

Automated Image Analysis using OMERO



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- Part of the University of Sussex
 - The GDSC is a research centre investigating the responses of cells to genome damage and their relationship to cancer and other aspects of human disease
 - 19 research groups
 - Microscopy suite includes a variety of fluorescence microscopes and imaging systems (Nikon, Olympus, DeltaVision, Zeiss)
 - Fixed cell and live cell imaging

Image Analysis Problem



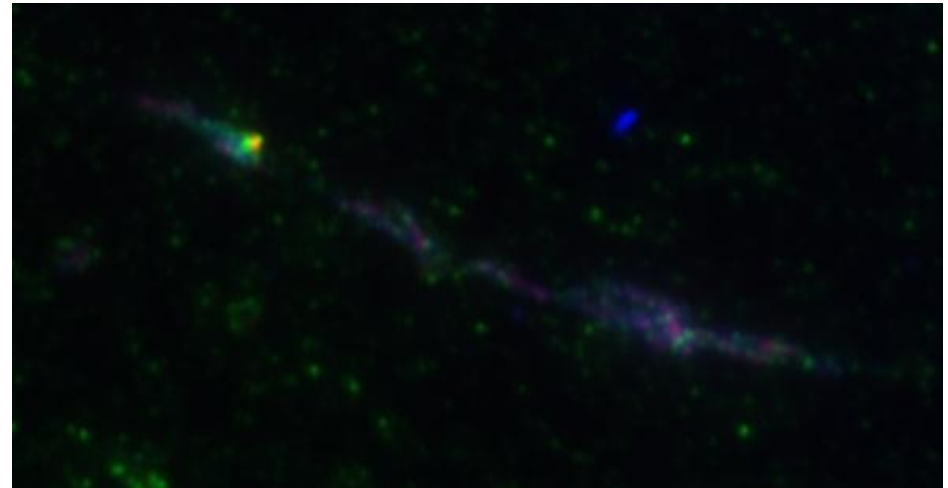
- OMERO clients on all PCs
 - Server is connected to the university HPC grid
 - Daily back-up
 - Off-site back-up mirror
 - Easy storage expansion
 - Worldwide (i.e. off-site) access

- Expression levels of tagged proteins during cell cycle
- Segmentation
- Colocalisation
- Correlation
- Spot occurrence (frequency and distance)
- Noise reduction
- Deconvolution
- High Dynamic Range Imaging (HDRI)

- Huygens (SVI)
- Autoquant (MediaCybernetics)
- Imaris (Bitplane)
- ImageJ
 - Free (no licensing)
 - Runs on any computer
 - Extensible architecture (using plugins)
 - Large community of developers

Example: Colocalisation Analysis

- Multiple protein tags
 - Do they occur together?
- Pearson Correlation Coefficient

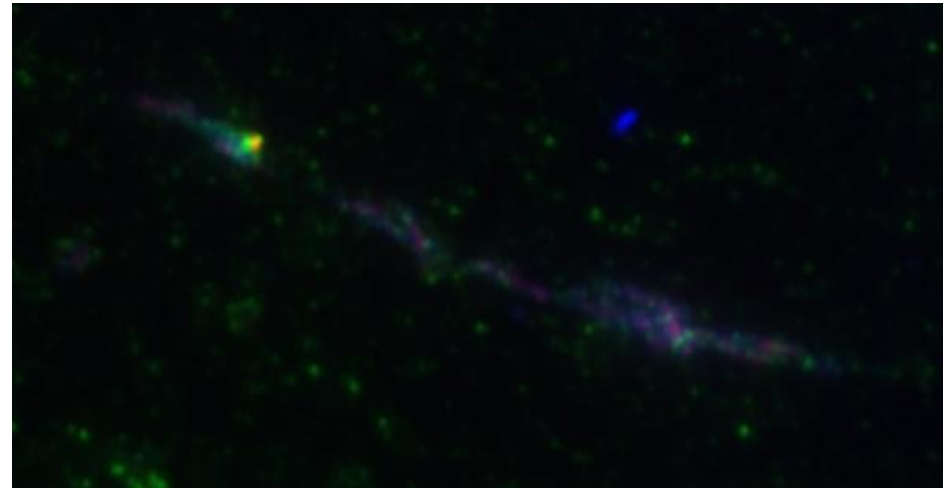


Placeholder slide for movie 'ImageJ Correlation.mov'

The movie shows an example of an ImageJ plugin to perform correlation analysis on all-vs-all channels in an image. The key points to note are the user input options and the output results in tabular format.

