

Kilonova detection in Fink

by

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Fink Collaboration meeting (19th May, 2022)

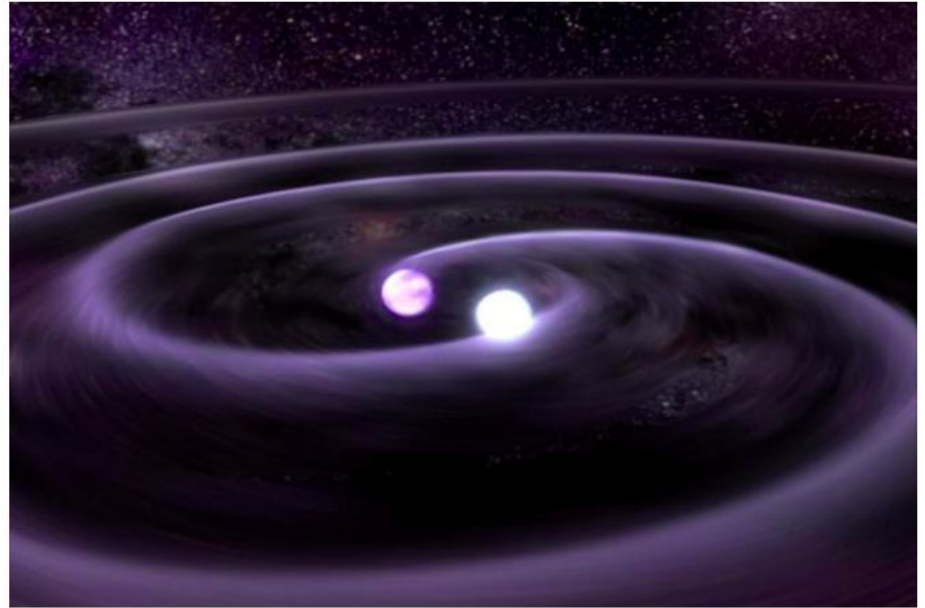


Special thanks to: Emille Ishida (LPC), Anais Moller(LPC), Julien Peloton(IJCLab)

Kilonova

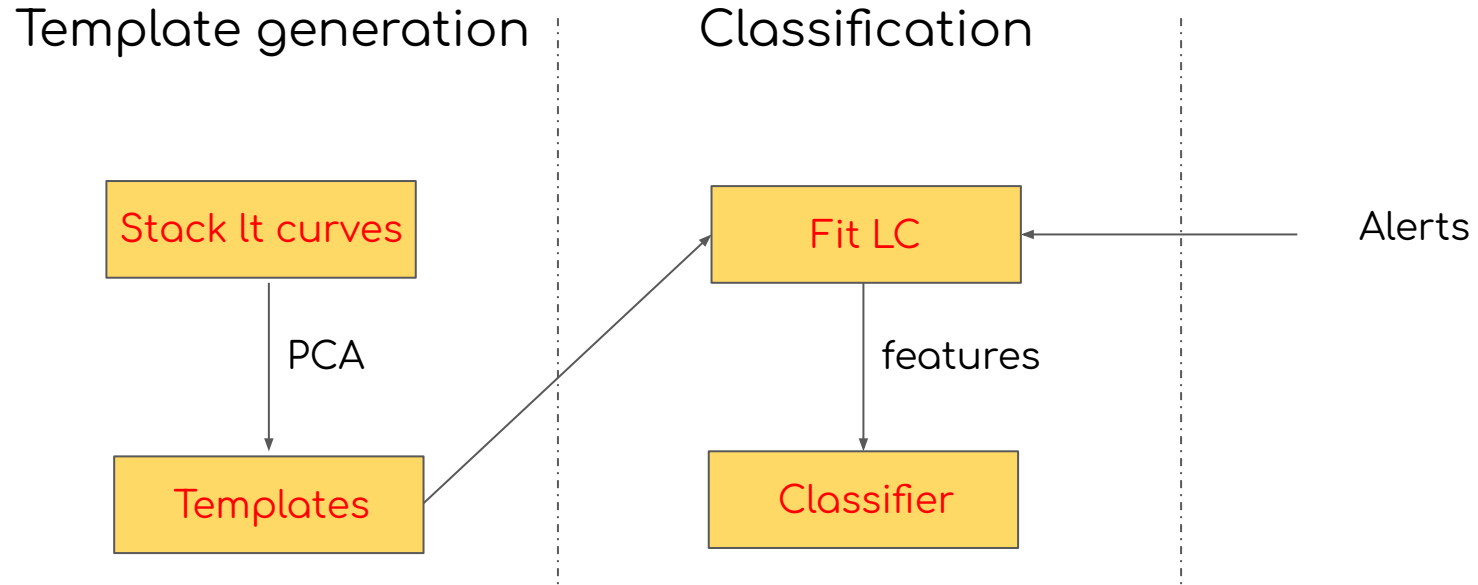
1

- Binary neutron star mergers
- Possible GW detection (GW170817)



