An Overview of the LSST Pipelines

Jim Bosch, Princeton/LSST - ADASS 2018

A Detailed Look at Some of ~~An Overview of~~ the LSST Pipelines

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Large Synoptic Survey Telescope

~~A Detailed Look at Some of~~

An Overview of the LSST Pipelines

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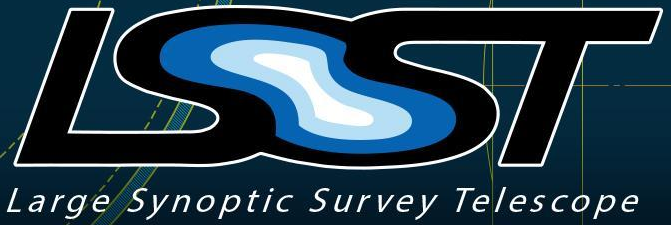
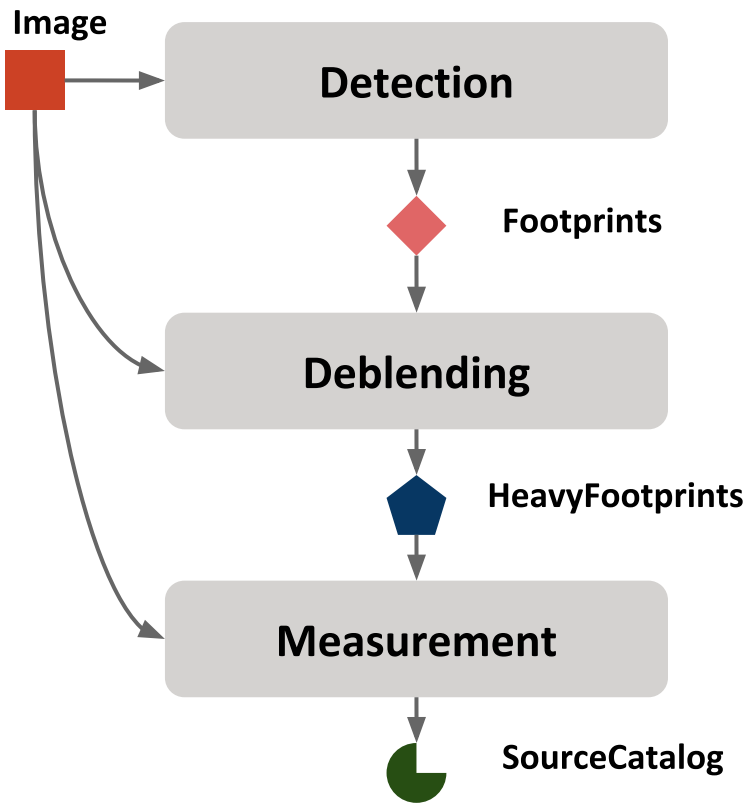
~~Woefully Incomplete~~



Making a Catalog

Let's start with a simple operation: we want to make a catalog containing measurements of the sources detected in a single image.

The LSST Pipeline splits this into three steps.

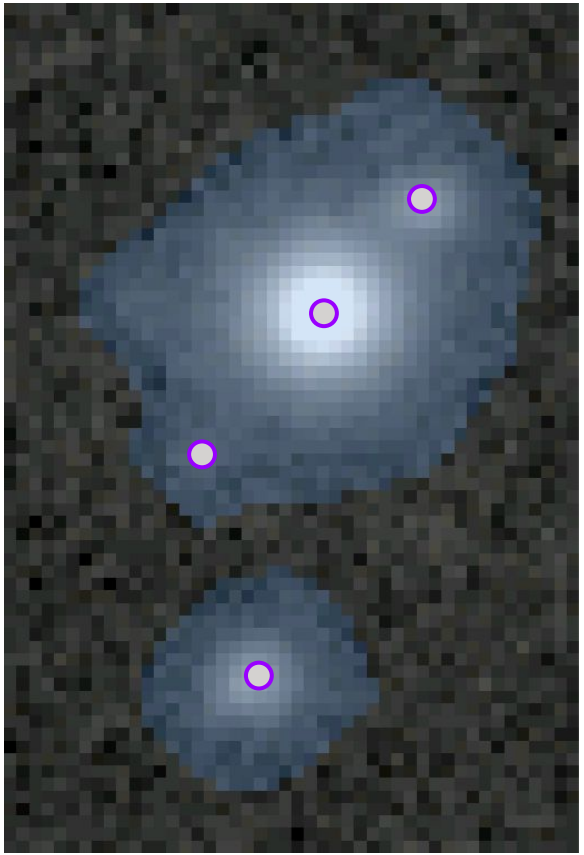


Detection

- Smooth image by the PSF.
- Find above-threshold regions.
- Find peaks within them.
- Grow regions by PSF width.

Not heuristic: this is maximum likelihood *for isolated point sources*.

And it's *usually* fine for extended and slightly-blended sources.

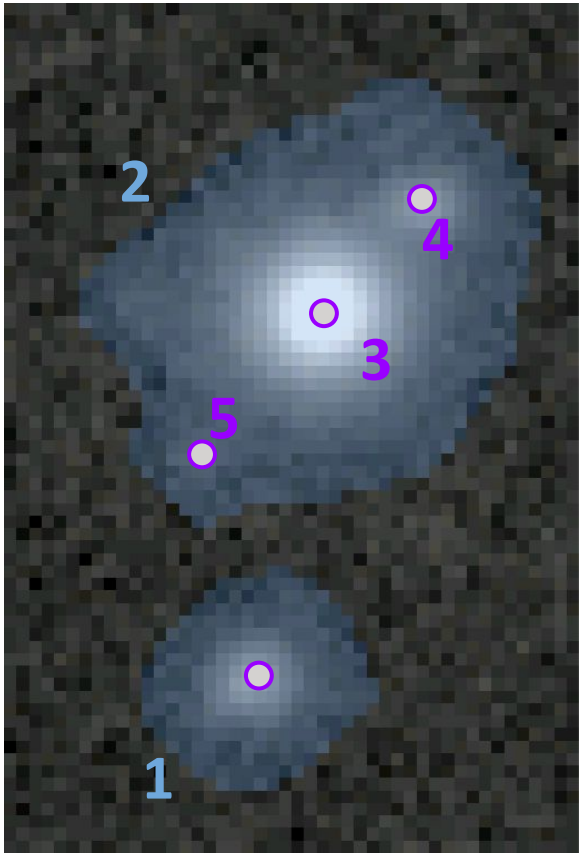


Deblending

We want to measure all of these, even #2.

Two(-ish) choices:

- Fit models to all sources iteratively or simultaneously.
- Construct a counterfactual image that isolates each source, and measure them individually.



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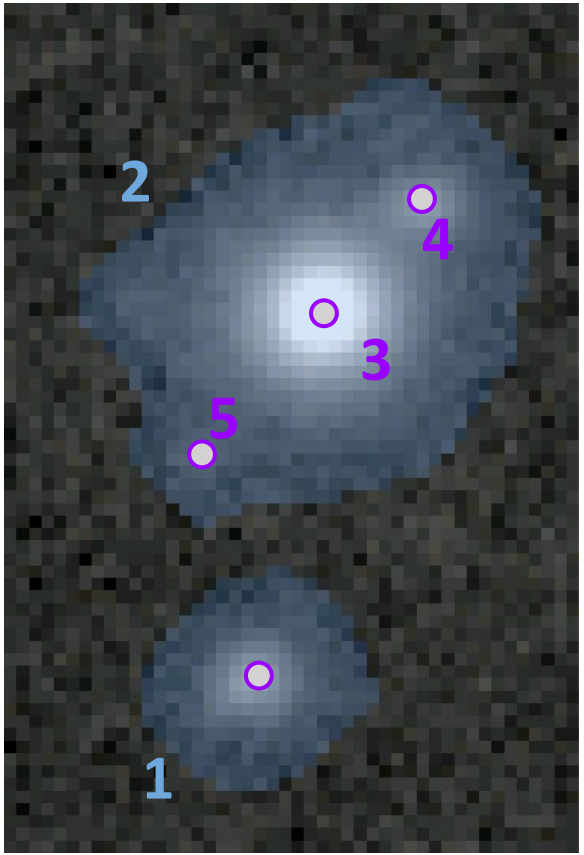
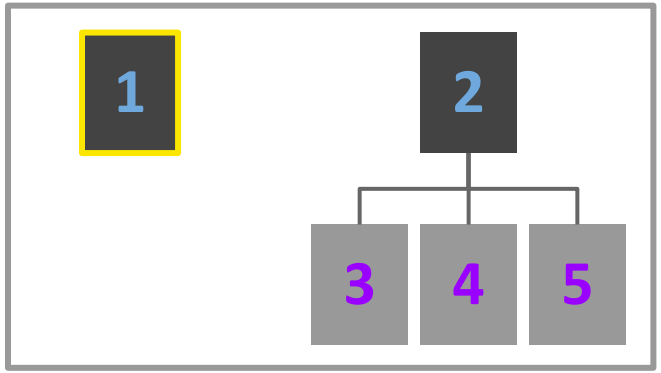


Parents, Children, & HeavyFootprints



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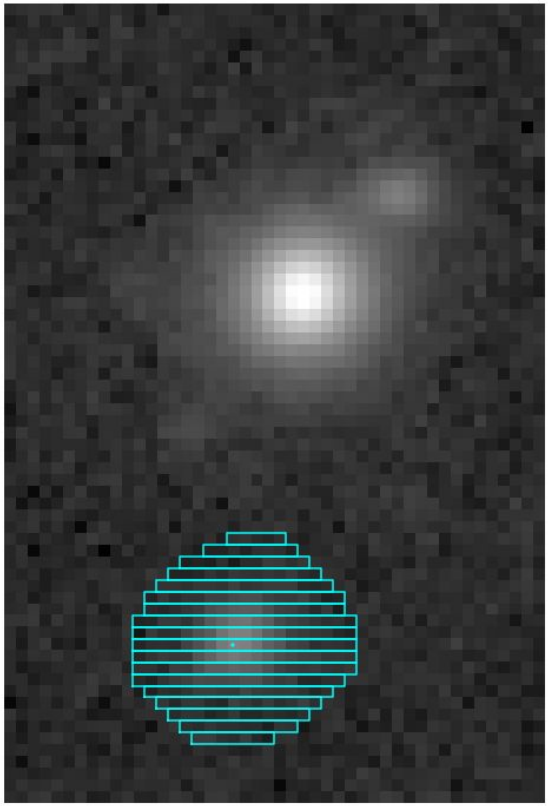

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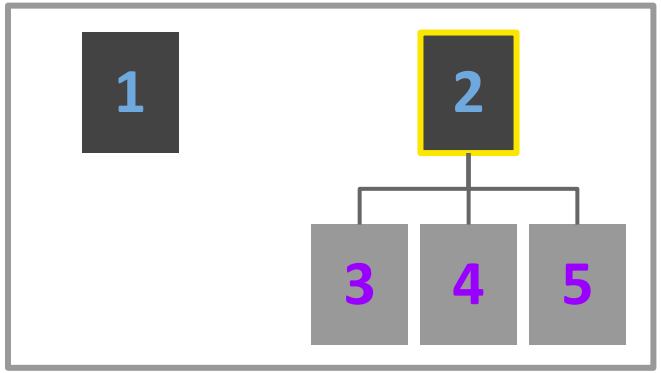

