PLAsTiCC

Photometric LSST Astronomical Time-series Classification Challenge

LSST – France, CPPM – Marseille, 16-18 January 2018

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From previous talk ...

SN photometric classification is crucial to ensure full exploitation of the data

and

it is also very difficult!

The first SN photometric classification challenge...

Kessler et al., 2010, PASP, Volume 122, Issue 898, pp. 1415

Simulations: Ia, Ib/c, II as expected from DES

Data size: ~20.000 objects, 1103 for training

Participants: 10 groups, 13 entries

Kessler et al., 2010, PASP, Volume 122, Issue 898, pp. 1415

LIST OF PARTICIPANTS IN THE SNPhotCC.

Participants	Abbreviation[a]	Classified +Z[b]/noZ[c]	SN z_{ph}[d]	CPU[e]	Description (strategy class[f])
P. Belov and S. Glazov	Belov & Glazov	yes/no	no	90	light curve χ^2 test against Nugent templates (2)
S. Gonzalez	Gonzalez	yes/yes	no	120	cuts on SiFTO fit χ^2 and fit parameters (1)
J. Richards, Homrighausen, C. Schafer, P. Freeman	InCA[g]	no/yes	no	1	Spline fit & nonlinear dimensionality reduction (4)
J. Newling, M. Varuguese,	JEDI-KDE	yes/yes	no	10	Kernel Density Evaluation with 21 params (4)
B. Bassett, R. Hlozek,	JEDI Boost	yes/yes	no	10	Boosted decision trees (4)
D. Parkinson, M. Smith,	JEDI-Hubble	yes/no	no	10	Hubble diagram KDE (3)
H. Campbell, M. Hilton, H. Lampeitl, M. Kunz, P. Patel (JEDI group[h])	JEDI Combo	yes/no	no	10	Boosted decision trees + Hubble KDE (3+4)
S. Philip, V. Bhatnagar,	MGU+DU-1[i]	no/yes	no	< 1	light curve slopes & Neural Network (2)
A. Singhal, A. Rai, A. Mahabal, K. Indulekha	MGU+DU-2	no/yes	no	< 1	light curve slopes & Random Forests (2)
H. Campbell, B. Nichol,	Portsmouth χ^2	yes/no	no	1	SALT2–χ^2_r & False Discovery Rate Statistic (1)
H. Lampietl, M .Smith	Portsmouth-Hubble	yes/no	no	1	Deviation from parametrized Hubble diagram (3)
D. Poznanski	Poz2007 RAW	yes/no	yes	2	SN Automated Bayesian Classifier (SN–ABC) (2)
	Poz2007 OPT	yes/no	yes	2	SN–ABC with cuts to optimize $\mathcal{C}_{\mathrm{FoM-Ia}}$ (2).
S. Rodney	Rodney	yes/yes	yes	230	SN Ontology with Fuzzy Templates (2)
M. Sako	Sako	yes/yes	yes	120	χ^2 test against grid of Ia/II/Ibc templates (2)
S. Kuhlmann, R. Kessler	SNANA cuts	yes/yes	yes	2	Cut on MLCS fit probability, S/N & sampling (1)

[a]Groups are listed alphabetically by abbreviation.
[b]Classifications included for SNPhotCC/HOSTZ.
[c]Classifications included for SNPhotCC/noHOSTZ.
[d]photo-z estimates included.
[e]Average processing time per SN (seconds) using similar 2-3 GHz cores.
[f]From §3, strategy classes are 1) selection cuts, 2) Bayesian probabilities, 3) Hubble-diagram parametrization and 4) statistical inference.
[g]International Computational Astrophysics Group: http://www.incagroup.org
[h]Joint Exchange and Development Initiative: http://jedi.saao.ac.za
[i]MGU=Mahatma Gandhi University, DU=Delhi University.

The first SN photometric classification challenge...

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Simulations: Ia, Ib/c, II as expected from DES

Data size: ~20.000 objects, 1103 for training

Participants: 10 groups, 13 entries

Case studies: with/without photometric redshift 12/8 

Full light curves 13 

Early light curves 0 

The first SN photometric classification challenge...