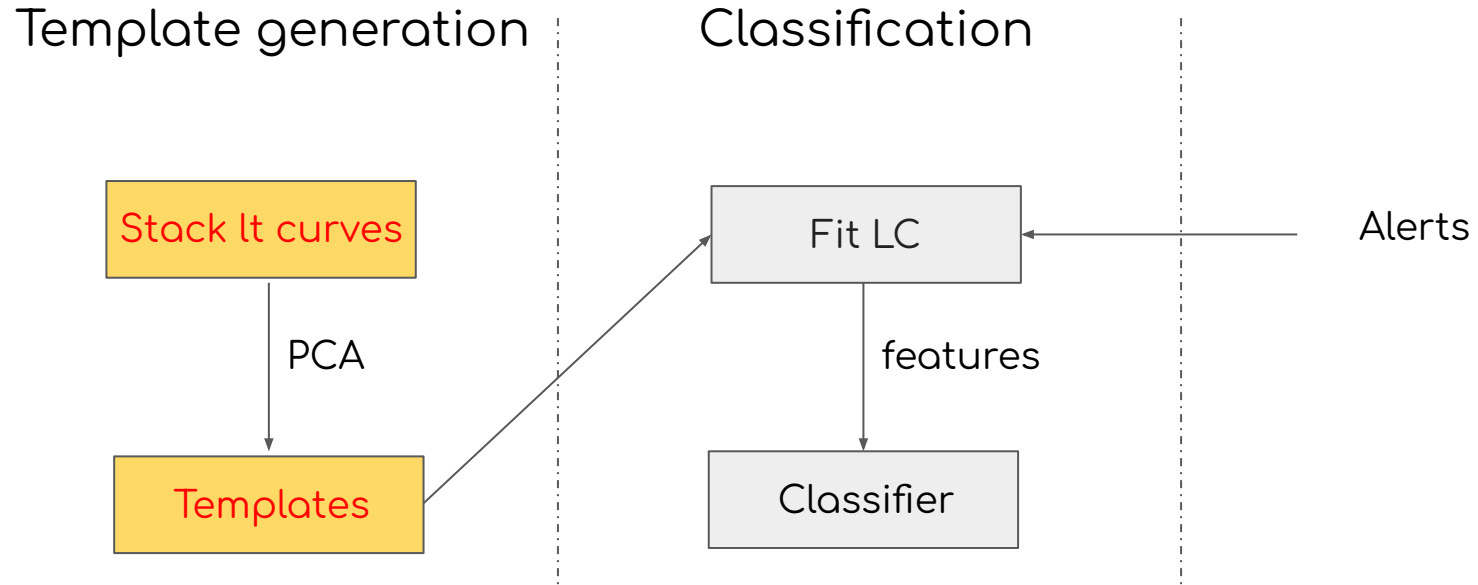
KN module for Fink

2



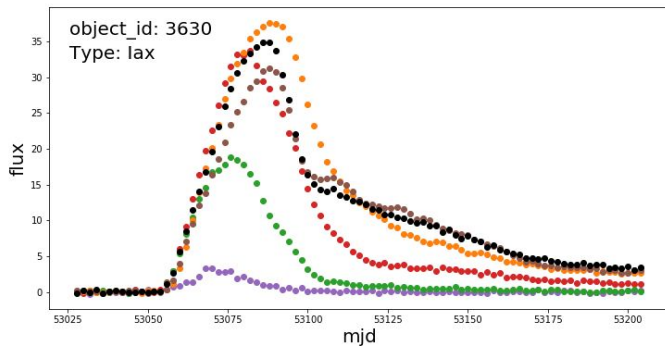
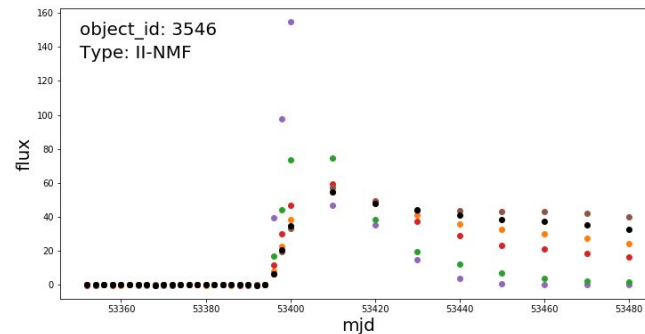
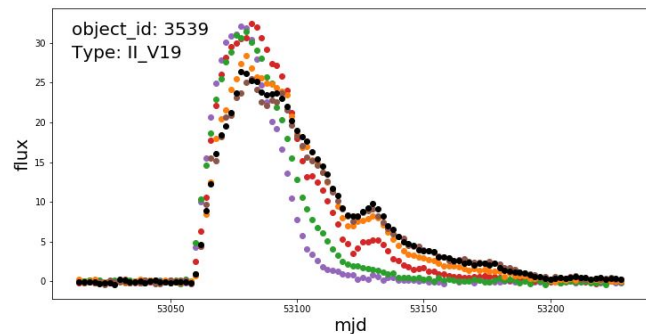
KN module for Fink

3



Generating PCs: Dataset (RESSPECT 'perfect' simulations)

