Data Management & Science Support for the System

Chris Smith

On any given night, more than a trillion bits of astronomical data flow from instruments operating in the US ground-based “System” of optical/infrared telescopes. In most cases, these bits are of greatest interest to the astronomers at the telescopes making the observations. But, the scientific potential of these bits does not stop with the astronomers and their focused observational programs.

Those same images and spectra can be of great value for other astronomers pursuing different research programs. In order to realize the full scientific potential of the data taken each night throughout the System, a coordinated program of data management must be developed to capture, archive, and deliver these data to the wide community of potential users. This effort must also support the scientific analysis of the data with highly effective tools and services, which should take advantage of both the strong existing foundation of IRAF and the promise of new platforms (both desktop and Web-based).

A well-coordinated data management program would have a multiplicative effect on the efficiency of the System. The NOAO Data Products Program (DPP) has developed an evolutionary vision to meet this challenge.

We have focused our initial efforts on developing the infrastructure necessary to capture data from NOAO telescopes and affiliated observatories, safely preserve it, and deliver both raw and some reduced data products from the NOAO Science Archive (NSA) to Principal Investigators and other users through the NOAO National Virtual Observatory (NVO) Portal. Over the next few years, our operational efforts must grow to support both the users of the NSA and Portal, and more generally, the users of the broader NVO. The NSA and Portal are important components of the NVO, and we will ensure that they remain so.

As the Virtual Observatory evolves, our development efforts will shift from fundamental infrastructure to a more general effort. In this phase of our vision, the DPP will be capable of supporting a broader range of sources of data from instruments throughout the System, while simultaneously providing effective means to exploit the petabytes of data that will be accumulating in the NVO (even before LSST arrives!)

This combination—a strong operational infrastructure, and the development of tools and services that take full advantage of the Virtual Observatory and its distributed resources—will provide users of NOAO and the System with a dynamic platform from which to pursue the next generation of astronomical discoveries.
In the September 2007 NOAO/NSO Newsletter, we announced the beta release of a new version of IRAF software version 2.14, along with our plans for continued investment over the next year. The first phase of this plan is now complete with the full release of IRAF version 2.14 for PC-IRAF systems (Mac OSX, Linux, and Cygwin) as well as several new external packages. The new release is available for immediate download from iraf.noao.edu.

We expect that the final release of the version 2.14 system, which includes ports to SunOS and Solaris (sparc CPU), FreeBSD and Solaris (Intel CPU), will be ready in the first quarter of 2008.

The initial PC-IRAF release was delayed slightly by the announcement of Mac OSX Leopard in order to address any problems present in what will certainly be a common upgrade for many users. The ongoing support for SunOS/Solaris is driven by the continued use of IRAF on these platforms at the Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory telescopes and elsewhere. No other platform ports are planned at this time, as we believe these PC-IRAF and Sun operating systems sufficiently cover the vast majority of IRAF systems in use today.

Major Features of IRAF 2.14

The version 2.14 release formalizes much of the work contributed in the context of iraf.net into an official release from NOAO. Specific changes to note include:

• New platform support (both OS and GCC compiler support)
• Numerous bug fixes
• ECL (with cmdline history and editing capability) is now the default
• FITS is now the default image format

Additional new tasks and features:

BPMEDIT - Examine and edit bad pixel masks associated with images
SKYSEP - Compute angular separation between two RA/Dec values
SKYGROUP - Group a list containing RA/Dec into spatial sublists
RAVERAGE - Compute running average, standard deviation, and envelope
ZPN projection supported in WCS interfaces

New XTOOLS procedures for expanding MEF image extensions
Access to 2MASS and USNO-B1 catalogs from ASTCAT package

New external packages:

ACE - Astronomical Catalog Environment
FITSTUTIL - Includes new FITS compression capabilities
MSCRED - Mosaic reductions (enhanced/generalized capabilities)
NEWFIRM wide-field infrared imager - General infrared data reduction and analysis
National Virtual Observatory (NVO) - Virtual Observatory tools and applications

These enhancements were made in support of new NOAO instrumentation and other projects such as the NVO (see accompanying article) and NOAO pipeline processing. These packages will continue to be developed as needed by the NOAO program, and some tasks are expected to be included in the core system in a future release.

X11IRAF version 2.0 Release

The X11IRAF package has also seen some recent development, most noticeably in the addition of support for “24-bit” displays in XImtool. Overall the X11IRAF tools have been upgraded with changes needed to support new platforms and compilers, but they remain functionally much the same.

