



Transient Classifiers for Fink: glimpses from the ELAsTiCC Data Challenge

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Summary

- About Fink Broker
- ELASTiCC: Successor of PLASTiCC
- Fink Classifiers
 - **CATS Broad Classifier**
 - SuperNNova
 - Early Supernova Ia
 - AGN
 - SLSN
- Future Work



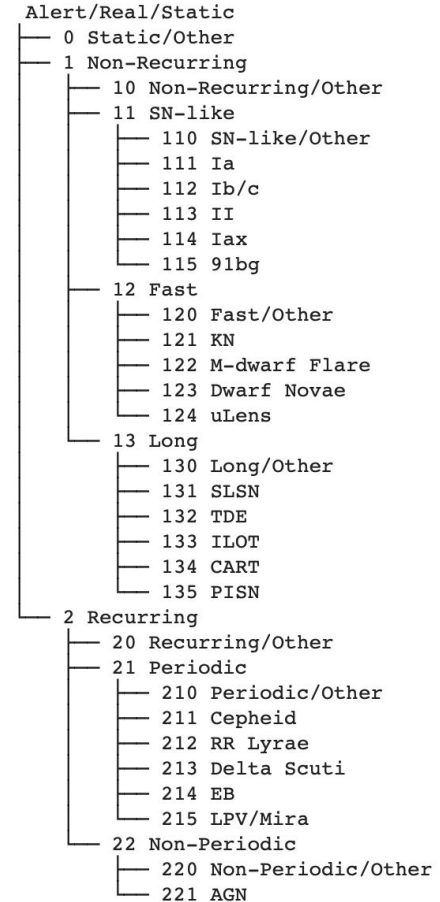
Fink Broker

- Fink is a Community driven project that processes time-domain alerts streams and connect them with follow-up facilities and science teams
- Since 2020, Fink Broker process alerts stream from the Zwicky Transient Facility.
- Fink Broker was selected as a community broker to process the full stream of transient alerts from Vera Rubin Observatory / LSST
- Computing is centralized but classifier development is done by different groups

