Transient classification with photometry

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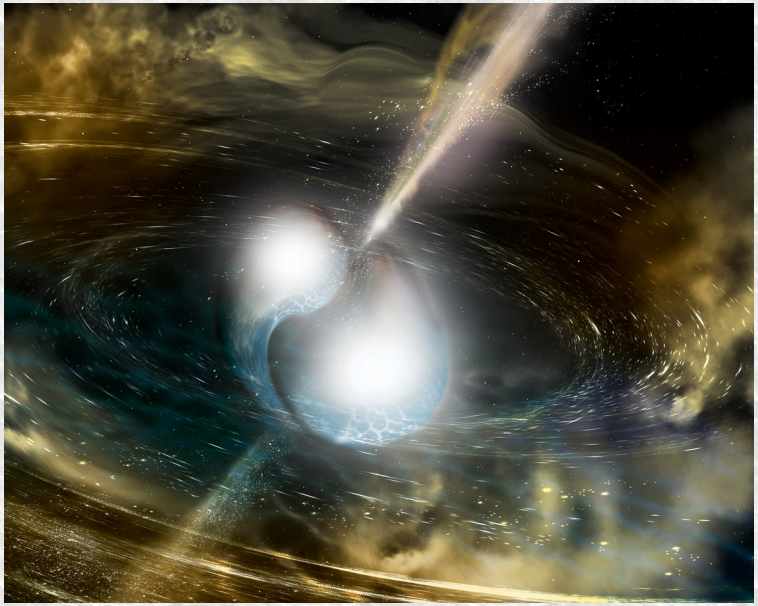
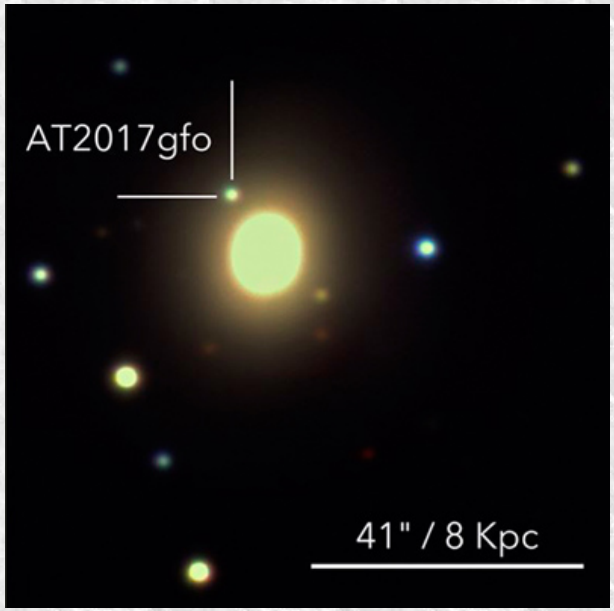
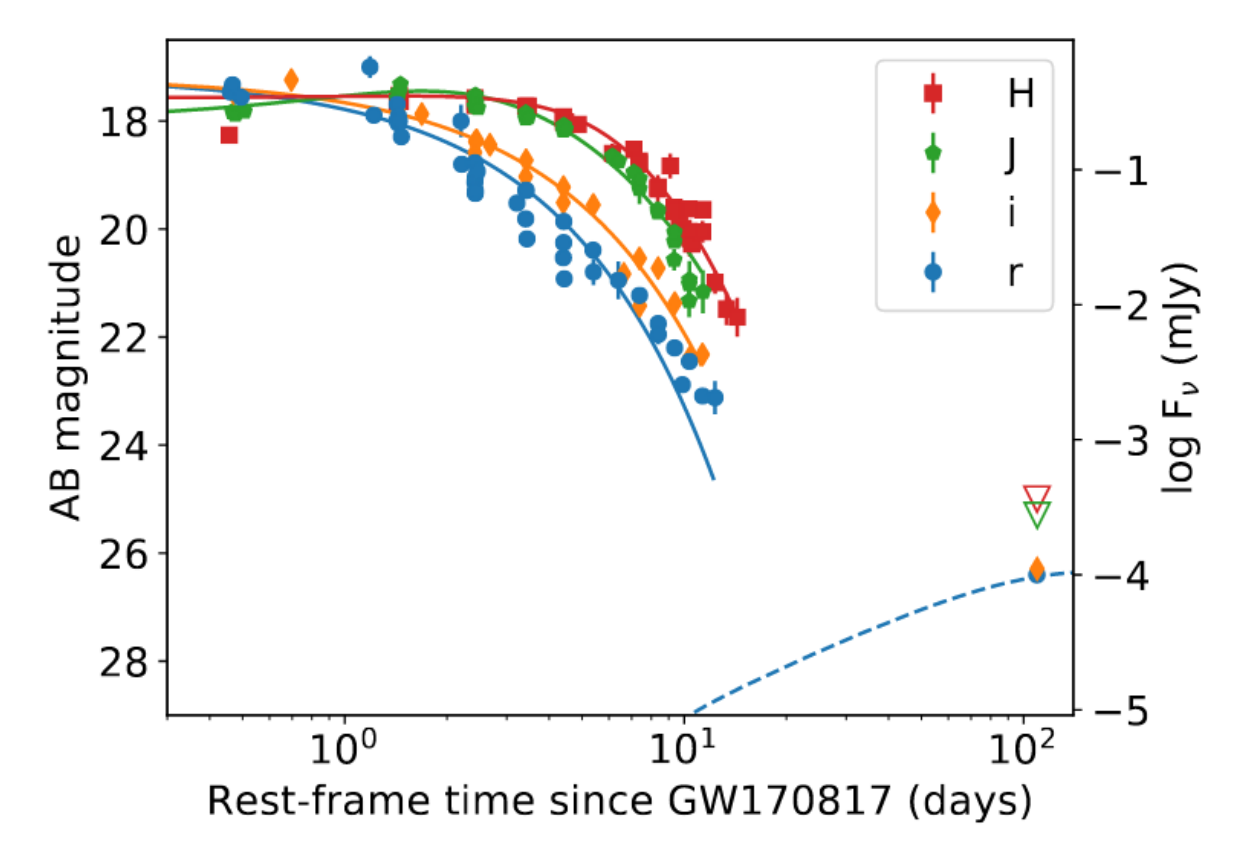
Why such a project ?

