Libre Space Foundation

What the hell was that?

Satellite Behavior Analysis with Machine Learning

Xabier Crespo Álvarez - Core Contributor of LSF

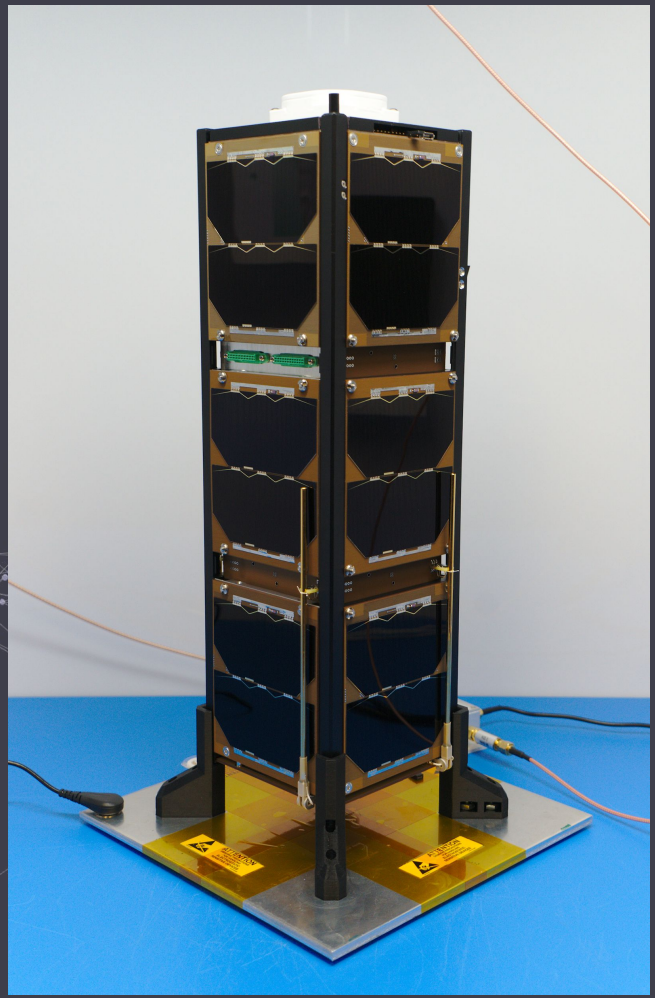
Polaris

MACHINE LEARNING & SATNOGS

Bobcat-1

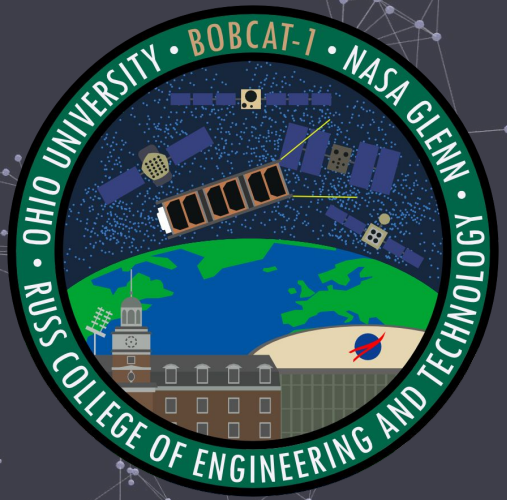
- 3U CubeSat in LEO
- Made by Ohio University in Athens, Ohio
- Launched on October 2nd in Antares rocket
- Put in orbit from ISS on November 4th

- Mission goals:
  - **Scientific**: measure GNSS inter-constellation timing offsets
  - **Education**: hands-on experience for students
  - **Outreach**: get students interested in space research



