Blending Results on HSC Data with Injected Fake Sources

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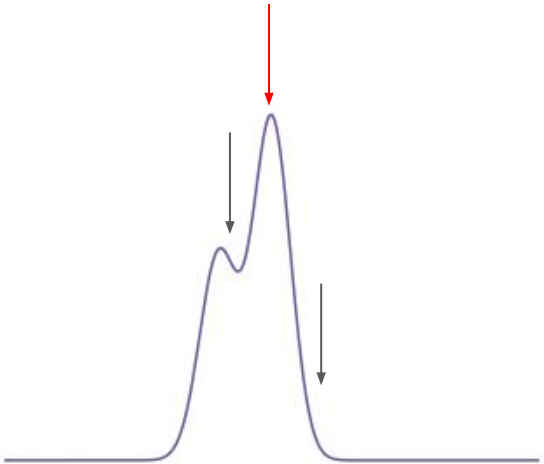
Background

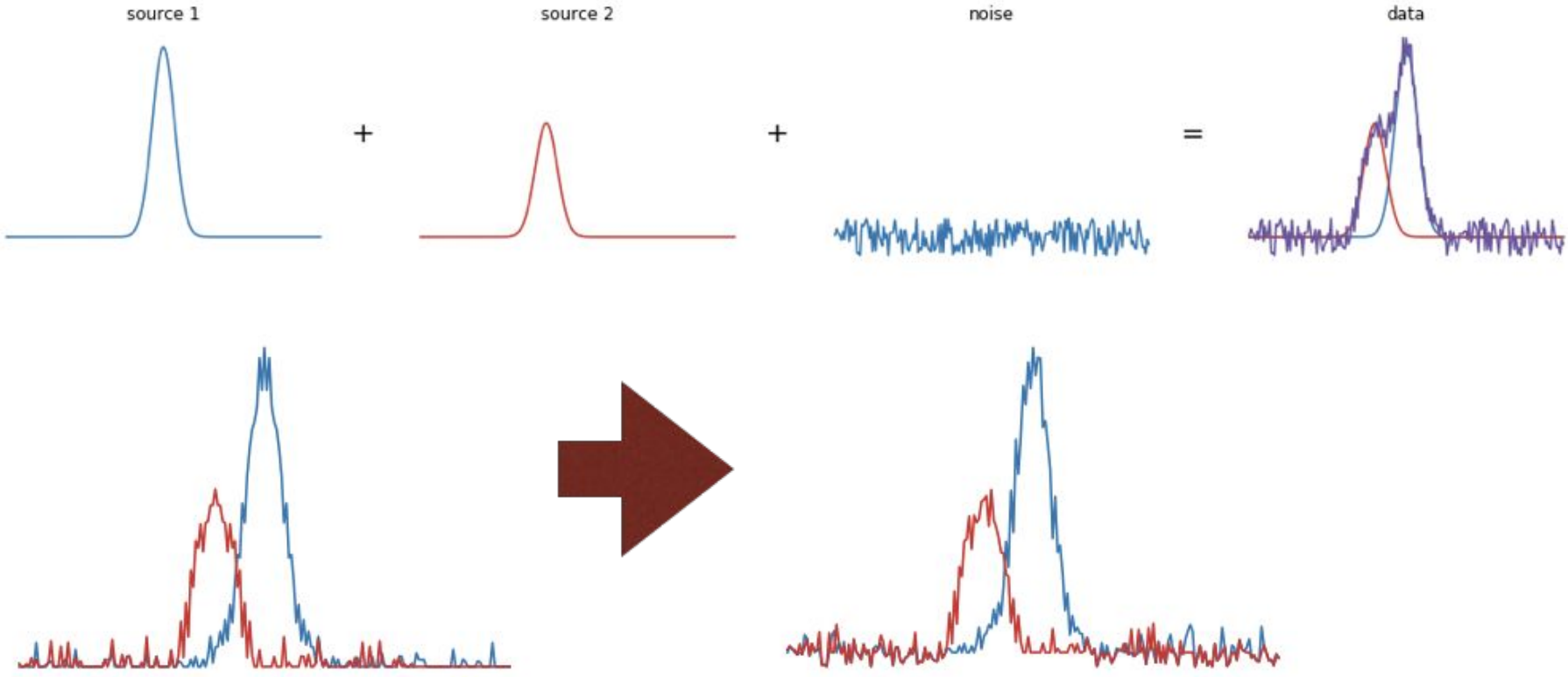
SDSS/Current HSC Deblender

- Attempts to use the least restrictive model:
  - Attempt to fit each source to the PSF (stars and very faint galaxies)
  - Make a symmetric template for each remaining source
  - Make that template monotonically decreasing from the peak
  - Use the template to redistribute the flux in the original image



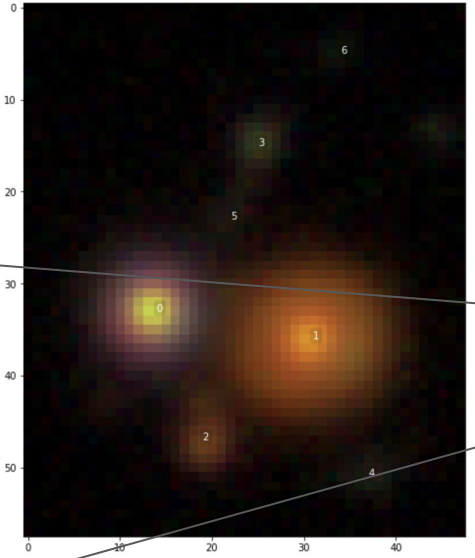
SDSS/Current HSC Deblender

More realistic 1D Example



Scarlet Basic Model

Data



Model

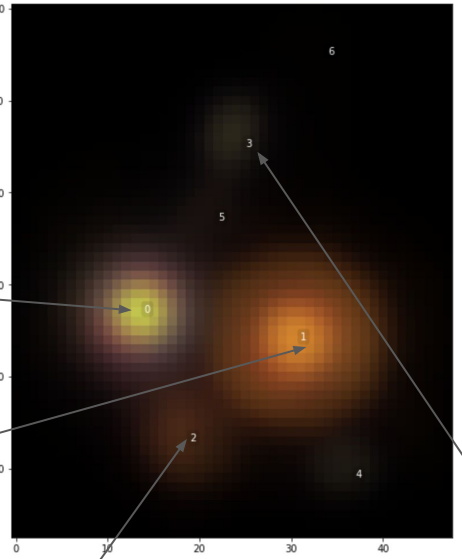
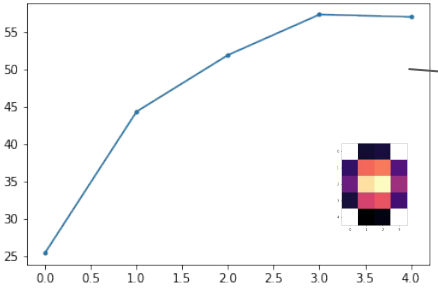
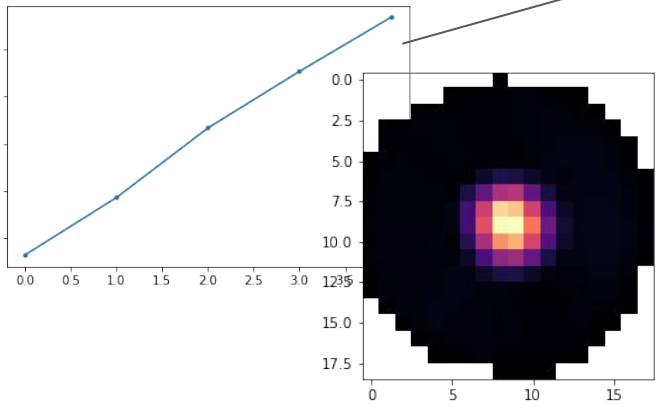


