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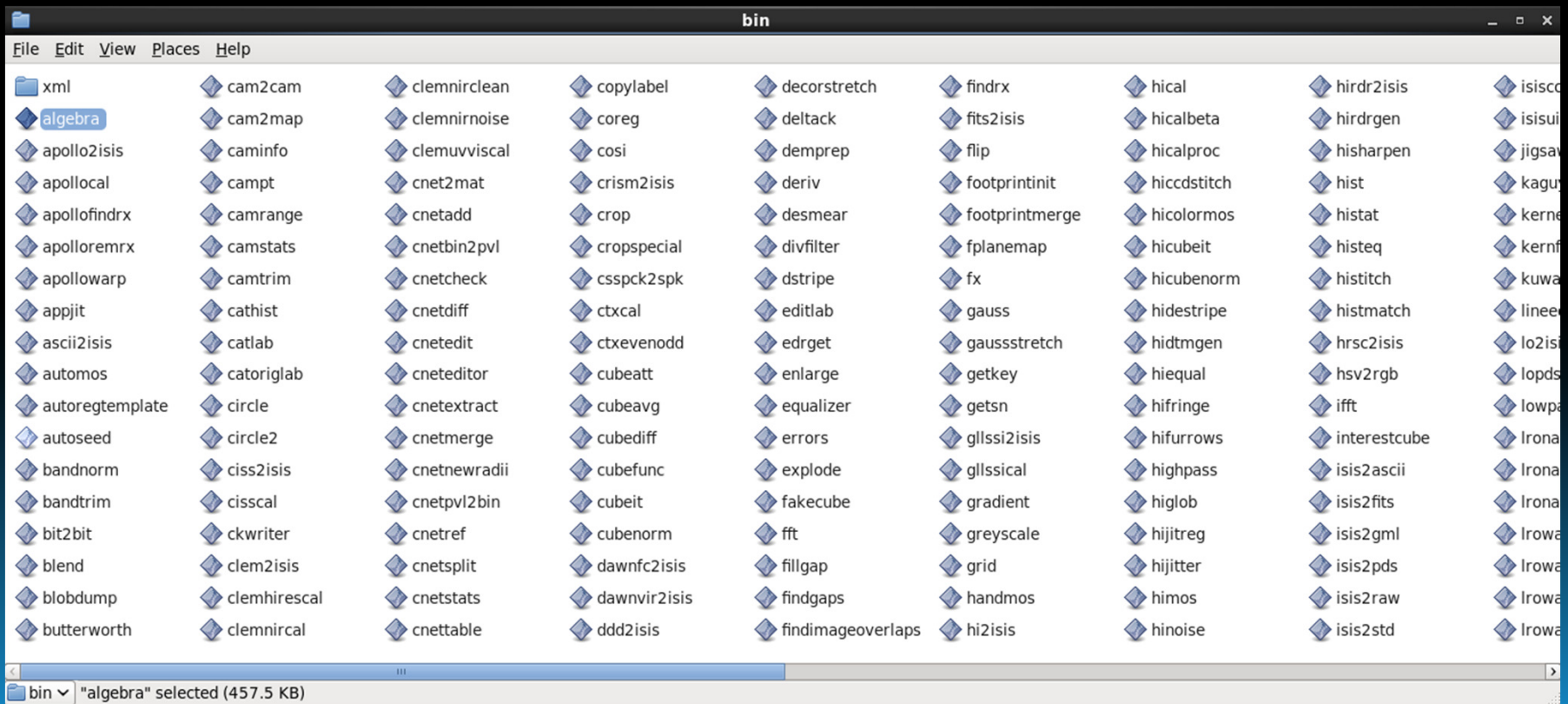
USER SYSTEM OF ASTROGEOLOGY TECHNOLOGIES

# Introduction

- USGS Astrogeology Research Program
  - Trent Hare and Moses Milazzo
- ISIS (Integrated Software for Imagers & Spectrometers)
  - A tool used in analyzing images from planetary missions

