ObitTalk User Documentation

Obit: Merx mollis mortibus nuper

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Abstract

This documents describes the ObitTalk interface to AIPS and Obit Software. ObitTalk is a python package which allows running AIPS and Obit tasks and scripts and direct access to astronomical data using Obit. Obit implements multiple data types, currently AIPS and FITS data. Most of the material in this document is also available in the on–line documentation. This document assumes familiarity with python and with AIPS and radio astronomical techniques. The difference with AIPS and POPS usage is explained.

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1.1 Introduction

ObitTalk is derived from the ParselTongue project at JIVE and provides a scripting and interactive command line interfaces to astronomical data and processing software. In particular, AIPS and FITS data structures as used in the AIPS and Obit software packages are supported as well as AIPS tasks and Obit tasks and other python enabled software.

Obit is intended as an environment optimized for the development and evaluation of new data processing algorithms. As such, it is not a full featured data processing system. However, with the interoperability of Obit and AIPS, the ObitTalk interface to both Obit and AIPS does present the user with a full featured data processing environment for radio interferometry. This utility package facilitates the access to data and images from python as well as various interactive features. The details of the functions in this package are given later. Many of these functions have equivalents in POPS although adapted to python.

AIPS tasks will use the AIPS XAS TV which must be started separately. Obit tasks and ObitTalk use the ObitView image display and/or the ObitMess task message server each of which must also be started independently. If AIPS is not available, ObitTalk still can work using FITS or AIPS files.

ObitTalk can start tasks or scripts either locally or on a remote machine which has an ObitTalk-Server process running. Some remote data access is supported through the AIPSUVData, AIPSImage, FITSUVData and FITSImage classes. Currently other python functions only work interactively locally or remotely using the ObitScript class.

Tasks, scripts and more detailed access to and manipulation of data are available. These are described briefly below and methods of obtaining more detailed descriptions are described.

This document contains both tutorial and reference material. New users should read the first few sections; later sections are mostly for reference.

1.2 Obtaining Software

Obit and related software is available from http://www.cv.nrao.edu/∼bcotton/Obit.html. The simplest installation is to Linux binary version which can be obtained from https://www.cv.nrao.edu/ bcotton/ObitBin/index.html. The binary distribution is a tarball that can be unpacked, added to your $PATH and directly executed. An updated build–from–source installation is currently (Apr 2025) under development. Obit depends heavily on third party software which is described on the Obit page. Support of the Obit package is extremely limited. The components of the Obit/ObitTalk package are:

- Obit
  Basic Obit package and the support for radio interferometry
- ObitView
  Image display used by Obit.
- ObitMess
  Task message display server used by ObitTalk.
- ObitTalk
  Scripting and interactive interface to Obit software. There is also an ObitTalk3 which explicitly uses python 3. The distributed version was build for python3.6. If your version is more recent you will need to rename share/python/_Obit.cpython-36m-x86_64-linux-gnu.so to share/python/_Obit.so.

1.3 Starting ObitTalk

The operation of ObitTalk is influenced by the values of a number of environment variables to specify the locations of directories with python modules, data directories and Obit and AIPS task documentation and executable files. Some of these are set to standard values by the ObitTalk startup script. Obit related values may be set by the ObitTalk script used by the binary installation. If the AIPS shell variables AIPS_ROOT and AIPS_VERSION are previously set by an AIPS startup script no further action needs to be taken to use AIPS. If you wish to use python modules not in one of the standard locations, set PYTHONPATH to include the directories. For example, using tcsh and setting PYTHONPATH to use modules in both directories pointed to by myPython1 and myPython2:

```
% setenv PYTHONPATH "$myPython1":"$myPython2"
```

Custom setups can be implemented using an ObitTalk startup script as discussed below.

If you wish to use the ObitView image display or the ObitMess task message window, you can start them before ObitTalk. If ObitView is in your path:

```
% ObitView &
```

will start the display server. If this fails to start the display, see the discussion of ObitView below. ObitMess can be started in the same fashion; see sections 1.5 and 1.6 for more details.

Then, if the script ObitTalk (or ObitTalk3) is in your path:

```
% ObitTalk3 [scriptname]
```

should start the python3 version ObitTalk.

If the environment variables AIPS_ROOT and AIPS_VERSION are defined, or an .obitrc.py startup script file is found defining them, ObitTalk will make AIPS tasks and data available. If the optional scriptname is given, then the python interpreter will do some simple AIPS initialization and execute the python script “scriptname”. If no script is specified then ObitTalk will ask for your AIPS number and do its AIPS initialization (if AIPS is available) and go into an interactive python session. Outside of the NRAO, AIPS user numbers are relatively arbitrary and can be used to separate different projects. Note: AIPS number 1 is a bad idea if you plan on using AIPS/POPS. The python prompts are:

```
>>>
```

1.3.1 AIPS Setup

Obit can use AIPS format data whether or not AIPS is available; most operations involving visibility data are more efficient using AIPS than FITS format. In order to use AIPS format, AIPS directories are needed. Purely Obit use of AIPS format places no restrictions on these directories but AIPS use requires a SPACE file. To create a directory for AIPS data in /export/data/DATA_1:

```
% mkdir /export/data/DATA_1
% touch /export/data/DATA_1/SPACE
```

The names of the AIPS directories must be provided either using the AIPS or Obit startup scripts.

In order to run AIPS tasks, the location of the AIPS help and executable files needs to be specified; these are under $AIPS_ROOT/$AIPS_VERSION. This definition can be done in either standard AIPS setup scripts or in the Obit startup script (see next section). Furthermore, AIPS tasks read their parameters from a file named $DA00/TDD000004;. The path $DA00 needs to be provided either by the AIPS or the Obit Startup scripts.

1.3.2 Startup Script

When ObitTalk starts, it looks for a startup script named .obitrc.py in either the users home directory or the current working directory (the latter has priority). If found, it is executed as python code. This can be used to define the AIPS and Obit setups and can be used in the absence of AIPS startup scripts. The following startup script fragment shows how to define AIPS tasks and data, Obit tasks and FITS data directories. This can be used to define both local and remote data directories; see section 1.14.2 for a discussion of defining data directories on remote systems. Example startup scripts can be found in $OBIT/share/scripts/obitrc.py, /usr/share/obit/scripts/obitrc.py, or dot.obitrc.py in the top level of the binary distribution.

```
# Startup script
print ("Executing startup script ")
import ObitTalkUtil

###################### Define ###################################
# Define AIPS_ROOT and AIPS_VERSION for access to AIPS Software
AIPS_ROOT    = "/export/data_1/users/aips/"
AIPS_VERSION = "31DEC23/"
# Define directory for AIPS TDD000004; file
DA00         = "/export/data/aips/DA00/SMEAGLE/"
# Define OBIT_EXEC for access to Obit Software
OBIT_EXEC    = None  # (def /usr/lib/obit/bin)
OBIT_EXEC    = "/export/data_1/users/bcotton/Git/Obit/ObitSystem/Obit/"

# Define AIPS directories (URL, disk name)
# URL = None for local disks
aipsdirs = [ \
    (None, "/export/data_1/aips/DATA/SMEAGLE_1"), \
    (None, "/export/data_1/aips/DATA/SMEAGLE_2"), \
    (None, "/export/data_1/aips/DATA/SMEAGLE_3"), \
    (None, "/export/data_2/aips/DATA/SMEAGLE_4")]

# Define FITS directories (URL, disk name)
# URL = None for local disks
fitsdirs = [ \
    (None, "/export/data_1/users/bcotton/Software.dir/AIPS/FITS")]

# setup environment
ObitTalkUtil.SetEnviron(AIPS_ROOT=AIPS_ROOT, AIPS_VERSION=AIPS_VERSION, \
                        OBIT_EXEC=OBIT_EXEC, DA00=DA00, ARCH="LNX64",  \
                        aipsdirs=aipsdirs, fitsdirs=fitsdirs)

# Make sure AIPS Tasks enabled
if 'LD_LIBRARY_PATH' in os.environ:
    os.environ['LD_LIBRARY_PATH']+=':'+os.environ['AIPS_ROOT']+\
    os.environ['AIPS_VERSION']+os.environ['ARCH']+'/LIBR/INTELCMP/'
else:
    os.environ['LD_LIBRARY_PATH'] = os.environ['AIPS_ROOT']+\
    os.environ['AIPS_VERSION']+os.environ['ARCH']+'/LIBR/INTELCMP/'

# List directories
ObitTalkUtil.ListAIPSDirs()
ObitTalkUtil.ListFITSDirs()

# Any other customization goes here
```

1.4 Object–orientation for POPS users

Many of the differences between AIPS/POPS and ObitTalk are because the latter is generally object–oriented. "Object–oriented" in this context means little more than variables are more substantial than the floats and strings and simple arrays of POPS variables (although these also exist). A python (hence ObitTalk) variable is a relatively arbitrary thing and can be a scalar number, string, an array or list of variables or the interface to a dataset such as an image or uv data.

In ObitTalk, the interface to a data set is assigned to a variable and this variable is used to specify operations in a way not very different from INNAME, INCLASS, INDISK, INSEQ ... are used to specify a dataset in POPS. This allows having an arbitrary number of such data objects while avoiding the conflicts in usage of INNAME... in POPS.

The usual object–oriented syntax is that "class methods" (functions which can operate on an object) are invoked like this:

```
>>> object.function(arguments)
```

where "object" is the python object, "function" is the function name and arguments are the additional arguments, the object is implicitly an argument, by convention called "self" in python. In python documentation of function interfaces, "self" appears as the first argument of the function although it is invoked as shown above. As a convenience to POPS users many of these functions are also implemented in the more traditional procedural form, for instance, the following produce the same result:

```
>>> myTask.explain()
```

or

```
>>> explain(myTask)
```

1.4.1 Data objects

ObitTalk uses Obit to access the external (i.e. disk) representations of datasets and Obit allows multiple "native" data representations. At present AIPS and FITS (as practiced by AIPS) external representations are supported. (Note, the old style random groups FITS for UV data as written by AIPS task FITTP is NOT supported but the tables format written by FITAB is.) The distinction between external representations is largely hidden except for the process of creating ("instantiation" in computerese) the interface object in which its representation must be specified. For example, to create an interface object to an AIPS image described by the strings Aname (AIPS Name), Aclass (AIPS class), and integers disk (AIPS disk number) and seq (AIPS sequence number):

```
>>> myImage=Image.newPAImage(``myImage'', Aname, Aclass, disk, seq, exists, err)
```

where exists is True if the image is expected to previously exist and False otherwise. Messages and error conditions are registered in err (defined at ObitTalk startup) and any error messages can be viewed by:

```
>>> ShowErr(err)
```

Thereafter the variable myImage is used to access the AIPS image but beyond this point, it is largely irrelevant if the underlying file is an AIPS or FITS (or other) format. For instance, the header can be displayed:

```
>>> imhead(myImage)
Object: J0555+39
Observed: 2001-01-25 Telescope:  VLBA     Created: 2006-04-18
Observer: BC111      Instrument: VLBA
Minimum =  -7.5144e-06  Maximum =    1.5197e-05 JY/BEAM
--------------------------------------------------------------
Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
RA---SIN   164    5 55 30.80561      78.00          -5e-05    0.00
DEC--SIN   167   39 48 49.1650       87.00           5e-05    0.00
STOKES       3      IPol              1.00               1    0.00
FREQ         1      4.2826e+10        1.00           4e+06    0.00
--------------------------------------------------------------
Coordinate equinox 2000.0  Coordinate epoch 2000.00
Observed RA    5 55 30.80561 Observed Dec  39 48 49.1650
no. Comp      200
Clean Beam      0.001 x      0.001 asec, PA     0.0 deg.
Rest freq            0 Vel type: LSR,  wrt  radio
Alt ref value            0  wrt pixel     1.00
```

In this sense, objects can have members (other objects) or functions which operate on the object. For instance, the “header” of myImage which is referred to as an ImageDescriptor in ObitTalk is referenced as myImage.Desc and the function which destroys the object as well as its external representation is myImage.Zap() (functions are denoted with parenthess even if there are no arguments. Note the names of variables are arbitrary and “myImage” could as well be “Judy” and are used in error and other informative messages.

Local disk numbers in AIPS data files have the same meaning as in POPS. FITS disk numbers correspond to the directories pointed to by the environment variables $FITS, $FITS01, $FITS02.... FITS disk 0 has a special meaning in which the filename is either relative to the current working directory or a full path to the file. Disk numbers may also be defined on remote computers.

1.4.2 Tasks

An important type of object in ObitTalk is the Task object. This object defines the interface to tasks (parameters, documentation, etc.) Currently, interfaces to AIPS tasks and Obit tasks are supported. Tasks have the same meaning as in POPS and are programs that run independently of the python process and are generally compiled Fortran or C programs. In order to run a task, a task object is first created; at this point AIPS or Obit needs to be specified but after the object is created the type of task is relatively minor. One difference between POPS and python is that the final single quote around a POPS string causes it to be converted to upper case whereas no case conversion is done in python. If you want a AIPS file name or class which contains upper case letters, you must type it that way. Tasks may have output as well as input parameters.

If tasks are run synchronously (using the task_obj.go() syntax), a python RunTime exception will be thrown if the task finishes in other than a normal completion, either detects an uncorrectable problem or aborts. In any mode of running an Obit task, the output parameter “retCode” will have a value of 0 if the task terminated normally without detecting a problem and -1 otherwise. Note: this value will be -999 during the task execution.

Tasks functions

There are a number of common task functions which can be invoked from a task object. These functions also have a short version to simplify typing. For example:

```
>>> myTask.i
```

is equivalent to

```
>>> myTask.inputs()
```

These common task functions and the short form are explained in the following:

- inputs (short i)
  This function is to list the current values of the tasks input parameters with a short description.

- outputs (short o)
  This function is to list the current values of the tasks output parameters with a short description.

- help (short h)
  This function is to list the help documentation for the task.

- explain (short e)
  This function is to list any extended documentation for the task.

- go (short g)
  This function starts the task in synchronous mode using the current input parameters.

- abort (short a)
  This function aborts the task. A "Control C" while running a task synchronously has the same effect.

- wait (short w)
  This function suspends operations pending the completion of the task.

Arrays in AIPS Tasks

The main difference between Obit and AIPS tasks as well as a major difference between POPS and python is that array indexing in POPS arrays is one relative whereas in python indexing is zero relative. In other words, the first element of array parm in POPS is parm(1) and in python it is parm[0] (also note the parentheses and square brackets). Since the AIPS documentation describes array values by their one relative indices, using zero relative addressing is a serious potential source of trouble; aparm(3) in POPS is aparm[2] in python. To avoid this problem, ObitTalk adds a extra, unused, element at the beginning of each array to keep the indexing consistent with AIPS documentation. To enforce this scheme, ObitTalk does not allow you to modify the first element of an array. This causes an additional problem, that you cannot set a AIPS task array parameter as:

```
>>> AIPStaskObj.ArrayParm = [1,2,3,4] # Fails
```

Instead, there are two options, using slicing of the parameter array:

```
>>> AIPStaskObj.ArrayParm[1:] = [1,2,3,4] # OK
```

or using the AIPSList class:

```
>>> AIPStaskObj.ArrayParm = AIPSList([1,2,3,4]) # OK
```

Multidimensional arrays can be set

```
>>> AIPStaskObj.Array2DParm = AIPSList([[1,2,3,4],[5,6,7,8]]) # OK
```

(Note the double square brackets).

Arrays in Obit Tasks

Arrays in Obit task array parameters have zero–relative indexing so statements like

```
>>> ObitTaskobj.ArrayParm = [1,2,3,4] # OK
```

work as expected.

Examples

An example of creating a task object named im to run AIPS task IMEAN is:

```
>>> im=AIPSTask("IMEAN")
```

The parameters of the task can then be set:

```
>>> im.inname='07030+51396'; im.inclass='PCUBE'; im.indisk=1; im.inseq=2
>>> im.BLC=AIPSList([10,10]); im.TRC=AIPSList([100,100])
```

The Inputs can be reviewed:

```
>>> im.i
IMEAN:  Task to print the mean, rms and extrema in an image
Adverbs     Values                                      Comments
--------------------------------------------------------------------------------
 dohist      -1.0                                        True (1.0) do histogram plot.
                                                         = 2 => flux on x axis
 userid       0.0                                        User ID.  0=>current user
                                                           32000=>all users
 inname      07030+51396                                 Image name (name)
 inclass     PCUBE                                       Image name (class)
 inseq        2.0                                        Image name (seq. #)
 indisk       1.0                                        Disk drive #
 blc         10.0, 10.0, 0.0, 0.0, 0.0, 0.0, 0.0         Bottom left corner of image
                                                         0=>entire image
 trc         100.0, 100.0, 0.0, 0.0, 0.0, 0.0, 0.0       Top right corner of image
                                                         0=>entire image
 nboxes       0.0                                        No. of ranges for histogram.
 pixrange    0.0, 0.0                                    Min and max range for hist.
 functype                                                'LG' => do log10 plot of #
                                                         samples, else linear
 pixavg       0.0                                        Estimate of mean noise value
 pixstd       0.0                                        Estimate of true noise rms
                                                            < 0 => don't do one
                                                            = 0 => 2-passes to get
 docat        1.0                                        Put true RMS in header
 ltype        3.0                                        Type of labeling: 1 border,
                                                         2 no ticks, 3 - 6 standard,
                                                      7 - 10 only tick labels
                                                      <0 -> no date/time
 outfile                                              Name of output log file,
                                                      No output to file if blank
 dotv        -1.0                                     > 0 Do plot on the TV, else
                                                      make a plot file
 grchan       0.0                                     Graphics channel 0 => 1.
```

and the task run:

```
>>> im.g
IMEAN2: Task IMEAN  (release of 31DEC02) begins
IMEAN2: Initial guess for PIXSTD taken from ACTNOISE inheader
IMEAN2: Image= 07030+51396 .PCUBE .   2 1   xywind=    1    1  241  241
IMEAN2: Mean and rms found by fitting peak in histogram:
IMEAN2: Mean=-3.1914E-06 Rms= 2.7893E-04  **** from histogram
IMEAN2: Mean and rms found by including all data:
IMEAN2: Mean= 1.8295E-05 Rms= 5.2815E-04 JY/BEAM  over    174243 pixels
IMEAN2: Flux density =  2.0006E-01 Jy.   beam area =  15.93 pixels
IMEAN2: Minimum=-1.5441E-03 at  164  180    1    1
IMEAN2: Skypos: RA 07 02 04.303  DEC 51 51 23.18
IMEAN2: Skypos: IPOL  1400.000 MHZ
IMEAN2: Maximum= 4.0180E-02 at   93  159    1    1
IMEAN2: Skypos: RA 07 03 36.211  DEC 51 47 11.65
IMEAN2: Skypos: IPOL  1400.000 MHZ
IMEAN2: returns adverbs to AIPS
IMEAN2: Appears to have ended successfully
IMEAN2: smeagle      31DEC06 TST: Cpu=       0.0  Real=       0
```

1.4.3 functions = verbs

In addition to tasks, ObitTalk allows POPS verb–like functionality by means of functions using data interface objects. This allows access to headers, data values and unlike POPS, access to much of the high level functionality in the Obit class libraries as well as all of the functionality of python. Numerous operations which in POPS require tasks can be performed by ObitTalk functions. Examples are the conversions between AIPS and FITS types (functions imlod, uvlod, imtab, uvtab). Much of the POPS functionality is implemented in ObitTalk functions.

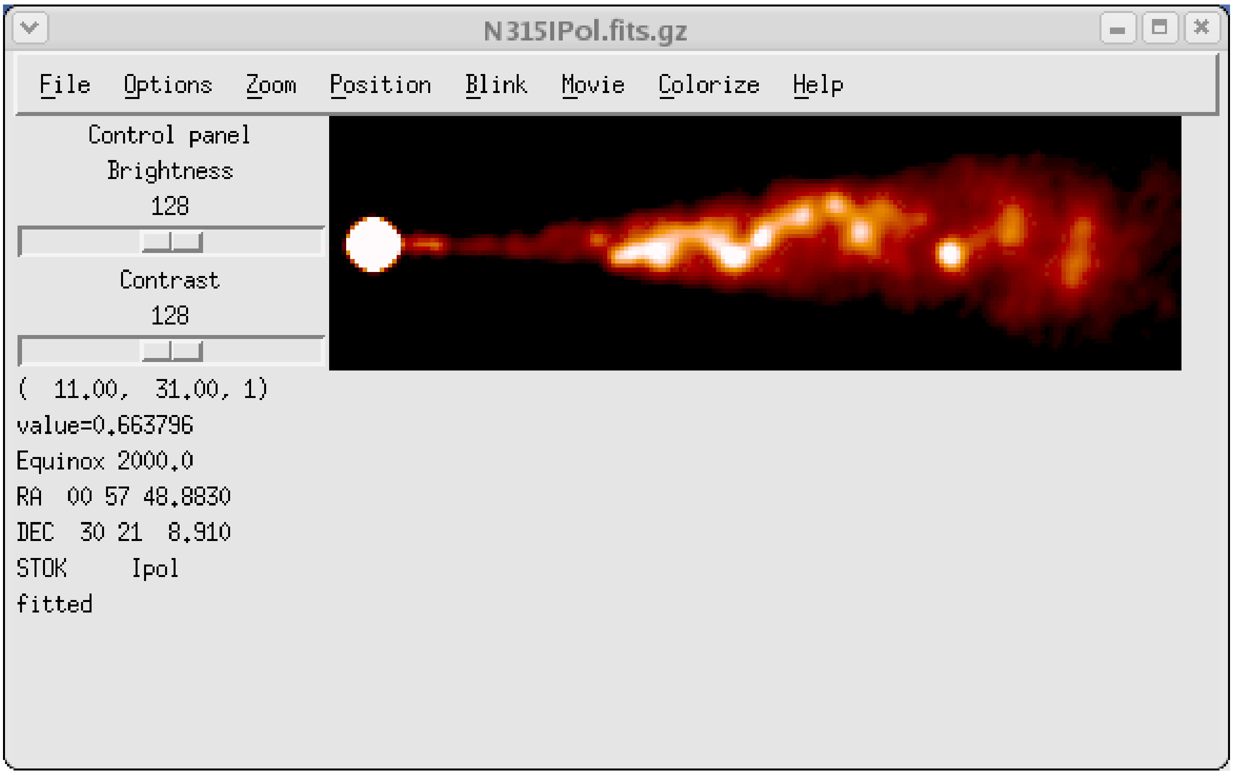
1.5 ObitView Image Display

While AIPS tasks can use the AIPS TV, the image display used by ObitTalk and Obit tasks is ObitView which is run as an independent program. ObitView can be used as an image browser independently of ObitTalk. To display image myImage on a running ObitView simply:

```
>>> tvlod(myImage)
```

A screen shot of the ObitView window is shown in Figure 1.1.

ObitView uses the xmlrpc protocols to communicate between tasks and as such allows communication between different computers by means of the internet. Parts of this protocol involve fixed port numbers which means that only a single ObitView can run on a given computer using a given port number. An attempt to start a second will fail with a “can’t bind” message. By default



```
Brightness
128
Contrast
128
(  11.00,  31.00, 1)
value=0.663796
Equinox 2000.0
RA  00 57 48.8830
DEC  30 21  8.910
STOK     Ipol
fitted
```

Figure 1.1: Screenshot of ObitView window.

port 8765 is used but others may be used as well. For instance to use port 8888, start ObitView as follows

```
% ObitView -port 8888 &
```

Then ObitTalk can be told to use this port by:

```
>>> newDisplay(8888)
```

Obit tasks which use the display have a parameter dispURL which should be set to ”http://localhost:8888/RPC2” to use the new display.

If the display is running on a machine on which the data is not visible, use “http://myhost:port/RPC2” where myhost is the network name and port is the port number (usually 8765), Example, to set the display on a task object named task:

```
>>> task.dispURL="http://canis.cv.nrao.edu:8765/RPC2"
```

When a remote process displays on an ObitView display, it first copies the image as a compressed FITS image to the display which saves the file in its current working directory as ObitDisplayFITS.fits.gz. It is useful to start ObitView from a directory where it is both possible and desirable to write these temporary files.

If there is trouble connecting to the display server port (e.g. firewall, address translation) and you have ssh login access between the relevant hosts then it is possible to use ssh port forwarding through the secure connection. From the command shell on the client side (as seen by ObitView) issue:

```
 % ssh -L localport:host:hostport user@host
```

where localport is the local port number (typically 8765 for ObitView), host is the host on which the ObitView process is running and host port is the port on host that the target ObitView is watching. Then, give the task or ObitTalk on the client end (again as seen by ObitView) a url for itself other than localhost; this will cause the file to be transmitted. For instance if the result of the shell “hostname” command is “smeagle” create an ObitTalk display:

```
>>> newDisplay(URL="http://smeagle:8765/RPC2")
```

A tvlod should then cause to image to be displayed on the host specified in the ssh command.

ObitView is used by ObitTalk and Obit tasks to display images and perform some interactive operations such as specifying CLEAN boxes. ObitView gives much more control over the display of an image than is possible in the AIPS TV. Once an image is loaded, all of the display controls are available; there is extensive online help.

When an interactive CLEAN box or other window setting session begins, a RequestBox dialog appears with the image displayed overlaid by the current CLEAN window; instructions are given in a text box. The radio buttons at the top of this dialog specify what action is to be taken by the calling program when the “OK” button on the bottom is hit and the calling program resumes. These options are:

- Continue
  Continue with the edited window.

- Abort
  Shutdown immediately.

- Quit Operation
  Terminate the current operation and continue/shutdown in an orderly fashion. For a simple CLEAN, this means stop the clean here and do whatever component restoration/flattening operations were requested. If this command is given in a CLEAN as part of a self–calibration cycle, the current CLEAN is terminated and the self–calibration continues. If this command is given at the end of a self–calibration cycle then the self-calibration proceeds as if it were converged.

- Turn Off TV
  No more displays of the image. Inside a CLEAN this causes no more displays during the current CLEAN but this does not affect displays in some outer operation (e.g. self calibration). If the TV display is turned off in one CLEAN of a self–calibration loop then it is turned off in subsequent CLEANs.

- View Field
  If the image is a multi–facet image, then the display (with possible editing of its CLEAN window) of another facet is requested by this option and the facet number (1-relative) entered in the text box labeled “Request field”

If editing of the window displayed is desired, then the “Clear” button deletes the current window (not normally needed or desired) and the “Edit” button puts the display in window editing mode. The message dialog appears with detailed instruction about editing. There are several types of boxes used by Obit CLEANing and these are shown in different colors (subject to some user selection). Not all types are always used. The types of CLEAN boxes are:

- “Inner” boxes
  These are the traditional CLEAN window boxes specifying the regions in which components may be selected.

