CLASSIFYING TESS LIGHT CURVES OF VARIABLE STARS WITH MACHINE LEARNING

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Introduction

- The Transiting Exoplanet Survey Satellite (TESS) launched in 2018 and produces optical light curves (brightness over time) across almost the entire sky
- Here I use machine learning to classify TESS light curves into different classes of variable stars (e.g., eclipsing binary, pulsator, etc.)
- Classifications will be used for a complementary anomaly detection project, which will search for light curves that may be either members of rare or unknown variable types or candidates for transiting megastructures (SETI interest)
- Goal: classify 3+ variable types, each with 90%+ accuracy, on sectors 1-26 of TESS data

Methods

- First variable type: eclipsing binaries (EBs) from Villanova *Kepler* catalog (2922 objects)
- Data cleaning: converted to TESS IDs, restricted to TESS sector 14 (for constant systematic effects) and kept only those between TESS magnitude 10 and 15. Left with 2172 objects
- Summarized light curves into 29 numerical features with Cesium
- Machine learning with scikit-learn: support vector, random forest, and k-nearest neighbors classifiers on EB vs. non-EB. Grid sweeps over hyperparameters with Weights & Biases

Results

- Maximum accuracy around 80% with each of three classifiers
- Precision typically between 0.7-0.8, recall up to approximately 0.9

Discussion/Next Steps

- Current performance leaves room for improvement
- Filter out known long-period EBs from data (may not be detectable as EBs from TESS) -- this should improve accuracy, hopefully past 0.8
- Try other premade and custom features on light curves (e.g., m-statistic)
- Classify other variable star types (next: flare stars)
- Strategic Minority Oversampling Technique (SMOTE) for fixing imbalanced data
- Experiment with other classifiers (including neural networks)

