Searching for Anomalies in the ZTF Catalog of Periodic Variable Stars

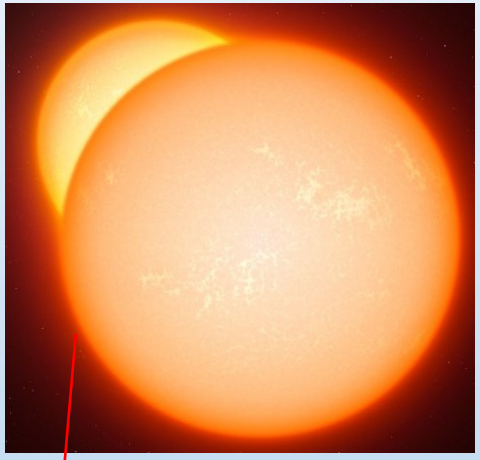
Periodic variable stars (PVSs)

Image credit: astro.wisc.edu

Intrinsic

Or

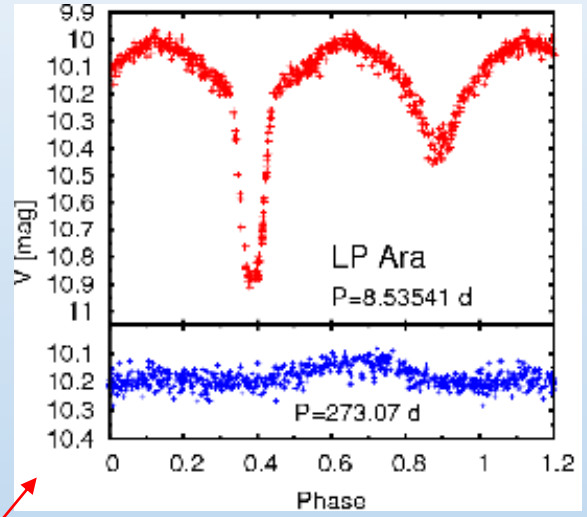
Image credit: newatlas.com



Extrinsic

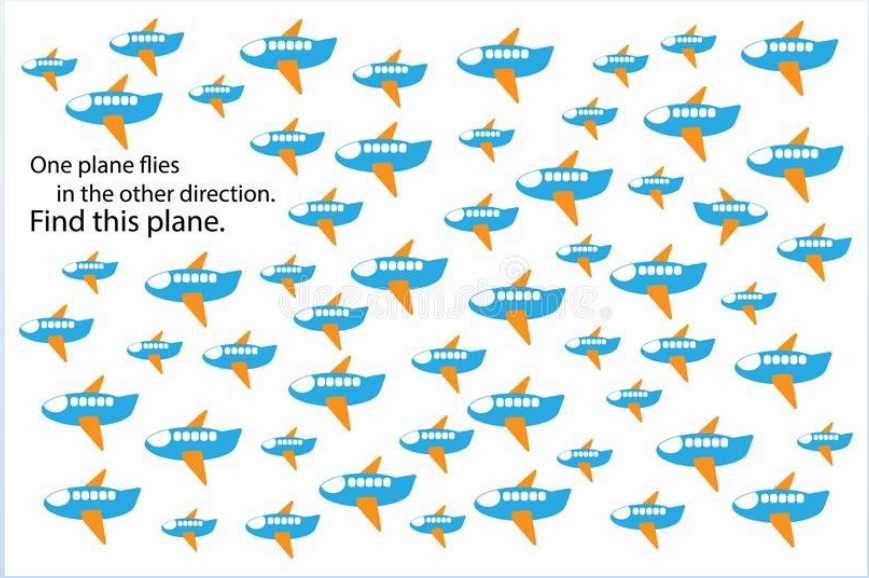
Produce

Image credit: Michalska et al. (2009)



- Periodic variable stars → brightness changes periodically
- Source: Pulsations, eclipsing, and more …
- The physics of sources encoded in their light curves
- Search for wild cats → new discoveries

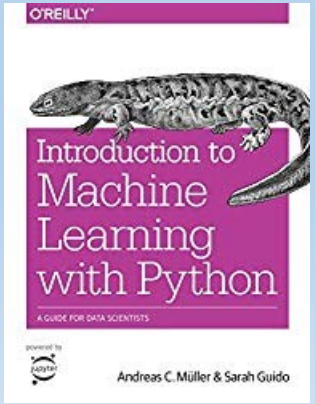
How to tackle the problem ? Machine Learning!