Example: Colocalisation Analysis

- I don't want to process each image
 - Can I process all my images together?
 - Can I process them from where they are stored?
- Yes – if you use OMERO



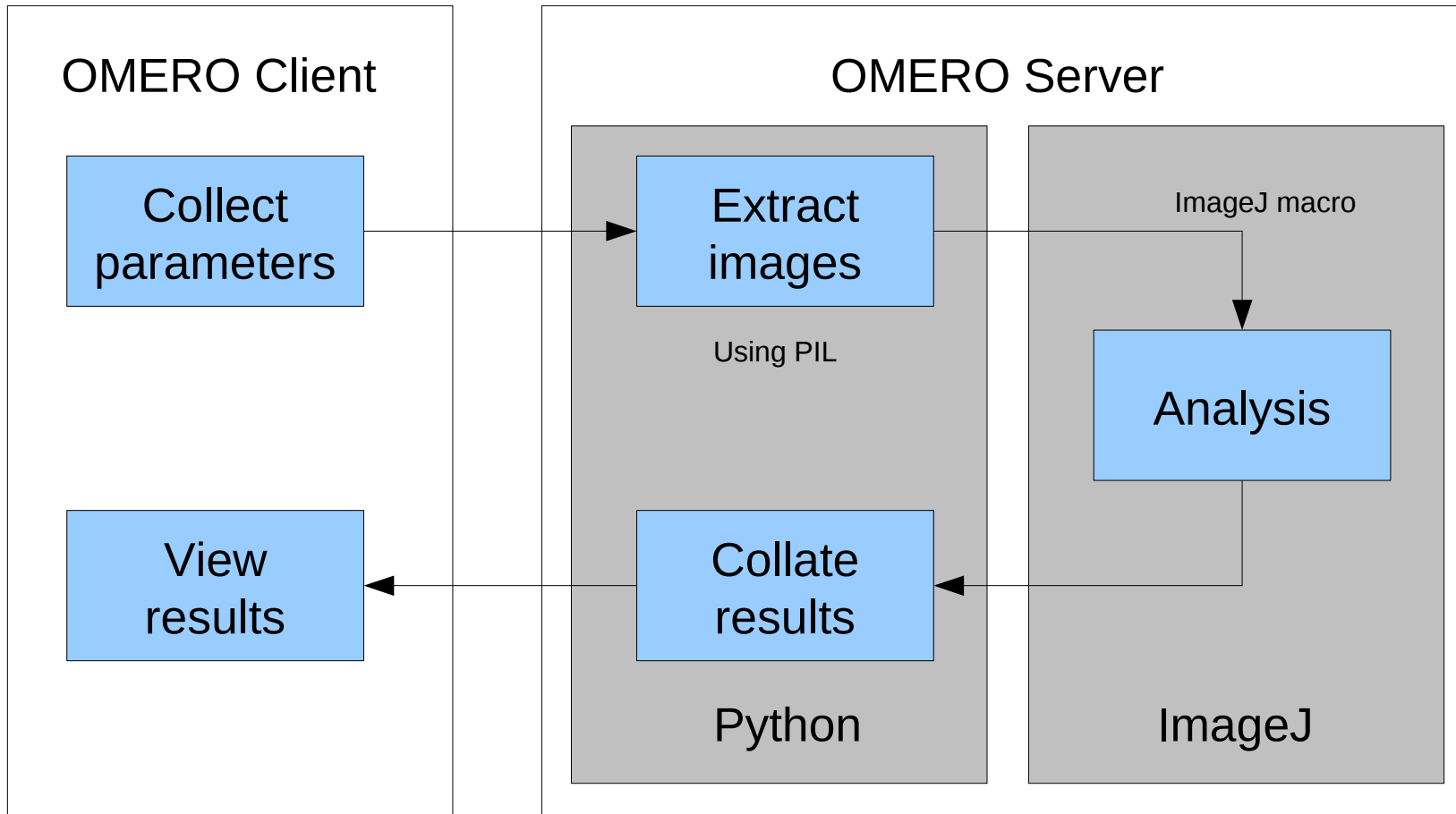
- Runs scripts on your images
 - Python scripts using the OMERO API
 - Scripts are hosted on the server and run on OMERO.grid processors
 - Scripts can call other programs, e.g. ImageJ, or Matlab code
 - Can be started from any OMERO client (desktop or web)