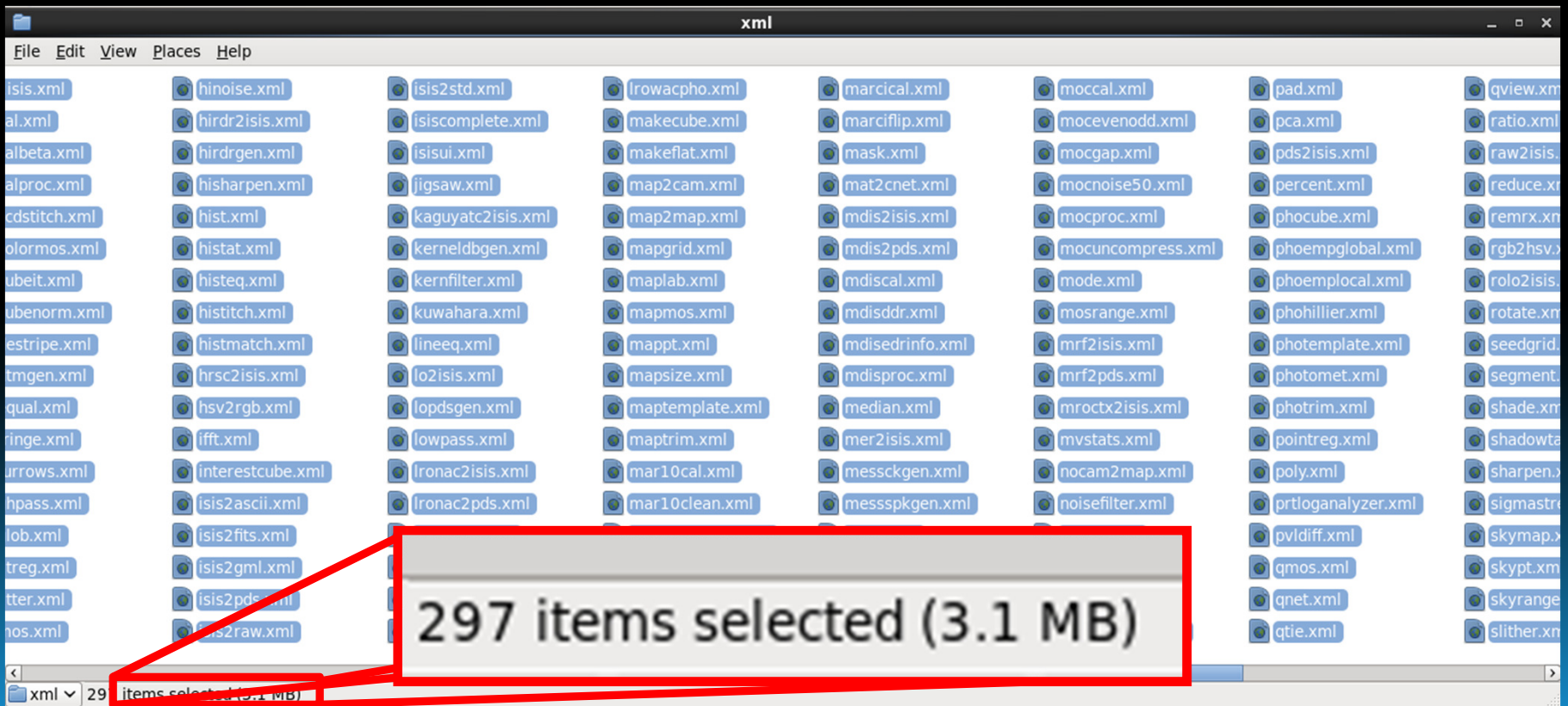
# Problem

- $\approx 300$  C++ programs run individually from the command line.



# Problem Continued

- $\approx 300$  XML documents used to create a different GUI for each (run locally).



# Solution Plan

- Create a centralized GUI
  - Organized and easy to use
  - Workflow creation
- Help Center
  - Documentation within the GUI

# Requirements & Specifications

- Expandability
  - Integrate new ISIS programs
  - Adapt to future environments
- Ease of Use
  - Everything needed to make a workflow at one's fingertips
- Design for Unix/Linux environments

# Solution Overview

The screenshot displays the Galaxy web interface with the 'lowpass' tool selected. The interface includes a top navigation bar with 'Galaxy' and menu items like 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. On the left, a 'Tools' sidebar lists various categories including 'CORE PROGRAMS', 'Cameras', 'Control Networks', 'Display', and 'Filters'. The 'lowpass' tool configuration panel is the central focus, showing the 'Input Cube' set to '10: pds2isis on data 1' and a list of 'Filter Pixel Types' with checkboxes for 'Filter valid pixels', 'Filter invalid pixels', 'Filter Null pixels', 'Filter LIS pixels', 'Filter LRS pixels', 'Filter HIS pixels', and 'Filter HRS pixels'. An 'Execute' button is at the bottom of the configuration panel. Below the configuration, a descriptive text explains the tool's function: 'This program applies a lowpass or blurring filter to a cube. An NxM boxcar is moved through the cube and average of the boxcar at each position is computed. This average, which effectively blurs the data, is written to the output cube. The user has the ability to choose which input pixels are filtered including 1) all pixels, 2) pixels within a user specified range, 3) pixels outside a user specified range, and 4) special pixels. In general, the larger the boxcar the more'. On the right, a 'History' panel shows a list of jobs, including '10: pds2isis on data 1' (2.0 Mb) and '1: mars\_viking.pds' (1.0 Mb, pds format, database: 2). The 'Done' button is visible at the bottom left of the interface.