Image from HSC COSMOS Field

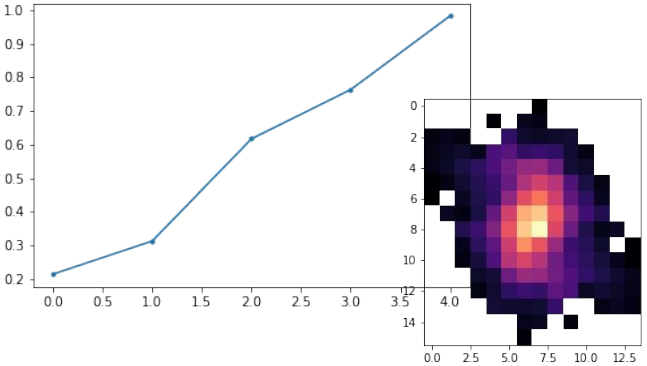
Source 0



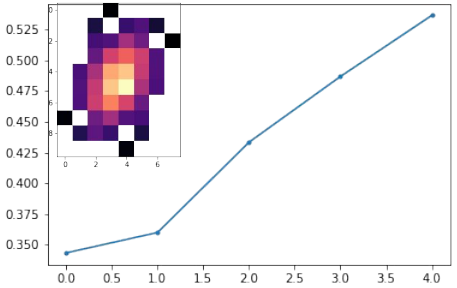
Source 1



Source 2



Source 3

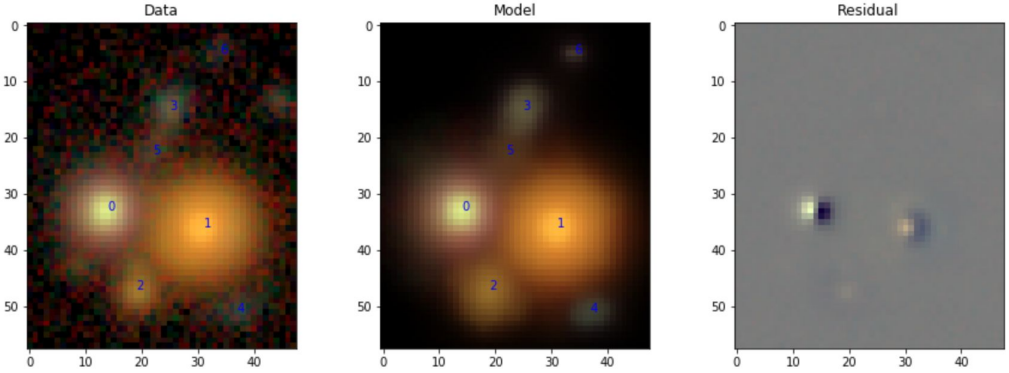


Changes from scarlet 0.4 (paper) to 0.5 (current)

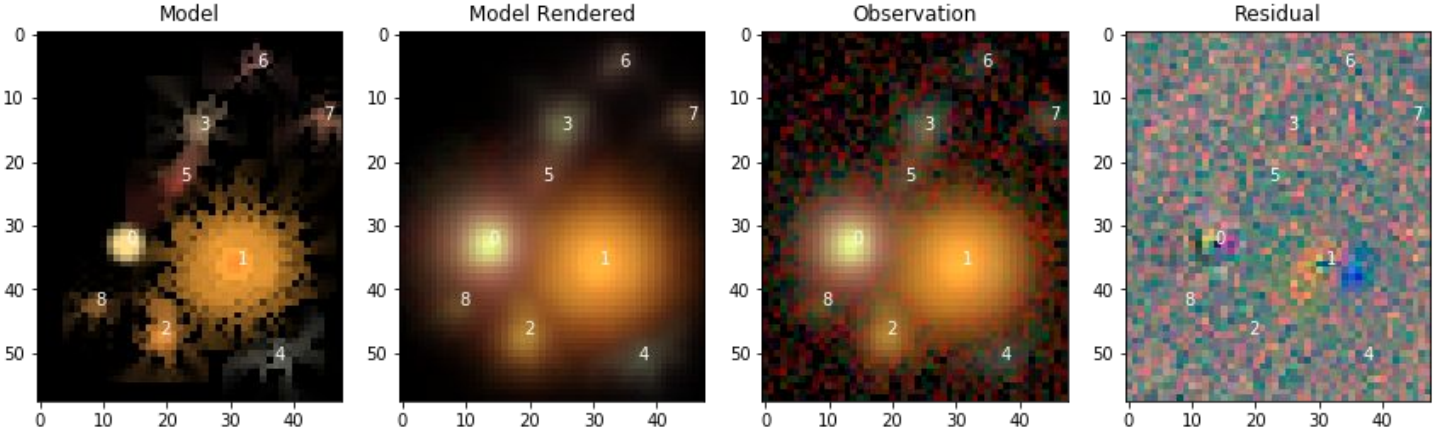
- Sources are no longer centered in a box and interpolated to fractional positions
  - Removed biases due to interpolation errors
  - Fixed catastrophic errors caused by improper shifts for faint sources (~10% failure)
- Convolution is done on the entire image using DFTs
  - Full scene convolution necessary for joint processing
  - Improved runtime by an order of magnitude
- Overall decrease in fidelity from version 0.4 to 0.5
  - The constraints don’t work as well for bright stars
  - We use a course convergence check to improve runtime at the cost of models that haven’t really converged
  - scarlet 1.0 has a similar runtime with a smaller relative error and residuals improved by an order of magnitude. Stay tuned!

Very quick look at scarlet 1.0

scarlet 0.5



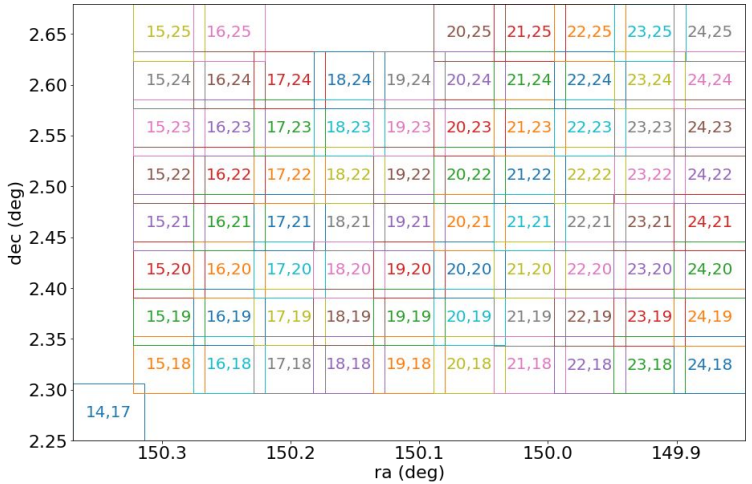
scarlet 1.0

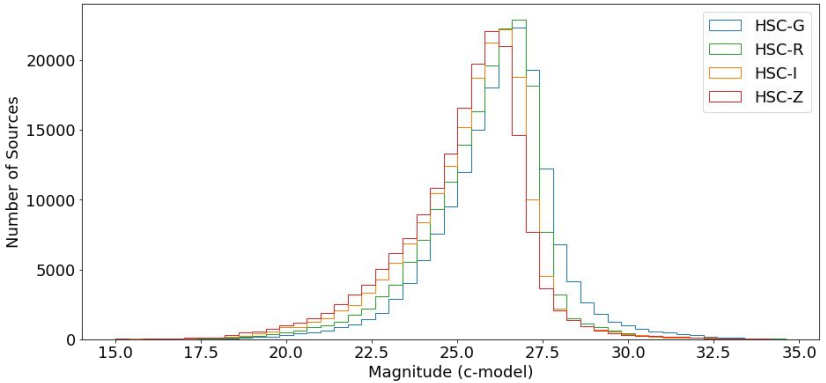


Datasets

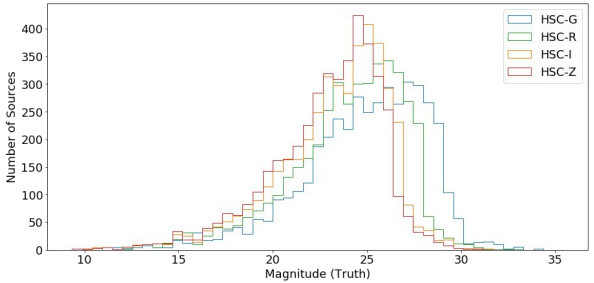
HSC Data Info

- **78** 1k ×1k patches from HSC COSMOS dataset, tract **9813**, with fake sources injected by Sophie Reed
- Using LSST Science Pipeline detection:
  - Total sources: 179,064
  - Total blends: 23,765
  - Total isolated sources: 42,112 (23.5%)
  - Total fakes injected (and detected): 4,760 (2.7%)
  - Unique fakes: 3,580 (2%)

