



ALeRCE

Automatic Learning for the
Rapid Classification of Events



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Förster+2020, Carrasco-Davis+2020, Sánchez-Sáez+2020, <http://alerce.science/>

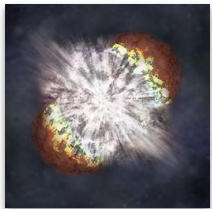




ALeRCE is a Chilean-led initiative
to build a community broker for
LSST and other large etendue
survey telescopes



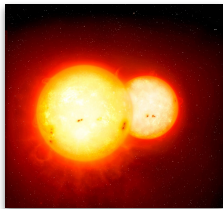
Scientific questions



Transients

Progenitors of stellar explosions (outermost layers) & explosion physics (ejecta structure).

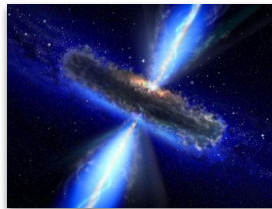
How does the Universe expand?



Variable stars

Microlensing events, changing mode stellar pulsators, rapid reaction to eclipsing events, eruptive events.

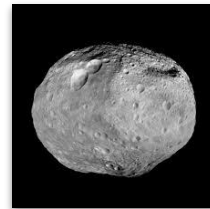
How is matter distributed in our galaxy?



Supermassive black holes

Changing state AGNs, reverberation mapping, detection of intermediate mass black holes, tidal disruption events.

How do black holes affect the evolution of galaxies?



Asteroids

Near earth objects, size distribution, collisional or rotational disintegration.

How was the solar system formed?



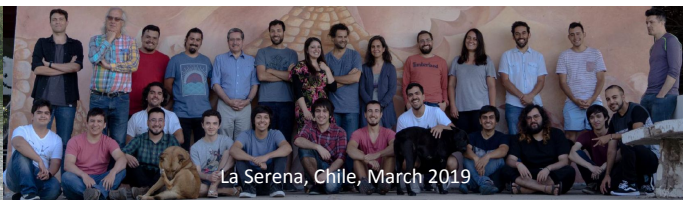
ALeRCE

>2000 users from >50 countries (Google Analytics)