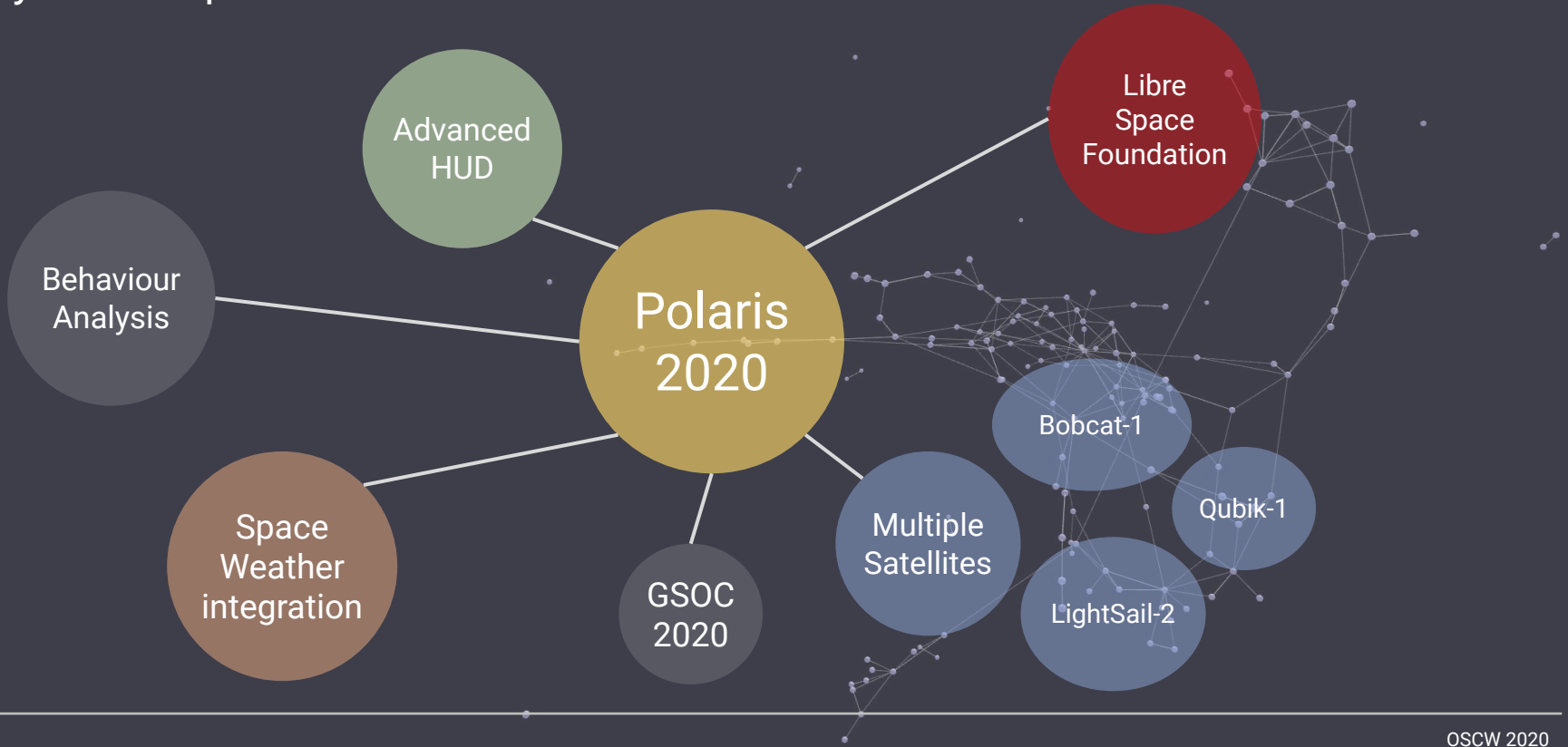
Bobcat-1 & LSF

- Fully integrated into SatNOGS
- 5000+ telemetry frames decoded so far
- Team active in SatNOGS community (dashboard)



