BisQue

Scientific image data management and analysis in the Cloud

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Center for Bio-Image Informatics, UCSB, 2014

- Textual and 5D graphical annotations
- Biologically meaningful objects and groups

Annotations

- Large-scale
- Cluster support
- Data parallelization
- Extensible

Analysis

Visualization

- 5D large images
- 200+ formats
- Data summarization

Management

- Scalable and distributed
- Everything is web accessible
- Searchable

BisQue

No need to customize

Kosik Lab

3D CLSM analysis
+Metadata
    condition, channels
Results:
    Nucleus location,
    Cell classification,
    Count PHF+/PHF-
    Cell Density

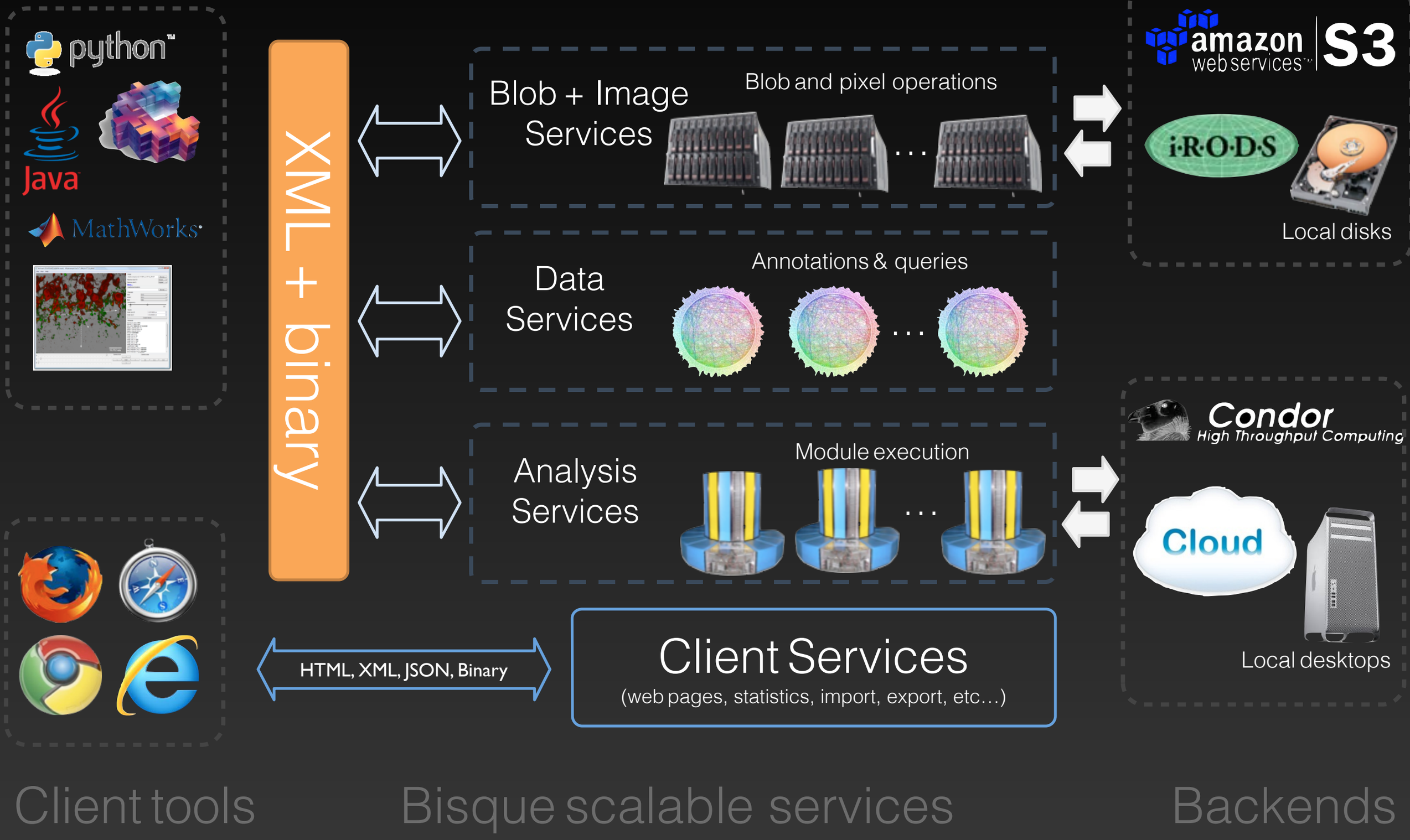
Greenpeace

Video analysis
900GB Video
+Metadata
    depth, location
Results:
    Object Location,
    Object type,
    Laser dots,
    resolution...