- “Inner” unboxes
  Specifies regions in which components are NOT to be selected. Used in the autoCenter mode. Takes precedent over overlapping Inner boxes.

- “Outer” boxes
  Specifies regions inside of which the autoWindow algorithm is allowed to place Inner boxes. For multi–facet images these generally correspond to the region of the facet to be used when the image is flattened. These are not editable.

Editing of the displayed CLEAN window is performed by a combination of mouse motions, clicks and keyboard characters (either case) as described in the informational text box:

- **e/E:** Create a new rectangular window with the bottom left corner near the current position of the mouse pointer. Left mouse clicks will cause this corner to move to the current pointer location.

- **f/F:** Create a new circular window with the center at the current position of the mouse pointer. Left mouse clicks will cause the center to move to the current pointer location.

- **a/A:** Switch between corners for rectangular boxes or center/radius for circular boxes. Left mouse clicks and movement of the pointer will move the corner or center/radius of the current CLEAN box.

- **c/C:** Stop editing the current box. A new box can be specified with a left mouse click with the pointer near the corner/center/radius of an existing box to be modified.

- **b/B:** Deletes the current box.

- **g/G:** Toggles the current box between box and unbox; the color should change.

- **d/D:** Exits editing mode.

When all editing of the window is complete, the “OK” button with “Continue” selected causes the calling program to resume with the specified operation and the edited window. The “Cancel” button is like “OK” except that any editing of the window is discarded.

The program timeout (length of time ObitView will wait before sending a program the default response, i.e. “Continue”) can be set using the “Options” menu. The default timeout is infinite but can be specified to a finite period. The actual minimum is 5 seconds to give time to actually respond interactively and any activity on the editing dialog disables the timeout for that instance.

1.6 ObitMess Task Message Display

The ObitMess server is used in order to display task messages and to provide user input for tasks running asynchronous. Use of this faculity is described in Section 1.7.2. To be used in an ObitTalk session, is must be started independently.

Like ObitView, ObitMess uses the xmlrpc protocols to communicate with ObitTalk and as such allows communication between different computers by means of the internet. Parts of this protocol involve fixed port numbers which means that only a single ObitMess can run on a given computer using a given port number. An attempt to start a second will fail with a “can’t bind” message. By default port 8777 is used but others may be used as well. For instance to use port 8889, start ObitMess as follows

```
% ObitMess -port 8889 &
```

Then ObitTalk can be told to use this port when starting a task (myTask) by:

```
>>> tw=go(mytask, URL="http://localhost:8889/RPC2")
```

If there is trouble connecting between ObitTalk and the message server port (e.g. firewall, address translation) and you have ssh login access between the relevant hosts then it is possible to use ssh port forwarding through the secure connection. From the command shell on the client side (as seen by ObitMess) issue:

```
 % ssh -L localport:host:hostport user@host
```

where localport is the local port number (typically 8777 for ObitMess), host is the host on which the ObitMess process is running and host port is the port on host that the target ObitMess is watching.

When ObitMess is started a window will appear with the label "Obit task message server" and a Quit button. Additional windows will be produced as needed. Only hit the "Quit" button when you are through with the message server.

1.7 ObitTalk Basics

Obit consists of class libraries and a number of prepackaged tasks similar to AIPS tasks. The classes are implemented in c but there are python bindings to much of the high-level functionality allowing python scripts a high degree of flexibility in accessing and manipulating data. ObitTalk can execute Obit Tasks, Scripts and functions as well as AIPS tasks but not POPS verbs.

Obit can support multiple physical data formats as long as they are uniquely mapable to a common data model. Above a data access level, the underlying physical data representation is (mostly) hidden. Currently, AIPS and FITS (as practiced by AIPS) are supported. AIPS and Obit tasks (mostly) are completely interoperable and may be mixed.

Data objects generally have a "descriptor" member, e.g. each Image has an ImageDesc giving the "header" information. These can be accessed by conversion to and from a python dict (dictionary) in the relevant Descriptor class function. An example of an AIPS image in catalog slot 2 of AIPS disk 2:

```
>>> indisk=2
>>> image=getname(2,indisk)
>>> dict = image.Desc.Dict
```

Or, the function Header will display the contents in a human readable form:

```
>>> image.Header()
```

Note: function imhead(image) is a different path to the same end.

Catalogs in AIPS data directories can be viewed using the functions Acat(), AMcat(), AUcat() for all, image and uv entries; there are numerous optional arguments an explaination of which can be obtained by

```
>>> help(Acat)
Acat(disk=None, first=1, last=1000, Aname=None, Aclass=None, Aseq=0, giveList=False)
    Catalog listing of AIPS files on disk disk

    The class remembers the last disk accessed
    Strings use AIPS wild cards:
        blank => any
        '?'   => one of any character
        "*"   => arbitrary string
    If giveList then return list of CNOs
    disk      = AIPS disk number to list
    first     = lowest slot number to list
    last      = highest slot number to list
    Aname     = desired AIPS name, using AIPS wildcards, None -> don't check
    Aclass    = desired AIPS class, using AIPS wildcards, None -> don't check
    Aseq      = desired AIPS sequence, 0=> any
    giveList = If true, return list of CNOs matching
```

Directories in FITS "disks" can be displayed by Fdir

```
>>> help(Fdir)
Fdir(disk=None, dir=None)
    Catalog listing of FITS files on disk disk

    The class remembers the last disk accessed
    disk      = AIPS disk number to list
    dir       = relative or abs. path of directory, def. = cwd
                Only used if disk == 0
```

1.7.1 Tasks

Following are lists of tasks available through ObitTalk.
AIPS Tasks

- All AIPS tasks

Obit Tasks Some potentially useful Obit tasks include the following:

- **AutoFlag** Radio interferometry data editing software
- **BPass** Simple UV bandpass calibration
- **Calib** Calibrate visibility data (amp & phase)
- **CLCal** Apply gain solutions to a CL table
- **Convol** Convolve images
- **CubeClip** Remove insignificant pixels from 3D cube
- **CubeVel** Flux weighted velocity image from 3D cube
- **Feather** Task to feather together images
- **FndSou** Task to generate a source catalog from an image
- **GetJy** Determine calibrator flux densities
- **HGeom** Task to make an image consistent with another image
- **IDIin** Read IDI format UV data (BLBA)
- **IDIout** Write IDI format UV data

- **Imager** Radio interferometry imaging task
- **Lister** Listing of data and calibration tables
- **MapBeam** Map beam polarization
- **MCube** Task to accumulate image planes into a cube
- **MednFlag** Automated UV flagging about a median value
- **MFImage** Wideband imaging
- **noFQId** Set FqIDs in continuum data to 1
- **Quack** Flags specified portion of scans of UV data
- **SCMap** Interferometry self calibration imaging
- **SetJy** Modify SoUrce (SU) table
- **SNCor** Modify visibility gain (AIPS SN) table
- **SNFilt** Fits for instrumental phases in SN table.
- **SNSmo** Smooth visibility gain (AIPS SN) table
- **Split** Split multi–source UV data to single source
- **Splat** Copy multi–source UV data with calibration/selection
- **SplitCh** Split UV data to multiple channels
- **Squish** Compress image cube along third axis
- **SubImage** Task to copy a sub region of an image
- **TabCopy** Task to one or more tables
- **Template** Task to print the mean, rms and extrema in an image
- **UVBlAvg** Baseline dependent time and/or frequency averaging
- **UVCopy** Copy UV data
- **UVPolCor** Correct off-axis instrumental polarization in UV data
- **UVSim** Simulate UV data
- **UVSub** Task to subtract a clean model from a uv data base

To see task documentation either a python task object may first be created and its documentation viewed, or more directly:

```
AIPSHelp("AIPS_task_name")
or
ObitHelp("Obit_task_name")
```

To create a task object:

```
>>> im=AIPSTask("IMEAN")
```

to create an AIPS task object for task IMEAN, or

```
>>> fe=ObitTask("Feather")
```

to create an Obit Task object for Feather. Note the names of the objects are arbitrary.

Task parameters can be set using the form object.parameter=value:

```
>>> im.inname="MY FILE"
```

where the parameter names are subject to tab completion. Array values are given in square brackets "[ ]", the usual form for a python list. AIPS array values are indexed 1-relative and Obit arrays 0-relative but this is largely transparent. Note: unlike POPS, ALL strings are case sensitive. There are convenience functions setname, set2name and setoname to copy the name information to a task object for the first and second input objects and the output object:

```
>>> setname (myImage, im)
```

Task parameters can be reviewed using the inputs() function:

```
>>> im.inputs() # short form im.i
```

or

```
>>> inputs(im)
```

POPS style help can be viewed:

```
>>> im.help()  # short form im.h
```

or

```
>>> help(im)
```

or EXPLAIN (if available) by:

```
>>> im.explain()  # short form im.e
```

or

```
>>> explain(im)
```

Tasks can be run using the go function:

```
>>> im.go()  # short form im.g
```

The above form of the go function runs synchronously and does not return until the task finishes. Log messages will appear in the screen; if logging to a file is desired, set the name of the file (relative or full path) on the task object's logFile member:

```
>>> im.logFile="myLog.log"
```

For Obit tasks, there is an alternative logging method, writting messages directly to a file and NOT displaying them on the terminal or Message Server; this is useful for batch, script driven processing. The logging file is specified as:

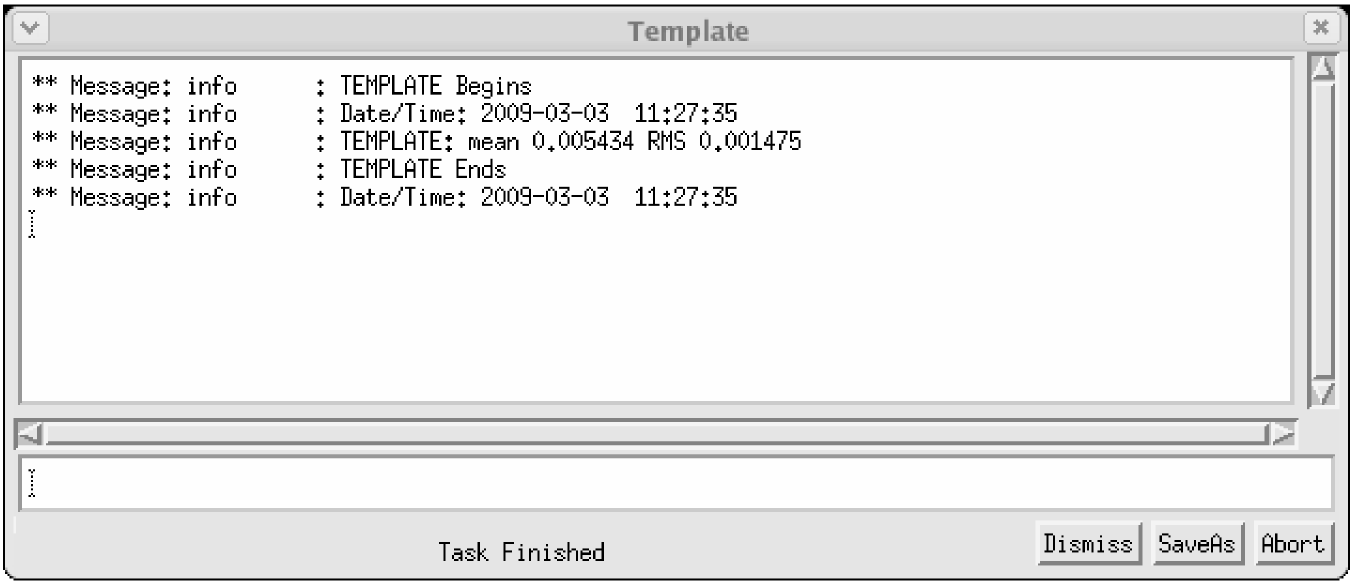
```
>>> im.taskLog="myLog.log"
```

This avoids problems with using logging by ObitTalk which include missed or mangled messages and the task hanging due to a full message buffer.

After a task is run which generates output values, these can be viewed using the outputs function:

```
>> im.outputs()  # short form im.o
```

and the values can be accessed through the task parameter. The task functions work for both AIPS and Obit tasks. Obit tasks have an output parameter "retCode" which will have a value of -999 until the task completes without detecting a problem After such a completion, the value will be 0, or -1 if an error is detected. -999 means the task aborted.



```
** Message: info      : TEMPLATE Begins
** Message: info      : Date/Time: 2009-03-03  11:27:35
** Message: info      : TEMPLATE: mean 0.005434 RMS 0.001475
** Message: info      : TEMPLATE Ends
** Message: info      : Date/Time: 2009-03-03  11:27:35
```

Task Finished

Figure 1.2: Message window for Obit task Template after completion.

1.7.2 Asynchronous Tasks

If the ObitMess message server is running and the doWait parameter on the task (or script) object is set to False, it is possible to execute asynchronously:

```
>> window = go(TaskObj)
```

If TaskObj.doWait==True, the task is run synchronously with messages written to the python command window. When a task is run asynchronously (TaskObj.doWait=False), a new ObitMess window with a scrolling text box will appear on the screen; the task messages will appear in this window and the task can be controlled from this window. If the task accepts terminal input, then this text can be entered into the text box below the message box, one line at a time and hitting the Enter key. If the window is expecting user input, the status becomes “Awaiting user input” and the task will suspend until the response is typed into the response line and the Enter key hit. The task status shown at the bottom of this window gives “Running”, “Finished” and there are buttons that allow aborting the task, saving the messages in a text file or closing the window.

A screen shot of a message window is shown in Figure 1.2.

The TaskWindow object returned when an asynchrous task is started can be used to suspend python operations until the task completes:

```
>> window.wait()
```

or abort the task:

```
>> window.abort()
```

Tasks (or scripts) can also be run asynchronously without a runtime display of the messages. This is done using the MsgBuf argument to the go function which will then execute the task (or script) and save the messages. In this case the go function returns a TaskMsgBuffer. The task messages can be saved to a logfile or obtained from the TaskMsgBuffer object:

```
>> buffer = go(myTask,MsgBuf=True)
>> buffer.wait()
>> messages = buffer.Messages()
```

TaskMsgBuffer objects also have an abort function.

1.7.3 Disk Numbers and Task Executation

"Data disks" as defined in ObitTalk include the information about the location of the data and ObitTalk will attempt to execute the task where the data defined for it resides. This means that disk numbers cannot be defaulted as then ObitTalk cannot decide where to execute the task or tell if all data reside on the same host. For Obit Tasks operating on FITS files, disk 0 has a special meaning, that the filename given is relative to the current working directory.

1.7.4 Scripts

Scripts can be executed locally directly as a command line argument to ObitTalk or interactively using the ObitScript class (see Section 1.14.3). When a script is executed from the command line, there is no prompt for the AIPS user number which must be supplied by the script. To use all features of the Obit python interface, a full initialization of Obit is also needed. An example python fragment in a script given on the command line initializing Obit for user 100 is the following:

```
# Initialize Obit for AIPS user 100
user=100
from OTObit import *
AIPS.AIPS.userno=user
OSystem.PSetAIPSuser (user)
err=OErr.OErr()
```

Scripts can run from an interactive ObitTalk session (started with no arguments) and can be run synchronously or asynchronously and either locally or remotely using the ObitScript class. Remote ObitScripts have full access to the functionality aforted locally visible data, which it is to the script.

1.7.5 Task logs

Messages from running AIPS or Obit tasks will appear in the python window if the task is being run synchronously or in the Task Window if run asynchronously. Each Task window has a button that allows writing the contents into a file; otherwise the logging messages are lost when the window closes. If logging to a file is desired, set the name of the file (relative or full path) on the task object's logFile member:

```
>>> im.logFile="myLog.log"
```

This will cause the messages to be logged as the task runs.

For batch, script–driven processing it may be desirable to write messages directly to the log file from the task and not to the terminal output or Message Server. This also avoids the problems of ObitTalk occasionally losing or mangling messages or causing the task to hang due to a full I/O buffer. Obit tasks can invoke direct logging using the taskLog task object member:

```
>>> im.taskLog="myLog.log"
```

1.7.6 ObitTalk/Obit routines

ObitTalk has python binding to the Obit c library that allow access to data and many high level functions. Thus, scripts or interactive use can be controlled by data values in files. (Note: in general functions which manipulate data require that the data be visible locally whereas tasks and the ObitTalk Data classes do not).

Control parameters to Obit (c) routines are largely passed in an InfoList structure (a type of associative array similar to a python dict) but many of the python interface routines take care of this detail and their parameters are passed through a python dictionary. Details are available via the python help command. Use of ObitTalk routines is described below.

1.7.7 Messages and error handling

In ObitTalk error handling and messages use the OErr class. ObitTalk defines a variable err at startup for this purpose. Python functions bound to Obit routines which can generate either messages or error conditions are passed an OErr argument. Messages are generally not shown until explicitly requested, this allows suppressing messages when necessary.

Note: if an error condition is indicated on err and has not been cleared and/or messages displayed, then subsequent functions passed err will simply return without-performing their function.

OErr functions include:

- **ShowErr(err)** Display any messages and clear any error conditions.
- **OErr.PClear(err)** Clear Obit error stack err and error condition
- **OErr.PIsErr(err)** Tells if an error condition exists
- **OErr.PLog(err, eCode, message)** Add message To Obit Error/message stack err
- **OErr.PSet(err)** Set Obit error flag
- **OErr.printErr(err)** Prints Obit error/message stack
- **OErr.printErrMsg(err, message='Error')** Prints Obit error stack and throws runtime exception on error
- **OErr.OErrIsA(err)** Tells if object thinks it's a Python ObitErr

Each OErr message has a severity level:

- **OErr.Info** Informative message
- **OErr.Warn** Warning message (not an error)
- **OErr.Traceback** Traceback information from c routines.
- **OErr.MildError** Error (but may not be serious)
- **OErr.Error** Error message
- **OErr.StrongError** Serious error
- **OErr.Fatal** Program cannot continue

1.7.8 Lock and Parameter Files

ObitTalk uses files in /tmp to indicate that resources are allocated and for input and output parameter files for ObitTasks. If problems occur then these files may not be properly disposed of and may need to be deleted by hand. These will have names like Obit_pops_no_.pid (e.g. Obit3.5942) indicating an allocated "POPS number" or ObitTask_Input.pops_no (e.g. SCMapInput.1) indicating the input parameter file to an Obit Task (SCMap).

1.7.9 Modifying Data Headers

The Obit/python interface can be used to modify data headers through the Descriptor classes (ImageDesc, UVDesc, etc). The actual memory resident structure is a c structure which can be translated to and from a python dict. The general procedure is

1. Open the object Read/Write

   ```
   >>>  help(x.Open)
   Open(self, access, err, blc=None, trc=None) method of Image.Image instance
       Open an image persistent (disk) form

       self   = Python Image object
       access    = access READONLY (1), WRITEONLY (2), READWRITE(3)
       err       = Python Obit Error/message stack
       blc       = if given and a list of integers (min 2) giving
       bottom left corner (1-rel) of subimage
       trc       = if given and a list of integers (min 2) giving
       top right corner (1-rel) of subimage
   ```

2. Obtain the descriptor in python dict form using the x.Desc.Dict function.

3. Modify the contents of the dict making sure to maintain its structure, format of date strings and data types.

4. Update the Descriptor using a x.Desc.Dict = dict type statement

5. Update descriptor in external representation using the data object's UpdateDesc function.

   ```
   UpdateDesc(self, err, Desc=None) method of Image.Image instance
       Update any disk resident structures about descriptor

       self      = Python Image object
       err       = Python Obit Error/message stack
       Desc      = Descriptor, if None then use current descriptor
                   Contents can be accessed through the Dict member
   ```

6. Close object

An example is shown in the following in which the value of "observer" is changed from "Axxxx" to "my code":

```
>>> x=getname(17)
AIPS Image W3           VLA    1 1
>>> imhead(x)
AIPS Image Name: W3           Class: VLA    seq:        1 disk:    1
Object: W3
Observed: 1992-07-17 Telescope:  VLA      Created: 2006-09-25
Observer: Axxxx      Instrument: VLA
Minimum =       -0.018  Maximum =         2.452 JY/BEAM
--------------------------------------------------------------
```

```
Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
RA---SIN   320   2 25 36.44334     161.00       -1.72914    0.00
DEC--SIN   320  62  6 11.2407      161.00        1.72914   -0.35
FREQ         1      8.6697e+09       1.00    6.05469e+06    0.00
STOKES       1      IPol             1.00              1    0.00
--------------------------------------------------------------
Coordinate equinox 2000.0  Coordinate epoch 2000.00
Observed RA    2 25 36.44334 Observed Dec  62  6 11.2407
no. Comp        1
Clean Beam    6.99984 x    6.99984 asec, PA     0.0 deg.
Rest freq            0 Vel type: Observer,  wrt  Optical
Alt ref value   1.1704e+05  wrt pixel    16.00
Maximum version number of AIPS CC tables is 1
Maximum version number of AIPS HI tables is 1

>>> x.Open(Image.READWRITE,err)
>>> d=x.Desc.Dict
>>> d["observer"]
'Axxxx   '
>>> d["observer"]="my code"
>>> x.Desc.Dict=d
>>> x.UpdateDesc(err)
>>> x.Close(err)
>>> imhead(x)
AIPS Image Name: W3           Class: VLA    seq:        1 disk:    1
Object: W3
Observed: 1992-07-17 Telescope:  VLA      Created: 2006-09-25
Observer: my code    Instrument: VLA
Minimum =       -0.018  Maximum =         2.452 JY/BEAM
--------------------------------------------------------------
Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
RA---SIN   320   2 25 36.44334     161.00       -1.72914    0.00
DEC--SIN   320  62  6 11.2407      161.00        1.72914   -0.35
FREQ         1      8.6697e+09       1.00    6.05469e+06    0.00
STOKES       1      IPol             1.00              1    0.00
--------------------------------------------------------------
Coordinate equinox 2000.0  Coordinate epoch 2000.00
Observed RA    2 25 36.44334 Observed Dec  62  6 11.2407
no. Comp        1
Clean Beam    6.99984 x    6.99984 asec, PA     0.0 deg.
Rest freq            0 Vel type: Observer,  wrt  Optical
Alt ref value   1.1704e+05  wrt pixel    16.00
Maximum version number of AIPS CC tables is 1
Maximum version number of AIPS HI tables is 1
```

1.7.10 Object parameter lists

It is frequently necessary to pass parameters to Obit functions to control their behavior. These are sometimes explicit arguments of python functions but in other cases they are passed through the InfoList member of the object. This is particularly used for data selection and calibration parameters. An InfoList is conceptually similar to a python dict structure although less flexible. An InfoList is a list of labeled data items, each item is a scalar or an array of a given data type. The data types supported are int, long (explicitly 32 bit in c), float, double (explicitly 64 bit in c), boolean and strings. More details can be obtained by viewing the help function on the class.

Obit data (and other) objects will have an InfoList member which can generally be accessed through the List member. Conversion to and from python dict structures is by means of the Dict member of the InfoList class. Simple access to entries in an InfoList are through the set and get functions.

```
set(self, name, value, ttype=None) method of InfoList.InfoList instance
    Save a value in an InfoList

    Set an entry in an InfoList, possibly redefining its type and dimension
    self     = input Python InfoList
    name     = name of desired entry
    value    = value to save, either a scalar integer, float, boolean or string
               or a 1D array of one of these types
               Type and dimensionality determined from value unless ttype is set
    ttype     = data type, "double", "long", None=>type of value
```

```
get(self, name) method of InfoList.InfoList instance
    Retrieve a value from an InfoList

    returns python list containing data:
    0 - return code, 0=OK else failed
    1 - name
    2 - type
        int=1, oint=3, long=4, float=9, double=10, string=13, boolean=14
    3 - dimension array as list, e.g. [1,1,1,1,1] for scalar
    4 - data array
    self     = input Python InfoList
    name     = name of desired entry
```

Usage of these functions as shown in the following in which x is an Obit data object.

```
>>> x.List.set("fvalue",1.234)
>>> x.List.get("fvalue")
[0, 'fvalue', 9, [1, 1, 1, 1, 1], [1.2339999675750732]]
>>> x.List.set("farray",[1.234,4.567,7.890])
>>> x.List.get("farray")
[0, 'farray', 9, [3, 1, 1, 1, 1], [1.2339999675750732, 4.5669999122619629, 7.8899998664855595
>>> x.List.set("darray",[1.234,4.567,7.890],"double")
>>> x.List.get("darray")
[0, 'darray', 10, [3, 1, 1, 1, 1], [1.234, 4.5670000000000002,
    7.8899999999999997]]
```

```
>>> x.List.Dict
{'DISK': [2, [1, 1, 1, 1, 1], [1]], 'FileType': [2, [1, 1, 1, 1, 1],
    [1]],
'fvalue': [9, [1, 1, 1, 1, 1], [1.2339999675750732]],
'darray': [10, [3, 1, 1, 1, 1], [1.234, 4.5670000000000002,
    7.8899999999999997]],
'User': [2, [1, 1, 1, 1, 1], [100]],
'farray': [9, [3, 1, 1, 1, 1], [1.2339999675750732,
    4.5669999122619629, 7.8899998664855957]],
'CNO': [2, [1, 1, 1, 1, 1], [40]],
'Disk': [2, [1, 1, 1, 1, 1], [1]], 'nVisPIO': [2, [1, 1, 1, 1, 1], [1]]}
>>>
```

1.7.11 Accessing UV Data

There are a number of Obit Class functions that perform highlevel operations of uv data sets (UV objects) in the CleanVis, UVImager, and UVSelfCal classes. For details, import these classes and view the help documentation. Visibility data can be read from and written to data objects using the UV ReadVis and WriteVis functions employing objects of the UVVis class.

The selection, calibration and editing of visibility data can be controlled by setting parameters on the InfoList member of the UV data object. Many of these are set using the interface to highlevel class functionality, but for a given parameter which is not part of the class function interface definition, the value can be set directly through the InfoList (see section 1.7.10). A complete list of the UV data selection/calibration/editing parameters follows.

- doCalSelect boolean scalar
  Select/calibrate/edit data?

- Stokes string (4,1,1)
  Selected output Stokes parameters: " "⇒ no translation,"I ","V ","Q ", "U ", "IQU ", "IQUV", "IV ", "RR ", "LL ", "RL ", "LR ", "HALF" = RR,LL, "FULL"=RR,LL,RL,LR. [default " "] For data with linear feeds substiture "X" and "Y" for "R" and "L". In the above 'F' can substitute for "formal" 'I' (both RR+LL or XX+YY).