GW170817 + GRB170817A



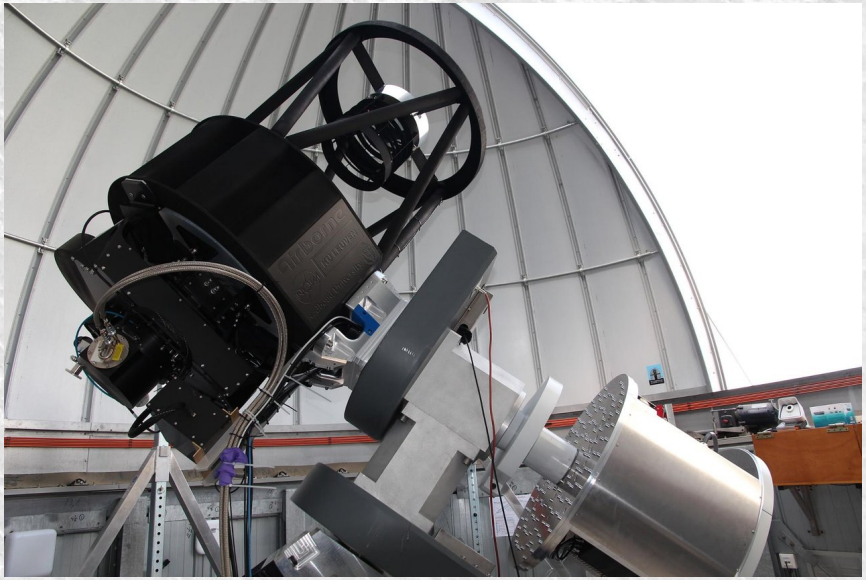


Smartt et al. 2017

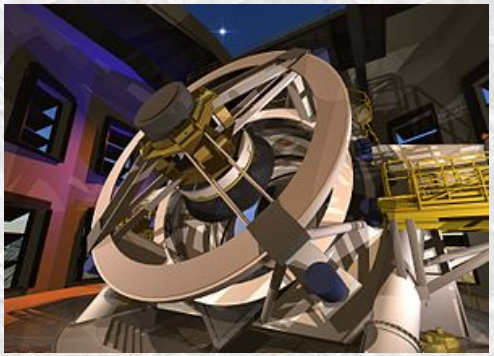


Lyman et al. 2018

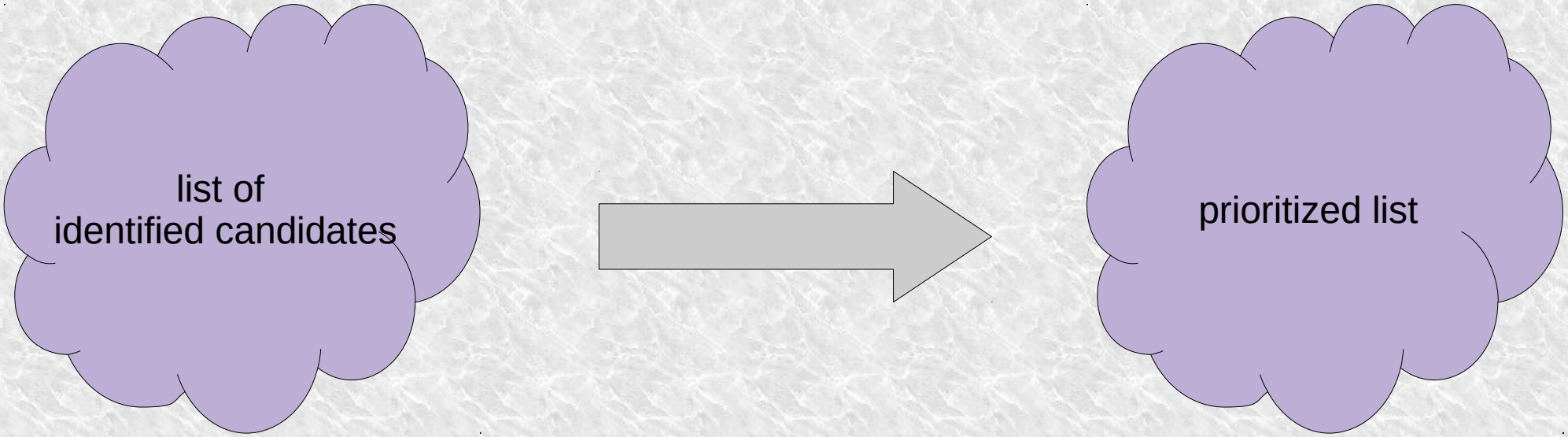
more than 1,000,000 alerts per night



BlackGEM

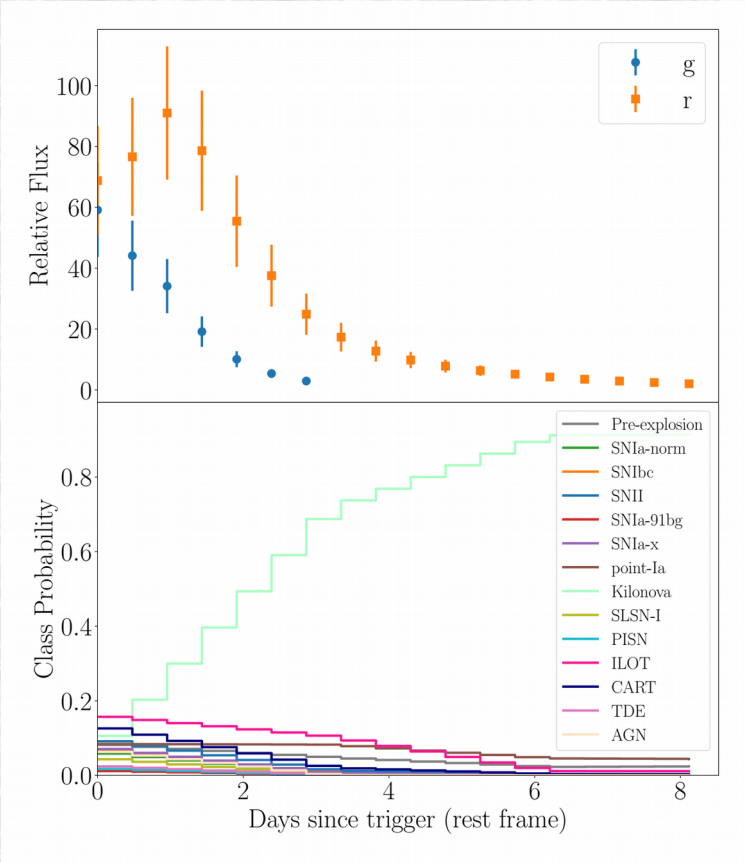


LSST


list of
identified candidates
prioritized list

Open source tool

- machine-learning based tool
- it distinguishes among 14 templates
- Input : lightcurve of a transient in several filters