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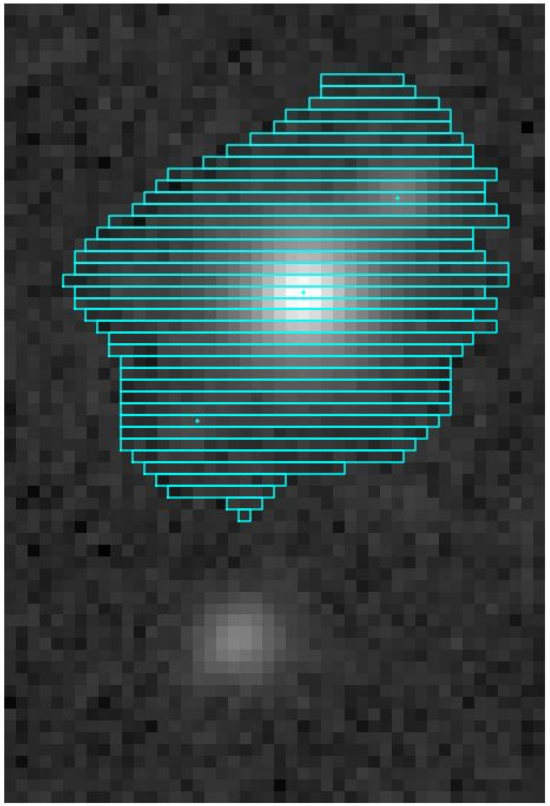

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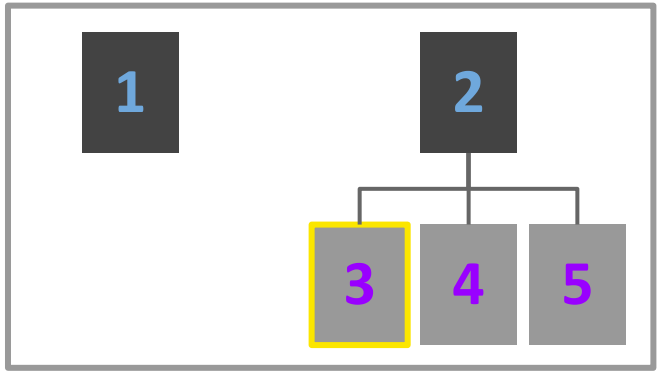

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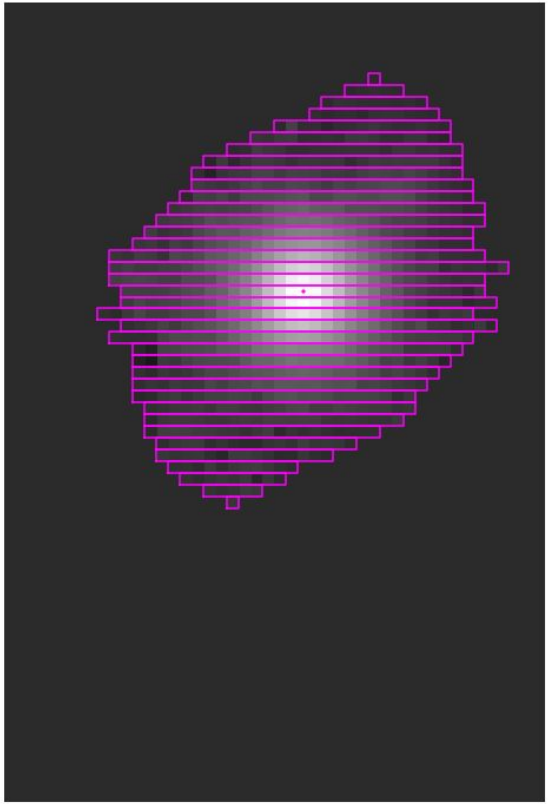

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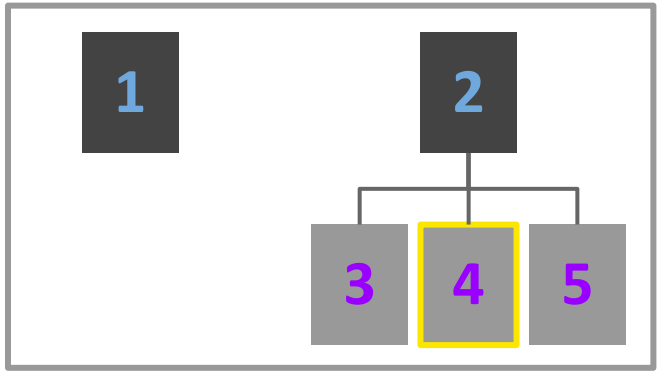

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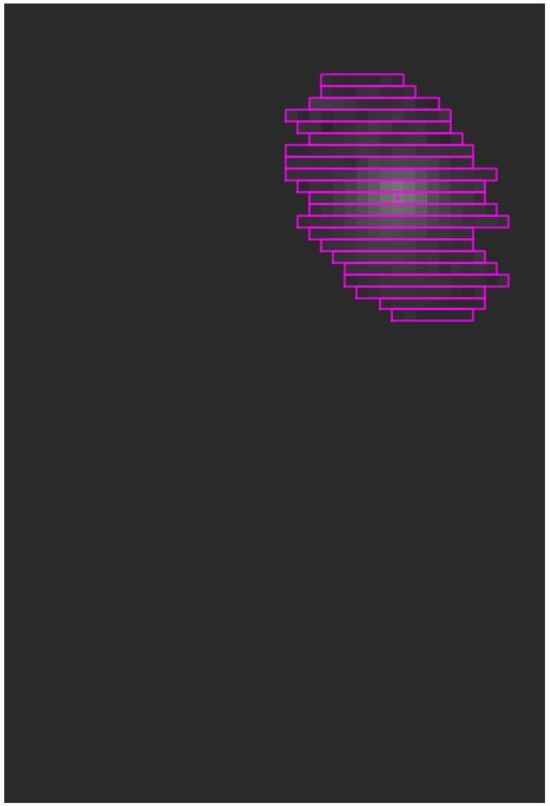

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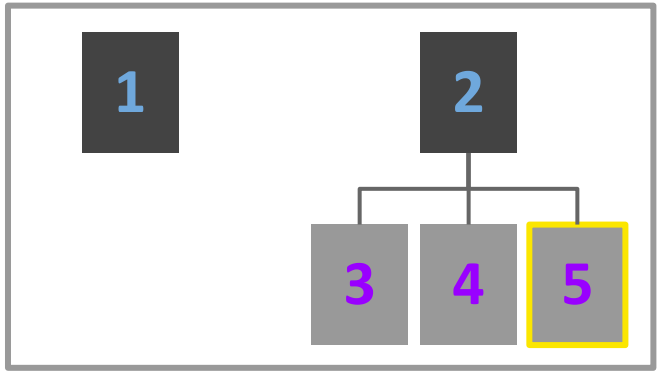

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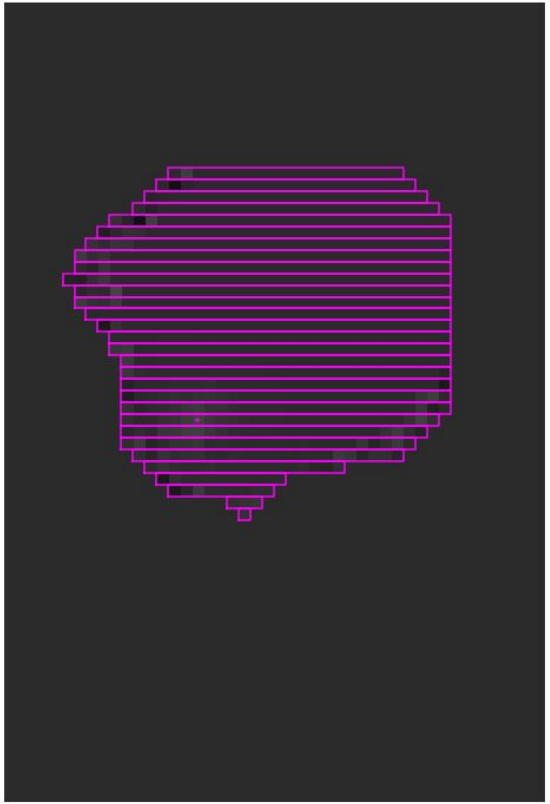
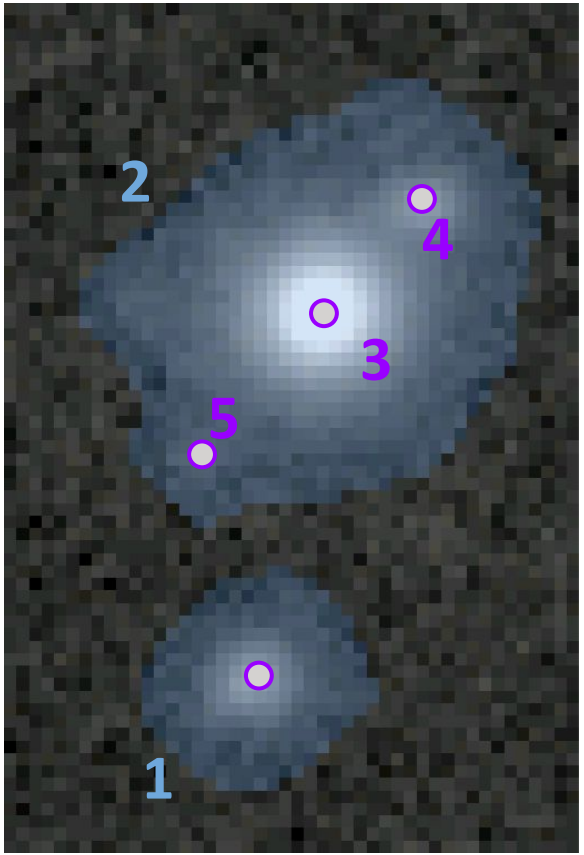


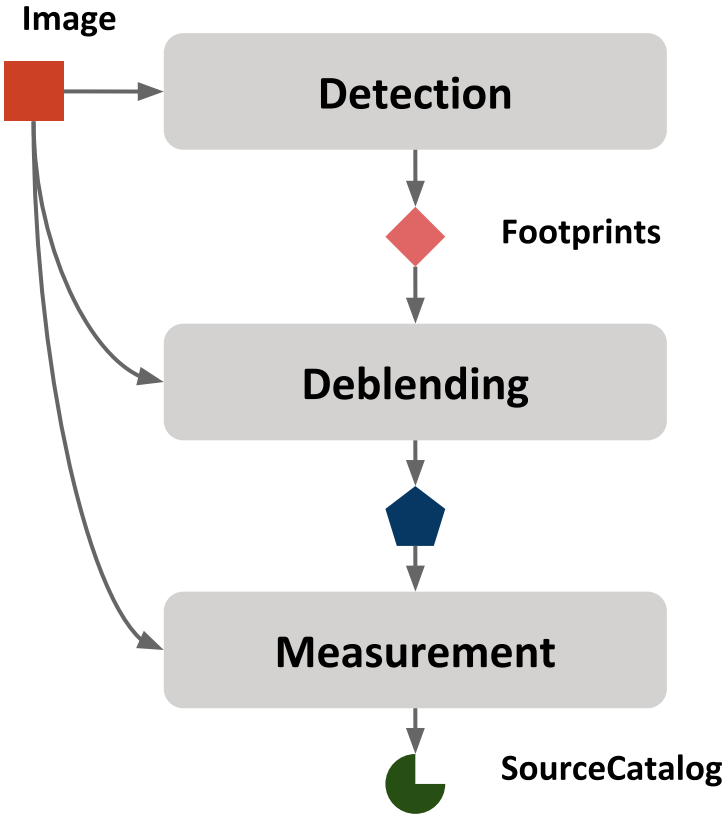
Measurement

- Replace all Footprints with noise.
- For each source:
  - Insert HeavyFootprint.
  - Run centroid algorithms.
  - Run shape algorithms.
  - Run flux and other algorithms.
  - Re-replace with noise.
- Re-insert all HeavyFootprints.