- Scripts have to be custom written
- Suit analysis tasks with sequential non-interactive steps
- Only admin scripts run on the server

Placeholder slide for movie 'OMERO Correlation.mov'

The movie shows an example of running the ImageJ correlation analysis plugin on a set of images within OMERO using OMERO scripts. The key points to note are the user input options match those of the ImageJ plugin and the output results in tabular format are sent to the user in an e-mail. They are also attached to the dataset that was selected to run the script.

Running ImageJ via OMERO



- ImageJ can run a script on the command line

Note: Requires a Headless version of ImageJ for UNIX systems

- Why not pass the OMERO Image IDs to ImageJ?

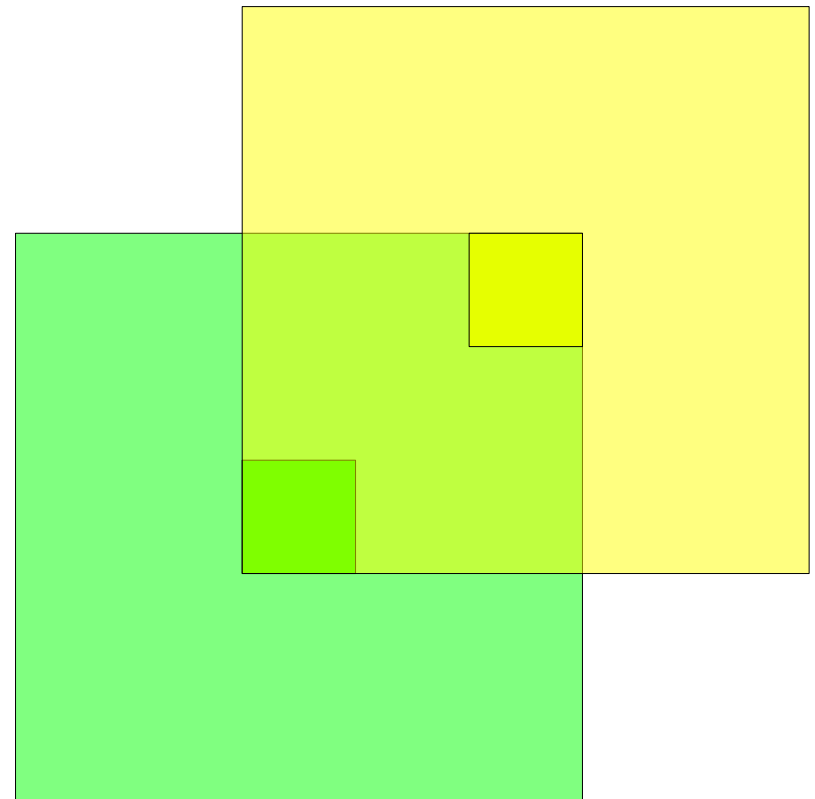
This would be possible but would require passing the user's authentication credentials through. Loading from file has no security issues

- Directly executing ImageJ scripts allows adaptation of ImageJ recorded macros

Development of the ImageJ analysis plugin then only requires that it can be recorded with all arguments by the ImageJ recorder. This applies to the majority of plugins and ImageJ commands

