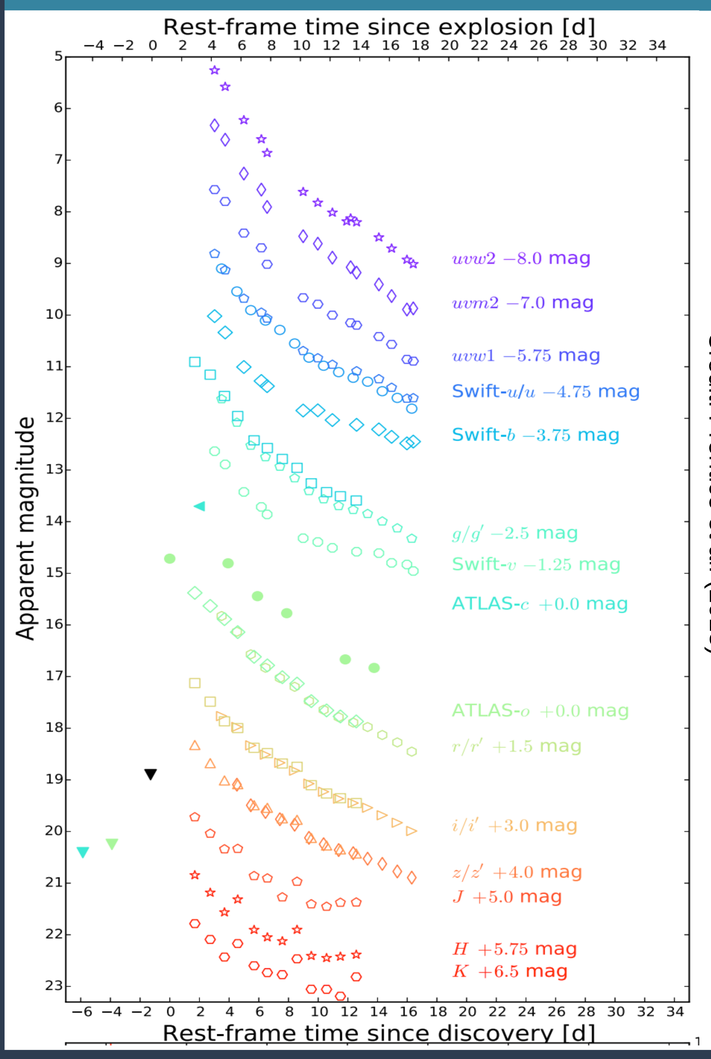
Transient Search and Classification in Subaru/Hyper Supreme-Cam Data Using Machine Learning

Shubham Bhardwaj, Nozomu Tominaga
SOKENDAI/NAOJ
shubham.bhardwaj.grad.nao.ac.jp

Introduction



- Unusual, luminous, fast evolving transients (FETs), different from normal supernovae (SNe) are often common.
- Example: AT2018cow (Prentice et al. 2018).
- ATLAS data point obtained +0.6 days from maximum has m_c = 13.6 mag (−20.5 mag, uncorrected for MW extinction).
- After peak, the light curve (LC) decayed at a rate of 0.05–0.2 mag per day, with the bluer bands typically decaying faster than the redder bands.

WHY PECULIAR TRANSIENTS ARE IMPORTANT?

- they roughly account for 1% of the core-collapse SNe (CCSNe) (Drout et al. 2014).
- Studying peculiar transients will help to understand the properties of their progenitor stars and their evolution history.

Data: Subaru-HSC Time Domain

- Data: forcedsrc_s20a (latest data release).
- 874 data tables: 38 different tracts.
- Filters: g, i, r, y, and z.
- Each tract has different RA and Dec coverage.
- Main data table: DEEP+ULTRADEEP: fsrc_s20a_dud_[tract number]_[filter]: 174 columns.

	visit	ccd	filter	mjd	exptime	fluxmag0	fluxmag0err	id	coord_ra	coord_dec	...	merr_ap57	m_ap84	merr_ap84_fl	merr_
0	198702	69	g	58845.273881	180.0	1.196200e+13	3.333732e+09	170684014682705549	350.200592	-0.643152	...	0.1657	24.0474	0.2565	0
1	198702	69	g	58845.273881	180.0	1.196200e+13	3.333732e+09	170684014682705551	350.126032	-0.642882	...	0.0088	20.6648	0.0124	0
2	198702	69	g	58845.273881	180.0	1.196200e+13	3.333732e+09	170684014682705554	350.147451	-0.641464	...	0.0467	22.1033	0.0500	0
3	198702	69	g	58845.273881	180.0	1.196200e+13	3.333732e+09	170684014682705556	350.157824	-0.641856	...	0.1462	23.3863	0.1438	0
4	198702	69	g	58845.273881	180.0	1.196200e+13	3.333732e+09	170684014682705558	350.230548	-0.641695	...	0.1118	23.0793	0.1033	0