- BChan int scalar
  First spectral channel (1-rel) selected. [def all]

- EChan int scalar
  Highest spectral channel (1-rel) selected. [def all]

- BIF int scalar
  First IF (1-rel) selected. [def all]

- EIF int scalar
  Highest IF (1-rel) selected. [def all]

- doPol int scalar
  $> 0 \Rightarrow$ calibrate polarization.

- PDVer int scalar
  PD table version.

- doCalib int scalar
  $> 0 \Rightarrow$ calibrate, $2 \Rightarrow$ also calibrate Weights
- gainUse int scalar
  SN/CL table version number, $0 \Rightarrow$ use highest
- flagVer int scalar
  Flag table version, $0 \Rightarrow$ use highest, $< 0 \Rightarrow$ none
- BLVer int scalar
  BL table version, $0 >$ use highest, $< 0 \Rightarrow$ none
- Subarray int scalar
  Selected subarray, $<= 0 \Rightarrow$all [default all]
- dropSubA bool scalar
  Drop subarray info?
- FreqID int scalar
  Selected Frequency ID, $<= 0 \Rightarrow$all [default all]
- timeRange float (2,1,1)
  Selected timerange in days.
- UVRange float (2,1,1)
  Selected UV range in kilowavelengths.
- InputAvgTime float scalar
  Input data averaging time (sec). Used for fringe rate decorrelation correction.
- Sources string (?,?,1)
  Source names selected unless any starts with a '-' in which case all are deselected (with '-' stripped).
- souCode string (4,1,1)
  Source Cal code desired,
  - ' ' ⇒ any code selected
  - '* ' ⇒ any non blank code (calibrators only)
  - '-CAL' ⇒ blank codes only (no calibrators)
- Qual int scalar
  Source qualifier, -1 [default] = any
- Antennas int (?,1,1)
  a list of selected antenna numbers, if any is negative then the absolute values are used and the specified antennas are deselected.
- corrType int scalar
  Correlation type, 0=cross corr only, 1=both, 2=auto only.
- passAll bool scalar
  If True, pass along all data when selecting/calibration even if it's all flagged. Data deselected by time, source, antenna etc. is not passed.

- doBand int scalar
  Band pass application type $< 0 \Rightarrow$ none:

  1. If = 1 then all the bandpass data for each antenna will be averaged to form a composite bandpass spectrum, this will then be used to correct the data.
  2. If = 2 the bandpass spectra nearest in time (in a weighted sense) to the uv data point will be used to correct the data.
  3. If = 3 the bandpass data will be interpolated in time using the solution weights to form a composite bandpass spectrum, this interpolated spectrum will then be used to correct the data.
  4. If = 4 the bandpass spectra nearest in time (neglecting weights) to the uv data point will be used to correct the data.
  5. If = 5 the bandpass data will be interpolated in time ignoring weights to form a composite bandpass spectrum, this interpolated spectrum will then be used to correct the data.

- Smooth float (3,1,1)
  specifies the type of spectral smoothing

  - Smooth[0] = type of smoothing to apply:
    - $0 \Rightarrow$ no smoothing
    - $1 \Rightarrow$ Hanning
    - $2 \Rightarrow$ Gaussian
    - $3 \Rightarrow$ Boxcar
    - $4 \Rightarrow$ Sinc (i.e. sin(x)/x)
  - Smooth[1] = the "diameter" of the function, i.e. width between first nulls of Hanning triangle and sinc function, FWHM of Gaussian, width of Boxcar. Defaults (if < 0.1) are 4, 2, 2 and 3 channels for Smooth[0] = 1 - 4.
  - Smooth[2] = the diameter over which the convolving function has value - in channels. Defaults: 1, 3, 1, 4 times Smooth[1] used when

- BPVer int scalar
  Band pass (BP) table version, $0 \Rightarrow$use highest

- SubScanTime float scalar
  {Optional} if given, this is the desired time (days) of a sub scan. This is used by the selector to suggest a value close to this which will evenly divide the current scan. $0 \Rightarrow$ Use scan average. This is only useful for ReadSelect operations on indexed ObitUVs.

As an example of the data selection usage, to specify that only autocorrelations are desired in UV data object myUV in subsequent operations:

```
>>> myUV.List.set('corrType',2)
```

1.8 Parallel Processing

ObitTalk and Obit tasks implement some basic aspects of parallel processing. These include using multiple cores and/or processors with shared memory in a computer using multi–threading and distributing tasks across nodes of a cluster or workstations on a LAN. These are described in the following sections.

1.8.1 Multi–threading

Many of the more expensive operation in Obit allow using multiple processors/cores which share memory. The technique of multi–threading is used for this. Obit tasks which support multi–threading have a parameter, nThreads, giving the maximum number of threads to allow in a parallel operation. In general, this should not be more than the actual number of processors/cores available but may be fewer if multiple tasks are to be run using threading or the particular task executation cannot make good use of more than a given number of threads. Threading in functions called from scripts can be invoked as in the following example of allowing two parallel threads.

```
>>> # Allow multiple threads
>>> OSystem.PAllowThreads(16)  # 16 threads max.
```

1.8.2 GPU

The most compute intensive operations have a GPU implementation in cuda. In tasks, these are invoked using the doGPU and doGPUGrid parameters. Multiple GPU can be used for visibility data gridding using parameter array GPU_no. Usage of GPUs must be implemented in a built–from–source version due to licencing and other restrictions

1.8.3 Cluster Nodes

ObitTalk can start parallel, independent processes on multiple nodes of a cluster of workstations on a network; these can be either tasks or ObitScripts. Executation is initiated on the node/workstation on which the data disks are defined. See sections 1.7.3 and 1.14 for more details.

1.9 Examples

The following give simple examples of using ObitTalk.

1.9.1 Display AIPS Catalog

The examine your AIPS image catalog on disk 7

```
>>> AMcat(7)
AIPS Directory listing for disk 7
  1 CYG A 74 MHz.MODEL .    1 MA 13-Apr-2004 10:25:32
```

1.9.2 Create Python Image Object

To create a python object for the AIPS image in slot 1 and name it “x”:

```
>>> x=getname(1,7)
AIPS Image CYG A 74 MHz MODEL  7 1
```

1.9.3 Display Data Header

To view the image header of x:

```
>>> imhead(x)
AIPS Image Name: CYG A 74 MHz Class: MODEL  seq:        1 disk:    7
Object: 3C405
Observed: 2001-01-19 Telescope:  VLA      Created: 2001-03-03
```

```
Observer: AD441      Instrument: VLA
Minimum =          -25  Maximum =       4638.2 JY/BEAM
--------------------------------------------------------------
Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
RA---SIN   512  19 59 28.35406     256.00             -5    0.00
DEC--SIN   512  40 44  2.0862      257.00              5    0.32
FREQ         1        7.38e+07       1.00    1.55029e+06    0.00
STOKES       1      IPol             1.00              1    0.00
--------------------------------------------------------------
Coordinate equinox 2000.0  Coordinate epoch 2000.00
Observed RA   19 59 28.35406 Observed Dec  40 44  2.0862
no. Comp      697
Clean Beam    24.9998 x    24.9998 asec, PA     0.0 deg.
Rest freq            0 Vel type: Observer,  wrt  Optical
Alt ref value            0  wrt pixel     0.00
Maximum version number of AIPS CC tables is 1
Maximum version number of AIPS HI tables is 1
```

1.9.4 Display an Image

To display image x in ObitView:

```
>>> tvlod(x)
```

Note: if ObitTalk thinks something has gone wrong with the image display, the python object may need to be recreated. To recreate the default image display:

```
>>> newDisplay()
```

1.9.5 Image Pixel Access

Access to arrays of image pixel values is through the FArray class. Images can be read into or written from FArray objects which can be manipulated in many ways. See help(FArray) for details. In the following the pixel array in an image is read and several operations are performed.

```
>>> # Create image object from AIPS catalog entry
>>> x = Image.newPAImage("Swan","Cygnus A","J2000",1,1,True,err)
>>> ShowErr(err)                 # Check for errors
>>> x.Open(Image.READONLY,err)   # Open image
>>> x.Read(err)                  # Read plane
>>> pixels=x.FArray              # python FArray object from image
>>> pixels.Mean                  # Display Mean of pixel values
49.573715209960938
>>> pixels.RMS                   # Display RMS of pixel values
4.758549690246582
>>> FArray.PSMul(pixels, 5.0)    # Scale all pixels by 5
>>> pixels.Mean                  # Display new mean
247.86857604980469
>>> x.Close(err)                 # Close image
>>> pixels.get(100,100)          # Display (0-rel) pixel [100,100]
8.0
>>> pixels.set(3.1415926,100,100) # set value of pixel [100,100]
>>> pixels.get(100,100)         # See new value
3.1415925025939941
```

1.9.6 Run an AIPS task

To run AIPS task IMEAN on x and view the values returned:

```
>>> imean=AIPSTask("imean")  # Define task object
>>> setname(x,imean)         # Fill in info on x to task object
>>> imean.i                  # View inputs
Adverbs     Values                                  Comments
--------------------------------------------------------------------------------
 dohist      -1.0                                    True (1.0) do histogram plot.
                                                     = 2 => flux on x axis
 userid       0.0                                    User ID.  0=>current user
                                                       32000=>all users
 inname      CYG A 74 MHz                            Image name (name)
 inclass     MODEL                                   Image name (class)
 inseq        1.0                                    Image name (seq. #)
 indisk       7.0                                    Disk drive #
 blc         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0       Bottom left corner of image
                                                       0=>entire image
 trc         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0       Top right corner of image
                                                       0=>entire image
 nboxes       0.0                                    No. of ranges for histogram.
 pixrange    0.0, 0.0                                Min and max range for hist.
 functype                                            'LG' => do log10 plot of #
                                                     samples, else linear
 pixavg       0.0                                    Estimate of mean noise value
 pixstd       0.0                                    Estimate of true noise rms
                                                        < 0 => don't do one
                                                        = 0 => 2-passes to get
 docat        1.0                                    Put true RMS in header
 ltype        3.0                                    Type of labeling: 1 border,
                                                     2 no ticks, 3 - 6 standard,
                                                     7 - 10 only tick labels
                                                     <0 -> no date/time
 outfile                                             Name of output log file,
                                                     No output to file if blank
 dotv        -1.0                                    > 0 Do plot on the TV, else
                                                     make a plot file
 grchan       0.0                                    Graphics channel 0 => 1.

>>> imean.g       # Execute task
IMEAN1: Task IMEAN  (release of 31DEC02) begins
IMEAN1: Image= CYG A 74 MHz.MODEL .   1 7   xywind=    1    1  512  512
IMEAN1: Mean and rms found by fitting peak in histogram:
IMEAN1: Mean= 4.8010E-02 Rms= 4.7438E+00  **** from histogram
```

```
IMEAN1: Mean and rms found by including all data:
IMEAN1: Mean= 1.8457E+00 Rms= 6.0963E+01 JY/BEAM  over    262144 pixels
IMEAN1: Flux density =  1.7080E+04 Jy.   beam area =  28.33 pixels
IMEAN1: Minimum=-2.5000E+01 at   59  145    1    1
IMEAN1: Skypos: RA 20 00 55.087  DEC 40 34 45.54
IMEAN1: Maximum= 4.6382E+03 at  252  256    1    1
IMEAN1: Skypos: RA 19 59 30.116  DEC 40 43 57.20
IMEAN1: Skypos: IPOL  73.800 MHZ
IMEAN1: returns adverbs to AIPS
IMEAN1: Appears to have ended successfully
IMEAN1: smeagle      31DEC06 TST: Cpu=       0.0  Real=       0

>>> imean.o     # Examine outputs
Adverbs     Values                                     Comments
--------------------------------------------------------------------------------
 pixavg      0.0480099283159                            Estimate of mean noise value
 pixstd      4.74377298355                              Estimate of true noise rms
                                                           < 0 => don't do one
                                                           = 0 => 2-passes to get
```

1.9.7 Run an Obit task (FndSou)

To run Obit task FndSou on an image, x, containing multiple sources to generate a source catalog (use sf.h for detailed help):

```
>>> sf=ObitTask("FndSou")
>>> setname(x,sf)
>>> sf.outDisk=1
>>> sf.NGauss=20      # Max. number of sources (islands)
>>> sf.CutOff=2       # Minimum pixel brightness to consider
>>> sf.Retry=1        # Try multiple components if residuals exceed this
>>> sf.doMult=True    # Allow using multiple Gaussians per source
>>> sf.doWidth=True   # Fix width
>>> sf.Parms=[2., 5., 0., 1]
>>> sf.RMSsize=50     # Size of window to use to determine image RMS
>>> sf.prtLv=1        # Some diagnostic output
>>> sf.doVL=True      # Generate VL table
>>> sf.i              # Display inputs
FndSou:  Task to fit Gaussian models to an image by least-squares
Adverbs     Values                                     Comments
--------------------------------------------------------------------------------
 DataType    AIPS                                      FITS" or "AIPS" type of input
 inName      1400+208                                  Image Name (Name) 1
 inClass     ICLEAN                                    Image Name (Class) 1
 inSeq          1                                      Image Name (Seq. #) 1
 inDisk         1                                      Disk drive # 1
 inFITS                                                Filename 1 if FITS image
 BLC         0, 0, 0, 0, 0, 0, 0                       Bottom left corner of image
                                                         0=>entire image
 TRC         0, 0, 0, 0, 0, 0, 0                    Top right corner of image
                                                      0=>entire image
 doVL        True                                   Convert to VL table?
 doPBCorr    False                                  PB correction to VL table?
 asize       25.0                                   antenna diam. for PB corr.
 doResid     False                                  Catalog residual map?
 outName                                            Output Image Name
 outClass                                           Output Image Class
 outSeq         0                                   Output Image Seq. #
 outDisk        1                                   output Disk drive
 outFITS                                            Output Filename if FITS image
 NGauss        20                                   Max. Number of islands
 NPass          1                                   Number of passes through resid.
 CutOff       2.0                                   Flux cutoff level
 Retry        1.0                                   Retry level
 Sort                                               Sort Order of output ' '=RA
 OutPrint                                           Printer disk file to save
 doMult      True                                   >0 => fit multiple peaks
 doWidth     True                                   >0 => fit widths
 Gain        0.05                                   Amp-dependent part of retry
                                                    and warning levels
 Parms       2.0, 5.0, 0.0, 1.0, 0.0                Components constraints
                                                    [0] flux < Parms[0]
                                                    [1] widths>Parms[1] cells
                                                    [2] peaks>Parms[2] cells
                                                    outside fitting region
                                                    [3] if >0 don't allow Gauss
                                                    smaller than CLEAN beam
 RMSsize       50                                   Size of region to determine RMS
 prtLv          1                                   Debug print level

>>> sf.g              # run task
** Message: info      : FndSou Begins
** Message: info      : Date/Time: 2007-10-11  13:47:51
** Message: info      : Found 23 islands pass 1
** Message: info      : Successfully fitted 20 components
** Message: info      : Attempt to break 0 islands into multiple
** Message: info      : 0 Attempts to break islands failed
** Message: info      : 0 components rejected for low peak
** Message: info      : 0 fits hit iteration limit
Found 23 islands in 1 passes
Successfully fitted 20 components
Attempt to break 0 islands into multiple
0 Attempts to break islands failed
0 components rejected for low peak
0 fits hit iteration limit

   ...
```

```
** Message: info      : FndSou Ends
** Message: info      : Date/Time: 2007-10-11  13:47:58
```

1.9.8 Table Access (print contents of VL table)

To create a python object from the VL table created in the previous example and display its contents using the Catalog module utility PVLPrint:

```
>>> import Catalog
>>> vltab=x.NewTable(Table.READONLY, "AIPS VL",1,err)
>>> Catalog.PVLPrint(vltab,x,err)
>>> ShowErr(err) # Display any error messages

 Listing of fitted VL table values
Fitted sizes in asec, Peak, Flux, IRMS in mJy, residual values relative to Peak
Error estimates (asec, mJy, deg) given under value
             RA           Dec          Peak    Flux    IRMS  Fit Maj Fit min
    1  13 43 56.1032   22 18 21.163  3666.31  4806.81  90.186 104.886  80.000
                1.80           1.12    93.92   123.13           3.021   1.822
    2  13 48 14.5900   24 15 57.461  5508.17  5917.91  87.870  85.951  80.000
                0.82           0.81    89.29    95.93           1.442   1.253
    3  13 48 51.8784   26 35 44.011  2742.81  3484.55  77.721  98.355  82.667
                1.60           1.69    81.18   103.13           3.143   2.266
    4  13 49 39.0137   21 07 29.926 13631.90 13820.04 112.454  81.104  80.000
                0.41           0.40   112.83   114.39           0.676   0.658
    5  13 50 58.3986   15 51 55.507  2479.43  2733.85  91.272  88.209  80.000
                1.94           1.88    93.20   102.76           3.473
   ...
```

1.9.9 Table Row Data

In the following example, the header of an AIPS CC (Clean Components) table is converted to a dict and printed and the first few rows are read into a python dict structure and printed.

```
>>> imDict=x.Desc.Dict
>>> xinc = abs(imDict[’cdelt’][0])   # X Cell spacing
>>> yinc = abs(imDict[’cdelt’][1])   # Y Cell spacing
>>> cctab=x.NewTable(Table.READONLY,"AIPS CC",1,err)
>>> thead=cctab.Desc.Dict
>>> thead   # Display contents of python dict
{’repeat’: [1, 1, 1, 1], ’nrow’: 114, ’dim1’: [1, 1, 1, 1],
’sortOrder2’: 0, ’sortOrder1’: 0, ’dim2’: [1, 1, 1, 1],
’dim0’: [1, 1, 1, 1], ’version’: 1, ’lrow’: 16, ’Table name’: ’AIPS CC’,
’FieldName’: [’FLUX’, ’DELTAX’, ’DELTAY’, ’_status’],
’type’: [9, 9, 9, 2], ’FieldUnit’: [’JY’, ’DEGREES’, ’DEGREES’, ’’]}

>>> cctab.Open(Table.READONLY,err)
>>> ShowErr(err) # Display any error messages
>>> for i in range(1,5):    # Loop over first 4 rows printing
...     row = cctab.ReadRow(i, err)    # Read row i (1-rel)
...     xcell = row["DELTAX"][0]/xinc  # X position in cells
...     ycell = row["DELTAY"][0]/yinc  # Y position in cells
...     flux  = row["FLUX"][0]         # Flux
...     print "%5d %5.2f %5.2f %10.2f" % (i,xcell, ycell,flux)
...
    1 -16.00  6.00    1260.95
    2 -47.00 16.00     646.20
    3 -16.00  5.00     626.66
    4 -46.00 16.00     527.65
>>> cctab.Close(err)                   # Close table
```

1.9.10 Writing to a History

The following example writes a timestamp and a comment into a image processing history and then prints the history.

```
>>> hi = x.History(Image.READWRITE, err)       # Extract history object from image
>>> r=hi.Open(History.READWRITE, err)          # Open history
>>> hi.TimeStamp(" Start Obit "+ObitSys.pgmName,err) # Timestamp
>>> r=hi.WriteRec(-1,"Some comment",err)       # write comment
>>> r=hi.Close(err)                            # Close
>>> OErr.printErrMsg(err, "Error with history")# Error test
>>> PrintHistory(x)                            # Show history
History for AIPS:Image:Cygnus A.J2000.1.1
     1 --------------------------------------------------------------------
     2 --------------------------------------------------------------------
     3 /Begin "HISTORY" information found in fits tape header by IMLOD
...
  1553         / 2007-10-11T21:12:11  Start Obit ObitPython
  1554 Some comment
```

1.9.11 Modify Visibility Data

The UV functions ReadVis and WriteVis read and write single visibility records in the form of python UVVis objects which contain the following members:

- **u** u coordinate (lambda)
- **v** v coordinate (lambda)
- **w** w coordinate (lambda)
- **time** Visibility time in days since 0 h on reference day
- **ant1** antenna 1 of baseline
- **ant2** antenna 2 of baseline
- **vis** visibilities as list of tuples (vis, wt) as (complex, float)

The visibilities are in the order defined in the data descriptor:

- **jlocs** 0-rel axis order: Stokes' parameters
- **incs** Increment in data: Stokes (in floats)
- **jlocf** 0-rel axis order: Frequency
- **incf** Increment in data: Frequency (in floats)
- **jlocif** 0-rel axis order: IF
- **incif** Increment in data: IF (in floats)

The following example uses the UVVis class to read the records in a UV data file, multiply the complex visibilities by 2.0 and the weights by 0.5. To specify data selection, calibration and editing to be applied to data as it is read, see section 1.7.11.

```
# Input AIPS file
x = UV.newPAUV("inUV", "RX_Tau", "IF2", 1, 1, True,err, nvis=1)
x.Open(UV.READONLY, err)
OErr.printErrMsg(err, "Error with input image")
# Output AIPS file
y = UV.newPAUV("outUV", "RX_Tau", "Copy", 1, 1, False,err, nvis=1)
UV.PClone(x, y, err)
y.Open(UV.WRITEONLY, err)
OErr.printErrMsg(err, "Error with output image")

# Get information about data
nvis  = x.Desc.Dict["nvis"]           # Number of visibilities
jstok = x.Desc.Dict["jlocs"]          # Order in data of Stokes
nstok = x.Desc.Dict["inaxes"][jstok]  # Number of Stokes (polarizations)
stokinc = x.Desc.Dict["incs"]/3       # Increment between Stokes in vis
jfreq = x.Desc.Dict["jlocf"]          # Order in data of Frequency
nfreq = x.Desc.Dict["inaxes"][jfreq]  # Number of Frequencies
freqinc = x.Desc.Dict["incf"]/3       # Increment between channels in vis
jif   = x.Desc.Dict["jlocif"]         # Order in data of IF
nif   = x.Desc.Dict["inaxes"][jif]    # Number of IFs
ifinc = x.Desc.Dict["incif"]/3        # Increment between IFs in vis

# Loop over input file
for i in range(0, nvis):
    # read to UVVis
    v = x.ReadVis(err)
    vlist = v.vis  # array of tuples (complex vis, float weight)
    # Multiply each vis by two, multiply weight by 0.5
    # Loop over IF
    for iif in range (0, nif):
        # Loop over Frequency channel
        for ifreq in range (0, nfreq):
            # Loop over Stokes
            for istok in range (0, nstok):
                indx = istok*stokinc + ifreq*freqinc + iif*ifinc
                # Extract visibility tuple
                tup = vlist[indx]
                vlist[indx] = (2.0*tup[0],tup[1]*0.5)  # multiply/replace
    # Write data to output
    y.WriteVis(v, err)
    OErr.printErrMsg(err, "Error copying file")

# Close files
x.Close(err)
y.Close(err)
OErr.printErrMsg(err, "Error closing file")
```

1.9.12 Write Quantized FITS image

The following example reads an AIPS image and writes a integerized FITS image with the pixel values truncated at a set fraction of the RMS "noise" in the image. This operation creates an image which is more compressible but with a controlled loss of precision. Note: in practice is is better to use the ObitTalk function imtab as it is simpler to use and will also copy tables; this example is given to show how to access images in ObitTalk.

```
# Specify input and output
inDisk   = 1
Aname    = "INPUT IMAGE"
Aclass   = "CLASS"
Aseq     = 1
outDisk  = 1
outFile  = "Quantized.fits"

# Create Images
inImage   = Image.newPAImage("Input image", Aname, Aclass, inDisk, Aseq, True, err)
# Note: inImage can also be created using getname(cno,disk)
outImage  = Image.newPFImage("Output image",   outFile,  outDisk,  False, err)
Image.PClone(inImage, outImage, err)   # Same structure etc.
OErr.printErrMsg(err, "Error initializing")

# Fraction of RMS
fract = 0.25

# Copy to quantized integer image with history
inHistory  = History.History("history", inImage.List, err)
Image.PCopyQuantizeFITS (inImage, outImage, err, fract=fract, inHistory=inHistory)
OErr.printErrMsg(err, "Writing to FITS")
```

1.9.13 Subtract a CLEAN model from UV Data

The following python script fragment subtracts the Fourier transform of a CLEAN model, multiplied by 0.5 from one uv data set and writes another. Several steps are necessary to create a SkyModel from an image mosaic containing a single image. Then, control parameters are entered into the input dict for SkyModel.PSubUV which is used to perform the operation. The input and output data are all FITS files with names inFile, inModel, outFile on FITS "disks" inDisk and outDisk. Note: this operation is more simply performed by task UVSub.

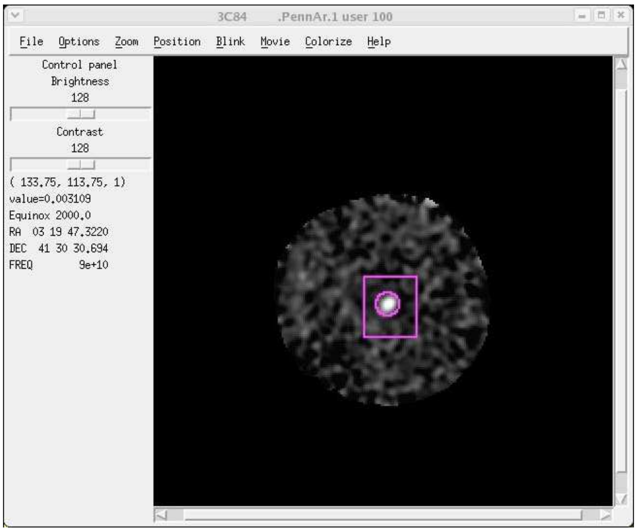
```
import SkyModel, ImageMosaic
# Set data
inData  = UV.newPFUV("Input uv data", inFile, inDisk, True, err)
inImage = Image.newPFImage("Input image",inModel, inDisk, True, err)
outData = UV.newPFUV("Output uv data", outFile, outDisk, False, err)
OErr.printErrMsg(err, "Error initializing")

# Make Image Mosaic with a single image
mosaic = ImageMosaic.newObit("Mosaic", 1, err)
OErr.printErrMsg(err, "Error making mosaic")

# Add image to mosaic
ImageMosaic.PSetImage(mosaic, 0, inImage)

# Make SkyModel from mosaic
model = SkyModel.PCreate("SkyModel", mosaic)
OErr.printErrMsg(err, "Error making SkyModel")

# Control parameters to input dict, most defaulted
Input = SkyModel.UVSubInput
Input['InData']      = inData   # Input uv data
Input['SkyModel']    = model    # SkyModel
Input['OutData']     = outData  # output uv data
Input['doCalSelect'] = False    # No calibration or data selection
Input['Stokes']      = '    '   # No conversion of Stokes
Input['Factor']      = 0.5      # Multiply model FT by 0.5
Input['Mode']        = 0        # Fastest FT type (DFT or Grid)
Input['Type']        = 0        # Use CLEAN model from CC table
Input['CCVer']       = [2]      # Use CC table 2 (array of 1 per image)

# Subtract Fourier transform of sky model from inData, write outData
SkyModel.PSubUV(err, Input)
OErr.printErrMsg(err, "Error subtracting")
```

1.9.14 Image Gaussian Fitting

Fitting of Gaussians to an image over a large area can be performed by task FndSou and over more limited areas using the ImageFit class function Fit. This function takes an image and a FitRegion which defines the fitting area of the image and the initial set of values defining the Gaussians to be fit. Image class functions TVFit and GaussFit provide a simplified interface to the fitting routines.

