ALeRCE broker: current status and demo


http://alerce.science/
Outline

- Introduction
- Goals
- Team / Methodology
- Infrastructure
- Machine Learning

- Demo
  - Web Interfaces
  - API
  - Jupyter notebooks
Future time domain astronomy ecosystem

Survey telescopes

Alert brokers/TOMs + other brokers/TOMs

Follow up telescopes
Astronomical infrastructure in Chile

Cerro Armazones
European Extremely Large Telescope

Cerro Paranal
Very Large Telescope, VLT, Survey Telescope, Vista Survey Telescope

Cerro las Campanas
Giant Magellan Telescope

La Silla Observatory
several telescopes
Cerro Tololo
several telescopes

Cerro Pachón
Large Synoptic Survey Telescope, others

Magelleni

CCAT

GMT

CTA

VISTA

LSST

E-ELT

TAO

VLT

SOAR

Gemini

ALMA

CTIO

La Silla

Chilean institutions: access to ~10% observing time
ALeRCE is a Chilean-led initiative to build a community broker for LSST and other large etendue survey telescopes.
Goals

To facilitate the study of non-moving, variable and transients objects:

- **Fast classification** of transients, variable stars and active galactic nuclei
- **Flexibility** to adapt to different science cases (taxonomy, data products)
- **Connect** survey and **follow up** resources in Chile and abroad
Scientific Questions

Transients

Variable Stars

Active Galactic Nuclei
Agile Methodology

- Daily meetings + 2 weeks sprints
- Product owner
- Kanban / Backlog
- Weekly ML/training set meetings

Javier Arredondo, Ernesto Castillo, Francisco Forster, Diego Rodríguez, Daniela Ruz, Ignacio Reyes, Camilo Valenzuela
ALeRCE infrastructure

- Distributed Storage
- Distributed messaging
- Services
- Distributed database
- Container orchestrator
ALeRCE infrastructure

Distributed Storage

Services

Distributed database

Container orchestrator

Distributed messaging

AWS

Apache Kafka

PostgreSQL

cassandra

docker

kubernetes
ALeRCE pipeline
ZTF Data Model

Diagram:
- ASTRONOMICAL OBJECT
  - DETECTIONS
  - NON DETECTIONS
  - XMATCH
  - FEATURES
  - PROBABILITIES
    - EARLY CLASSIFICATION
    - LATE CLASSIFICATION
Classification

- Current Classifiers:
  - Convolutional Neural Network (stamps)
  - Random Forest (light curve)

- Future Classifiers:
  - Domain Adaptation
  - Data Augmentation
  - Outlier Detection
  - Forecasting
Late Classifier

Convolutional Neural Network
(using first stamps)

*Classes:* AGN, SN, VS, asteroid, bogus

Random Forest
(using light curve, at least 5 observations)

*Classes:*
- **Stochastic:** AGN-I, Blazar, CV/Nova
- **Transients:** SNe Ia, SNe Ibc, SNe II, SNe IIn, SLSNe
- **Periodic stars:** EBSD/D, EBC, DSCT, RRL, Ceph, LPV, Periodic Other
Detection Threshold

$P_{\text{class } i(t_0)}$
Convolutional recurrent neural network

Detection Threshold

$P_{\text{class } i}(t_0)$

Carrasco-Davis+18
PASP
Training vs domain overfitting

Carrasco-Davis+18
PASP
Summary

- **Goals:**
  - Fast classification: transients, variable stars and AGN
  - Flexibility to adapt to different science cases
  - Connect survey and follow up

- **Interdisciplinary team:**
  - Machine Learning
  - Astronomy
  - Computer Science

- **Infrastructure:**
  - Modular / Distributed / Robust

- **Machine Learning:**
  - Classification: CNN / Random Forest
  - Outlier Detection
  - Domain Adaptation / Data Augmentation
  - Forecasting
DEMO
http://alerce.science
Web Interfaces

API

Jupyter Notebooks

ALeRCE
Automatic Learning for the Rapid Classification of Events

http://alerce.science

Output stream
(real-time follow-up)

TOMs
Web Interfaces

ZTF Explorer
http://alerce.online

SN Hunter
http://snhunter.alerce.online
SNe reported by ALeRCE

![SNe reported by ALeRCE with at least two detections](chart.png)

- **1st detection**
- **2nd detection**

**Time between detection and last non-detection [days]**

**Z**
API

- ZTF Database: [http://ztf.alerce.online](http://ztf.alerce.online)
- Avro/Stamps: [http://avro.alerce.online](http://avro.alerce.online)
- catsHTM Cone Search & Xmatch: [http://catshtm.alerce.online](http://catshtm.alerce.online) *

* Soumagnac & Ofek (2018), (Ofek 2014; ascl.soft 07005)
Jupyter Notebooks

https://github.com/alercebroker/usecases/tree/master/notebooks

- API
- Transients
- Variable Stars
- Active Galactic Nuclei