References

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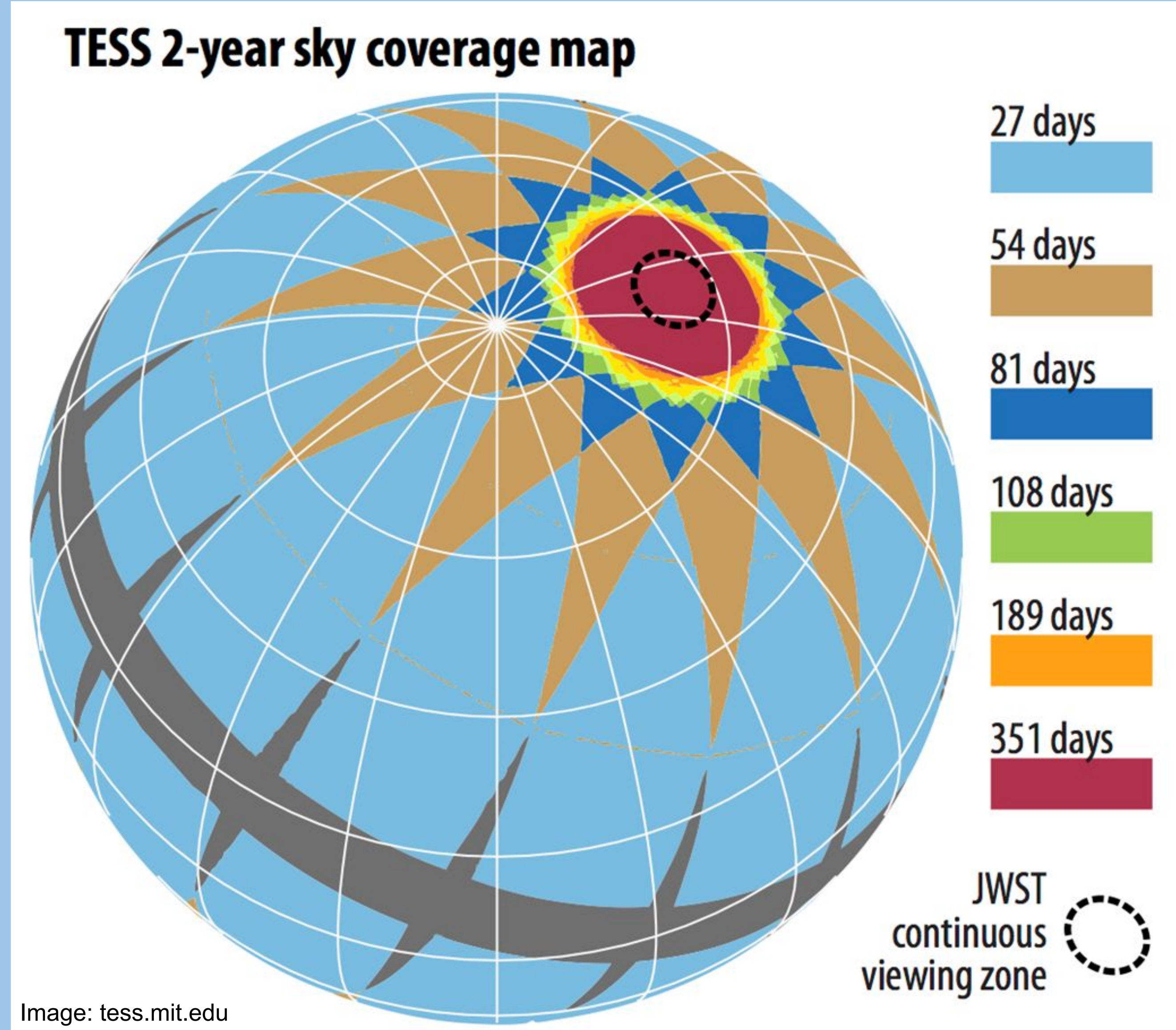
