the UK community broker for LSST (ZTF now)

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University of Edinburgh

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Queens University Belfast

https://lasair-ztf.lsst.ac.uk

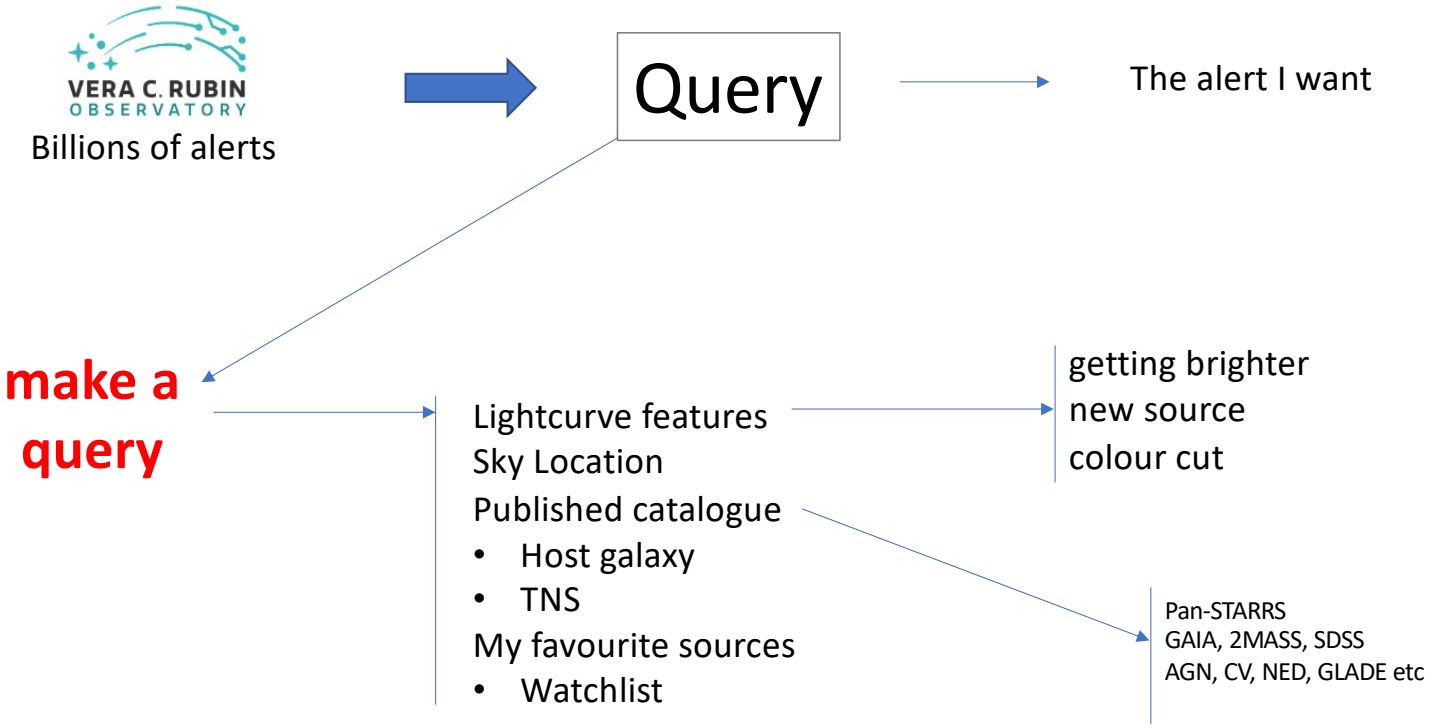
What does Lasair do?

Billions of alerts

Query

The alert I want

What does Lasair do?



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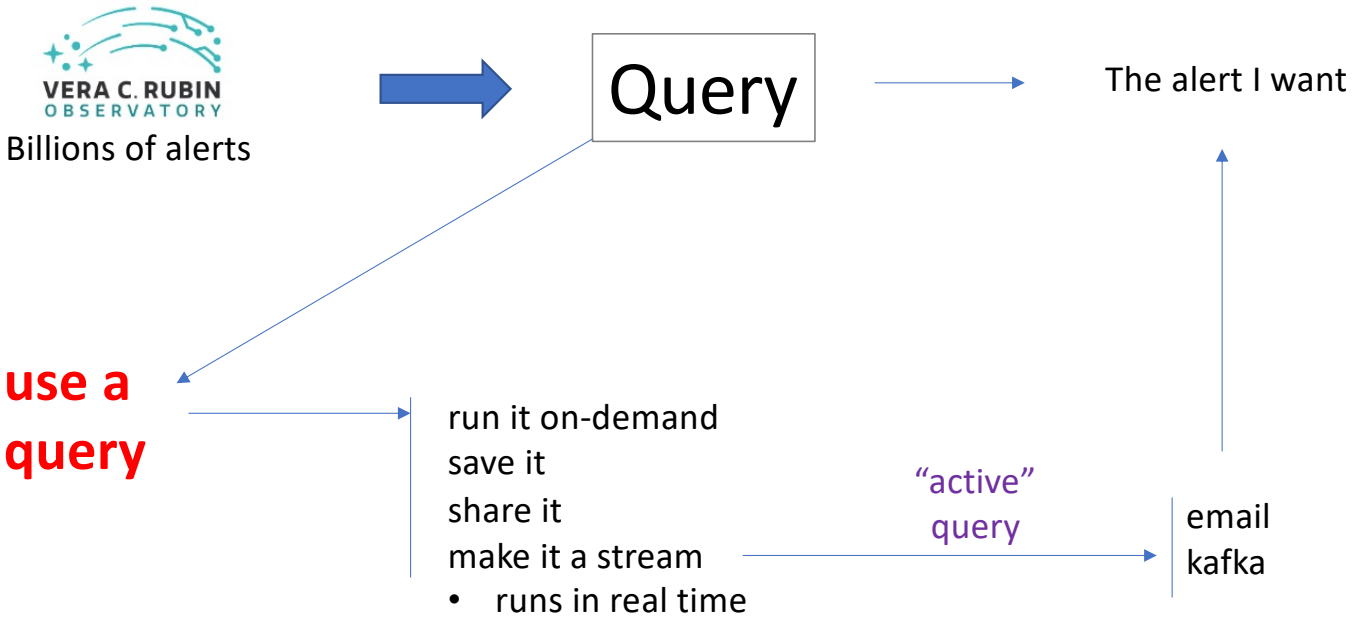
What does Lasair do?