- Output : time-dependent probability for each template



daniel-muthukrishna/astrorapid: Real-time ... - GitHub

https://github.com › daniel-muthukrishna › astrorapid

Real-time Automated Photometric IDentification (RAPID) of astronomical transients using deep learning - daniel-muthukrishna/**astrorapid**.

Only four templates :

→ KN

→ SN :SNIa-norm, SNIbc, SNIa-91bg, SNIa-x, point-Ia,SLSN-I,PISN

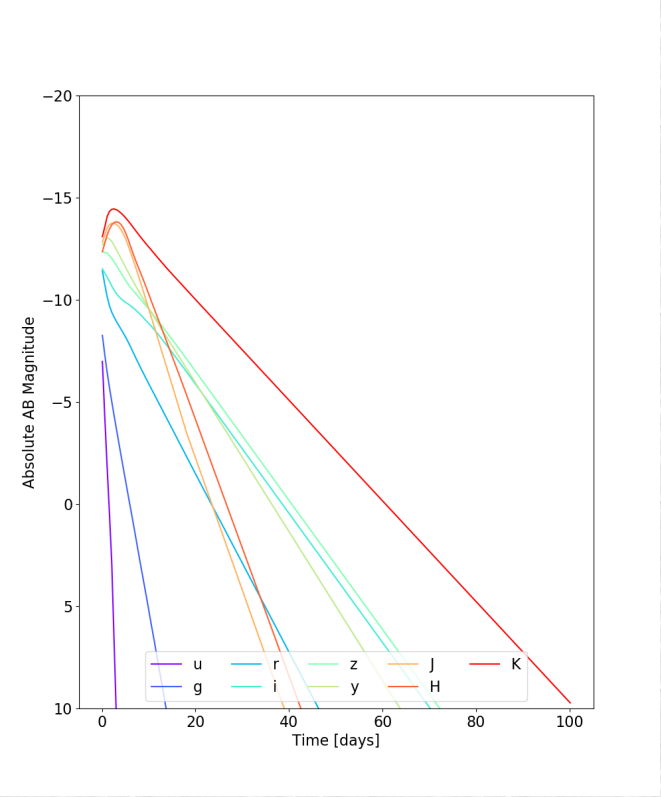
→ Others :ILOT, CART, TDE, AGN, Pre-explosion