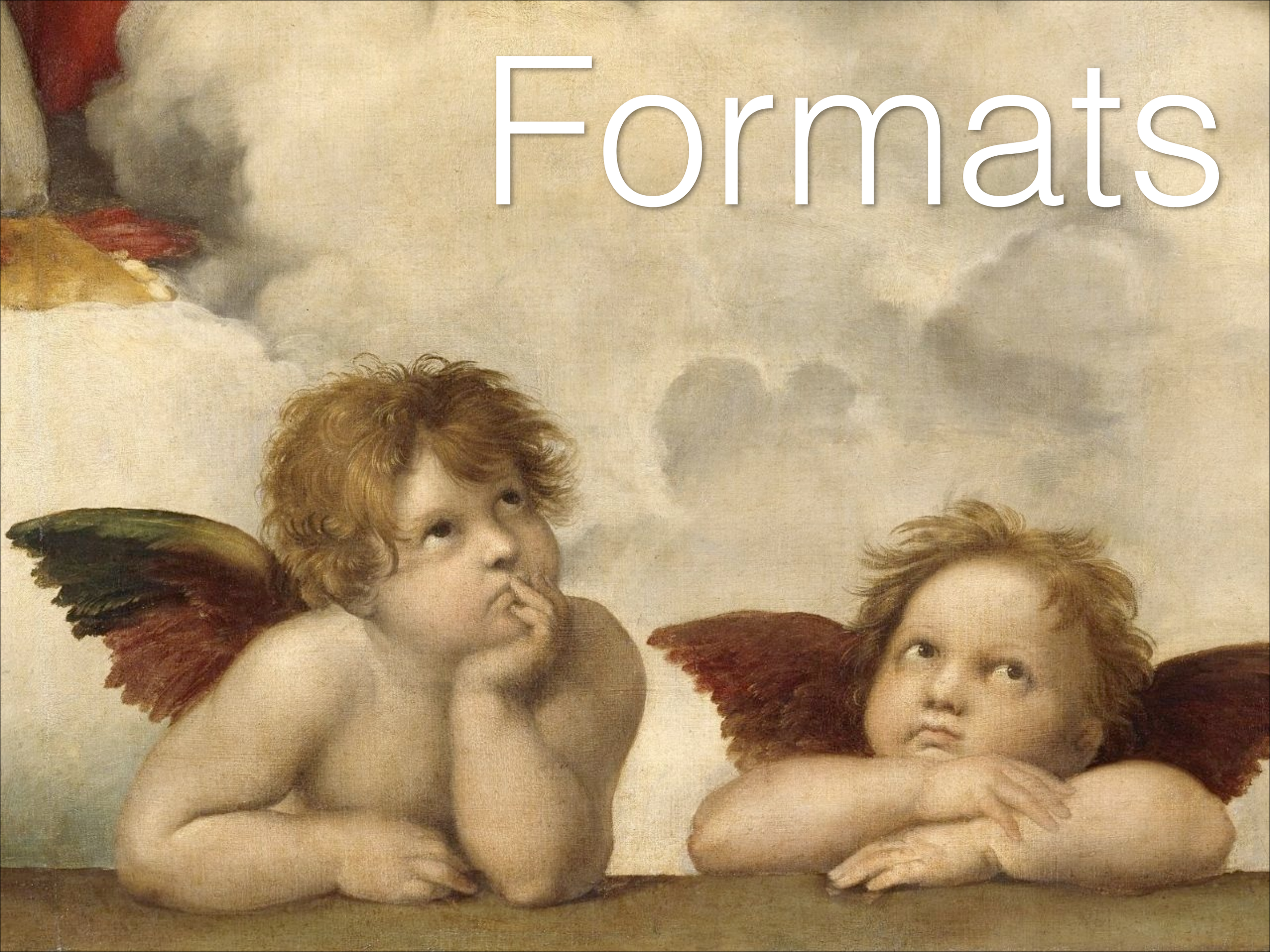
Spalding Lab

HT 4D Analysis
100GB Timeseries
+Metadata
    conditions, mutaton...
Results:
    Root tips in time,
    Seed perimeter,
    Root angle,
    seed area...