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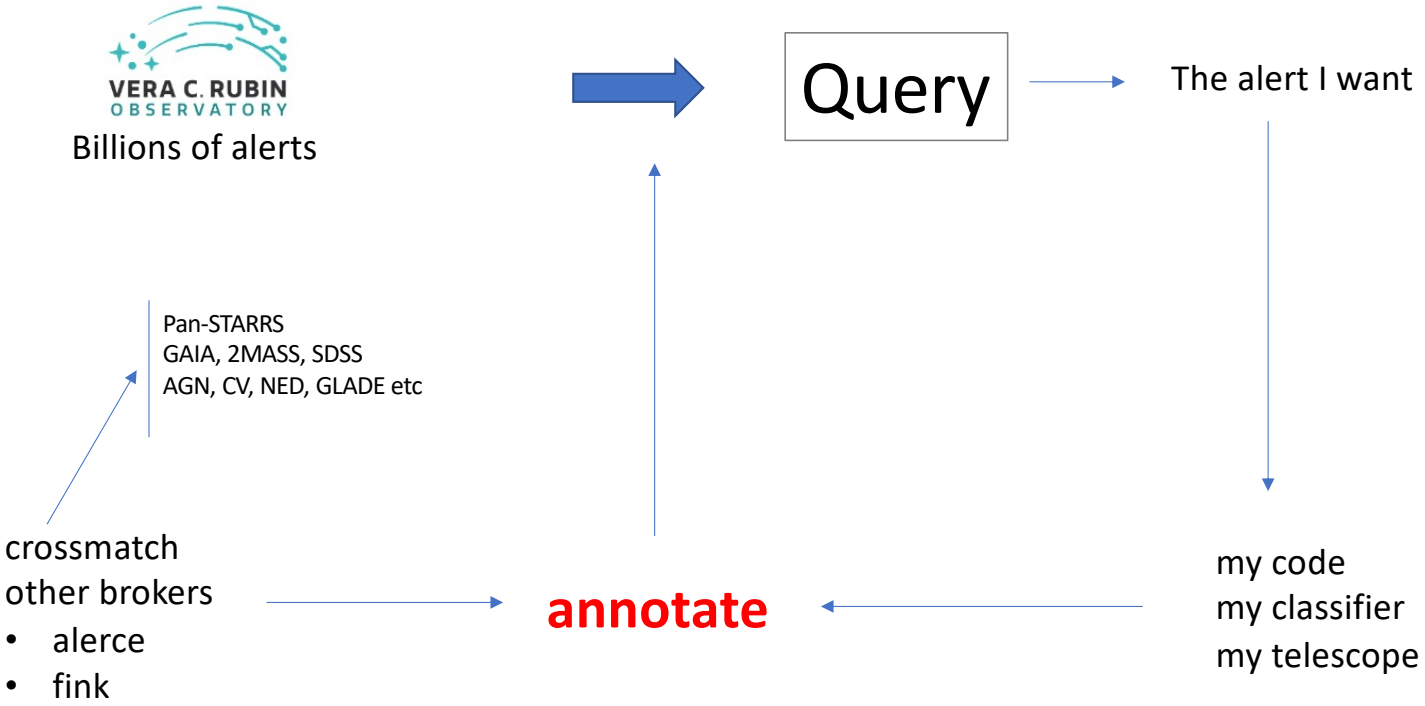
What does Lasair do?



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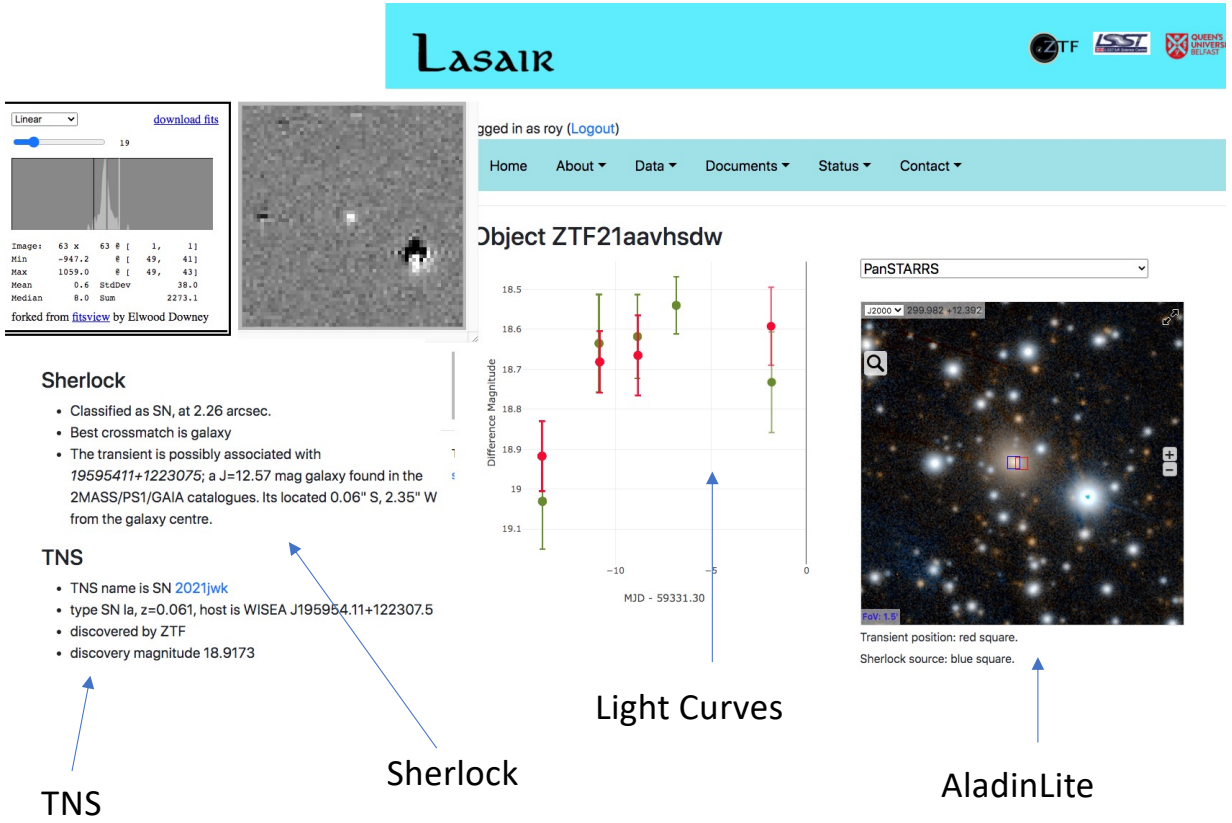
Lasair object view