These releases mark the beginning of a longer-term strategy which aims to satisfy the short-term needs of the DPP program, NOAO operations, and the astronomical community, while providing a bridge to the development of future scientific software tools and environments in coordination with STScI, Gemini, and other astronomical software development groups. While NOAO will provide direct support for specific project-related packages (e.g., NEWFIRM and NVO), overall IRAF user support will still be the main responsibility of the iraf.net community site. DPP staff will be active participants at both the internal project helpdesk as well as the broader iraf.net forums, and future announcements of new releases will be made online and in this Newsletter.
IRAF and UNIX Tools for the VO

Mike Fitzpatrick

VOClient is a new software package developed for the National Virtual Observatory (NVO) that provides an easy-to-use interface between desktop applications and remote Virtual Observatory (VO) data and services, without requiring the developer to know the details of the underlying technologies. The VOClient library has allowed us not only to integrate the Image Reduction and Analysis Facility (IRAF) system with the VO, but to also create a set of UNIX tools that make the package immediately useful to users.

Because VOClient is a C-language interface, using it within the IRAF Command Language (CL) and SPP languages to create new VO functions was straightforward. The result is the new IRAF NVO external package that contains a CL interpreter with VO capabilities (called VO-CL) and a variety of script and compiled tasks that provide tools for remote data query and retrieval and several demonstration science applications.

The IRAF NVO package tasks are built using standard VO protocols, allowing new VO resources to be discovered and used by tasks without requiring a new package release. These tools provide access to hundreds of catalogs and image archives, as well as thousands of tables published in journals. Aside from data access, toolbox tasks supply convenient applications to simplify the process of, for example, overlaying radio contours on an image display, identifying catalog sources in a field, or finding complementary data taken at other observatories.

Tasks use the native IRAF support for sexagesimal values to allow users to work naturally in terms of Right Ascension/Declination, or positions can be resolved from names automatically. The familiar @-file syntax supports list processing, and in cases where a search position and size are required, an image’s World Coordinate System can be used to derive the information. For example, to access the Guide Star Catalog (GSC2.2) about a given point on the sky, these three commands are equivalent:

nvo> vocatalog gsc2.2 ngc4528
nvo> vocatalog gsc2.2 12:34:06 11:20:00
nvo> vocatalog gsc2.2 ngc4528.fits

The UNIX command-line tools in VOClient, dubbed VO-CLI, provide much of the same functionality as their IRAF counterparts, but they are much easier to use from non-IRAF scripting environments and can parallelize large queries to greatly speed up data query and retrieval. Additionally, these tools may be used within the IRAF NVO package to take advantage of the faster query speeds.

There are three VO-CLI tasks at present. The VOSESAME task provides a simple object name-to-position resolution function. The VOREGISTRY task permits a user to search the VO for data resources using keywords or by specifying options that define a constraint such as “any x-ray image archive.” Optional output includes a simple count of the results or a complete description of the tables that would be returned.

The heart of the VO-CLI tasks is VODATA which combines the other tasks’ abilities to create and resolve resource and object lists with the query and retrieval of actual data. Output tables may be saved in a variety of formats (even Google Sky), and the concepts of being able to use common names for VO services and user-friendly input formats are a key part of the interface. For example, to retrieve all XMM-Newton data for a particular object use the command:

% vodata -get xmm-newton 3c273

Once completed, the user will have 27 new images downloaded from the XMM-Newton archive service.

Further information about the IRAF NVO package, the VO-CLI tools and VOClient library may be found at iraf.noao.edu and nvo.noao.edu/vo-cli.

The VO-CLI site also includes a demonstration Web interface to each of the tasks including enhanced interfaces to environments such as Java, Python, and IDL.
NOAO Helps Bring the Night Sky to Google Earth

Christopher J. Miller & Douglas Isbell

Google recently released version 4.2 of its popular Google Earth software, which allows Internet users to explore the night sky in color and in various levels of detail via an interface known as Sky for Google Earth.

NOAO and DPP have started to integrate many of the amazing color-composite images taken with NOAO telescopes and instruments into Sky for Google Earth. As step one, we have worked with Andy Connolly at the University of Washington and his collaborators Jeremy Brewer, Ryan Scranton, and Simon Krughoff, to include two surveys from the NOAO Science Archive: the Magellanic Clouds Emission Line Survey (MCELS; Chris Smith of NOAO is the Principal Investigator) and the Local Group Survey (led by Principal Investigator Phil Massey of Lowell Observatory). Many thanks go to Sean Points and Knut Olsen, both of NOAO, for providing the color composites. Step two this winter will see about two dozen press release-quality images from the online NOAO Image Gallery integrated into the Google system.