Valdivia, Chile, November 2018



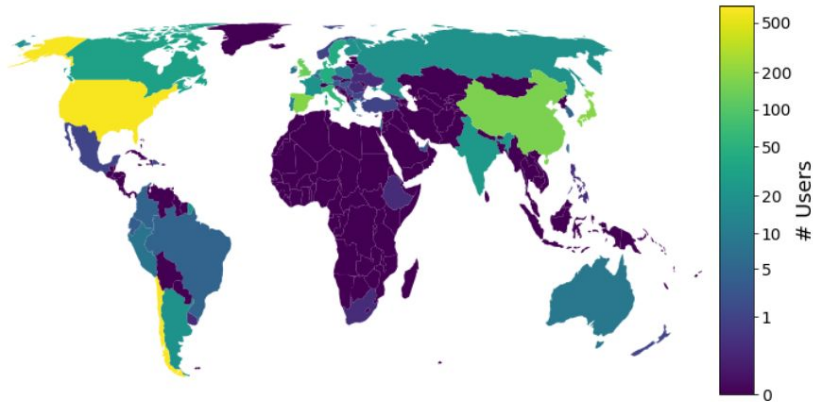
Santiago, Chile, June 2019



La Serena, Chile, March 2019

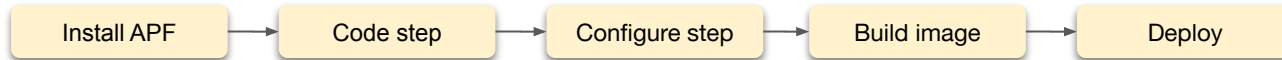
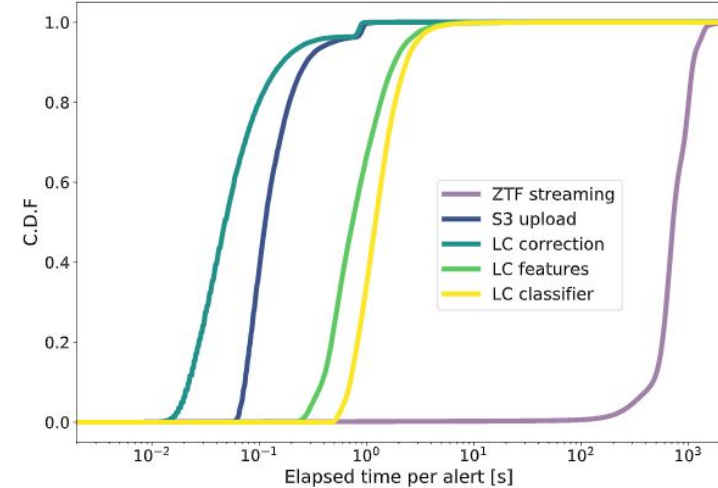
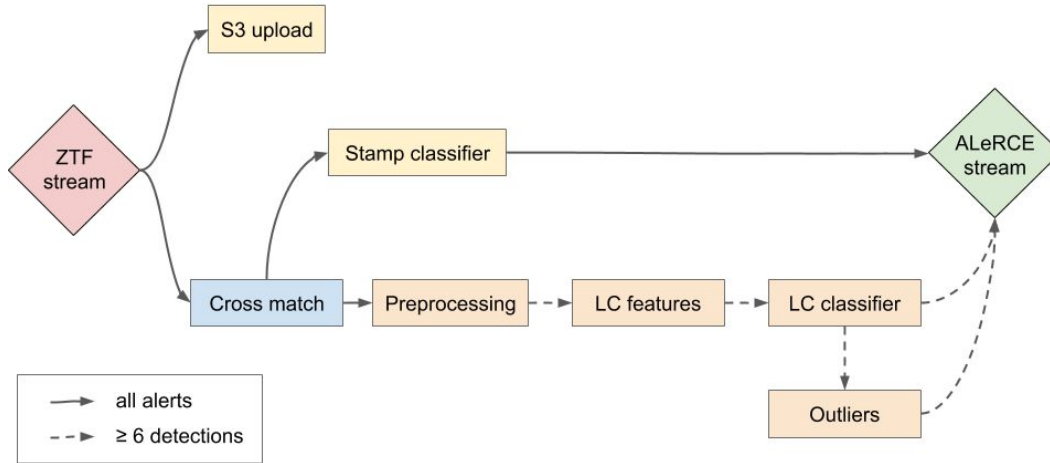


Concepción, Chile, Jan 2020





Alert Processing Framework (APF)



