

What is DASH?

- › Fast and autonomous supernova spectral classification tool
- › Uses Deep Learning to train a matching algorithm
- › Classifies spectra into specific type and age

SNIa: Ia-norm, Ia-91T, Ia-91bg, Ia-02cx, Ia-csm, Ia-pec

SNIb: Ib-norm, Ibn, IIb, Ib-pec

SNIc: Ic-norm, Ic-broad, Ic-pec

SNIi: IIP, IIL, IIn, II-pec

- › Graphical interface and python library available
- › Tested successfully on
 - Operating Systems: Mac/Linux/Windows
 - Python 2/3

Problems with current methods

- › Superfit and SNID rely on iterative template matching processes
 - Computation **time increases linearly with the number of templates**
 - Can only compare to **one template at a time** (rather than the aggregate set of each SN type)
- › Chi-squared minimisations are **slow**
- › **Not autonomous**: requires a lot of human-input

How DASH improves

› Speed

- **Autonomously** classify several spectra at once
- **Significantly faster** (example: 70 classified spectra in 18 seconds)

› Accuracy

- DASH classifies based on **features instead of templates**
 - Uses aggregate set of templates rather than a single template
- Softmax regression probabilities

› Precision

- **More specific classification** including age and specific type

› Installation and ease of use

- Graphical interface and **python library**
- Very simple installation and use



- › **Type:** Correct broad type (i.e. Ia, Ib, Ic, II) identified by the matching algorithm.
- › **Subtype:** Correct subtype (i.e. Ia-norm, Ib-pec, Ib-norm, etc.) identified.
- › **Type and Age:** Correct broad type and the correct age bin identified by the matching algorithm.
- › **Subtype and Age:** Correct subtype and the correct age bin identified.

Criteria	Correctly Classified
Type	98%
Type (Ignoring Ib/c mismatches)	100%
Subtype	93%
Type and Age	91%
Subtype and Age	87%

Results with OzDES Data

- › OzDES data from the last couple of runs at the end of 2016.
- › Matches Superfit in 100% of confirmed cases
- › Classified all 23 spectra in <10 seconds!
- › Able to classify more spectra
 - Precise likelihood measurements (from softmax regression)
 - More precise measurement (with age and specific type)

Name	Redshift	ATEL Classification	DASH		Match?
			Classification	Probability	
DES16E1de	0.292	Ia? (+2)	Ia-pec (+2 to +10)	91%	✓
DES16E2dd	0.0746	Ia (+3)	Ia-norm (+2 to +6)	89%	✓
DES16X3km	0.0542	II (+)	IIP (+6 to +10)	99.7%	✓
DES16X3er	0.167	Ia (+2)	Ia-91T (-2 to +6)	86%	✓
DES16X3hj	0.308	Ia (0)	Ia-norm (-2 to +2)	90%	✓
DES16X3es	0.554	Ia? (0)	IIP (+22 to +26)	92%	x
DES16X3jj	0.238	II? (+)	Ic-pec (-2 to 2)	37%	x
DES16C3fv	0.322	Ia (-6)	Ia-norm (-10 to +2)	99.8%	✓
DES16C3bq	0.241	Ia (+0)	Ia-norm (-2 to +6)	99.6%	✓
DES16E1md	0.178	Ia (0)	Ia-norm (-6 to +2)	99%	✓
DES16E1ah	0.149	II (+)	Ia-91T (+14 to +22)	75%	x
DES16C3ea	0.217	Ia (+)	Ia-norm (+10 to +26)	88%	✓
DES16X1ey	0.076	II (+)	IIb (+2 to +6)	38%	✓
DES16C3bq	0.237	Ia (+)	Ia-norm (-2 to +6)	97%	✓
DES16E2aoh	0.403	Ia (+)	Ia-norm (-2 to +6)	88%	✓
DES16X3aqd	0.033	IIP (+)	IIb (-6 to +2)	99%	✓
DES16X3biz	0.24	Ia (-)	Ia-norm (-14 to +2)	98%	✓
DES16C2aiy	0.182	Ia (+)	Ia-norm (-2 to +6)	99.99%	✓
DES16C2ma	0.24	Ia (+)	Ia-norm (+14 to +22)	99.2%	✓
DES16X1ge	0.25	Ia (+)	Ia-norm (+14 to +22)	99.7%	✓
DES16X2auj	0.144	Ia (0)	Ia-norm (-6 to +6)	84%	✓
DES16E2bkg	0.478	Ia (0)	Ia-norm (-2 to +6)	99%	✓
DES16E2bht	0.392	Ia (+3)	Ia-norm (-6 to +2)	58%	✓

Installation

› `pip install astrodash`

› For the graphical interface you will also need PyQt4

`conda install pyqt=4`

› Also available open source at:

<https://github.com/daniel-muthukrishna/DASH>



Select Spectra

DES16C2ma_C2_combined_1

Browse

Priors

- Trained at $z = 0$
- Known z 0.24
- Agnostic Redshift Model
- SN + Gal Trained Model

Min Redshift 0

Max Redshift 0.5

Smooth 13

Re-fit with priors

Cancel

100%

Best Matches

No.	Type	Age	Softmax Prob..
1	la-norm	18 to 22	0.799639
2	la-norm	14 to 18	0.142247
3	la-norm	22 to 26	0.0265204
4	la-pec	2 to 6	0.0179083
5	la-91T	18 to 22	0.00453055
6	la-norm	10 to 14	0.00384507
7	la-91T	14 to 18	0.002831

Analyse selection

Plot Template la-norm 18 to 22 Host Galaxy

sn2001gc_la-norm_18.2 < > Redshift 0.24



```
import dash

classify = dash.Classify(filenamees, knownRedshifts)

print classify.list_best_matches()

classify.plot_with_gui(indexToPlot=0)
```


In the next updates / Future improvements

- › Display added probabilities of specific SN type
- › False positive rejection
- › Identification of Host Galaxy
 - Extra dimension of classification bins
 - CombinedSpectrum = $\alpha(\text{SN}) + \beta(\text{Host})$
- › Redshifting (currently from host galaxy with user-input from MARZ)
 - Call MARZ and directly pull redshift
 - Agnostic Redshift Model
- › Use past 4 years of OzDES data in Neural network training