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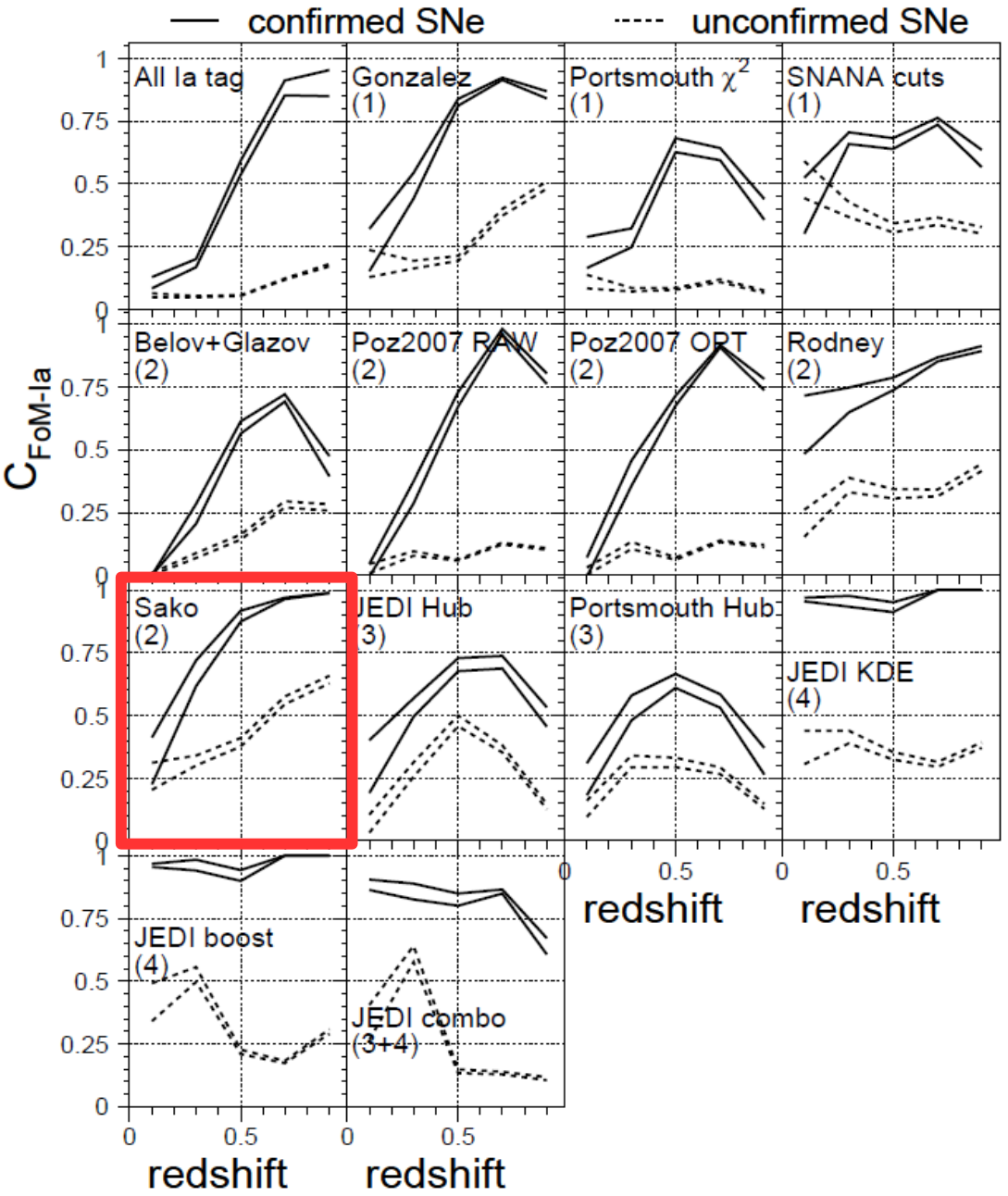

Outcomes:

1 – None of the methods obviously outperformed the others

2 – SNID had better overall metric

3- An updated data set was released to the community

For LSST...

A data challenge aimed to prepare a larger community for the LSST data paradigm

2017ClassificationChallenge: an LSST Photometric Classification Challenge

Renée Hložek, Tina Peters, Rick Kessler, Dan Scolnic, Saurabh Jha, Ashish Mahabal, Federica Bianco, Hiranya Peiris, Michelle Lochner, Robert Schumann, Rob Firth, Mark Sullivan, Alex Malz, Lluís Galbany, Emille Ishida, Rahul Biswas, Bob Nichol

Enabling Science Grant

Goals:

1. Up to date view on ML performances on LSST data
2. Engage non-astronomers in the classification task
3. Boost the development of new algorithms
4. **Provide a data set for future studies**

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Photometric LSST Astronomical Time-series Classification Challenge

A data challenge aimed to prepare a larger community for the LSST data paradigm

Participation is **open to everyone**:
no need to be LSST or DESC member!

PLAsTiCC

Photometric LSST Astronomical Time-series Classification Challenge

A data challenge aimed to prepare a larger community for the LSST data paradigm

Call for notice of intent for transient model inputs for PLAsTiCC: Photometric LSST Astronomical Time-series Classification Challenge

May 1, 2017

Renée Hložek, Rick Kessler, Anita Bahmanyar, Federica Bianco, Rahul Biswas, Mi Dai, Seth Digel, Jason McEwen, Rob Firth, Dominique Fouchez, Lluís Galbany, Philippe Gris, Emille Ishida, Saurabh Jha, Michelle Lochner, Ashish Mahabal, Alex Malz, Bob Nichol, Johanna Pasquet, Tina Peters, Hiranya Peiris, Chad Schafer, Robert Schuhmann, Dan Scolnic, Mark Sullivan, Elizabeth Swann.