LSST – Commence in 2023

20 TB data/night.

- When the candidate number is small – scan one by one
- What if the number increase exponentially?



- Machine learning would be a reliable and automatic method!

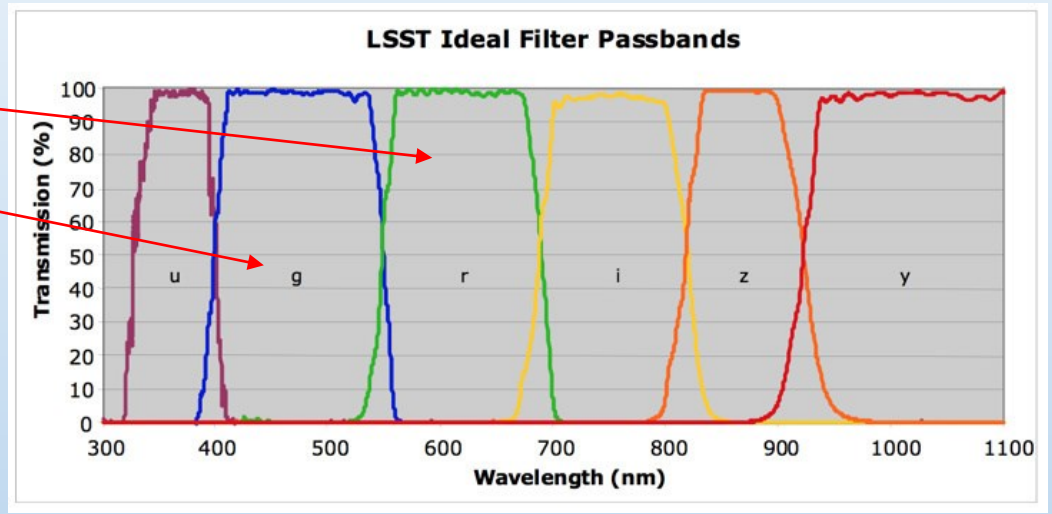
Aim – Use ML to search for anomalous PVSs

Data pre-processing – Feed meaningful info to machine

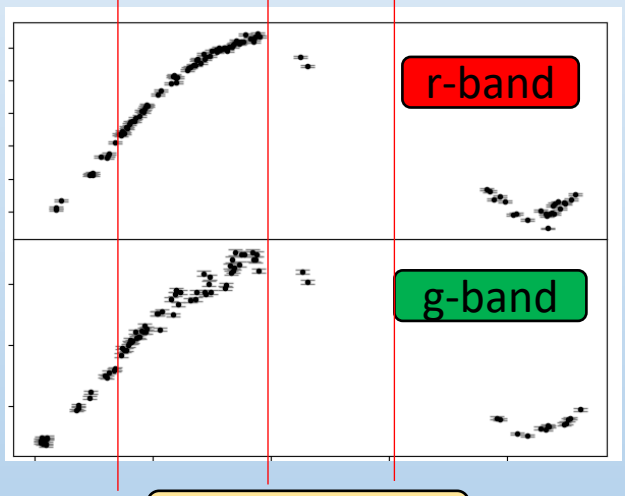
The Zwicky Transient Facility Catalog of Periodic Variable Stars

Xiaodian Chen[1], Shu Wang[1], Licai Deng[1], Richard de Grijs[2,3,4], Ming Yang[5], and Hao Tian[6]

