Variable object classification for the third Gaia Data Release (DR3)

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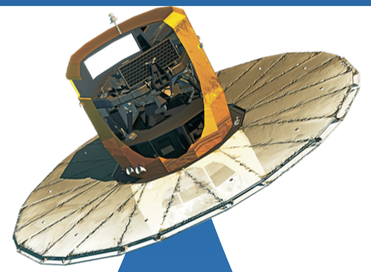
Preparation

- **Crossmatching**
  - >150 catalogs
  - ~8 M sources
  - ~100 (sub) types
  - based on positional and magnitude difference
- **Training set for General Variability Detection**
  - 2 types: 60 K 'variables' and 63 K 'others'
- **Training set for General classification**
  - 40 type groups: 60 K variables

Execution

- **Classifier framework H2O** (www.h2o.ai)
- **General Variability Detection**
  - XGBoost: binary classifier
  - Completeness: 99%
  - Contamination in variables: 0.4%
- **General classification**
  - About 100 one-vs-rest classifiers *for each variable type* using XGBoost (XGB) and Distributed RandomForest (DRF).
  - Several multi-class classifiers using XGB and DRF.
  - Several DRF *meta-classifiers* combining the one-vs-rest or multi-class classifier results.
- **Main challenge: very unbalances variability types**



1.8 billion sources

4-band time series:
G_{CCD}: 365 billion obs
G_{BP}: 46.6 billion obs
G_{RP}: 48.4 billion obs
RV: 565 million obs
+ astrometric param.

Statistical parameters

General Variability Detection
supervised classification

Period search and modelling

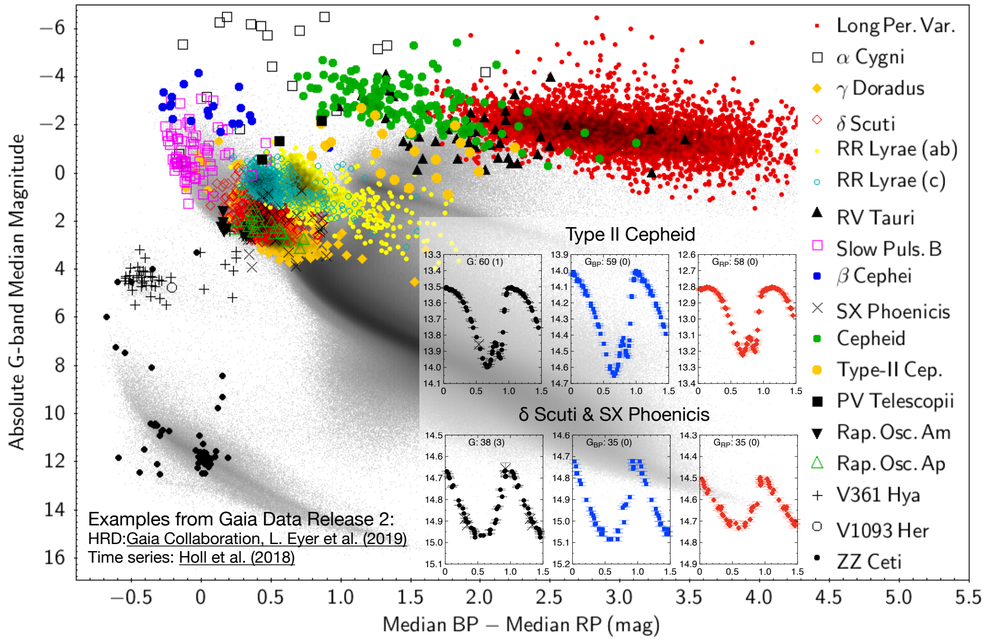
General
supervised classification **25 types**

Active Galactic Nuclei	RR Lyrae star
Main-seq. oscillators	Eclipsing binary
Long Period Variables	Planetary transit
Compact companions	Cepheid

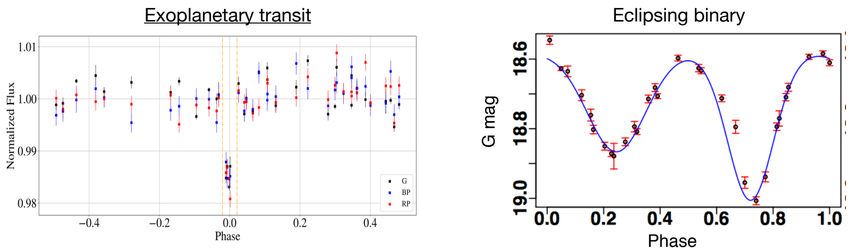
Specific Object Studies

Verification & Validation

Systematic semi-automated procedure for each class (incl. literature comparison)



Example light curves from Gaia images of the week:



Results

- To be published in Gaia DR3 (mid 2022)
- About 11 million variables
- 24 variability types + galaxies

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