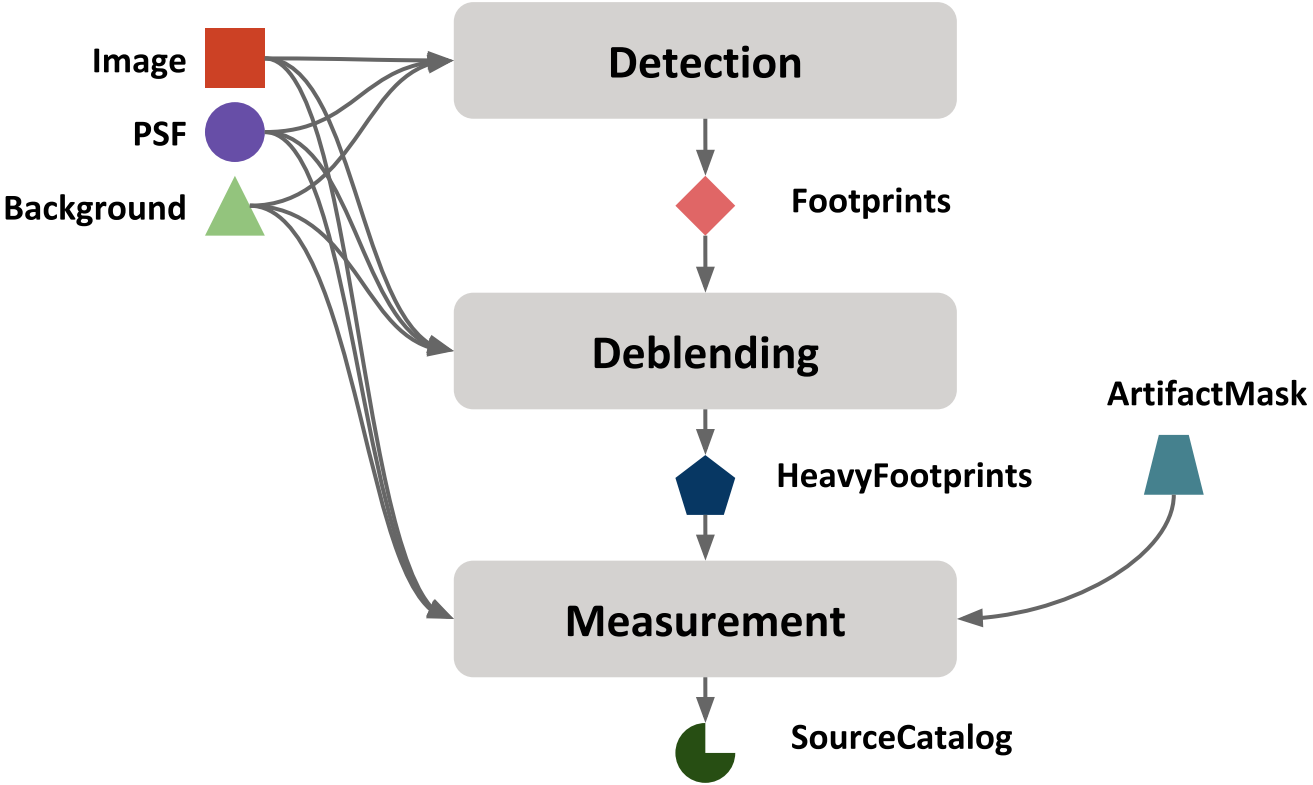
Catalog Complete!

That was easy.

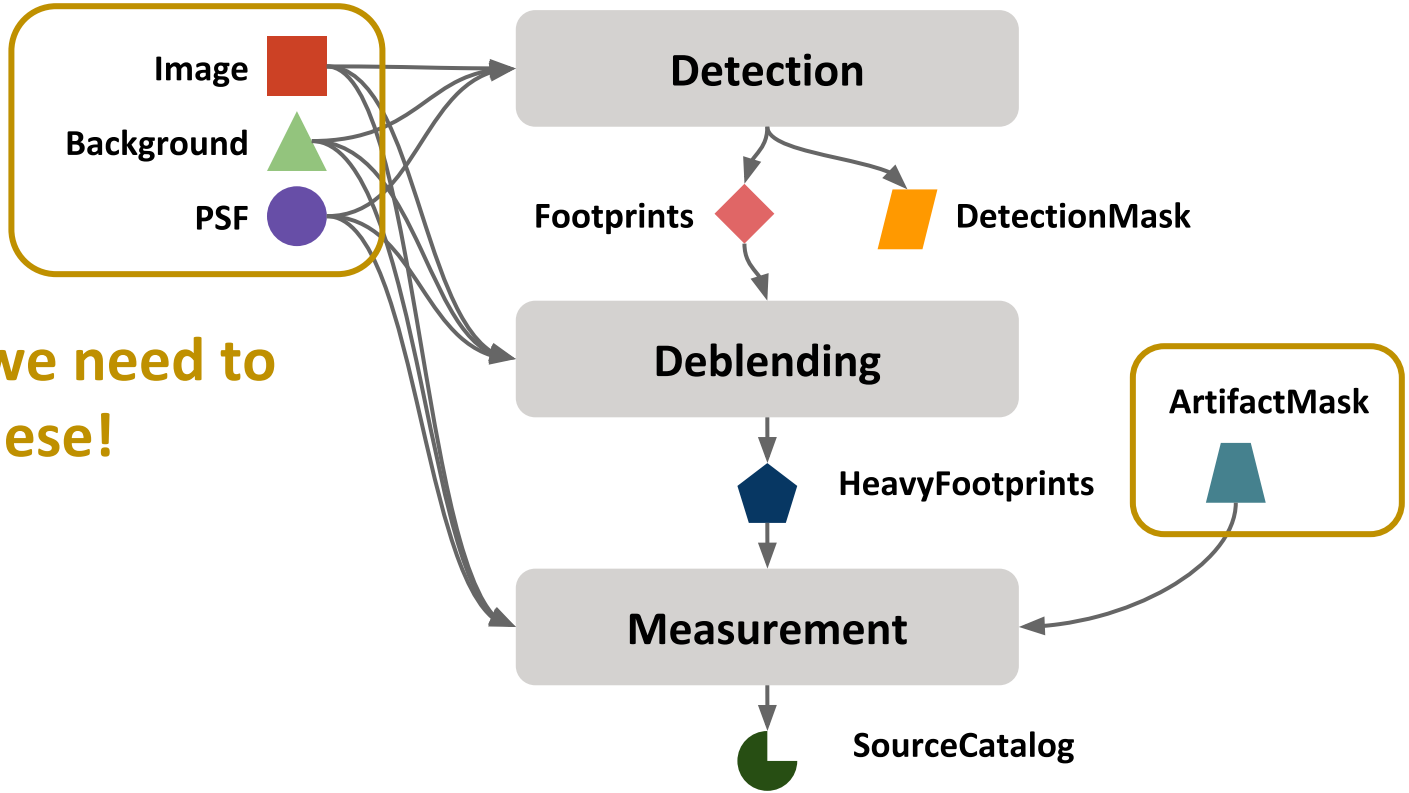


Catalog Complete!

Too easy.



Starting from Zero



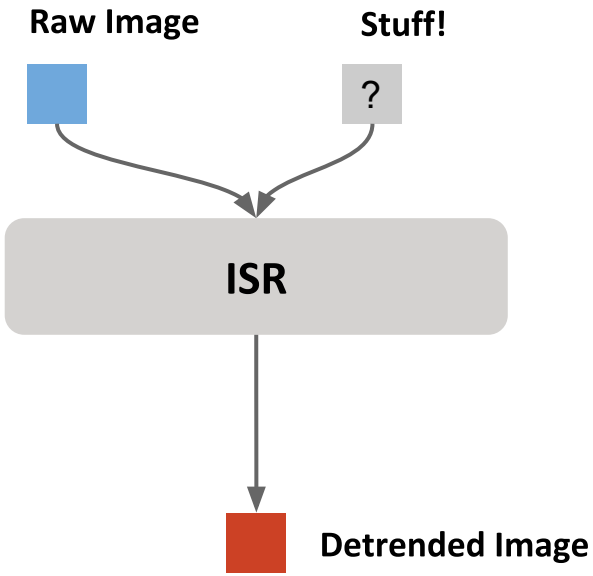
First we need to get these!

Not Appearing in this Talk: Instrument Signature Removal

All the flat/bias/dark/fringe correction you know and love, plus:

- a Collimated Beam Projector
- an Auxiliary Telescope
- forward modeling of the atmosphere

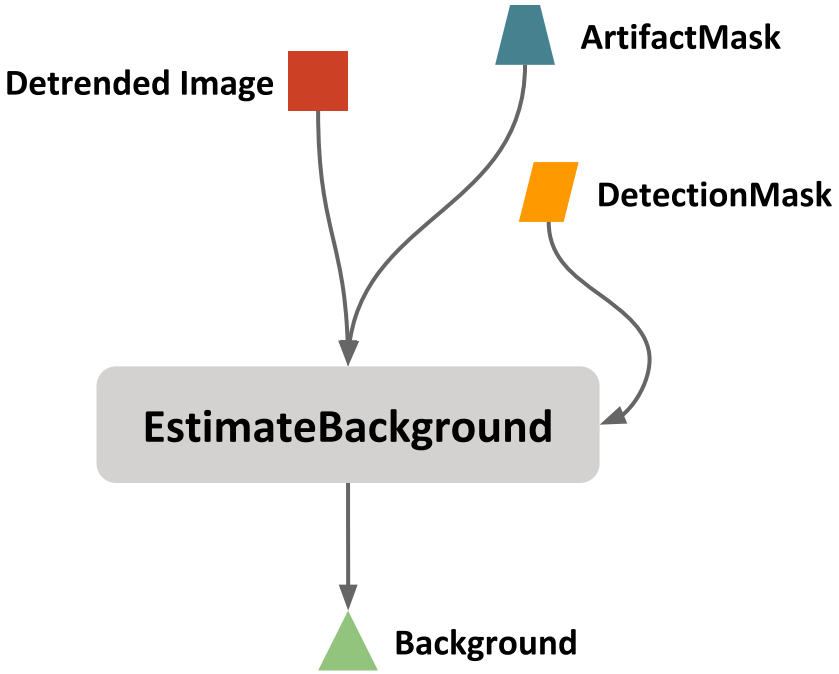
and more!



Background Modeling

- Mask out detections and artifacts.
- Spatially bin pixel values (sigma-clipped mean).
- Either interpolate (splines) or approximate (polynomials) to smooth.

