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Center for Analysis Systems and Applications

Developing next-generation analysis capabilities

CASA

SOHBRIT

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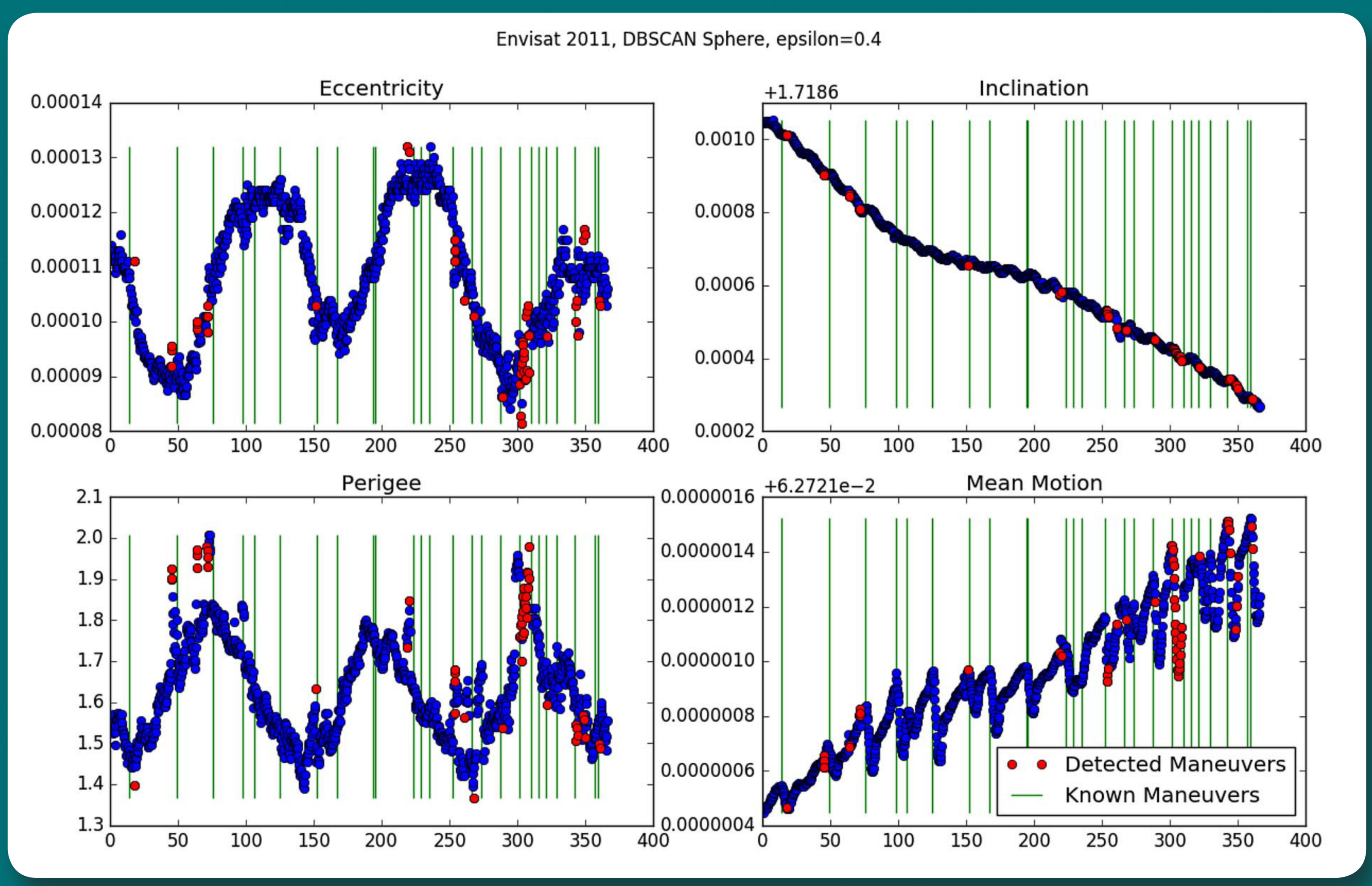
Problem Statement:

The SOHBRIT (Space Object Hyperspectral BRDF Imaging Telescope) project is focused on creating a fully autonomous pipeline for data acquisition and analysis. *Our portion of the pipeline is star and maneuver identification.* Star identification is the process of using the stars found in the field of view to perform calibration measurements such as location and scale. Maneuver identification involves the classification of anomalies found in data obtained in previous steps of the pipeline.