4



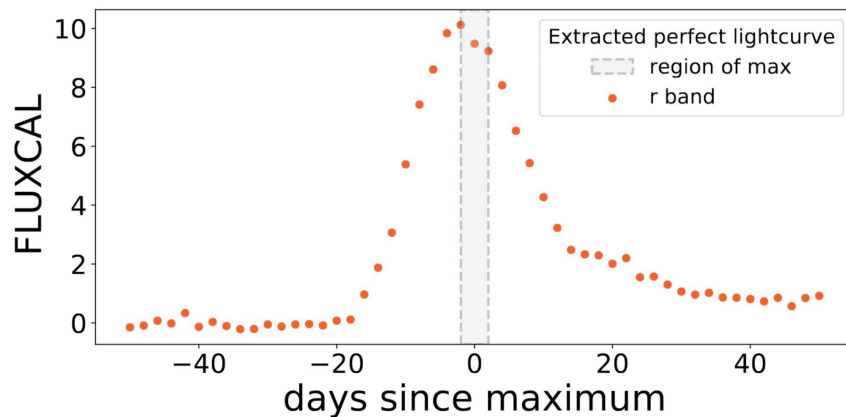
'Perfect' simulations:

- Different types of transient events
- Readings every 2 days
- No missing data points

Generating PCs: Anchoring the data

5

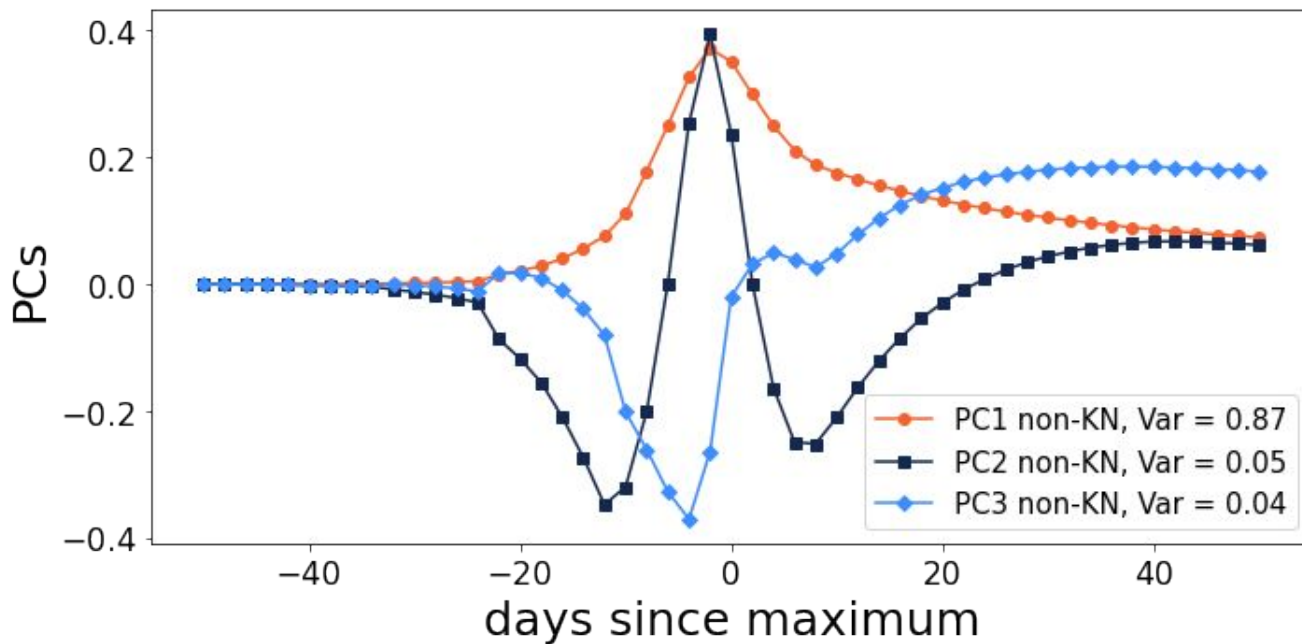
- Events: 1000 KN events + 1000 non-KN events
- Filter only 'g' and 'r' bands of LSST
- Extract 100 days of data in such a way that Amplitude is placed at day 50.