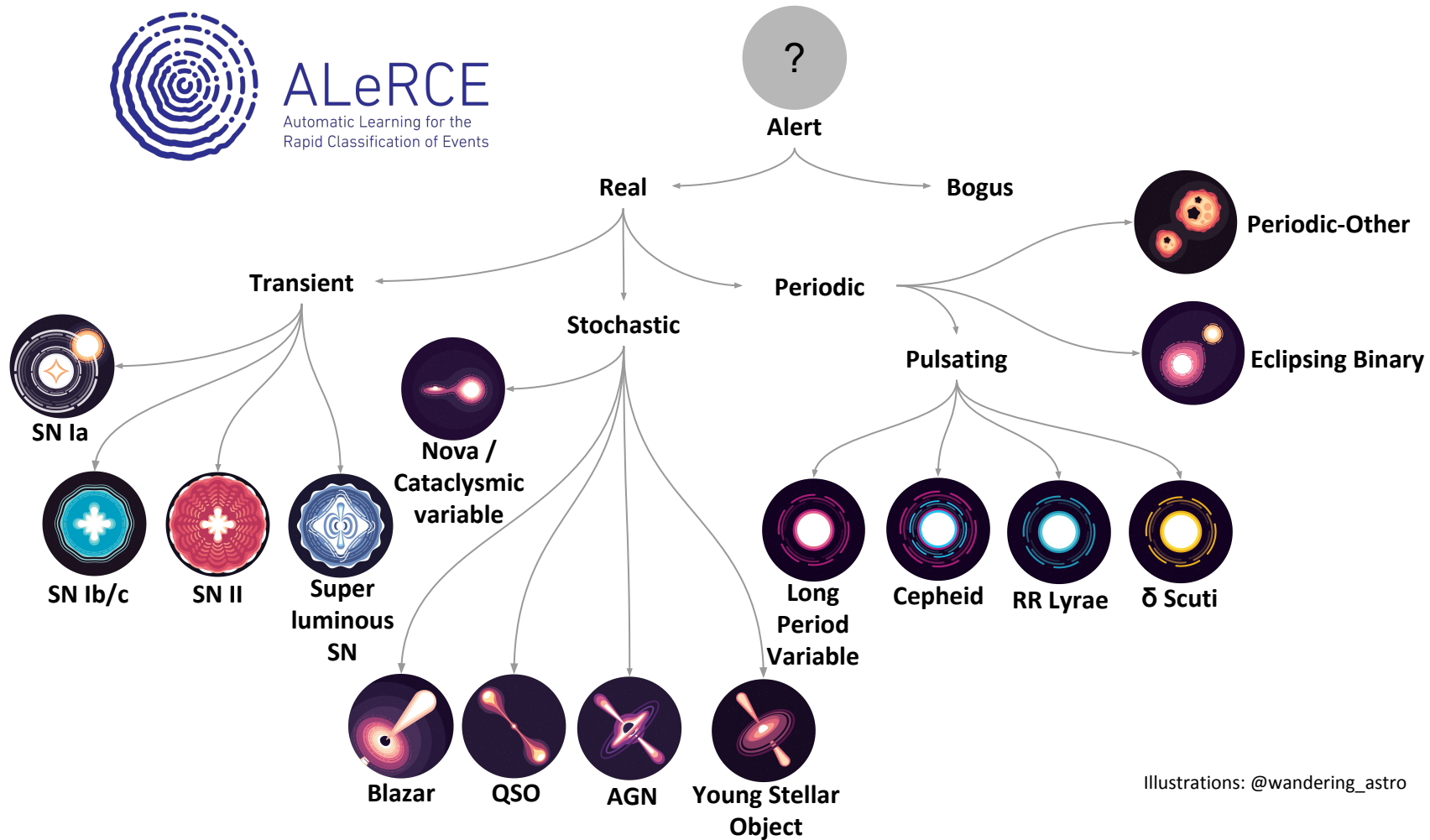
<https://apf.readthedocs.io/en/latest/>





ALeRCE

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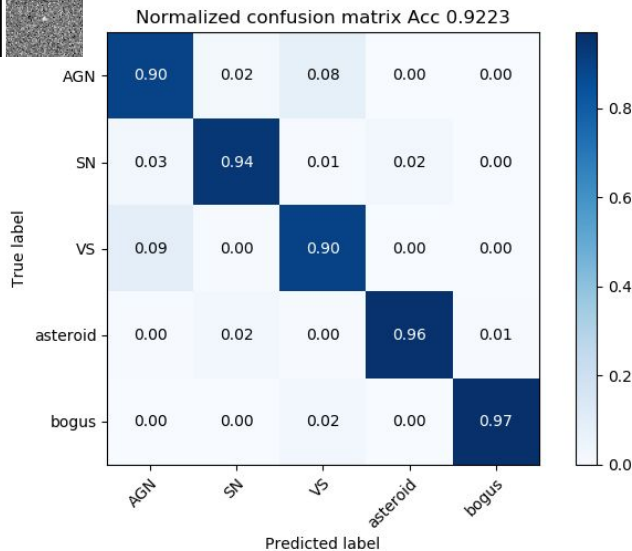
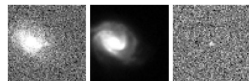
Illustrations: @wandering_astro



Stamp based classifier

Convolutional neural network
Carrasco-Davis et al. 2020

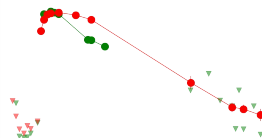
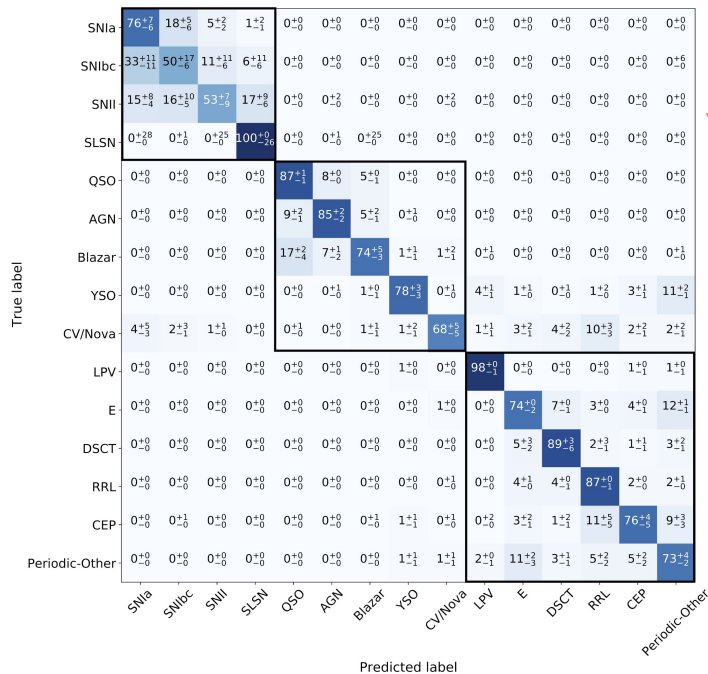
AGN, SN, VS, asteroid, bogus