FITS viewer

Each detection



Candidates (To sort, click the column headings)

MJD	UTC	Filter	magpsf	status	images
59349.461	2021-05-15 11:03:12	r	19.300 ± 0.115	t	target ref diff
59347.466		r	17.574	non-detection	
59347.452		g	17.850	non-detection	
59345.462	2021-05-11 11:05:42	r	19.337 ± 0.130	t	target ref diff
59345.424		g	20.169	non-detection	
59342.464	2021-05-08 11:07:53	g	19.654 ± 0.126	t	target ref diff

Light Curves

TNS

Sherlock

AladinLite

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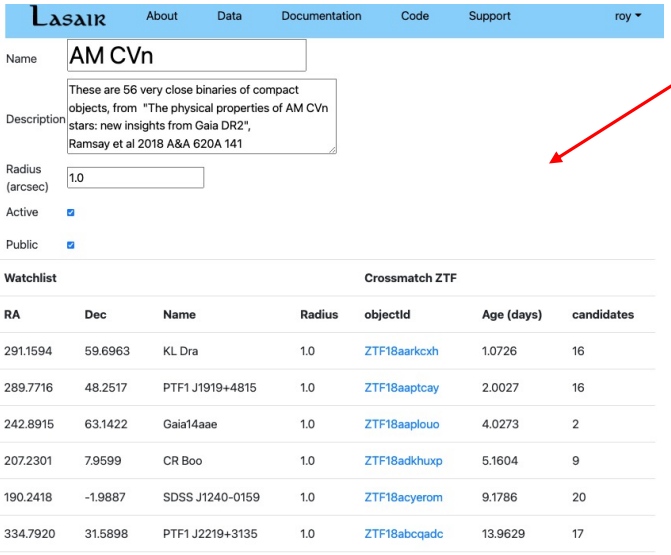
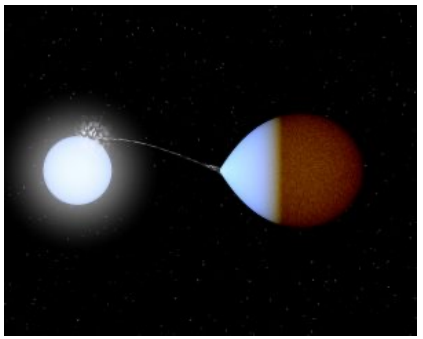
Lasair “Watchlist”

- Named ”interesting” sources with radius
- If “active”, matching objects are tagged real-time
- Can be public or private
- Query can include watchlist constraint



SDSS Quasar	Main DR9 Quasar catalog with z<1.5 VII/269/dr9	17631	10.0 arcsec	✓	
Cataclysmic Variables	Catalog of Cataclysmic Variables (Downes+ 2001-2006) Vizier V/123A	1830	0.2 arcsec	✓	
WFCAM	J/A+A/573/A100/WVSC Post annotation WFCAM Variable Star Catalog (Ferreira Lopes+, 2015) ReadMe+ftp2015A&A...573A.100F WFCAM Variable Star Catalog: parts C1 (periodic variables, table4), C2 (no main periodicity, table 6), and C3 (low-amplitude variables table 8) (334 rows)	334	1.0 arcsec	✓	
BL Lac for TeV	BL Lac candidates for TeV observations (Massaro+, 2013)	42	5.0 arcsec	✓	✓
AM CVn	These are 56 very close binaries of compact objects, from "The physical properties of AM CVn stars: new insights from Gaia DR2", Ramsay et al 2018 A&A 620A 141	55	1.0 arcsec	✓	✓
Milliquas_1000000	million	999998	2.0 arcsec	✓	✓
Gaia DR2 white dwarfs	Gaia DR2 white dwarf candidates (Gentile Fusillo+, 2019) MNRAS.482.4570G	486641	5.0 arcsec	✓	✓