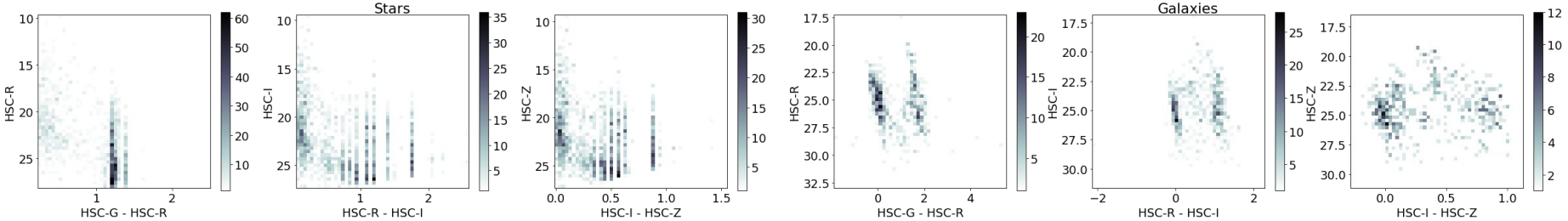




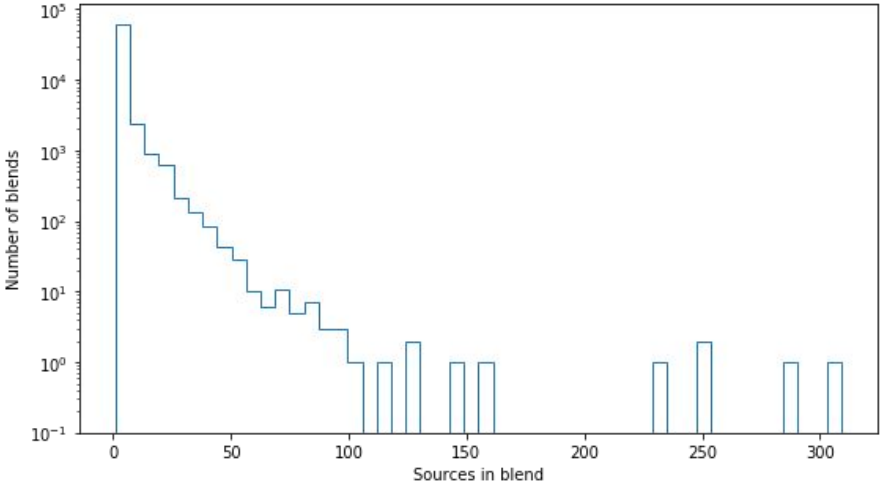
Simulated Sources Info

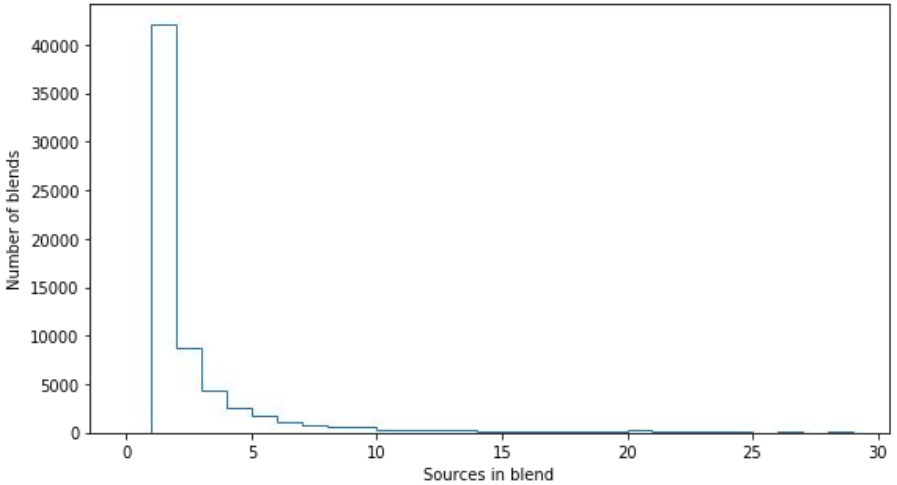


- **~4760** total fake sources ~(3265 stars, 1495 galaxies)
- Injected sources come from the Fatboy catalog at UW, which gives RA/DEC positions and magnitudes for stars and galaxies, and parametric model parameters (Sersic bulge, exponential disk) for galaxies
- All sources within the sky coordinates of the HSC patches were injected using the insertFakes task.



HSC Data Info: Blending

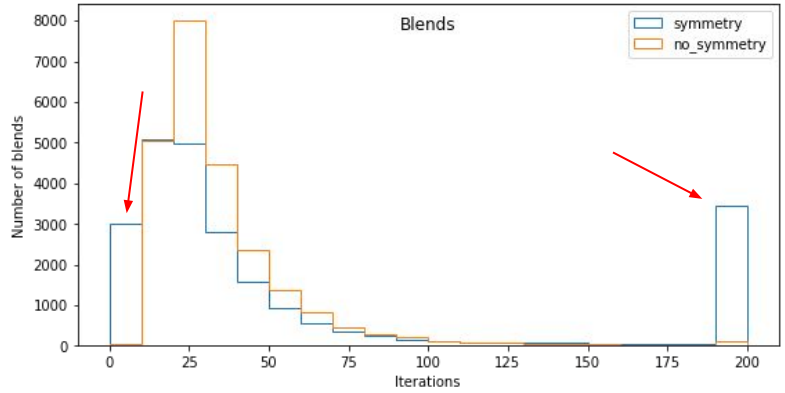


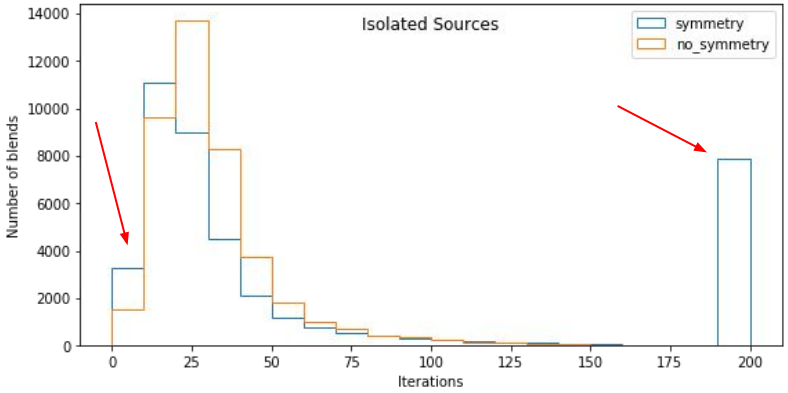


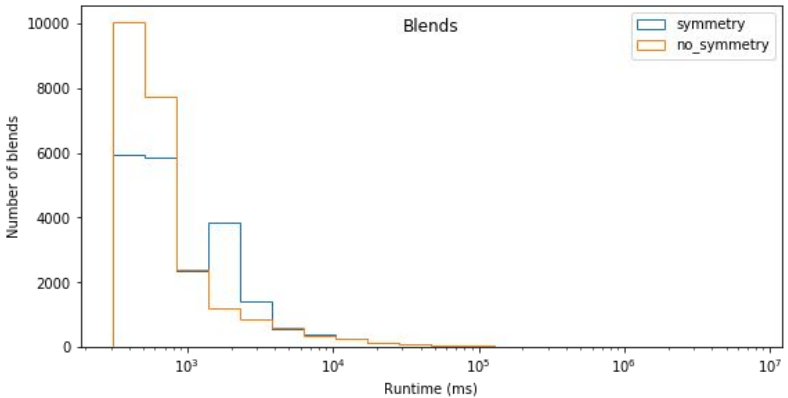
Deblender Statistics

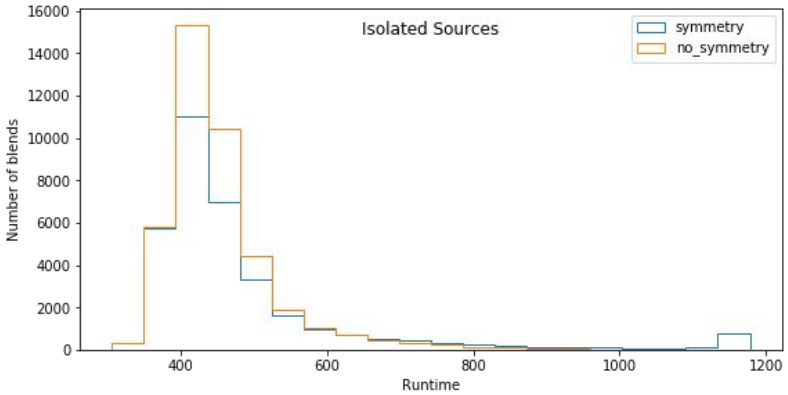
	Total Sources	Isolated Sources	Blends	Deblended Fake Sources	Isolated Runtime (per source)	Blend Runtime (per source)	Failed Isolated	Failed Blends
SDSS-HSC	179,064	42,112 (23.5%)	23,765	4,285 (2.4%)	-	-	0	0
scarlet (sym)	188,824	40,971 (21.7%)	23,765	3,829 (2.0%)	605 ms	696 ms	1,202 (5.1%)	2,820 (11.9%)
scarlet	218,164	41,501 (19.0%)	23,765	4,760 (2.2%)	449 ms	386 ms	615 (2.6%)	13 (0.05%)