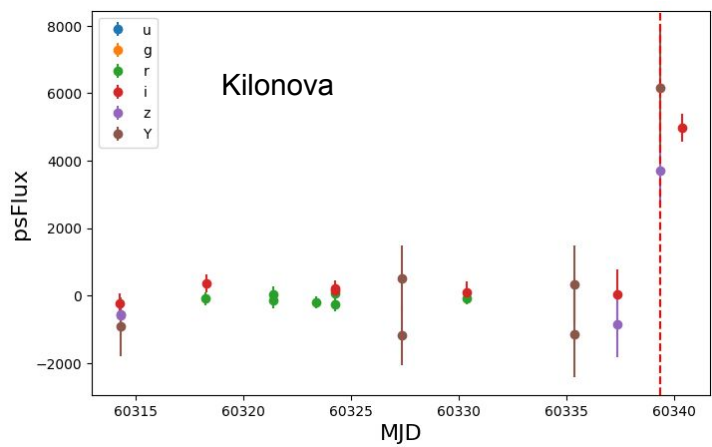
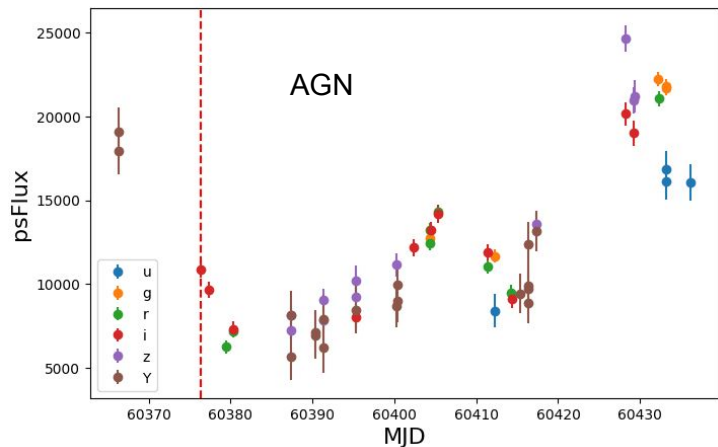
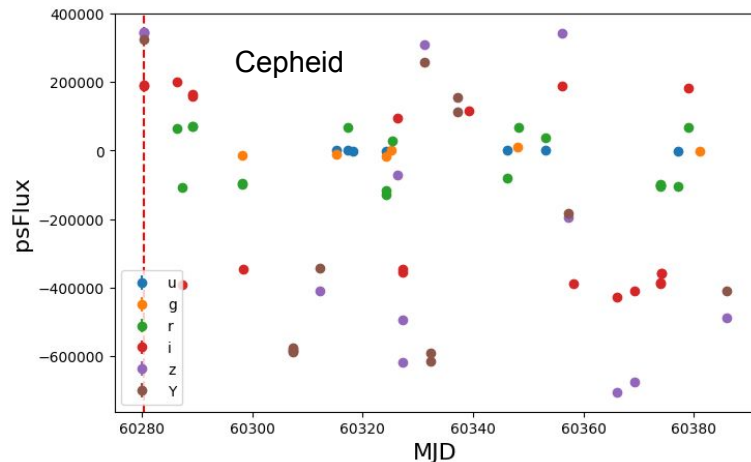
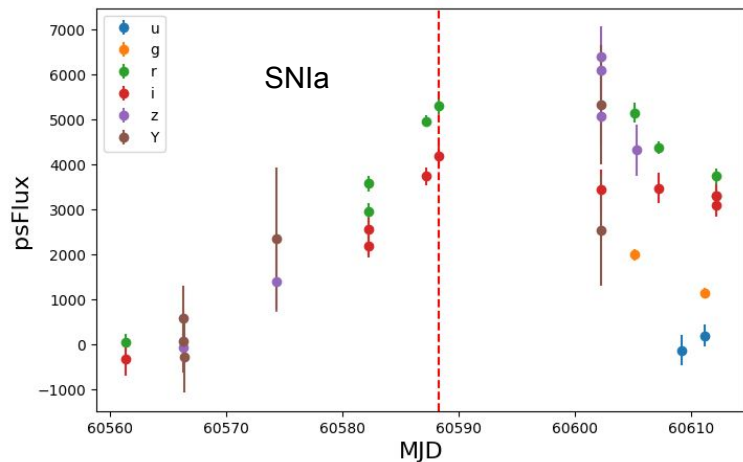


ELAsTiCC

- ELAsTiCC: The successor of PLAsTiCC (**P**hotometric **L**SST **A**stronomical **T**ime-series **C**lassification **C**hallenge)
- **Extended LSST Astronomical Time-series Classification Challenge**
- ELAsTiCC aims to mimic alert content from Vera Rubin LSST.
- Millions of synthetic light curves:
 - SNANA
 - 6 filters (ugrizY)
 - Rubin depth and cadence
 - Extinction and atmospheric noise
 - Realistic host galaxy associations
 - Several Different models in a tree-based taxonomy