PLAsTiCC

Photometric LSST Astronomical Time-series Classification Challenge

A data challenge aimed to prepare a larger community for the LSST data paradigm

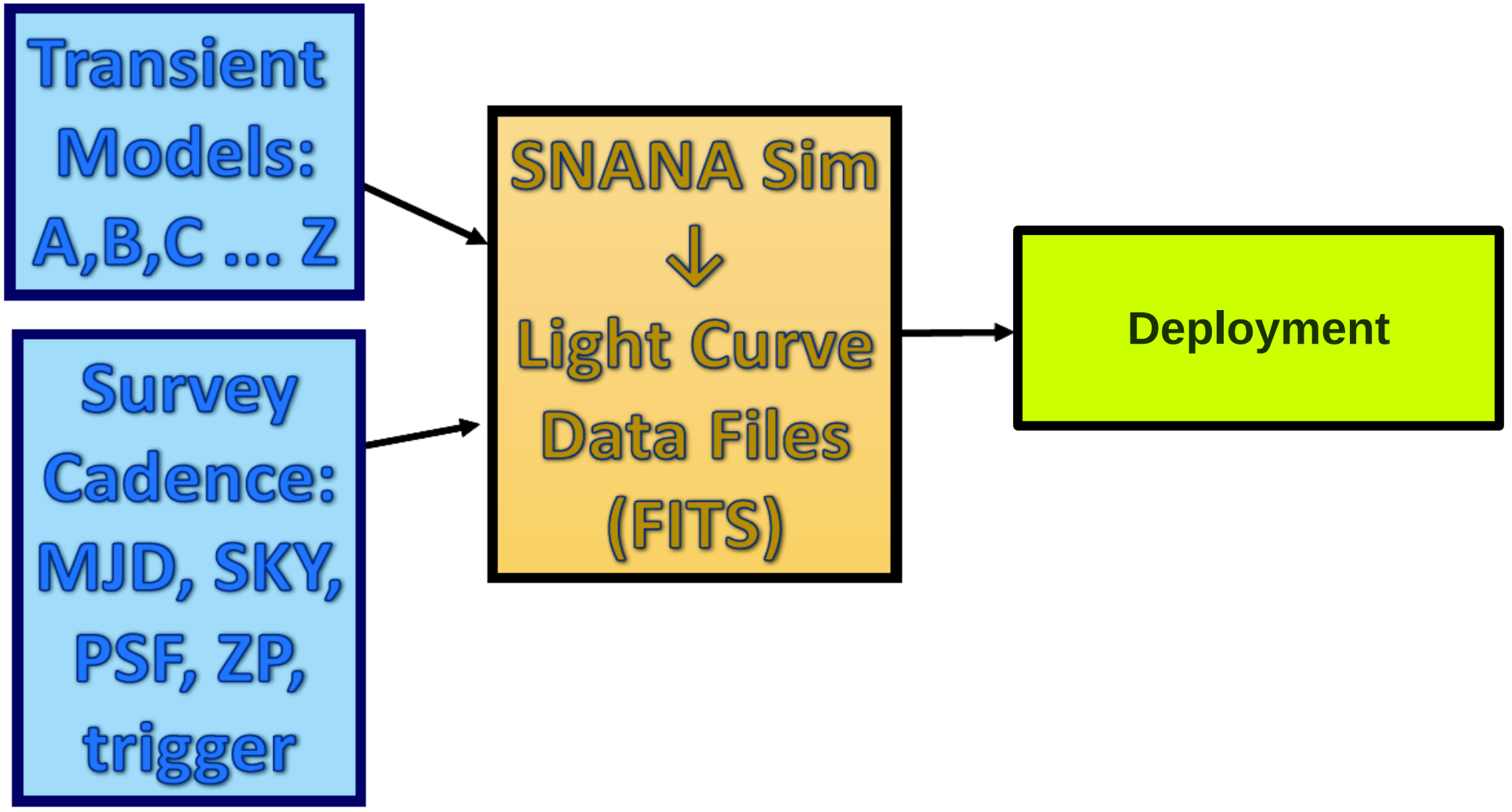
- SNANA simulations → Light curves in observer-frame (no images!)
- 3 years worth of LSST data, ~ 100 MB
- ~ 10^7 objects
- Around 20 transient models
  (galactic and extra-galactic, periodic and non-periodic)

- Please respect model-information policy:
  ``don't ask, don't tell"

- Training sample will be small and biased
- Not all models will be present in the training sample

PLAsTiCC - *Current status*

Simulation Architecture



Slide by Rick Kessler, I PLAsTiCC workshop, July 2017

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Open questions

- Cadence
- Size/composition of the training sample
- Photometric redshift
- Host galaxy information
- Metric
- Early epoch design

PLAsTiCC

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What will we ask?

- Best performance: Supervised Learning
- Best performance: Unsupervised Learning
- Best performance: Novelty/anomaly detection
- Full light curves and early epoch

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How it will be deployed?

kaggle™

RAPID ANALYTICS AND MODEL PROTOTYPING (RAMP)

COLLABORATIVE CHALLENGE WITH CODE SUBMISSION

Paris-Saclay Center for Data Science

Deployment:

How to engaged a larger community?