Bin or approximate on the largest *continuous* scale possible



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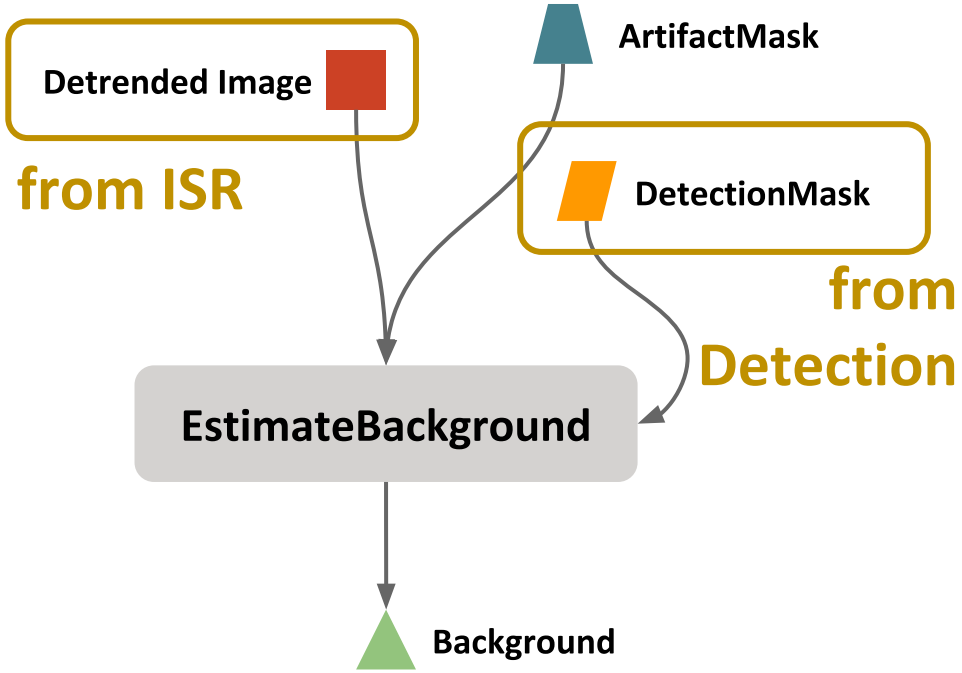
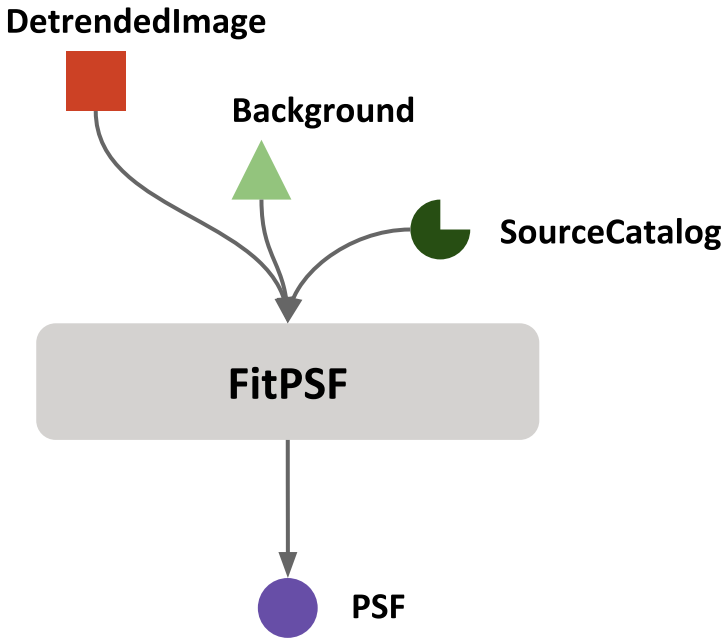


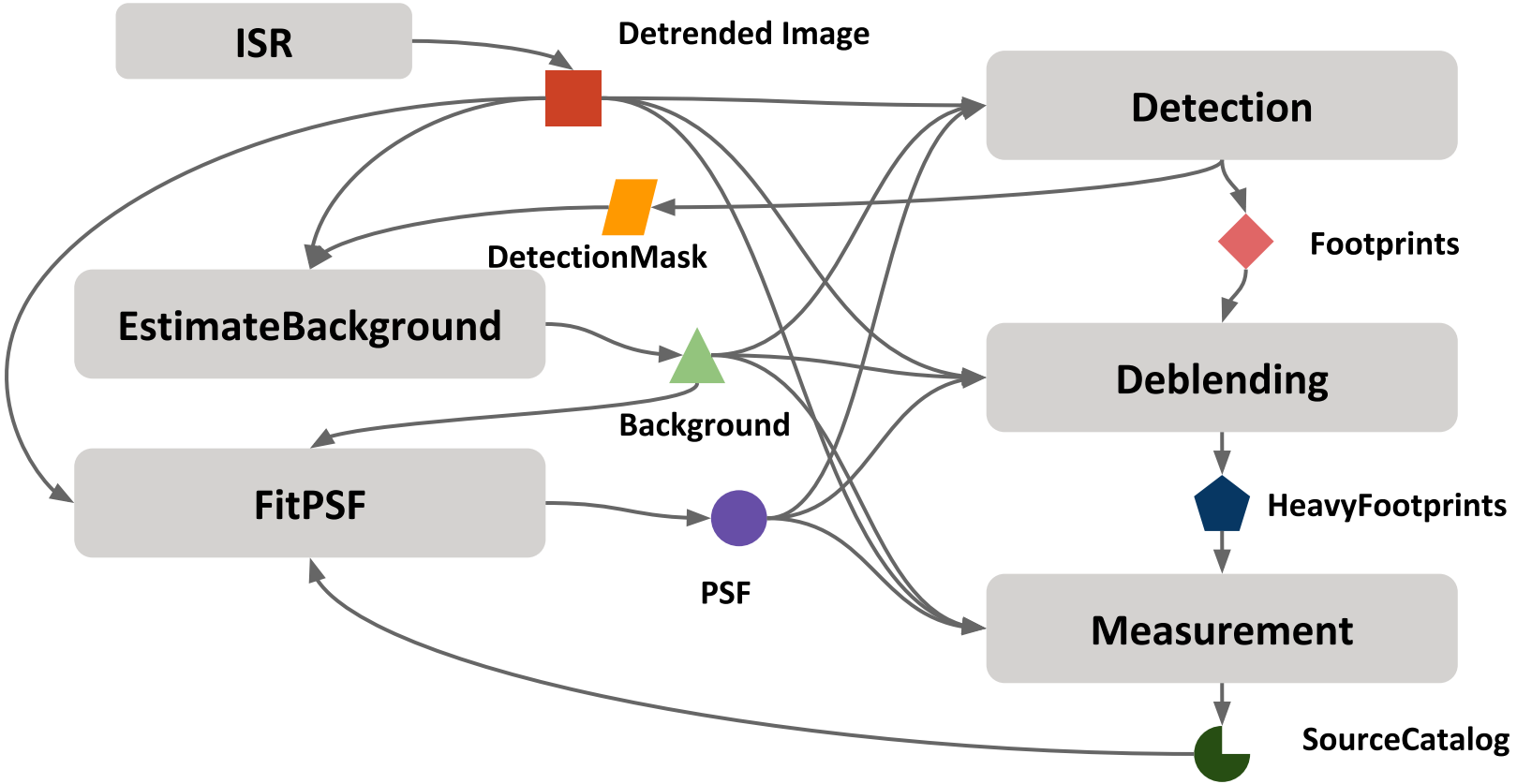
PSF Modeling

- Select securely-classified, isolated stars from source measurements.
- Fit a spatially varying model to them.

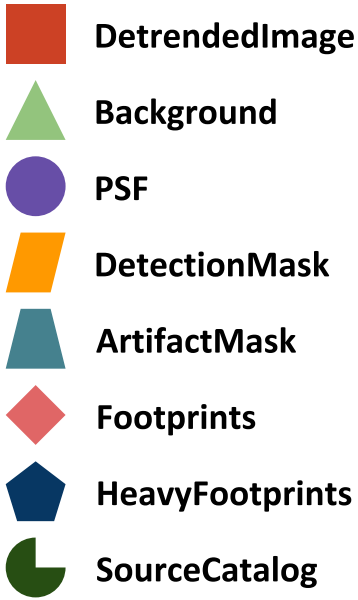
Could fit over the full focal plane *if* the model could handle changes in focus between chips.