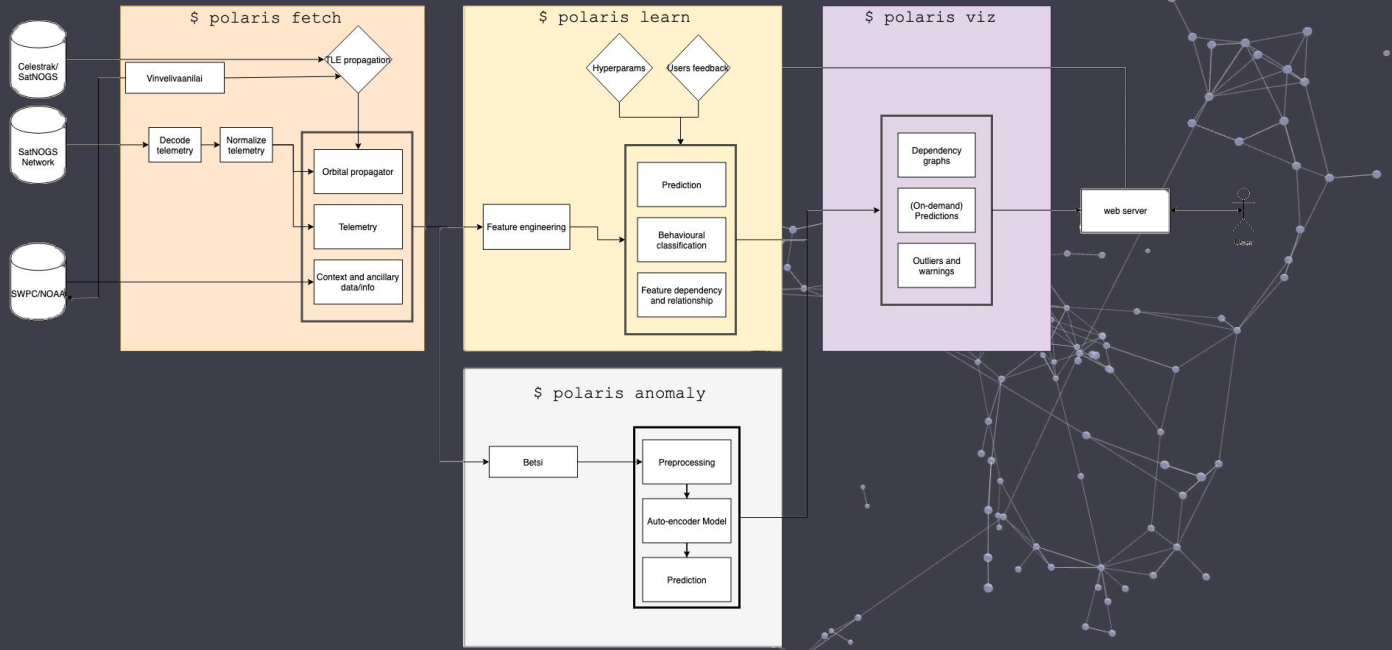
Polaris in 2020

A year of improvements



Polaris

Open Source ML for Spacecraft Diagnostic

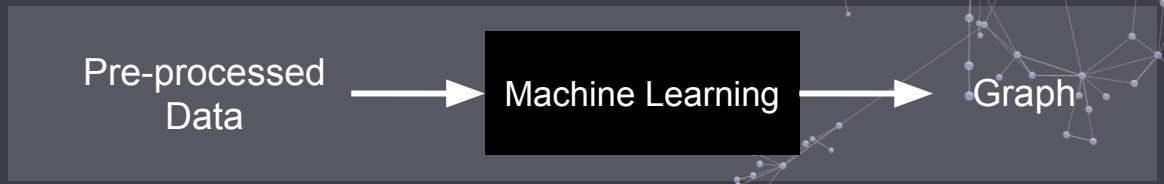


Source: https://gitlab.com/librespacefoundation/polaris/polaris/-/wikis/Overview

Polaris

Benefiting from a rich Python ML ecosystem

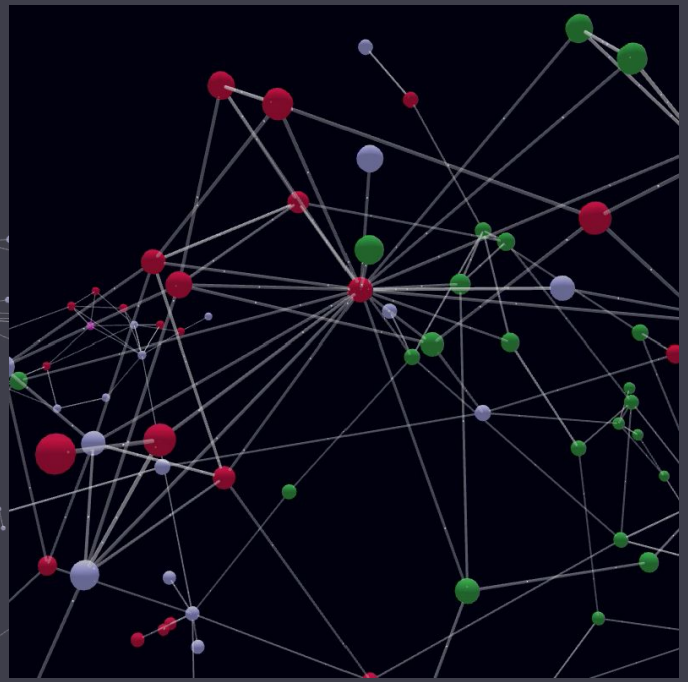
Action	Tool
Model	XGBoost (link)
Feature engineering	fets (link)
Logging	MLflow (link)
Hyperparameter tuning	GridSearchCV/scikit (link)



The Force of the Data

A 3D Graph for Dependencies

Item	Meaning
Nodes	Telemetry/feature
Links	Dependency
Dots	Degree of dependency
Number of connections	Level of significance
Color	Group (manual)



LightSail-2 Dependency Graph

What we came looking for...