Specially non-astronomers!

PLAsTiCC meeting at SLAC

Speakers	Date	Venue
Alexander Boucaud (Paris-Saclay Center for Data Science)	09 Fev 2018	SLAC
Margarita Demkins (Kaggle)		
Alex Malz (New York University)		

Chair

Emille Ishida (Universite Clermont-Auvergne)

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Emille Ishida (Universite Clermont-Auvergne)

Let me know if you wish to join!

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Next steps

- A lot of validation tasks (Rick Kessler)
- Host information and metrics (Alex Malz)
- Deployment: PLAsTiCC workshop @ SLAC (Emille Ishida)
- Weekly telecon at Friday, 16:00h – Paris time

PLAsTiCC

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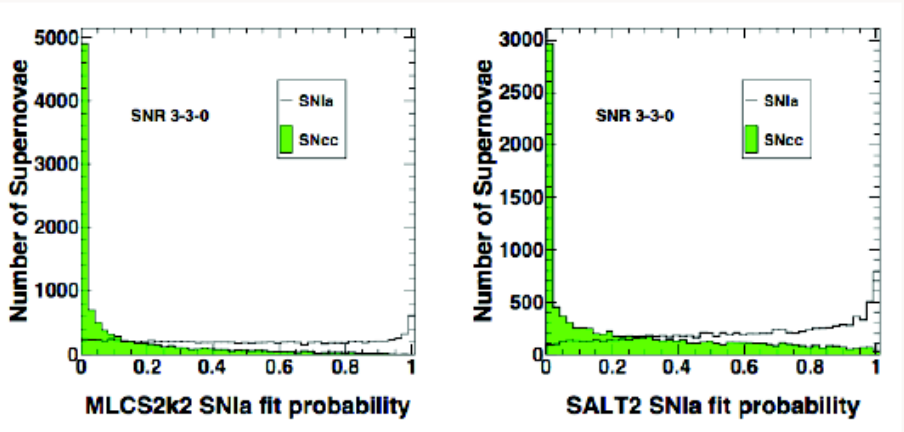
Expected release date:

May/2018

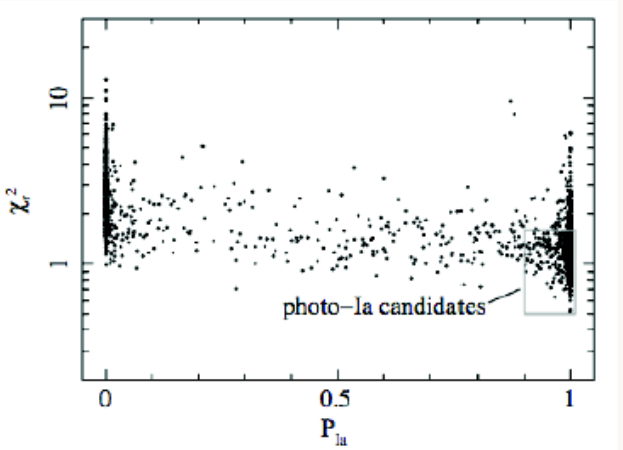
Extra Slides

After the first SN photometric classification challenge...

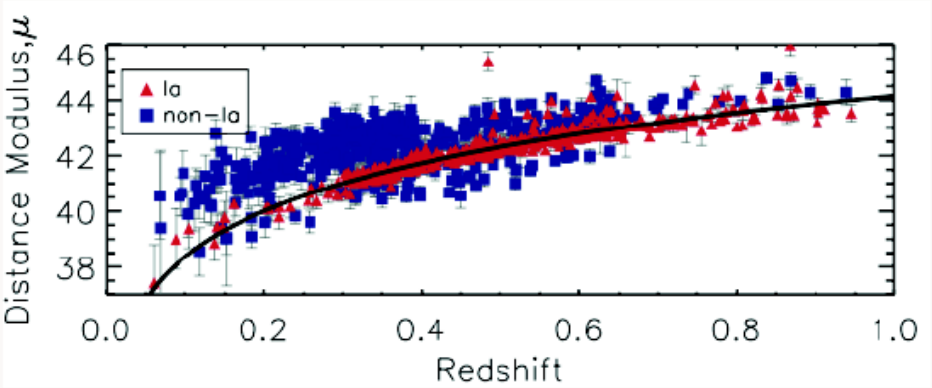
Fit Ia template to determine type
Bayesian inference using Ia and non-Ia templates
Define Hubble diagram >> Ia are those that are close
Perform parametric light curve fits, then ML/statistics



