Accelerated Astronomical Source Finding

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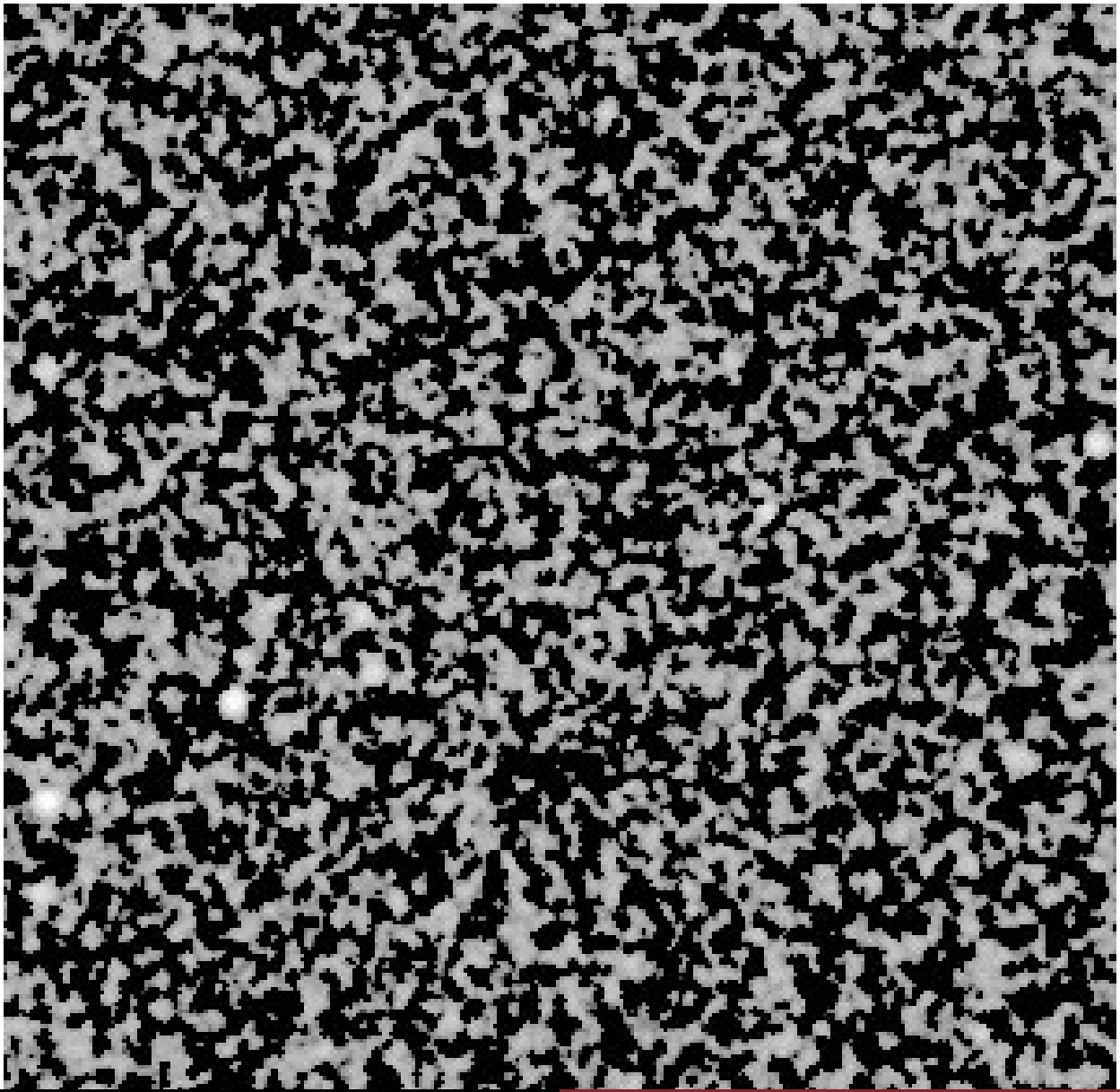
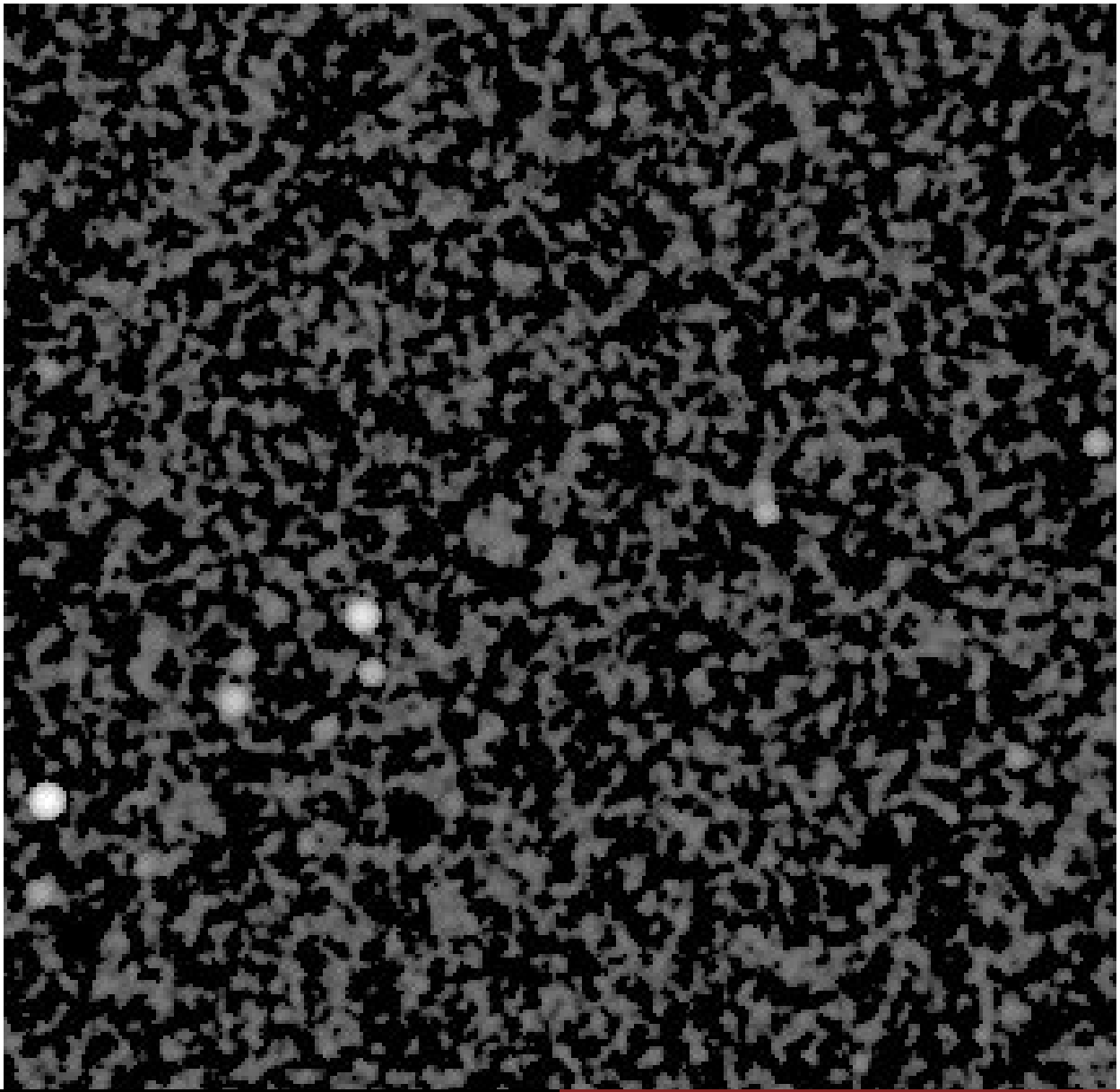
What is Radio Astronomy Source Finding?