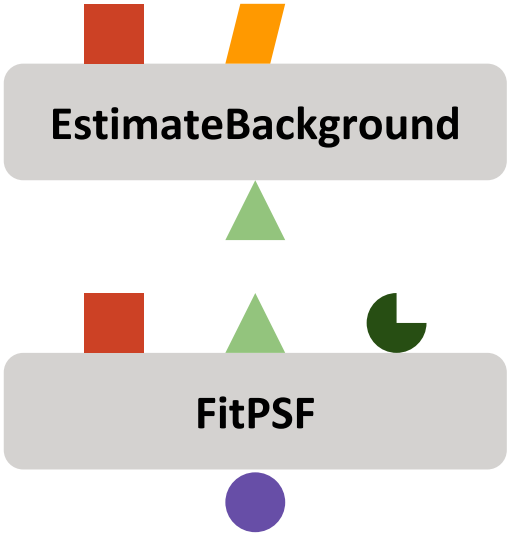


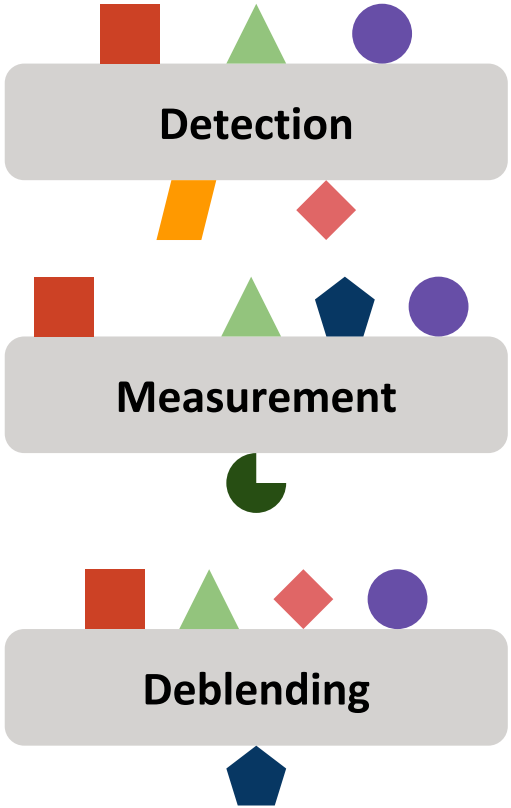
Starting from Zero, Again

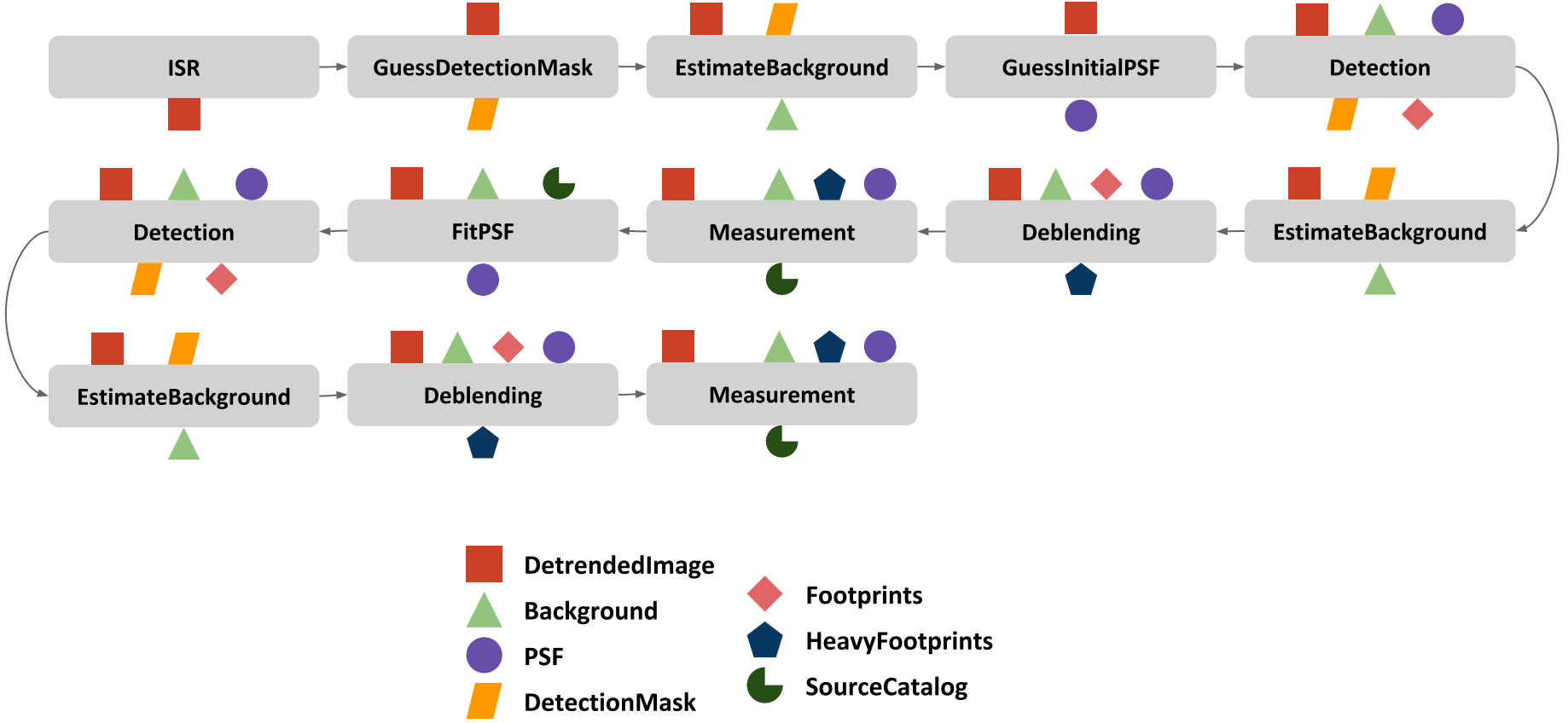


It's a Puzzle!


DetrendedImage
Background
PSF
DetectionMask
ArtifactMask
Footprints
HeavyFootprints
SourceCatalog


EstimateBackground
FitPSF


Detection
Measurement
Deblending


ISR
GuessDetectionMask
EstimateBackground
GuessInitialPSF
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EstimateBackground
Deblending
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FitPSF
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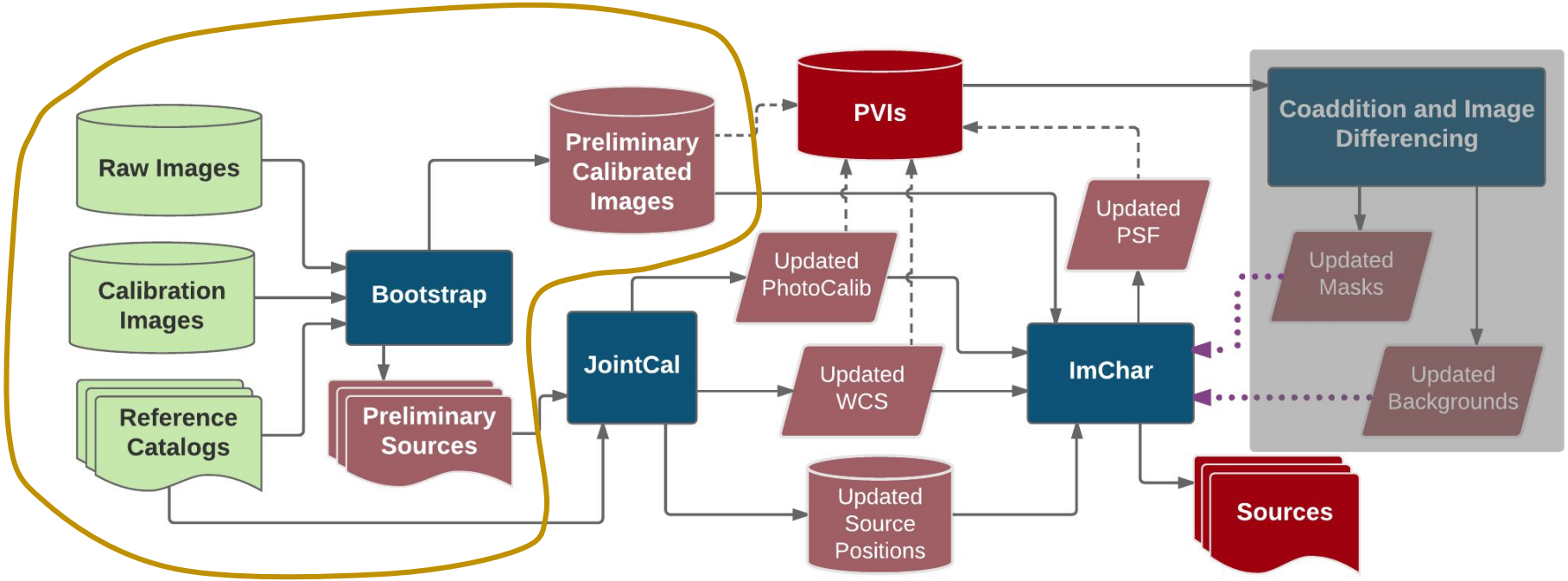
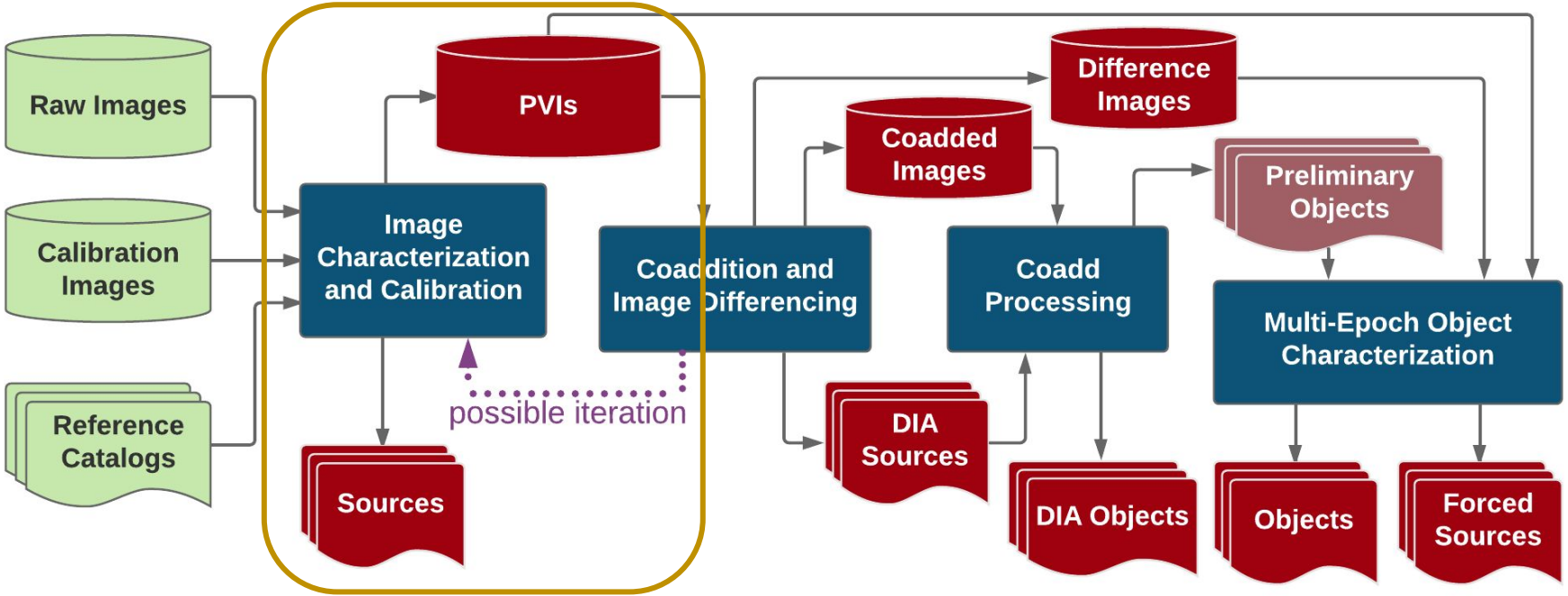
SourceCatalog

Zooming Out



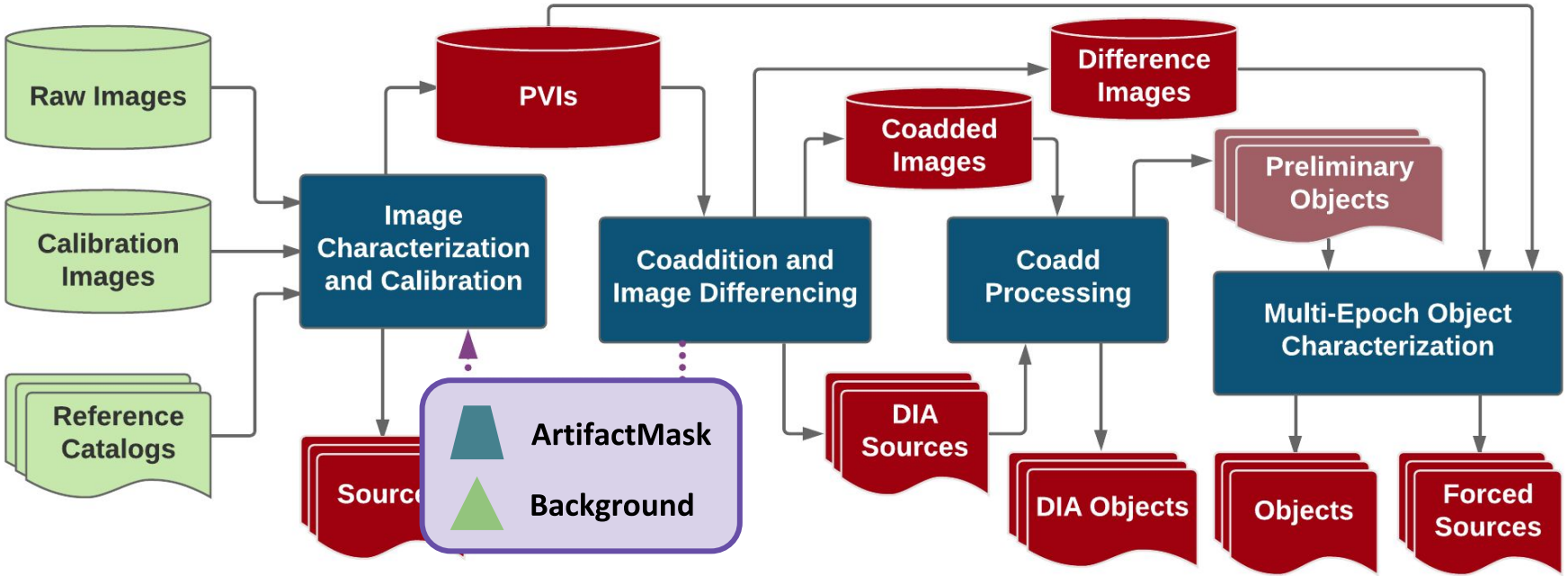
all of the previous slides just describe the Bootstrap step!

