Image Reconstruction in Radio Astronomy

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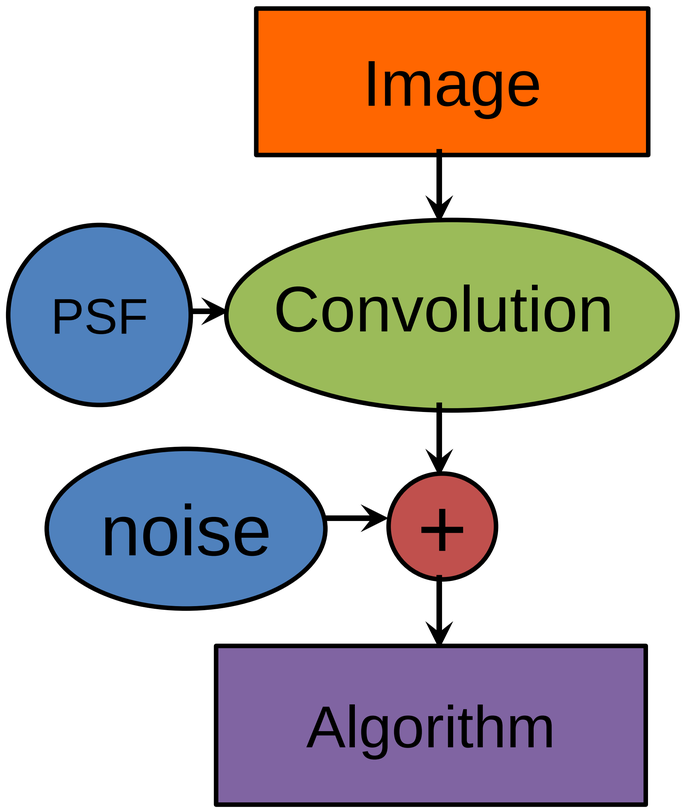
Problem Statement:

- **National Radio Astronomy Observatory** (NRAO) operates radio telescopes in WV
- Improved deconvolution can increase resolution / shorten scans



Algorithm:

- Approximate message passing [Donoho et al.]

  $x^{t+1}=\eta(A^T(y-Ax^t+\mathbf{CT})+x^t)$
- Image denoiser η [Mihcak et al.]
- Correction term CT
- Enforce convergence w/ damping, noise estimation, …
- Iterate

Future work:

- GPU implementation (image below took a week)
- Reduce artifacts by subtracting interference

Goals:

- **Interface** into NRAO data
- **Perform noisy deconvolution** by modifying compressive imaging algorithm [Tan et al. 2014]
- **Optimize** algorithm for memory usage (typical problem involves 10^7 measurements, 10^5 pixels)

Model:

- Map to inverse problem, **y=Ax+z**
- x – image (over pixel grid)
- z – interference (estimatable) + Gaussian noise
- y – ***very*** noisy measurements
- A – construct ***big*** matrix on the fly from point spread function (PSF)

→ saves memory ☺

Results: (Orion constellation)