Options for Generating Detection Efficiencies for DIASources

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Introduction

Detection efficiency, η, is:
the probability that a source is detected given that it exists

↳ today, *point* sources in *difference* images

The detection efficiency, η, is a function of parameters $\vec{P}$, e.g.,

- apparent magnitude of the source
- local surface brightness (e.g., of host galaxy)
- proximity to a static-sky object (e.g., bright star, host core)
- field crowdedness
- image quality (FWHM)
- sky brightness
- airmass (DCR correction)
- location in focal plane (e.g., edge distortion)

Science Use Cases for $\boldsymbol{\eta}(\vec{\mathrm{P}})$

Scientific analyses that need $\boldsymbol{\eta}(\vec{\mathrm{P}})$ include, e.g.,

- occurrence rates
- population studies
- sample selections

for transients and variables that are discovered via difference imaging.

$\boldsymbol{\eta}(\vec{\mathrm{P}})$ *is not currently a data product listed in the DPDD, and we want to clarify DM's plans for the Community*

DPDD = Data Products Definitions Document (ls.st/dpdd)

Science Use Cases for $\eta(\vec{P})$

Typically, $\eta(\vec{P})$ is derived for an imaging survey by injecting fake point sources* into a direct image, running a difference-image source detection pipeline, and evaluating the fraction of fakes that are recovered.

*Here we mean random fake sources that span the range of $\vec{P}$ like real objects, but are not simulated as particular classes of light curves and injected into sequential images.

fake injected sources are also not currently a data product listed in the DPDD, which we also want to clarify

DPDD = Data Products Definitions Document (ls.st/dpdd)

Related DM Deliverables

Fake injection is planned to occur for both Prompt & Data Release DIA data products.

Primarily motivated by requirements that the DMS provide:

#1 *spuriousness* ($\mathcal{S}$) for `DIASources` (i.e., real/bogus)

#2 *spuriousness thresholds* ($\mathcal{T}_\mathcal{S}$) for purity & completeness cuts

I.e., a subset of `DIASources` that is 90% complete and 95% pure could be obtained by imposing $\mathcal{S}>\mathcal{T}_\mathcal{S}$.

Fake injection is part of the process needed to provide #2, and the DMS is sized to accommodate this processing.

DMS = Data Management System

Open Questions to be Resolved

The fake injection motivated by these requirements is not *necessarily* sufficient to produce an $\boldsymbol{\eta(\vec{P})}$ matrix that will serve the broad range of scientific analyses of difference-image objects.

To make $\eta(\vec{P})$, further DM study includes:

- the parameter space $\vec{P}$ needed for science
- the accuracy of $\boldsymbol{\eta(\vec{P})}$ needed for science
- timescales for assessing Prompt pipeline $\boldsymbol{\eta(\vec{P})}$
- whether the *mode** of fake injection matters for science
- how to make available $\boldsymbol{\eta(\vec{P})}$ or the fakes' data

E.g., simulating 2D PSFs vs. cloning the image's stars; how to treat variable stars.