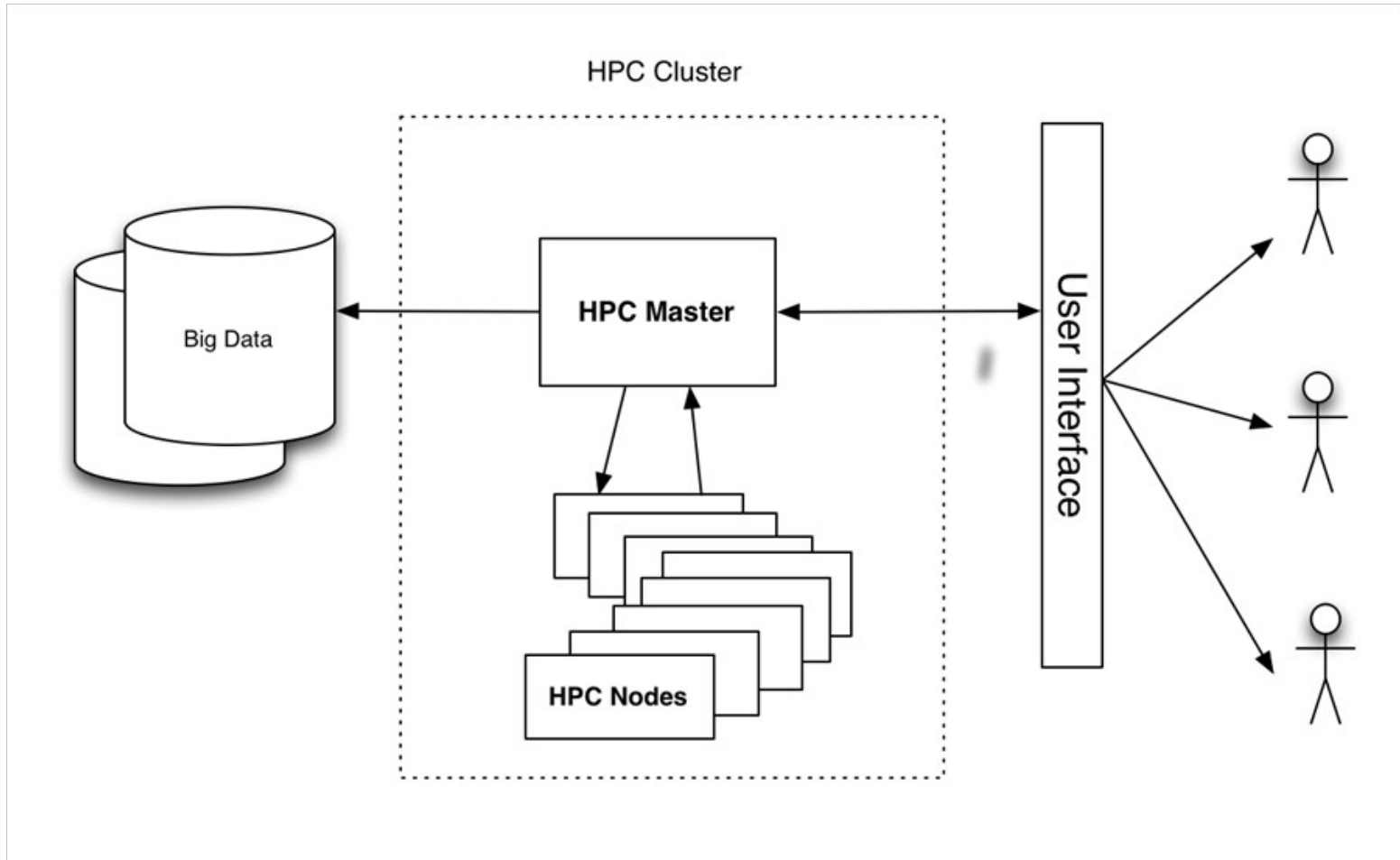
Example: Noise Reduction

- Each pixel is processed in the context of its neighbours
- Typical movie of 12 hour time-lapse experiment can take hours to process
- Results not effected by any other pixels
- Processing can be split up and run independently