The following is an example of an interactive model fitting session, a screen shot of the ObitView window after the fitting region and model are specified is shown in figure 1.3

```
>>> # Define image
>>> x=Image.newPAImage("image","3C84","PennAr",1,1,True,err)
>>> # Interactively set fitting region followed by fitting
>>> fr = x.TVFit(x,disp,err)
```



```
Brightness
128
Contrast
128
( 133.75, 113.75, 1)
value=0.003109
Equinox 2000.0
RA  03 19 47.3220
DEC  41 30 30.694
FREQ        9e+10
```

Figure 1.3: Screenshot of ObitView window specifying fitting region with model.

The image will be loaded to the display, hit the "edit" button on the RequestBox, then specify the region to fit on the display with a rectangular box, followed by circular boxes to mark Gaussian components initial locations and initial sizes; instructions are given in the ObitView Message Box. When done, hit "d" and then "OK" on the bottom of the RequestBox. Example results:

```
Model fit for 3C84
RA     3 19 47.73316 (   0.518 asec),  pixel  131.441 (   0.259)
Dec   41 30 36.7370  (   0.594 asec),  pixel  116.772 (   0.297)
Peak Flux density   0.0109 (0.000725) JY/BEAM
Integrated Flux density   0.0164 ( 0.00109) Jy
Fitted Major axis   15.148 (    1.13) asec,    7.574 (    0.33) pixels
Fitted Minor axis   11.228 (   0.661) asec,    5.614 (    0.33) pixels
Fitted Position angle  -36.995 (    7.84) deg

Deconvolved model
Deconvolved Major axis     10.8 (    1.12) asec,    5.385 (   0.814) pixels
Deconvolved Minor axis     3.55 (    1.63) asec,    1.776 (   0.814) pixels
Deconvolved Position angle   143.01 (    5.49) deg
```

Image class function GaussFit can be used for noninteractive fitting. The defaults are generally adequate for a single source near the reference pixel. Both TVFit and GaussFit return a FitRegion object.

Additional functionality can be obtained by using ImageFit functions directly, first

```
>>> import ImageFit, FitRegion, FitModel
```

The ImageFit.Fit function is described in the following:

```
Fit(self, err, input={'FluxLow': 0.0, 'GMajLow': 0.0, 'GMajUp': 1e+20,
     'GMinLow': 0.0, 'GMinUp': 1e+20, 'MaxIter': 0, 'PosGuard': 0.0,
     'fitImage': None, 'fitRegion': None, 'prtLv': 0, ...})
  Fit a model to an image
  Resultant model left in FitRegion reg
  inImageFit = Python ImageFit object
  image      = ObitImage to be fitted
  reg        = Fit region defining what is to be fitted and initial guess
  err        = Python Obit Error/message stack
  input      = input parameter dictionary

  Input dictionary entries:
  fitImage Image to be fitted
  fitRegion FitRegion to be fitted
  MaxIter  int Maximum number of iterations [def. 10 per fitted parameter]
  prtLv    int Message level, 0=>none [def 0]
  PosGuard float Distance (cells) from edge to allow center  [def no bound]
  FluxLow  float Lower bounds on Flux density [def no bound]
  GMajUp   float Major axis upper bound (cells) [def no bound]
  GMajLow  float Major axis lower bound (cells) [def no bound]
  GMinUp   float Minor axis upper bound (cells) [def no bound]
  GMinLow  float Minor axis lower bound (cells) [def no bound]
```

A FitRegion can be created interactively using the image viewer and FitRegion.PSetup():

```
PSetup(inImage, disp, err)
   Interactive initial definition of fitting region

  Interactively allows the user to set the region of the image
  to be fitted and the initial model.
  The fitting region is first specified with a rectangular window
  and then the initial models to be fitted with circular windows.
  Returns FitRegion, leaves image pixel array on inImage
    image  = image to be fitted
    disp   = image display to use
    err    = Obit Error/message stack
```

Fitted models can then be viewed on the screen or written to a file by FitRegion.Print()

```
  Print(self, ImDesc, file=None)
      Display human readable contents

      self     = object with Model to display
      ImDesc   = Image Descriptor with Beam, etc.
      file     = if present, the name of a file into which to write
                 the information rather than displaying it on the screen
```

or, can be accessed in python using the array of FitModel objects in the FitRegion.

1.10 Radio Interferometry Applications

There are a number of applications of particular interest to interferometric imaging. Detailed discussions of a number of related topics are given in papers and memos referenced in https://www.cv.nrao.edu/∼bcotton/Obit.html.

1.10.1 Calibration and Imaging Pipelines

There are several calibration and imaging pipeline for specific instruments available.

EVLA

A scripted calibration and imaging package for EVLA continuum observations is described in https://www.cv.nrao.edu/∼bcotton/ObitDoc/EVLAObitScripts.pdf. The top level of this set of python scripts is $OBIT/python/EVLAContPipe.py. This processes continuum observations, including polarization and starts from data in ALMA SDM format. This can also be used for the continuum portion of spectral line datasets.

ALMA

A scripted calibration and imaging package for ALMA continuum observations is described in https://www.cv.nrao.edu/∼bcotton/ObitDoc/ALMAScripts.pdf. The top level of this package is in $OBIT/python/ALMAPipe.py.

VLBA

A dated processing pipeline for VLBA continuum observations is implemented in
$OBIT/python/VLBAContPipeWrap.py. Documentation is available in the (pretty old) files
https://www.cv.nrao.edu/∼bcotton/ObitDoc/VLBAPipeMan.pdf and
https://www.cv.nrao.edu/∼bcotton/ObitDoc/VLBAPipelineHeuristics.pdf. There is also the source code for user documentation in a now defunct language in
https://www.cv.nrao.edu/∼bcotton/ObitDoc/VLBAPipelineUserManual.rst.

MeerKAT

A scripted calibration and imaging package for MeerKAT data is described in https://www.cv.nrao.edu/∼bcotto
The top level of this package is $OBIT/python/$OBIT/python/. The details of obtaining the appropriate data from the SARAO archive are being worked out (May 2025).

1.10.2 Importing Data into AIPS Format

There are several programs for converting external uv data formats into AIPS format.

- **ASDMList:** Lists the contents of an ALMA SDM format data set.
- **BDFIn:** This task reads EVLA or ALMA data in ALMA SDM format and writes AIPS or AIPS task FITAB format. The latter is generally a bad idea as it can be VERY sloy.
- **IDIIn:** IDI format was intended to be a generic data interchange format for visibility data but only the VLBA and VLITE has adopted it. IDIIn converts to AIPS format.; IDIOut writes IDI format.

Task Lister with optype='SCAN' will give a listing of the contents of a uv data set with an index (AIPS NX) table.

Note: UVFITS format must be converted by AIPS task UVLOD or FITLD.

1.10.3 Data Editing

There are a number of utilities for flagging data - marking them as bad. Help documentation is available for the tasks or functions. These function by adding entries in the AIPS FG flagging table which can be applied when accessing the associated data through the flagVer parameter.

- **AutoFlag:** This utility has a number of facilities for flagging data on criteria such as excessive amplitudes in Stokes I and/or polarized intensities or by excessive RMSes over a given time interval. It also includes several means of flagging data based on frequency domain characteristics such as deviations from a running median in frequency.
- **MednFlag:** Flags data based on deviations from running medians in time.
- **UVFlag:** Flags selected data including those shadowed by another antenna.
- **SrvrEdt:** Flags remaining data for records in which the bulk of the data has been flagged and it is assumed all are bad.
- **UV.PFlag:** Function PFlag in python class UV allows flagging selected data directly from python.

```
PFlag(inUV, err, flagVer=1, timeRange=[0.0, 1e+20], Ants=[0, 0],
    Source='Any', Chans=[1, 0], IFs=[1, 0], freqID=0, subA=0,
    Stokes='1111', Reason=' ')

    Adds flagging table entry.
    inUV      = Python Obit UV on which to write flags
    err       = Python Obit Error/message stack
    flagVer   = flagging table version number
    timeRange = pair of floats giving the beginning and end time in days,
                inclusive, of the data to be flagged
    Source    = Source name, "Any" => all sources.
    Chans     = pair of ints giving first and last spectral channel numbers
                (1-rel) to be flagged; 0s => all
    IFs       = pair of ints giving first and last IF numbers
                (1-rel) to be flagged; 0s => all
    Ants      = first and second antenna  numbers for a baseline, 0=>all
    Stokes    = String giving Stokes to be flagged,
                "FFFF"  where F is '1' to flag corresponding Stokes, '0' not.
                Stokes order 'R', 'L', 'RL' 'LR' or 'X', 'Y', 'XY', 'YX'
    subA      = Subarray
    freqID    = Frequency ID
    Reason    = reason string for flagging (max 24 char)
```

1.10.4 Calibration

Data calibration is a complex subject covering a number of instrumental and atmospheric effects and numerous tasks deal with different parts. Calibrating and editing steps are often interleaved. The are two, similar types of gain calibration tables, total “AIPS CL” and differential “AIPS SN”. Gain, delay and fringe rate calibration consists of a sequence of tasks that each generate an AIPS SN table which is then applied to the previous total calibration table using task CLCal. Gain tables

(AIPS CL, AIPS SN) have a set of values per spectral window (AKA IF). Bandpass (AIPS BP) tables have a complex gain per spectral channel. Instrumental polarization (AIPS PD) tables have values per channel/IF. Calibration is generally applied on the fly in applications accessing the data using parameters doCalib, gainUse, doBand, BPVer, doPol and PDVer.

- **Calib:** The basic gain calibration routine is task Calib which, given a model for each source, can determine phase, complex gain or gain and group delay.
- **CLCal:** This task applies a differential gain (AIPS SN) table to a previous total gain table (AIPS CL) and writes a new one.
- **SetJy:** This task sets standard or specified flux densities into the source table (AIPS SU) for sources to be used in calibration.
- **GetJy:** Derives flux densities for secondary gain calibrators from primary ones. This uses solutions in an AIPS SN table.
- **CLCor:** Applies corrections to AIPS CL Tables.
- **SNCor:** Applies corrections to AIPS SN Tables.
- **SYGain:** Determines gain corrections for EVLA data based on the switched power table (AIPS SW) and writes an incremental gain table (AIPS SN).
- **BPass:** Given a source model calculates a bandpass (AIPS BP table).
- **PCal:** Determines instrumental polarization parameters (elipticity and orientation in AIPS PD table) and optionally the cross–hand phase difference function (AIPS BP table). Can use up to 10 calibrators with, or without, known polarization.
- **MazrCal:** Calculates complex gains for VLBI maser observations given a spectral cube. A variant of self calibration.
- **RLDly:** Determine the R-L (RCP-LCP) phase and delay function for data with circular feeds based on observations of a known polarized calibrator. Generates an AIPS SN table which **MUST** be applied in CLCal with refAnt=-1 (or its effects will be lost.)
- **RLPass:** Generate a bandpass table (AIPS BP) giving the R-L phase difference function.
- **XYDly:** Determine the X-Y phase and delay function for data with linear feeds based on observations with a known polarized calibrator(s). Generates an AIPS SN table which **MUST** be applied in CLCal with refAnt=-1 (or its effects will be lost.)

1.10.5 Imaging

Several tasks can image one or more target fields applying external calibration and editing on the fly. Self calibration is supported as part of the process.

- **MFImage:** Wideband continuum imaging. Uses multiple constant fractional bandwidth subbands to deal with the varying antenna gain and sky brightness with frequency and tiling to deal with the noncoplanarity of the observations.
- **Imager:** Spectral line imager using tiling for curvature effects.
- **SCMap:** Narrowband VLBI self calibration images.

1.10.6 Image Manipulation

Pixel data in images can be manipulated in a number of ways.

- **SubImage:** Select a subset (including all) of an image and write a new image.
- **Convol:** Convolve an image with a Gaussian beam (or image) to obtain an image at a coarser resolution.
- **HGeom:** Regrid an image on the grid defined by a second image.
- **RMSyn:** Rotation measure synthesis of spectral Q and U cubes including those generated by MFImage or Imager.
- **F/CArray Utilities:** Image planes can be read and written into/from ObitFArray (float) pixel arrays and converted to/from complex (ObitCarray) arrays (see GetPlane and PutPlane in the Image class). The FInterpolate class enables interpolation between pixels in an FArray.

  ```
  Import FArray, CArray and FArrayUtil # to use in python.
  ```

  There are numerous functions in the python FArray and CArray classes and FArrayUtil utility module . These functions are efficiently implemented in c using multithreading and vectorization. See help(FArray), help(CArray) and help(FArrayUtil). Magic value blanking is supported in most cases except for FFTs. Blanked pixel are those without a valid value.
- **FFT:** The Obit python FFT class can be used to Fast Fourier Transform Obit FArrays and CArrays.

1.11 Obit classes and utility packages with python interfaces

There are a number of Obit functions with high level python interfaces. To see more details import and view the help for each:

```
>>> import History
>>> help(History)
```

Obit/AIPS/Radio Interferometry/Image classes and utilities

- **AIPSDir** AIPS directory class
- **CArray** Complex array class
- **Catalog** Source catalog class
- **CleanImage** Image CLEAN
- **CleanVis** Visibility based CLEAN
- **ConvUtil** Image convolution utilities
- **FArray** float array class
- **FArrayUtil** FArray utilities
- **FeatherUtil** Image feathering utilities

- **FFT** Fast Fourier Transform class
- **FInterpolate** Float array interpolator
- **FITSDir** FITS directory routines
- **FitModel** Source fitting model
- **FitRegion** Source fitting region
- **History** History class
- **ImageDesc** Image Descriptor (header)
- **ImageMosaic** Image Mosaic class
- **Image** Image class
- **ImageFit** Image fitting class
- **ImageUtil** Image utilities
- **InfoList** Obit associative array for control info
- **IonCal** Ionospheric calibration
- **MergeCal** Partial fix for screwed up VLBA cal. data
- **MosaicUtil** Image mosaicing utilities
- **OData** Base Data (image, UV, OTF) class
- **ODisplay** Interface to ObitView display
- **OErr** Obit message/error class
- **OPlot** Ploting interface
- **OSystem** Obit System class
- **OWindow** (CLEAN) image window class
- **ParserUtil** Obit task input/output file parser
- **SkyGeom** Celestial geometry
- **SkyModel** Sky model class
- **SkyModelVMBeam** Tabulated beam Sky model class
- **SkyModelVMIon** Ionospheric Sky Model class
- **SpectrumFit** Spectrum fitting class
- **TableDesc** Table descriptor (header) class
- **TableList** Table list for data object (Image, UVData, OTF)

- **Table** Table class
- **TableUtil** Table utilities
- **TableSTar** manipulate AIPS STar tables
- **TaskWindow** Task message window class
- **TimeFilter** Time filtering class
- **UVDesc** UV data descriptor (header)
- **UVGSolve** UV gain solutions
- **UVImager** UV data imager class
- **UV** UV data class
- **UVRFIXize** RFI Excision class
- **UVSelfCal** UV Self calibration class
- **UVSoln2Cal** UV SN to CL table routines.
- **UVVis** UV visibility access class
- **VLACal** VLA calibration/pipeline utilities
- **ZernikeUtil** Zernike polynomial utilities

1.12 OTObit Functions

The following are functions available from OTObit which are all automatically imported when ObitTalk in started.

1.12.1 AIPSHelp

```
AIPSHelp(Task)
    Give Help for AIPS task Task

    Task    = AIPSTask name to give (e.g. "IMEAN")
```

1.12.2 AllDest

```
AllDest(disk=None, Atype='  ', Aname='            ', Aclass='      ', Aseq=0)
    Delete AIPS files matching a pattern

    Strings use AIPS wild cards:
        blank => any
        '?'   => one of any character
        "*"   => arbitrary string
    disk      = AIPS disk number, 0=>all
    Atype     = AIPS entry type, 'MA' or 'UV'; '  => all
    Aname     = desired AIPS name, using AIPS wildcards, None -> don't check
    Aclass    = desired AIPS class, using AIPS wildcards, None -> don't check
    Aseq      = desired AIPS sequence, 0=> any
```

1.12.3 AMcat

```
AMcat(disk=1, first=1, last=1000)
    Catalog listing of AIPS Image files on disk disk

    Strings use AIPS wild cards:
        blank => any
        '?'   => one of any character
        "*"   => arbitrary string
    If giveList then return list of CNOs
    disk      = AIPS disk number to list
    first     = lowest slot number to list
    last      = highest slot number to list
    Aname     = desired name, using AIPS wildcards, None -> don't check
    Aclass    = desired class, using AIPS wildcards, None -> don't check
    Aseq      = desired sequence, 0=> any
    giveList  = If true, return list of CNOs matching
```

1.12.4 AUcat

```
AUcat(disk=1, first=1, last=1000)
    Catalog listing of AIPS UV data files on disk disk

    Strings use AIPS wild cards:
        blank => any
        '?'   => one of any character
        "*"   => arbitrary string
    If giveList then return list of CNOs
    disk      = AIPS disk number to list
    first     = lowest slot number to list
    last      = highest slot number to list
    Aname     = AIPS desired name, using AIPS wildcards, None -> don't check
    Aclass    = AIPS desired class, using AIPS wildcards, None -> don't check
    Aseq      = AIPS desired sequence, 0=> any
    giveList  = If true, return list of CNOs matching
```

1.12.5 Acat

```
Acat(disk=1, first=1, last=1000)
    Catalog listing of AIPS files on disk disk

    The class remembers the last disk accessed
    Strings use AIPS wild cards:
        blank => any
        '?'   => one of any character
        "*"   => arbitrary string
    If giveList then return list of CNOs
    disk      = AIPS disk number to list
    first     = lowest slot number to list
    last      = highest slot number to list
    Aname     = desired AIPS name, using AIPS wildcards, None -> don't check
    Aclass    = desired AIPS class, using AIPS wildcards, None -> don't check
    Aseq      = desired AIPS sequence, 0=> any
    giveList  = If true, return list of CNOs matching
```

1.12.6 ClearErr

```
ClearErr(err=<C OErr instance>)
    Print any errors and clear stack

    err  = Python Obit Error/message stack, default is OTObit version
```

1.12.7 Fdir

```
Fdir(disk=None, dir=None)
    Catalog listing of FITS files on disk disk

    The class remembers the last disk accessed
    disk      = AIPS disk number to list
    dir       = relative or abs. path of directory, def. = cwd
                Only used if disk == 0
```

1.12.8 ObitHelp

```
ObitHelp(Task)
    Give Help for OBIT task Task

    Task    = ObitTask name to give (e.g. "Feather")
```

1.12.9 PrintHistory

```
PrintHistory(ObitObj, hiStart=1, hiEnd=1000000, task=None, file=None)
    Display history log or write to file

    Reads selected history records and displays with "more"
    ObitObj   = Python Obit object with history
    err       = Python Obit Error/message stack
    hiStart   = if given the first (1-rel) history record
    hiEnd     = if given the highest (1-rel) history record
    task      = If given, only list entries beginning with the string
                given in task
    file      = if present, the name of a file into which to write
                the history rather than displaying it on the screen
```

1.12.10 ShowErr

```
ShowErr(err=<C OErr instance>)
    Print any errors and clear stack

    err  = Python Obit Error/message stack, default of OTObit version
```

1.12.11 alldest

```
alldest(Aname='.*', Aclass='.*', Atype='.?', Adisk=0, Aseq=0, test=False)
    Delete AIPS files matching a pattern

    Uses regular expression matching for strings
    Note: "+" values are escaped
    Clears any status before deleting
    Aname    = AIPS file name , " " => any
    Aclass   = AIPS class name,  " " => any
    Atype    = 'MA', 'UV' or any
    Adisk    = AIPS disk number, 0=> any
    Aseq     = AIPS sequence number; 0=> any
    test    = if true only list and not delete
```

1.12.12 altswitch

```
altswitch(inImage)
    Switch frequency and velocity

    Algorithm lifted from AIPS AU7.FOR
    inImage   = Python Image object, created with getname, getFITS
```

1.12.13 clearstat

```
clearstat(o, code=4)
    Clear status of AIPS catalog entry

    Clears AIPS status of object o,
    Optionally sets status using code parameter
    o    = Obit AIPS Data object
    code = status code:
        0 = Add write status
        1 = Clear write status
        2 = Increment Read Status
        3 = Decrement Read Status
        4 = Clear All Status
```

1.12.14 copyInputs

```
copyInputs(inTask, outTask)
        Copy values from one task object to another
        Copies parameter values from inTask to outTask which are in both the
        inTask and outTask _input_list.
        Need not be the same task.
        inTask    = Task object to copy from
        outTask   = Task object to copy to
```

1.12.15 day2dhms

```
day2dhms(tim)
        convert a time in days to a string as d/hh:mm:ss.s

        Returns time as string:  "d/hh:mm:ss.s"
        tim       time in days
```

1.12.16 dhms2day

```
dhms2day(st)
        convert a time string in d/hh:mm:ss.s to days

        Returns time in days
        st        time string as "d/hh:mm:ss.s"
```

1.12.17 explain

```
explain(TaskObj)
    Give explanation for a task if available

    TaskObj    = Task object whose inputs to list
```

1.12.18 getFITS

```
getFITS(file, disk=1, Ftype='Image')
    Return Obit object for FITS file in file on disk

    file      = FITS file name
    disk      = FITS disk number
    Ftype     = FITS data type: 'Image', 'UV'
```

1.12.19 getname

```
getname(cno, disk=1)
    Return Obit object for AIPS file in cno on disk

    cno       = AIPS catalog slot number
    disk      = AIPS disk number
```

1.12.20 go

```
go(TaskObj, MsgBuf=False, URL="http://localhost:8777/RPC2")
    Execute task
    Returns TaskWindow object if run asynchronously (doWait=True)
    or the task message log if run synchronously (doWait=False)
    The wait() function on the TaskWindow will hang until the task finishes
    TaskObj    = Task object to execute
                 If doWait member is true run synchronously,
                 else run with messages in a separate Message window
    MsgBuf     = if true and  TaskObj.doWait=False run asynchronously
                 using a TaskMsgBuffer
    URL        = URL of ObitMess message server if MsgBuf=False
```

1.12.21 imhead

```
imhead(ObitObj)
    List header

    ObitObj    = Obit or ObitTalk data object
```

1.12.22 imlod

```
imlod(filename, inDisk, Aname, Aclass, Adisk, Aseq, err)
    Load FITS Image data to AIPS

    Read a ImageTAB FITS Image data file and write an AIPS data set
    filename   = name of FITS file
    inDisk     = FITS directory number
    Aname      = AIPS name of file
    Aclass     = AIPS class of file
    Aseq       = AIPS sequence number of file
    Adisk      = FITS directory number
    err        = Python Obit Error/message stack
    returns AIPS Image data object
```

1.12.23 imstat

```
imstat(inImage, blc=[1, 1, 1, 1, 1], trc=[0, 0, 0, 0, 0])
    Get statistics in a specified region of an image plane

    Returns dictionary with statistics of selected region with entries:
        Mean    = Mean value
        RMSHist = RMS value from a histogram analysis
        RMS     = Simple RMS value
        Max     = maximum value
        MaxPos  = pixel of maximum value
        Min     = minimum value
        MinPos  = pixel of minimum value
    inImage   = Python Image object, created with getname, getFITS
```

1.12.24 imtab

```
imtab(inImage, filename, outDisk, err, fract=None, quant=None,
        exclude=['AIPS HI', 'AIPS PL', 'AIPS SL'], include=['AIPS CC'],
        headHi=False))
    Write Image data as FITS file

    Write a Image data set as a integer FITAB format file
    History written to header
    inImage    = Image data to copy
    filename   = name of FITS file
    inDisk     = FITS directory number
    err        = Python Obit Error/message stack
    fract      = Fraction of RMS to quantize
    quant      = quantization level in image units, has precedence over fract
                 None or <= 0 => use fract.
    exclude    = List of table types NOT to copy
                 NB: "AIPS HI" isn't really a table and gets copied anyway
    include    = List of table types to copy
    headHi     = if True move history to header, else leave in History table
    returns FITS Image data object
```

1.12.25 inputs

```
inputs(TaskObj)
    List task inputs

    TaskObj    = Task object whose inputs to list
```

1.12.26 newDisplay

```
newDisplay(port=8765, URL=None)
    Recreate display to another display server

    port   = port number on local machine
    URL    = Full URL (e.g. http://localhost:8765/RPC2)
```

1.12.27 setname

```
setname(inn, out)
    Copy file definition from inn to out as in...

    Supports both FITS and AIPS
    Copies Data type and file name, disk, class etc
    inn  = Obit data object, created with getname, getFITS
    out  = ObitTask object,
```

1.12.28 set2name

```
set2name(in2, out)
```

```
    Copy file definition from in2 to out as in2...

    Supports both FITS and AIPS
    Copies Data type and file name, disk, class etc
    in2  = Obit data object, created with getname, getFITS
    out  = ObitTask object,
```

1.12.29 set3name

```
set3name(in3, out)
    Copy file definition from in3 to out as in3...

    Supports both FITS and AIPS
    Copies Data type and file name, disk, class etc
    in3  = Obit data object, created with getname, getFITS
    out  = ObitTask object,
```

1.12.30 set4name

```
set4name(in4, out)
    Copy file definition from in4 to out as in4...

    Supports both FITS and AIPS
    Copies Data type and file name, disk, class etc
    in4  = Obit data object, created with getname, getFITS
    out  = ObitTask object,
```

1.12.31 setoname

```
setoname(inn, out)
    Copy file definition from inn to out as outdisk...

    Supports both FITS and AIPS
    Copies Data type and file name, disk, class etc
    inn  = Obit data object, created with getname, getFITS
    out  = ObitTask object,
```

1.12.32 setwindow

```
setwindow(w, out)
    Set BLC and TRC members on out from OWindow w

    Uses first window in first field on w which must be a rectangle
    This may be set interactively using tvlod
    w    = OWindow object
    out  = ObitTask object, BLC and TRC members [0] and [1] are modified
```

