Dark Matter and Stellar Stream Detection

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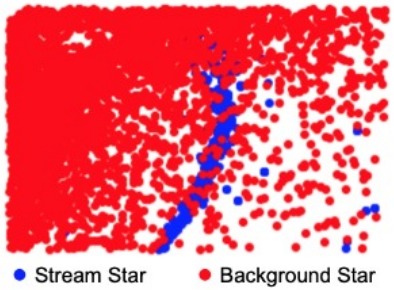
Overview

Background

- Can potentially identify evidence of dark matter based on disturbances in stellar stream
- In 2018, STREAMFINDER algorithm published – able to find stream structures that may lie along any simple or complex orbits
- We aim to expand on these results by improving detection of new stellar streams
- Due to shortage of existing streams, simulated streams are used for model training (Group A)
- Models are then "fine-tuned" and validated on GD1

Problem Description

- Highly imbalanced dataset:
  - Stream stars to background star ratio of 1:250 in GD1
- Given a small number of stars from the same stream, can we identify other candidates belonging to the same stream?



Data Interpretation

Key Variables

Variable	Description
ra	Right ascension
dec	Declination
pmra	Proper motion in ra direction
pmdec	Proper motion in dec direction
g	G-band mean magnitude
g_bp	G-band mean magnitude less integrated BP mean magnitude
g_rp	G-band mean magnitude less integrated RP mean magnitude

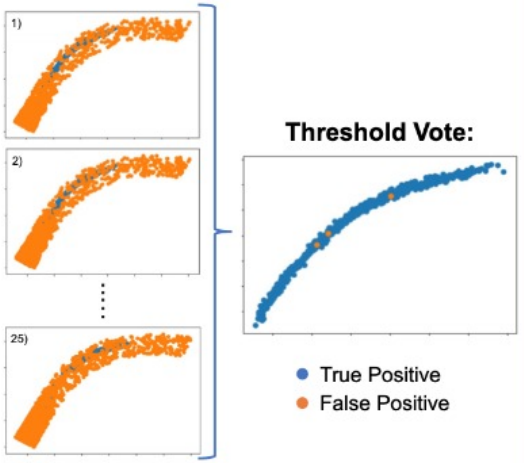
Isochrone Filtering

- Spectral data for a given cluster can be fitted in color space to obtain its age and metallicity of the cluster
- The distances from Earth, computed from the age and metallicity, reduce the number of background stars

Results

EskNN

Ensemble kNN

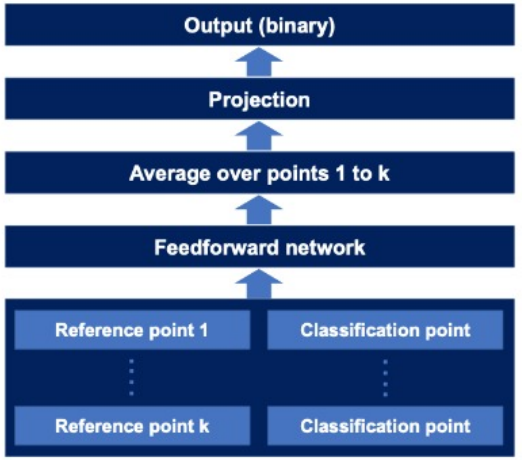


Results

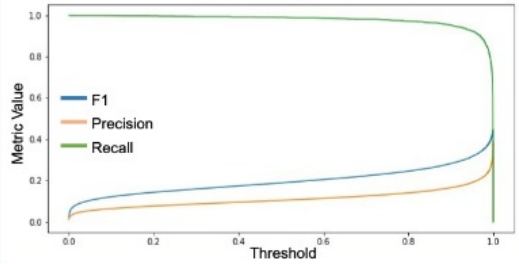
Training	F1 (Simulated)	F1 (GD1)	AUC (GD1)
Group A Stars	0.606	0.325	0.597
GD1 (10%)	Not evaluated	0.731	0.807

DSNN

Model Architecture



GD1 Results



Conclusion and Future Work

GD1 Evaluation Results

Method	F1	AUC
ESkNN	0.731	0.807
DSNN	0.448	0.994

Future Work

- Spectral clustering
- Distance metric learning (non-linear)
- Validation on Palomar 5 (real stream)
- Deep clustering methods