

# Crowded Fields Update

Colin Slater

# Where we were ~2 years ago

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- General consensus that:
  - Image differencing is a requirement over all of the sky.
  - Only “crowded field processing” sufficient to enable image differencing is required
  - Simultaneous stellar fitting may be useful for enabling diffim, and is scientifically useful, but is just one of many difficult algorithms we’d like to have and not the most urgent at the moment.

# Strategy since then

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- Had a strategy to prototype a DAOPhot-implementation with stack components (PSFs, detection, centroiding) + eigen for solving. My hope was this could be a basis for community contributions – more about that later.
- Prototype simultaneous fitter results (lsst-dm/pipe\_crowd):
  - Running a single round of this works, produces reasonable answers
  - The key to getting depth is to do multiple rounds of detection-measure-subtraction-redetection.
  - Something about the prototype prevented it from being able to go deeper in these additional rounds.

## In-kind

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- Took on in-kind contribution from the Netherlands, two postdocs (sequentially, 0.2 FTE) who would try to understand what was the issue and improve the performance.
- Postdocs were able to run and test the code, and had good ideas for what to check, but we all were eventually baffled and didn't make a significant improvement.
  - Bottom line: My fault, not theirs.

# Possible Causes?

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- Inaccurate PSFs, bad subtraction of modeled stars, light in the wings of stars: None of these seemed to be the problem.
- Lack of thought in how to select which new detections are “real” and avoid either over-detecting junk or not detecting deep enough into the noise: very possible, this is often where ad hoc heuristics live and are key parts to this type of code.
- Mistakes in implementation with stack tasks: very worried about this, hard to either find or disprove.
  - Current detection-centroiding-measurement framework is very rigid and hard to make it run twice on the same image. Seems very likely for bugs to crop up here when trying to do such roundabout things.

# Options

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- 1) Make the prototype work — I'm mostly exhausted with this, but willing to make one more push on the stack/functional aspects if others are willing to join
- 2) Wrap a third party package — This is the right choice if there are subtle details that dominate scientific performance, and we'd do better to use someone else's fine-tuning of these parameters.
- 3) Let the community do their own processing, likely DAOPhot — Goal was to avoid this, but I've seen no other plans from the community.