1.12.33 tabdest

```
tabdest(ObitObj, tabType, tabVer)
```

```
        Delete a table

        Deletes associated tables
        ObitObj   = Python Obit object with tables
        tabType   = Table type,  NB AIPS tables names start with "AIPS "
                    e.g. "AIPS CC"
        tabVer    = table version, 0=> highest, <0 => all
```

1.12.34 tget

```
tget(inn, file=None)
    Restore task object from disk

    Restore values in task object
    inn   = task name, or a task object of the desired type
            in the latter case, the input object will NOT be modified
    file  = optional file name, the default is <task_name>.pickle
            in the current working directory
```

1.12.35 tput

```
tput(to, file=None)
    save task object

    save values in task object
    to    = task object to save
    file  = optional file name, the default is <task_name>.pickle
            in the current working directory
```

1.12.36 tvlod

```
tvlod(image, window=None)
    display image

    image  = Obit Image, created with getname, getFITS
    window = Optional window for image to edit
```

1.12.37 tvstat

```
tvstat(inImage)
    Set region in an image using the display and tell mean, rms

    Returns dictionary with statistics of selected region with entries:
        Mean    = Mean value
        RMSHist = RMS value from a histogram analysis
        RMS     = Simple RMS value
        Max     = maximum value
        MaxPos  = pixel of maximum value
        Min     = minimum value
        MinPos  = pixel of minimum value
    inImage   = Python Image object, created with getname, getFITS
```

1.12.38 uvTabSave

```
   uvTabSave(inUV, filename, outDisk, err, \
       exclude=['AIPS HI', 'AIPS_AN', 'AIPS FQ', 'AIPS PL', 'AIPS SL'],\
       include=[])
        Write UV data tables (but not data) to a FITS file

        Write tables associated with UV data set as a FITAB format file
        History written to header
        inUV       = UV data to copy
        filename   = name of FITS file
        inDisk     = FITS directory number
        err        = Python Obit Error/message stack
        exclude    = List of table types NOT to copy
                     NB: "AIPS HI" isn't really a table and gets copied anyway
        include    = List of table types to copy (FQ, AN always done )
        returns FITS UV data object
```

1.12.39 uvlod

```
uvlod(filename, inDisk, Aname, Aclass, Adisk, Aseq, err)
    Load FITS UV data to AIPS

    Read a UVTAB FITS UV data file and write an AIPS data set
    filename   = name of FITS file
    inDisk     = FITS directory number
    Aname      = AIPS name of file
    Aclass     = AIPS class of file
    Aseq       = AIPS sequence number of file
    Adisk      = FITS directory number
    err        = Python Obit Error/message stack
    returns AIPS UV data object
```

1.12.40 uvtab

```
uvtab(inUV, filename, outDisk, err, compress=False,
       exclude=['AIPS HI', 'AIPS AN', 'AIPS FQ', 'AIPS SL', 'AIPS PL'],
       include=[], headHi=False)
    Write UV data as FITS file

    Write a UV data set as a FITAB format file
    History written to header
    inUV       = UV data to copy
    filename   = name of FITS file
    inDisk     = FITS directory number
    err        = Python Obit Error/message stack
    exclude    = List of table types NOT to copy
                 NB: "AIPS HI" isn't really a table and gets copied anyway
    include    = List of table types to copy (FQ, AN always done )
                 Exclude has presidence over include
    headHi     = if True move history to header, else leave in History table
    returns FITS UV data object
```

1.12.41 window

```
window(image)
    Make a window object for an image

    Returns OWindow object
    image  = Obit image object
```

1.12.42 zap

```
zap(o)
    Zap object o

    Delete Image, UV or OTF data files
    Removes all external components (files)
    o    = Obit Data object to delete
```

1.13 OTObit Data

The OTObit environment contains a number of useful pieces of information concerning your current session. These should all be imported into the scripting or interactive environment at startup.

```
    AIPSdisks = ['/usr/AIPS/DATA/GOLLUM_1', '/usr/AIPS/DATA/GOLLUM_2', '/u...
    Adisk = 1
    FITSdisks = ['/usr/AIPS/FITS']
    Fdisk = 1
    ObitSys = <C OSystem instance>
    dir = None
    disp = <C ODisplay instance> ObitView
    dsk = 'DA10'
    err = <C OErr instance>
    nAIPS = 8
    nFITS = 1
    popsno = 1
    userno = 103
```

1.14 Remote Usage

In order to run tasks or scripts or access data on a remote machine, an ObitTalkServer must be running on the remote host and the client ObitTalk must be told the URL of the remote server and the list of directory names on the remote host.

1.14.1 ObitTalkServer

The target host machine must have installed AIPS and Obit systems. Remote access is provided through a ObitTalkServer process which can be started once the initial AIPS processes are run to define the standard AIPS directories. Note: this does NOT include the AIPS data directories $DA01 .... The default is for ObitTalkServer to watch port 8000 although this can be modified in the ObitTalkServer script. The xmlrpc URL of this server process is then 'http://mymachine.org:8000/RPC2' where mymachine.org is a suitable network name for the host. The host must allow client access to port 8000.

An example of creating a remote AIPSImage is:

```
>>> ai=AIPSImage("3C43","PCube",disk,1)
```

This can then be displayed on a running ObitView by either:

```
>>> tvlod(ai)
```

to display of the current ObitView display, or

```
>>> ai.display(url)
```

where url is the optional url of an ObitView server. Note: if url is not specified and the local ObitView server is the default, the default server display will be used; this is likely to seldom be the desired effect so you should use the second form and give the url of your ObitView as seen by the remote server.

1.14.2 Remote data directories

The set of AIPS data directories on a machine depends on a number of factors, login name, user number, system configuration files as well as command line arguments. Due to this complexity, the current configuration of ObitTalk does not allow an automated discovery of these directories and they must be explicitly supplied. After the ObitTalk startup has initialized the local data directories, remote AIPS directories can be defined:

```
>>> url = 'http://mymachine.org:8000/RPC2'
>>> dirname = '/export/data_1/aips/DATA/MINE_1'
>>> disk = len(AIPS.AIPS.disks)
>>> AIPS.AIPS.disks.append(AIPS.AIPSDisk(url, disk, dirname))
```

This directory will then be accessable as disk disk. Note: to define an additional local AIPS disk, set url to None. The function AIPSCat(disk) will give a directory listing of this directory, tasks and the AIPSUVData and AIPSImage classes can access data in these directories. For a task to use remote data, all "disks" specified must be on the same host. Disk numbers on the task object will automatically be translated to the local numbers on the remote host. Note: ObitTalk uses disks to determine where a task is to be run so NO disk numbers may be defaulted. Example usage follows:

```
>>> url='http://192.168.1.140:8000/RPC2'
>>> dirname='/export/data_1/aips/DATA/VINO_1'
>>> disk = len(AIPS.AIPS.disks)
>>> AIPS.AIPS.disks.append(AIPS.AIPSDisk(url, disk, dirname))
>>> t=ObitTask("Template")
>>> t.DataType='AIPS'
>>> t.inDisk=disk
>>> t.inName='0319+415'
>>> t.inClass='IClean'
>>> t.inSeq=1
>>> t.g
[1, '** Message: info      : TEMPLATE Begins']
[1, '** Message: info      : TEMPLATE: mean -0.000005 RMS 0.000736']
[1, '** Message: info      : TEMPLATE Ends']
```

or an AIPS task:

```
>>> AIPS.AIPS.disks.append(AIPS.AIPSDisk(url, disk, dirname))
>>> im=AIPSTask("imean")
>>> im.indisk=disk
>>> im.inname='0319+415'
>>> im.inclass='IClean'
>>> im.inseq=1
>>> im.g
IMEAN1: Task IMEAN  (release of 31DEC05) begins
IMEAN1: Initial guess for PIXSTD taken from ACTNOISE inheader
IMEAN1: Image= 0319+415    .IClean.   1 1   xywind=    1    1  397  397
IMEAN1: Mean and rms found by fitting peak in histogram:
IMEAN1: Mean=-1.7323E-05 Rms= 7.2413E-04  **** from histogram
IMEAN1: Mean and rms found by including all data:
IMEAN1: Mean=-4.8774E-06 Rms= 7.3894E-04 JY/BEAM  over     20441 pixels
IMEAN1: Flux density = -5.3379E-03 Jy.   beam area =  18.68 pixels
IMEAN1: Minimum=-2.4419E-03 at  397  350    1    1
IMEAN1: Skypos: RA 03 20 09.53788  DEC 41 26 27.4046
IMEAN1: Maximum= 2.8951E-03 at  300  378    1    1
IMEAN1: Skypos: RA 03 20 12.14383  DEC 41 26 35.8283
IMEAN1: Skypos: IPOL  4860.100 MHZ
IMEAN1: returns adverbs to AIPS
IMEAN1: Appears to have ended successfully
IMEAN1: vino         31DEC05 TST: Cpu=       0.0  Real=       0
```

Note: since the task definition is likely obtained from the client host, be sure the versions of Obit and AIPS are compatable.

1.14.3 ObitScript class

Any file containing python instructions can be fed to ObitTalk as a command line argument in a non interactive session. Scripts can also be use in interactive sessions using the ObitScript class. The ObitScript class allows defining scripts that can be executed either locally or remotely on a host with a running ObitTalkServer. Scripts are similar to tasks and share many properties like synchronous or asynchronous operation. Scripts may use all Obit classes with python bindings for data local to the host on which it is executing and has all the task and remote data access available interactively. Note: before a script can be run on a remote machine, the AIPS data directories on the remote host must be entered into list of disks as described above.

Scripts are text strings containing valid commands. Note: the script must follow python indententation rules, a backslash n (cannot be said in latex) indicates a line break. Scripts can be supplied as simple strings, a list of strings or the name of a file containing the text of the script. An example usage follows

```
>>> import ObitScript
>>> script = \
>>>     'im=Image.newPAImage("image","0900+398III","IClean",1,23,True,err)\n'+ \
>>>     'im.Header(err)\n'
>>> s=ObitScript.ObitScript("myScript", script=script)
>>> s.i  # Show script text
Listing of script myScript
im=Image.newPAImage("image","0900+398III","IClean",1,23,True,err)
im.Header(err)

>>> s.g
** Message: info      : myScript Begins
User 100
AIPS Image Name:  0900+398III Class: IClean seq:       23 disk:    1
Object: 0900+398
Observed: 2005-04-04 Telescope:  VLA      Created: 2007-02-09
Observer: AP452      Instrument: VLA
Minimum =     -0.74624  Maximum =       33.584 JY/BEAM
--------------------------------------------------------------
Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
RA---SIN   256   9  9 33.38948     129.00            -20    0.00
DEC--SIN   256  42 53 47.3748      129.00             20    0.00
FREQ         1      7.3794e+07       1.00    1.46484e+06    0.00
STOKES       1      IPol             1.00              1    0.00
--------------------------------------------------------------
Coordinate equinox 2000.0  Coordinate epoch 2000.00
Observed RA    9  0  0.00000 Observed Dec  39 47 60.0000
Phase shifted in X      1.836 in Y      3.096
no. Comp        1
Clean Beam    76.3171 x    71.8424 asec, PA   -68.5 deg.
Rest freq            0 Vel type: Observer,  wrt  Optical
Alt ref value            0  wrt pixel     0.00
Maximum version number of AIPS CC tables is 1
Maximum version number of AIPS HI tables is 1
** Message: info      : myScript Ends
```

The execution of a script is done by wrapping the script in Obit initialization and shutdown code and writing it to a disk file in /tmp where it is fed as the command line input to ObitTalk. If the ObitScript object member debug is set to True then a copy of the script file will be saved.

The following describes the ObitScript class and can be obtained online by:

```
>>> help(ObitScript)
```

```
DESCRIPTION
    This module provides the ObitScript class.
    This class allows running Obit/python scripts either
    locally or remotely

    ObitScripts are derived from Task and share most of execution properties.
    In particular, ObitScripts can be executed either locally or remotely.
    In this context a script is a character string containing a sequence of
    ObitTalk or other python commands and may be included when the script
    object is created or attached later.
    An example:
    script="import OSystem
    print 'Welcome user',OSystem.PGetAIPSuser()
    "

CLASSES
    ObitScriptMessageLog
    Task.Task(MinimalMatch.MinimalMatch)
        ObitScript

  class ObitScript(Task.Task)
     This class implements running Obit/python Scripts

     The ObitScript class, handles client-side script related operations.
     Actual script operations are handled by server-side proxies.
     For local operations, the server-side functionality is
     implemented in the same address space but remote operation is
     through an xmlrpc interface.

     An ObitScript has an associated proxy, either local or remote.
     A proxy is a module with interface functions,
     local proxies are class modules from subdirectory Proxy with the
     same name (i.e. ObitScript) and the server functions are implemented
     there.  Remote proxies are specified by a URL and a proxy from the
     xmlrpclib module is used.

     Method resolution order:
         ObitScript
         Task.Task
         MinimalMatch.MinimalMatch

     Methods defined here:

     __call__(self)

     __getattr__(self, name)

     __init__(self, name, **kwds)
         Create ObitScript task object

         Creates Script Object.
         name  = name of script object
         Optional Keywords:
             script   = Script to execute as string or list of strings
             file     = Name of text file containing script
             URL      = URL on which the script is to be executed
```

```
                   Default = None = local execution
        AIPSDirs = List of AIPS directories on URL
                   Default = current AIPS directories on url
        FITSDirs = List of FITS directories on URL
                   Default = current FITS directories on url
        AIPSUser = AIPS user number for AIPS data files
                   Default is current
        version  = AIPS version string, Default = current
    Following is a list of class members:
        url      = URL of execution server, None=Local
        proxy    = Proxy for URL
        script   = Script as text string
        userno   = AIPS user number
        AIPSDirs = List of AIPS directories on URL
        FITSDirs = List of FITS directories on URL
        AIPSUser = AIPS user number for AIPS data files
        version  = AIPS version string
        _message_list = messages from Script execution

__setattr__(self, name, value)

abort(self, proxy, tid, sig=15)
    Abort the script specified by PROXY and TID.

    Calls abort function for task tid on proxy.
    None return value
    proxy = Proxy giving access to server
    tid   = Task id in pid table of process to be terminated
    sig   = signal to sent to the task

explain(self)
    List script

feed(self, proxy, tid, banana)
    Feed the script a  BANANA.

    Pass a message to a running script's sdtin
    proxy   = Proxy giving access to server
    tid     = Script task id in pid table of process
    bananna = text message to pass to script input

finished(self, proxy, tid)
    Determine if script has finished

    Determine whether the script specified by PROXY and TID has
    finished.
    proxy = Proxy giving access to server
    tid   = Task id in pid table of process
```

```
go(self)
    Execute the script.

    Writes task input parameters in the task parameter file and
    starts the task synchronously returning only when the task
    terminates. Messages are displayed as generated by the task,
    saved in an array returned from the call and, if the task
    member logFile is set, written to this file.

help(self)
    List script.

inputs(self)
    List script

messages(self, proxy=None, tid=None)
    Return task messages

    Returns list of messages and appends them to the object's
    message list.
    proxy = Proxy giving access to server
    tid   = Task id in pid table of process

outputs(self)
    Not defined.

spawn(self)
    Spawn the script.

    Starts script asynchronously returning immediately
    Messages must be retrieved calling messages.
    Returns (proxy, tid)

wait(self, proxy, tid)
    Wait for the script to finish.

    proxy = Proxy giving access to server
    tid   = Task id in pid table of process

----------------------------------------------------------------------
Data and other attributes defined here:

AIPSDirs = []

FITSDirs = []

debug = False
```

```
     doWait = False

     isbatch = 32000

     logFile = ’’

     msgkill = 0

     proxy = <module ’LocalProxy’ from ’/export/users/bcotton/share/obittal...

     script = ’’

     url = None

     userno = 0

     version = ’TST’

     ----------------------------------------------------------------------
     Methods inherited from MinimalMatch.MinimalMatch:

     __repr__(self)

  class ObitScriptMessageLog
     Methods defined here:

     __init__(self)

     zap(self)
         Zap message log.

     ----------------------------------------------------------------------
     Data and other attributes defined here:

     userno = -1
```

1.15 Local Python Data Interface Classes

Local and remote script execution data access is allowed through the direct python bindings to the data classes. These classes are Image, UV (radio interferometric data) which are derived from the base OData class. Most of the top level class functionality, e.g. making an image from a data set, are available through these classes. The online documentation for these classes can be obtained by

```
>>> help(Image)
>>> help(UV)
>>> import OTF; help(OTF)
```

Class members are accessed as using the “object_name.value” form as

```
>>> header=uv.Desc.Dict
```

to get the “header” from uv data uv as a python dict. Class functions (have “self” as an argument are called as

```
>>> uv.Header(err)
```

Note, “self” not included directly in the argument. Functions which do not have “self” as an argument (usually have names starting with ’P’) need to include the class:

```
>>> UV.PHeader(uv, err)
```

All data ojects have a Descriptor (the “Desc” member) which can be read and written (requires open and close of data object). Conversion between the c memory resident forms and a python dict is by means of the “Dict” member of the descriptor classes:

```
>>> d=uv.Desc.Dict
>>> d
{'origin': 'Obit    ', 'jlocr': 4, 'obsdat': '1996-11-16', 'equinox':  2000.0,
'observer': 'AC473   ',
'ptype': ['UU-L-SIN', 'VV-L-SIN', 'WW-L-SIN', 'BASELINE', 'TIME1   '],
'ilocid': -1, 'obsdec': 30.2984147222, 'xshift': 0.0, 'ilocws': -1,
'jlocd': 5, 'restFreq': 0.0, 'ilocsu': -1, 'nvis': 1594634, 'ilocb': 3,
'ilocv':1, 'ilocw': 2, 'iloct': 4, 'ilocu': 0, 'nrparm': 5, 'instrume': 'VLA',
'epoch':2000.0, 'isort': 'TB', 'VelDef': 0, 'inaxes': [3, 2, 30, 1, 1, 1, 0],
'yshift': 0.0, 'ilocit': -1, 'object': 'MCFIELD ',
'ctype': ['COMPLEX ', 'STOKES  ', 'FREQ    ', 'IF      ', 'RA      ',  'DEC     '],
'cdelt': [1.0, -1.0, 97656.25, 1.0, 1.0, 1.0, 0.0], 'jlocif': 3,
'JDObs': 2450403.5, 'date': '2007-07-07', 'ilocfq': -1, 'jlocf': 2, 'VelReference': 3,
'ncorr': 60, 'jlocc': 0, 'crpix': [1.0, 1.0, 16.0, 1.0, 1.0, 1.0, 1.0], 'jlocs': 1,
'name': 'AIPS UV data', 'teles': 'VLA     ', 'altRef': 125100.0,
'numVisBuff': 0, 'naxis': 6, 'crota': [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0],
'bunit':'UNCALIB ', 'firstVis': 0, 'altCrpix': 16.0, 'obsra': 195.75129125000001,
'crval': [1.0, -1.0, 316562500.0, 1.0, 195.75129125000001, 30.2984147222, 0.0]}
```