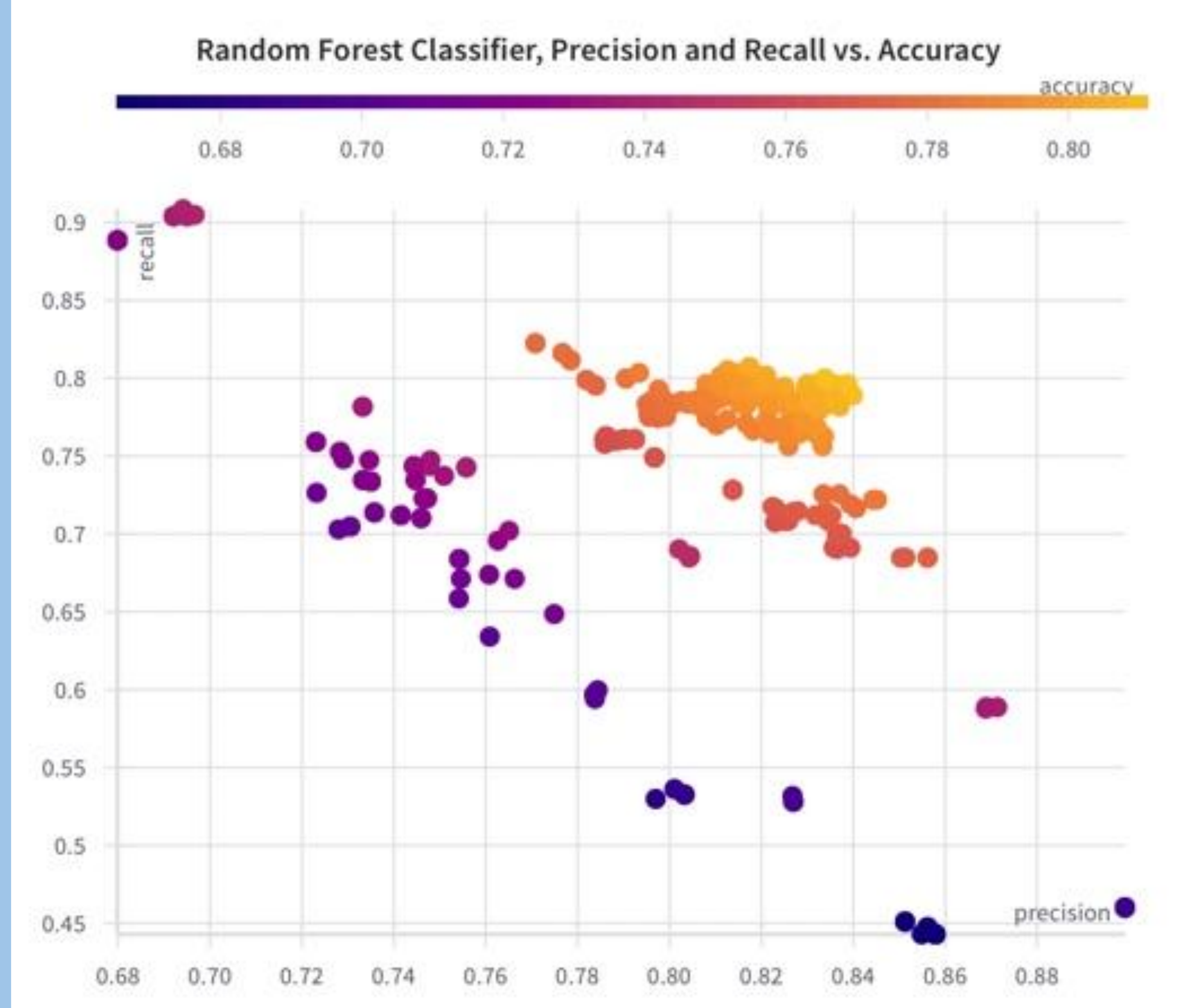
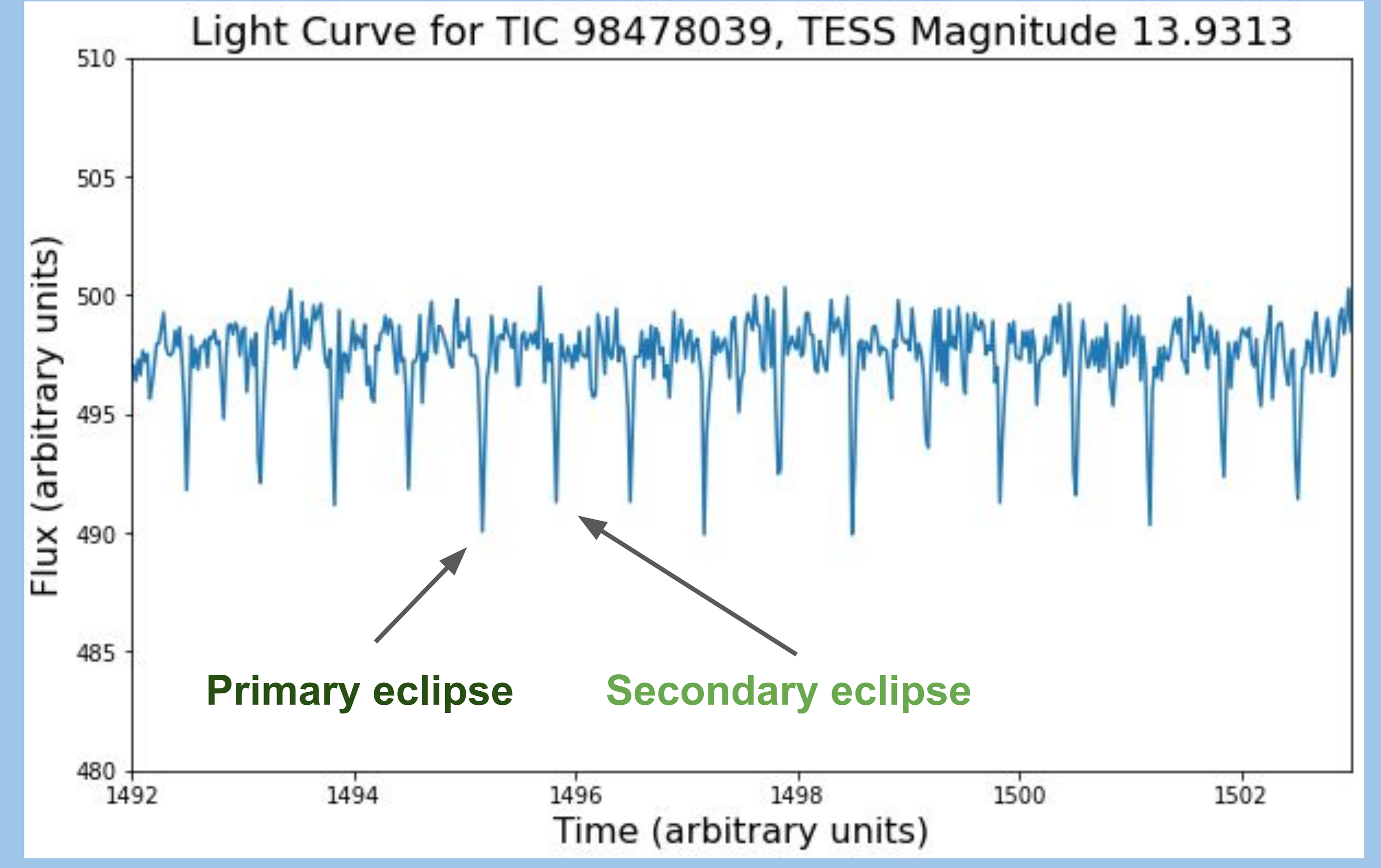
