The CASA software for radio astronomy: status update from ADASS 2019

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Abstract. CASA, the Common Astronomy Software Applications package, is the primary data processing software for the Atacama Large Millimeter/submillimeter Array (ALMA) and the Karl G. Jansky Very Large Array (VLA), and is frequently used also for other radio telescopes. The CASA software can process data from both single-dish and aperture-synthesis telescopes, and one of its core functionalities is to support the data reduction and imaging pipelines for ALMA, VLA and the VLA Sky Survey (VLASS). These proceedings of the 2019 Astronomical Data Analysis Software & Systems (ADASS) conference give an update of CASA project, and highlights new developments that are important to the user community.

1. Introduction

The Common Astronomy Software Applications package CASA (McMullin et al. 2007, CASA team et al. in prep.), is being developed with the primary goal of supporting the data reduction and analysis needs of ALMA and the VLA, with a versatility that also benefits the processing of data from other radio telescopes. The CASA package can process both interferometric and single dish data. One of its core functionalities is to support the ALMA, VLA and VLA Sky Survey (VLASS) pipelines.

The CASA infrastructure consists of a set of C++ tools bundled together under an iPython interface as data reduction tasks. This structure provides flexibility to process the data via task interface or as a python script. In addition, many post-processing tools are available for even more flexibility and special reduction needs. Starting with CASA

6 later this year, the user will gain more flexibility to integrate CASA in a standard Python environment.

In these proceedings, we provide a status update of the CASA software and highlight a few upcoming new developments for 2020. The CASA team presented these results at the 29th Astronomical Data Analysis Software & Systems (ADASS) conference that was held from 6−10 October 2019 in Groningen, the Netherlands.

CASA is developed by an international consortium of scientists based at the National Radio Astronomical Observatory (NRAO), the European Southern Observatory (ESO), the National Astronomical Observatory of Japan (NAOJ), the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA), the CSIRO division for Astronomy and Space Science (CASS), and the Netherlands Institute for Radio Astronomy (ASTRON), under the guidance of NRAO.

2. Imaging: algorithm improvements and parallelization

TCLEAN is the CASA task that is used for imaging and deconvolution. TCLEAN is the successor of CLEAN, which is no longer being maintained.

TCLEAN has seen recent improvements in mosaicing, widefield/wideband imaging, weighting, deconvolution techniques and automated masking. In our continuing push to make CASA more reliable for users[1], a suite of 30+ functional verification tests have been written for tclean to evaluate various imaging modes relating to joint mosaicing and wideband imaging. The CASA team aims to make certain verification tests for both imaging and calibration available to users with the start of CASA 6.

CASA now also supports parallel imaging as a standard mode of operation (Castro et al. 2017). With the use of ten or more cores and working in the mpicasa environment, typical speed-up factors of 4−5 can in most cases be reached when imaging standard MeasurementSets (Bhatnagar et al. 2015; Emonts 2018). The Atacama Large Millimeter/submillimeter Array has adopted parallel imaging as a standard mode for data processing as of Cycle-6.

3. CASA 6: Modular Integration in Python

CASA has always been distributed as a single, integrated application, including a Python interpreter and all the libraries, packages and modules. As part of the ongoing development of CASA 6, and the switch from Python 2 to 3, CASA will provide greater flexibility for users to integrate CASA into existing Python workflows, with tools and tasks as standard Python modules.

From CASA 6 onward, CASA should really be thought of as the system described in Figure 1, comprising only the tools and tasks that CASA 5 currently provides. In addition, the plan is for important functionality like CARTA, the CASA viewer, and CASA plotms to be available as independent Python 3 modules (like casatools and casatasks). For example, the CASA viewer process would correspond to one of the "process" ellipses in the diagram. All of the other functionality will be preserved and

[1]Making CASA more reliable is one of the recommendations from the user community that resulting from our 2018 CASA User Survey: https://casa.nrao.edu/casadocs/casa-5.6.0/memo-series/casa-memos/casa_memo_user_statistics.pdf/view

will be available in an all-inclusive distribution, which also continues to serve users who are not interested in this new capability.

