The CASA software for radio astronomy: status update from ADASS 2018

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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. In these proceedings of the 28th Astronomical Data Analysis Software & Systems (ADASS) conference, we give an overview of several new features in CASA's main imaging task tclean, which have been taken into production with the ALMA pipeline version of the latest CASA 5.4 release. This includes improved automated masking for image deconvolution, as well as parallel imaging options to improve imaging speeds. In addition, we highlight two upcoming developments for 2019. The first is the anticipated arrival of a first-look version of the Cube Analysis and Rendering Tool for Astronomy (CARTA), which is expected to eventially replace the CASA viewer. The other development is a fundamental chance in the way the different CASA components (e.g., tools and task) can be integrated within the Python environment, allowing much greater flexibility for users starting CASA 6. We will also summarize an updated list of CASA links to guide the user community to the latest CASA information and documentation.

1. Introduction

The Common Astronomy Software Applications package CASA (McMullin et al. 2007), 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.

In these proceedings, we provide a status update of the CASA software and highlight a few upcoming new developments for 2019. The CASA team presented these results at the 28th Astronomical Data Analysis Software & Systems (ADASS) conference that was held from 11−15 November 2018 at the University of Maryland.

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. TCLEAN: parallelized imaging and automated masking

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

An important new feature in TCLEAN is the option of automated masking in the devoncolution process, allowing to accurately clean images (Kepley et al. in prep). This "auto-multithresh" algorithm (automated masking using multiple thresholds) can be enabled within TCLEAN by setting USEMASK = 'AUTO-MULTITHRESH'. The algorithm successfully captures emission from point and extended sources in images with varying noise and sidelobe levels. Although it was originally developed for ALMA, the algorithm also works well for a wide variety of data. ADASS contributions by Amanda Kepley (O.12.1) and Takahiro Tsutsumi (P.12.15) provide further details.

ALMA Cycle 6 (CASA 5.4.0) also offers the first pipeline use of parallel processing mode in TCLEAN, achieving substantial performance improvement for imaging (Bhatnagar et al. 2015; Emonts 2018). This parallel mode can be triggered in the mpicasa environment using the parameter PARALLEL = TRUE on normal MS files (i.e., without partitioning the data into multi-MS files). While several small issues remain to be resolved, we are confident that this mode utilized by the ALMA imaging pipeline is mature and suitable for general use on standard data sets.

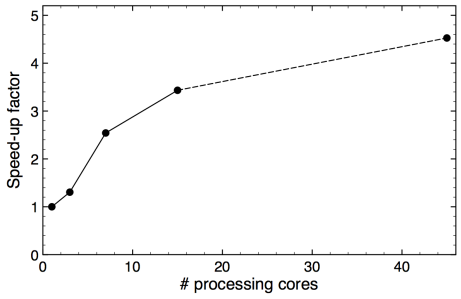

Figure 1. PLACEHOLDER ONLY

3. 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)[1] 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 a first-look version is planned for release end 2018. 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.

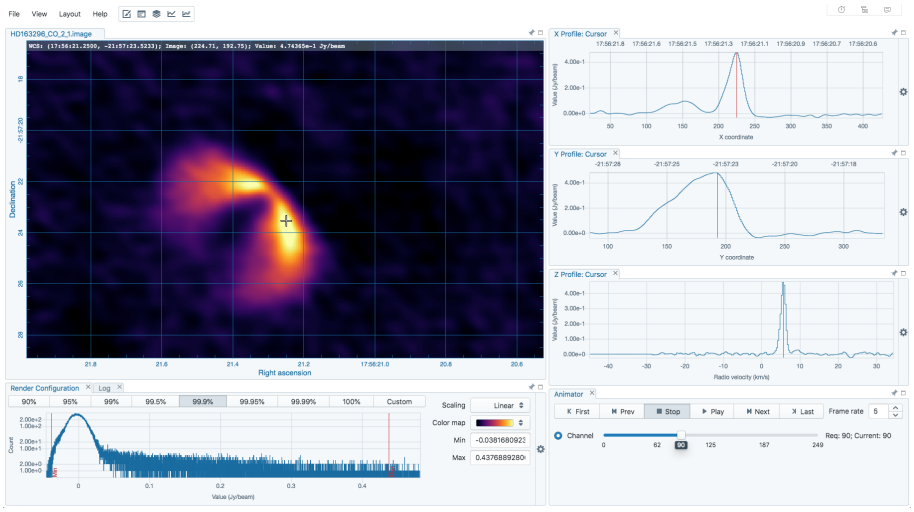

Figure 2. Screen-shot of the CARTA visualization software (credit: Kuo-Song Wang & CARTA team).

4. CASA 6: Flexibility in Python

CASA consists of C++ tools bundled together under an iPython interface as data reduction tasks. CASA has always been distributed as a single, integrated application, including a Python interpreter and all the libraries, packages and modules. This monolithic distribution makes it difficult to use CASA along with other Python packages.

As part of a switch from Python 2 to 3, CASA will be reorganized to support building CASA tools with Python's distutils (and GNU autoconf). This will allowing greater flexibility for users to integrate CASA in their preferred environment, with

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

tools and tasks as Python Standard Modules. CASA will also continue an all-inclusive distribution under Python 3 for users who are not interested in this new option.

The first release under this new approach will be CASA 6.0, expected in mid 2019.

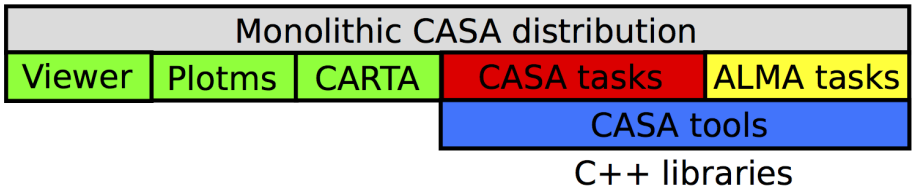

Figure 3. Block diagram of CASA 6. Each block depends on those below, and can be distributed independently. The GUI blocks (green) are independent of Python.

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

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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References

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

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