Dataset: RESSPECT sims

Generated templates

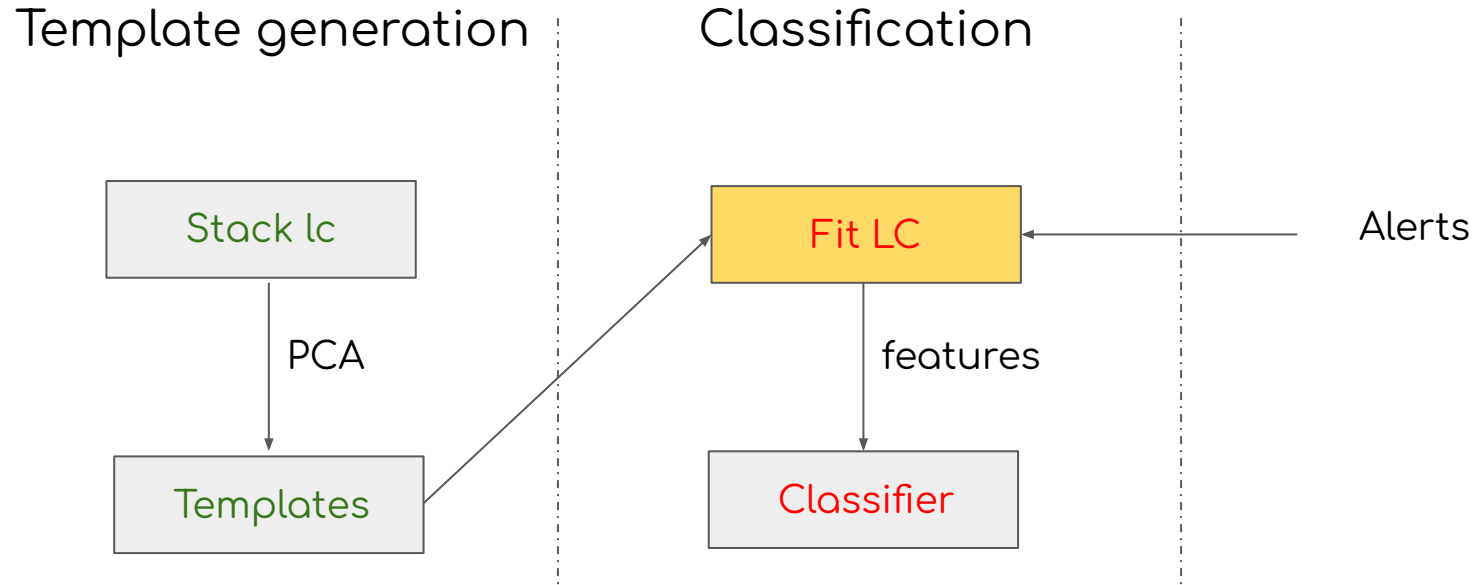
6



Next we will represent light curves as a linear combination of these 3 curves

Flowchart

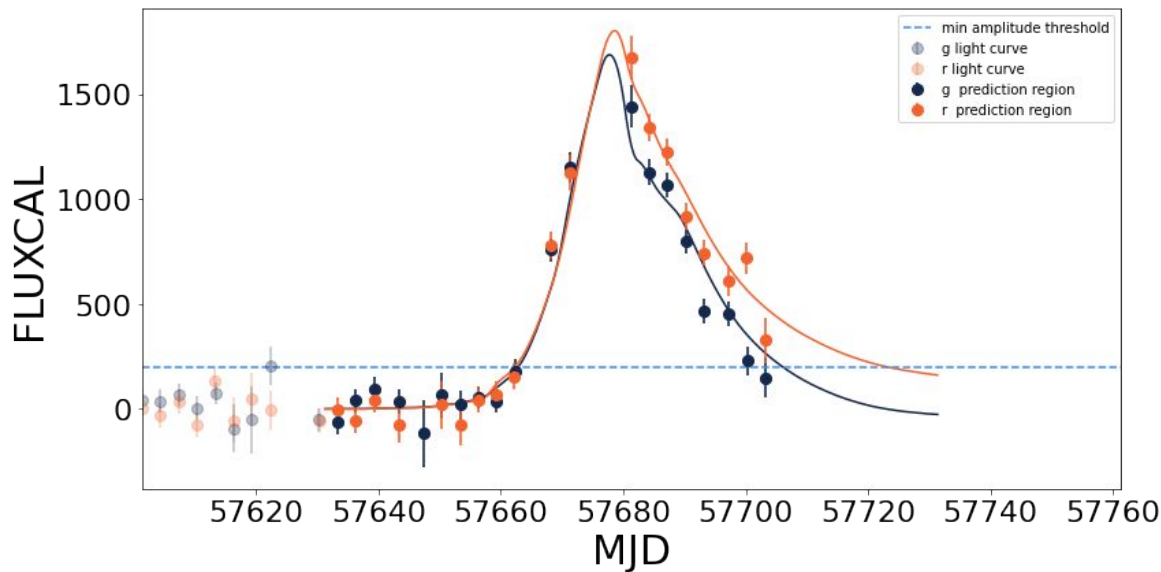
7



Now we will represent light curves as a linear combination of the templates

Fitting the curve: ZTF Simulations

8



For each band:

Make fit only if max flux is above a threshold (>200)

