

CASA Tutorial

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Resources

- VLA Data reduction workshop 2019:
<https://science.nrao.edu/science/meetings/2019/vla-data-reduction/program>
- CASA Documentation: <https://casa.nrao.edu/casadocs>
- CASA Guides:
https://casaguides.nrao.edu/index.php/Main_Page
- CASA cookbook:
https://casa.nrao.edu/casa_cookbook.pdf

Introduction

- *Common Astronomy Software Applications (CASA)*, the successor to the *Astronomical Image Processing System (AIPS)*, is the most common software package for reducing interferometry data
- Provides a unified framework for all tasks, including Python 2 environment and scripting functionality.
- Supports old fashioned AIPS-like task interface and interactivity, or Python scripting capability. Jupyter notebooks not supported (but soon!).

Fun fact: AIPS was built in Fortran, designed to be run on main-frames using tape readers to get data. Did not really fit well with era of personal computers. All tasks limited to 5 letter names, all variables 8 letters.

Introduction

- Standard interface is an iPython command-line, which supports all the usual commands: Python code (import, if-then-else, etc.), % commands (%run, %paste), system commands (cd, ls)
- Visibility data usually stored in *Measurement Sets* (MSs), which store many tables (visibilities, antenna information, pointings, source information, weather, etc)
- Images are stored in proprietary CASA format, but trivially converted to FITS.

Quick Tips

- MSs store visibilities with 3 columns: DATA, CORRECTED_DATA, and MODEL. Keep track of what is in each column, and when tasks are modifying the columns! It's easy to accidentally overwrite something by accident. Keep a spare copy of the data when possible
- Use interactive/task mode to inspect the data, learn the software, and test different things. Along the way, make a script to replicate everything you've done.

Never believe that you're only going to do something once. Inevitably, things will need to be re-run, and you'll be glad you made a script with all the parameters set, so you don't need to remember what parameters you used.

Logger

Time	Priority	Origin	Message
2020-03-31 13:05:04	INFO	::casa	
2020-03-31 13:05:04	INFO	::casa	Checking telemetry submission interval
2020-03-31 13:05:04	INFO	::casa	Creating a new telemetry time stamp file./Users/cvaneck/.casa/telemetry-14e1786c1c
2020-03-31 13:05:04	INFO	::casa	Telemetry submit interval not reached. Not submitting data.
2020-03-31 13:05:04	INFO	::casa	Next telemetry data submission in: 6 days, 23:59:59.999940
2020-03-31 13:05:04	INFO	::casa	CASA Version PIPELINE 5.6.1-8
2020-03-31 14:00:17	INFO	listobs:::	
2020-03-31 14:00:17	INFO	listobs:::+	#####
2020-03-31 14:00:17	INFO	listobs:::+	#### Begin Task: listobs ####
2020-03-31 14:00:17	INFO	listobs:::	listobs(vis="3c391_ctm_mosaic_10s_spw0.ms",selectdata=True,spw="",field="",antenn
2020-03-31 14:00:17	INFO	listobs:::+	uvrange="",timerange="",correlation="",scan="",intent="",
2020-03-31 14:00:17	INFO	listobs:::+	feed="",array="",observation="",verbose=True,listfile="",
2020-03-31 14:00:17	INFO	listobs:::+	listunfl=False,cachesize=50,overwrite=False)
2020-03-31 14:00:17	INFO	..ms::summary	=====
2020-03-31 14:00:17	INFO	..s::summary+	MeasurementSet Name: /Users/cvaneck/Projects/CASA_tutorial/3c391_ctm_p
2020-03-31 14:00:17	INFO	..s::summary+	=====
2020-03-31 14:00:17	INFO	..s::summary+	Observer: Dr. James Miller-Jones Project: T.B.D.
2020-03-31 14:00:17	INFO	..s::summary+	Observation: EVLA
2020-03-31 14:00:17	INFO	..Properties	Computing scan and subscan properties...
2020-03-31 14:00:17	INFO	..ms::summary	Data records: 845379 Total elapsed time = 28681.5 seconds
2020-03-31 14:00:17	INFO	..s::summary+	Observed from 24-Apr-2010/08:02:10.0 to 24-Apr-2010/16:00:11.5 (UTC)
2020-03-31 14:00:17	INFO	..ms::summary	=====
2020-03-31 14:00:17	INFO	..s::summary+	ObservationID = 0 ArrayID = 0
2020-03-31 14:00:17	INFO	..s::summary+	Date Timerange (UTC) Scan FldId FieldName nRows
2020-03-31 14:00:17	INFO	..s::summary+	24-Apr-2010/08:02:10.0 - 08:02:30.0 1 0 J1331+3030 650
2020-03-31 14:00:17	INFO	..s::summary+	08:02:20.0 - 08:09:30.0 2 0 J1331+3030 13975
2020-03-31 14:00:17	INFO	..s::summary+	08:09:20.0 - 08:16:28.0 3 0 J1331+3030 13975
2020-03-31 14:00:17	INFO	..s::summary+	08:19:38.0 - 08:24:26.5 4 1 J1822-0938 7035
2020-03-31 14:00:17	INFO	..s::summary+	08:24:48.0 - 08:29:48.0 5 2 3C391 C1 7590
2020-03-31 14:00:17	INFO	..s::summary+	08:29:38.0 - 08:34:48.0 6 3 3C391 C2 7821

The logger is where output is printed. Keep an eye on it every time you run a task! Also, save the log before quitting, because it can be very useful.

Common tasks

- listobs: list observation details
- plotms: visualize visibility data
- flagdata: flag out visibilities
- split/concat: divide/combine measurement sets
- gaincal: solve for Jones matrix parameters (gain and phase)
- applycal: apply calibration tables to visibilities
- tclean: Produce image from visibilities, and Clean
- imview/viewer: look at images
- exportfits: converts image to FITS

Syntax

- Use 'tasklist' to see a list of CASA tasks.
'taskhelp' gives short summaries of each task
'doc' or 'doc('task')' opens CASADocs in browser.
'<task>?' opens task help
- Task mode:
'inp <task>' to see list of parameters
'<parameter> = <value>' to set parameters
'go' to start task
'tget <task>' to recover parameters from last run, 'tput' to save parameters, 'default <task>' to reset.
- Python scripting mode: call like a function.
<task>(parm1=1, parm2=2, parm3=3,...)

Parameter syntax

- Tilde for ranges: spw='0~3'
- Comma for separate entries: spw='0~3,7,11'
- Colon for sub-ranges, semi-colon for separate entries (channels within spw): spw='7:0~40', spw='11:10;20;30'
- Asterisk for wildcards: field='3C*'
- Exclamation mark for NOT: antenna='!5'
- Ampersand for baselines: antenna='5&12'
- Less than/greater than for ranges: uvrage='<1000'

All of these parameters are strings, because they get passed into CASA's internal parameter parsing system.

Lab report (for crediting students)

- Reduce 1 data set (can be tutorial or other), up to and including imaging. Maybe make a few measurements with the final image?
- Record what tasks were run, with what parameters. Make some short comments on the purpose of each task, the reason for choosing particular parameter values.
- Submit a lab report with this information and a few screenshots. This will be graded on understanding of the process and explanations for decisions made in the process. Don't spend a lot of time on it!