**Galaxy** Analyze Data Workflow Shared Data Admin Help User

**Tools** Options

CORE PROGRAMS

Cameras

Control Networks

Display

Filters

- deriv Apply horizontal or vertical derivative
- divfilter Apply a spatial high pass filter to a cube (divide)
- dstripe Remove horizontal or vertical stripes/noise from a cube
- gauss Filter a cube through a kernel using Gaussian weight
- gradient Apply Sobel or Roberts gradient to a cube
- highpass Apply a spatial high pass filter to a cube
- interestcube Used to test Interest Operators

**lowpass**

**Input Cube:**  
10: pds2isis on data 1  
Select ISIS Cube to apply the filter to.

**Filter Pixel Types:**  
Select All Unselect All

- Filter valid pixels
- Filter invalid pixels
- Filter Null pixels
- Filter LIS pixels
- Filter LRS pixels
- Filter HIS pixels
- Filter HRS pixels

Execute

This program applies a lowpass or blurring filter to a cube. An NxM boxcar is moved through the cube and average of the boxcar at each position is computed. This average, which effectively blurs the data, is written to the output cube. The user has the ability to choose which input pixels are filtered including 1) all pixels, 2) pixels within a user specified range, 3) pixels outside a user specified range, and 4) special pixels. In general, the larger the boxcar the more

**History** Options

Unnamed history 2.0 Mb

- 10: pds2isis on data 1
- 1: mars\_viking.pds  
1.0 Mb  
format: pds, database: 2  
Info: uploaded None file  
Image in pds format

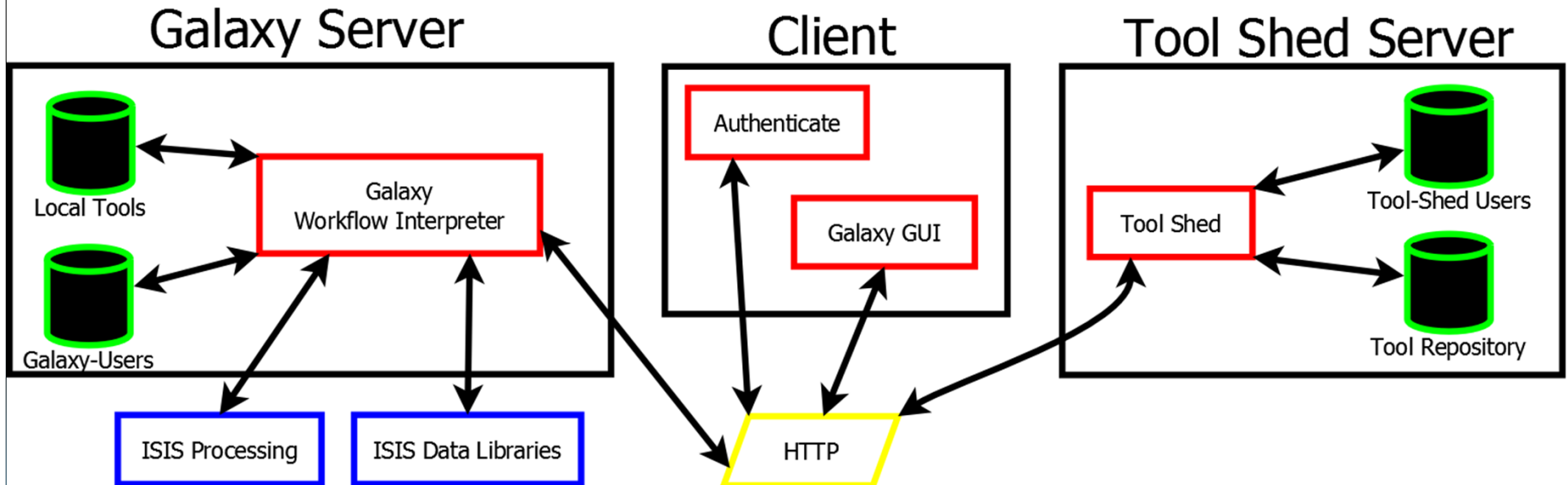
Done

# Galaxy

- What is it?
  - Open source software
  - Workflow creator
  - Uses XML, Javascript and Python
- Why use it?
  - Preexisting foundation vs. recreating the wheel



# Architecture Overview



# Analyze Data View

- Includes several key features

The screenshot displays the Galaxy web interface with the 'Analyze Data' tab selected. The main workspace shows the configuration for the 'lowpass' tool. The 'Input Cube' is set to '10: pds2isis on data 1'. Under 'Filter Pixel Types', several options are checked: 'Filter invalid pixels', 'Filter LIS pixels', 'Filter LRS pixels', and 'Filter HIS pixels'. The 'Execute' button is visible at the bottom of the tool configuration panel.