Light curve based classifier

Balanced Hierarchical Random Forest
Sánchez-Sáez et al. 2020

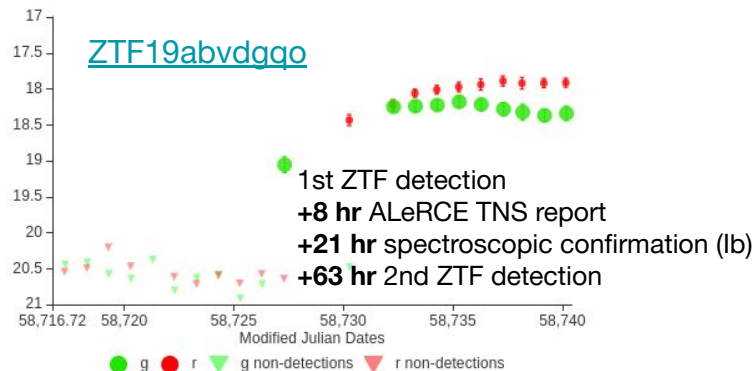
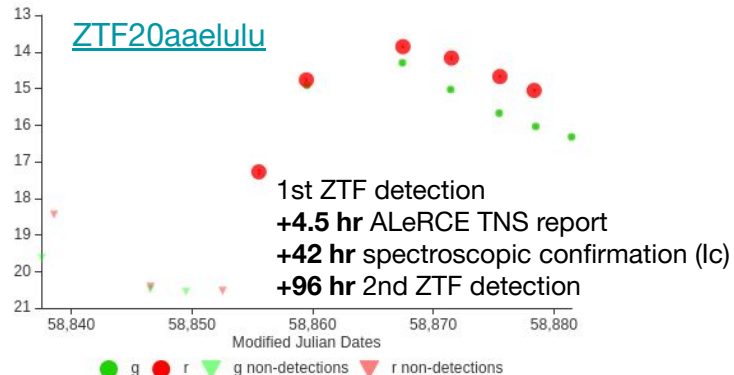
SNla, SNIbc, SNIi, SLSNe, QSO, AGN, Blazar, YSO, CV/Nova, LPV, E, DSCT, RRL, CEP, Periodic-Other





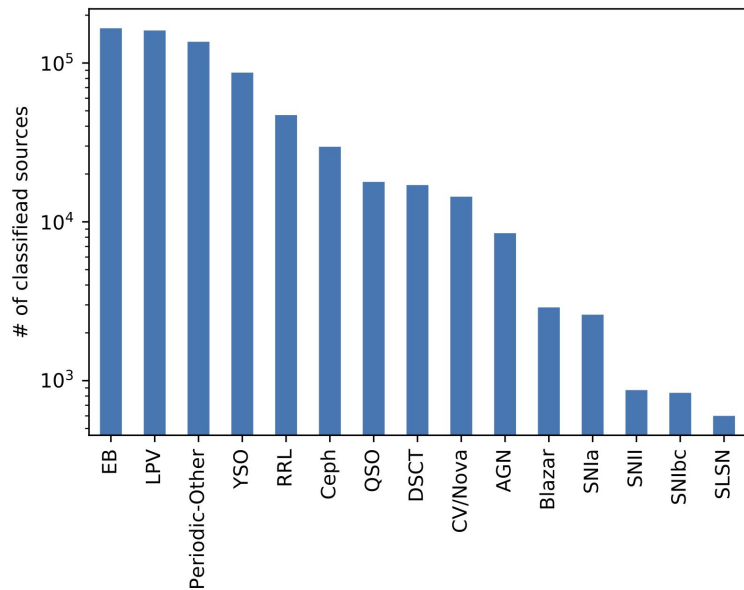
ZTF discovered & ALeRCE reported SNe

>4400 SNe submitted to TNS
(currently ~70% efficiency, ~80% purity)