Example Light Curves



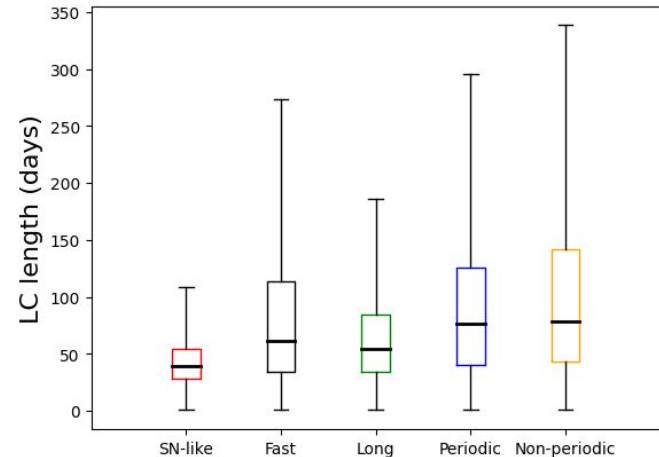
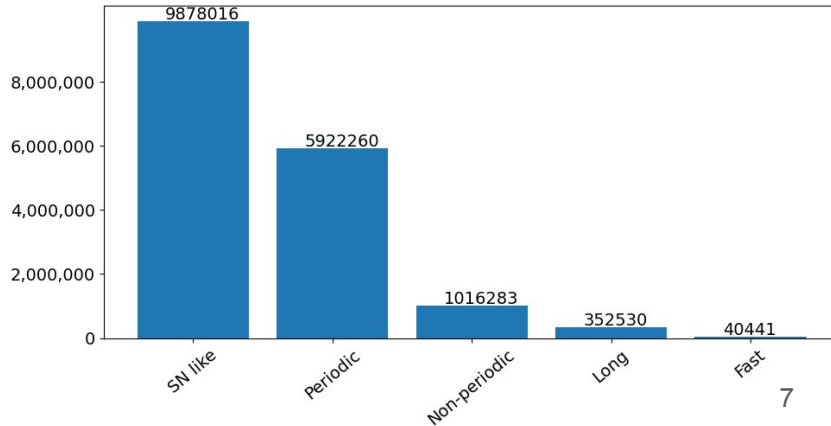
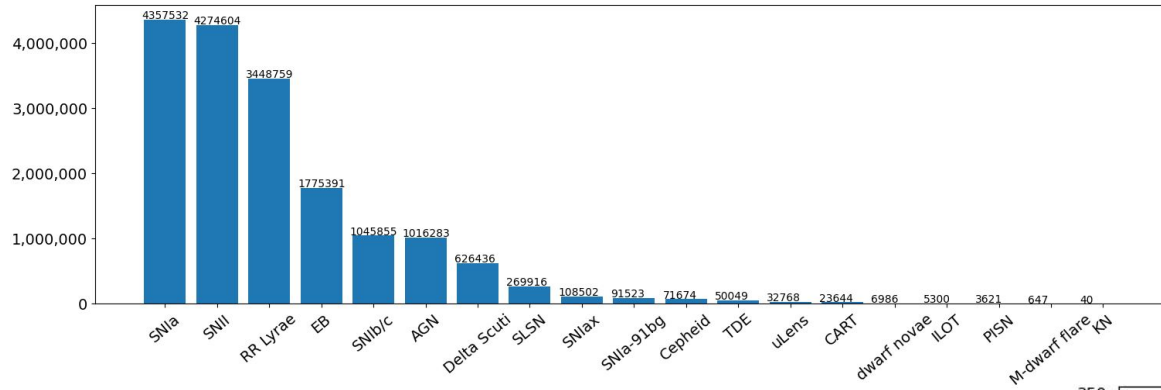
The streamed Sample

- ELASTiCC team streamed alerts daily through the ZTF Alert Distribution Server. 3 years of simulated light curves.
- Truth Table released after 3 years of data were streamed.
- After the unblinding, we used the first year of streamed alerts as training sample.
 - Enhanced version of the initial training sample



Statistics for ELASTiCC Year 1

17,233,868 alerts - 1,676,431 unique objects



Fink Classifiers

- **CATS (CBPF Alert Transient Search) Broad Classifier**
- SuperNNova (Anais Möller)
- AGN (Etienne Russeil)
- SLSN (Etienne Russeil)
- Early SNIa (Marco Leoni, Emille Ishida)