Plan is to include the wide survey data

Preliminary Work

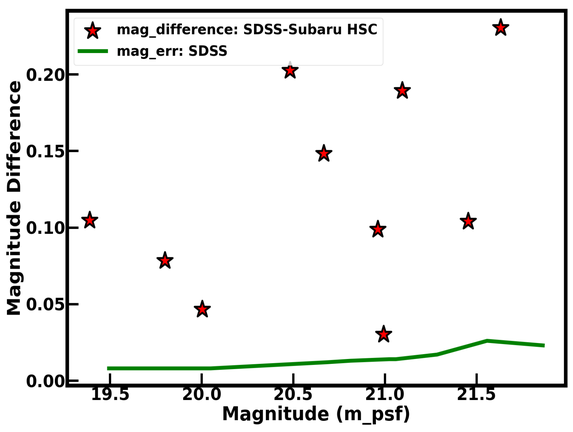


Figure 4: Magnitude difference between the standard stars (SDSS – HSC) for filter “g” (red triangles) for a single visit and ccd. Green line: magnitude error of the standard stars in SDSS.

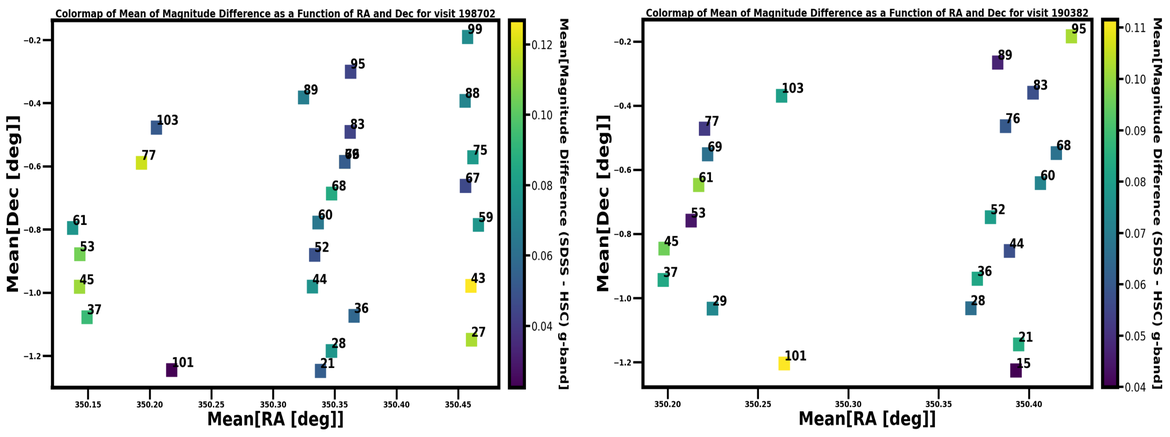
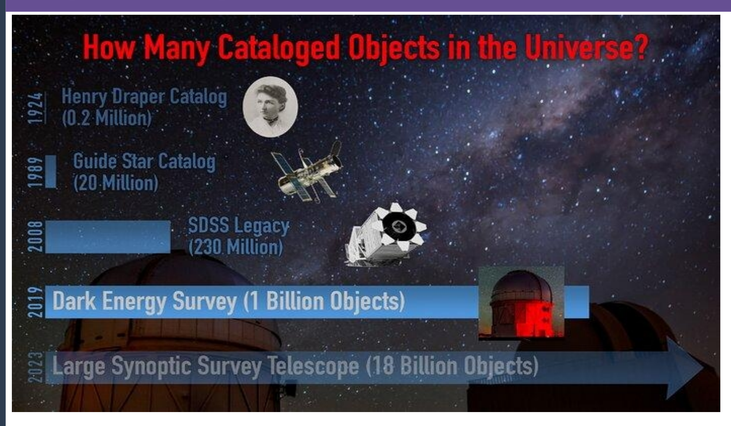


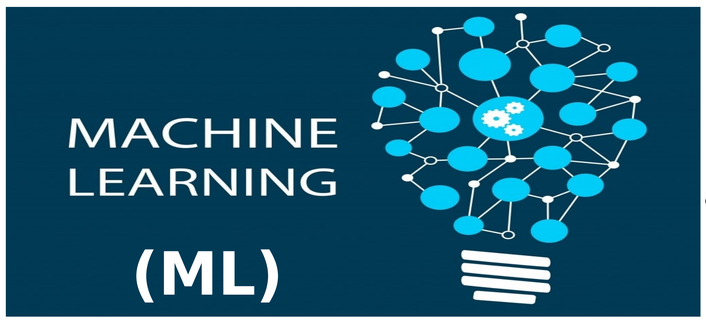
Figure 5: Colormap of the mean of the magnitude difference between the standard stars (SDSS – HSC) as a function of RA and Dec for filter “g” for two different visits combining all ccds in that visit within the same tract.