- Data are given in g- and r- band filters



Raw Detections

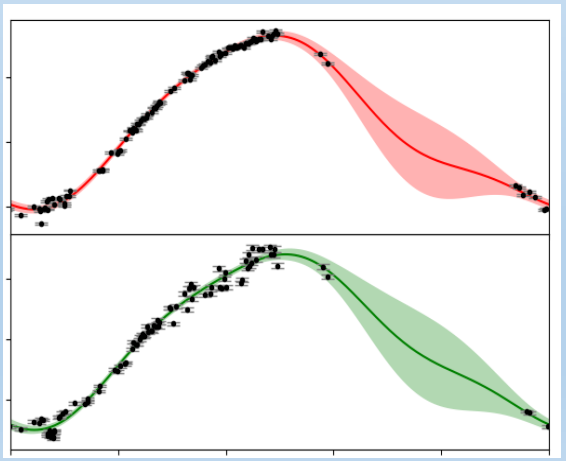


Phase-Folding

$$\phi = \frac{t}{\tau} - \left[\frac{t}{\tau}\right]$$

Period

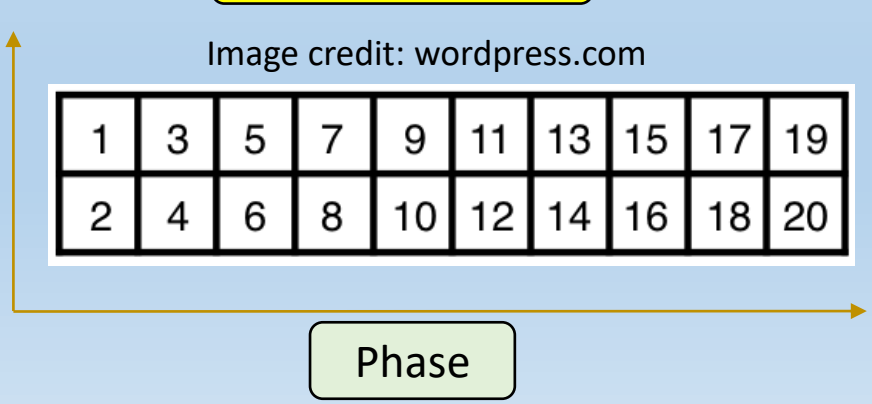
Multivariate-GPR



Normalised

Stacked "Images"