The left sidebar contains a 'Tools' panel with a list of 'CORE PROGRAMS' and 'Filters'. The 'Filters' section includes:
 

- deriv**: Apply horizontal or vertical derivative
- divfilter**: Apply a spatial high pass filter to a cube (divide)
- dstripe**: Remove horizontal or vertical stripes/noise from a cube
- gauss**: Filter a cube through a kernel using Gaussian weight
- gradient**: Apply Sobel or Roberts gradient to a cube
- highpass**: Apply a spatial high pass filter to a cube
- interestcube**: Used to test Interest Operators

The right sidebar shows the 'History' panel with a list of jobs:
 

- Unnamed history (2.0 Mb)
- 10: pds2isis on data 1
- 1: mars\_viking.pds (1.0 Mb, format: pds, database: 2, Info: uploaded None file)

The bottom status bar shows 'Done'.

# Workflow View

- Workflow functionality

The screenshot displays the Galaxy web interface for workflow management. At the top, there is a navigation bar with the Galaxy logo and tabs for 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. Below the navigation bar, the page title is 'Your workflows'. On the right side of this section, there are two buttons: 'Create new workflow' and 'Upload or import workflow'. A table lists the workflows with columns for 'Name' and '# of Steps'. One workflow is visible with 4 steps. A context menu is open over the first workflow, listing actions: Edit, Run, Share or Publish, Download or Export, Clone, Rename, and Delete. Below the table, there is a section titled 'Shared with you by others' with a sub-section 'Shared with you.' and a 'menu' button. At the bottom of the interface, there is a 'Done' button.

Galaxy

Analyze Data Workflow Shared Data Admin Help User

Your workflows

Create new workflow Upload or import workflow

Name	# of Steps
	4

- Edit
- Run
- Share or Publish
- Download or Export
- Clone
- Rename
- Delete

Shared with you by others

Shared with you.

menu

Done

# Workflow View Continued

- Same tools list as Analyze Data View

The screenshot displays the Galaxy Workflow View interface. The top navigation bar includes "Galaxy", "Analyze Data", "Workflow", "Shared Data", "Admin", "Help", and "User". The main area is divided into three panels:

- Tools:** A list of tools is shown on the left, with a red circle highlighting the "isis2pds" tool. The list includes:
  - test:interest Operators
  - isis2pds: Convert an ISIS Cube to a PDS formatted image.
  - kernfilter: Filter a cube through a kernel
  - kuwahara: Filter a cube, smoothing but preserving edges
  - lowpass: Apply lowpass or blurring filter to a cube
  - median: Set pixels to median of surrounding pixel values
  - minmax: Apply a minimum or maximum filter to a cube
  - pds2isis: Convert PDS formatted image to a ISIS Cube.
- Workflow Canvas | Demo Workflow:** A central grid showing a workflow. It consists of four tool nodes:
  - Input Dataset:** Output "output" connected to the "Input .pds" input of the top "pds2isis" node.
  - lowpass:** Input "Input Cube" connected to the "Input CUB" input of the bottom "isis2pds" node.
  - pds2isis (top):** Output "TO (cub)" connected to the "Input CUB" input of the bottom "isis2pds" node.
  - isis2pds (bottom):** Output "TO (pds)" highlighted with a blue box.
- Details:** A panel on the right showing the configuration for the selected "Tool: isis2pds". It includes:
  - Input CUB:** Data input 'FROM' (cub)
  - Edit Step Actions:** "Rename Dataset" dropdown set to "TO", a "Create" button, and a "Rename Dataset on TO" action.
  - New output name:** A text box containing "Demo Workflow Output".
  - A description: "This action will rename the result dataset." and "Add actions to this step; actions are applied when this workflow step completes."

The bottom of the interface shows a "Done" button.