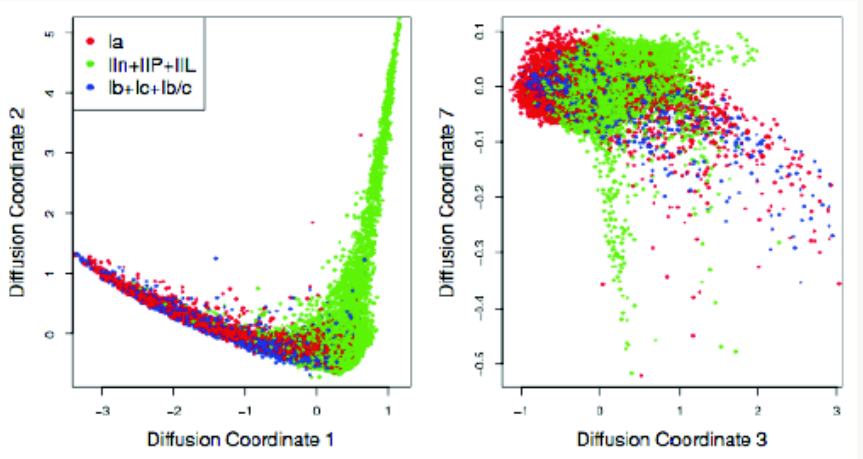
Gjergo+13



Sako+11



Newling+11



Richards+12

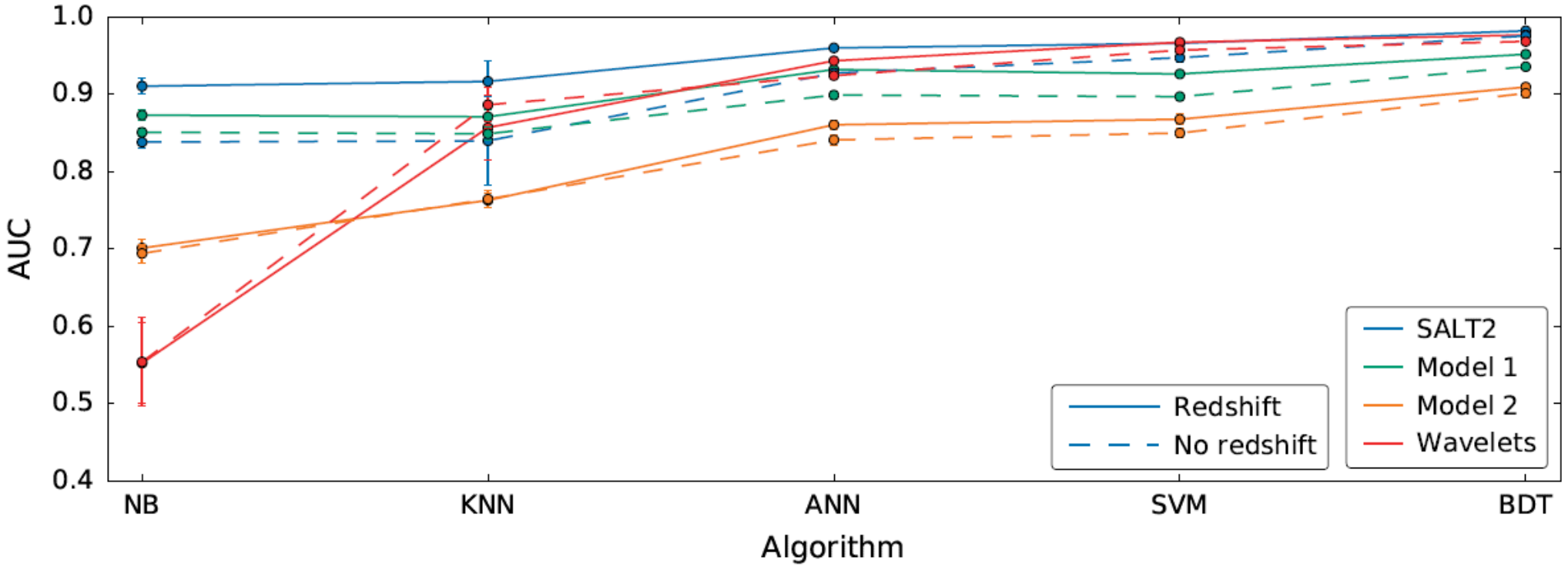
Slide from Adam A. Miller, CIERA-LSST SN Workshop, 2 June 2017

More recently ...