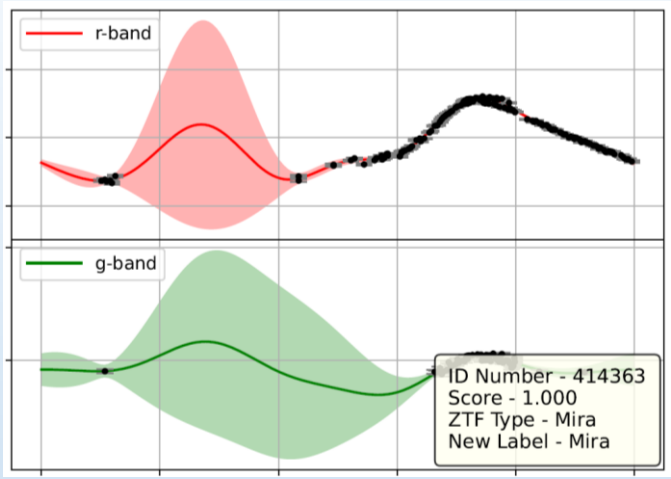
Image credit: wordpress.com

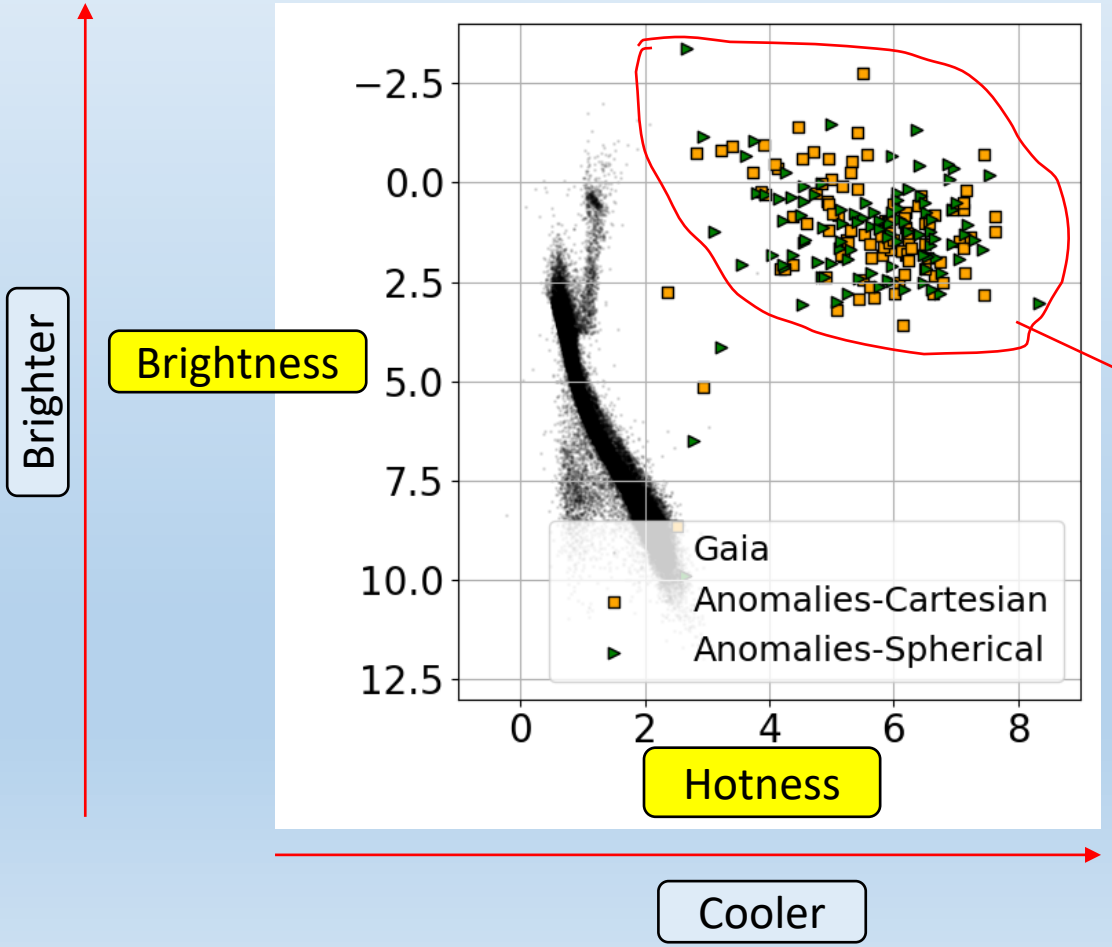


The Anomalies

- Anomalous periodic variables are
  - Irregular oscillating
  - High variability

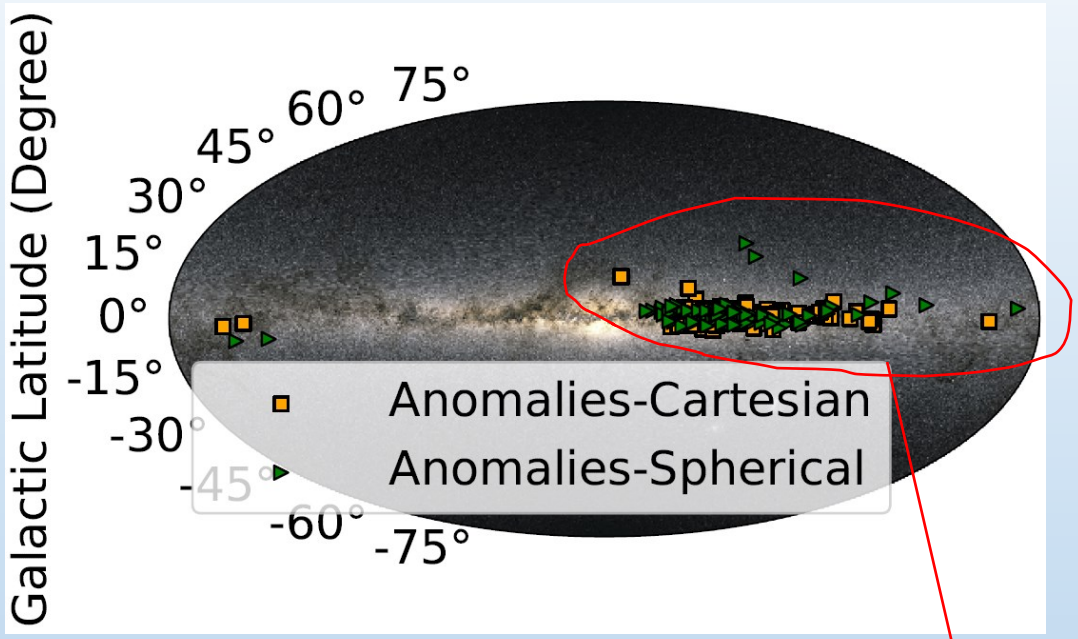
Illustrations





- Plotted HR-Diagram
- Anomalies are
  - Brighter
  - Cooler
- Corresponds to evolved stars In their late phase of evolution

The Anomalies



- Located in the vicinity of the Galactic disk
- Younger (with respect to the Galactic age)