Deblender Statistics: runtime

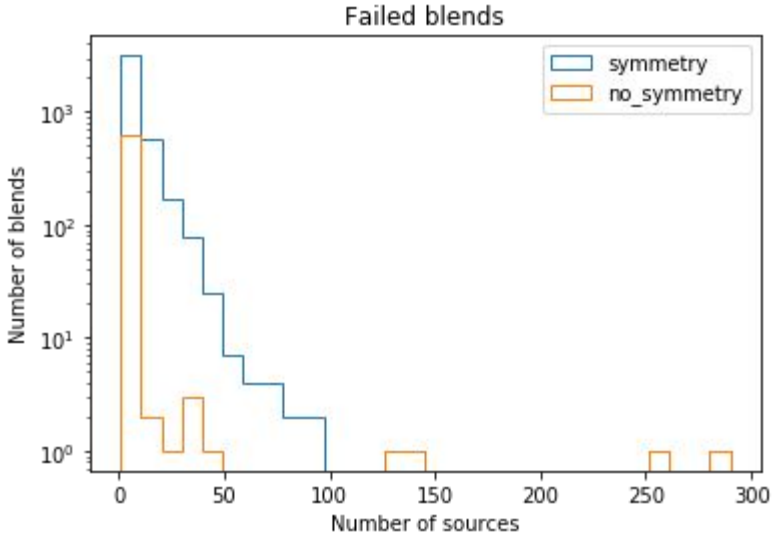








Deblender Statistics: Failures

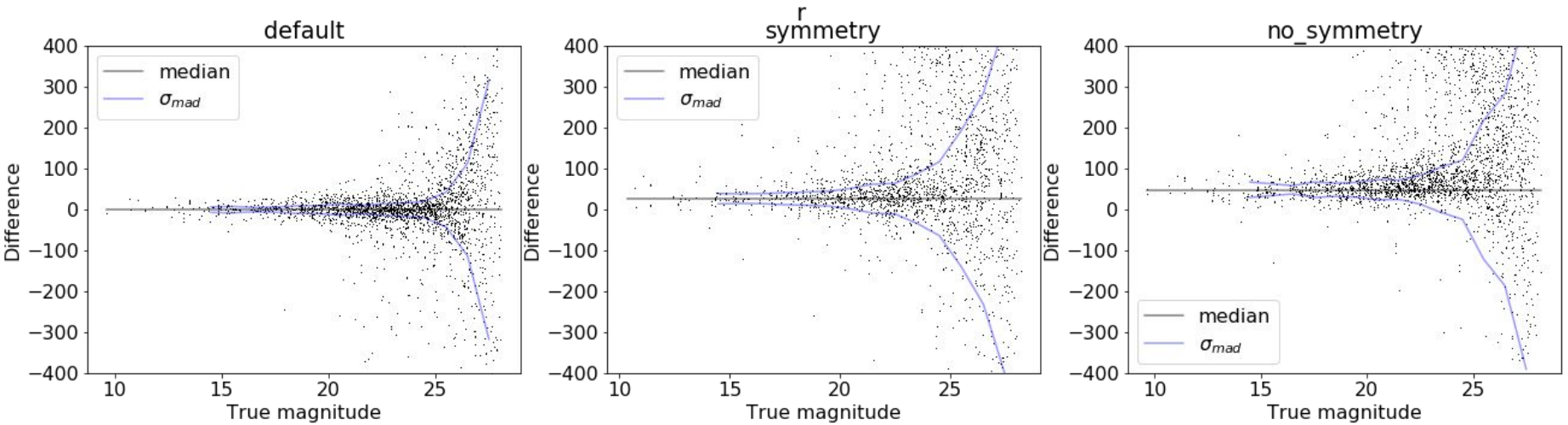


Analysis

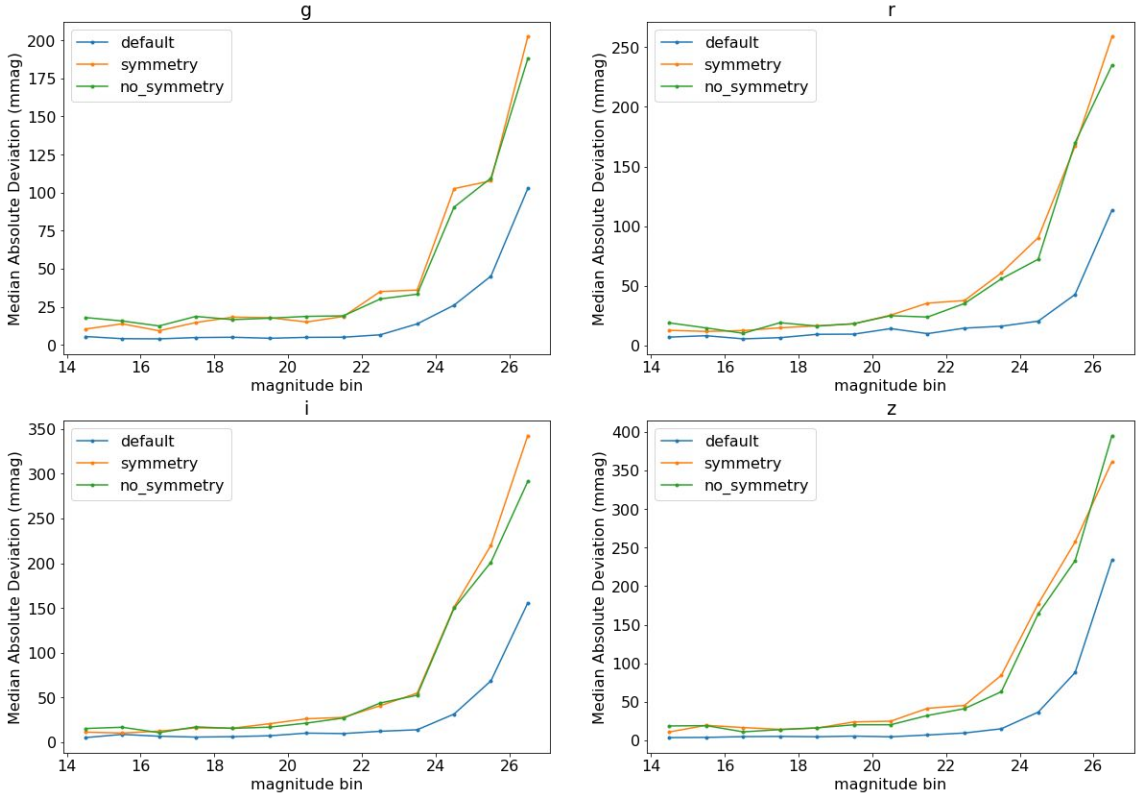
Analysis of injected sources

- Photometric measurements made using the following criteria
  - The “default” SDSS-HSC deblender
    - psf mags for stars and c-model mags for galaxies
  - scarlet with “symmetry” and monotonicity constraints
    - Total flux in scarlet model
  - scarlet “no symmetry” and only a monotonicity constraint
    - Total flux in scarlet model
- The “difference” plots use truth - model
  - Only r-band magnitudes are shown to make the plots more visible (results are qualitatively the same in all bands)