→ Indistinguishable

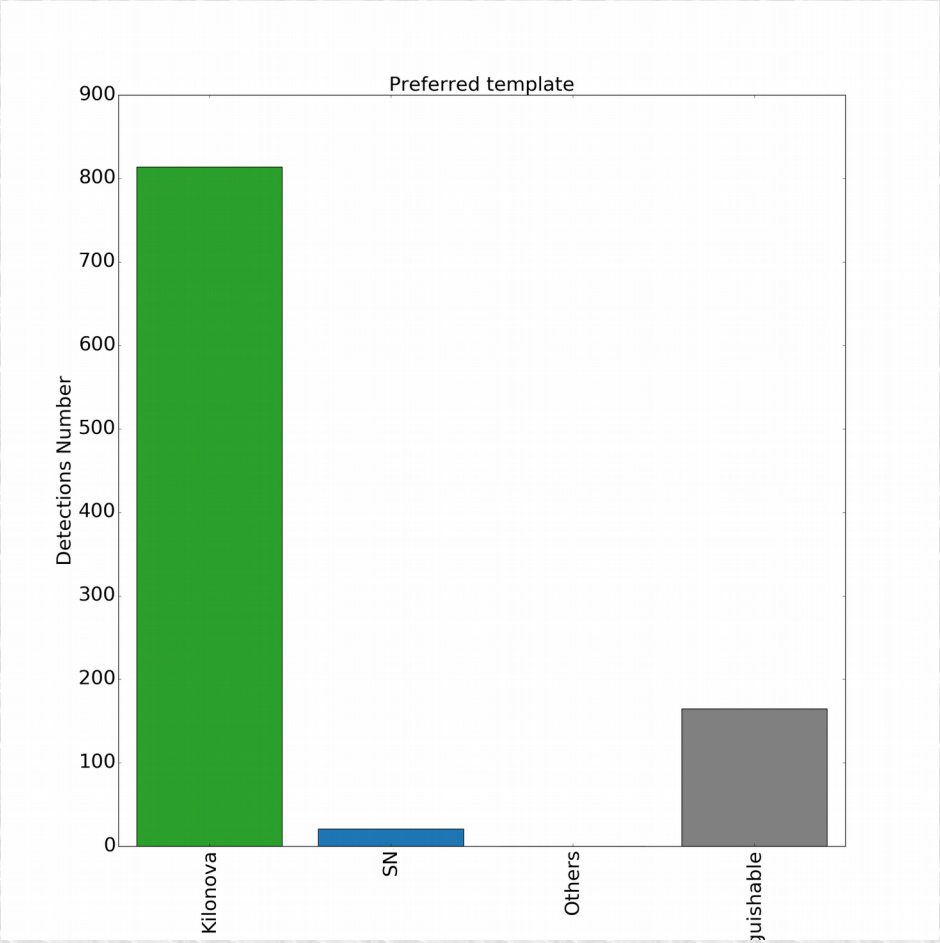
After a few days of observations can I decide if the transient I am looking to is a Kilonova ?