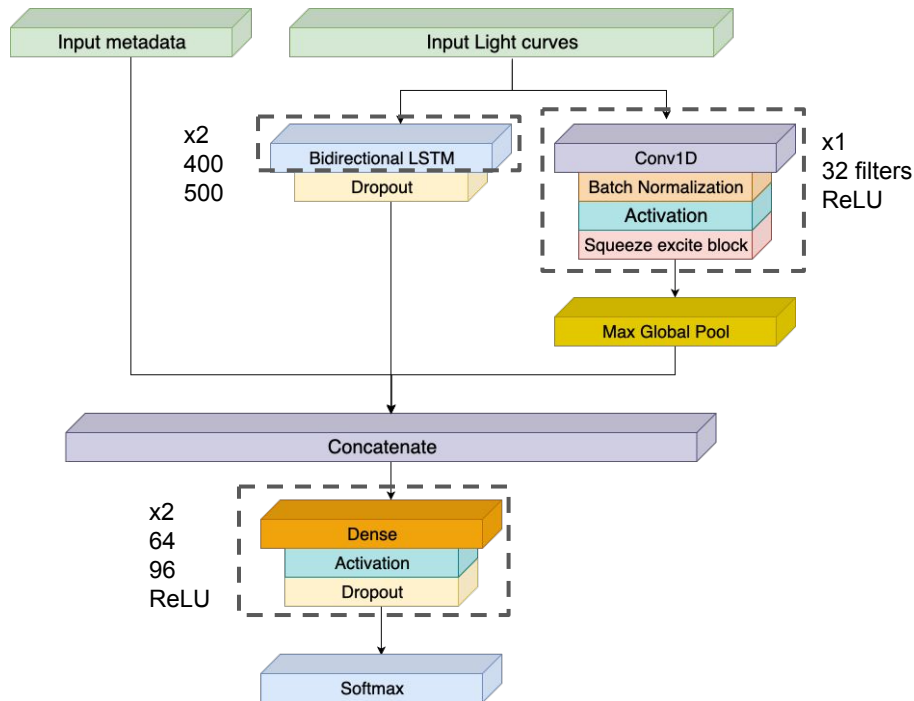


Fraga et al., 2023 - in prep



CATS

- Broad Classifier: Uses 5 superclasses from the taxonomy
- Multivariate LSTM Fully Convolutional Network adapted to two different inputs
- Hyperparameter and architecture optimization
- Light curve: (gap in MJD to the first point, normalized flux, normalized flux error, filter
- Metadata Used:
 - Extinction
 - Host galaxy photoz + error
 - Transient z + error

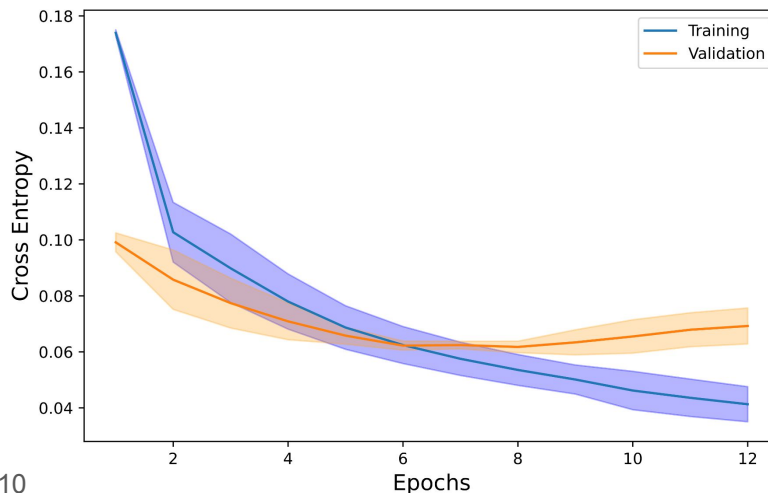
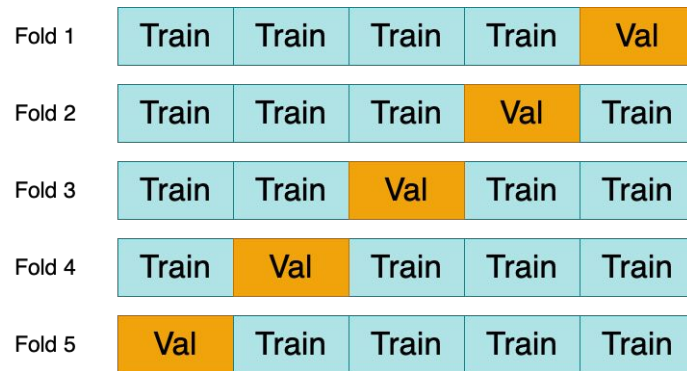


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CATS - Training

- 5-fold cross-validation
- 80% of the unique objects
- Split the unique IDs: alerts of a given object are either in training or test
- Alerts + Forced photometry (only LCs with more than 1 point)
- Model with the lowest validation loss chosen as best at each fold