Science data key parameters:

- CNR (Carrier to Noise Ratio)
- Gyroscope
- Magnetometer
- Sun Position Sensor

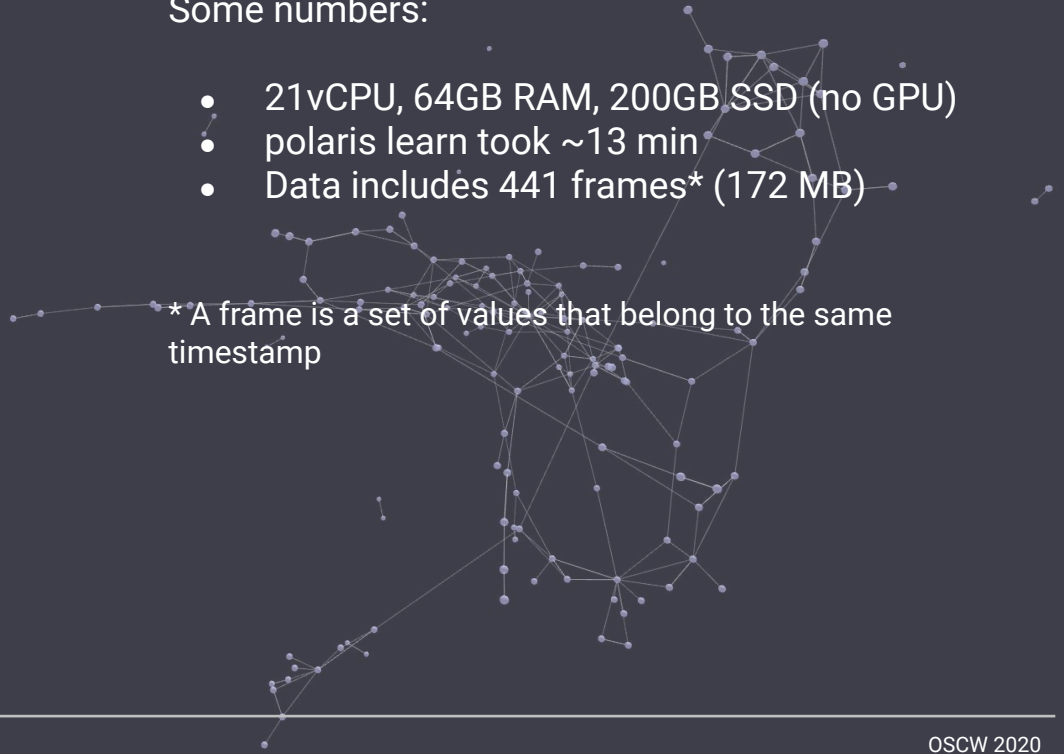
Space weather key data:

- DGD (Daily Geomagnetic Data)
- DSD (Daily Solar Data)
- DPD (Daily Particle Data)