# Workflow View Continued

- Drag and drop workflow builder

The screenshot displays the Galaxy workflow builder interface. The top navigation bar includes 'Galaxy', 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. The main area is divided into three panels:

- Tools:** A list of tools with descriptions, including `isis2pds`, `kernfilter`, `kuwahara`, `lowpass`, `median`, `minmax`, and `pds2isis`.
- Workflow Canvas | Demo Workflow:** A grid-based workspace where workflow steps are connected. The steps shown are:
  - Input Dataset** (output: output) connected to **pds2isis** (Input .pds, TO (cub)).
  - lowpass** (Input Cube, TO (cub)) connected to **isis2pds** (Input CUB, TO (pds)).A red circle highlights the workflow canvas area. A blue box highlights the **isis2pds** tool in the canvas.
- Details:** A panel for the selected tool, `isis2pds`. It shows:
  - Tool: isis2pds**
  - Input CUB**: Data input 'FROM' (cub)
  - Edit Step Actions**: Includes 'Rename Dataset' and 'Create' buttons.
  - Rename Dataset on TO**: A section for configuring the output name, currently set to 'Demo Workflow Output'.
  - New output name:** A text input field containing 'Demo Workflow Output'.
  - Description:** 'This action will rename the result dataset.'
  - Footer:** 'Add actions to this step; actions are applied when this workflow step completes.'

The bottom status bar shows 'Done'.

# Workflow View Continued

- Edit actions of each step.

The screenshot displays the Galaxy workflow editor interface. The top navigation bar includes 'Galaxy', 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. The main area is divided into three panels:

- Tools:** A list of tools including 'testinterestOperators', 'isis2pds', 'kernfilter', 'kuwahara', 'lowpass', 'median', 'minmax', and 'pds2isis'. The 'isis2pds' tool is highlighted.
- Workflow Canvas | Demo Workflow:** A grid-based workspace showing a workflow. It includes an 'Input Dataset' (output) connected to a 'pds2isis' tool (Input .pds, TO (cub)). Below this, a 'lowpass' tool (Input Cube, TO (cub)) is connected to another 'isis2pds' tool (Input CUB, TO (pds)). A red circle highlights the 'isis2pds' tool, and a red arrow points from it to the 'Details' panel.
- Details:** A panel for the selected 'Tool: isis2pds'. It shows 'Input CUB' with 'Data input 'FROM' (cub)'. Under 'Edit Step Actions', there is a 'Rename Dataset on TO' action with a 'New output name:' field containing 'Demo Workflow Output'. A red circle highlights the 'Add' button (a star icon) next to the action list.

The bottom status bar shows 'Done'.



# Running Workflows

- Return to the Analyze Data View to run

The screenshot displays the Galaxy web interface. The top navigation bar includes 'Galaxy' and tabs for 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. The left sidebar lists 'Tools' under 'MISSION SPECIFIC PROGRAMS', including various Mars-related missions like Apollo, Cassini, and Mars Reconnaissance Orbiter. The main content area is titled 'Your workflows' and features a table with the following data:

Name	# of Steps
<a href="#">Demo Workflow</a>	4

Below the table, it states 'Workflows shared with you by others' and 'No workflows have been shared with you.' A button 'Switch to workflow management view' is also present. The right sidebar shows the 'History' panel with a list of workflow steps:

- Unnamed history (2.0 Mb)
- 10: pds2isis on data 1
- 1: mars\_viking.pds (1.0 Mb, format: pds, database: 2, Info: uploaded None file)

The 'Image in pds format' section is visible at the bottom of the history panel.

# Tool Shed - Repository

Galaxy Tool Shed
Repositories Admin Help User

**Administration**

**Repositories**

- [Browse by category](#)
- [Browse all repositories](#)
- [Browse metadata](#)

**Categories**

- [Manage categories](#)

**Security**

- [Manage users](#)
- [Manage groups](#)
- [Manage roles](#)

**Repository revision**

repository tip  
 Select a revision to inspect and download versions of tools from this repository.

**isis3**

**Clone this repository:**  
hg clone <http://usat-admin@134.114.52.66:9009/repos/usat-admin/isis3>

**Name:**  
  
 Repository names cannot be changed if the repository has been cloned.