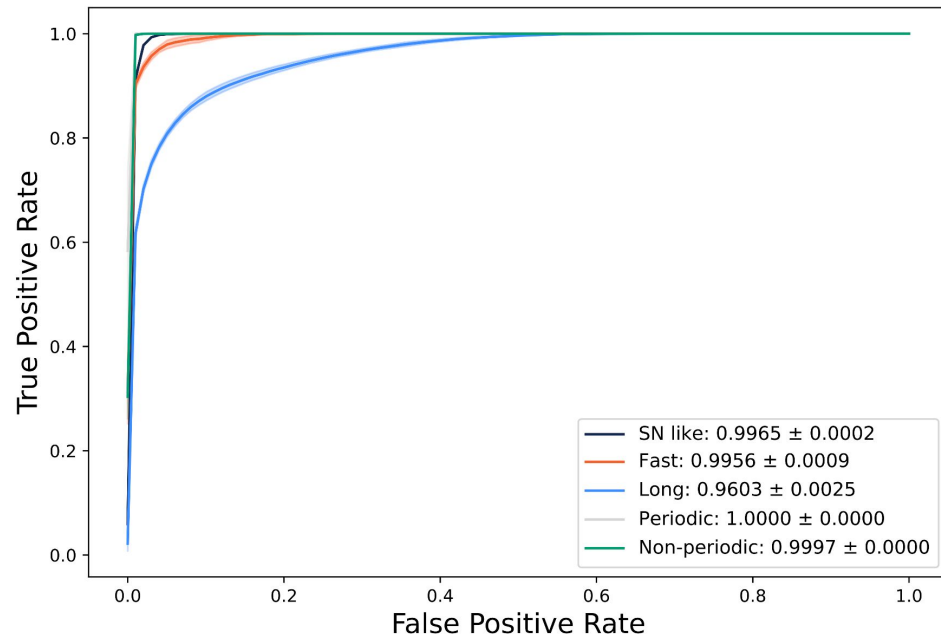


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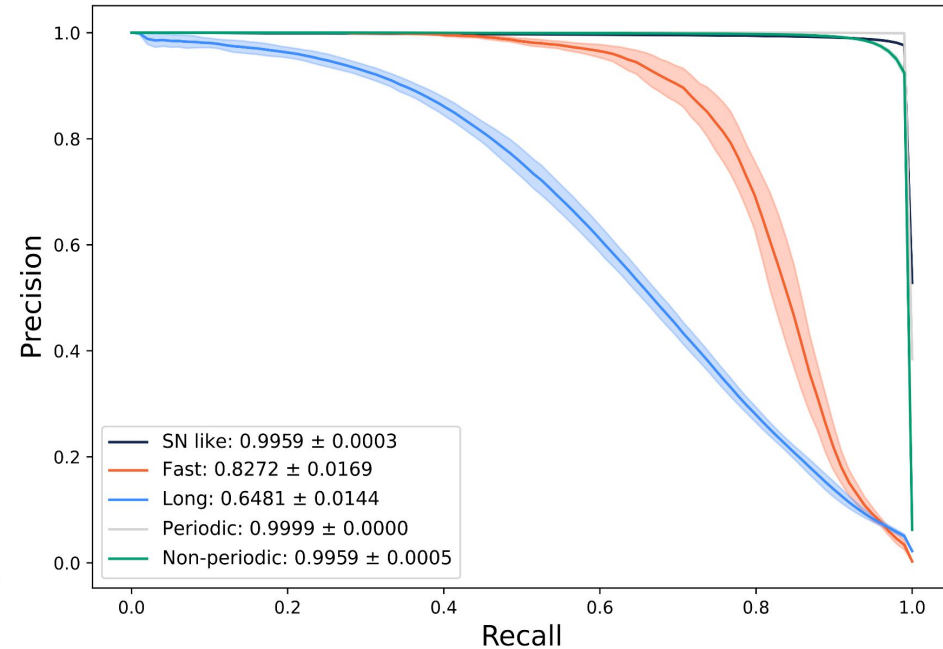


Cross Validation Results - metrics

Receiver Operating Characteristic (ROC)