1.15.1 Obit python Image class

The interface to Images use FArray objects to store the pixel data. The FArray class allows efficient pixel manipulation and knows about magic value blanking of pixels. The data arrays in memory can also be access for use with NumPy. Further functions are available in python modules ImageUtil, CleanImage, ConvUtil, ImageMosaic, MosaicUtil and Feather modules The following describes the Image class.

```
NAME
    Image - Python Obit Image class

DESCRIPTION
    This class contains an astronomical image and allows access.
    An ObitImage is the front end to a persistent disk resident structure.
    Magic value blanking is supported, blanked pixels have the value
    OBIT_MAGIC (ObitImageDesc.h).
    Pixel data are kept in an FArray structure which is how Python acceses the data.
    There may be associated tables (e.g. "AIPS CC" tables).
    Both FITS and AIPS cataloged images are supported.
    Image Members with python interfaces:
    exist     - True if object previously existed prior to object creation
    InfoList  - used to pass instructions to processing
    ImageDesc - Astronomical labeling of the image Member Desc
    FArray    - Container used for pixel data Member FArray
    PixBuf    - memory pointer into I/O Buffer, can be used to pass
                data to NumPy
    Additional Functions are available in ImageUtil.

CLASSES
    OData.OData(OData.ODataPtr)
        Image

    class Image(OData.OData)
       Python Obit Image class

       Additional Functions are available in ImageUtil.

       Method resolution order:
           Image
           OData.OData
           OData.ODataPtr

       Methods defined here:

       Clone(self, outImage, err)
           Make a copy of a object but do not copy the actual data

           This is useful to create an Image similar to the input one.
           self   = Python Image object
           outImage    = Output Python Image object, must be defined
           err    = Python Obit Error/message stack

       Close(self, err)
           Close an image  persistent (disk) form

           self      = Python Image object
           err       = Python Obit Error/message stack

       Copy(self, outImage, err)
           Make a deep copy of input object.

           Makes structure the same as self, copies data, tables
           self   = Python Image object to copy
           outImage    = Output Python Image object, must be defined
           err    = Python Obit Error/message stack

       GetPlane(self, array, plane, err)
           Read an image  persistent (disk) form to an (optional) specified FArray

           The data to be read is specified in the InfoList member as modified by plane
           self   = Python Image object
           array  = Python FArray to accept data, if None use inImage buffer
           plane  = array of 5 integers giving (1-rel) pixel numbers
           err    = Python Obit Error/message stack

       Header(self, err)
           Write image header on output

           self   = Python Obit Image object
           err    = Python Obit Error/message stack

       ImageIsA(self)
           Tells if input really a Python Obit Image

           return true, false (1,0)
           self   = Python UV object

       Info(self, err)
           Get underlying data file info

           self   = Python Obit Image object
           err    = Python Obit Error/message stack

       Open(self, access, err, blc=None, trc=None)
           Open an image persistent (disk) form

           self   = Python Image object
           access    = access READONLY (1), WRITEONLY (2), READWRITE(3)
           err       = Python Obit Error/message stack
           blc       = if given and a list of integers (min 2) giving
           bottom left corner (1-rel) of subimage
           trc       = if given and a list of integers (min 2) giving
           top right corner (1-rel) of subimage

       PutPlane(self, array, plane, err)
           Write an image persistent (disk) form from an (optional) specified FArray

           The data to be written is specified in the InfoList member as modified by plane
           self   = Python Image object
           array     = Python FArray to provide data, if None use inImage buffer
           plane     = array of 5 integers giving (1-rel) pixel numbers
           err       = Python Obit Error/message stack

       Read(self, err)
           Read an image  persistent (disk) form
           The data to be read is specified in the InfoList mamber
           Uses FArray member as buffer.
           self      = Python Image object
           err       = Python Obit Error/message stack

       ReadFA(self, array, err)
           Read an image  persistent (disk) form to a specified FArray

           The data to be read is specified in the InfoList member
           self   = Python Image object
           array  = Python FArray to accept data
           err    = Python Obit Error/message stack

       ReadPlane(self, err, blc=None, trc=None)
           Read an image plane into the FArray

           Reads the plane specified by blc, trc
           into the FArray associated with the image
           self     = Python Image object
           err      = Python Obit Error/message stack
           blc      = if given and a list of integers (min 2) giving
                      bottom left corner (1-rel) of subimage
           trc      = if given and a list of integers (min 2) giving
                      top right corner (1-rel) of subimage
           returns Python  FArray from Image with data read

       Scratch(self, err)
           Create a scratch file suitable for accepting the data to be read from self

           A scratch Image is more or less the same as a normal Image except that it is
           automatically deleted on the final unreference.
           self      = Python Image object
           err       = Python Obit Error/message stack

       UpdateDesc(self, err, Desc=None)
           Update any disk resident structures about descriptor

           self      = Python Image object
           err       = Python Obit Error/message stack
           Desc      = Descriptor, if None then use current descriptor
                       Contents can be accessed throuth the Dict member

       Write(self, err)
           Write an image  persistent (disk) form

           The data to be written is specified in the InfoList member
           Uses FArray member as buffer.
           self      = Python Image object
           err       = Python Obit Error/message stack

       WriteFA(self, array, err)
           Write an image  persistent (disk) form from a specified FArray

           The data to be written is specified in the InfoList member
           self      = Python Image object
           array     = Python FArray to write
           err       = Python Obit Error/message stack

       WritePlane(self, imageData, err)
           Write an image plane.

           Writes the plane specified by blc, trc on image infoList
           Checks if the current FArray on Image is compatable with
           imageData.
           self      = Python Image object
           imageData = Python FArray with data to write
           err       = Python Obit Error/message stack

       __del__(self)

       __getattr__(self, name)

       __init__(self, name)

       __repr__(self)

       __setattr__(self, name, value)

       cast(self, toClass)
           Casts object pointer to specified class

           self     = object whose cast pointer is desired
           toClass  = Class string to cast to ("ObitImage")

       ----------------------------------------------------------------------
       Methods inherited from OData.OData:

       CopyTables(self, outOData, exclude, include, err)
           Copy Tables from one OData to another

           self      = Python OData object
           outOData     = Output Python OData object, must be defined
           exclude   = list of table types to exclude (list of strings)
           has priority
           include   = list of table types to include (list of strings)
           err       = Python Obit Error/message stack

       Dirty(self)
           Mark OData as needing a header update to disk file

           self     = Python OData object

       FullInstantiate(self, access, err)
           Fully instantiate an OData by opening and closing

           return 0 on success, else failure
           self   = Python OData object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           err       = Python Obit Error/message stack

       GetHighVer(self, tabType)
           Get highest version number of a specified Table
                   returns highest tabType version number, 0 if none.
           self   = Python OData object
           tabType   = Table type, e.g. "OTFSoln"

       GetName(self)
           Tells OData object name (label)

           returns name as character string
           self   = Python OData object

       History(self, access, err)
           Return the associated History

           self      = Python OData object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           err       = Python Obit Error/message stack

       IsScratch(self)
           Tells if OData is a scratch object

           return true, false (1,0)
           self   = Python OData object

       NewTable(self, access, tabType, tabVer, err, numOrb=0,
               numPCal=3, numIF=1, numPol=1, numTerm=0, numChan=1,
               numTones=1, numBand=1, numTabs=1, npoly=1, numCoef=5, noParms=0)
           Return the specified associated table

           Table will be created if necessary.
           self      = Python OData object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           tabType   = Table type, e.g. "AIPS AN"
           tabVer    = table version, if > 0 on input that table returned,
           if 0 on input, the highest version is used.
           err       = Python Obit Error/message stack
           Optional parameters, values only used if table created
           numOrb    = Number of orbital parameters (AN)
           numPCal   = Number of polarization parameters (AN)
           numIF     = Number of IFs (FQ, SN, CL, BP, BL, TY, CQ)
           numPol    = Number of Stokes’ (SN, CL, BP, BL, PC, TY, GC, MC, IM)
           numTerm   = Number of terms in model polynomial (CL)
           numChan   = Number of spectral channels (BP)
           numTomes  = Number of Phase cal tones (PC)
           numTabs   = Number of ??? (GC)
           numCoef   = Number of polynomial coefficents (NI)
           numBand   = Number of Bands(?) (IM, GC)
           npoly     = number of polynomial terms (IM)
           noParms   = Number of parameters in CC table model
           maxis1-5  = Dimension of axes of IDI data matrix

       ODataIsA(self)
           Tells if input really a Python Obit OData

           return true, false (1,0)
           self   = Python OData object

       Rename(self, err, newFITSName=None, newAIPSName=’   ’,
               newAIPSClass=’       ’, newAIPSSeq=0)
           Rename underlying files

           self   = Python OData object
           err       = Python Obit Error/message stack
           For FITS files:
           newFITSName = new name for FITS file

           For AIPS:
           newAIPSName  = New AIPS Name (max 12 char) Blank => don’t change.
           newAIPSClass = New AIPS Class (max 6 char) Blank => don’t change.
           newAIPSSeq   = New AIPS Sequence number, 0 => unique value

       UpdateTables(self, err)
           Update any disk resident structures about the current tables

           Returns 0 on success
           self      = Python Image object
           err       = Python Obit Error/message stack

       Zap(self, err)
           Delete underlying files and the basic object.
```

```
           self      = Python OData object
           err       = Python Obit Error/message stack

       ZapTable(self, tabType, tabVer, err)
           Destroy specified table

           Returns 0 on success
           self      = Python OData object
           tabType   = Table type, e.g. "AIPS CC"
           tabVer    = table version, integer
           err       = Python Obit Error/message stack

FUNCTIONS
    ObitName(ObitObject)
        Return name of an Obit object or input if not an Obit Object

    PClone(inImage, outImage, err)
        Make a copy of a object but do not copy the actual data

        This is useful to create an Image similar to the input one.
        inImage   = Python Image object
        outImage  = Output Python Image object, must be defined
        err       = Python Obit Error/message stack

    PClone2(inImage1, inImage2, outImage, err)
        Make a copy of a object but do not copy the actual data

        inImage1  = Python Image object to clone
        inImage2  = Python Image object whose geometry is to be used
        outImage  = Output Python Image object, must be defined,
                    will be defined as Memory only
        err       = Python Obit Error/message stack

    PCloneMem(inImage, outImage, err)
        Make a Memory only clone of an Image structure

        This is useful for temporary structures
        inImage   = Python Image object
        outImage  = Output Python Image object, must be defined
        err       = Python Obit Error/message stack

    PClose(inImage, err)
        Close an image  persistent (disk) form

        inImage   = Python Image object
        err       = Python Obit Error/message stack
```

```
PCompare(in1Image, in2Image, err, plane=[1, 1, 1, 1, 1])
    Compare a plane of two images

    returns list [max. abs in1Image, max abs difference, RMS difference]
    in1Image  = Python Image object
    in2Image  = Python Image object, on output, the FArray contains the difference.
    err       = Python Obit Error/message stack
    plane     = plane to compare

PCopy(inImage, outImage, err)
    Make a deep copy of input object.

    Makes structure the same as inImage, copies data, tables
    inImage   = Python Image object to copy
    outImage  = Output Python Image object, must be defined
    err       = Python Obit Error/message stack

PCopyQuantizeFITS(inImage, outImage, err, fract=0.25, quant=None, inHistory=None)
    Make a copy of an image quantizing to a 16 or 32 bit integer
        FITS image

    inImage   = Python Image object
    outImage  = Output Python Image object, must be defined
                but not fully created
    err       = Python Obit Error/message stack
    fract     = quantization level as a fraction of the plane min. RMS
    quant     = quantization level in image units, has precedence over fract
                None or <= 0 => use fract.
    inHistory = if given a History object to copy to the output FITS header

PCopyTables(inImage, outImage, exclude, include, err)
    Copy Tabeles from one image to another

    inImage   = Python Image object
    outImage  = Output Python Image object, must be defined
    exclude   = list of table types to exclude (list of strings)
                has priority
    include   = list of table types to include (list of strings)
    err       = Python Obit Error/message stack

PDirty(inImage)
    Mark Image as needing a header update to disk file

    inImage     = Python Image object

PFArray2FITS(inArray, outFile, err, outDisk=1, oDesc=None)
    Write an FArray to a FITS image
    Very rudimentary header attached
    Returns image object
    inArray   = Python FArray object
    outFile   = Name of FITS file
    outDisk   = FITS disk number
    oDesc     = None or ImageDescriptor to be written
    err       = Python Obit Error/message stack

PFArray2Image(inArray, outImage, err)
    Attach an FArray to an image and write it

    Very rudimentary header attached
    inArray   = Python Image object
    outImage  = Python Image to write
    err       = Python Obit Error/message stack

PFullInstantiate(inImage, access, err)
    Fully instantiate an Image by opening and closing

    return 0 on success, else failure
    inImage   = Python Image object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err       = Python Obit Error/message stack

PGetBeam(inImage)
    Return Beam attached to Image

    returns Beam with image pixel data
    inImage   = Python Image object

PGetDesc(inImage)
    Return the member ImageDesc

    returns ImageDesc as a Python Dictionary
    inImage   = Python Image object

PGetFArray(inImage)
    Return FArray used to buffer Image data

    returns FArray with image pixel data
    inImage   = Python Image object

PGetHighVer(inImage, tabType)
    Get highest version number of a specified Table

    returns highest tabType version number, 0 if none.
    inImage   = Python Image object
    tabType   = Table type, e.g. "OTFSoln"
```

```
PGetList(inImage)
    Return the member InfoList

    returns InfoList
    inImage   = Python Image object

PGetName(inImage)
    Tells Image object name (label)

    returns name as character string
    inImage   = Python Image object

PGetPixBuf(inImage)
    Return python memory buffer for pixel array in memory
    Can be used to pass data to NumPy
    inImage   = Python Image object

PGetPlane(inImage, array, plane, err)
    Read an image  persistent (disk) form to an (optional) specified FArray

    The data to be read is specified in the InfoList member as modified by plane
    inImage   = Python Image object
    array     = Python FArray to accept data, if None use inImage buffer
    plane     = array of 5 integers giving (1-rel) pixel numbers
    err       = Python Obit Error/message stack

PGetTable(inImage, access, tabType, tabVer, err, noParms=0)
    Return (create) the specified associated table

    Specific table types are recognized and the appropriate constructor
    called, these may have additional parameters.  This allows creating
    new tables of the appropriate type.
    returns Python Obit Table
    inImage   = Python Image object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    tabType   = Table type, e.g. "AIPS AN", or "OTFSoln"
    tabVer    = table version, if > 0 on input that table returned,
                if 0 on input, the highest version is used.
    err       = Python Obit Error/message stack
    noParms   = Number of parameters in CC table model

PGetTableList(inImage)
    Return the member tableList

    returns tableList
    inImage   = Python Image object
```

```
PHeader(inImage, err)
    Print image descriptor

    inImage   = Python Image object
    err       = Python Obit Error/message stack

PImageGetTable(inImage, access, tabType, tabVer, err)
    Obsolete use PGetTable

PIsA(inImage)
    Tells if input really a Python Obit Image

    return True, False (1,0)
    inImage   = Python Image object

PIsScratch(inImage)
    Tells if Image is a scratch object

    return true, false (1,0)
    inImage   = Python Image object

POpen(inImage, access, err, blc=None, trc=None)
    Open an image persistent (disk) form

    inImage   = Python Image object
    access    = access READONLY (1), WRITEONLY (2), READWRITE(3)
    err       = Python Obit Error/message stack
    blc       = if given and a list of integers (min 2) giving
                bottom left corner (1-rel) of subimage
    trc       = if given and a list of integers (min 2) giving
                top right corner (1-rel) of subimage

PPutPlane(inImage, array, plane, err)
    Write an image persistent (disk) form from an (optional) specified FArray

    The data to be written is specified in the InfoList member as modified by plane
    inImage   = Python Image object
    array     = Python FArray to provide data, if None use inImage buffer
    plane     = array of 5 integers giving (1-rel) pixel numbers
    err       = Python Obit Error/message stack

PRead(inImage, err)
    Read an image  persistent (disk) form

    The data to be read is specified in the InfoList mamber
    Uses FArray member as buffer.
    inImage   = Python Image object
    err       = Python Obit Error/message stack
```

```
PReadFA(inImage, array, err)
    Read an image  persistent (disk) form to a specified FArray

    The data to be read is specified in the InfoList member
    inImage   = Python Image object
    array     = Python FArray to accept data
    err       = Python Obit Error/message stack

PReadPlane(inImage, err, blc=None, trc=None)
    Read an image plane into the FArray

    Reads the plane specified by blc, trc
    into the FArray associated with the image
    inImage   = Python Image object
    err       = Python Obit Error/message stack
    blc       = if given and a list of integers (min 2) giving
                bottom left corner (1-rel) of subimage
    trc       = if given and a list of integers (min 2) giving
                top right corner (1-rel) of subimage
    returns Python  FArray from Image with data read

PScratch(inImage, err)
    Create a scratch file suitable for accepting the data to be read from inImage

    A scratch Image is more or less the same as a normal Image except that it is
    automatically deleted on the final unreference.
    inImage   = Python Image object
    err       = Python Obit Error/message stack

PSetBeam(inImage, beam)
    Replace the Beam attached to an Image

    inImage   = Python Image object
    beam      = Python Beam Image to attach

PSetFArray(inImage, array)
    Replace the FArray on an Image

    inImage   = Python Image object
    array     = Python FArray to attach

PSwapAxis(inImage, err, ax1=3, ax2=4)
    Swap axes on an image

    The order of two adjacent axes may be swapped if the dimensionality
    of at least one of them is 1
    inImage  = Image whose axes are to be swapped
    err      = Python Obit Error/message stack
    ax1      = first (1-rel) axis number
    ax2      = second (1-rel) axis number

PUnref(inImage)
    Decrement reference count

    Decrement reference count which will destroy object if it goes to zero
    Python object stays defined.
    inImage   = Python Image object

PUpdateDesc(inImage, err, Desc=None)
    Update external representation of descriptor

    inImage = Python Image object
    err     = Python Obit Error/message stack
    Desc    = Image descriptor, if None then use current descriptor

PUpdateTables(inImage, err)
    Update any disk resident structures about the current tables

    inImage   = Python Image object
    err       = Python Obit Error/message stack

PWrite(inImage, err)
    Write an image  persistent (disk) form

    The data to be written is specified in the InfoList member
    Uses FArray member as buffer.
    inImage   = Python Image object
    err       = Python Obit Error/message stack

PWriteFA(inImage, array, err)
    Write an image  persistent (disk) form from a specified FArray

    The data to be written is specified in the InfoList member
    inImage   = Python Image object
    array     = Python FArray to write
    err       = Python Obit Error/message stack

PWritePlane(Image, imageData, err)
    Write an image plane.

    Writes the plane specified by blc, trc on image infoList
    Checks if the current FArray on Image is compatable with
    imageData.
    Image     = Python Image object
    imageData = Python FArray with data to write
    err       = Python Obit Error/message stack

PZap(inImage, err)
    Delete underlying files and the basic object.

    inImage   = Python Image object
    err       = Python Obit Error/message stack

PZapTable(inImage, tabType, tabVer, err)
    Destroy specified table

    inImage   = Python Image object
    tabType   = Table type, e.g. "AIPS CC"
    tabVer    = table version, integer
    err       = Python Obit Error/message stack

input(inputDict)
    Print the contents of an input Dictionary

    inputDict = Python Dictionary containing the parameters for a routine

newObit(name, filename, disk, exists, err)
    Create and initialize an Image structure

    Create, set initial access information (full image, plane at a time)
    and if exists verifies the file.
    Returns the Python Image object
    name     = name desired for object (labeling purposes)
    filename = name of FITS file
    disk     = FITS directory number
    exists   = if true then the file is opened and closed to verify
    err      = Python Obit Error/message stack

newPACNO(disk, cno, exists, err, verbose=True)
    Create and initialize an AIPS based Image structure

    Create, set initial access information (full image, plane at a time)
    and if exists verifies the file.
    Returns the Python Image object
    isOK member set to indicate success
    disk     = AIPS directory number
    cno      = AIPS catalog number
    exists   = if true then the file is opened and closed to verify
    err      = Python Obit Error/message stack
    verbose  = If true any give error messages, else suppress

newPAImage(name, Aname, Aclass, disk, seq, exists, err, verbose=True)
    Create and initialize an AIPS based Image structure
```

```
        Create, set initial access information (full image, plane at a time)
        and if exists verifies the file.
        Returns the Python Image object
        isOK member set to indicate success
        name     = name desired for object (labeling purposes)
        Aname    = AIPS name of file
        Aclass   = AIPS class of file
        seq      = AIPS sequence number of file
        disk     = FITS directory number
        exists   = if true then the file is opened and closed to verify
        err      = Python Obit Error/message stack
        verbose  = If true any give error messages, else suppress

    newPFImage(name, filename, disk, exists, err, verbose=True)
        Create and initialize an FITS based Image structure

        Create, set initial access information (full image, plane at a time)
        and if exists verifies the file.
        isOK member set to indicate success
        Returns the Python Image object
        name     = name desired for object (labeling purposes)
        filename = name of FITS file
        disk     = FITS directory number
        exists   = if true then the file is opened and closed to verify
        err      = Python Obit Error/message stack
        verbose  = If true any give error messages, else suppress
```