**Synopsis:**

**Detailed description:**

**Revision:**  
2:d39aa471564b

**Owner:**  
usat-admin

**Times downloaded:**  
0

**Location:**  
database/community\_files/000/repo\_3

**Deleted:**  
False

**Preview tools and inspect metadata by tool version**

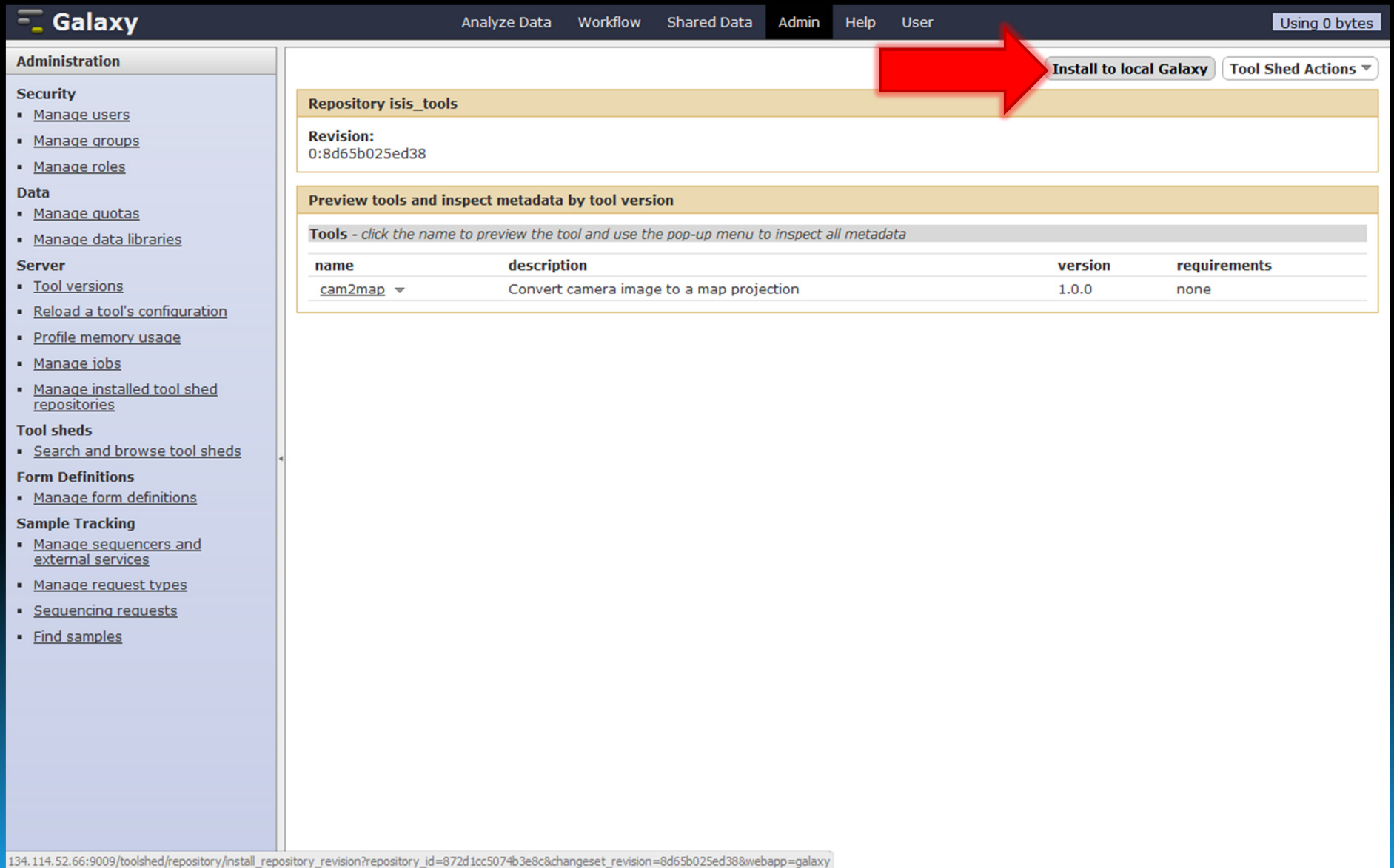
**Tools** - click the name to preview the tool and use the pop-up menu to inspect all metadata

name	description	version	requirements
<a href="#">Viking to ISIS</a>	▼ This program will import a PDS formatted Viking EDR into an Isis cube. The input file can be in compressed or decompressed form	1.0.0	none

- Upload files to repository
- View change log
- Browse or delete repository tip files
- Reset all repository metadata
- Download as a .tar.gz file
- Download as a .tar.bz2 file
- Download as a zip file



# Tool Repositories



The screenshot displays the Galaxy web interface. The top navigation bar includes 'Galaxy', 'Analyze Data', 'Workflow', 'Shared Data', 'Admin', 'Help', and 'User'. A 'Using 0 bytes' indicator is in the top right. The left sidebar contains a navigation menu with categories: Administration, Security (Manage users, Manage groups, Manage roles), Data (Manage quotas, Manage data libraries), Server (Tool versions, Reload a tool's configuration, Profile memory usage, Manage jobs, Manage installed tool shed repositories), Tool sheds (Search and browse tool sheds), Form Definitions (Manage form definitions), and Sample Tracking (Manage sequencers and external services, Manage request types, Sequencing requests, Find samples).