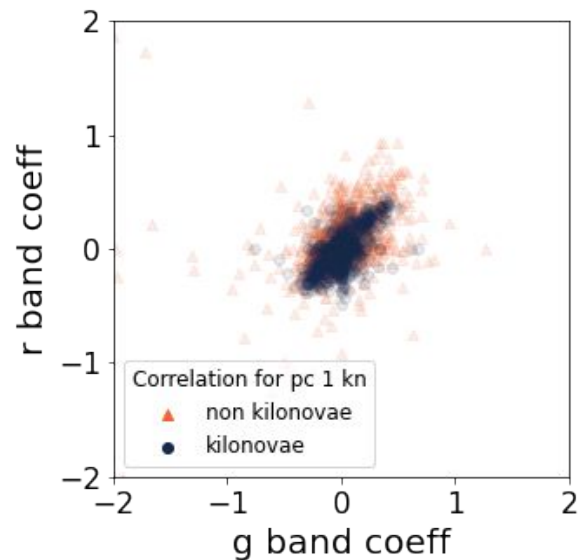
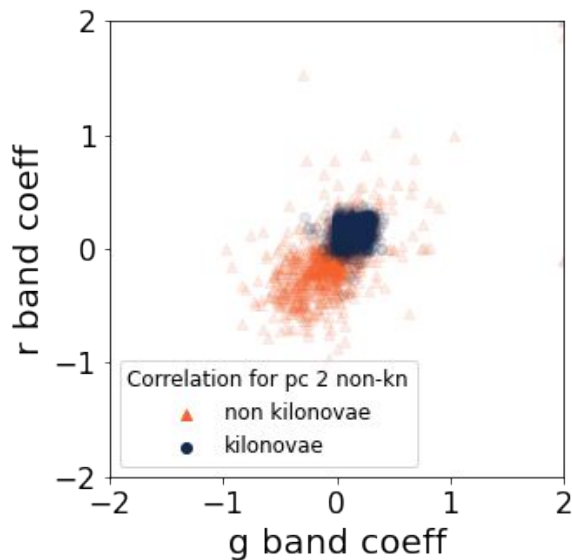
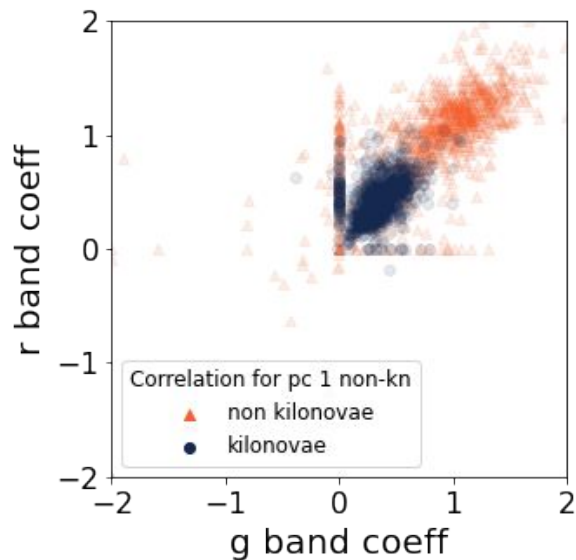
Anchor the data with day 50 of the prediction region as highest flux.

Optimize values of PC coefficients to obtain the fit.

$$loss = \sum_i^N \frac{(l_{p,i} - l_i)^2}{\sigma_i^2} + \left[\sum_{k=1}^3 c_k^2 - c_1^2 H(c_1) \right] \frac{f_{\max}^2}{\sigma_{f_{\max}}^2}$$