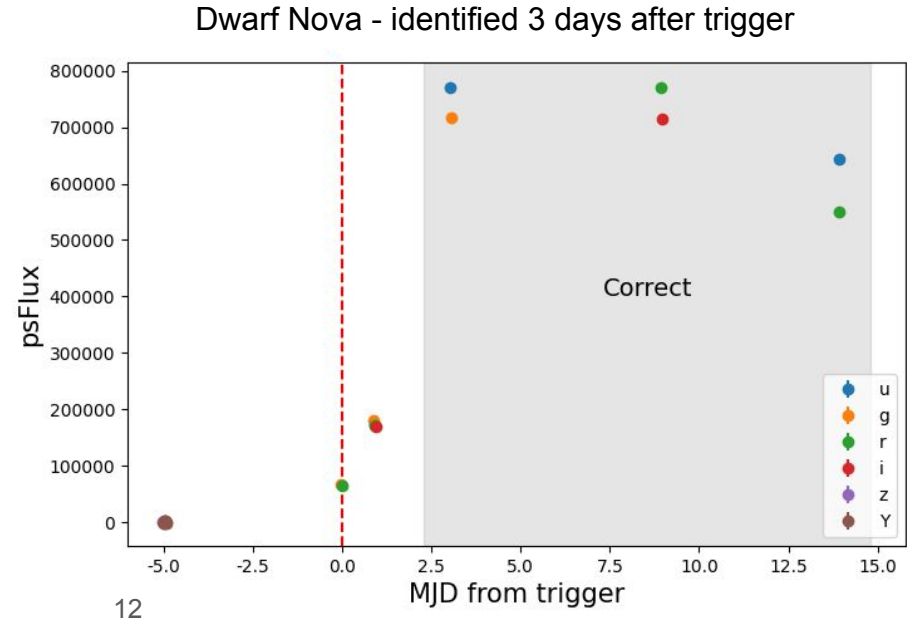
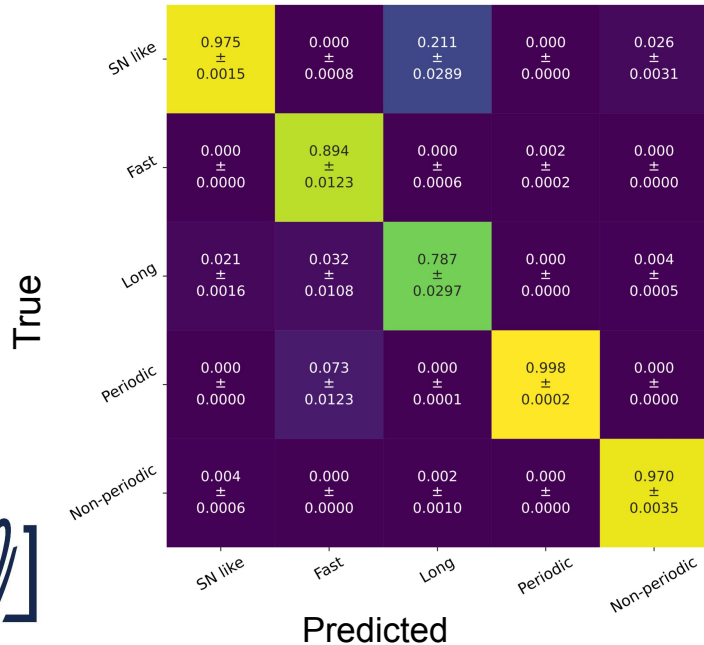
Precision Recall Curve



Cross Validation Results - Discussion

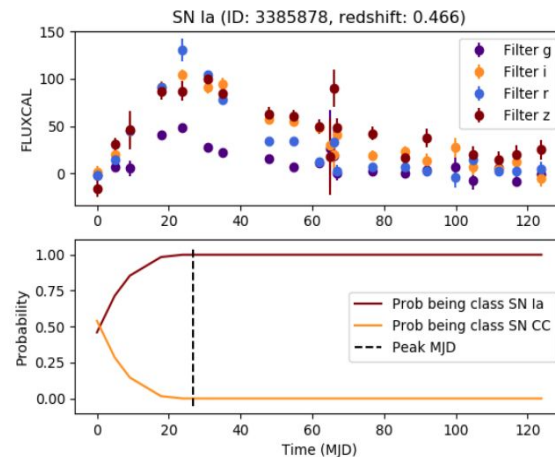
- Model performed well on most classes - Purity almost 100%
- Able to classify fast events only a few days after the trigger
- Greatest source of confusion: Long \rightarrow SN like
 - Driven by SLSN