Results

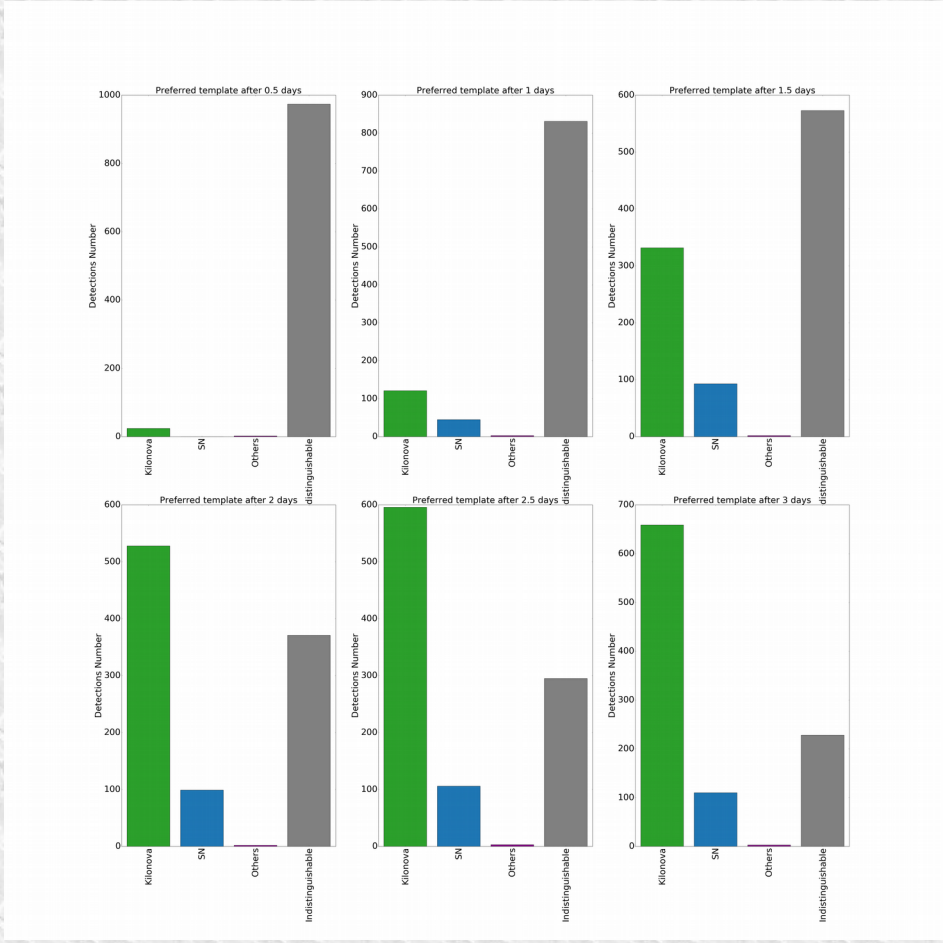
- 1000 Kilonova lightcurves simulations
- similar to ZTF lightcurve
- only ‘r’ and ‘g’ bands
- 2 observations / day in each band



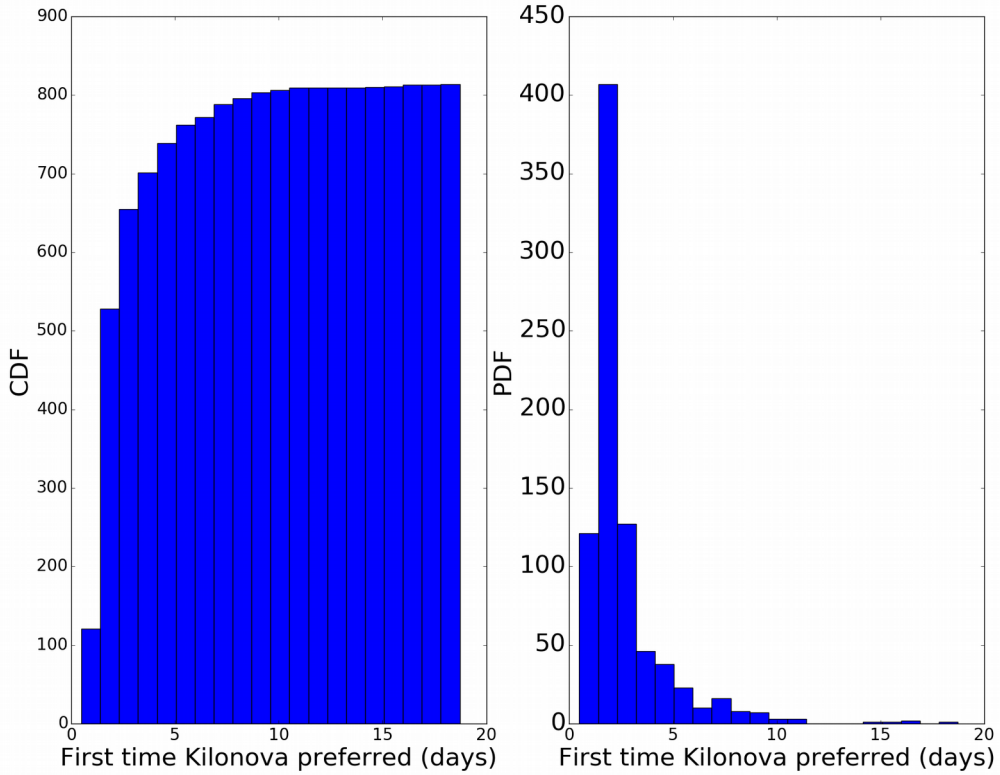
Coughlin et al. 2018 (https://arxiv.org/abs/1805.09371)
Coughlin et al. 2019 (https://arxiv.org/abs/1812.04803)



