OME and ImageJ

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LOCI, www.loci.wisc.edu
Mission of LOCI:

- New optical instrumentation to facilitate studies of the dynamics of living specimens.
- Better software for capture and visualization of dynamic, 3-D biological events
- Been OME Development partner since 2002
- Image Informatics for multidimensional data
  - spatial and temporal
  - spectral and lifetime dimensions
  - polarization
Our data:

Fluorescence, Spectra, Lifetime ($\lambda, \tau$)

Time-Lapse ($t$)

Dynamics

Chemistry

Physics

Phase, Polarization, Scatter, Harmonics ($\phi, \theta, ...$)

Structure

Space ($x, y, z$)

Supporting Technologies

Hardware
Acquisition software
Analysis and Visualization
Data Management
Overview of our OME efforts

• Specific OMERO linked applications
  • BK Cho in Murphy lab on Omero.searcher
  • Forward Project for data dissemination

• Originated **OME-TIFF** in 2004
  • Now fully integrated into OMERO
  • Used by many open and commercial tools
  • Our current focus on robust tools to read and write OME-TIFF

• Originated **Bio-Formats** in 2005
  • Partnership with OME and Glencoe
  • Over 120 formats
  • Over 30,000 installations
  • Recent development focus on SCIFIO

• XML Schema Improvements for Acquisition
  • Our WiscScan software and now MicroManager
  • Fused Data models with “OME-TIFF”

• Interoperability with other tools—Cell Profiler, Knime, etc

• ImageJ 2.0 (ImageJDev.org)
What is ImageJ2?

✔ A standalone application
What is ImageJ2?

✓ A standalone application

✓ A reusable library
What is ImageJ2?

- A standalone application
- A reusable library
- An extensible collection of services & plugins
ImageJ2 Guiding Principles

- Preserve backwards compatibility
- Maintain good performance
- Support N-dimensional imaging
- Use common input and output for data
- Minimize complexity
  - Introduce dependencies only when benefits outweigh disadvantages
- Employ modern software development practices
Benefits of ImageJ2

- What Will ImageJ 2.0 Do for Me?
  - Work with existing plugins and macros
  - Work with new plugins and scripts
  - Handle larger, more complex datasets
  - Multidimensional visualization tools
  - Easier to link with other software
  - Easier plugin management
OMERO is powerful server-side imaging software
ImageJ is powerful client-side imaging software
Both paradigms are valuable to scientists
Many operations are common to client & server
  - E.g.: Bio-Formats is used for both
Goal is to identify more areas for code sharing:
  - Big images (e.g., tiling with mipmaps)
  - Image rendering and thumbnails
  - ROIs, Many others
  - Joint Hackathons
What is ImageJ2?

✓ A framework for image processing routines
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- Bio-Formats and OME-XML provide an interchange format for microscopy data
What is ImageJ2?

✓ A framework for image processing routines

- ImageJ2 and ImgLib2 provide a platform for sharing image processing routines
ImgLib2

- “Write once, run anywhere”

### Pixel types
- 1-bit binary
- 8-bit signed integer
- 8-bit unsigned integer
- 12-bit unsigned integer
- 16-bit signed integer
- 16-bit unsigned integer
- 32-bit signed integer
- 32-bit unsigned integer
- 64-bit signed integer
- 32-bit single precision floating point
- 64-bit double precision floating point
- Complex numbers
- Arbitrary precision arithmetic
- Even non-numeric types
- Fully extensible

### Data source
- Files on disk
- Remote URLs
- Local or remote database (OMERO, CATMAID, etc.)
- Fully extensible

### Internal representation
- Array: Single primitive array
- Planar: One primitive array per plane
- Cell: Primitive arrays as N-D blocks
- SCIFIO: Cells filled on demand from source
- Write modified cells to disk cache
- Fully extensible

### Much more
- Generative functions
- Out of bounds strategies
- Compose views on images
- Recursive images
- Sparse images
- OPS: image-wise operations
- Image data projections
- Resampling & transformation
- Transparent type conversion
- Metadata attachments
- Interface-driven design
- Highly compile-time safe
- Performance optimizations
- Exploit Java’s JIT compiler

https://github.com/imagej/imglib
ImageJ2 Commands

- “Write once, run anywhere”
- Operations with typed inputs and outputs
- Maps well to other paradigms
  - KNIME nodes
  - CellProfiler modules
  - OMERO scripts

https://github.com/imagej/imagej
public class Tubeness2_0 extends AbstractPlugIn implements PlugIn {

    @Parameter(label="Input image")
    public ImagePlus original = null;

    @Parameter(label="Sigma")
    public double sigma = 1.0;

    @Parameter(label="Use calibration")
    public boolean useCalibration = false;

    @Parameter(label="Output image", output=true)
    public ImagePlus result = null;

    @Plugin(type=Command.class)
    public class Tubeness2_0 extends ContextCommand {

        @Parameter(label="Input image")
        private Dataset original;

        @Parameter(label="Sigma")
        private double sigma = 1.0;

        @Parameter(label="Use calibration")
        private boolean useCalibration;

        @Parameter(label="Output image", ioType=ItemIO.OUTPUT)
        private Dataset result;

    }

}
ImageJ on the server side

- In progress: execute ImageJ commands as OMERO scripts
- Drop ImageJ onto the server, gain access to its commands
- All headless ImageJ2 commands + many ImageJ1 plugins
- Working prototype later this summer

[Diagram showing ImageJ, ij-omero-server, OMERO, and ZeroC]

https://github.com/imagej/imagej-omero
http://trac.openmicroscopy.org.uk/ome/ticket/918
What is SCIFIO?

✓ A framework for scientific image I/O
What is SCIFIO?

- A framework for scientific image I/O

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What is SCIFIO?

✓ A framework for scientific image I/O

▪ SCIFIO provides an exchange framework for scientific image data
SCIFIO

- Core is BSD licensed
- Supports 26 open image formats so far
- In use as image I/O provider for ImageJ2
- Backwards compatible with Bio-Formats 4.x
- For more about SCIFIO, see the poster

https://github.com/scifio/scifio
SciJava Software Stack

- ImageJ2’s image I/O: SCIFIO
- ImageJ2’s data model: ImgLib2
- ImageJ2’s plugin framework: SciJava Common

https://github.com/scijava/scijava-common
Fiji Is Just ImageJ

- Distribution of ImageJ with useful plugins
- Focuses on life sciences analysis problems
- Ships the latest Bio-Formats 4.4.x release
- Also ships with ImageJ2 including SCIFIO
- BF 4.4 & SCIFIO do not conflict with each other
- IJ1 uses Bio-Formats; IJ2 uses SCIFIO
- Either can be used from scripts, macros, etc.

https://github.com/fiji/fiji
ImageJ Hackathon-Madison