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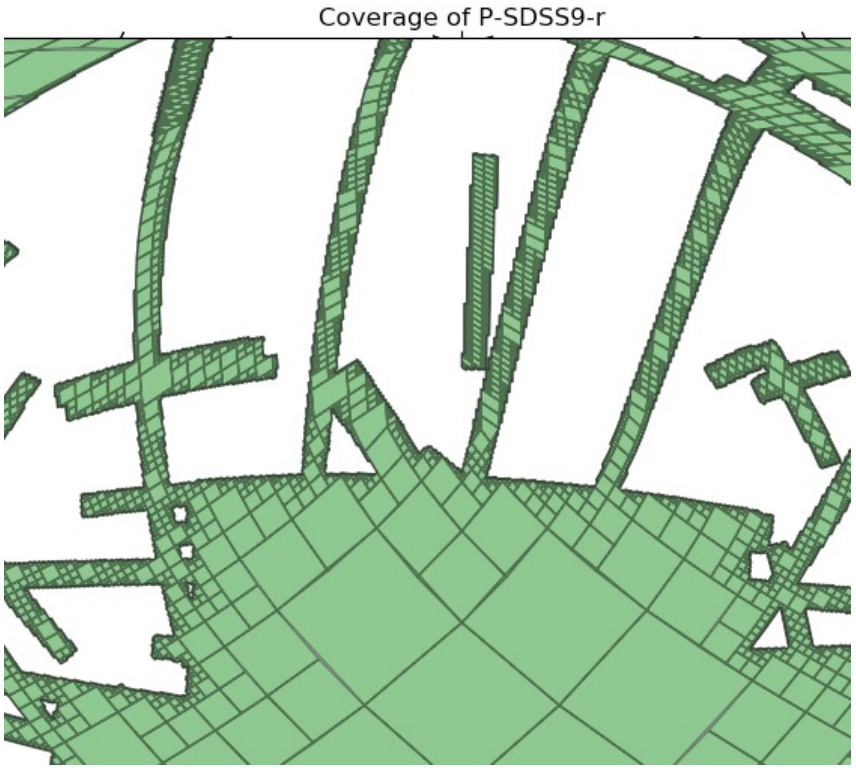
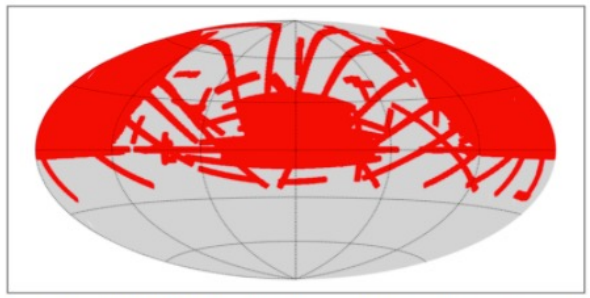
Lasair “Area”



Upload a MOC file

- Objects inside are tagged
- Query can include only these
- Examples
  - Survey footprints
  - GW or other skymap
  - My telescope coverage

Name	SDSS
Description	The area of the SDSS footprint
Active	yes
Public	yes



Area has 786793 objects, shown below.. To see the original input data, click here.

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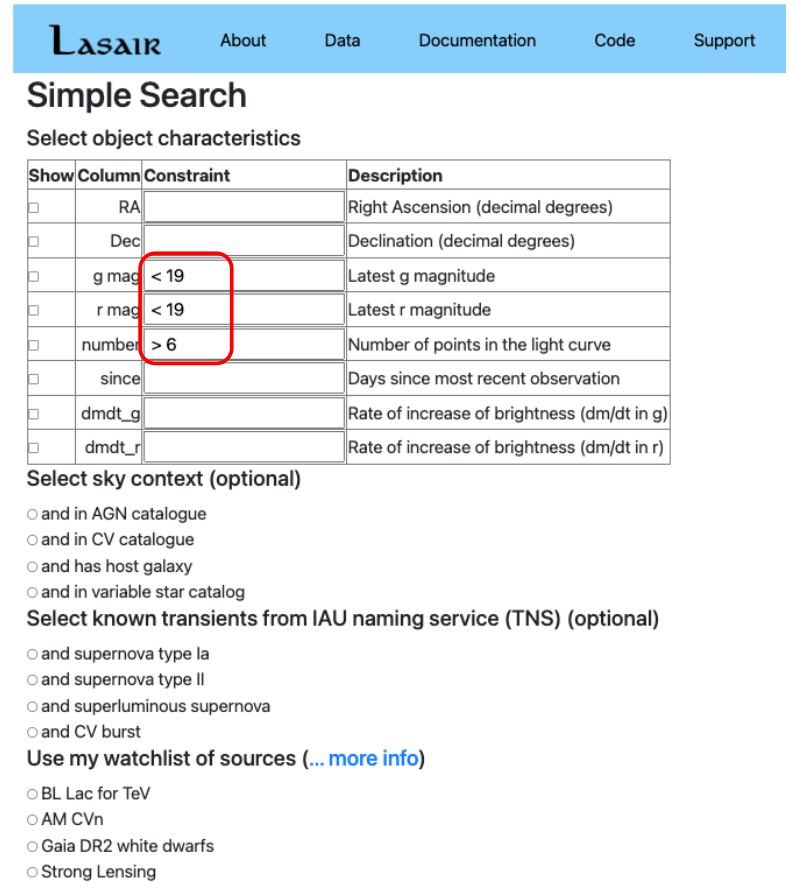
Lasair Design Decisions

- It's a platform not a product
  - Users share queries, watchlists
  - Users contribute classifiers and annotations
- SQL based
  - Astronomers have got used to it
  - Expressive AND can be ring-fenced
  - On-demand AND Streaming
    - Same query for both!
    - Streaming in time order
- Short and long lightcurves
  - features and queries from last month (will be year for LSST)
    - for scalability
  - long LC display/download

Simple Query

(coming soon)

- Form based
  - Fill in criteria
  - Basic crossmatch
  - TNS match
  - my watchlists



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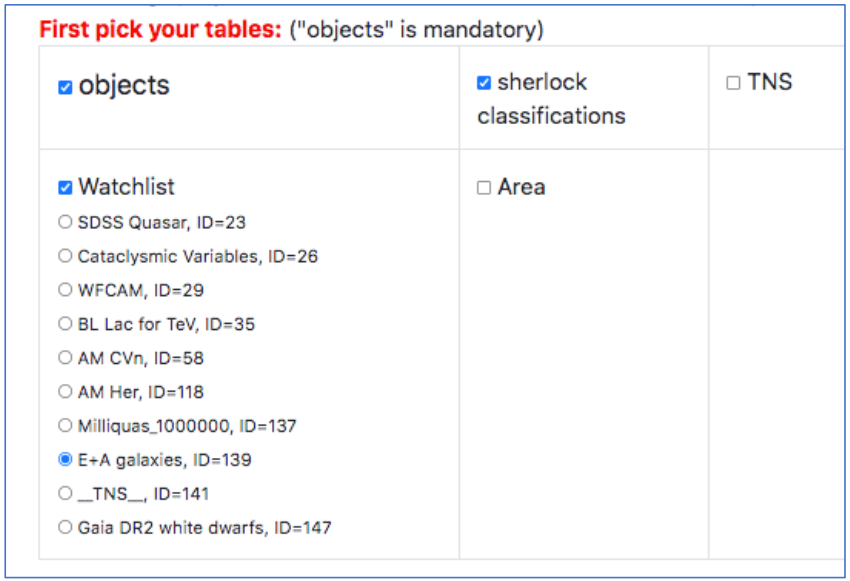
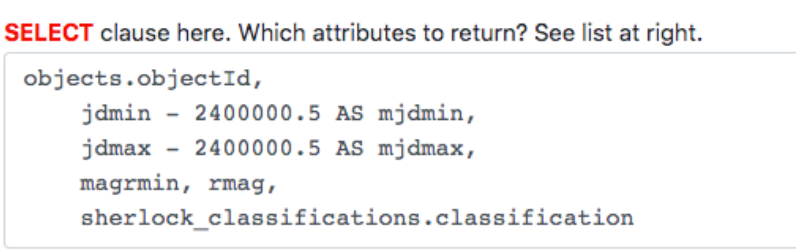
Advanced Query Builder