- long term classification (6/7 days)
- > 80 % successful rate



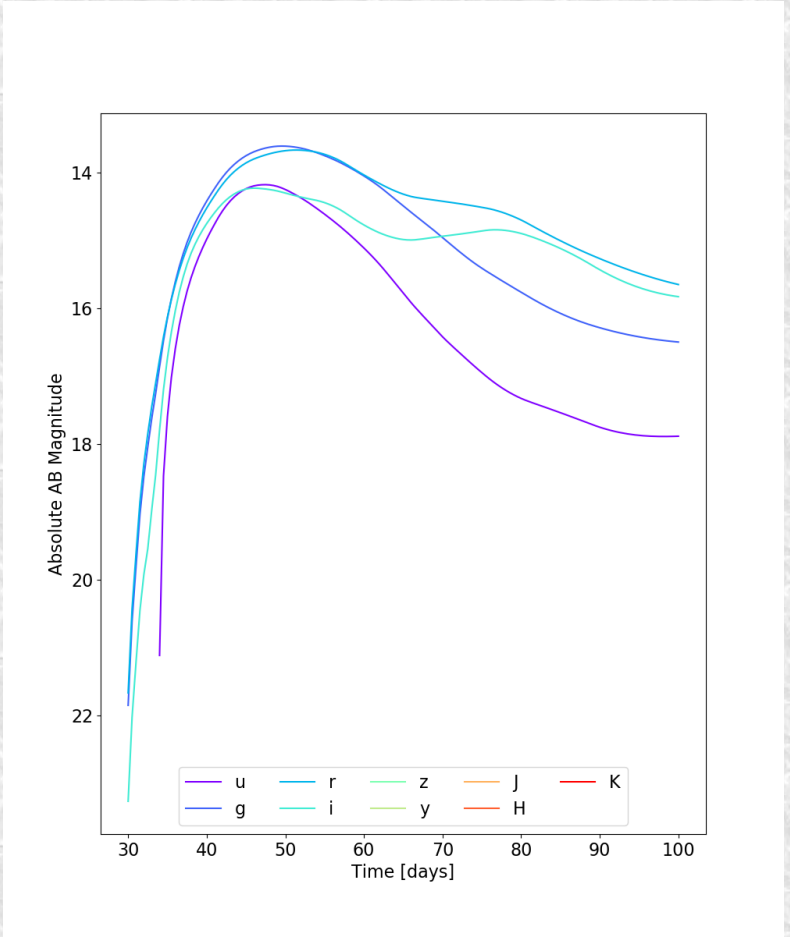
- firsts few days of observation
- after only 2 days « KN » preferred



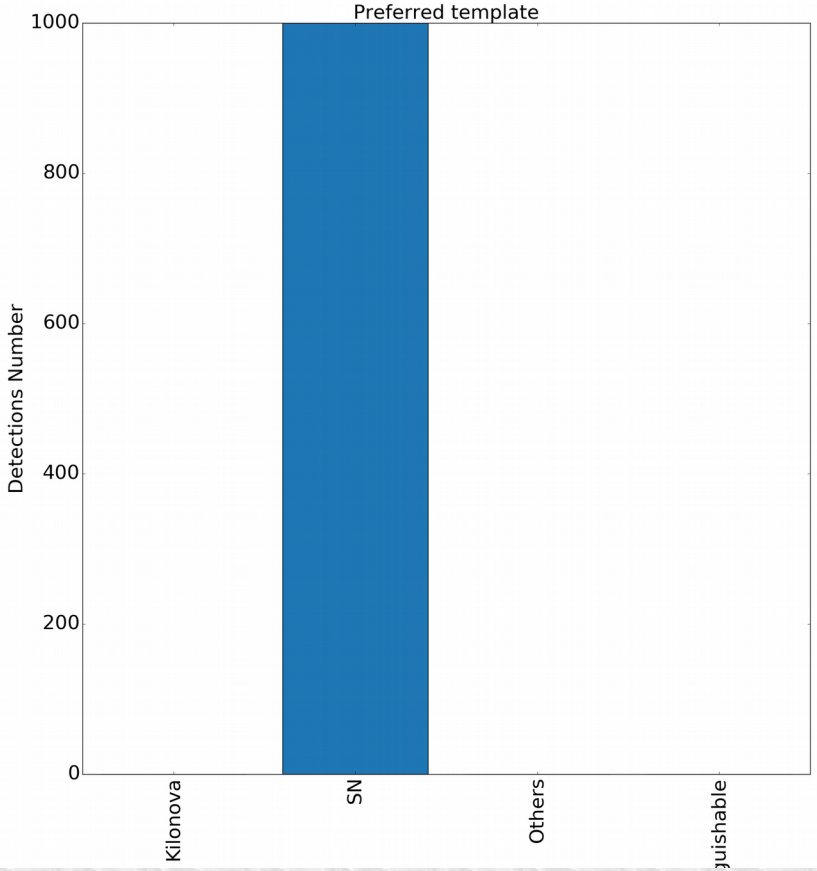
Intermediate result : given a KN lightcurve :

