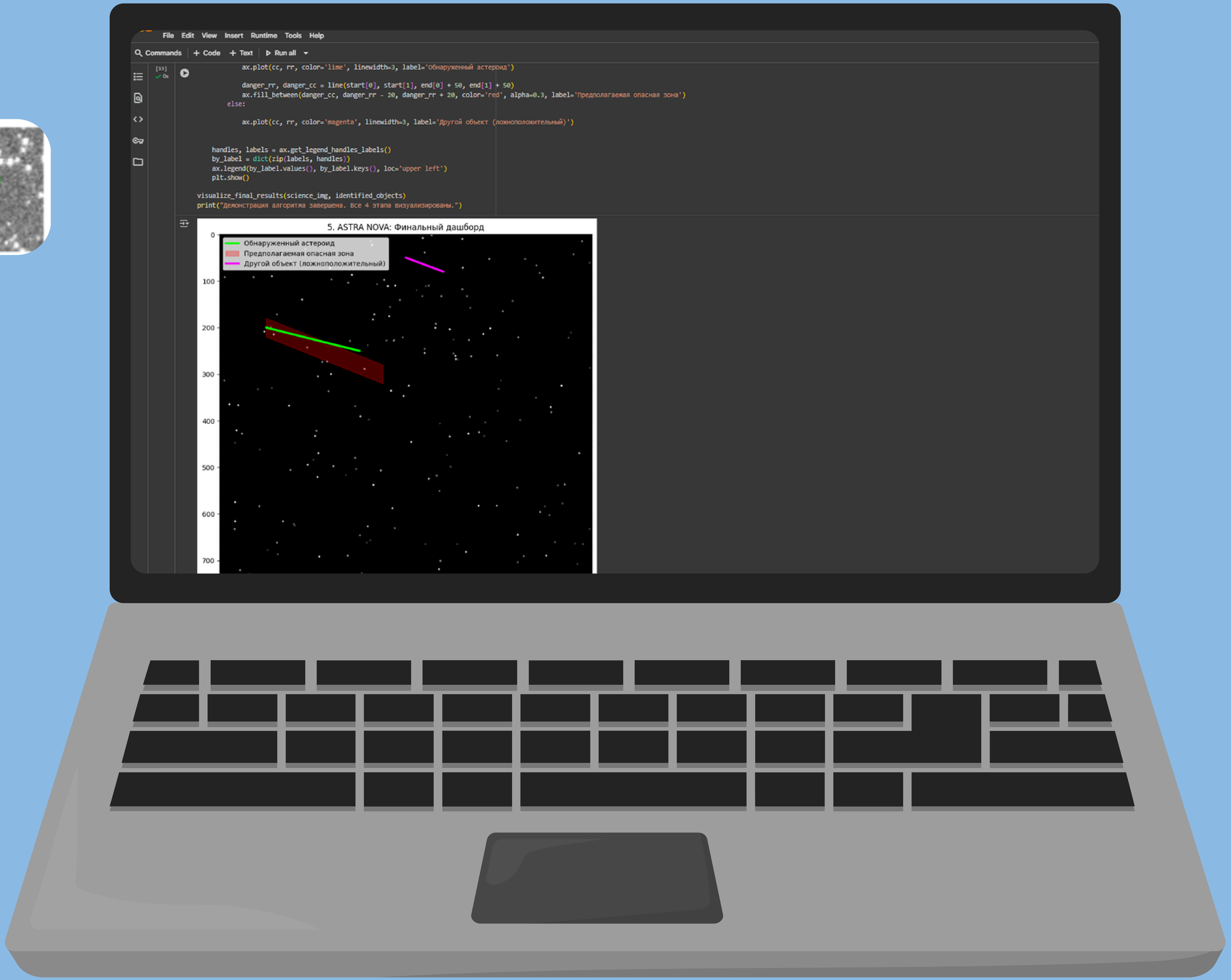


9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

8 DECENT WORK AND ECONOMIC GROWTH




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


File Edit View Insert Runtime Tools Help
Commands + Code + Text Run all
5. ASTRA NOVA: Финальный дашборд
Обнаруженный астероид
Предполагаемая опасная зона
Другой объект (ложноположительный)