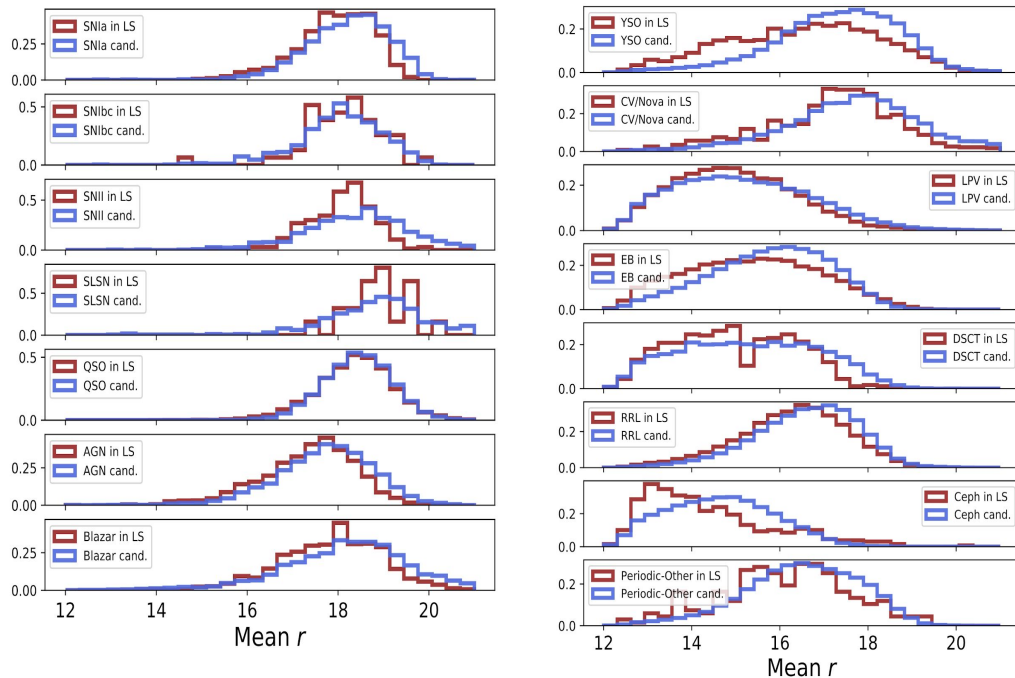




Objects classified by the light curve classifier

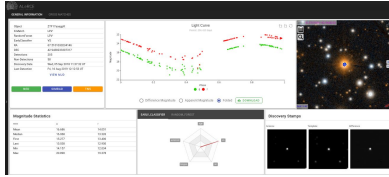


Class distribution in the unlabeled set (Sánchez-Sáez et al. 2020)

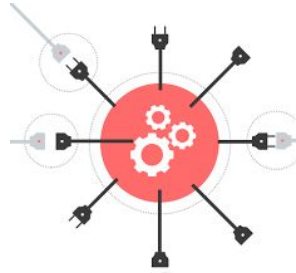


Magnitude distribution in the labeled vs unlabeled sets (Sánchez-Sáez et al. 2020)

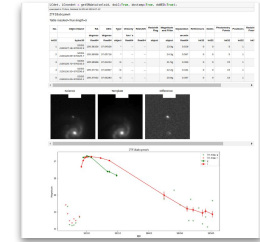
Web Interfaces



API



Jupyter
Notebooks

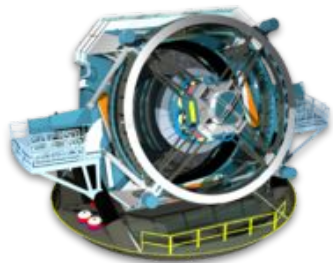


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<http://alerce.science>

Output stream
(real-time follow-up)