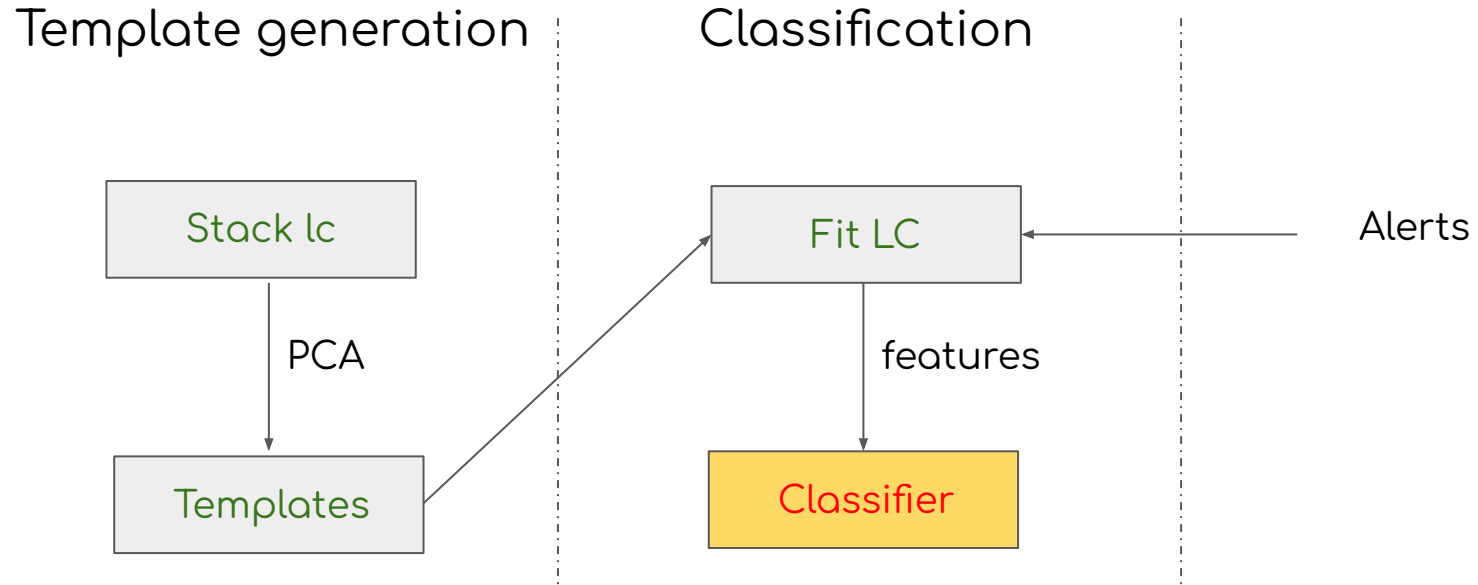
Correlation plots

9



Flowchart

10



Now we will represent light curves as a linear combination of the templates

Classification (Random Forest)

11

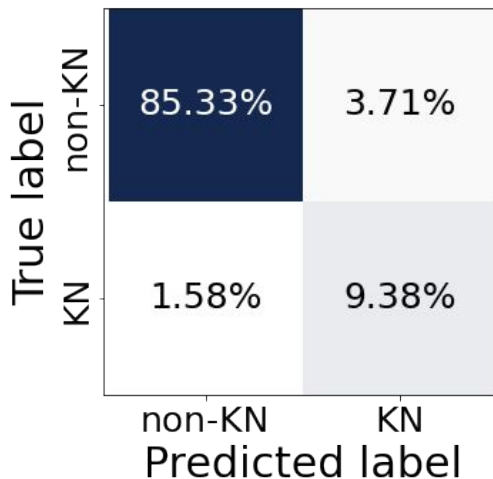
Features: fit coefficients, max flux, fit residual

Train dataset:

total number of events: 21205
total number of KN: 3210
total number of non KN: 17995

Test statistics:

total number of events: 20198
total number of KN: 2213
total number of non KN: 17985



A confusion matrix for a binary classification task. The vertical axis is labeled 'True label' with categories 'non-KN' and 'KN'. The horizontal axis is labeled 'Predicted label' with categories 'non-KN' and 'KN'. The matrix cells contain the following values: Top-left (True non-KN, Predicted non-KN) is 85.33% in a dark blue box; Top-right (True non-KN, Predicted KN) is 3.71% in a light gray box; Bottom-left (True KN, Predicted non-KN) is 1.58% in a white box; Bottom-right (True KN, Predicted KN) is 9.38% in a light gray box. An arrow labeled 'results' points from the test statistics section to this matrix.

True label	non-KN	KN
	85.33%	3.71%
KN	1.58%	9.38%
Predicted label		

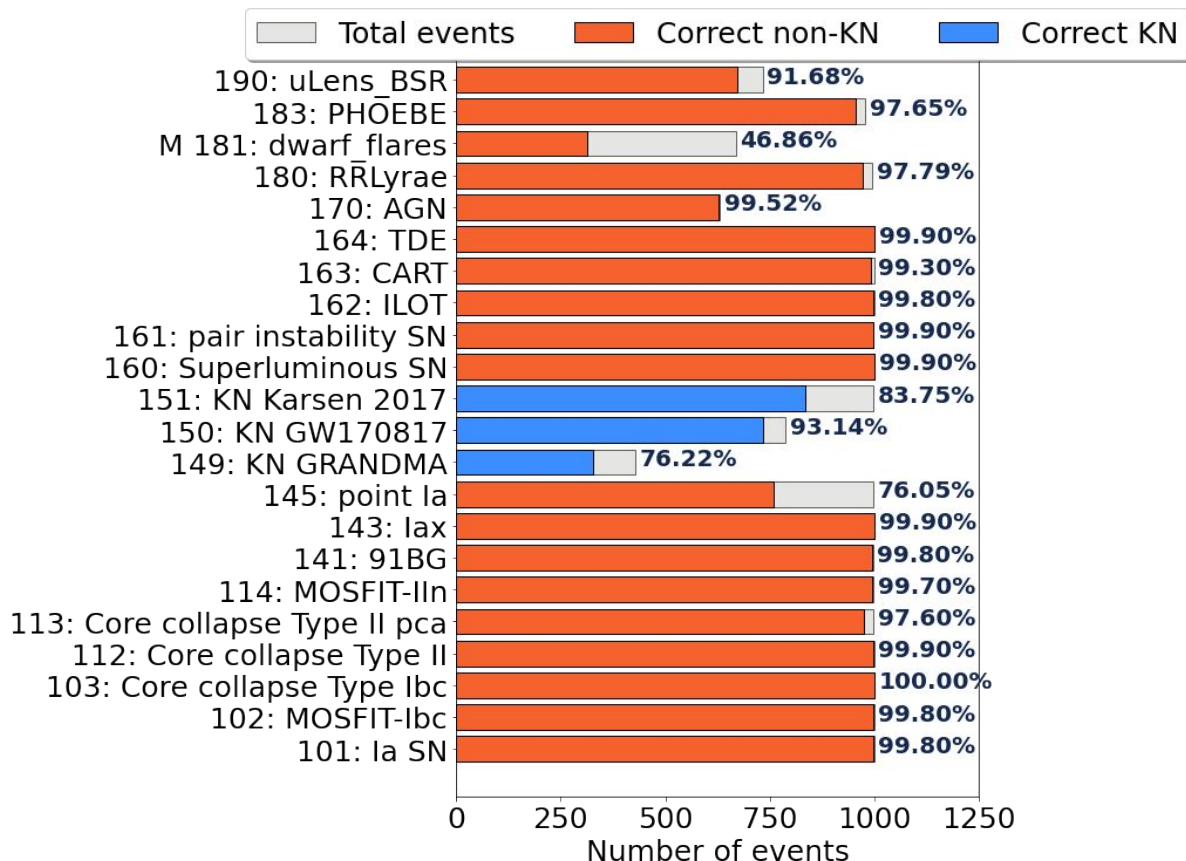
True Positive : 1894
False Positive : 750
True negative : 17235
False negative : 319