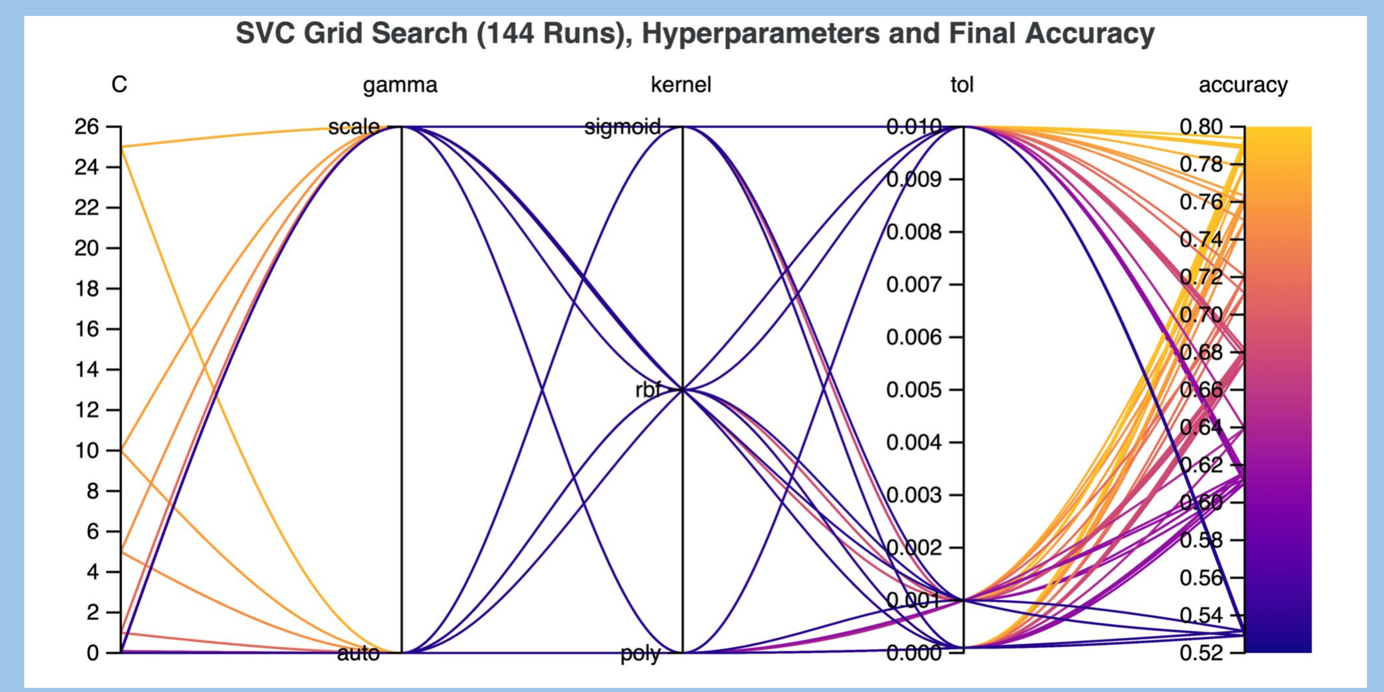
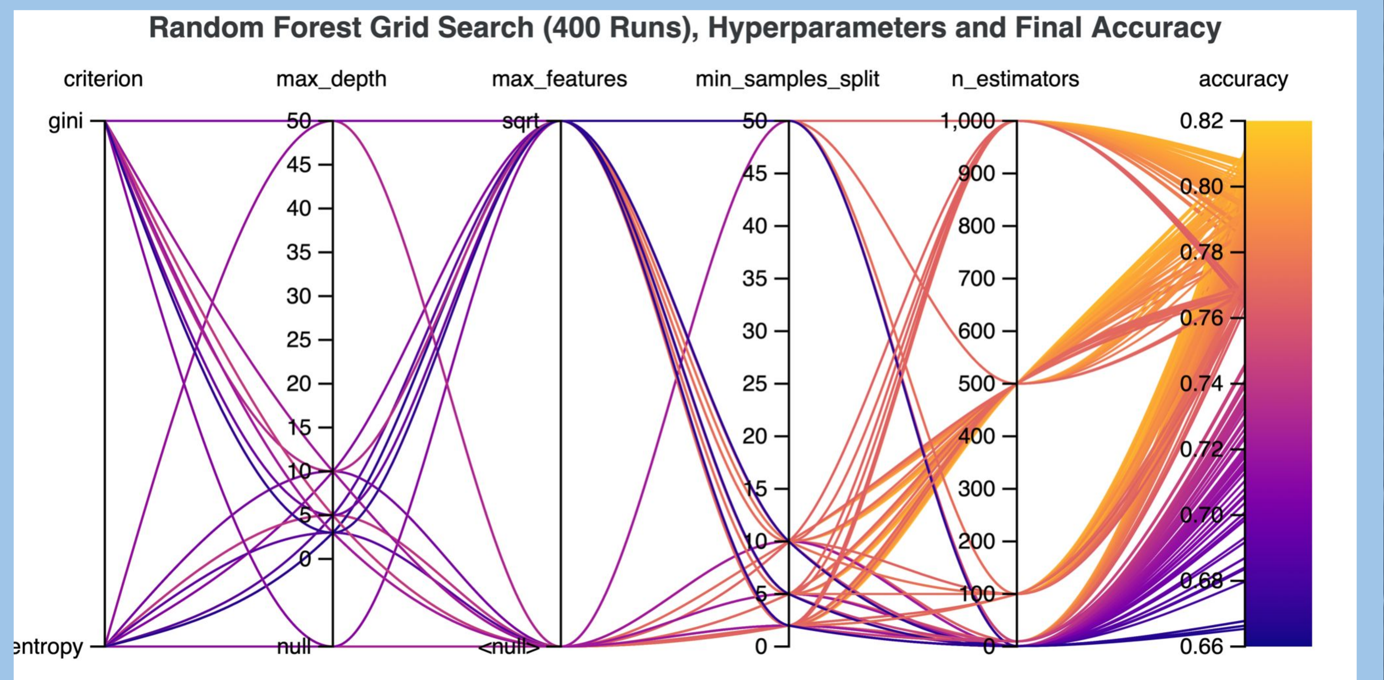


Image: tess.mit.edu









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