PSNID
(overview & tutorial)

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"Preparing for SN science in the LSST era"

Photometric SN IDentification

- Initially developed as spectroscopic targeting algorithm
- Updated to analyze photometric SNIa samples

Important to remember this point!

NOT designed for optimal SN classification across all subtypes

References: Sako 2011; Sako 2014

Photometric SN IDentification

Computes (over a grid of redshift, color, lc shape):

- Probability of each template fitting the data (reduced χ^2)
- Best-fit template for each subtype (Ia, Ibc, II)
- Bayesian probability of each subtype

MORE important points to remember

- A limited subset of CCSN templates are used *intentionally*

- Probabilities are normalized to 1 (sensitive to non-SN or other contamination)

Photometric SN IDentification

Additional Features

- Can use DM15 model or SALT2 for ("no difference")
- MCMC mode for estimating **SNIa** parameter uncertainty
- Absolute magnitude allowed to float ('dmu' parameter)

Potential Changes/Improvements

- Increased core-collapse sample
  (more templates already in SNANA for simulations)
- Inclusion of other subtypes

Photometric SN IDentification

Nearest Neighbor Method (NN)

- PSNID parameters for each SN is compared to those PSNID params generated in a survey from which the SN originates

- Best-fit type is that with highest concentration of simulated SNe close to it in param space

- Distance in each dimension of param space weighted according to survey characteristics
(i.e., needs to be re-calibrated for each survey)

Part 2: Running PSNID

For examples, please refer to directory
PSNID_Tutorial_LSST2016

Running PSNID: SNANA

- PSNID currently exists ***only*** as part of SNANA
  - Plans underway to make a public, standalone, python version
- Only proper (limited) documentation is part of the SNANA manual
  - Description of algorithm in 2011 paper; 2014 for NN
- Download SNANA: http://snana.uchicago.edu/
  - Both SNANA and SNDATA_ROOT

Running PSNID: SNANA

Important scripts/utilities

- $SNANA_DIR/bin
  - psnid.exe: Main PSNID module
  - snana.exe: Various uses, including photometry versioning
  - snlc_sim.exe: Create simulations; useful for NN mode
  - snlc_fit.exe: Fits a SNIa model to data;
    e.g., for params of a spec-confirmed sample
  - kcor.exe: To create k-correction table for new set of filters

- $SNANA_DIR/util
  - split_and_fit.pl: Run code (PSNID; snlc_fit) in batch mode
  - sim_SNgrid.pl: Create a new grid for PSNID templates
  - NEARNBR_pipeline.pl: Nearest-neighbor version of PSNID

- Survey Specific Information
  - $SNDATA_ROOT/SURVEY.DEF
  - $SNDATA_ROOT/filters
  - $SNDATA_ROOT/kcor)

Running PSNID: Example 01

Running a test script

> psnid.exe FIRST_PSNID.nml

- Namelist files (.nml)
  - Contain all input information to SNANA scripts
  - Different namespaces within code:
    &SNLCINP = selection of input data; format of outputs; SNANA data cut params
    &PSNIDINP = parameters specific to PSNID

- Outputs (for 'version')
  - version.SNANA.text: CIDs after SNANA specific cuts w/ basic LC info
  - version.FITRES.text: **MAIN OUTPUT**; includes fit and bayesian probability, plus best-fit parameters
  - version.LCPLOT.text: observed + fit data for each best-fit template
  - version.LCLIST.text: List of CIDs in the above file

Running PSNID: Example 02

Turning light curves into SNANA readable format

> snana.exe SNANA_to_ASCII.nml

- Light curve requirements
  - Filters must be defined in $SNDATA_ROOT/filters; kcor.exe run
  - FLUXCAL units (f = 10^(0.4(27.5-mag)))
  - Input: .IGNORE, .README, .LIST files (plus text files for each SN)
  - Output: same as Input, plus …
    *_PHOT.FITS: (all the photometric information for all the CIDs)
    *_HEAD.FITS: (all the header information for all the CIDs)

- Photometry versions locations
  - Default path is $SNDATA_ROOT/lcmerge
    (idea is that there are well-defined sets of photometry)
  - PRIVATE_DATA_PATH = ‘My/Path’
    for accessing data stored elsewhere

Running PSNID: Example 03

Understanding SNANA (&SNLCINP) inputs

> psnid.exe SNANA_PSNID.nml

- CIDs
  - cutwin_cid: window of CID range
  - SNCID_LIST: list of CIDs in NML file (must be used with cutwin_cid)
  - SNCID_LIST_FILE: list of CIDs in separate file (must be used with cutwin_cid)

- SNTABLE_LIST
  - various options for defining output format

- Other
  - OPT_MWEBV: extinction parameters
  - CUTWIN_NEPOCH: range of valid epochs necessary
  - also available: cuts on SNRMAX; epoch relative to peak

http://snana.uchicago.edu/doc/snana_manual.pdf

Running PSNID: Example 04

Understanding PSNID outputs

> psnid.exe FIRST_PSNID.nml

- FITRES
  - ITYPE_BEST: Dependent on cuts placed in NML file on PBAYES and FITRES for each subtype
  - TMAX, TOBSMIN, TOBSMAX: MJD of best-fit peak, plus observer-frame constrained phase range
  - ePARAMs: uncertainties only defined for SNIa model in MCMC mode
  - Optional outputs (e.g., peakmag_r)

- LCPLOT
  - Gives LC for best-fit model for EACH subtype
  - Chi-squared from best-fit model to data at each datapoint
  - MJD and rest-frame phase for each observation

Running PSNID: Example 05

Changing PSNID Parameters

> psnid.exe PSNID_CUTS.nml

> psnid.exe PSNID_CUTS_MCMC.nml

- Main Options
  - GRID models: *Templates_Ia* and *Templates_NonIa* keywords
  - Color, DMU are interpolated over: specify number of grid points
  - OPT_ZPRIOR: Flat (0); spectroscopic (1); or photo-z (2) redshift prior.
  - MCMC_NSTEP: 0 —> grid only; >0 —> MCMC, which gives uncertainties
  - Outlier rejection: Optional cuts to remove outliers from fit.
    CHISQMIN_OUTLIER; NREJECT_OUTLIER

Running PSNID: Example 06

Changing PSNID Grid

> sim_SNgrid.pl sim_SDSS_SALT2.input

- Ia input file
  - Type Ia model (e.g., SALT2.GUY10)
  - Number of grid parameters in redshift, shape space (color & T as well)
  - Filters & kcorrection file specified
  - Parameter ranges
  - Input cosmology (for absolute magnitudes)

- Non-Ia input file
  - No parameter ranges; rather, input file of non-Ia models to use
  - Weights can be specified

Running PSNID: Example 07

Batch Mode

> split_and_fit.pl BATCH_PSNID.NML

- NML Parameters
  - JOBNAME_LCFIT: name of script to be run on each submitted job (i.e., psnid.exe)
  - PSNID_OUTPUT: Directory to store outputs for jobs, plus final merged FITRES
  - GZIP_FLAG: useful for reducing the size of the directory of individual jobs