1.15.2 Obit python UV class

Further utilities are available in the SkyModel, IonCal, CleanVis UVSelfCal, UVGSolve, UVImager, and UVSoln2Cal python modules. The following describes the UV class.

```
NAME
    UV - Python Obit inteferometer (UV) data class

DESCRIPTION
    This class contains interoferometric data and allows access.
    An ObitUV is the front end to a persistent disk resident structure.
    There maybe (usually are) associated tables which either describe
    the data or contain calibration and/or editing information.
    Both FITS (as Tables) and AIPS cataloged data are supported.
    Most access to UV data is through functions as the volume of the data is
    inappropriate to be processed directly in python.

    UV Members with python interfaces:
    exist     - True if object previously existed prior to object creation
    List      - used to pass instructions to processing
    Desc      - Astronomical labeling of the data
```

```
TableList - List of tables attached
VisBuf    - memory pointer into I/O Buffer, can be used to pass
            data to NumPy

Data selection, calibration and editing parameters on List member:
  "doCalSelect" bool (1,1,1) Select/calibrate/edit data?
  "Stokes"      string (4,1,1) Selected output Stokes parameters:
           "    "=> no translation,"I   ","V   ","Q   ", "U   ",
           "IQU ", "IQUV",  "IV  ", "RR  ", "LL  ", "RL  ", "LR  ",
           "HALF" = RR,LL, "FULL"=RR,LL,RL,LR. [default "    "]
           In the above 'F' can substitute for "formal" 'I' (both RR+LL).
  "BChan"   int (1,1,1) First spectral channel selected. [def all]
  "EChan"   int (1,1,1) Highest spectral channel selected. [def all]
  "BIF"     int (1,1,1) First "IF" selected. [def all]
  "EIF"     int (1,1,1) Highest "IF" selected. [def all]
  "doPol"   int (1,1,1) >0 -> calibrate polarization.
  "doCalib" int (1,1,1) >0 -> calibrate, 2=> also calibrate Weights
  "gainUse" int (1,1,1) SN/CL table version number, 0-> use highest
  "flagVer" int (1,1,1) Flag table version, 0-> use highest, <0-> none
  "BLVer"   int (1,1,1) BL table version, 0> use highest, <0-> none
  "BPVer"   int (1,1,1) Band pass (BP) table version, 0-> use highest
  "Subarray"  int (1,1,1) Selected subarray, <=0->all [default all]
  "dropSubA"  bool (1,1,1) Drop subarray info?
  "FreqID"    int (1,1,1) Selected Frequency ID, <=0->all [default all]
  "timeRange" float (2,1,1) Selected timerange in days.
  "UVRange"   float (2,1,1) Selected UV range in kilowavelengths.
  "InputAvgTime" float (1,1,1) Input data averaging time (sec).
            used for fringe rate decorrelation correction.
  "Sources" string (?,?,1) Source names selected unless any starts with
            a '-' in which case all are deselected (with '-' stripped).
  "souCode" string (4,1,1) Source Cal code desired, '    ' => any code selected
                               '*   ' => any non blank code (calibrators only)
                               '-CAL' => blank codes only (no calibrators)
  "Qual"     int (1,1,1)  Source qualifier, -1 [default] = any
  "Antennas" int (?,1,1) a list of selected antenna numbers, if any is negative
             then the absolute values are used and the specified antennas are deselectec
  "corrtype" int (1,1,1) Correlation type, 0=cross corr only, 1=both, 2=auto only.
  "passAll"  bool (1,1,1) If True, pass along all data when selecting/calibration
                              even if it's all flagged,
                              data deselected by time, source, antenna etc. is not passe
  "doBand"   int (1,1,1) Band pass application type <0-> none
      (1) if = 1 then all the bandpass data for each antenna
          will be averaged to form a composite bandpass
          spectrum, this will then be used to correct the data.
      (2) if = 2 the bandpass spectra nearest in time (in a weighted
          sense) to the uv data point will be used to correct the data.
      (3) if = 3 the bandpass data will be interpolated in time using
          the solution weights to form a composite bandpass spectrum,
              this interpolated spectrum will then be used to correct the
              data.
          (4) if = 4 the bandpass spectra nearest in time (neglecting
              weights) to the uv data point will be used to correct the
              data.
          (5) if = 5 the bandpass data will be interpolated in time ignoring
              weights to form a composite bandpass spectrum, this
              interpolated spectrum will then be used to correct the data.
      "Smooth"  float (3,1,1) specifies the type of spectral smoothing
         Smooth(1) = type of smoothing to apply:
            0 => no smoothing
            1 => Hanning
            2 => Gaussian
            3 => Boxcar
            4 => Sinc (i.e. sin(x)/x)
          Smooth(2) = the "diameter" of the function, i.e.
            width between first nulls of Hanning triangle
            and sinc function, FWHM of Gaussian, width of
            Boxcar. Defaults (if < 0.1) are 4, 2, 2 and 3
            channels for Smooth(1) = 1 - 4.
          Smooth(3) = the diameter over which the convolving
            function has value - in channels.
            Defaults: 1, 3, 1, 4 times Smooth(2) used when
     "SubScanTime" float scalar [Optional] if given, this is the
          desired time (days) of a sub scan.  This is used by the
          selector to suggest a value close to this which will
          evenly divide the current scan.
          0 => Use scan average.
          This is only useful for ReadSelect operations on indexed ObitUVs.

CLASSES
    OData.OData(OData.ODataPtr)
        UV

    class UV(OData.OData)
       Python Obit inteferometer (UV) data class

       UV Members with python interfaces:
       List      - used to pass instructions to processing
       TableList - List of tables attached
       Desc      - Astronomical labeling of the data
       VisBuf    - memory pointer into I/O Buffer, can be used to pass
                   data to NumPy

       Method resolution order:
           UV
           OData.OData
           OData.ODataPtr
```

```
Methods defined here:

Clone(self, outUV, err)
    Make a copy of a object but do not copy the actual data

    This is useful to create an UV similar to the input one.
    self   = Python UV object
    outUV  = Output Python UV object, must be defined
    err    = Python Obit Error/message stack

Close(self, err)
    Close a UV  persistent (disk) form

    returns 0 on success, else failure
    self      = Python UV object
    err       = Python Obit Error/message stack

Copy(self, outUV, err)
    Make a deep copy of input object.

    Makes structure the same as self, copies data, tables
    self   = Python UV object to copy
    outUV  = Output Python UV object, must be defined
    err    = Python Obit Error/message stack

Header(self, err)
    Write image header on output

    self   = Python Obit UV object
    err    = Python Obit Error/message stack

Info(self, err)
    Get underlying data file info

    self   = Python Obit UV object
    err    = Python Obit Error/message stack

Open(self, access, err)
    Open a UV data persistent (disk) form

    Returns 0 on success, else failure
    self   = Python UV object
    access = access READONLY (1), WRITEONLY (2), READWRITE(3)
    err    = Python Obit Error/message stack

Read(self, err)
    Read a UV  persistent (disk) form
    Reads into buffer attached to UV data, use VisBuf for access
    Returns 0 on success, else failure
    self   = Python UV object
    err    = Python Obit Error/message stack

Scratch(self, err)
    Create a scratch file suitable for accepting the data to be read from self

    A scratch UV is more or less the same as a normal UV except that it is
    automatically deleted on the final unreference.
    self      = Python UV object
    err       = Python Obit Error/message stack

UVIsA(self)
    Tells if input really a Python Obit UV

    return true, false (1,0)
    self   = Python UV object

UpdateDesc(self, err, Desc=None)
    Update any disk resident structures about descriptor

    self      = Python UV object
    err       = Python Obit Error/message stack
    Desc      = Descriptor, if None then use current descriptor
                Contents can be accessed throuth the Dict member

Write(self, err)
    Write a UV  persistent (disk) form

    Writes buffer attached to UV data, use VisBuf for access
    returns 0 on success, else failure
    self      = Python UV object
    err       = Python Obit Error/message stack

__del__(self)

__getattr__(self, name)

__init__(self, name)

__repr__(self)

__setattr__(self, name, value)

cast(self, toClass)
    Casts object pointer to specified class
    self     = object whose cast pointer is desired
    toClass  = Class string to cast to ("ObitUV")

----------------------------------------------------------------------
Methods inherited from OData.OData:

CopyTables(self, outOData, exclude, include, err)
    Copy Tables from one OData to another

    self      = Python OData object
    outOData     = Output Python OData object, must be defined
    exclude   = list of table types to exclude (list of strings)
    has priority
    include   = list of table types to include (list of strings)
    err       = Python Obit Error/message stack

Dirty(self)
    Mark OData as needing a header update to disk file

    self     = Python OData object

FullInstantiate(self, access, err)
    Fully instantiate an OData by opening and closing

    return 0 on success, else failure
    self   = Python OData object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err       = Python Obit Error/message stack

GetHighVer(self, tabType)
    Get highest version number of a specified Table
            returns highest tabType version number, 0 if none.
    self   = Python OData object
    tabType   = Table type, e.g. "AIPS SN"

GetName(self)
    Tells OData object name (label)

    returns name as character string
    self   = Python OData object

History(self, access, err)
    Return the associated History

    self      = Python OData object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err       = Python Obit Error/message stack
```

```
IsScratch(self)
    Tells if OData is a scratch object

    return true, false (1,0)
    self   = Python OData object

NewTable(self, access, tabType, tabVer, err, numOrb=0,
        numPCal=3, numIF=1, numPol=1, numTerm=0, numChan=1,
        numTones=1, numBand=1, numTabs=1, npoly=1, numCoef=5, noParms=0)
    Return the specified associated table

    Table will be created if necessary.
    self      = Python OData object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    tabType   = Table type, e.g. "AIPS AN"
    tabVer    = table version, if > 0 on input that table returned,
    if 0 on input, the highest version is used.
    err       = Python Obit Error/message stack
    Optional parameters, values only used if table created
    numOrb    = Number of orbital parameters (AN)
    numPCal   = Number of polarization parameters (AN)
    numIF     = Number of IFs (FQ, SN, CL, BP, BL, TY, CQ)
    numPol    = Number of Stokes' (SN, CL, BP, BL, PC, TY, GC, MC, IM)
    numTerm   = Number of terms in model polynomial (CL)
    numChan   = Number of spectral channels (BP)
    numTomes  = Number of Phase cal tones (PC)
    numTabs   = Number of ??? (GC)
    numCoef   = Number of polynomial coefficents (NI)
    numBand   = Number of Bands(?) (IM, GC)
    npoly     = number of polynomial terms (IM)
    noParms   = Number of parameters in CC table model
    maxis1-5  = Dimension of axes of IDI data matrix

ODataIsA(self)
    Tells if input really a Python Obit OData

    return true, false (1,0)
    self   = Python OData object

Rename(self, err, newFITSName=None, newAIPSName='    ',
    newAIPSClass='      ', newAIPSSeq=0)
    Rename underlying files

    self   = Python OData object
    err       = Python Obit Error/message stack
    For FITS files:
    newFITSName = new name for FITS file
```

```
           For AIPS:
           newAIPSName  = New AIPS Name (max 12 char) Blank => don't change.
           newAIPSClass = New AIPS Class (max 6 char) Blank => don't change.
           newAIPSSeq   = New AIPS Sequence number, 0 => unique value

       UpdateTables(self, err)
           Update any disk resident structures about the current tables

           Returns 0 on success
           self      = Python OData object
           err       = Python Obit Error/message stack

       Zap(self, err)
           Delete underlying files and the basic object.

           self      = Python OData object
           err       = Python Obit Error/message stack

       ZapTable(self, tabType, tabVer, err)
           Destroy specified table

           Returns 0 on success
           self      = Python OData object
           tabType   = Table type, e.g. "AIPS CC"
           tabVer    = table version, integer
           err       = Python Obit Error/message stack

FUNCTIONS
    PClone(inUV, outUV, err)
        Make a copy of a object but do not copy the actual data

        This is useful to create an UV similar to the input one.
        inUV   = Python UV object
        outUV  = Output Python UV object, must be defined
        err    = Python Obit Error/message stack

    PClose(inUV, err)
        Close an image  persistent (disk) form

        inUV   = Python UV object
        err       = Python Obit Error/message stack

    PCopy(inUV, outUV, err)
        Make a deep copy of input object.

        Makes structure the same as inUV, copies data, tables
        inUV   = Python UV object to copy
        outUV  = Output Python UV object, must be defined
        err    = Python Obit Error/message stack

    PCopyTables(inUV, outUV, exclude, include, err)
        Copy Tabeles from one image to another

        inUV      = Python UV object
        outUV     = Output Python UV object, must be defined
        exclude   = list of table types to exclude (list of strings)
                    has priority
        include   = list of table types to include (list of strings)
        err       = Python Obit Error/message stack

    PDirty(inUV)
        Mark UV as needing a header update to disk file

        inUV     = Python UV object

    PEditClip(inUV, scratch, outUV, err)
        Clip raw visibilities

        control parameters on inUV info member
           "maxAmp" OBIT_float  (1,1,1) Maximum allowed amplitude
           "oper"   OBIT_string (4,1,1) operation type:
                "flag" flag data with amplitudes in excess of maxAmp
                "clip" clip amplitudes at maxAmp and preserve phase
                   default is "flag"
        returns UV data object
        inUV   = Python UV object to clip/flag
        scratch= True if this is to be a scratch file (same type as inUV)
        outUV  = Predefined UV data if scratch is False, may be inUV
                 ignored if scratch True.
        err    = Python Obit Error/message stack

    PEditClipStokes(inUV, scratch, outUV, err)
        Flag visibilities by Stokes

        Clip a uv data set.  Data with amplitudes of the selected stokes
        in excess of maxAmp are flagged.  Optionally all correlations associated
        may be flagged.  Stokes conversion as needed for test.
        Control parameters are on the inUV info member:
          "clipStok" OBIT_string (1,1,1) Stokes value to clip (I, Q, U, V, R, L)
                      default = "I"
           "flagAll"  Obit_bool   (1,1,1) if true, flag all associated correlations
                      default = True
           "maxAmp"   OBIT_float  (1,1,1) Maximum allowed amplitude
        returns UV data object
        inUV   = Python UV object to clip/flag
        scratch= True if this is to be a scratch file (same type as inUV)
        outUV  = Predefined UV data if scratch is False, may be inUV
                 ignored if scratch True.
        err    = Python Obit Error/message stack

    PEditFD(inUV, outUV, err)
        Frequency-domain editing of UV data - produces FG table

        Editing is done independently for each visibility channel.
        First clipping is done on correlator and Vpol amplitudes.
        Following this, an average and RMS is determined for each channel
        in each timeAvg period and a spectral baseline is established
        for the average values, either using a  median window filter (FDwidMW>0)
        or a linear baseline fit (FDwidMW<=0) to specified channels.
        Channels with excessive RMSes or residual amplitudes are flagged.
        Flagging is done by entering the offending data in FG table flagTab
        on outUV.
        Control parameters on inUV info member
          "flagTab" OBIT_int    (1,1,1) FG table version number [ def. 1]
          "timeAvg" OBIT_float  (1,1,1) Time interval over which to average
                    data to be flagged (days) [def = 1 min.]
          "FDmaxAmp"  OBIT_float (1,1,1) Maximum average amplitude allowed in the
                    spectrum before fitting.  Any channel exceeding this is
                    flagged in advance of the  baseline fitting or median
                    filtering,. default = infinite
          "FDmaxV"  OBIT_float (1,1,1) Maximum average amplitude allowed in V
                    polarization; any channel exceeding this is flagged in
                    advance of the  baseline fitting or median filtering,
                    Calculates V from difference in amplitudes.
                    default = infinite
          "FDwidMW" OBIT_int (1,1,1) If > 0 the width of the median window in channels.
                    An odd number (5) is recommended,  default or 0 => linear baseline
          "FDmaxRMS" OBIT_float (2,1,1) Flag all channels having RMS
                    values > maxRMS[0] of the channel median sigma.[default = 6.]
                    plus maxRMS[1] (default 0.1) of the channel average in quadrature
          "FDmaxRes" OBIT_float (1,1,1) Max. residual flux in sigma allowed for
                    channels outside the baseline fitting regions.
                    default = 6.
          "FDmaxResBL"  OBIT_float (1,1,1) Max. residual flux in sigma allowed for
                    channels within the baseline fitting regions.
                    Default = FDmaxRes
          "FDbaseSel"  OBIT_int (4,*,1) Channel selection to define spectral baseline
                    Used only for linear baseline fitting.
                    Select groups of channels/IF(s) to fit as sets
                    of (Start,end,inc,IF), i.e., chanSel = 6,37,1,0,
                    92,123,1,0 for two regions applying to all IFs.
                    Channel and IF numbers 1 -rel
                    The first group for which the end channel == 0 terminates the list
                    Channel increments defaults to 1
                    If the IF==0 then the group applies to all IF.
                    Default is channels 2 => nchan-1 all IFs
        inUV   = Python UV object to flag
                 Any prior selection and editing is applied.
        outUV  = UV data onto which the FG table is to be attached.
                 May be the same as inUV.
        err    = Python Obit Error/message stack

    PEditStokes(inUV, outUV, err)
        Stokes editing of UV data, FG table out

           All data on a given baseline/correlator are flagged if the
        amplitude of the datatype "FlagStok"  exceeds maxAmp.
        If a fraction of bad baselines on any antenna/channel/IF exceeds
        maxBad, then all data to that correlator is flagged.
        Flagging entries are written into FG table flagTab.
        Results are unpredictable for uncalibrated data.
        Control parameters on info member of inUV:
          "flagStok" OBIT_string (1,1,1) Stokes value to clip (I, Q, U, V, R, L)
                     default = "V"
          "flagTab" OBIT_int    (1,1,1) FG table version number [ def. 1]
                    NB: this should not also being used to flag the input data!
          "timeAvg" OBIT_float  (1,1,1) Time interval over which to determine
                    data to be flagged (days) [def = 1 min.]
          "maxAmp"  OBIT_float (1,1,1) Maximum VPol allowed
          "maxBad"  OBIT_float (1,1,1) Fraction of allowed flagged baselines
                    to an antenna above which all baselines are flagged.
                    [default 0.25]

        inUV   = Python UV object to clip/flag
        outUV  = UV data onto which the FG table is to be attached.
                 May be the same as inUV.
        err    = Python Obit Error/message stack

    PEditTD(inUV, outUV, err)
        Time-domain editing of UV data - produces FG table

        Fill flagging table with clipping by RMS values of the real and imaginary
        parts.  All correlations are clipped on each baseline if the RMS is
        larger than  the maximum.  The clipping is done independently in
        each time interval defined by timeAvg.
           The clipping level is given by MIN (A, MAX (B,C)) where:
        A = sqrt (maxRMS[0]**2 + (avg_amp * maxRMS[1])**2)
           and avg_amp is the average amplitude on each baseline.
        B = median RMS + 3 * sigma of the RMS distribution.
        C = level corresponding to 3% of the data.
           All data on a given baseline/correlator are flagged if the RMS
        exceeds the limit.  If a fraction of bad baselines on any correlator
        exceeds maxBad, then all data to that correlator is flagged.  In
        addition, if the offending correlator is a parallel hand correlator
        then any corresponding cross hand correlations are also flagged.
        Flagging entries are written into FG table flagTab.
        Control parameters on inUV info member
          "flagTab" OBIT_int    (1,1,1) FG table version number [ def. 1]
          "timeAvg" OBIT_float  (1,1,1) Time interval over which to determine
                    data to be flagged (days) [def = 1 min.]
                    NB: this should be at least 2 integrations.
          "maxRMS"  OBIT_float (2,1,1) Maximum RMS allowed, constant plus
                    amplitude coefficient.
          "maxBad"  OBIT_float (1,1,1) Fraction of allowed flagged baselines
                    [default 0.25]

        inUV   = Python UV object to clip/flag
        outUV  = UV data onto which the FG table is to be attached.
                 May be the same as inUV.
        err    = Python Obit Error/message stack

    PFullInstantiate(inUV, access, err)
        Fully instantiate an UV by opening and closing

        return 0 on success, else failure
        inUV   = Python UV object
        access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
        err       = Python Obit Error/message stack

    PGetDesc(inUV)
        Return the member UVDesc

        returns UVDesc as a Python Dictionary
        inUV   = Python UV object

    PGetFreq(inUV, err)
        Get Frequency information

        inUV   = Python UV object
        err       = Python Obit Error/message stack

    PGetHighVer(inUV, tabType)
        Get highest version number of a specified Table

        returns highest tabType version number, 0 if none.
        inUV   = Python UV object
        tabType   = Table type, e.g. "AIPS SN"

    PGetList(inUV)
```

```
    Return the member InfoList

    returns InfoList
    inUV   = Python UV object

PGetName(inUV)
    Tells UV object name (label)

    returns name as character string
    inUV   = Python UV object

PGetSubA(inUV, err)
    Get Subarray information

    returns 0 on success, else 1
    inUV   = Python UV object
    err       = Python Obit Error/message stack

PGetTable(inUV, access, tabType, tabVer, err, numOrb=0, numPCal=3,
        numIF=1, numPol=1, numTerm=0, numChan=1, numTones=1,
numBand=1, numTabs=1, npoly=1, numCoef=5, maxis1=2, maxis2=1,
        maxis3=1, maxis4=1, maxis5=1)
    Return (create)the specified associated table

    Specific table types are recognized and the appropriate constructor
    called, these may have additional parameters.  This allows creating
    new tables of the appropriate type.
    returns Python Obit Table
    inUV      = Python UV object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    tabType   = Table type, e.g. "AIPS AN"
    tabVer    = table version, if > 0 on input that table returned,
                if 0 on input, the highest version is used.
    err       = Python Obit Error/message stack
    Optional parameters, values only used if table created
    numOrb    = Number of orbital parameters (AN)
    numPCal   = Number of polarization parameters (AN)
    numIF     = Number of IFs (FQ, SN, CL, BP, BL, TY, CQ)
    numPol    = Number of Stokes' (SN, CL, BP, BL, PC, TY, GC, MC, IM)
    numTerm   = Number of terms in model polynomial (CL)
    numChan   = Number of spectral channels (BP)
    numTomes  = Number of Phase cal tones (PC)
    numTabs   = Number of ??? (GC)
    numCoef   = Number of polynomial coefficents (NI)
    numBand   = Number  Bands(?) (IM, GC)
    npoly     = number of polynomial terms (IM)
    maxis1-5  = Dimension of axes of IDI data matrix
```

```
PGetTableList(inUV)
    Return the member tableList

    returns tableList
    inUV   = Python UV object

PGetVisBuf(inUV)

PHeader(inUV, err)
    Print data descriptor

    inUV      = Python Obit UV object
    err       = Python Obit Error/message stack

PIsA(inUV)
    Tells if input really a Python Obit UV

    return true, false (1,0)
    inUV   = Python UV object

PIsScratch(inUV)
    Tells if UV is a scratch object

    return true, false (1,0)
    inUV   = Python UV object

PNewUVTable(inUV, access, tabType, tabVer, err)
    Obsolete use PGetTable

POpen(inUV, access, err)
    Open an image persistent (disk) form

    inUV   = Python UV object
    access    = access 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err       = Python Obit Error/message stack

PRename(inUV, err, newFITSName=None, newAIPSName='            ',
        newAIPSClass='      ', newAIPSSeq=0)
    Rename underlying files

    inUV   = Python UV object
    err       = Python Obit Error/message stack
    For FITS files:
    newFITSName = new name for FITS file

    For AIPS:
    newAIPSName  = New AIPS Name (max 12 char) Blank => don't change.
    newAIPSClass = New AIPS Class (max 6 char) Blank => don't change.
    newAIPSSeq   = New AIPS Sequence number, 0 => unique value

PScratch(inUV, err)
    Create a scratch file suitable for accepting the data to be read from inUV

    A scratch UV is more or less the same as a normal UV except that it is
    automatically deleted on the final unreference.
    inUV      = Python UV object
    err       = Python Obit Error/message stack

PUVInfo(inUV, err)
    Get file info for extant uv data object

    Fills in information on object, useful for scratch files
    inUV   = Python UV object
    err    = Python Obit Error/message stack

PUpdateDesc(inUV, err, Desc=None)
    Update external representation of descriptor

    inUV   = Python UV object
    err    = Python Obit Error/message stack
    Desc   = UV descriptor, if None then use current descriptor
             Contents can be accessed throuth the Dict member

PUpdateTables(inUV, err)
    Update any disk resident structures about the current tables

    inUV      = Python UV object
    err       = Python Obit Error/message stack

PUtilAvgF(inUV, outUV, err, scratch=False, NumChAvg=0, doAvgAll=False, ChanSel=None)
    Average A UV data set in Frequency

    returns Averaged UV data object
    inUV   = Python UV object to copy
             Any selection editing and calibration applied before average.
    outUV  = Predefined UV data if scratch is False, ignored if
             scratch is True.
    err    = Python Obit Error/message stack
    scratch  = True if this is to be a scratch file (same type as inUV)
    NumChAvg = Number of channels to average, [def.0  = all]
    doAvgAll = If TRUE then average all channels and IF.
    ChanSel  =  Groups of channels to consider (relative to channels &
                IFs selected by BChan, EChan, BIF, EIF)
                (start, end, increment, IF) as array of tuples
                where start and end at the beginning and ending
                channel numbers (1-rel) of the group to be included,
                increment is the increment between selected channels
                and IF is the IF number (1-rel)
                default increment is 1, IF=0 means all IF.
                Default is all channels in each IF.
                Example [(3,14,1,0),(25,30,1,0)] averages channels
                3 through 14 and 25 through 30 in each IF.

PUtilAvgT(inUV, outUV, err, scratch=False, timeAvg=1.0)
    Average A UV data set in Time

    returns Averaged UV data object
    inUV   = Python UV object to copy
             Any selection editing and calibration applied before average.
    outUV  = Predefined UV data if scratch is False, ignored if
             scratch is True.
    err    = Python Obit Error/message stack
    scratch  = True if this is to be a scratch file (same type as inUV)
    timeAvg  = Averaging time in min

PUtilCopyZero(inUV, scratch, outUV, err)
    Copy a UV data set replacing data by zero, weight 1

    returns UV data object
    inUV   = Python UV object to copy
    scratch= True if this is to be a scratch file (same type as inUV)
    outUV  = Predefined UV data if scratch is False
             ignored if scratch True.
    err    = Python Obit Error/message stack

PUtilCount(inUV, err, timeInt=1440.0)
    Count data values by interval in a UV dataset

    Each new source starts a new interval
    returns a dist with entries:
    numTime  = Number of time intervals
    numCorr  = Number of Correlations per vis
    Count    = Number of good correlation/visibilities
    Bad      = Number of flagged correlation/visibilities
    Source   = Source ID per interval (or 0 if no source ID)
    LST      = Average LST (days) per interval

    inUV   = Python UV object to copy
             Any selection editing and calibration applied before average.
    err    = Python Obit Error/message stack
    timeInt  = interval  in min (max 500 intervals)

PUtilIndex(inUV, err, maxScan=None, maxGap=None)
    Indexes a uv data
    inUV    = Python UV object to index
    err     = Python Obit Error/message stack
    maxScan = max. scan length in min. [def. long]
    maxGap  = max. scan gap in min. [def. long]

PUtilUVWExtrema(inUV, err)
    Get UV coverage information

    returns array [0]=maximum baseline length (in U,V), [1] = maximum W
    inUV   = Python UV object
    err    = Python Obit Error/message stack

PUtilVisCompare(in1UV, in2UV, err)
    Compares the visibilites in in1UV with those in in2UV

    returns RMS real, imaginary parts/amplitude
    in1UV   = Numerator  Python UV object
    in2UV   = Denominator Python UV object
    err       = Python Obit Error/message stack

PUtilVisDivide(in1UV, in2UV, outUV, err)
    Divides the visibilites in in1UV by those in in2UV

    outUV = in1UV / in2UV
    in1UV   = Numerator  Python UV object, no calibration/selection
    in2UV   = Denominator Python UV object
    outUV   = Output python UV object
    err     = Python Obit Error/message stack

PUtilVisSub(in1UV, in2UV, outUV, err)
    Subtracts the visibilites in in2UV from those in in1UV

    outUV = in1UV - in2UV
    in1UV   = First python UV object, no calibration/selection
    in2UV   = Second python UV object, calibration allowed
    outUV   = Output Python UV object, may be same as in1UV
    err     = Python Obit Error/message stack

PZap(inUV, err)
    Delete underlying files and the basic object.

    inUV      = Python UV object
    err       = Python Obit Error/message stack

PZapTable(inUV, tabType, tabVer, err)
    Destroy specified table
    Returns 0 on success
    inUV      = Python UV object
    tabType   = Table type, e.g. "AIPS AN"
    tabVer    = table version, integer
    err       = Python Obit Error/message stack

newPACNO(disk, cno, exists, err, verbose=True, nvis=1000)
    Create and initialize an AIPS based UV structure

    Create, set initial access information
    and if exists verifies the file.
    Sets buffer to hold 1000 vis.
    Returns the Python UV object
    isOK member set to indicate success
    disk     = AIPS directory number
    cno      = AIPS catalog number
    exists   = if true then the file is opened and closed to verify
    err      = Python Obit Error/message stack
    verbose  = If true any give error messages, else suppress
    nvis     = Number of visibilities read/written per call

newPAUV(name, Aname, Aclass, disk, seq, exists, err, verbose=True, nvis=1000)
    Create and initialize an AIPS based UV structure

    Create, set initial access information (full image, plane at a time)
    and if exists verifies the file.
    Sets buffer to hold 1000 vis.
    Returns the Python UV object
    isOK member set to indicate success
    name     = name desired for object (labeling purposes)
    Aname    = AIPS name of file
    Aclass   = AIPS class of file
    seq      = AIPS sequence number of file
    disk     = FITS directory number
    exists   = if true then the file is opened and closed to verify
    err      = Python Obit Error/message stack
    verbose  = If true any give error messages, else suppress
    nvis     = Number of visibilities read/written per call

newPFUV(name, filename, disk, exists, err, verbose=True, nvis=1000)
    Create and initialize an FITS based UV structure

    Create, set initial access information (full image, plane at a time)
    and if exists verifies the file.
    Sets buffer to hold 1000 vis.
    Returns the Python UV object
    isOK member set to indicate success
    name     = name desired for object (labeling purposes)
    filename = name of FITS file
    disk     = FITS directory number
    exists   = if true then the file is opened and closed to verify
    err      = Python Obit Error/message stack
    verbose  = If true any give error messages, else suppress
    nvis     = Number of visibilities read/written per call
```

1.15.3 Obit python OTF class - now defunct

To access the OTF class, your PYTHONPATH variable should include the ObitSD/python directory before the Obit/python directory. Then in ObitTalk:

```
>>>> import OTF
```