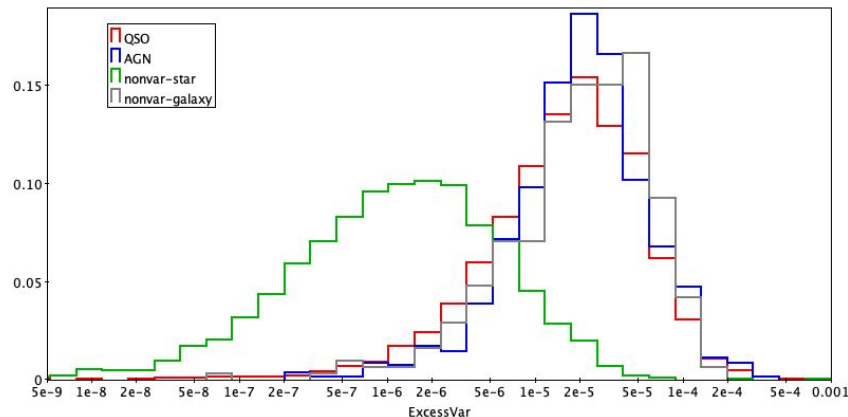
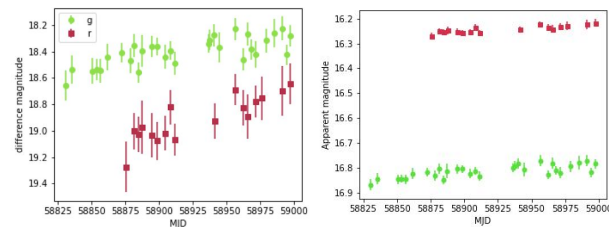
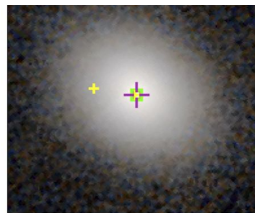


TOMs

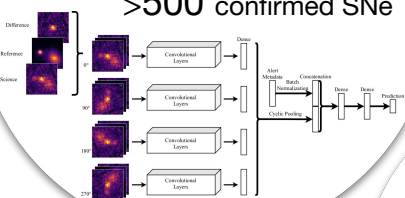


New: ZTF DR3 vs ZTF alert stream

- Stripe-82
 - labeled set alerts: labeled set DR3 = 1:10
 - known AGNs in alerts: known AGNs in DR3 = 1:20
- ZTF alert stream is better to study transients and nuclear variability in extended sources.
- Recalibrating ZTF DR3 light curves to better separate variable from non variable stars.
- Using ZTF DR3 autocorrelation structure to separate variable from non variables galaxies

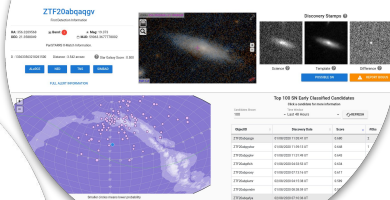


20 million classifications
>4000 TNS candidates
77 >500 confirmed SNe

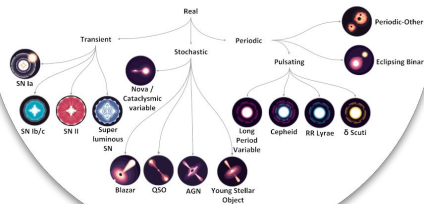


Find recent SNe

<https://snhunter.alerce.online/>



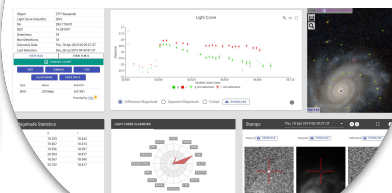
15 class taxonomy
million classifications



Automatic Learning for the Rapid Classification of Events

Search and visualize

<https://alerce.online/>



<http://alerce.science>

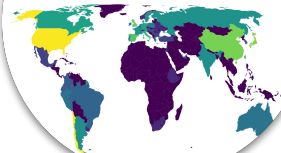


alercebroker

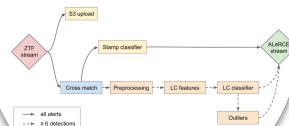
18 astro, 23 stat+ML
6 data engineers



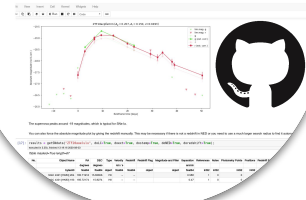
2000 users
50 countries



Modular design



SNe, Variable stars, AGN





ALeRCE's future

- New database & frontend moving from staging to production.
- Xmatch with ZTF DR3. Requires careful calibration.
- Include ZTF Phase II. Forced photometry will enable earlier classification.
- Include ATLAS and other streams. ZTF and ATLAS are complementary!
- Outlier detection in output stream & database.
- Scale infrastructure to Vera Rubin Observatory, xmatch streams in real-time!
- Focus on use cases and user experience.

Links

Homepage: <http://alerce.science>

Explorer: <https://alerce.online/>

New explorer: <http://dev.alerce.online>

SN Hunter: <https://snhunter.alerce.online/>

ALeRCE tutorial: [videos, slides & notebooks.](#)