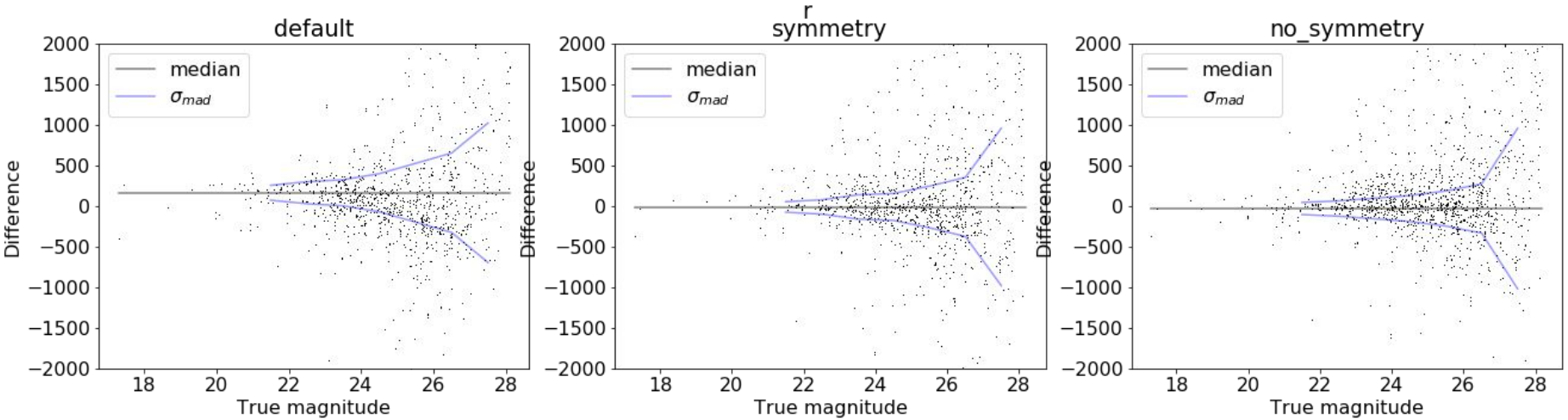
Stellar Magnitudes

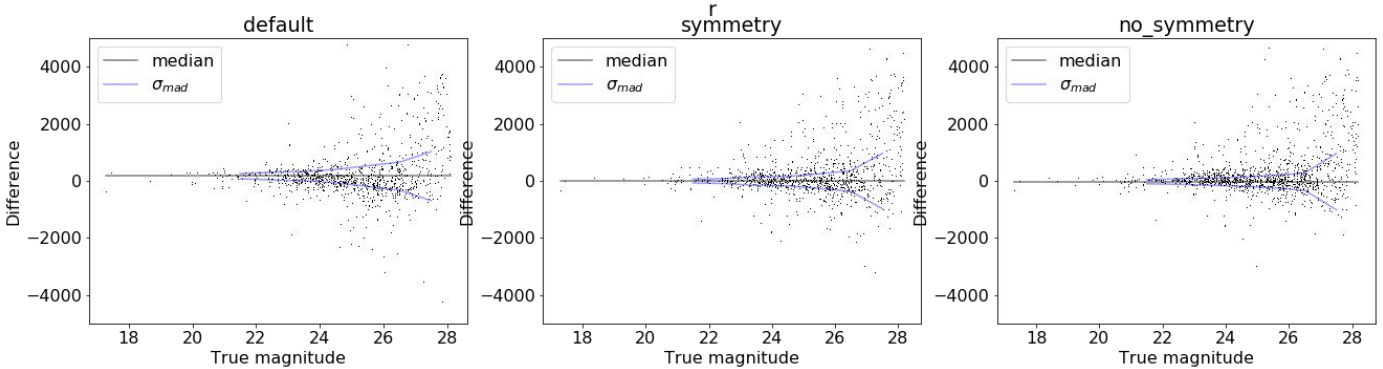


Stellar Magnitudes

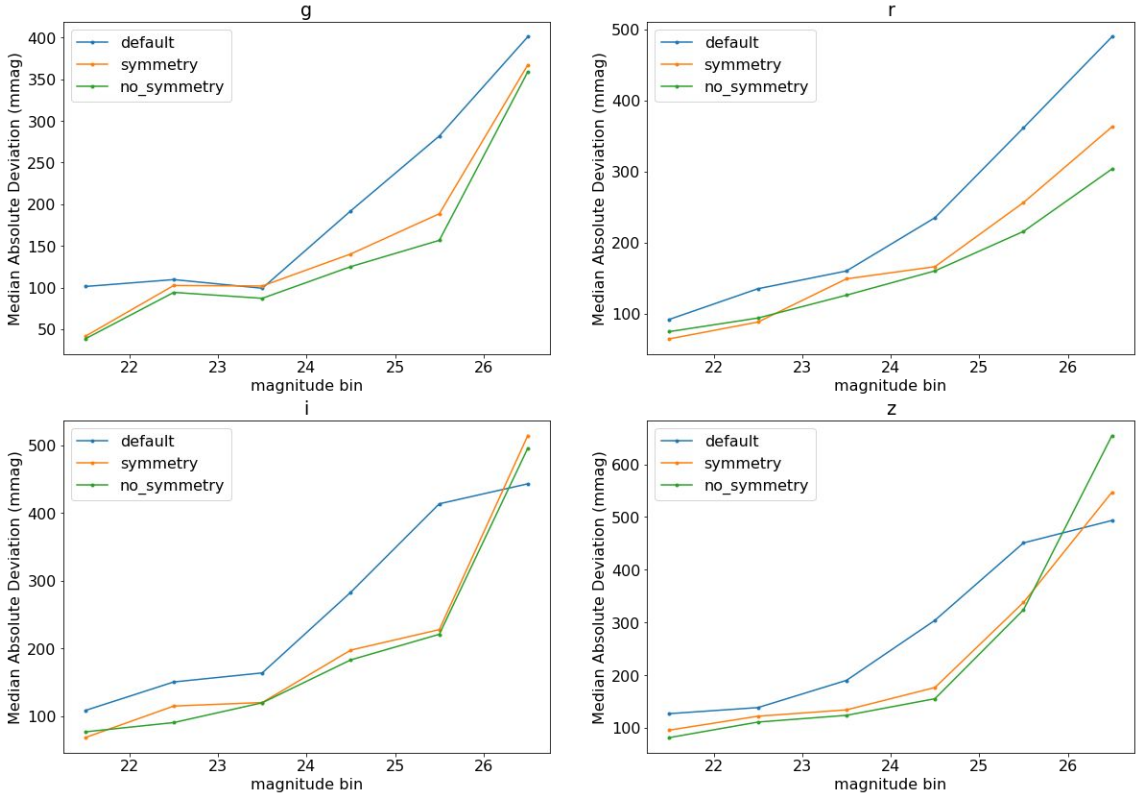


Galaxy Magnitudes

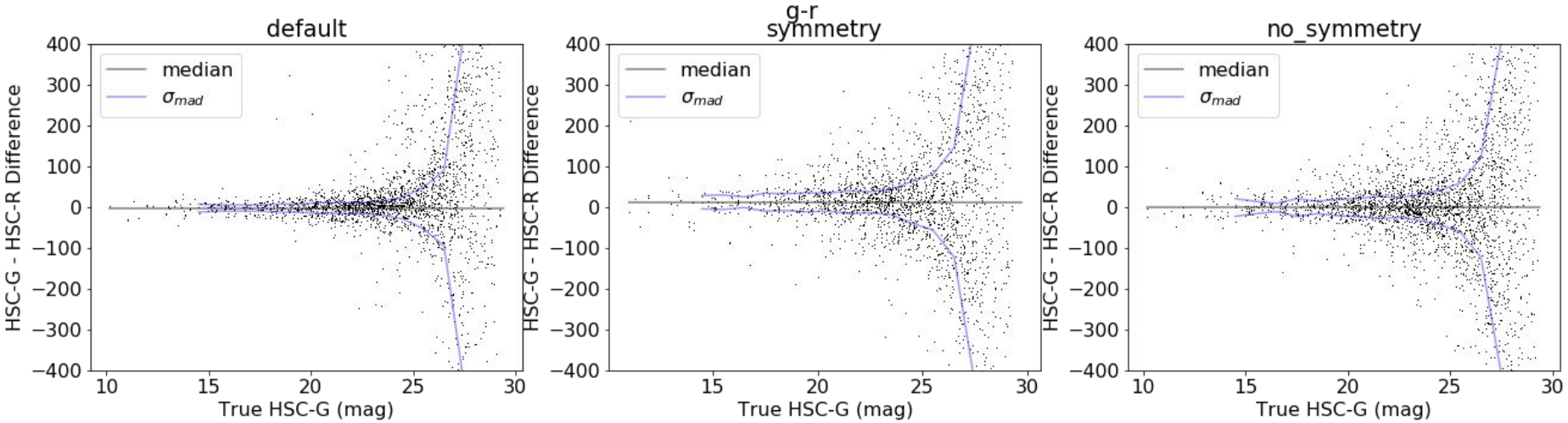




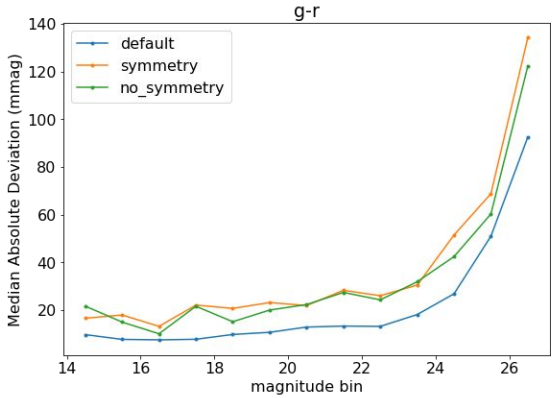
Galaxy Magnitudes

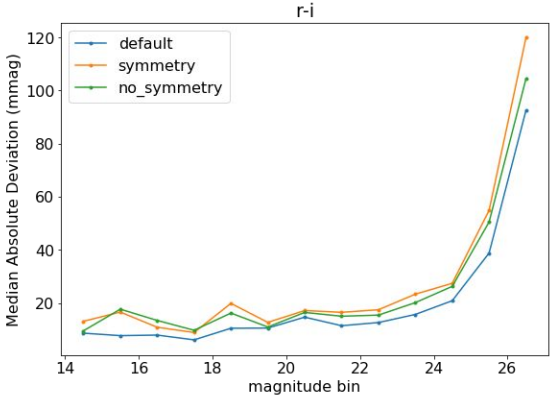


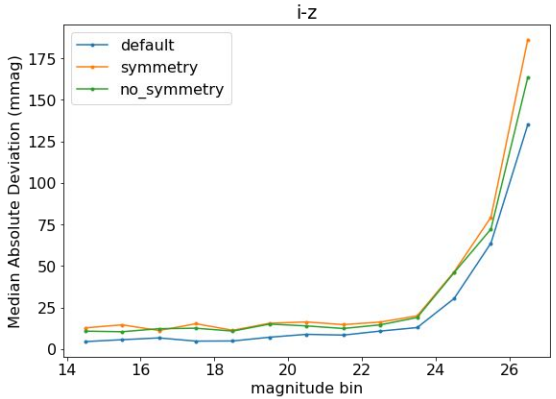
Stellar Colors



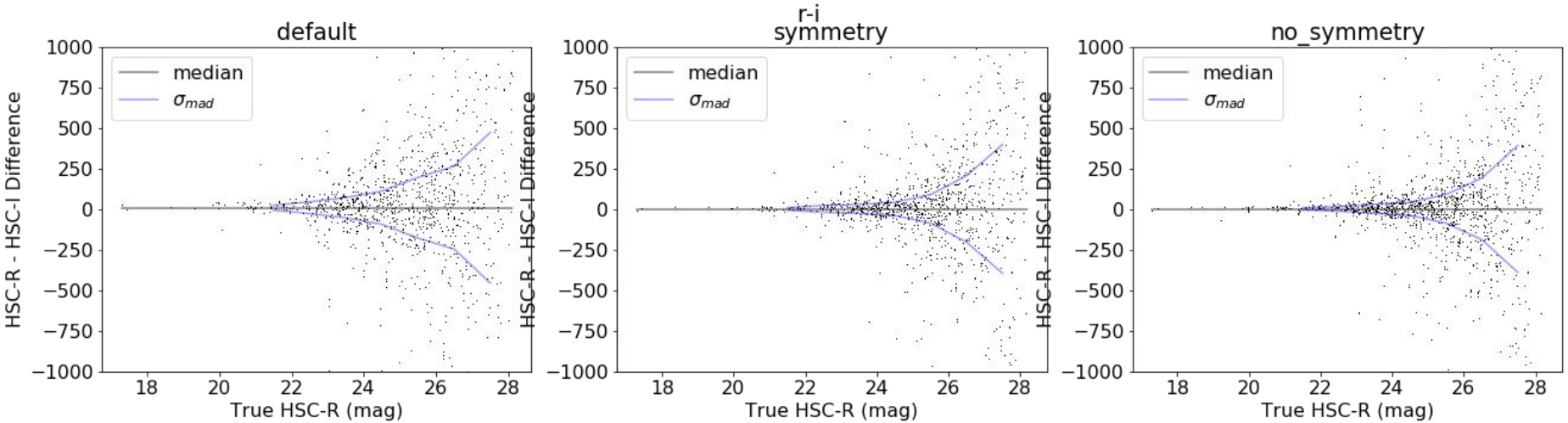
Stellar Colors



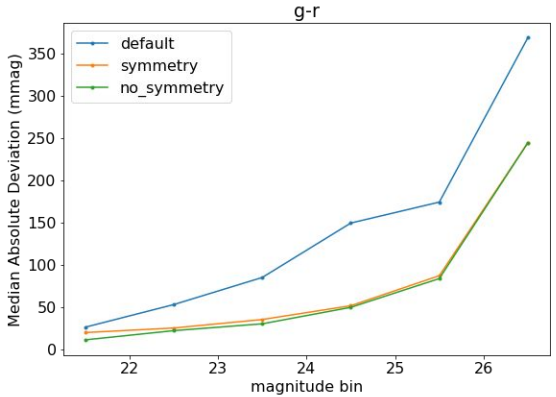


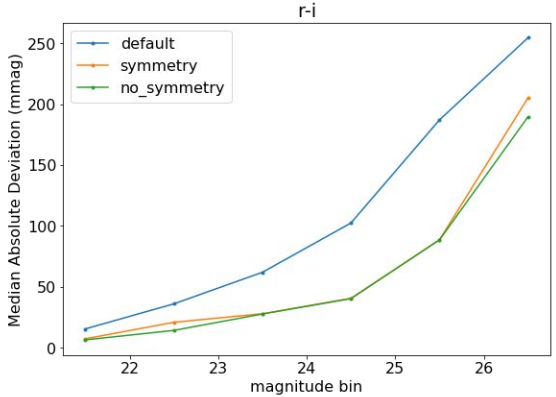


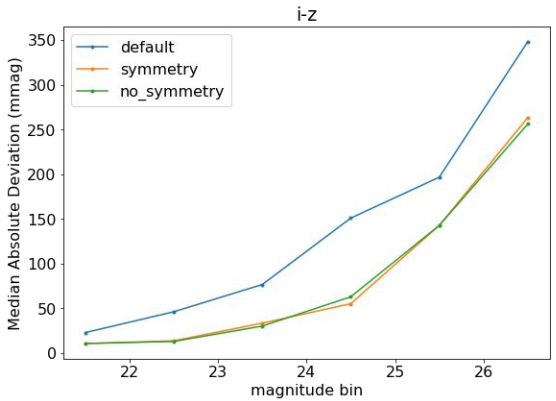
Galaxy Colors



Galaxy Colors