To see some of NOAO’s signature images in Sky for Google Earth, visit www.noao.edu/dpp/ge/ and download the NOAO Showcase “KML” file and open it in your Google Earth version 4.2. For more information or to download Google Earth, visit earth.google.com/sky/skyedu.html.

DPP Releases a New FITS Library for Ruby

David Gasson

The NOAO Data Products Program (DPP) announces the initial release of RFits, an object-oriented wrapper, written in Ruby, around the NASA High-Energy Astrophysics Science Archive Research Center’s CFITSIO library (heasarc.gsfc.nasa.gov/docs/software/fitsio/fitsio.html).

The Flexible Image Transport System (FITS) is a data format designed to provide a means for convenient exchange of astronomical data between installations whose standard internal formats and hardware differ.

RFits leverages the flexibility and expressiveness of the scripting language Ruby (www.ruby-lang.org/) to allow basic manipulation of FITS files. It is released under the Gnu General Public License (version 2) and is available to anyone in the community from rubyforge.org/projects/rfits/.

Here is a small code example that shows how a user might use the RFits module:

```ruby
RFits::File.open('m31.fits', 'rw') do |fits|
  img = fits[0]  # first extension is an image
  # retrieve/write header values using hash syntax
  header = img.header
  puts header['TELESCOP']
  # place a new keyword into the header called MY_HDR
  header['MY_HDR'] = 'Hello, world!'
  # retrieve/write pixel values using array syntax
  pixels = img.data
  first_pixel = pixels[0]
  pixels[10] = 5  # ninth pixel set to 5
end
```
NOAO DPP at ADASS XVII and the IVOA Meetings

Christopher Miller

The Astronomical Data Analysis Software and Systems (ADASS) conference is held each year to provide a forum for scientists and programmers concerned with algorithms, software, and software systems employed in the acquisition, reduction, analysis, and dissemination of astronomical data. The ADASS meetings are an important venue for the NOAO Data Products Program (DPP) to announce or demonstrate the tools and services being developed, and to collect information and ideas on what other developers are doing.

This year’s meeting was held in London and had a strong DPP presence:

- Mike Fitzpatrick IRAF: Developing in a New Age (poster)
- Christopher J. Miller et al. The NOAO NVO Portal and the Web 2.0 (talk)
- Rob Seaman Embedded Processing for the Virtual Observatory (poster)
- R. Chris Smith et al. The Ground-based O/IR Data Preservation Challenge at NOAO: Scaling up from Terabytes to Petabytes (poster)
- Frank Valdez et al. The NOAO Pipeline Applications (talk)
- Nelson Zárate and Mike Fitzpatrick The NEWFIRM Data Handling System (poster)
- Brian Thomas and Ed Shaya (University of Maryland and affiliated with NOAO DPP) A User Interface for Semantically Oriented Data Mining of Astronomy Repositories (poster)
- Robert Swaters et al. (University of Maryland and affiliated with NOAO DPP) The NOAO NEWFIRM Pipeline (poster)

There were also a number of extra sessions sponsored by NOAO DPP staff. Rob Seaman co-sponsored a “Birds-of-a-Feather” (BOF) entitled “Transient Event Reporting and Response with VOEvent,” and Mike Fitzpatrick, Rob Seaman, Frank Valdez and Nelson Zárate sponsored an IRAF users and developers BOF. Both BOFs were well attended.

The NOAO ADASS meeting abstracts are available to the public at the ADASS Web site www.adass.org.

Last year’s ADASS XVI meeting presentations have recently been published by the Astronomical Society of the Pacific as volume number 376 and are electronically available at: www.aspbooks.org. The editors of this edition of the ADASS proceedings are NOAO staff members Richard Shaw, Frank Hill and Dave Bell.

The International Virtual Observatory Alliance (IVOA) held its bi-annual interoperability meeting in Cambridge, UK, directly after the ADASS XVII meeting. DPP attendees included Chris Smith, Mike Fitzpatrick, and Rob Seaman. Presentations included The VO-CLI: Command-line Tools for the VO and Looking to VOEvent 2.0.