Zooming Out, Again



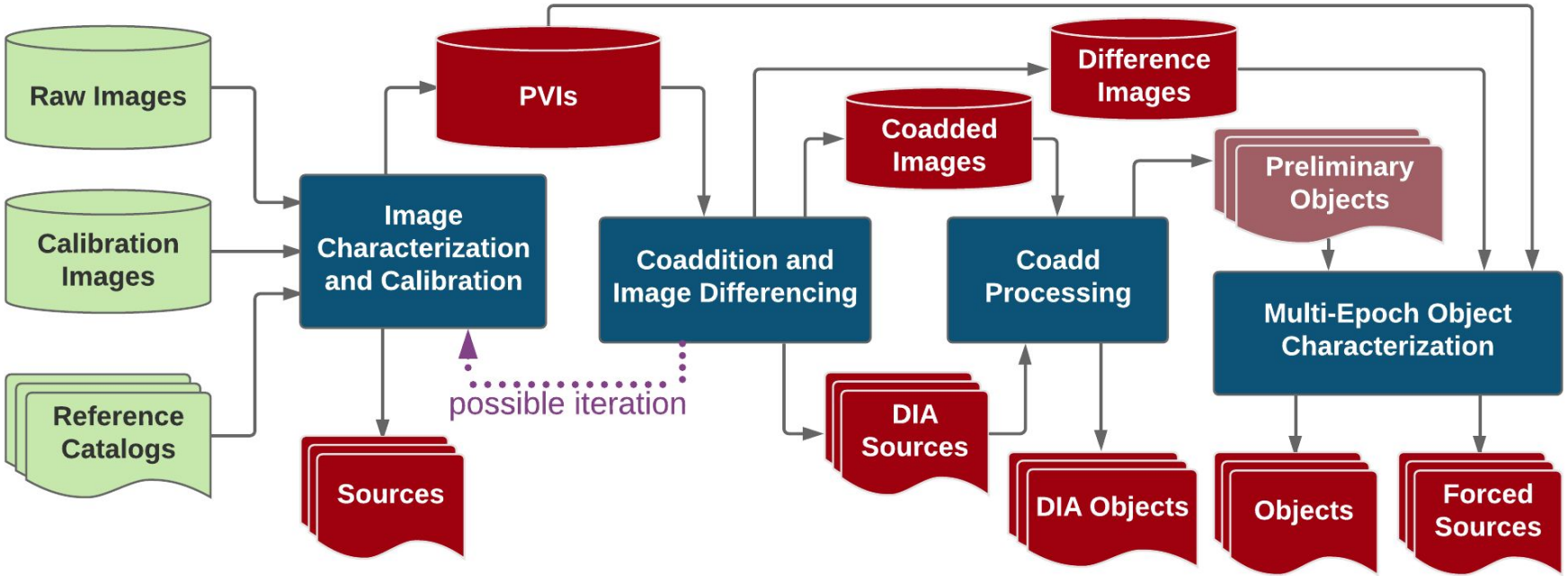
...and even the previous slide is just this bit.

Zooming Out, Again



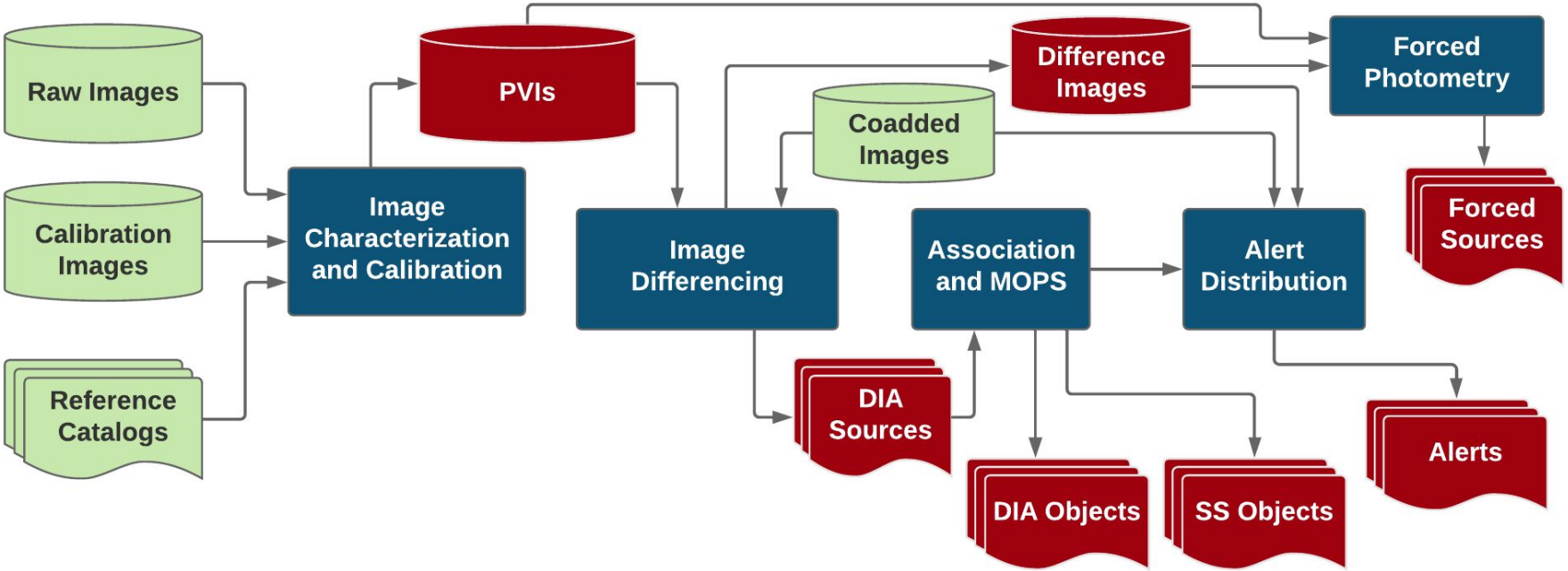
Remember these?

Data Releases vs. Prompt Processing



Data Release

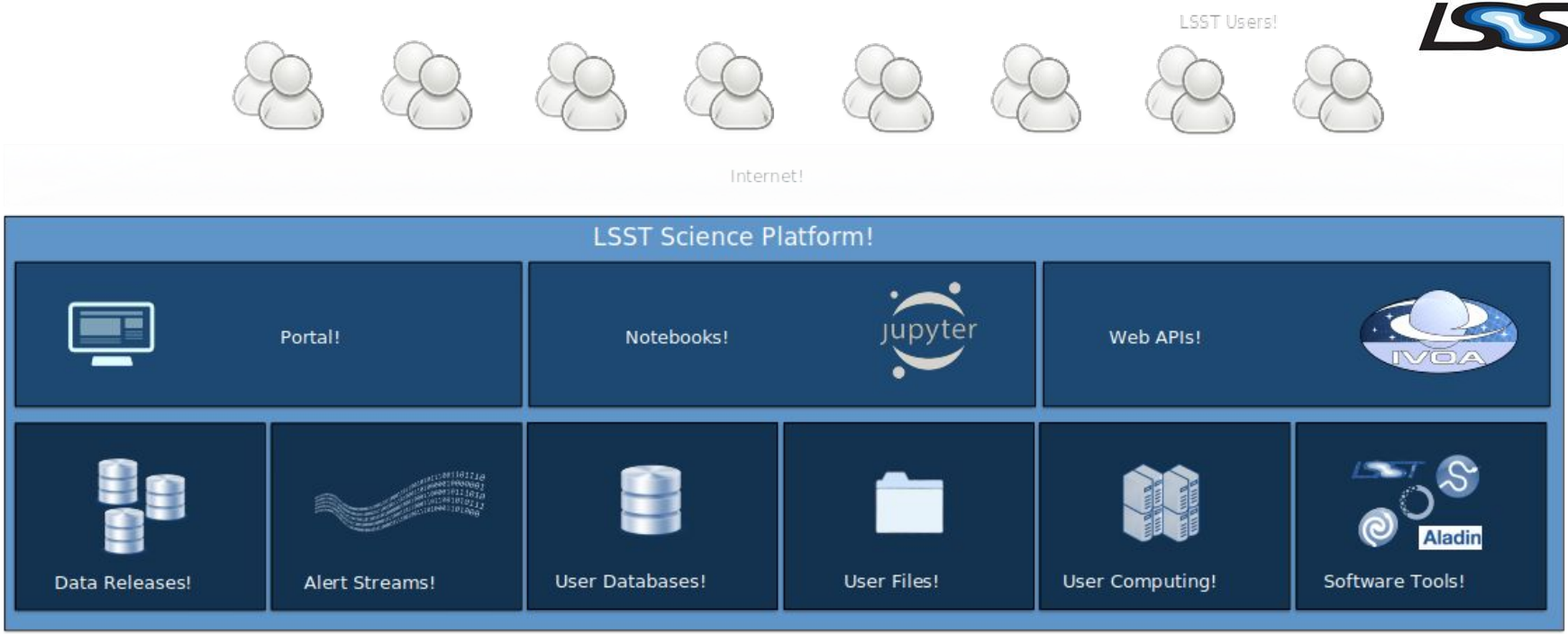
Data Releases vs. Prompt Processing



Prompt

For More Information

- Check out LSST's *Data Products Definition Document* at http://ls.st/dpdd for more information about the pipelines and particularly the data products they'll produce.
- LSST pipeline code is already being used to process data from Subaru's Hyper Suprime-Cam (right); see the *HSC Pipeline Paper* (Bosch et al 2018) to learn more about the algorithms and how they're working today.

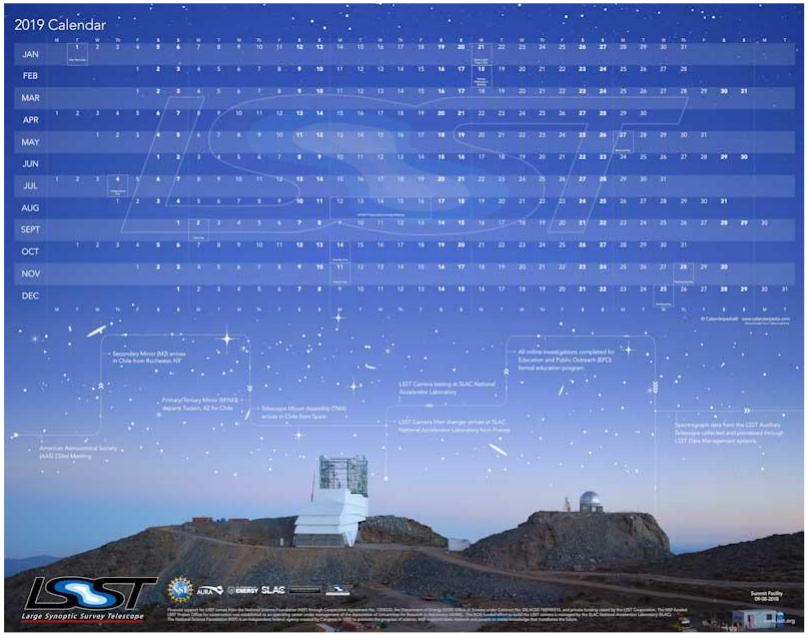


- LSST is also providing a data access system and analysis environment, which we're calling the *LSST Science Platform*.
- Learn more at http://ls.st/lse-319