The main content area shows the 'Repository isis\_tools' page. At the top right, there is a red arrow pointing to the 'Install to local Galaxy' button, with a 'Tool Shed Actions' dropdown menu next to it. Below this, the 'Revision' is listed as '0:8d65b025ed38'. A section titled 'Preview tools and inspect metadata by tool version' contains a table of tools. The table has columns for 'name', 'description', 'version', and 'requirements'. One tool is listed: 'cam2map' with a dropdown arrow, description 'Convert camera image to a map projection', version '1.0.0', and requirements 'none'.

134.114.52.66:9009/toolshed/repository/install\_repository\_revision?repository\_id=872d1cc5074b3e8c&changeset\_revision=8d65b025ed38&webapp=galaxy

# Tool Versioning

Galaxy Analyze Data Workflow Shared Data Admin Help User Using 0 bytes

**Administration**

**Security**

- [Manage users](#)
- [Manage groups](#)
- [Manage roles](#)

**Data**

- [Manage quotas](#)
- [Manage data libraries](#)

**Server**

- [Tool versions](#)
- [Reload a tool's configuration](#)
- [Profile memory usage](#)
- [Manage jobs](#)
- [Manage installed tool shed repositories](#)

**Tool sheds**

- [Search and browse tool sheds](#)

**Form Definitions**

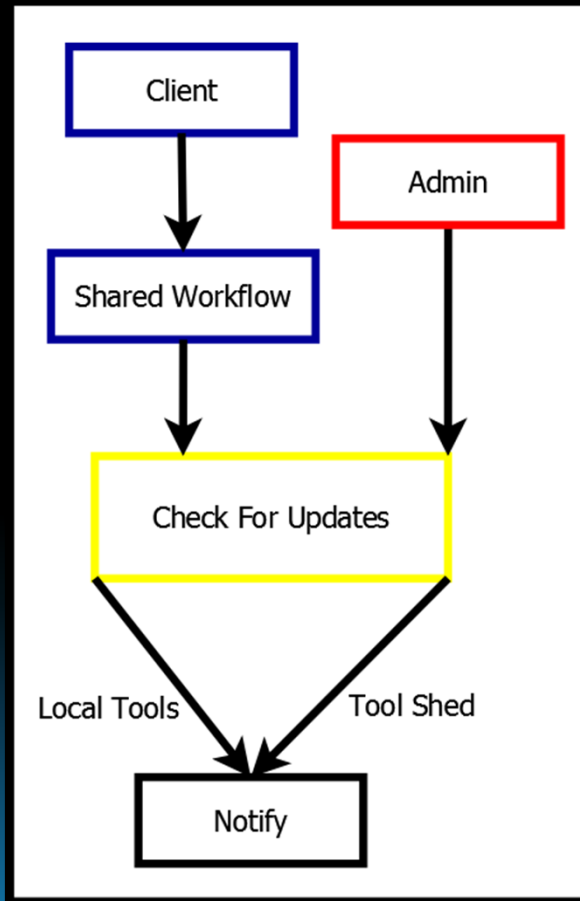
- [Manage form definitions](#)

**Sample Tracking**

- [Manage sequencers and external services](#)
- [Manage request types](#)
- [Sequencing requests](#)
- [Find samples](#)

ctxevenodd	ctxevenodd <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/ctxevenodd/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/ctxevenodd/1.0.0</a>
deriv	deriv <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/deriv/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/deriv/1.0.0</a>
divfilter	divfilter <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/divfilter/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/divfilter/1.0.0</a>
dstripe	dstripe <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/dstripe/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/dstripe/1.0.0</a>
gauss	gauss <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/gauss/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/gauss/1.0.0</a>
gradient	gradient <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/gradient/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/gradient/1.0.0</a>
highpass	highpass <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/highpass/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/highpass/1.0.0</a>
interestcube	interestcube <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/interestcube/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/interestcube/1.0.0</a>
isis2pds	isis2pds <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/isis2pds/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/isis2pds/1.0.0</a>
isis2std	isis2std <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/isis2std/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/isis2std/1.0.0</a>
kernfilter	kernfilter <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/kernfilter/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/kernfilter/1.0.0</a>
kuwahara	kuwahara <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/kuwahara/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/kuwahara/1.0.0</a>
lowpass	lowpass <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/lowpass/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/lowpass/1.0.0</a>
median	median <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/median/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/median/1.0.0</a>
minmax	minmax <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/minmax/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/minmax/1.0.0</a>
mroctx2isis	mroctx2isis <a href="https://134.114.52.66:9009/repos/usat-admin/isis3/mroctx2isis/1.0.0">134.114.52.66:9009/repos/usat-admin/isis3/mroctx2isis/1.0.0</a>

# Additional Features



- Cluster Processing
  - ▣ Multi-Threaded
- Tool Shed
  - ▣ Update Notification
- Shared workflows
  - ▣ Missing Dependency Notification