Classification (Results)

12

Test Dataset

total number of events: 20198
total number of KN: 2213
total number of non KN: 17985

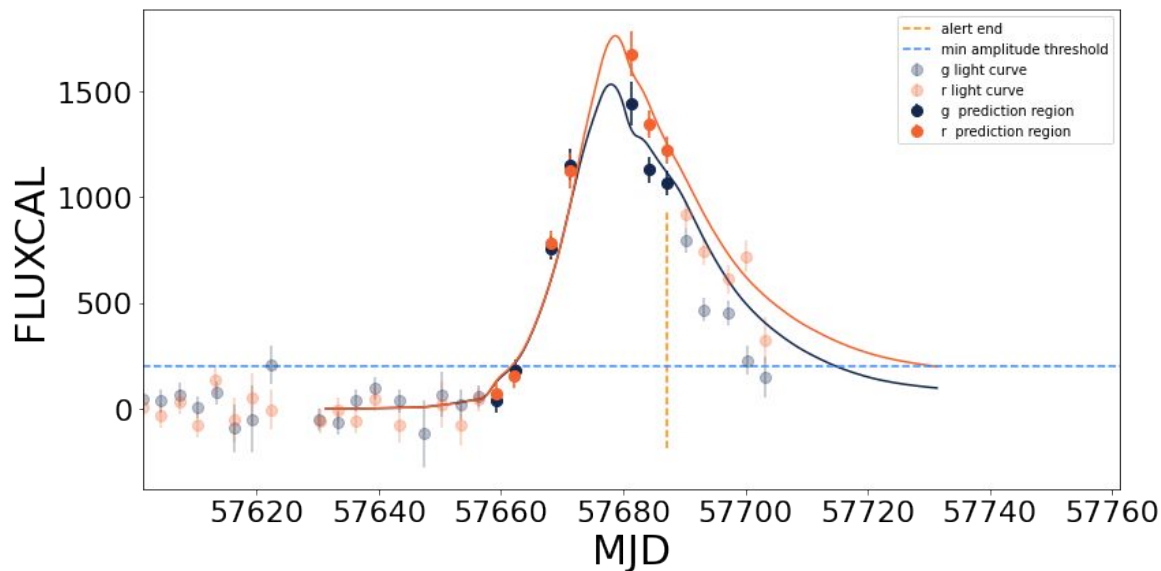




What about alerts?

Mimic alerts

14



Pick a point with flux>200

Use only 30 days of data before
this date

Classification (Random Forest)

15

Features: fit coefficients, max flux, fit residual

Train dataset:

total number of events: 20463
total number of KN: 2986
total number of non KN: 17477

Test statistics:

total number of events: 19450
total number of KN: 2005
total number of non KN: 17445