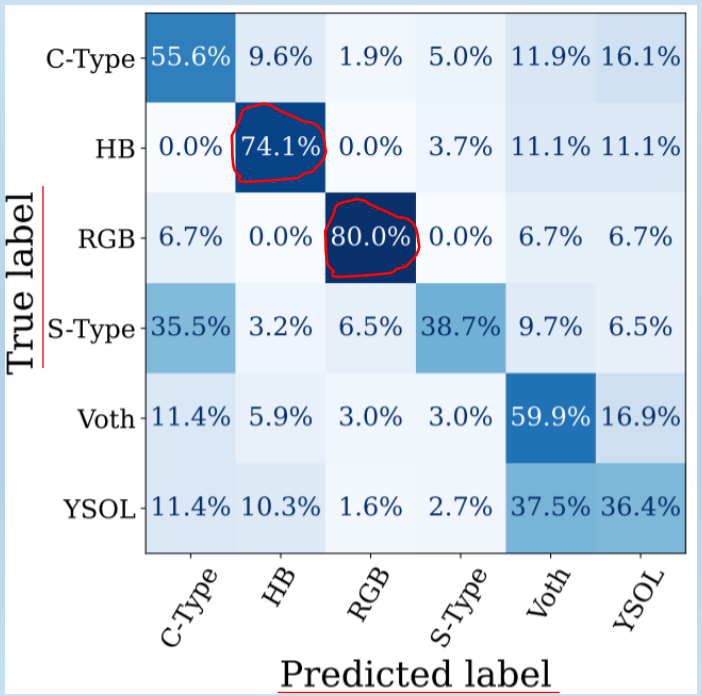
LSST

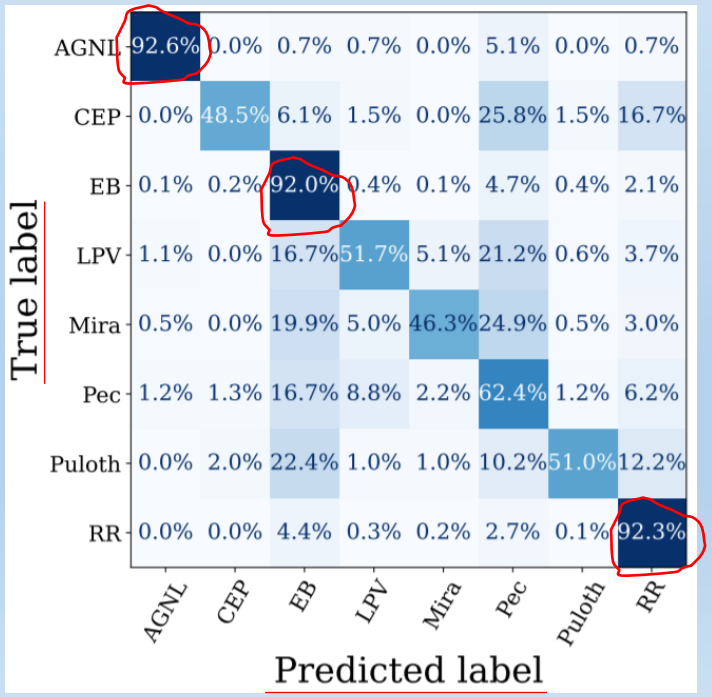
Image credit: symmetrymagazine.org

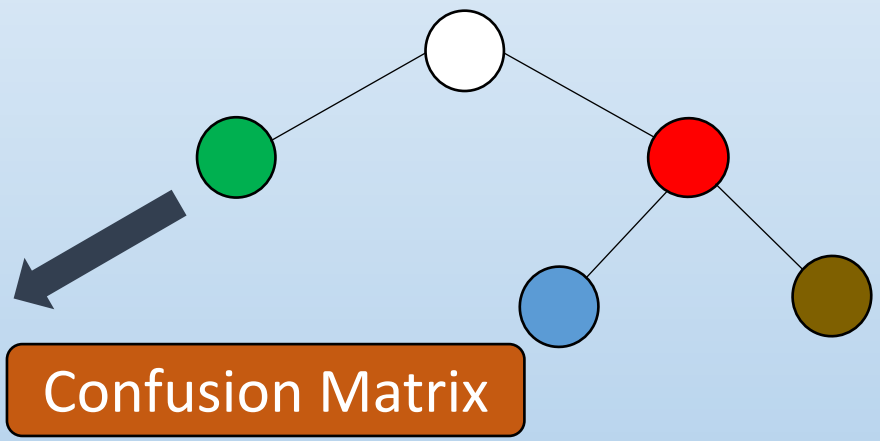
Detailed Spectroscopic Follow-Up Is Strongly Recommended!

Classifications Using The SIMBAD Labels

- Class labels from the SIMBAD catalogue
- Reliable but more expensive







- Good accuracy for SOME classes

Conclusion

I showed the application of machine learning in Astronomy for …

1. Detecting anomalous periodic variable stars
2. Building classification model for periodic variable stars

Thank You