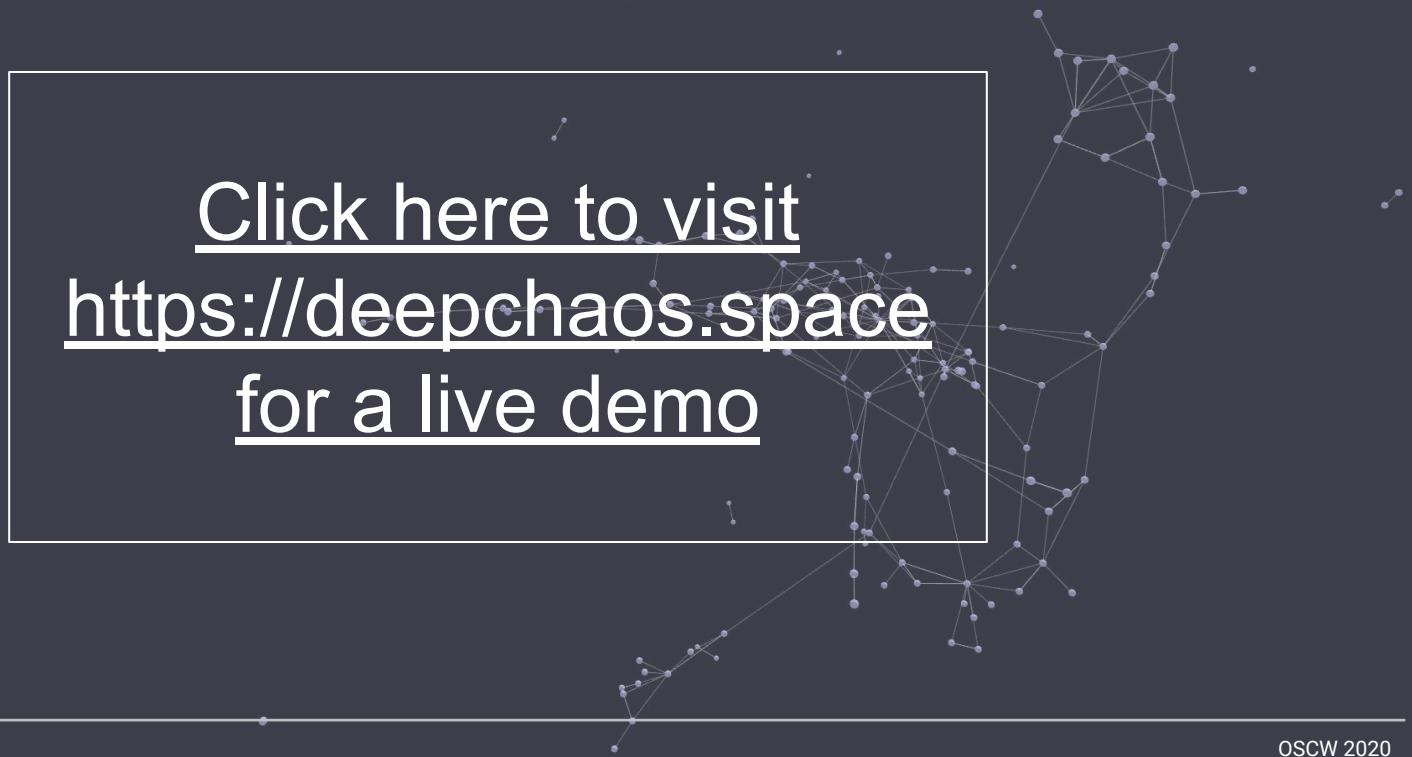
Some numbers:

- 21vCPU, 64GB RAM, 200GB SSD (no GPU)
- polaris learn took ~13 min
- Data includes 441 frames* (172 MB)

* A frame is a set of values that belong to the same timestamp



What we've obtained



Special thanks

Bobcat-1 team

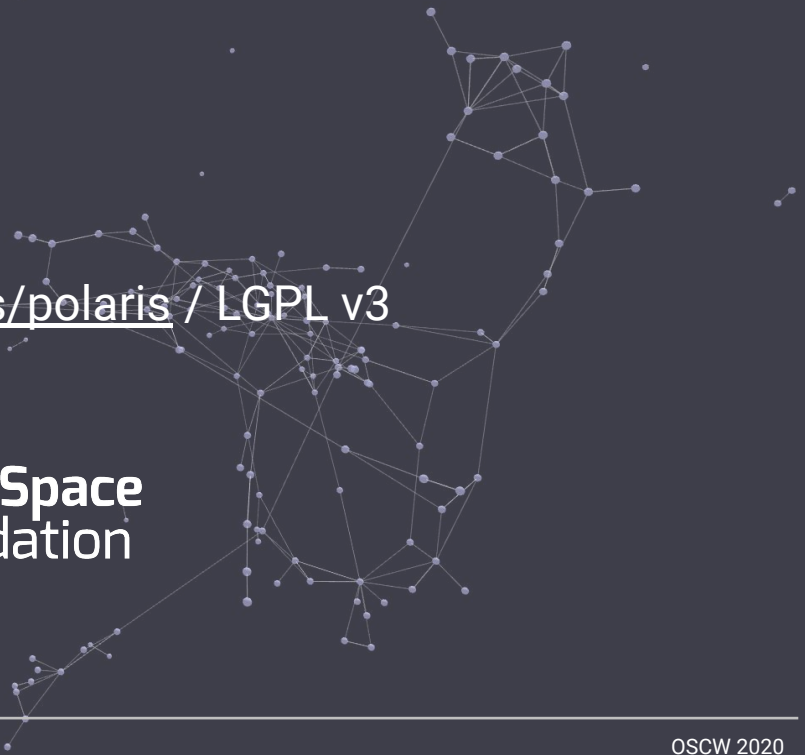
- Kevin Croissant
- Brian C. Peters

Polaris team

- Hugh Brown
- Jan-Peter Ceglarek
- Julien Flawinne
- Adithya Venkateswaran (GSoC 2020)
- Many more

Stay safe

...and if you want to run some self-diagnostics, use polaris



📧 xabi@libre.space

📢 riot.im/app/#/room/#polaris:matrix.org

🔍 gitlab.com/librespacefoundation/polaris/polaris / LGPL v3

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