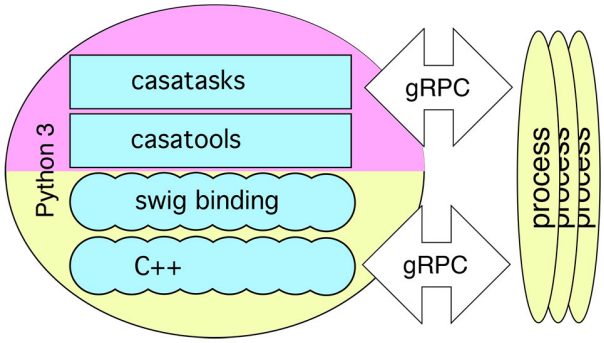

Figure 1. Schematic overview of processes in CASA 6.

4. Data Visualization: CARTA

For visualizing data products, most CASA users rely on the CASA Viewer. However, the number of "know issues" for the Viewer is growing, and the increasing sizes of data products will become ever more challenging for current visualization tools.

The Cube Analysis and Rendering Tool for Astronomy (CARTA)[2] is a new image visualization tool designed for the ALMA, VLA, and future radio telescopes such as the Square Kilometre Array (SKA). The CARTA architecture is suitable for visualizing images with large file sizes. CARTA is progressing steadily and version 1.2 has recently been released. The CASA team is planning on CARTA to replace the CASA Viewer in the coming years.

CARTA is being developed by a team consisting of the members from the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) in Taiwan, the National Radio Astronomy Observatory (NRAO) in the US, the University of Alberta in Canada, and the Inter-University Institute for Data Intensive Astronomy (IDIA) in South Africa.

5. CASA Resources

CASA website: please visit the CASA website for additional information:
https://casa.nrao.edu/

CASA help: for problems or questions, contact the NRAO or ALMA Helpdesk:
https://casa.nrao.edu/help_desk_all.shtml

CASA documentation: CASA Docs is the official CASA documentation:
https://casa.nrao.edu/casadocs

[2]https://cartavis.github.io/

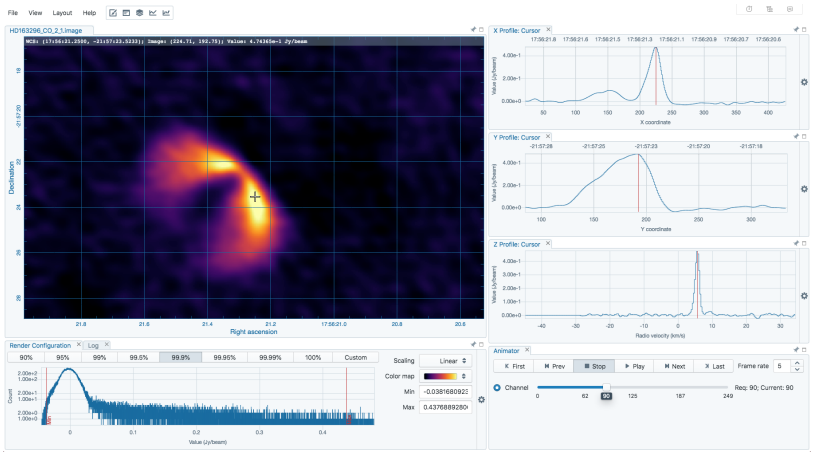

Figure 2. Screen-shot of the CARTA visualization software (credit: Kuo-Song Wang & CARTA team).

CASA Newsletter: a CASA Newsletter is sent to the community twice a year: https://science.nrao.edu/enews/casa_007/

CASA email lists: stay up-to-date on CASA announcements and register: https://casa.nrao.edu/mail_list.shtml

CASA feedback: the CASA team also welcomes general feedback from users: casa-feedback@nrao.edu

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[3]https://casa.nrao.edu/casadocs-devel/stable/knowledgebase-and-memos/casa-memos