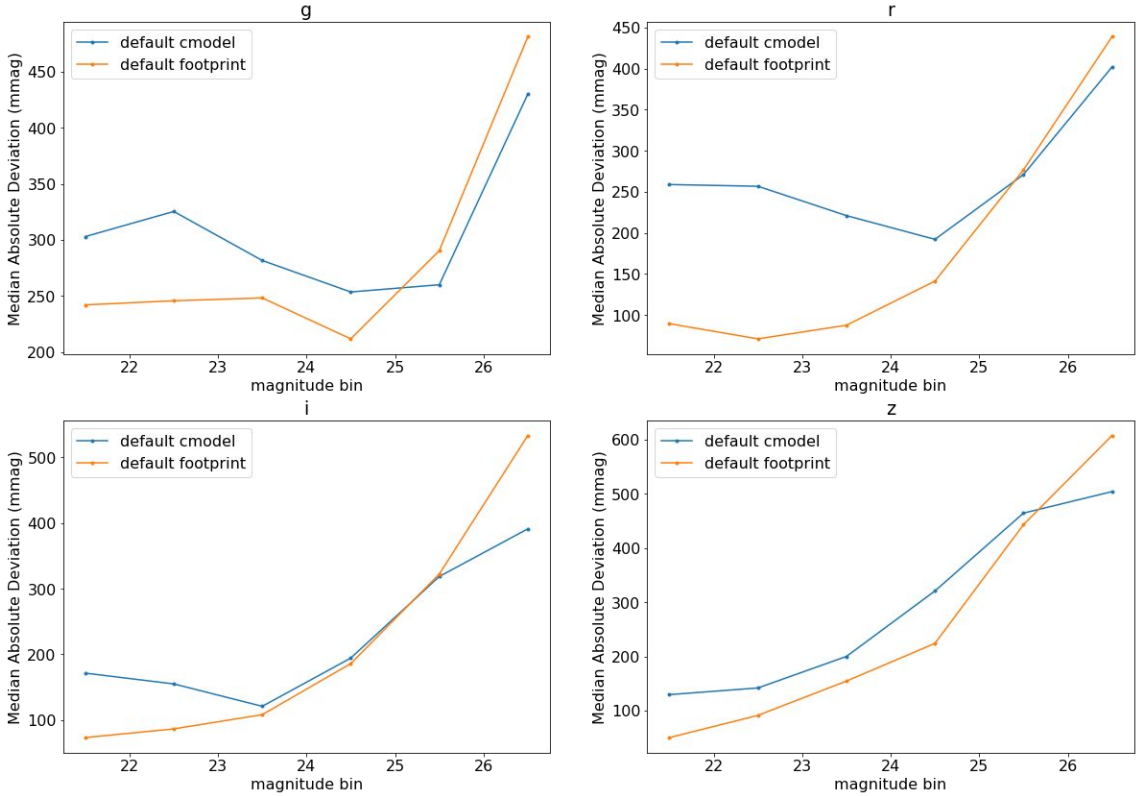


Conclusion

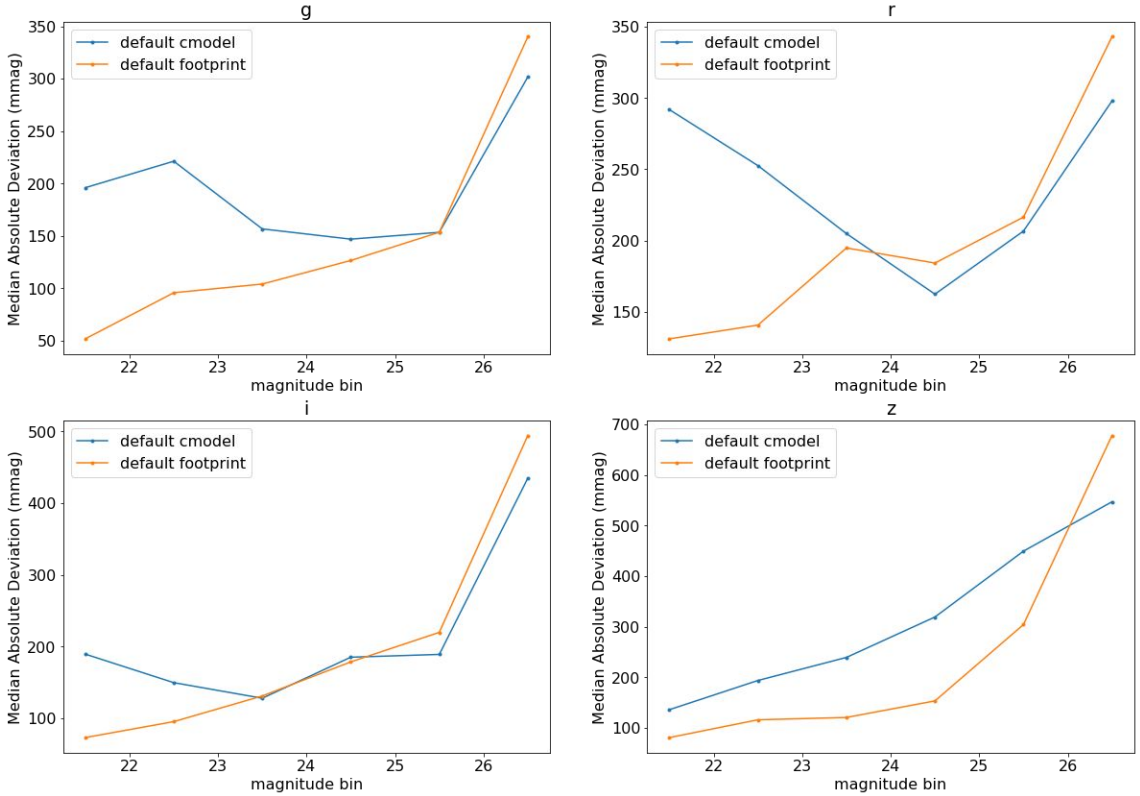
- scarlet can be run at scale on real data!
- Stellar magnitudes and colors are slightly degraded from the SDSS-HSC deblender (and the older version of scarlet) for a known reason that should be fixed in scarlet 1.0 (PR in review, Peter Melchior talk in January)
- In general deblending seems to perform slightly better without symmetry except for the faintest sources
- Galactic magnitudes and colors are significantly improved using scarlet
- We expect scarlet 1.0 to show significant improvements in all of these areas