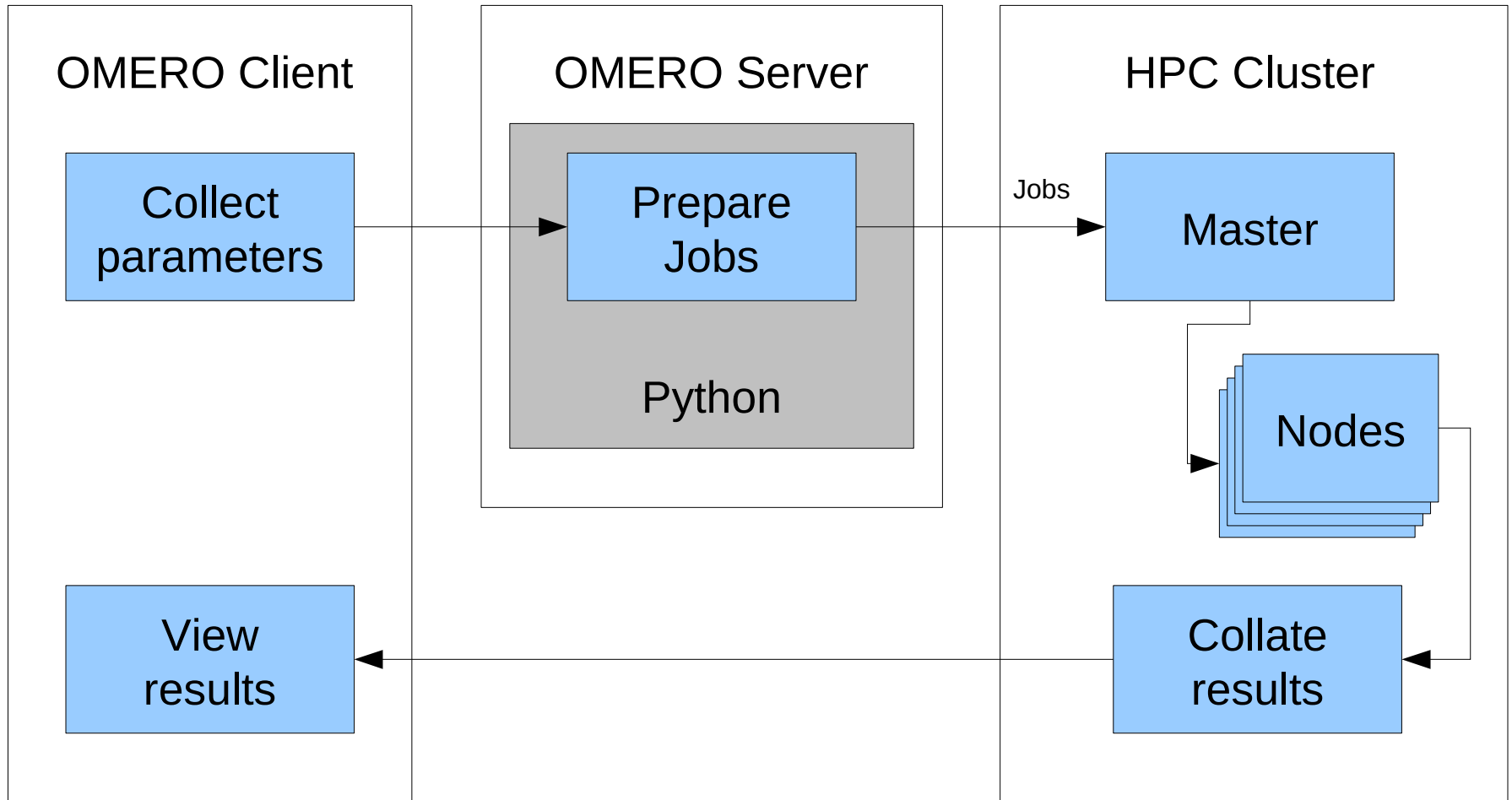


- High Performance Computing (HPC) clusters use multiple CPUs to increase speed
- Suitable for any task where work can be packaged up
- Each task can execute independently and results are collated at the end
- Queue system allocates resources for processing work
- Work is typically a script file thus can run any command-line programs supported on the nodes

Using a HPC Cluster



Using a HPC Cluster from OMERO



- Torque PBS:

Require jobs to be submitted from the master

- Use a local PBS queue with master node on the OMERO server

- All processing nodes have access to shared file storage - Images can be extracted within the OMERO script before job submission

- Asynchronous – Users are e-mailed when the results are ready

Possible future developments

- Standard library functions for extracting images, loading results, and e-mailing progress
- Support annotated plugins with no custom script code
- Use message queue brokers for reliability and load balancing
 - Require an asynchronous workflow
- Support HPC clusters from OMERO
 - Submit jobs and monitor status

Further Help

Website pages:

<http://www.sussex.ac.uk/gdsc/intranet/microscopy/omero>

<http://www.sussex.ac.uk/gdsc/intranet/microscopy/imagej>

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