

Improving image fidelity on astronomical data: Radio interferometer and single-dish data combination

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A comprehensive understanding of astrophysical processes often implies studying a large range of spatial scales. Astronomical observations hence have to capture both the emission of diffuse extended emission (using single-dish telescopes), and the emission from compact, localized sources (using interferometers). The final high-fidelity image is obtained after combination of the single-dish and interferometer observations. On theoretical/mathematical ground, various data combination methods have been proposed. In practice, the accuracy of these methods under realistic conditions have not yet been systematically profiled and compared. The workshop was motivated by the need to further develop, standardize, and assess these image combination processes, which will pave the way for precise imaging experiments.

The program of the workshop was divided among invited presentations introducing the different combination methods, hands-on data sessions with “working groups” (WGs) of 4-10 members, and discussion sessions among all participants to report the progress and challenges of the hands-on sessions, as well as any outstanding issues. Participants were divided into six “working groups” (WGs). Each WG worked several hours a day on a dataset (four observational datasets and two simulated datasets) to quantitatively profile the most commonly adopted combination methods. Their working progress was required to be documented in memos, which we have gathered here:

<https://github.com/teuben/dc2019/tree/master/report>

We plan to consolidate these memos, ensuring completeness and consistency, and ultimately submit them for publication as a single proceeding that describes both the workshop as well as the state-of-the-field of data combination. Although it may require additional testing, script generation and final editing, we will notify the Lorentz Center when this manuscript is complete.

This workshop, although small and focused in scope, brought together communities in several ways. First, we brought together the sub-millimeter and radio communities, both facing similar challenges for imaging processing. Second, we brought together observatory support staff (ALMA primarily, as well as software developers) and members of the astronomy community. After the workshop, participants will be ambassadors on the topic upon returning to their home institutions.

We anticipate scientific breakthroughs in the form of deeper and more accurate analysis of astronomical data. The procedures and scripts that we will provide for image combination (developed and tested by our 40+ participants) are unique in our field and will directly enable astronomical research for the community that has previously been limited by technical expertise.

Format of the workshop and additional comments:

We asked the participants to provide a draft report of each WG at the end of the week, and then a revised report 2 weeks after returning home. This was an effective way to encourage documented progress. Despite time was short, a lot of progress was made and the organizers have the information contained in the reports for preparing a final proceeding after the workshop. The groups had a range of expertise, which actually worked fine, as the more-experienced helped the less-experienced members.

During the workshop, we communicated among all the participants via a Slack space and multiple channels. We kept all data, scripts and presentations at a github page:

<https://github.com/teuben/dc2019>

We would very much like to have a follow-up workshop in about 1-2 years to assess the progress, once our memos/scripts are shared with the broader community, and perhaps additional tests have been done (or even, new methods developed).

We also suggest that for a rather technical workshop like ours, it would be helpful to have a two-week workshop option. The first week would be like the workshop held, followed by a more technical, developers' workshop to implement the tools discussed during the first week.

All participants, in particular the organizers, were very happy with their experience!

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