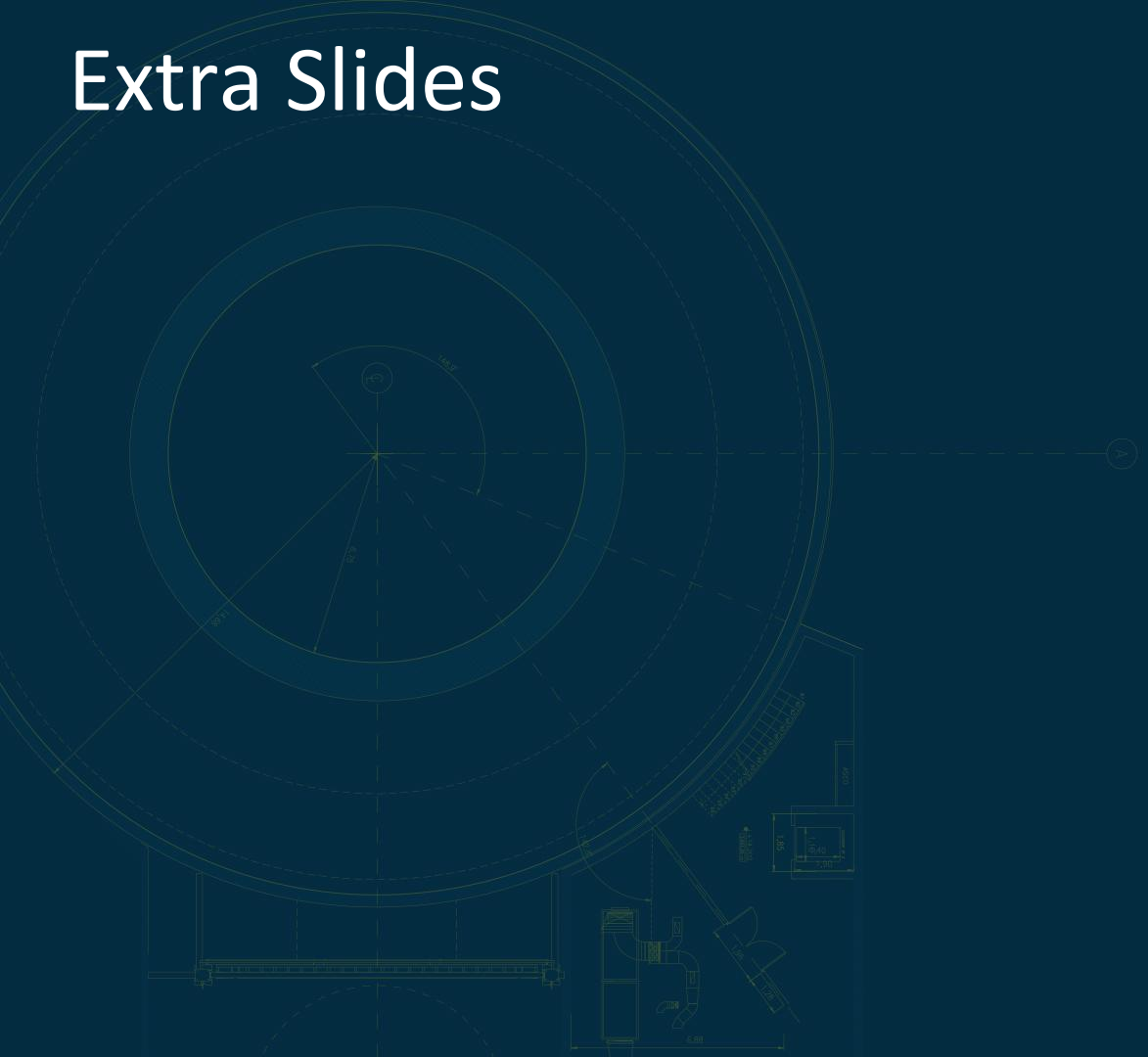
Got More Questions? Want Swag?

- Visit the LSST booth
- Get a demo
- Pick up some cool items!