Lochner et al., 2016, APJ 225, 2

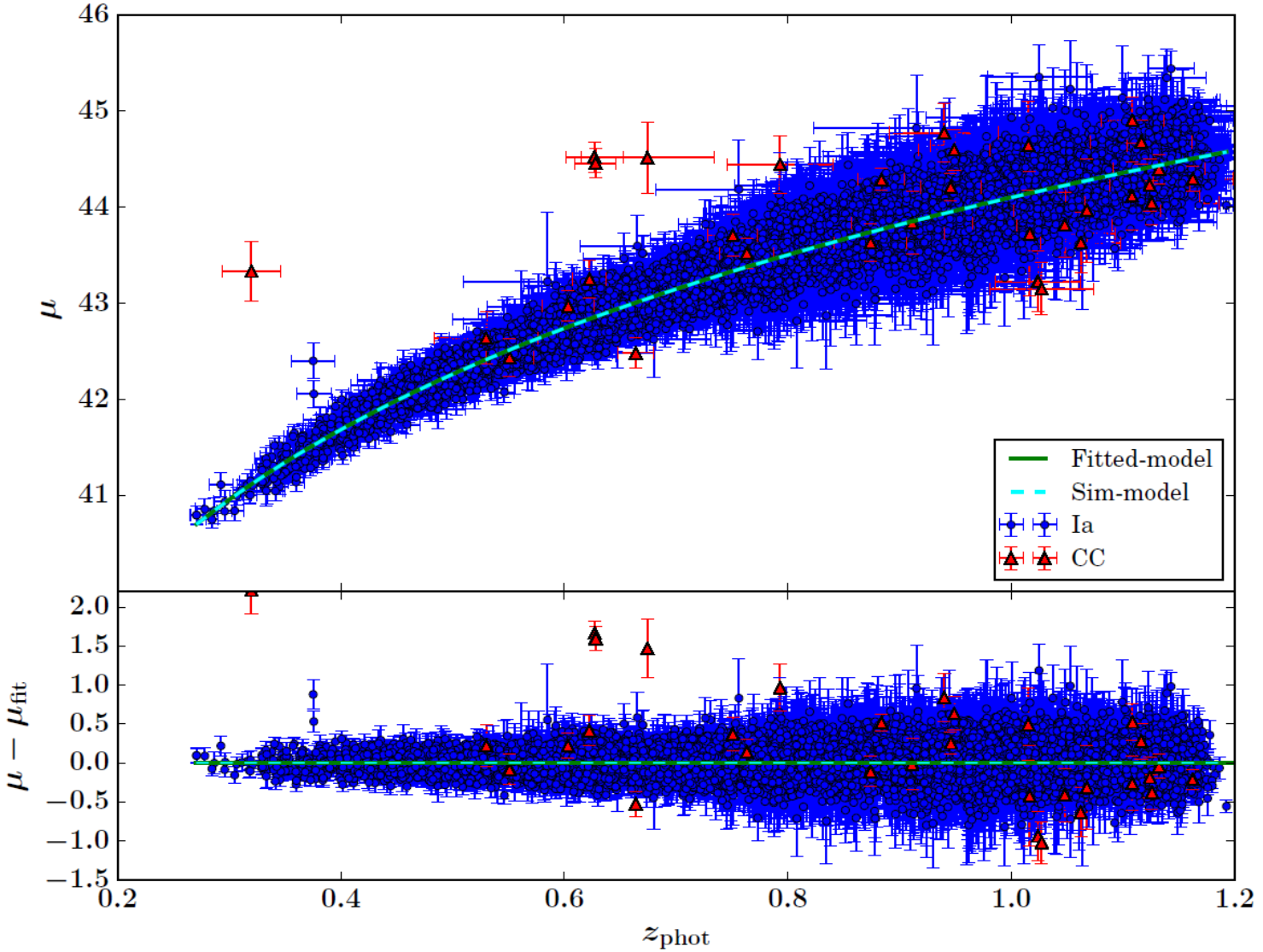
Comparison of different feature extraction + Machine Learning techniques

Post-SNPCC data



More recently ...

Dai et al., 2017 - arXiv:astro-ph/1701.05689



Simulations

10 years of LSST

Parametric fit +
Random Forest

SNANA simulation:

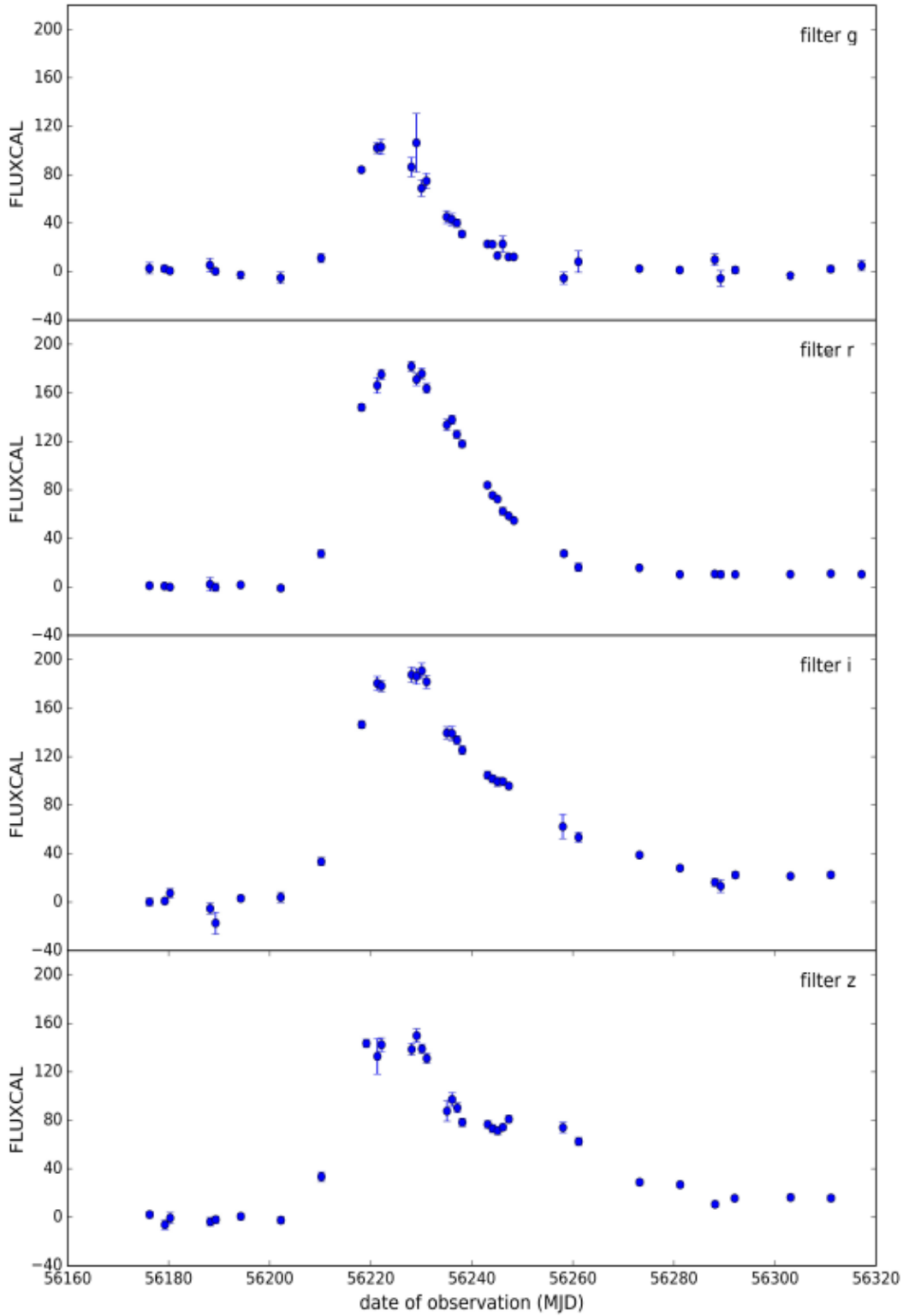
Header

```
SURVEY: DES
SNID:   2553
IAUC:    UNKNOWN
PHOTOMETRY_VERSION: DES
SNTYPE:  -9
FILTERS: griz
RA:      36.750000  deg
DECL:    -4.500000  deg
MAGTYPE: LOG10
MAGREF:  AB
FAKE:    2   (=> simulated LC with snlc_sim.exe)
MWEBV:   0.0283    MW E(B-V)
REDSHIFT_HELIO:   0.34470 +- 0.03150  (Helio, z_best)
REDSHIFT_FINAL:   0.34470 +- 0.03150  (CMB)
REDSHIFT_SPEC:    -9.00000 +- 9.00000
REDSHIFT_STATUS: OK

HOST_GALAXY_GALID:   12339
HOST_GALAXY_PHOTO-Z:   0.3447  +- 0.0315



SIM_MODEL:  NONIA  10  (name index)
SIM_NON1a:      43   (non1a index)
SIM_COMMENT:  SN Type = II , MODEL = SDSS-018834
SIM_LIBID:  2
SIM_REDSHIFT:  0.3283
SIM_HOSTLIB_TRUEZ:  0.3300  (actual Z of hostlib)
SIM_HOSTLIB_GALID:  12339
SIM_DLMU:      41.182091  mag   [ -5*log10(10pc/dL) ]
SIM_RA:        36.750000 deg
SIM_DECL:      -4.500000 deg
SIM_MWEBV:   0.0270   (MilkyWay E(B-V))
SIM_PEAKMAG:   22.98  23.13  23.60  23.05  (griz obs)
SIM_EXPOSURE:     1.0    1.0    1.0    1.0  (griz obs)
SIM_PEAKMJD:   56208.320312  days
SIM_SALT2x0:   3.366e-17
SIM_MAGDIM:    0.000
SIM_SEARCHEFF_MASK:  3  (bits 1,2=> found by software,humans)
SIM_SEARCHEFF:  1.0000  (spectro-search efficiency (ignores pipelines))
SIM_TRESTMIN:   -22.69   days
SIM_TRESTMAX:    67.56   days
SIM_RISETIME_SHIFT:   0.0 days
SIM_FALLTIME_SHIFT:   0.0 days

SEARCH_PEAKMJD:   56207.977
```

SNANA simulation:

Light curve

```
# TERSE LIGHT CURVE OUTPUT:
#
NOBS: 99
NVAR: 9
VARLIST:  MJD  FLT FIELD   FLUXCAL   FLUXCALERR   SNR    MAG     MAGERR  SIM_MAG
OBS:  56178.188  g NULL  -8.405e+00   9.406e+00  -0.89   99.000    5.000   98.968
OBS:  56178.195  r NULL   3.721e+00   7.172e+00   0.52   99.000    5.000   99.005
OBS:  56178.203  i NULL  -8.865e-01   6.833e+00  -0.13   99.000    5.000   99.065
OBS:  56178.211  z NULL  -4.081e+00   7.919e+00  -0.52   99.000    5.000   98.907
OBS:  56180.172  g NULL  -7.214e-01   4.012e+00  -0.18   99.000    5.000   98.968
OBS:  56180.188  r NULL   3.867e+00   3.175e+00   1.22   99.000    5.000   99.005
OBS:  56180.195  i NULL  -3.010e+00   4.395e+00  -0.68   99.000    5.000   99.065
OBS:  56180.203  z NULL   7.996e+00   4.965e+00   1.61   99.000    5.000   98.907
OBS:  56188.148  g NULL  -2.440e+01   1.796e+01  -1.36  128.000    0.000   45.106
OBS:  56188.289  r NULL   1.617e+00   3.995e+00   0.40   26.978  101.022   46.679
OBS:  56188.297  i NULL  -2.510e+00   8.132e+00  -0.31  128.000    0.000   47.554
OBS:  56188.312  z NULL   7.324e+00   5.394e+00   1.36   25.338    1.447   47.995
OBS:  56194.145  g NULL   8.978e-01   4.678e+00   0.19   27.617  100.383   40.917
OBS:  56194.156  r NULL   2.316e+00   2.751e+00   0.84   26.588  101.412   42.664
OBS:  56194.172  i NULL   3.518e+00   4.628e+00   0.76   26.134  101.866   43.390
OBS:  56194.188  z NULL  -7.580e+00   4.465e+00  -1.70  128.000    0.000   43.464
OBS:  56207.188  g NULL   5.977e+01   4.637e+00  12.89   23.059    0.088   22.989
OBS:  56207.195  r NULL   6.437e+01   3.691e+00  17.44   22.978    0.063   23.135
OBS:  56207.203  i NULL   3.419e+01   6.290e+00   5.44   23.665    0.221   23.672
OBS:  56207.219  z NULL   6.978e+01   6.101e+00  11.44   22.891    0.099   23.080
OBS:  56215.195  g NULL   5.340e+01   3.035e+00  17.59   23.181    0.064   23.136
OBS:  56215.203  r NULL   4.733e+01   2.390e+00  19.80   23.312    0.056   23.301
OBS:  56215.211  i NULL   4.553e+01   2.798e+00  16.27   23.354    0.069   23.411
OBS:  56215.227  z NULL   7.188e+01   3.696e+00  19.45   22.859    0.058   22.828
```



SNANA simulation:

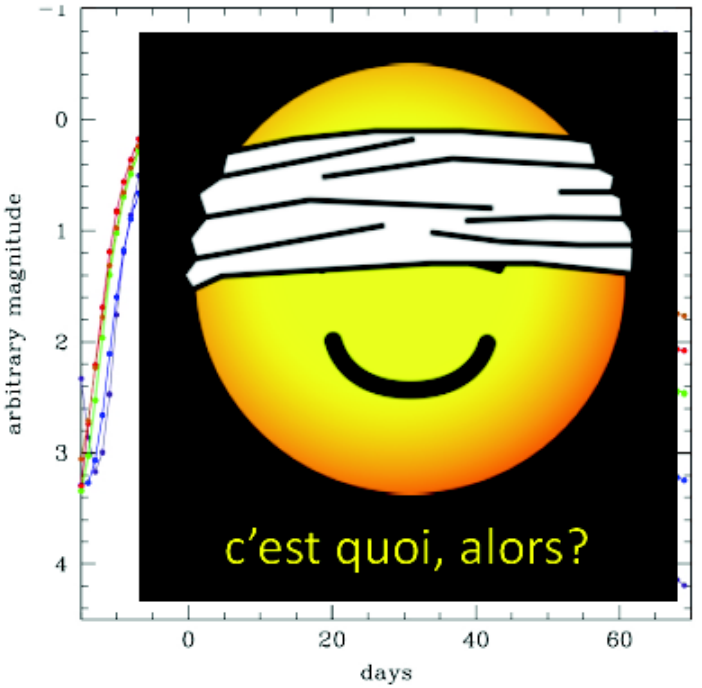
Light curve

Flux might be negative
due to sky subtraction

In principal, no redshift

No previous information about the date of maximum

Early-Epoch Challenge



- Important for LSST startup: classify transients with few epochs → enables spectroscopic follow-up.
- Full light-curve analysis is fun for science, but less critical for LSST operations.
- In 2010 SN(Ia+CC) challenge, **NOBODY** tried early-epoch classification !
- Should we ***require*** early-epoch classification to accept a submission ?
- How is early-epoch challenge defined ? Nobs past trigger ? Ndays past trigger ?
- How many early-epoch ranges to include ?

Slide by Rick Kessler, I PLAsTiCC workshop, July 2017