- Process of identifying galaxies or other objects from blind surveys of the sky.
- It is made difficult by the amount of noise that gets detected.
- Traditionally done by astronomers by hand. It's very tedious work.
- It is estimated that there are one hundred billion galaxies in the universe. It will be impossible for any team of humans to catalogue this.

Survey Example: Noisy



Survey Example: Denoised



Automated Methods

- There exist automated source finders with DUCHAMP being the most well known.
- With the next generation of Radio Interferometers we are expecting current generation source finders to take between hours and days.
- We are proposing using GPU's to accelerate the source finding process.

GPU

- GPU's are low-cost highly parallel coprocessors.
- Difficult to program on due to highly parallel nature and unusual memory hierarchy

Work Distribution

- We intend to work on two source finders independently. This prevents either of us from blocking the other.
- Source finders perform differently with respect to completeness and reliability as they often trade one off for the other.
- **Reliability** the ratio of true positive detected sources to total sources.
- **Completeness** the ratio of sources detected to actual sources.
- It is useful to have a variety of source finders depending on an astronomers work load.

Yaseen, DUCHAMP

- DUCHAMP is a complete source finding package that is well-known in the astronomy community
- According to Popping et al DUCHAMP performs the best in terms of completeness and reliability for point sources and one of the best for larger galaxies.

Pipeline overview

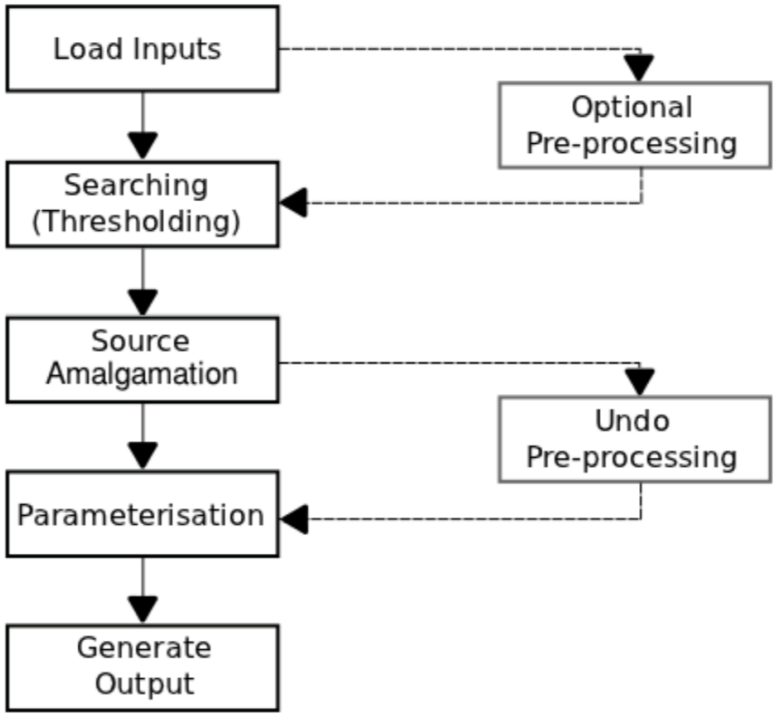


Figure : DUCHAMP pipeline

The DUCHAMP package takes a data cube and pushes it through a pipeline with data cube at one end and the parameterised sources at the other.

Jarred, SoFia: Smooth and Clip filter

Related Work

- Selavy, CPU parallel implementation of DUCHAMP.
- Badenhorst et al also did a CPU parallel implementation of the wavelet reconstruction filtering algorithm.
- Parallel Gaussian Source Finder has been ported to the GPU with massive performance improvements.

Testing

- The primary goal of this project is to accelerate the source finding process. Our most important metric is therefore execution speed.
- The execution time of the overall source finder depends on the data cube it is executing on. We should keep this constant or use predetermined data cubes.
- Compare against single threaded implementation.
- Ensuring correctness is of utmost importance.