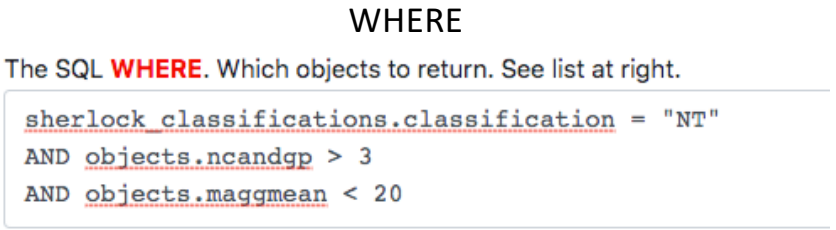
FROM



SELECT

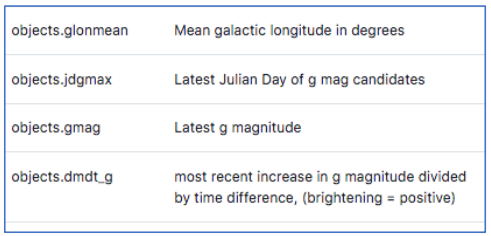


WHERE



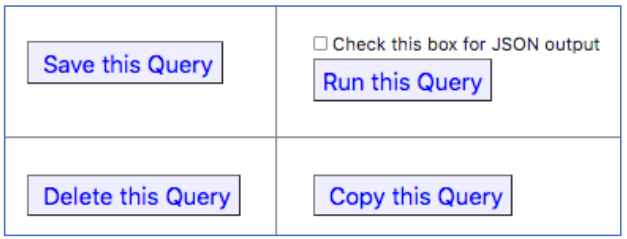
- FROM tables
- SELECT attributes
- WHERE conditions
- (use GUIDE)
- ACTION save, run, delete, copy

GUIDE



objects.glonmean	Mean galactic longitude in degrees
objects.jdgmax	Latest Julian Day of g mag candidates
objects.gmag	Latest g magnitude
objects.dmdt_g	most recent increase in g magnitude divided by time difference, (brightening = positive)

ACTION



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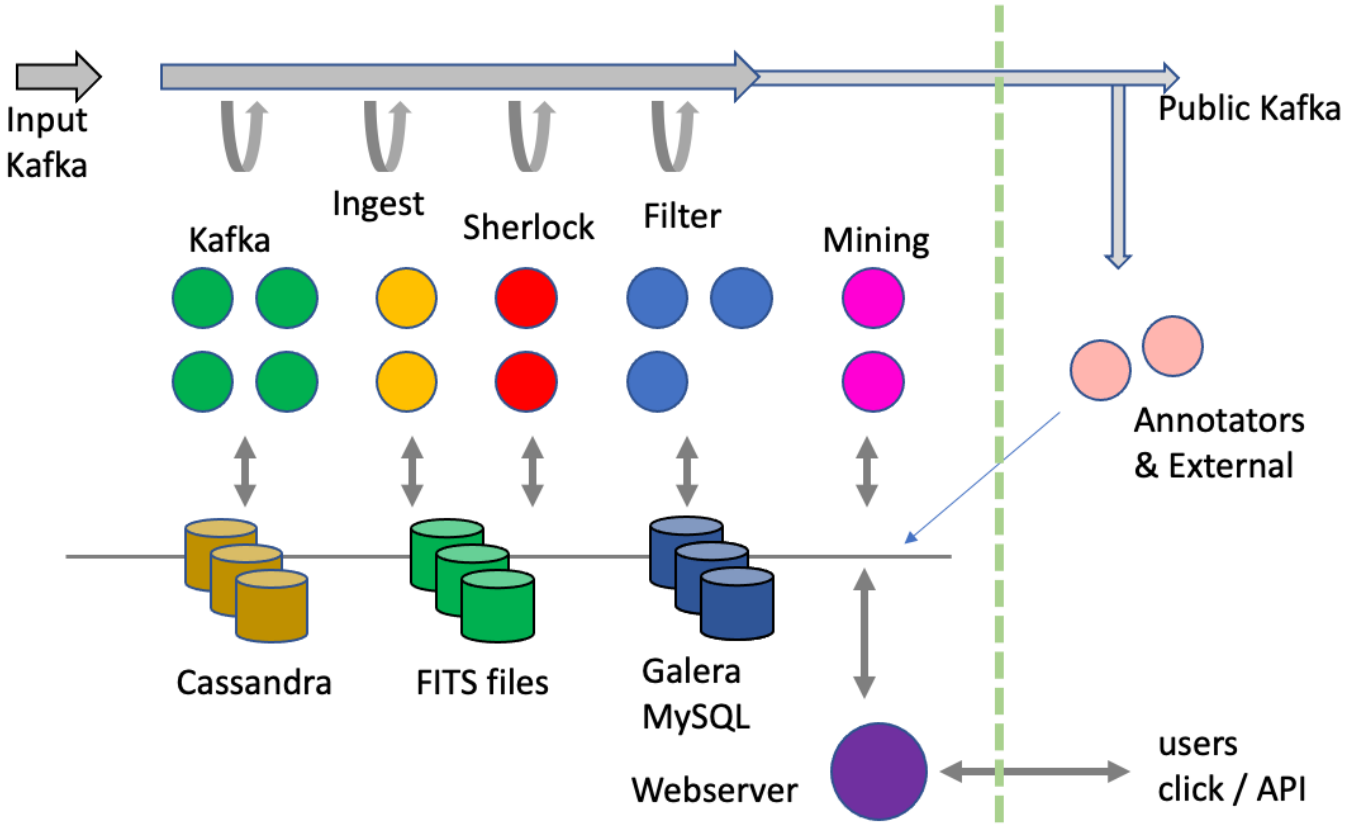
Lasair Scalable Data Pipeline Architecture