Fraga et al., 2023 - in prep



Others Classifiers in Fink - SuperNNova

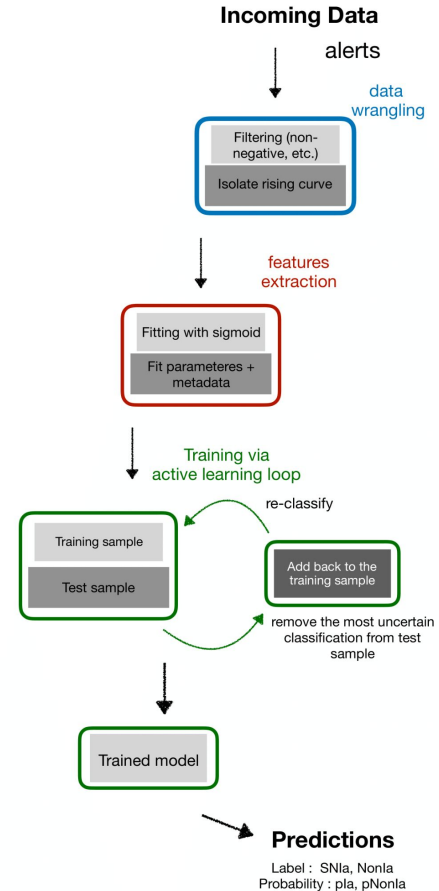
- SuperNNova: Different algorithms for light curve classification
 - Recurrent Neural Networks with Long-Short Term Memory
 - Bayesian Neural Networks with MC dropout
 - Bayes back propagation
- Detection + forced photometry used to make light curve data
- Metadata used:
 - Host galaxy redshift
 - Milk way extinction



Others Classifiers in Fink - Early SNIa

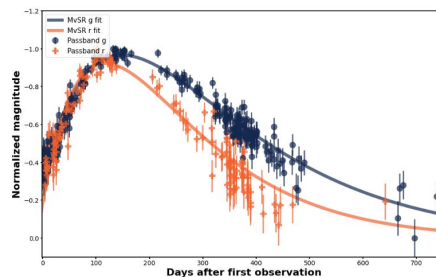
- Binary classifier with active learning and Random Forest Search tree algorithm.
- Features used:
 - ra, dec, host -ra, host - dec, (metadata)
 - host z (+ err), mwebv (metadata)
 - Set of parameters a, b, c obtained by fitting resulting rising lightcurve with sigmoid function

$$\sigma = \frac{c}{1 + \exp(-a(\Delta t - b))}$$

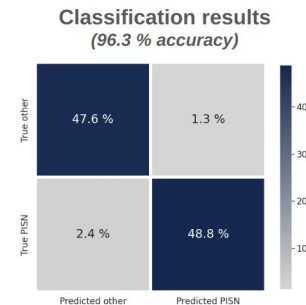


Others Classifiers in Fink - AGN + SLSN

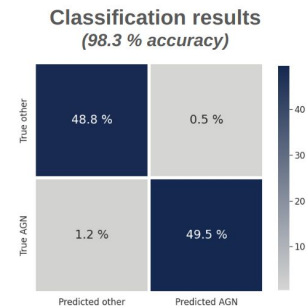
- Similar Algorithm for both classes
- Feature extraction of normalized alerts:
 - Function obtained with symbolic regression (per filter)
- Features used:
 - maximum and standard deviation of flux
 - mean SNR
 - R.A, DEC., host galaxy z (+ err), host galaxy dist
- Random Forest algorithm



SLSN:



AGN:



Future Work

- Y1 result analysis ongoing
- Apply CATS (and others) to ELAsTiCC Y2 and Y3
- Hierarchical classifier for ELAsTiCC in Fink
- Fink ELAsTiCC paper coming soon!!!