to make the OTF classes available. Further functions are available in the OTFUtil, CCBUtil, CleanOTF, CleanOTFRec,GBTDCROTF, OTFGetAtmCor, OTFGetSoln, and OTFSoln2Cal python modules. The following describes the OTF class.

```
NAME
    OTF - Python Obit "On-the-fly" (OTF) single dish data class

DESCRIPTION
    This class contains single dish data and allows access.
    An ObitOTF is the front end to a persistent disk resident structure.
    There maybe (usually are) associated tables which either describe
    the data or contain calibration and/or editing information.

    OTF Members with python interfaces:
    List      - used to pass instructions to processing
    Desc      - Astronomical labeling of the image
    TableList - List of tables attached
    RecBuf    - memory pointer into I/O Buffer

    Additional Functions are available in OTFUtil, OTFSoln2Cal, OTFGetSoln,
    OTFGetAtmCor,  CleanOTF

    There are a number of utility routines in this module which take
    control parameters in the form of python dictionaries
    (e.g. AtmCal, Clean, Concat, Image, ResidCal, Soln2Cal, Split)
    which each have defined dictionaries with default values and names of the
    routine and "Input" appended.
    Care should he taken not to change the data types of the entries in these
    dictionaries.
    These dictionaries can be listed in semi human readable form using the OTF.input
    function.

    Data selection, calibration and editing parameters on List member
      "doCalSelect" bool (1,1,1) Select/calibrate/edit data?
      "doCalib"     int  (1,1,1) >0 -> calibrate,
      "gainUse"     int  (1,1,1) SN/CL table version number, 0-> use highest
      "flagVer"     int  (1,1,1) Flag table version, 0-> use highest, <0-> none
      "BChan"       int  (1,1,1) First spectral channel selected. [def all]
      "EChan"       int  (1,1,1) Highest spectral channel selected. [def all]
      "Targets"     string (?,?,1) Target names selected. [def all]
      "timeRange"   float (2,1,1) Selected timerange in days. [def all]
      "Scans"       int  (2,1,1) Lowest and highest selected scan numbers. [def all]
      "Feeds"       int  (?,1,1) a list of selected feed numbers, [def all.]
      "keepCal"     bool (1,1,1) If true keep cal-on data, otherwise drop [def True.]

CLASSES
    OData.OData(OData.ODataPtr)
        OTF

    class OTF(OData.OData)
       Python Obit "On-the-fly" (OTF) single dish data class

       This class contains single dish data and allows access.
       An ObitOTF is the front end to a persistent disk resident structure.
       There maybe (usually are) associated tables which either describe
       the data or contain calibration and/or editing information.

       OTF Members with python interfaces:
       List      - used to pass instructions to processing
       Desc      - Astronomical labeling of the image
       TableList - List of tables attached
       RecBuf    - memory pointer into I/O Buffer

       Method resolution order:
           OTF
           OData.OData
           OData.ODataPtr

       Methods defined here:

       Clone(self, outOTF, err)
           Make a copy of a object but do not copy the actual data

           This is useful to create an OTF similar to the input one.
           self   = Python OTF object
           outOTF  = Output Python OTF object, must be defined
           err    = Python Obit Error/message stack

       Close(self, err)
           Close a OTF  persistent (disk) form

           returns 0 on success, else failure
           self      = Python OTF object
           err       = Python Obit Error/message stack

       Copy(self, outOTF, err)
           Make a deep copy of input object.

           Makes structure the same as self, copies data, tables
           self   = Python OTF object to copy
           outOTF  = Output Python OTF object, must be defined
           err    = Python Obit Error/message stack

       Header(self, err)
           Write image header on output

           self   = Python Obit OTF object
           err    = Python Obit Error/message stack

       Info(self, err)
           Get underlying data file info

           self   = Python Obit OTF object
           err    = Python Obit Error/message stack

       NewTable(self, access, tabType, tabVer, err, numDet=1,
               numPoly=0, numParm=0)
           Return the specified associated table

           self      = Python OTF object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           tabType   = Table type, e.g. "OTFSoln"
           tabVer    = table version, if > 0 on input that table returned,
                       if 0 on input, the highest version is used.
           err       = Python Obit Error/message stack
           Optional parameters, values only used if table created
           numDet    = Number of Detectors (OTFCal, OTFSoln, OTFScanData)
           numPoly   = Number of polynomial terms (OTFCal, OTFSoln)
           numParm   = Number of model parameters (OTFModel)

       OTFIsA(self)
           Tells if input really a Python Obit OTF

           return true, false (1,0)
           self   = Python OTF object

       Open(self, access, err)
           Open a OTF data persistent (disk) form

           Returns 0 on success, else failure
           self   = Python OTF object
           access = access READONLY (1), WRITEONLY (2), READWRITE(3)
           err    = Python Obit Error/message stack

       Read(self, err)
           Read a OTF  persistent (disk) form

           Reads into buffer attached to OTF data, use VisBuf for access
           Returns 0 on success, else failure
           self   = Python OTF object
           err    = Python Obit Error/message stack

       ReadRec(self, err)
           Read a OTF  persistent (disk) form

           Returns OTFRec structure from next record
           self   = Python OTF object
           err    = Python Obit Error/message stack

       Scratch(self, err)
           Create a scratch file suitable for accepting the data to be read from self

           A scratch OTF is more or less the same as a normal OTF except that it is
           automatically deleted on the final unreference.
           self      = Python OTF object
           err       = Python Obit Error/message stack

       UpdateDesc(self, err, Desc=None)
           Update any disk resident structures about descriptor

           self      = Python OTF object
           err       = Python Obit Error/message stack
           Desc      = Descriptor, if None then use current descriptor
                       Contents can be accessed throuth the Dict member

       Write(self, err)
           Write a OTF  persistent (disk) form

           Writes buffer attached to OTF data, use VisBuf for access
           returns 0 on success, else failure
           self      = Python OTF object
           err       = Python Obit Error/message stack

       WriteRec(self, outRec, err)
           Write a OTF  persistent (disk) form

           Writes buffer attached to OTF data, use VisBuf for access
           returns 0 on success, else failure
           self      = Python OTF object
           outRec    = OTFRec structure to write
           err       = Python Obit Error/message stack

         __del__(self)

       __getattr__(self, name)

       __init__(self, name)

       __repr__(self)

       __setattr__(self, name, value)

       cast(self, toClass)
           Casts object pointer to specified class

           self     = object whose cast pointer is desired
           toClass  = Class string to cast to ("ObitOTF")

       ----------------------------------------------------------------------
       Methods inherited from OData.OData:

       CopyTables(self, outOData, exclude, include, err)
           Copy Tables from one OData to another

           self      = Python OData object
           outOData     = Output Python OData object, must be defined
           exclude   = list of table types to exclude (list of strings)
           has priority
           include   = list of table types to include (list of strings)
           err       = Python Obit Error/message stack

           Mark OData as needing a header update to disk file

           self     = Python OData object

       FullInstantiate(self, access, err)
           Fully instantiate an OData by opening and closing

           return 0 on success, else failure
           self   = Python OData object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           err       = Python Obit Error/message stack

       GetHighVer(self, tabType)
           Get highest version number of a specified Table
                   returns highest tabType version number, 0 if none.
           self   = Python OData object
           tabType   = Table type, e.g. "OTFSoln"

       GetName(self)
           Tells OData object name (label)

           returns name as character string
           self   = Python OData object

       History(self, access, err)
           Return the associated History

           self      = Python OData object
           access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
           err       = Python Obit Error/message stack

       IsScratch(self)
           Tells if OData is a scratch object

           return true, false (1,0)
           self   = Python OData object

       ODataIsA(self)
           Tells if input really a Python Obit OData

           return true, false (1,0)
           self   = Python OData object

       Rename(self, err, newFITSName=None, newAIPSName='  ',
               newAIPSClass='      ', newAIPSSeq=0)
           Rename underlying files

           self   = Python OData object
           err       = Python Obit Error/message stack
           For FITS files:
           newFITSName = new name for FITS file

           For AIPS:
           newAIPSName  = New AIPS Name (max 12 char) Blank => don't change.
           newAIPSClass = New AIPS Class (max 6 char) Blank => don't change.
           newAIPSSeq   = New AIPS Sequence number, 0 => unique value

       UpdateTables(self, err)
           Update any disk resident structures about the current tables

           Returns 0 on success
           self      = Python Image object
           err       = Python Obit Error/message stack
```

```
       Zap(self, err)
           Delete underlying files and the basic object.

           self      = Python OData object
           err       = Python Obit Error/message stack

       ZapTable(self, tabType, tabVer, err)
           Destroy specified table

           Returns 0 on success
           self      = Python OData object
           tabType   = Table type, e.g. "AIPS CC"
           tabVer    = table version, integer
           err       = Python Obit Error/message stack

FUNCTIONS
    AtmCal(err, input= AtmCalInput )
        Basic atmospheric calibration.

        Applies Atmospheric calibration and optionally gross pointing offsets
        Returns the version number of the Soln Table on success.
        err     = Python Obit Error/message stack
        input   = input parameter dictionary

        Input dictionary entries:
        InData = input Python OTF to calibrate
        solint = solution interval (sec)
        tau0   = zenith opacity (nepers)
        minEl  = minimum elevation (deg)
        tTemp  = effective atmospheric temperature (per detector)
        tRx    = Receiver temperature per detector (K)
        calJy  = Noise cal value in Jy per detector
        raOff  = RA pointing offset (deg)
        decOff = Dec pointing offset (deg)

    ClearCal(inOTF, err)
        Delete calibration tables on an OTF

        Removes all OTFSoln and OTFCal tables
        inOTF    = Extant Python OTF
        err      = Python Obit Error/message stack

    Concat(err, input={'InData': None, 'OutData': None})
        Concatenates OTFs.

        Applies Copies InData to the end of  OutData.
        The files must be compatable (not checked)
        err     = Python Obit Error/message stack
        input   = input parameter dictionary

        Input dictionary entries:
        InData  = Python input OTF to calibrate
        OutData = Python output OTF, must be previously defined

    MBBaseCal(err, input=MBBaseCalInput)
        Continuum baseline fitting for multibeam instrument.

        Fit one term, time variable common, atmospheric polynomial and a single offset
        per detector.
        Since the different detectors each have an individual multiplicative term, the
        Atmospheric + offset are places in the the detector's additive term and the
        polynomial is set to zero.
        Scans in excess of 5000 samples will be broken into several.
        Returns the version number of the Soln Table on success.
        err     = Python Obit Error/message stack
        input   = input parameter dictionary

        Input dictionary entries:
        InData = input Python OTF to calibrate
        solint = solution interval (sec), entries 4 times per SolInt
        order  = polynomial order
        clipsig = Data outside of +/- clipsig ignored [def large]
        plotdet = Detector number (1-rel) to plot per scan [def =-1 = none]
        minEl   = minimum elevation (deg)
        gainuse = version number of prior table (Soln or Cal) to apply, -1 is none
        flagver = version number of flagging table to apply, -1 is none

    ObitName(ObitObject)
        Return name of an Obit object or input if not an Obit Object

    PClone(inOTF, outOTF, err)
        Make a copy of a object but do not copy the actual data

        This is useful to create an OTF similar to the input one.
        inOTF   = Python OTF object
        outOTF  = Output Python OTF object, must be defined
        err     = Python Obit Error/message stack

    PClose(inOTF, err)
        Close an image  persistent (disk) form

        inOTF     = Python OTF object
        err       = Python Obit Error/message stack

    PConcat(inOTF, outOTF, err)
        Copy data from inOTF to the end of outOTF
        inOTF   = Python OTF object
        outOTF  = Output Python OTF object, must be defined
        err     = Python Obit Error/message stack

    PCopy(inOTF, outOTF, err)
        Make a deep copy of input object.

        Makes structure the same as inOTF, copies data, tables
        inOTF     = Python OTF object to copy
        outOTF    = Output Python OTF object, must be defined
        err       = Python Obit Error/message stack

    PCopyTables(inOTF, outOTF, exclude, include, err)
        Copy Tabels from one image to another

        inOTF     = Python OTF object
        outOTF    = Output Python OTF object, must be defined
        exclude   = list of table types to exclude (list of strings)
                    has priority
        include   = list of table types to include (list of strings)
        err       = Python Obit Error/message stack

    PDirty(inOTF)
        Mark OTF as needing a header update to disk file

        inOTF     = Python OTF object

    PFullInstantiate(inOTF, access, err)
        Fully instantiate an OTF by opening and closing

        return 0 on success, else failure
        inOTF     = Python OTF object
        access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
        err       = Python Obit Error/message stack

    PGetDesc(inOTF)
        Return the member OTFDesc

        returns OTFDesc as a Python Dictionary
        inOTF   = Python OTF object

    PGetHighVer(inOTF, tabType)
        Get highest version number of a specified Table

        returns highest tabType version number, 0 if none.
        inOTF     = Python OTF object
        tabType   = Table type, e.g. "OTFSoln"
```

```
PGetList(inOTF)
    Return the member InfoList

    returns InfoList
    inOTF     = Python OTF object

PGetName(inOTF)
    Tells OTF object name (label)

    returns name as character string
    inOTF     = Python OTF object

PGetRecBuf(inOTF)

PGetTableList(inOTF)
    Return the member tableList

    returns tableList
    inOTF   = Python OTF object

PHeader(inOTF, err)
    Print data descriptor

    inOTF      = Python Obit OTF object
    err       = Python Obit Error/message stack

PIsA(inOTF)
    Tells if input really a Python Obit OTF

    return true, false (1,0)
    inOTF     = Python OTF object

PIsScratch(inOTF)
    Tells if OTF is a scratch object

    return true, false (1,0)
    inOTF   = Python OTF object

PNewOTFTable(inOTF, access, tabType, tabVer, err, numDet=1, numPoly=0, numParm=0)
    Return the specified associated table

    inOTF     = Python OTF object
    access    = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    tabType   = Table type, e.g. "OTFSoln"
    tabVer    = table version, if > 0 on input that table returned,
                if 0 on input, the highest version is used.
    err       = Python Obit Error/message stack
```

```
        Optional parameters, values only used if table created
        numDet    = Number of Detectors (OTFCal, OTFSoln, OTFScanData)
        numPoly   = Number of polynomial terms (OTFCal, OTFSoln)
        numParm   = Number of model parameters (OTFModel)

POTFInfo(inOTF, err)
    Get file info for extant uv data object

    Fills in information on object, useful for scratch files
    inOTF   = Python OTF object
    err    = Python Obit Error/message stack

POpen(inOTF, access, err)
    Open an image persistent (disk) form

    Returns 0 on success, else failure
    inOTF     = Python OTF object
    access    = access 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err       = Python Obit Error/message stack

PRename(inOTF, err, newFITSName=None)
    Rename underlying files

    inOTF   = Python OTF object
    err       = Python Obit Error/message stack
    For FITS files:
    newFITSName = new name for FITS file

PScratch(inOTF, err)
    Create a scratch file suitable for accepting the data to be read from inOTF

    A scratch OTF is more or less the same as a normal OTF except that it is
    automatically deleted on the final unreference.
    inOTF     = Python OTF object
    err       = Python Obit Error/message stack

PSetTarget(inOTF, Target, Flux, RA, Dec, err)
    Set target flux density and position

    inOTF     = Python OTF object
    Target    = Target name
    Flux      = Target Flux density
    RA        = RA in deg at mean equinox and epoch
    Dec       = Dec in deg at mean equinox and epoch
    err       = Python Obit Error/message stack

PUpdateDesc(inOTF, err, Desc=None)
    Update external representation of descriptor
    inOTF   = Python OTF object
    err     = Python Obit Error/message stack
    Desc    = OTF descriptor, if None then use current descriptor

PUpdateTables(inOTF, err)
    Update any disk resident structures about the current tables

    inOTF     = Python OTF object
    err       = Python Obit Error/message stack

PZap(inOTF, err)
    Delete underlying files and the basic object.

    inOTF     = Python OTF object
    err       = Python Obit Error/message stack

PZapTable(inOTF, tabType, tabVer, err)
    Destroy specified table

    inOTF     = Python OTF object
    tabType   = Table type, e.g. "OTFSoln"
    tabVer    = table version, integer
    err       = Python Obit Error/message stack

PolyBLCal(err, input=PolyBLCalInput)
    Polynomial baseline fit to residual data

    Each solution interval in a scan is median averaged
    (average of 9 points around the median) and then a polynomial fitted.
    Returns the version number of the Soln Table on success.
    err     = Python Obit Error/message stack
    input   = input parameter dictionary

    Input dictionary entries:
    InData = input Python OTF to calibrate
    solint = solution interval (sec)
    order  = polynomial order
    minEl  = minimum elevation (deg)
    gainuse = version number of prior table (Soln or Cal) to apply, -1 is none
    flagver = version number of flagging table to apply, -1 is none

ResidCal(err, input=ResidCalInput)
    Determine residual calibration for an OTF.

    Determines a solution table for an OTF by one of a number of techniques using
    residuals from a model image.
    Returns the version number of the Soln Table on success.
    err     = Python Obit Error/message stack
    input   = input parameter dictionary

    Input dictionary entries:
    InData  = Python input OTF to calibrate
    Model   = Python input model FArray, "None" means do not subtract model image
    ModelDesc= Python input model ImageDesc
    minFlux = Minimum brightness in model
    solint = solution interval (sec)
    solType = solution type:
       "Gain" solve for multiplicative term from "cals" in data.
             (solint, minRMS, minEl, calJy)
       "Offset" Solve for additive terms from residuals to the model.
             (solint, minEl)
       "GainOffset" Solve both gain and offset
             (solint, minRMS, minEl, calJy)
       "Filter"  Additive terms from filters residuals to the model.
             (solint, minEl)
        "multiBeam" Multibeam solution
             (solint, minEl)
    minEl  = minimum elevation (deg)
    minRMS = Minimum RMS residual to solution
    calJy  = Noise cal value in Jy per detector
    gainuse = version number of prior table (Soln or Cal) to apply, -1 is none
    flagver = version number of flagging table to apply, -1 is none

SelfCal(err, ImageInp=ImageInput, Soln2CalInp=Soln2CalInput)
    Self calibrate an OTF

    Image an OTF, optionally Clean, determine residual calibration,
    apply to Soln to Cal table.  If the Clean is done, then the CLEAN result is
    used as the model in the ResidCal, otherwise the dirty image from Image is.
    err         = Python Obit Error/message stack
    ImageInp    = input parameter dictionary for Image
    CleanInp    = input parameter dictionary for Clean, "None"-> no Clean requested
                  May be modified to point to the result of the Image step
    ResidCalInp = input parameter dictionary for ResidCal
                  Will be modified to give correct derived model image
    Soln2CalInp = input parameter dictionary for Soln2Cal

Soln2Cal(err, input=Soln2CalInput)
    Apply a Soln (solution) table to a Cal (calibration) table.

    err     = Python Obit Error/message stack
    input   = input parameter dictionary

    Input dictionary entries:
    InData = Python input OTF to calibrate
    soln   = Soln table version number to apply, 0-> high
    oldCal = input Cal table version number, -1 means none, 0->high
    newCal = output Cal table version number, 0->new

Split(err, input=SplitInput)
    Select and calibrate an OTF writing a new one.

    Applies calibration and editing/selection to inData and writes outData.
    err     = Python Obit Error/message stack
    input   = input parameter dictionary

    Input dictionary entries:
    InData  = input Python OTF to calibrate
    OutData = output Python OTF, must be previously defined
    average = if true average in frequency
    gainuse = version number of prior table (Soln or Cal) to apply, -1 is none
    flagver = version number of flagging table to apply, -1 is none

input(inputDict)
    Print the contents of an input Dictionary

    inputDict = Python Dictionary containing the parameters for a routine
    There should be a member of the dictionary ('structure') with a value
    being a list containing:
    1) The name for which the input is intended (string)
    2) a list of tuples consisting of (parameter name, doc string)
       with an entry for each parameter in the dictionary.
       The display of the the inputs dictionary will be in the order of
       the tuples and display the doc string after the value.
       An example:
       Soln2CalInput={'structure':['Soln2Cal',[('InData','Input OTF'),
                                               ('soln','input soln table version'),
                                               ('oldCal','input cal table version, -1=n
                                               ('newCal','output cal table')]],
                      'InData':None, 'soln':0, 'oldCal':-1, 'newCal':0}

makeImage(err, input=ImageInput)
    Image an OTF.

    Data is convolved and resampled onto the specified grid.
    Image is created and returned on success.
    err     = Python Obit Error/message stack
    input   = input parameter dictionary

    Input dictionary entries:
    InData  = input Python OTF to image
    OutName = name of output image file
    Disk    = disk number for output image file
```

```
        ra      = center RA (deg)
        dec     = center Dec (deg)
        nx      = number of pixels in "x" = RA
        ny      = number of pixels in 'Y' = dec
        xCells  = Cell spacing in x (asec)
        yCells  = Cell spacing in y (asec)
        minWt   = minimum summed weight in gridded image [def 0.1]
        ConvType= Convolving function Type 0=pillbox,3=Gaussian,4=exp*sinc,5=Sph wave
        ConvParm= Convolving function parameters depends on ConvType
          Type 2 = Sinc, (poor function - don't use)
            Parm[0] = halfwidth in cells,
            Parm[1] = Expansion factor
          Type 3 = Gaussian,
            Parm[0] = halfwidth in cells,[def 3.0]
            Parm[1] = Gaussian with as fraction or raw beam [def 1.0]
          Type 4 = Exp*Sinc
            Parm[0] = halfwidth in cells, [def 2.0]
            Parm[1] = 1/sinc factor (cells) [def 1.55]
            Parm[2] = 1/exp factor (cells) [def 2.52]
            Parm[3] = exp power [def 2.0]
          Type 5 = Spherodial wave
            Parm[0] = halfwidth in cells [def 3.0]
            Parm[1] = Alpha [def 5.0]
            Parm[2] = Expansion factor [not used]

        gainuse = version number of prior table (Soln or Cal) to apply, -1 is none
        flagver = version number of flagging table to apply, -1 is none
        doBeam  = Beam convolved with convolving Fn image desired? [def True]
        Beam    = Actual instrumental Beam to use, else Gaussian [def None]
        Beam

    newPOTF(name, filename, disk, exists, err, nrec=1000)
        Create and initialize an OTF structure

        Create, set initial access information (nrec records)
        and if exists verifies the file.
        Returns the Python OTF object
        name     = name desired for object (labeling purposes)
        filename = name of FITS file
        disk     = FITS directory number
        exists   = if true then the file is opened and closed to verify
        err      = Python Obit Error/message stack
        nrec     = Number of records read/written per call

DATA
    AtmCalInput = {'InData': None, 'aTemp': [0.0, 0.0], 'calJy': [1.0, 1.0...
    ConcatInput = {'InData': None, 'OutData': None}
    ImageInput = {'Beam': None, 'ConvParm': [0.0, 0.0, 0.0, 0.0, 0.0, 0.0,...
    MBBaseCalInput = {'InData': None, 'clipsig': 1e+20, 'flagver': -1, 'ga...
    PolyBLCalInput = {'InData': None, 'flagver': -1, 'gainuse': -1, 'minEl...
    ResidCalInput = {'Clip': 1e+20, 'InData': None, 'Model': None, 'ModelD...
    Soln2CalInput = {'InData': None, 'newCal': 0, 'oldCal': -1, 'soln': 0,...
    SplitInput = {'InData': None, 'OutData': None, 'average': 0, 'flagver'...
```

1.15.4 Obit python Table Class

Obit Table class objects can be created as shown in the following:

```
inUV=UV.newPAUV("UV", "20050415", "LINE", 1, 1, True,err)
tabType="AIPS SU"
tabVer=1
access=UV.READONLY
su = inUV.NewTable(access,tabType,tabVer,err)
```

If a new table is being created, some optional parameters may be needed depending on the table type (see help(UV) description of NewTable).

The table header (descriptor) can be obtained as a python Dict:

```
h = su.Desc.Dict
```

Data from a row in the table can be obtained as a python Dict:

```
su.Open(access,err)
row1 = su.ReadRow(access,err)
OErr.printErrMsg(err, "Error reading")
su.Close(err)
print "row1",row1
```

Note: these dict structures are independent of the underlying data structures.

The following describes the Obit Table class.

```
NAME
    Table - Python Obit Table class

DESCRIPTION
    This class contains tabular data and allows access.
    An ObitTable is the front end to a persistent disk resident structure.
    Both FITS (as Tables) and AIPS cataloged data are supported.

    Table Members with python interfaces:
    InfoList  - used to pass instructions to processing

    Table header keywords for specific table types are available in the keys
    member of a Table after the table has been opened.  These will be updated
    to disk when the table is closed.

CLASSES
    TablePtr
        Table

    class Table(TablePtr)
```

```
Methods defined here:

Close(self, err)
    Close an table  persistent (disk) form

    Specific table type keywords are written from the "keys" dict member
    self      = Python Table object
    err       = Python Obit Error/message stack

Open(self, access, err)
    Open an table persistent (disk) form

    Specific table type keywords are written to the "keys" dict member
    self   = Python Table object
    access    = access READONLY (1), WRITEONLY (2), READWRITE(3)
    err       = Python Obit Error/message stack

ReadRow(self, rowno, err)
    Read a specified row in a table and returns as a python Dict

    self   = Python Image object
    rowno     = row number (1-rel) to read
    err    = Python Obit Error/message stack

WriteRow(self, rowno, rowDict, err)
    Write an image  persistent (disk) form from a specified Dict

    Writes a single row
    self      = Python Image object
    rowno     = row number (1-rel) to write
    rowDict   = Python Dict of same form as returned by PReadRow
    err       = Python Obit Error/message stack

Zap(self, err)
    Delete underlying files and the basic object.

    self      = Python Table object
    err       = Python Obit Error/message stack

__del__(self)

__init__(self, name)

----------------------------------------------------------------------
Methods inherited from TablePtr:

__getattr__(self, name)
```

```
       __repr__(self)

       __setattr__(self, name, value)

    class TablePtr
       Methods defined here:

       __getattr__(self, name)

       __init__(self, this)

       __repr__(self)

       __setattr__(self, name, value)

FUNCTIONS
    PClone(inTab, outTab)
        Copy the structure of a Table

        inTab    = input Python Table
        outTab   = extant output Python Obit Table or None

    PClose(inTab, err)
        Close a table  persistent (disk) form

        Specific table type keywords are written from the "keys" dict member
        inTab     = Python Table object
        err       = Python Obit Error/message stack

    PConcat(inTab, outTab, err)
        Copy row data from inTab to the end of outTab

        inTab    = input Python Obit Table
        outTab   = extant output Python Obit Table
        err      = Python Obit Error/message stack

    PCopy(inTab, outTab, err)
        Copy a Table including persistent forms

        inTab    = input Python Obit Table
        outTab   = extant output Python Obit Table
        err      = Python Obit Error/message stack

    PDirty(inTable)
        Mark Table as needing a header update to disk file

        inTable     = Python Table object
```

```
PFullInstantiate(inTab, access, err)
    Open and close to fully instantiate

    return 0 on success, else failure
    inTab    = input Python Table
    access   = access code 1=READONLY, 2=WRITEONLY, 3=READWRITE
    err      = Python Obit Error/message stack

PGetDesc(inTab)
    Return the TableDesc from a Table

    returns TableDesc
    inTab    = input Python Table

PGetIODesc(inTab)
    Return the TableDesc from a Table's IO member

    returns TableDesc from IO member (disk resident version)
    if the IO member is not defined a None is returned.
    For most reliable results, this routine should be called when
    the table is opened with Write allowed.
    inTab    = input Python Table

PGetIOList(inTab)
    Return the InfoList from a Table's IO member

    returns InfoList from IO member (disk resident version)
    if the IO member is not defined a None is returned.
    For most reliable results, this routine should be called when
    the table is opened with Write allowed.
    inTab    = input Python Table

PGetList(inTab)
    Return the InfoList from a Table

    returns InfoList
    inTab    = input Python Table

PGetName(inTab)
    Returns object name (label)

    return name string
    inTab    = input Python Table

PGetVer(inTab)
    Get table version number

    returns table version number
    inTab    = input Python Table

PIsA(inTab)
    Tells if object thinks it's a Python Obit Table

    return true, false (1,0)
    inTab    = input Python Table

POpen(inTab, access, err)
    Open a table persistent (disk) form

    Specific table type keywords are written to the "keys" dict member
    inTab     = Python Table object
    access    = access READONLY (1), WRITEONLY (2), READWRITE(3)
    err       = Python Obit Error/message stack

PReadRow(inTab, rowno, err)
    Read a specified row in a table and returns as a python Dict

    Dict has keys:
       "Table name"  to give the name of the table
       Field named   (column labels)
    data are returned as a list of the field data type.
    inTab     = Python Table object
    rowno     = row number (1-rel) to read
    err       = Python Obit Error/message stack

PSort(inTab, colName, desc, err)
    Sort a table by contents of a column

    inTab    = input Python Obit Table to sort
    colName  = Column name (e.g. "Time")
    desc     = if true sort in descending order, else ascending
    err      = Python Obit Error/message stack

PUnref(inTab)
    Decrement reference count

    Decrement reference count which will destroy object if it goes to zero
    Python object stays defined.
    inTab   = Python Table object

PWriteRow(inTab, rowno, rowDict, err)
    Write an image  persistent (disk) form from a specified Dict

    Writes a single row
    inTab     = Python Table object
    rowno     = row number (1-rel) to write
```

```
        rowDict   = Python Dict of same form as returned by PReadRow
        err       = Python Obit Error/message stack

    PZap(inTab, err)
        Destroy the persistent form of a Table

        inTab    = input Python Obit Table
        err      = Python Obit Error/message stack

DATA
    READONLY = 1
    READWRITE = 3
    WRITEONLY = 2
```

1.16 ObitTalk Data Classes

The ObitTalk classes AIPSUVData, AIPSImage, FITSUVData and FITSImage allow local or remote access to AIPS and FITS Images and UV data. Functions in these data classes work for data on remote nodes. Details of these class interfaces can be viewed using:

```
>>> help(AIPSUVData)
>>> help(AIPSImage)
>>> help(FITSUVData)
>>> help(FITSImage)
```

1.16.1 AIPSUVData

```
class AIPSUVData(_AIPSData)
  This class describes an AIPS UV data set.

  Methods inherited from _AIPSData:

  exists(self)
      Check whether this image or data set exists.

      Returns True if the image or data set exists, False otherwise.

  getrow_table(self, type, version, rowno)
      Get a row from an extension table.

      Returns row ROWNO from version VERSION of extension table TYPE
      as a dictionary.

  header(self)
      Get the header for this image or data set.

      Returns the header as a dictionary.
```

```
header_table(self, type, version)
    Get the header of an extension table.

    Returns the header of version VERSION of the extension table
    TYPE.

table(self, type, version)

table_highver(self, type)
    Get the highest version of an extension table.

    Returns the highest available version number of the extension
    table TYPE.

tables(self)
    Get the list of extension tables.

verify(self)
    Verify whether this image or data set can be accessed.

zap(self)
    Destroy this image or data set.

zap_table(self, type, version)
    Destroy an extension table.

    Deletes version VERSION of the extension table TYPE.  If
    VERSION is 0, delete the highest version of table TYPE.  If
    VERSION is -1, delete all versions of table TYPE.


Properties inherited from _AIPSData:

disk
    Disk where this data set is stored.

    lambdaself

klass
    Class of this data set.

    lambdaself

name
    Name of this data set.

    lambdaself
```

```
  seq
      Sequence number of this data set.

      lambdaself

  userno
      User number used to access this data set.

      lambdaself
```

1.16.2 AIPSImage

```
class AIPSImage(_AIPSData)
  This class describes an AIPS image.

  Methods defined here:

  display(self, dispURL='http://localhost:8765/RPC2')
      Display an image.

      Displays image on ObitView server on dispURL
      dispURL = URL of ObitView server on which to display
      Returns True if successful

  Methods inherited from _AIPSData:

  exists(self)
      Check whether this image or data set exists.

      Returns True if the image or data set exists, False otherwise.

  getrow_table(self, type, version, rowno)
      Get a row from an extension table.

      Returns row ROWNO from version VERSION of extension table TYPE
      as a dictionary.

  header(self)
      Get the header for this image or data set.

      Returns the header as a dictionary.

  header_table(self, type, version)
      Get the header of an extension table.

      Returns the header of version VERSION of the extension table
      TYPE.
```

```
table(self, type, version)

table_highver(self, type)
    Get the highest version of an extension table.

    Returns the highest available version number of the extension
    table TYPE.

tables(self)
    Get the list of extension tables.

verify(self)
    Verify whether this image or data set can be accessed.

zap(self)
    Destroy this image or data set.

zap_table(self, type, version)
    Destroy an extension table.

    Deletes version VERSION of the extension table TYPE.  If
    VERSION is 0, delete the highest version of table TYPE.  If
    VERSION is -1, delete all versions of table TYPE.


Properties inherited from _AIPSData:

disk
    Disk where this data set is stored.

    lambdaself

klass
    Class of this data set.

    lambdaself

name
    Name of this data set.

    lambdaself

seq
    Sequence number of this data set.

    lambdaself

userno
```

```
      User number used to access this data set.

      lambdaself
```

1.16.3 FITSUVData

```
class FITSUVData(_FITSData)
  This class describes an FITS UV data set.

  Methods inherited from _FITSData:

  exists(self)
      Check whether this image or data set exists.

      Returns True if the image or data set exists, False otherwise.

  getrow_table(self, type, version, rowno)
      Get a row from an extension table.

      Returns row ROWNO from version VERSION of extension table TYPE
      as a dictionary.

  header(self)
      Get the header for this image or data set.

      Returns the header as a dictionary.

  header_table(self, type, version)
      Get the header of an extension table.

      Returns the header of version VERSION of the extension table
      TYPE.

  table(self, type, version)

  table_highver(self, type)
      Get the highest version of an extension table.

      Returns the highest available version number of the extension
      table TYPE.

  tables(self)
      Get the list of extension tables.

  verify(self)
      Verify whether this image or data set can be accessed.

  zap(self)
```

```
      Destroy this image or data set.

  zap_table(self, type, version)
      Destroy an extension table.

      Deletes version VERSION of the extension table TYPE.  If
      VERSION is 0, delete the highest version of table TYPE.  If
      VERSION is -1, delete all versions of table TYPE.


  Properties inherited from _FITSData:

  disk
      Disk where this data set is stored.

      lambdaself

  filename
      Filename of this data set.

      lambdaself
```

1.16.4 FITSImage

```
class FITSImage(_FITSData)
  This class describes an FITS image.

  Methods inherited from _FITSData:

  exists(self)
      Check whether this image or data set exists.

      Returns True if the image or data set exists, False otherwise.

  getrow_table(self, type, version, rowno)
      Get a row from an extension table.

      Returns row ROWNO from version VERSION of extension table TYPE
      as a dictionary.

  header(self)
      Get the header for this image or data set.

      Returns the header as a dictionary.

  header_table(self, type, version)
      Get the header of an extension table.
```

```
    Returns the header of version VERSION of the extension table
    TYPE.

table(self, type, version)

table_highver(self, type)
    Get the highest version of an extension table.

    Returns the highest available version number of the extension
    table TYPE.

tables(self)
    Get the list of extension tables.

verify(self)
    Verify whether this image or data set can be accessed.

zap(self)
    Destroy this image or data set.

zap_table(self, type, version)
    Destroy an extension table.

    Deletes version VERSION of the extension table TYPE.  If
    VERSION is 0, delete the highest version of table TYPE.  If
    VERSION is -1, delete all versions of table TYPE.

Properties inherited from _FITSData:

disk
    Disk where this data set is stored.

    lambdaself

filename
    Filename of this data set.

    lambdaself
```