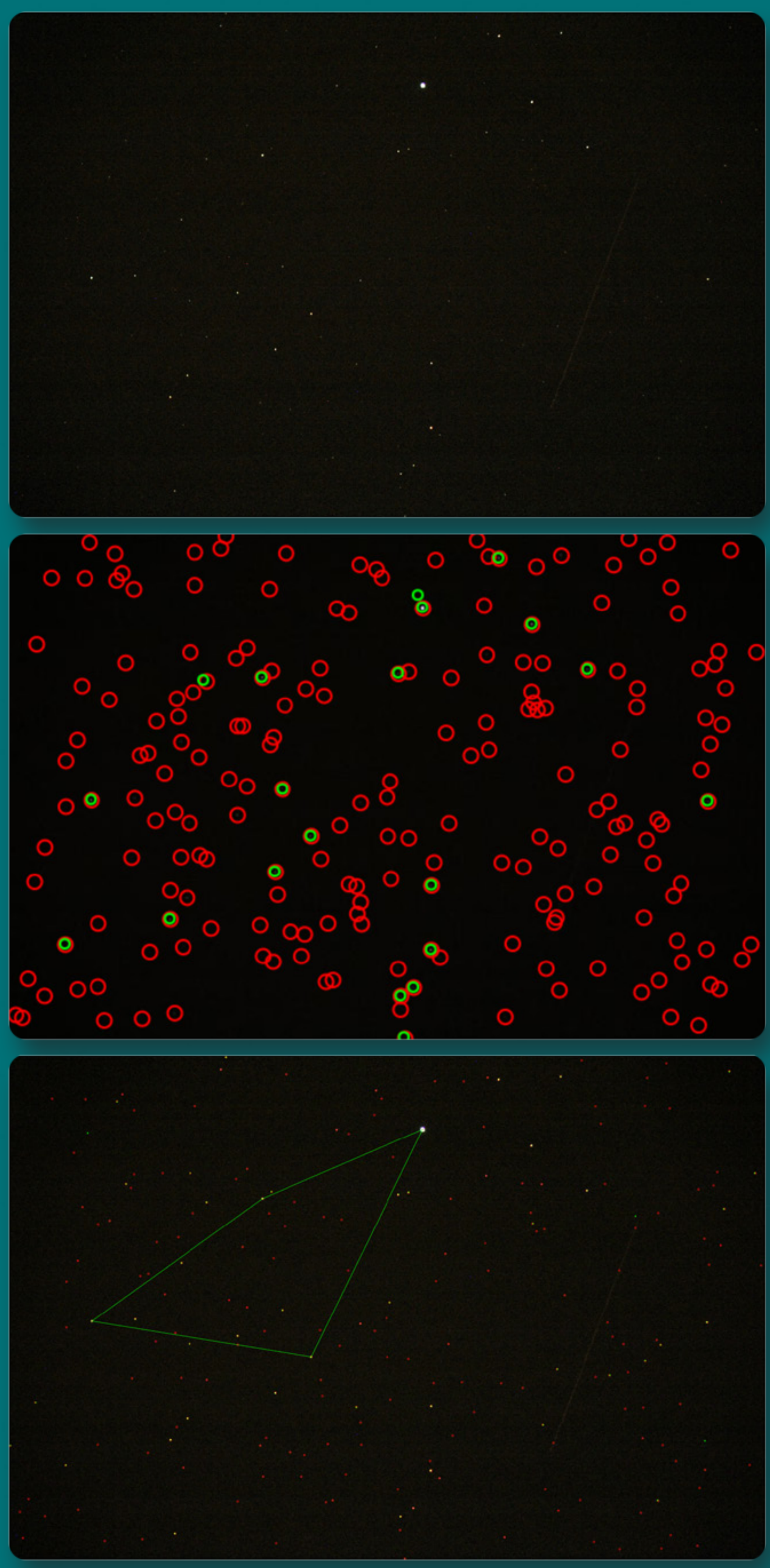


A plot showing various satellite data with the estimated and true maneuvers.

Objective and Approach:

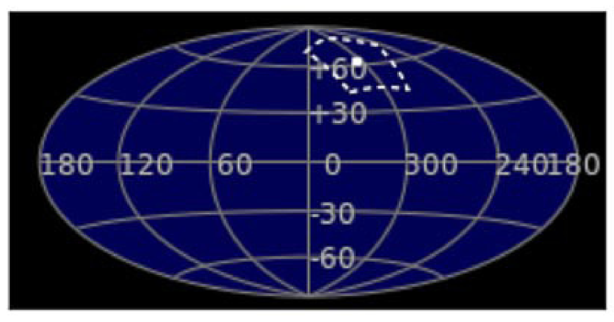
Given an image of arbitrary scale and orientation, we would like to be able to extract data such as the location in the sky, scale (arcseconds/pixel), distortion, and spurious sources with very high precision. The community standard for measurements such as these is currently the Astrometry.net codebase. *Our goal was to create a lightweight, flexible solution inspired by the Astrometry algorithms that is more accessible for cross-platform applications.*

To increase efficiency in maneuver related data, we wanted to create a library to retrieve data from an online database rather than files. To identify maneuvers, we looked at data, such as mean motion, inclination, eccentricity, and perigee. *Our goal focuses on improving machine learning anomaly detection algorithms that identify evidence of maneuvers.*



Calibration

Center (RA, Dec):	(305.211, 62.342)
Center (RA, hms):	$20^h\ 20^m\ 50.666^s$
Center (Dec, dms):	+62° 20' 31.578"
Size:	41.4 x 27.6 arcmin
Radius:	0.414 deg
Pixel scale:	0.479 arcsec/pixel
Orientation:	Up is 70.6 degrees E of N
WCS file:	wcs.fits
New FITS image:	new-image.fits
Reference stars nearby (RA,Dec table):	rdls.fits
Stars detected in your images (x,y table):	axy.fits
Correspondences between image and reference stars (table):	corr.fits
KMZ (Google Sky):	image.kmz



The star detection pipeline working on real data.

Results:

In the end, we were able to streamline the Astrometry algorithms in a way that allowed us to use them with a simple function call in Matlab.

We created a Python script to pull data from the TARDIS (TLE Analysis and Research Database Information Service) library to create an automated method of data collection. Using this data, we improved previously used supervised algorithms such as DBSCAN and One-class SVM, and optimized hyper-parameters to increase accuracy. Lastly, we began using supervised learning algorithms by creating training data and testing algorithms such as: random forest and linear discriminant analysis. *Comparing the methods, we were able to see an appreciable increase in accuracy and efficiency of the anomaly detection process.*

The 4", 11", and 16" telescopes that are responsible for collecting the data.