results

True label	non-KN	KN
	86.65%	3.04%
KN	4.04%	6.27%
Predicted label		

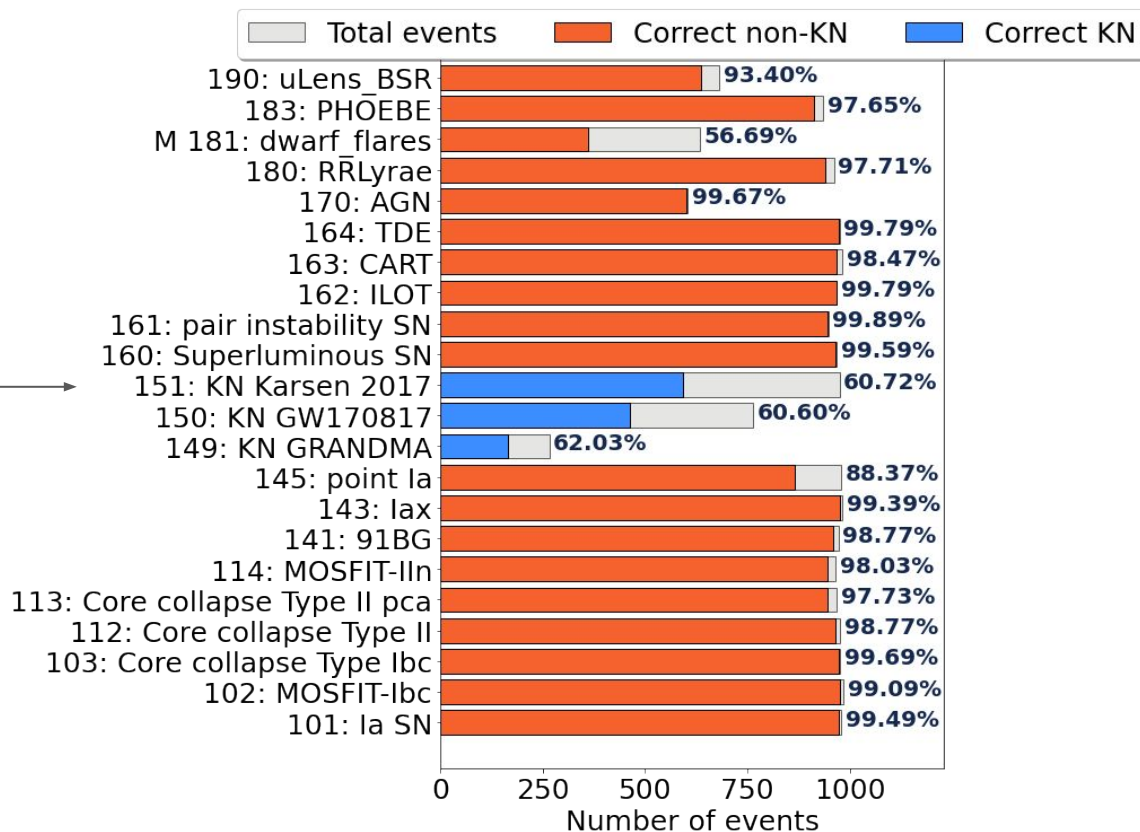
True Positive : 1220
False Positive : 592
True negative : 16853
False negative : 785

Classification results

16

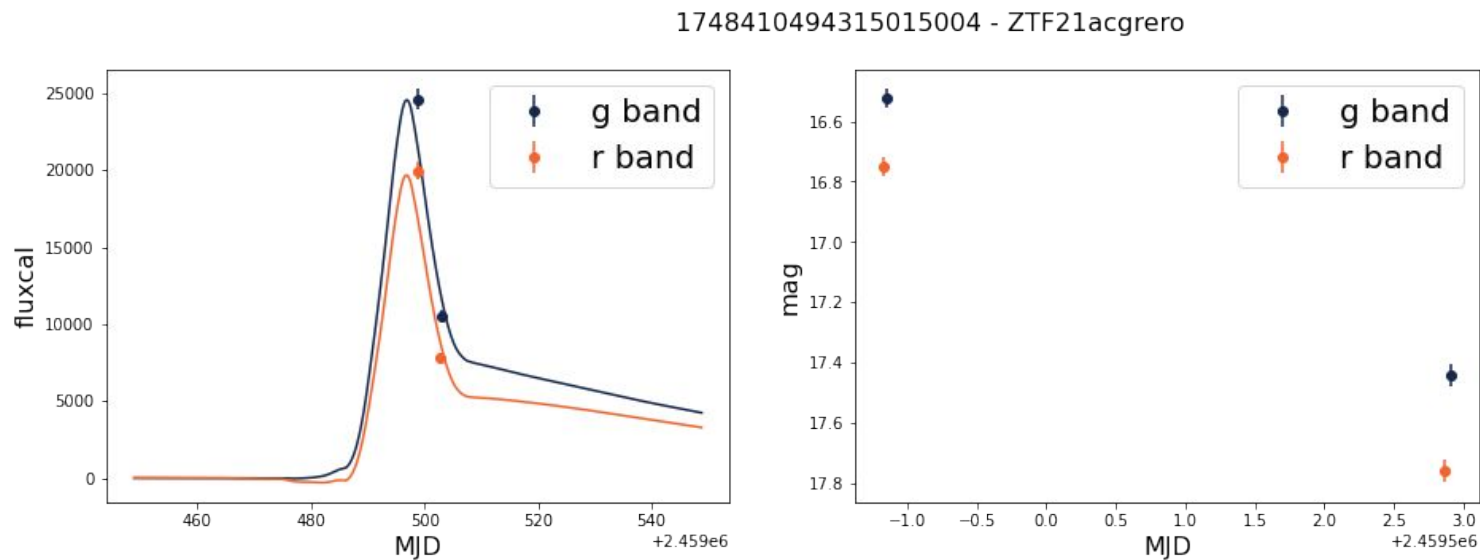
Test dataset:

total number of events: 19450
total number of KN: 2005
total number of non KN: 17445



Example of classified KN:

17



Score = 0.56

Summary and lessons learnt

18

- Requirement:
At least 2 points in a band with $\text{max_flux} > 200$
- Impurities mostly come from other transients
- Initial results on a smaller set of alerts are very encouraging!
Time for (another) test run?
- Common code base for training testing and deployment.
- Code available on git: <https://github.com/b-biswas/kndetect>

Thank you!