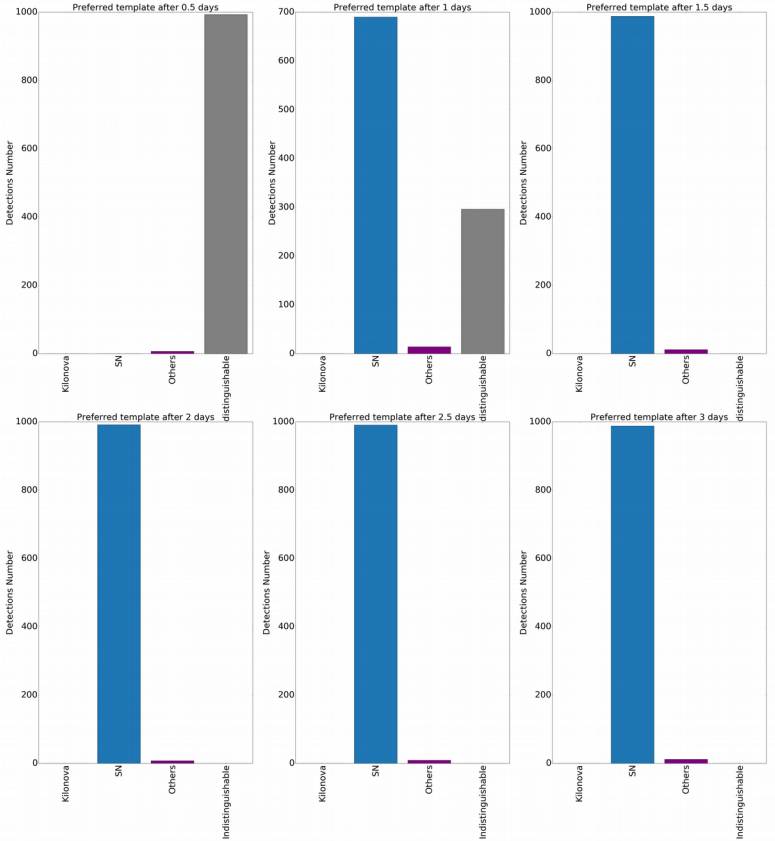
- it is well identified
- It is identified in just a few (2) days

- 1000 SN lightcurves simulations
- only ‘r’ and ‘g’ bands
- 2 observations / day in each band
- only ± 7 days with respect to the peak



Barbary et al. 2016 (http://adsabs.harvard.edu/abs/2016ascl.soft11017B)
Guy et al. 2007 (https://arxiv.org/abs/astro-ph/0701828)