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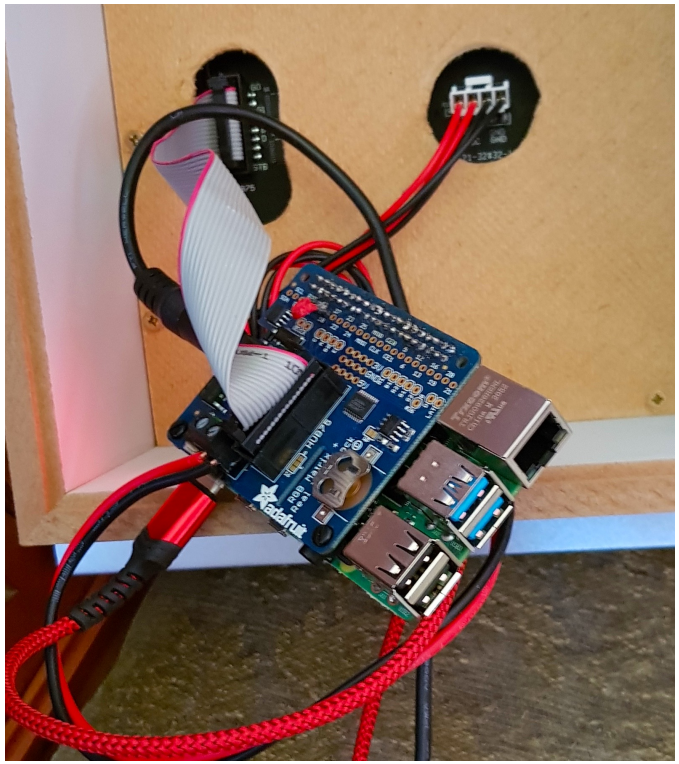
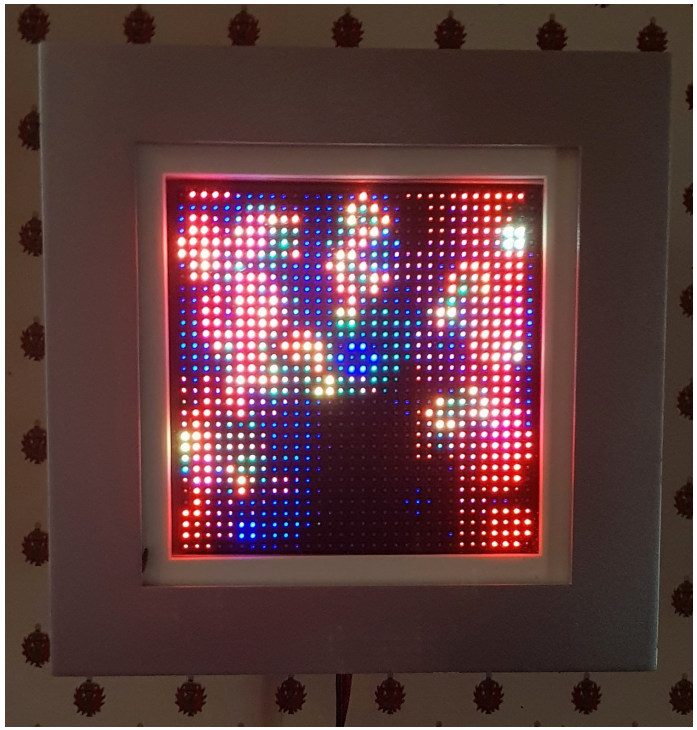
Wall-mounted alert monitor

with Lasair public Kafka

Raspberry Pi



32x32 LED array (Adafruit)



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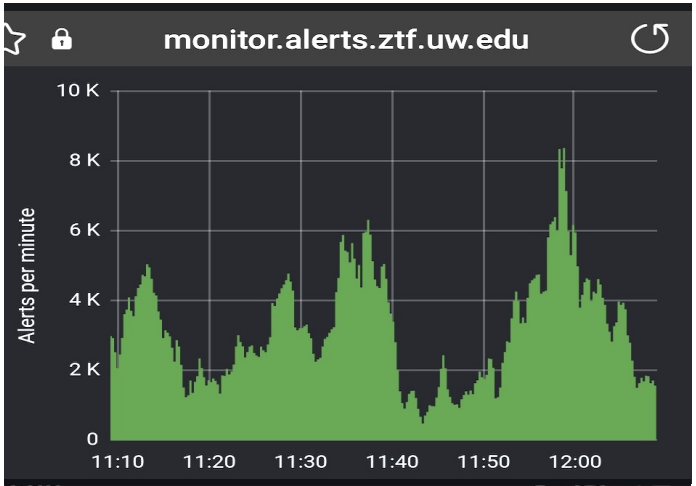
IRIS@Edinburgh “Somerville*” System

- Support for large-scale, high-performance database applications
    - OpenStack
    - **1600 TB HDD** Ceph file system and object store
    - **100 TB SSD** Ceph file systems
    - **320 cores** (16 GB/ core)
    - **100 Gbps** public network w/ 2×100 Gbps uplink to Internet

* Mary Somerville, polymath Scot for whom the word “Scientist” was coined in 1834 -- she made “man of science” obsolete.

Keeping up!