Scattered!!:- Could be because of the measurement error? Further investigation needed!!

Big Survey Data?



Including surveys from **Subaru/Hyper Supreme-Cam (Subaru-HSC).**



Preliminary Work

WHY?: To understand the data and to check if the data calibration is done correctly or not?

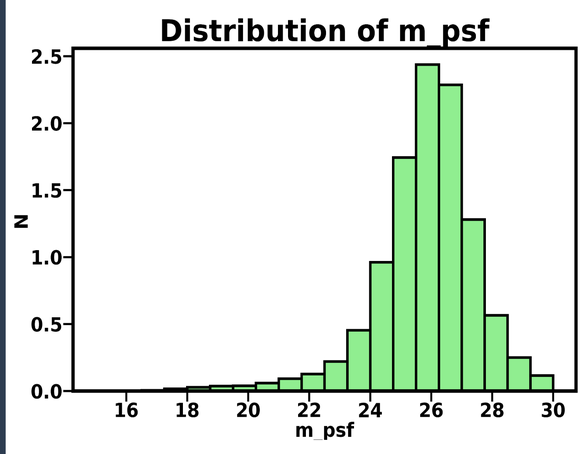


Figure 1: Distribution of “m_psf” for one of the tracts.

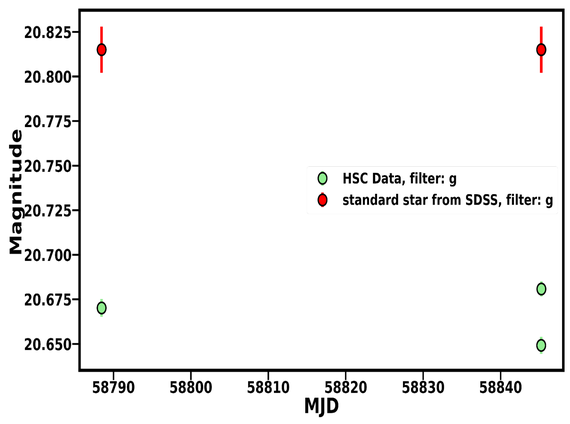


Figure 2: Magnitude comparison between one of the HSC standard star and corresponding SDSS standard star (in “g-band” only).

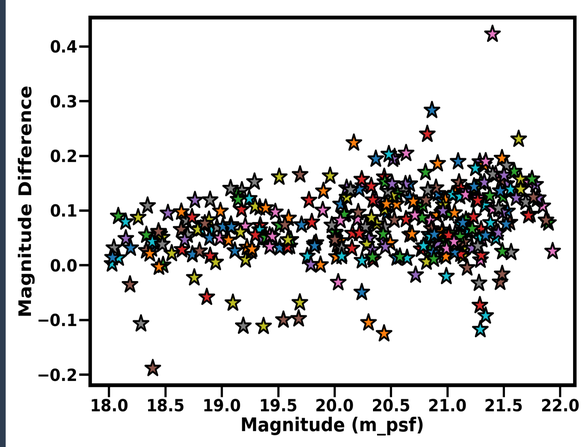


Figure 3: Magnitude difference between the standard stars (SDSS – HSC) for filter “g” considering all the visits and ccds.

WHAT WE FOUND?: Scatter in the magnitude difference between in the standard stars (SDSS – HSC).

WHAT WE PLAN TO DO?: Further investigate this scatter to identify its underlying cause and implement necessary corrections, focusing on calibrating and correcting the magnitude discrepancies.

Future Work

- Combine data from all filters for each tract.
- Classification: Unsupervised ML (DBSCAN, *k*-means, etc.), Supervised ML (Random Forest, SuperLearner, etc.).
- Anomaly detection: Isolation forest, active anomaly detection, etc.
- Visual inspection of the LC of the anomaly transient to check if the transient is really a peculiar transient or not.
- Multi-color LC modeling once or if a peculiar transient is identified.