Extras

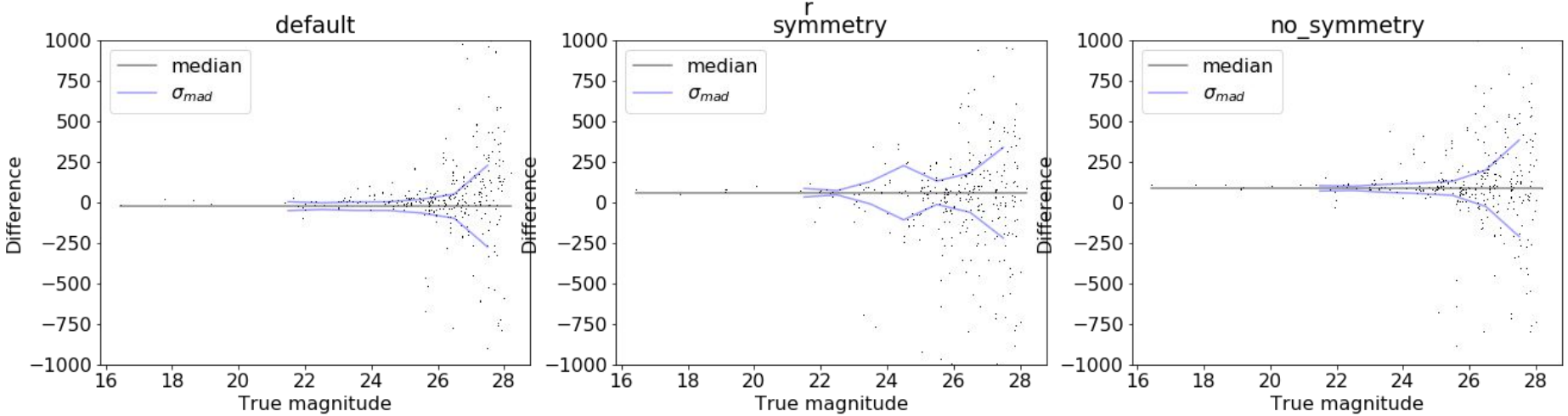
cmodel Galaxy Magnitudes



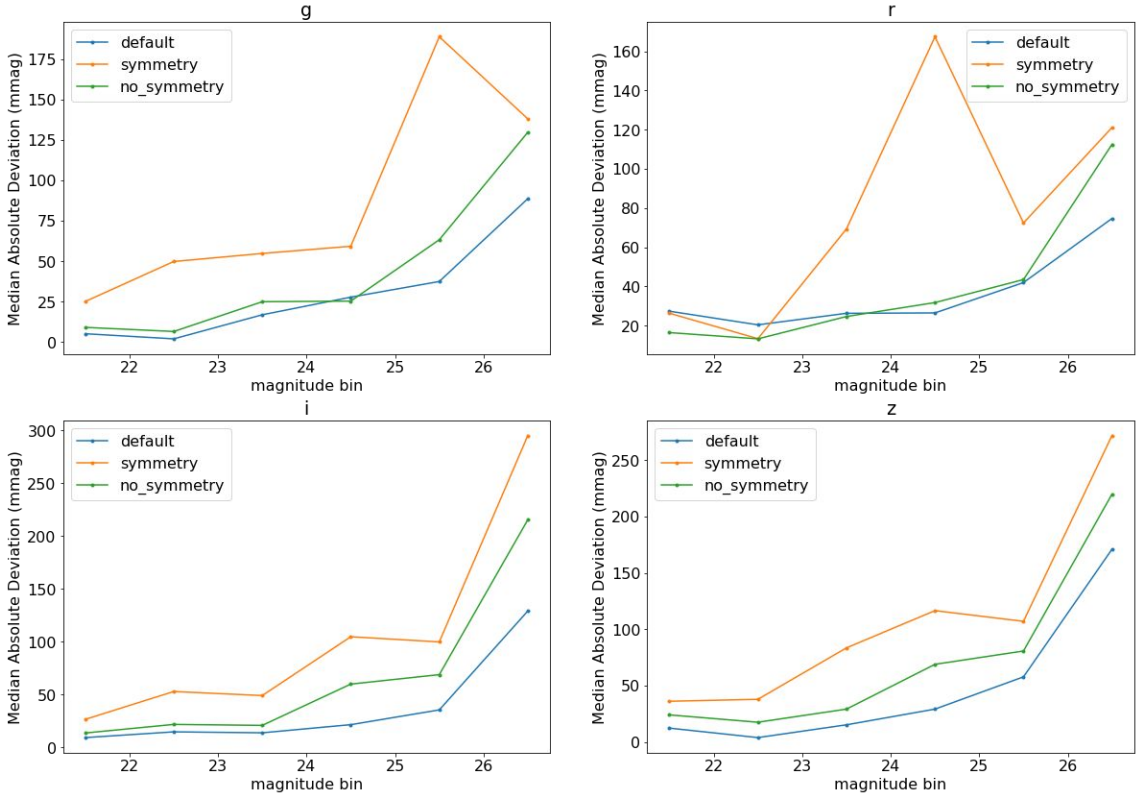
cmodel Galaxy Magnitudes



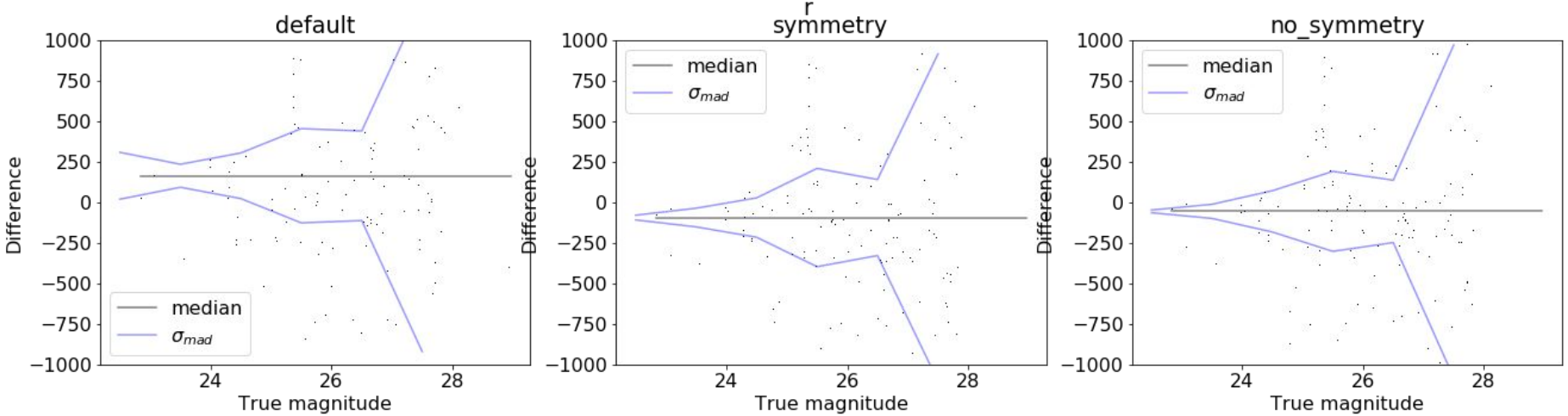
Isolated Stars



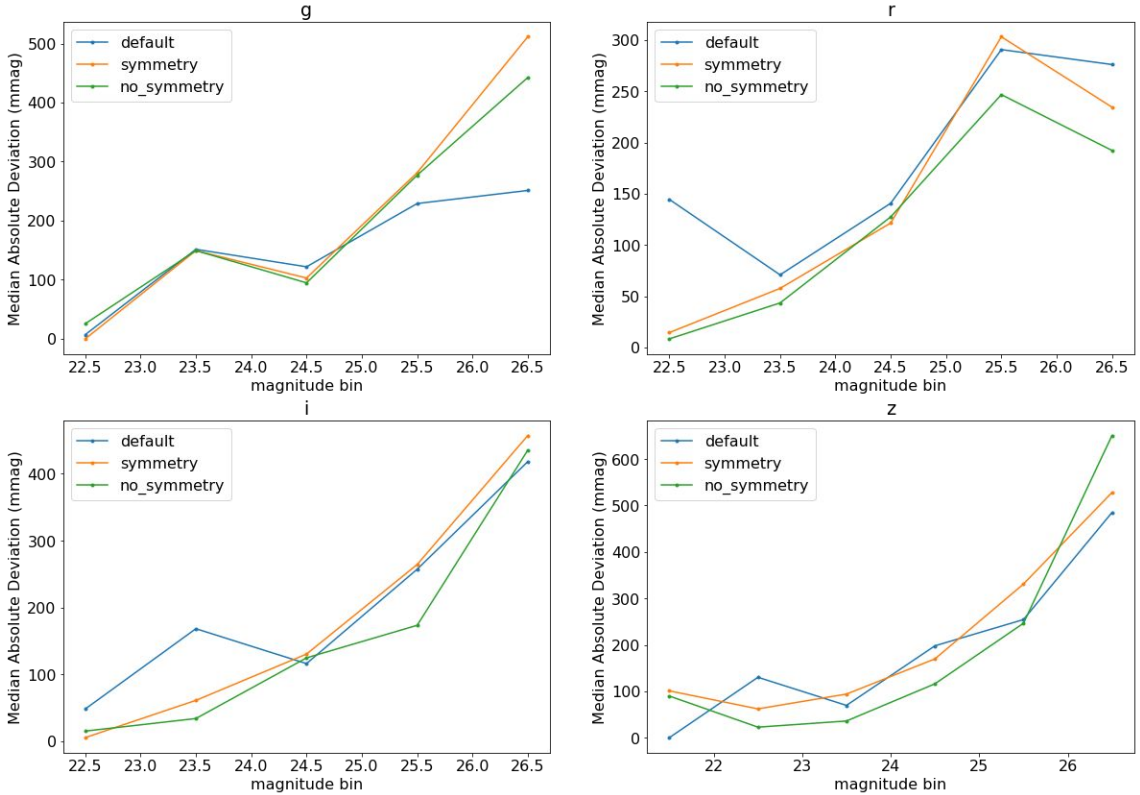
Isolated Stars



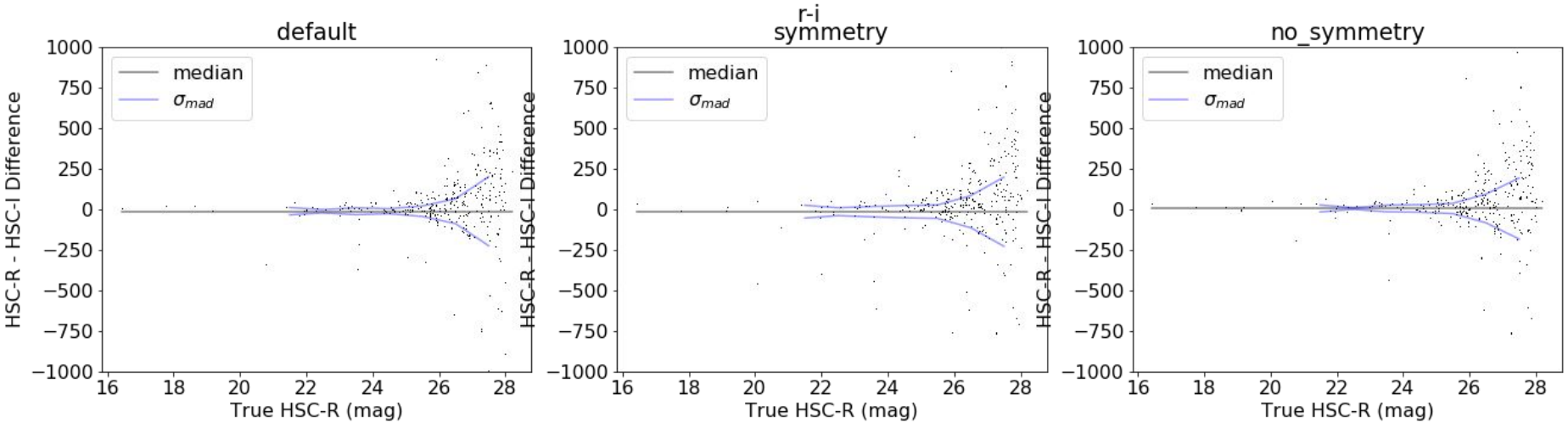