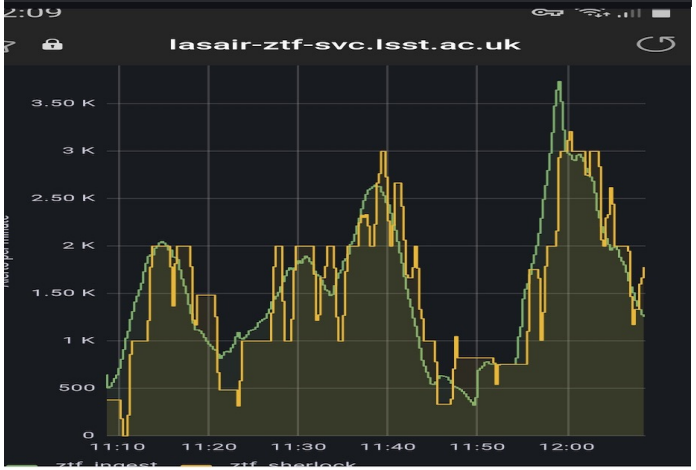
ZTF rates
California



LSST will be ~30 times the rate and volume of ZTF

Work this year has been on making Lasair FAST

Lasair processing
Edinburgh



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Gravitational Waves

Is one of these the counterpart of a GW event?

position and distance.

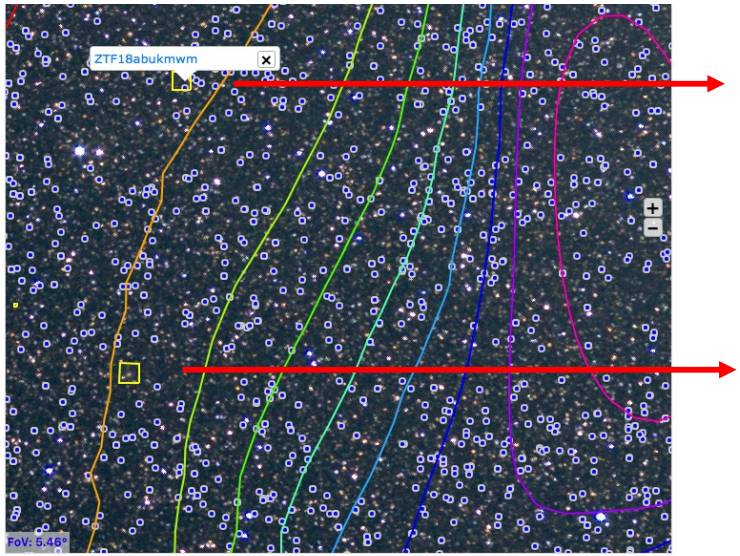
Gravitational Wave Skymap: S190518bb

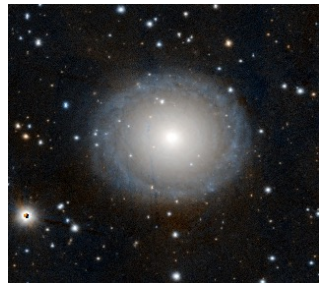
Distance	27.8 ± 15.3 Mpc
ISO Date:	2019-05-18T19:19:21.922921
Julian date:	2458622.305
Percent probability:	BNS=75, NSBH=0, BBH=0 MassGap=0
max prob RA,Dec	327.0, 32.6

☐ Coverage of ZTF From 20190518 To 20190

☐ Show ZTF candidates From -1.000 To 1.000

☑ Show galaxies from GLADE *doubleclick a galaxy*





200 most probable galaxies

Name (NED link)	Percent probability	Distance (Mpc)
NGC7217	2.72	20.04
LEDA AGC322487	2.28	22.85
UGC04195	1.57	74.58

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Sherlock Attributes

Smart crossmatch from ~40 catalogues

classification	Top-ranked contextual classification for the transient (NULL, AGN, BS, CV, NT, ORPHAN, SN, UNCLEAR, VS)
classificationReliabil:	Reliability of classification
description	Long-form, human-readable summary of the transient's characteristics as infered from Sherlock's classification
catalogue_object_type	Type of catalogue from which the best crossmatch is made
catalogue_table_name	Name/s of catalogue/s from which the best crossmatch is made
catalogue_object_id	Identifier in the catalogue/s from which the best crossmatch is made
Mag	Magnitude
MagFilter	Magnitude filter
MagErr	Magnitude error
z	Redshift of the top-ranked catalogue source match
photoZ	Redshift of the top-ranked catalogue source match
photoZErr	Redshift of the top-ranked catalogue source match
direct_distance	Determined from a non-redshift related measurement - e.g. Cepheids/standard candle (Mpc)
distance	Luminosity distance -- conversion from the spectral redshift (Mpc)
separationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
northSeparationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
eastSeparationArcsec	Transient's angular separation (arcseconds) from the top-ranked catalogue source match
physical_separation_kp	Distance in kilo parsec between transient and top-ranked catalogue source match

Lasair Lightcurve Features

objectId	ZTF object identifier
ramean	Mean RA in degrees
decmean	Mean Dec in degrees
rastd	Standard deviation of RA in arcseconds
decstd	Standard deviation of Dec in arcseconds
glatmean	Mean galactic latitude in degrees
glonmean	Mean galactic longitude in degrees
jdmin	Earliest Julian Day of candidates that cite this object
jdmax	Maximum of jdgmax and jdrmax
jdrmax	Latest Julian Day of r mag candidates
jdgmax	Latest Julian Day of g mag candidates

gmag	rmag	latest r magnitude
dmdt_g	dmdt_r	most recent increase in r magnitude divided by time difference, (brightening = positive)
dmdt_g_2	dmdt_r_2	2nd most recent increase in r magnitude divided by time difference
mag_g02	mag_r02	Latest Exponential Moving Average of difference magnitude in r band, with 2-day timesca
mag_g08	mag_r08	Latest Exponential Moving Average of difference magnitude in r band, with 8-day timesca
mag_g28	mag_r28	Latest Exponential Moving Average of difference magnitude in r band, with 28-day timesc
maggmin	magrmin	Minimum r magnitude of light curve (brightest)
maggmean	magrmean	Mean r magnitude of light curve
maggmax	magrmax	Maximum r magnitude of light curve (faintest)

g_minus_r	Value of g-r on most recent night when both were available
jd_g_minus_r	Julian date of most recent g measure on a night when both ag and r were available
ncand	Number in light curve
ncandgp	Number in light curve with good quality and brighter than reference
ncandgp_7	Number in light curve with good quality and brighter than reference in last 7 days
ncandgp_14	Number in light curve with good quality and brighter than reference in last 14 days
distpsnr1	Distance of closest source from PS1 catalog; if exists within 30 arcsec [arcsec]
sgscore1	Star/Galaxy score of closest source from PS1 catalog 0 <= sgscore <= 1 where closer to
sgmag1	g-band PSF magnitude of closest source from PS1 catalog; if exists within 30 arcsec
srmag1	r-band PSF magnitude of closest source from PS1 catalog; if exists within 30 arcsec

what else???