# Challenges: Tool Builder

- Problem:
  - ISIS XML to Galaxy XML
    - Imperfect mapping
    - Unused features
- Solution:
  - Tool Shed
    - Better for future

# Challenges: Tool Shed



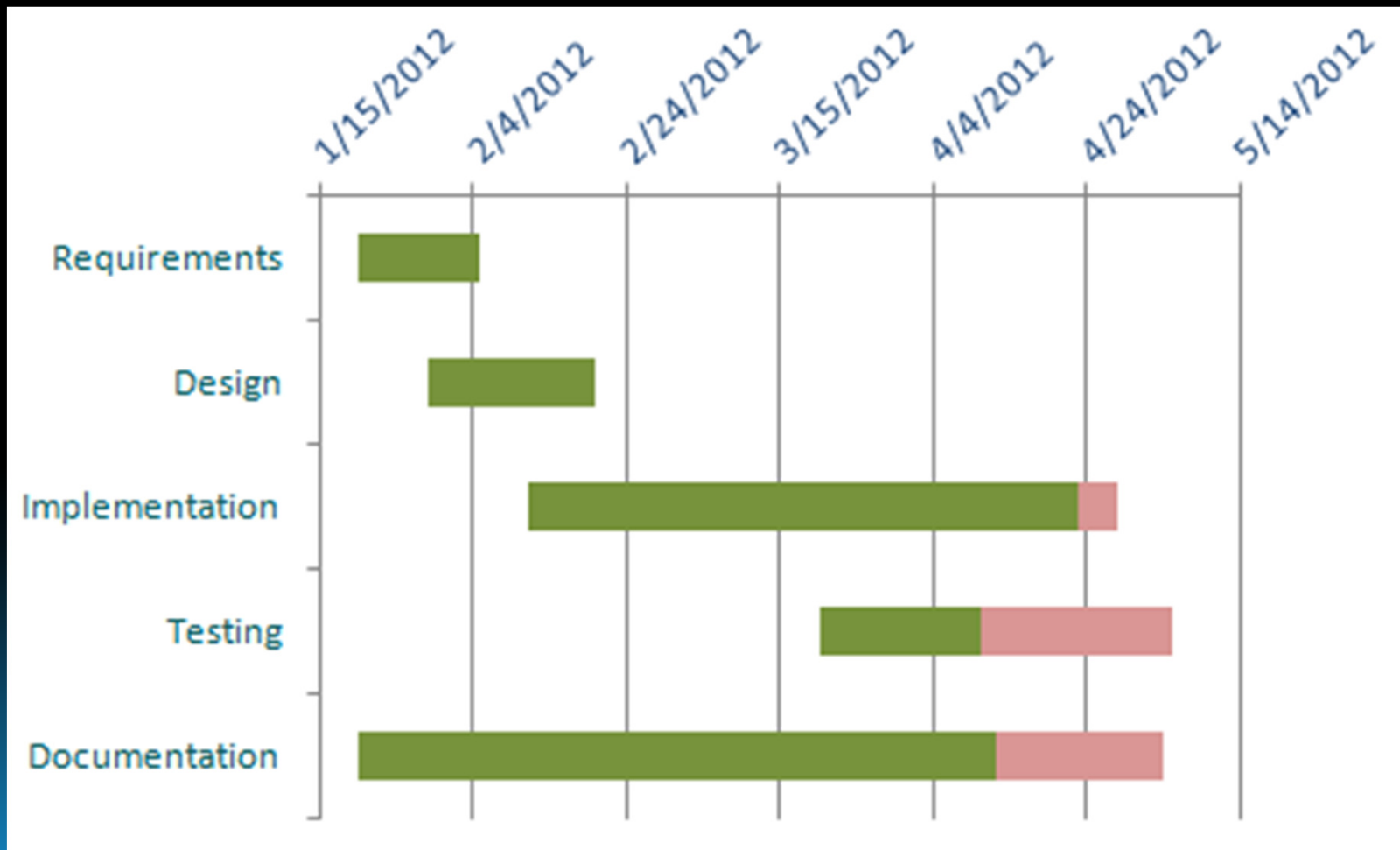
- Many database generations
- Learning Python
- Framework Knowledge

# Challenges: Galaxy

- Architecture
  - Galaxy
    - Bioinformatics
- Framework
  - ISIS Data Library
- Registering
  - Data Types
  - Tool configuration



# Schedule



## Conclusion

- All basic client requirements have been met
  - As well as many secondary goals
- Integrating ISIS into Galaxy lays the foundation for further enhancements in Astrogeology analysis
- Opportunities to expand Galaxy into new domains





**QUESTIONS?**