Isolated Galaxies



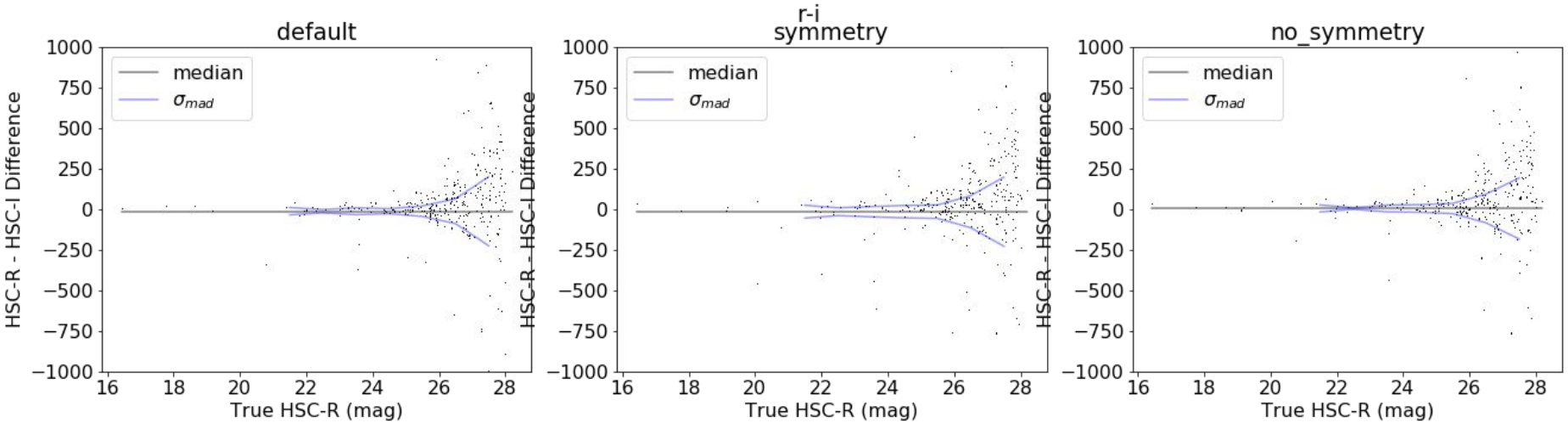
Isolated Galaxies



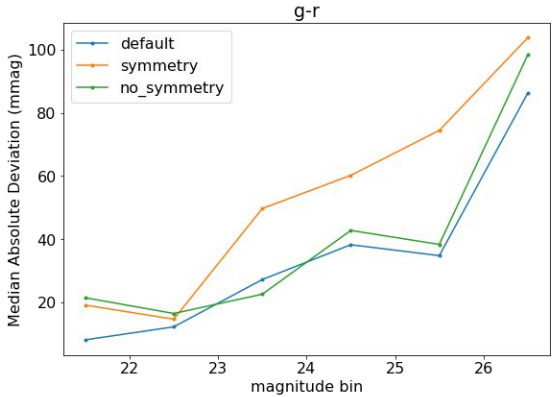
Isolated Star Colors

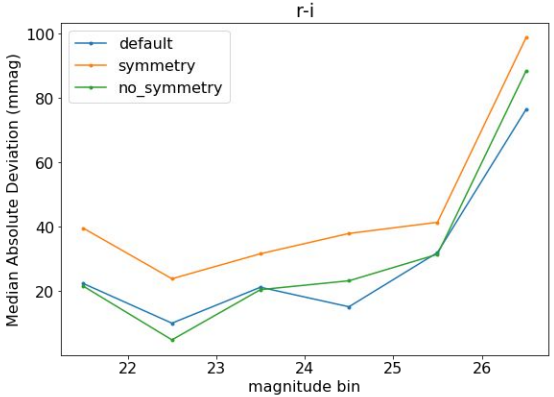


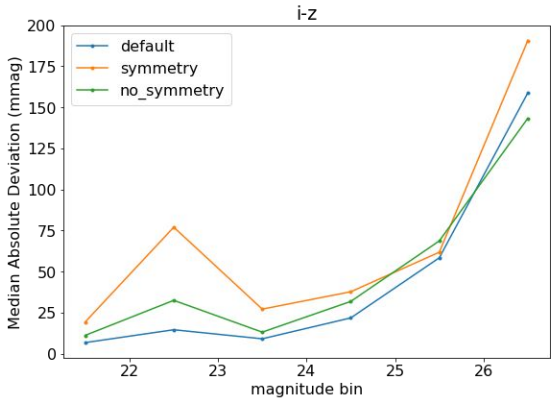
Isolated Star Colors



Isolated Galaxy Colors







Isolated Galaxy Colors