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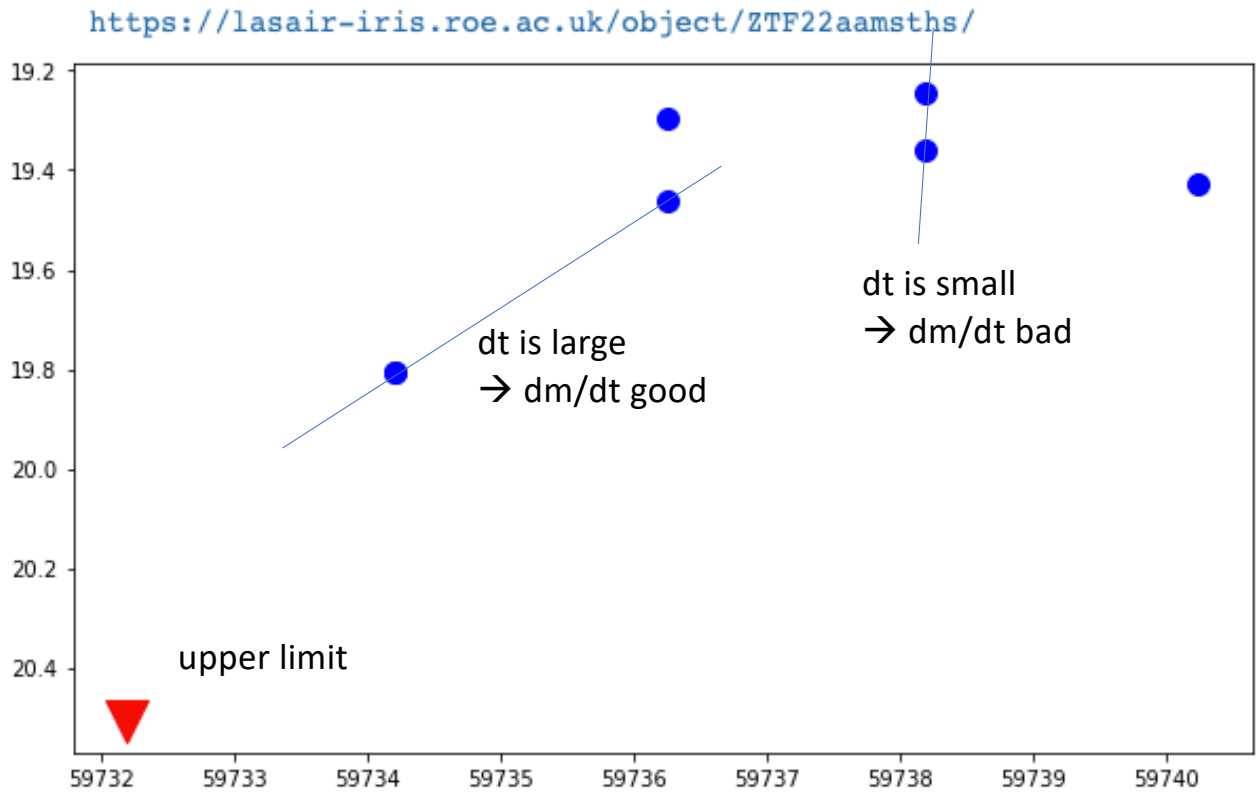
Features for Light Curves



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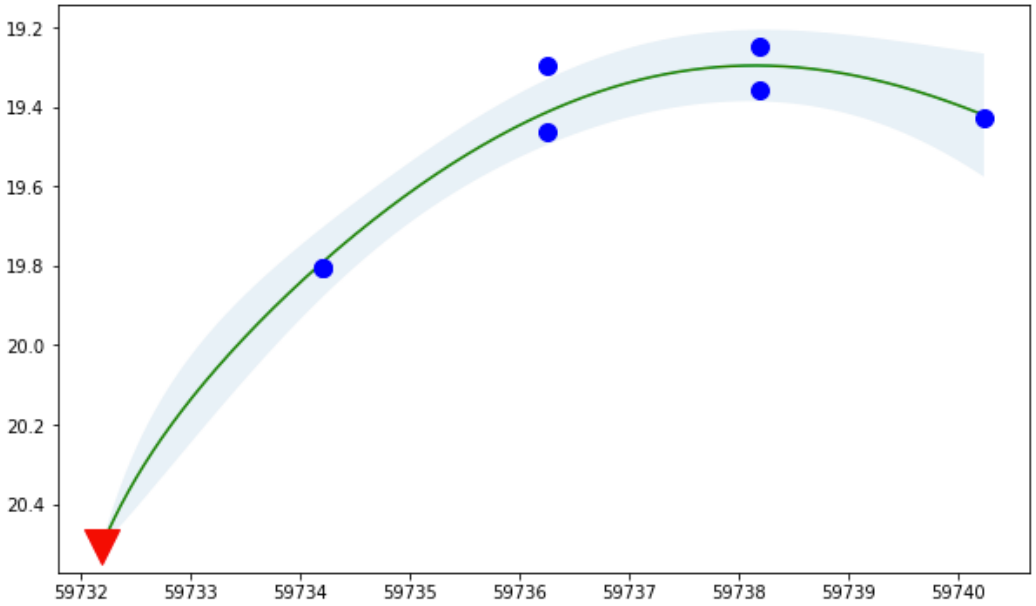
Gaussian Processes for Light Curves

- Removes human-made cadence
- Can handle upper limit
- Derivatives and error
- What about 6 light curves?

WE ARE LOOKING FOR INPUT ON LIGHT CURVE FEATURES!! TALK TO ROY OR STEPHEN!!



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