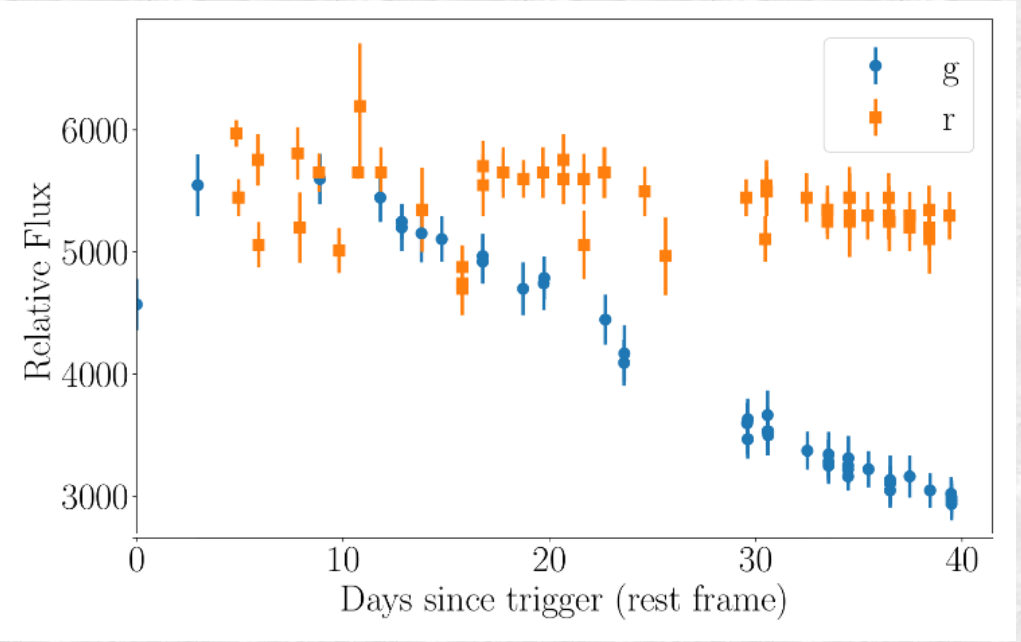


- long term classification (11/12 days)
- 100 % successful rate

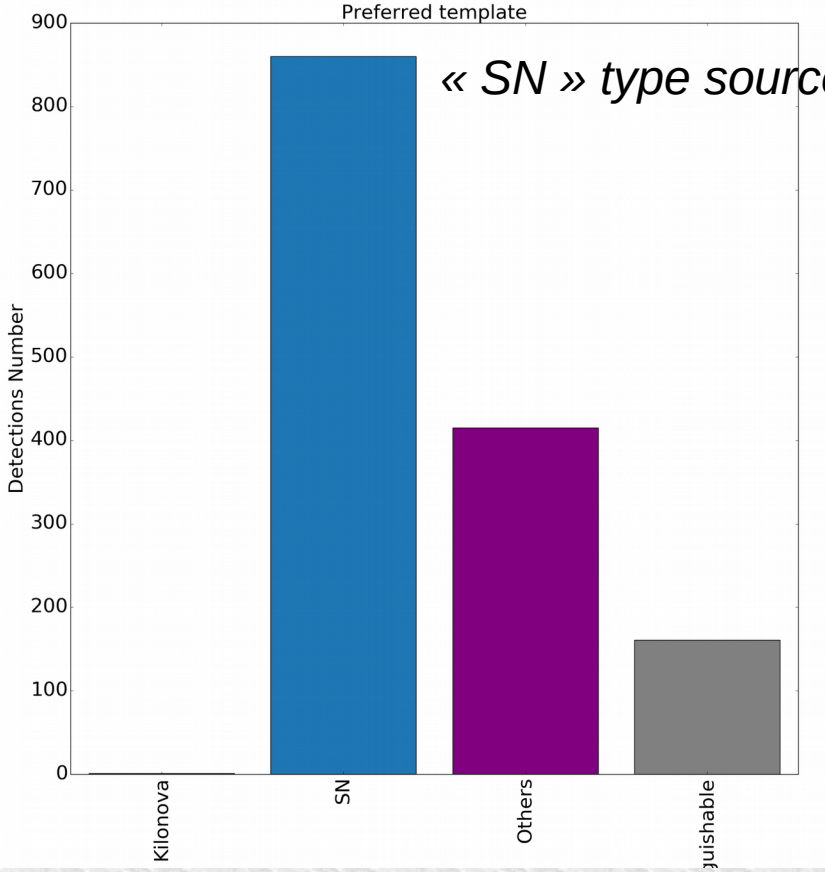
- firsts few days of observation
- after only 1 day « SN » preferred

ZTF real sources

- ZTF has more than 1000 classified events
- « SN » types : SLSN, SNII, SNIbc, SNIa
- « Others » types : AGN, CART, ILOT, TDE

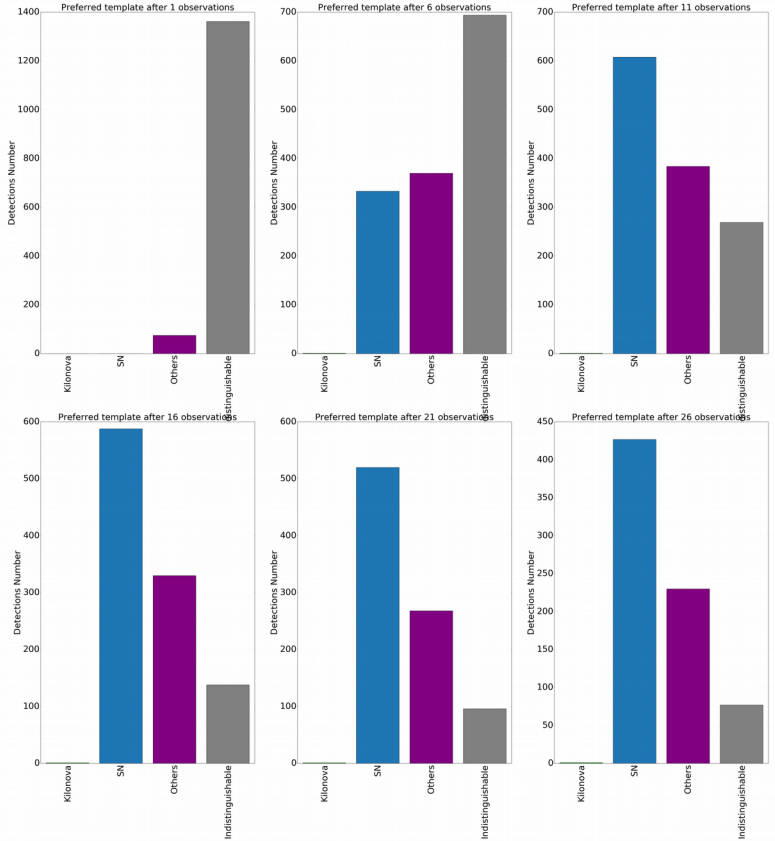


(ex. SNII lightcurve)



« SN » type sources

- long term classification
- > 50 % successful rate



- firsts few observations
- after only ≈ 10 observations « SN » preferred
- « KN » almost never preferred

Conclusion

- for ideally sampled lightcurves (twice each in g and r over 2 nights or 4 observations), kilonovae start to be preferred
- looking at real SNe with the usual MSIP (6 times per night cadence), it takes about 15 observations.