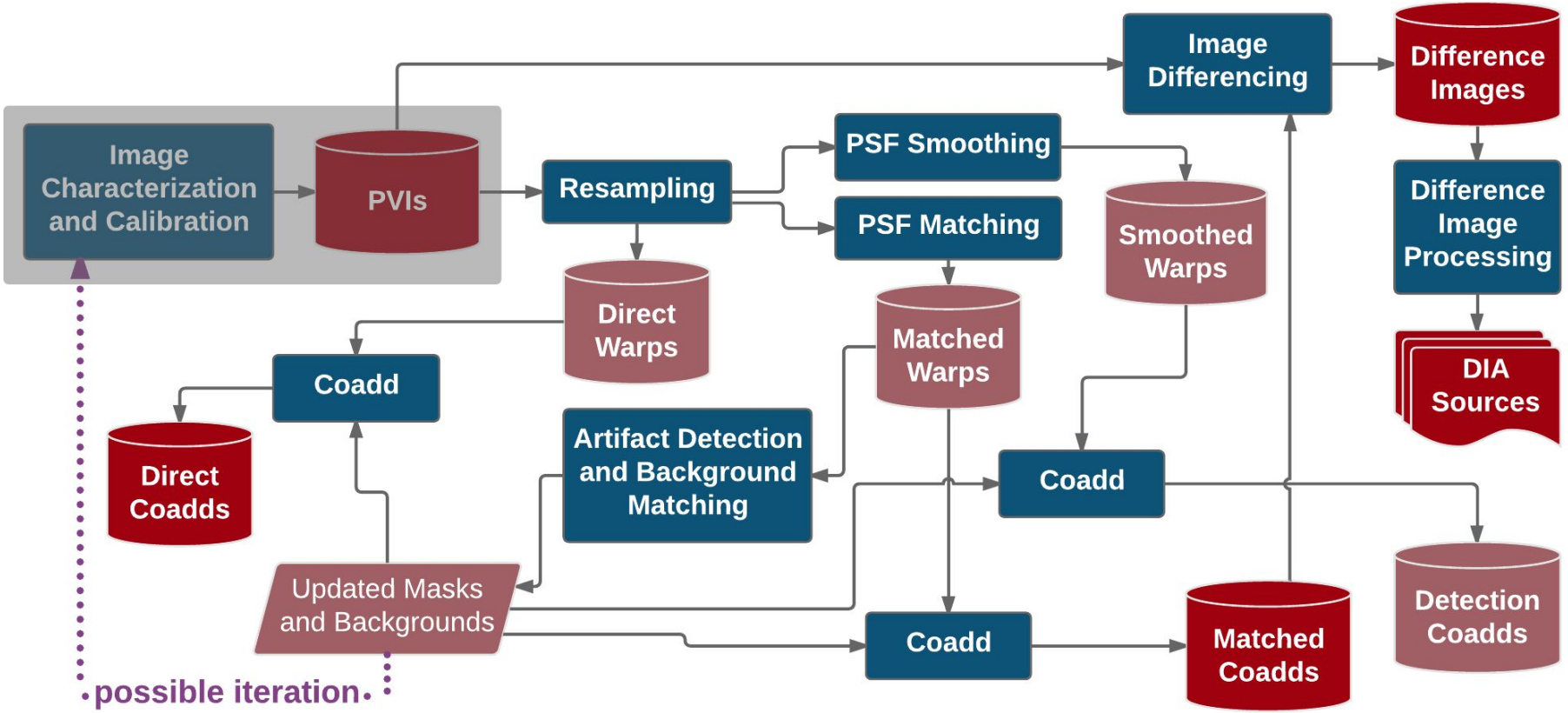
Screen cleaner



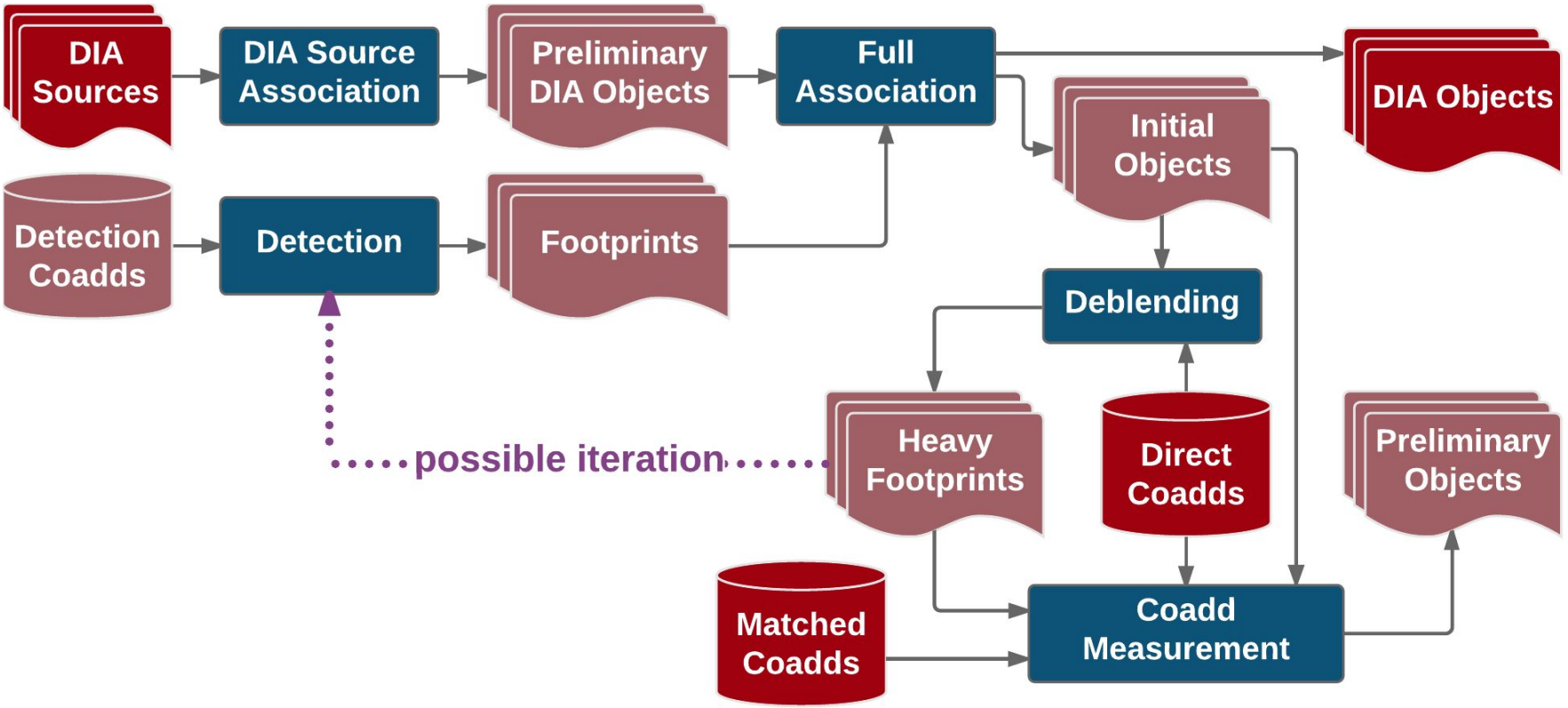
Extra Slides



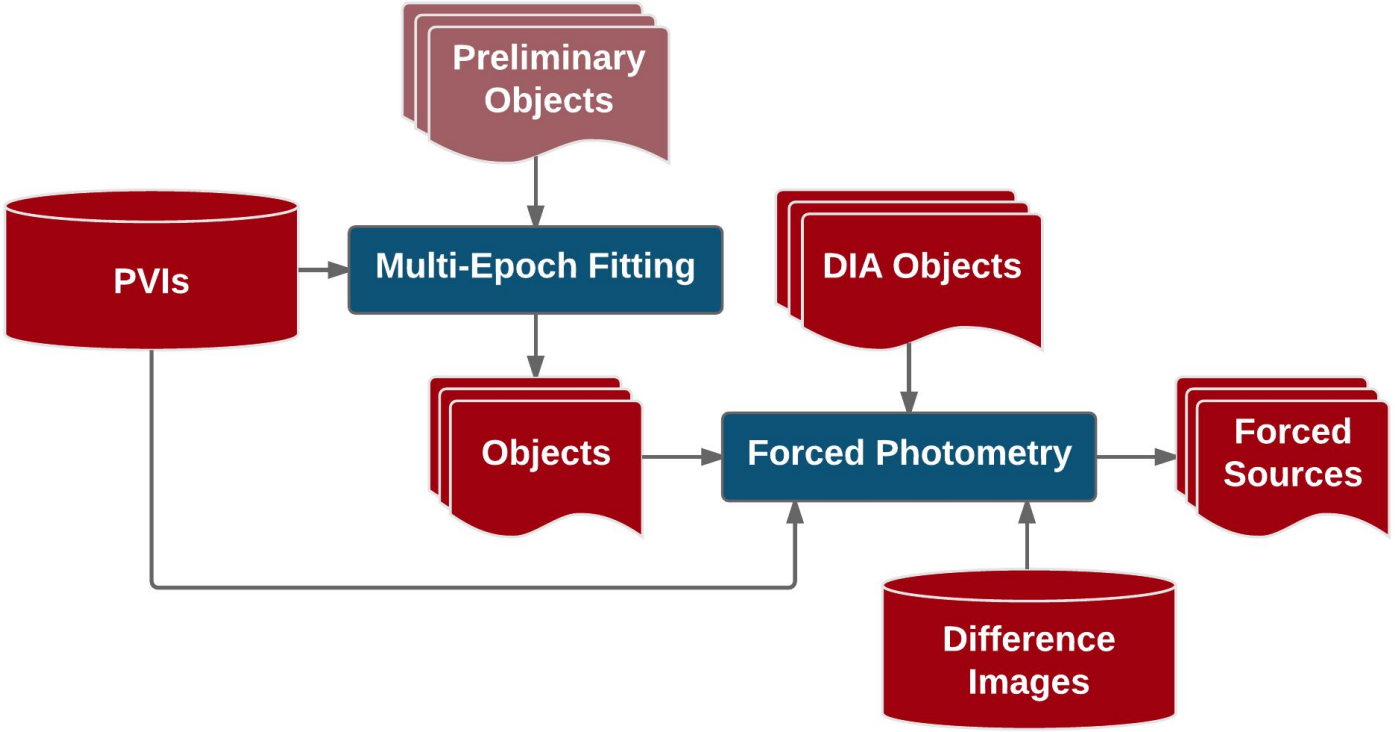
Coaddition and Image Differencing



Coadd Processing

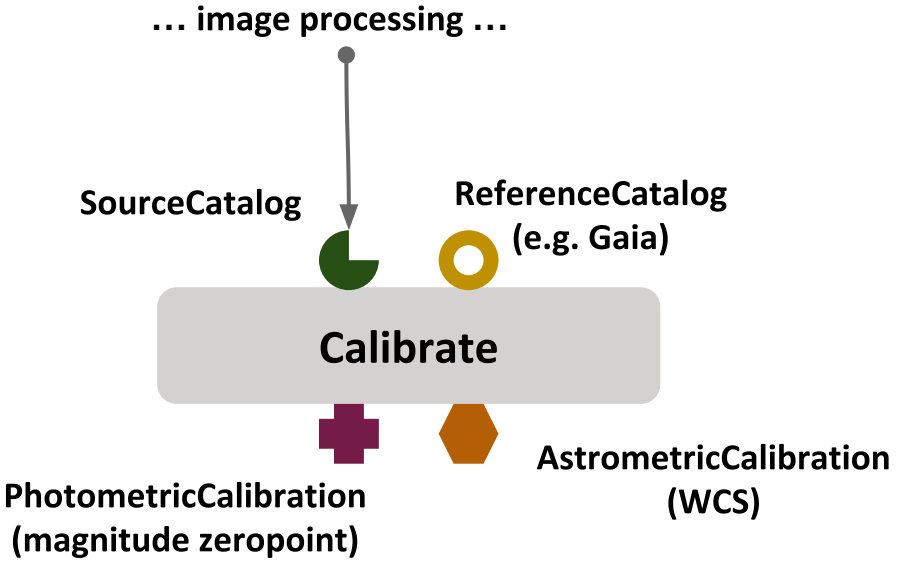


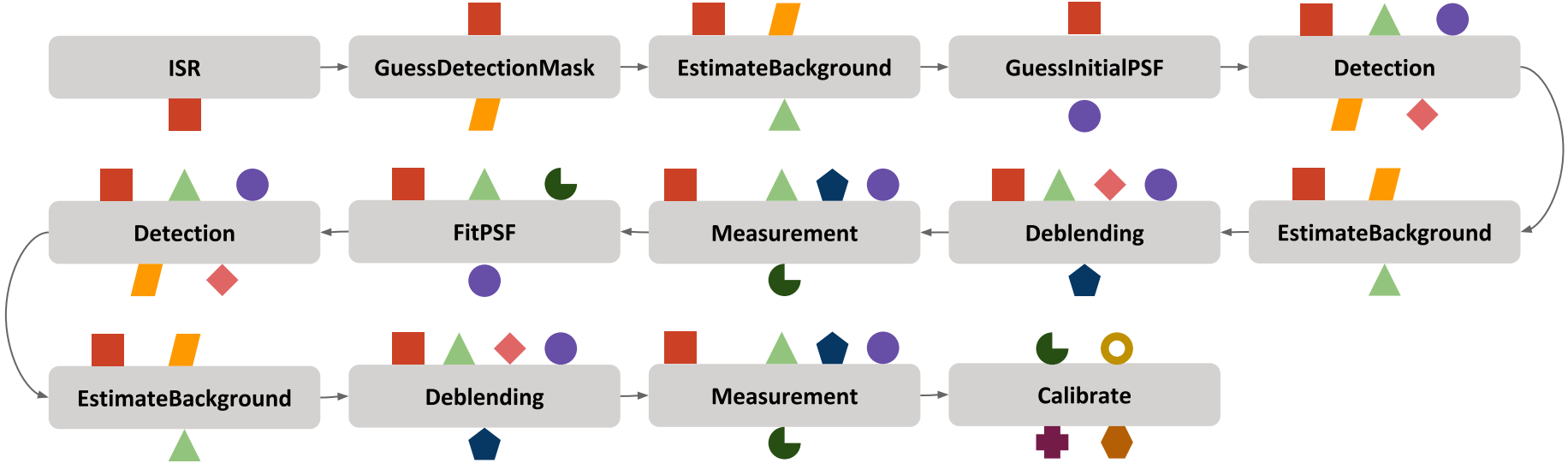
Multi-Epoch Object Characterization



One More Step

Once we've got good measurements built with the best PSF and background, we can match and calibrate to a reference catalog.

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EstimateBackground
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Measurement
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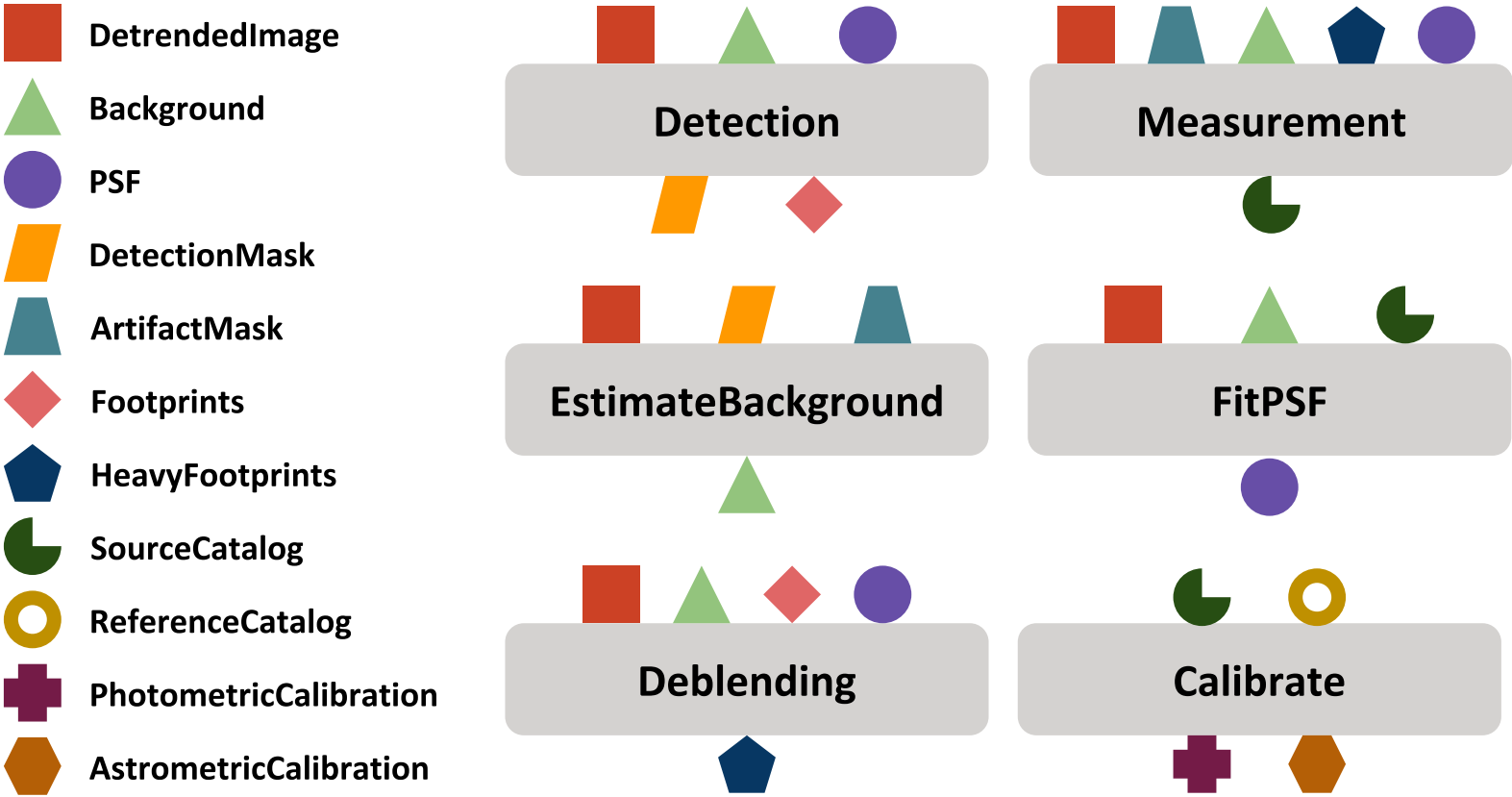
PSF
DetectionMask
Footprints
HeavyFootprints
SourceCatalog
ReferenceCatalog
PhotometricCalibration
AstrometricCalibration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PhotometricCalibration
AstrometricCalibration
Detection
Measurement
EstimateBackground
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Deblending
Calibrate