Bisque architecture



Formats



240+ Image formats

Bisque supports pluggable image en/de-coders

- Native -
  Most popular 5D images and videos
- OpenSlide -
  whole-slide images
- Imaris - *(exclusively for Bisque)*
  Industry leading microscopy support
- BioFormats -
  Largest open-source bio-image library

multi-file formats

- Any combination multi-file-multi-image
- In-place support with no re-conversion
- 5D series (e.g. TIFF Z series)
- User correctable geometry/resolution
- Proprietary (e.g. Volocity, Slidebook)
- Import/Export

On shoulders of giants

- High-throughput analysis,
- Distributed storage,
- On-demand computation

Condor
High Throughput Computing

i·R·O·D·S

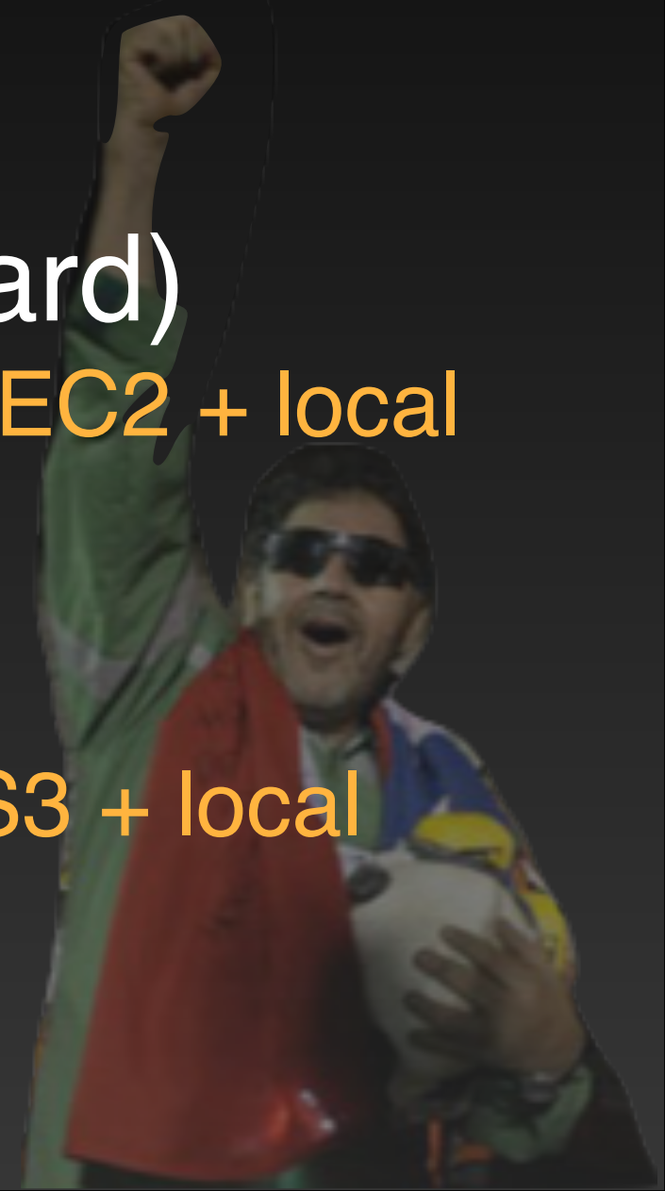
powered by
amazon
web services™

amazon
web services™
S3

RIGHTSCALE®
CLOUD MANAGEMENT

16 tools, what do you get?

- Click to Bisque (credit card)
  - Rightscale template for Amazon EC2
- Datacenter per dataset (credit card)
  - On-demand condor nodes on Amazon EC2 + local
- 99.999% reliability
  - Distributed data on iRODS + Amazon S3 + local



Bisque UI

- Web based - HTML5
- Query everything
- Integrated image analysis

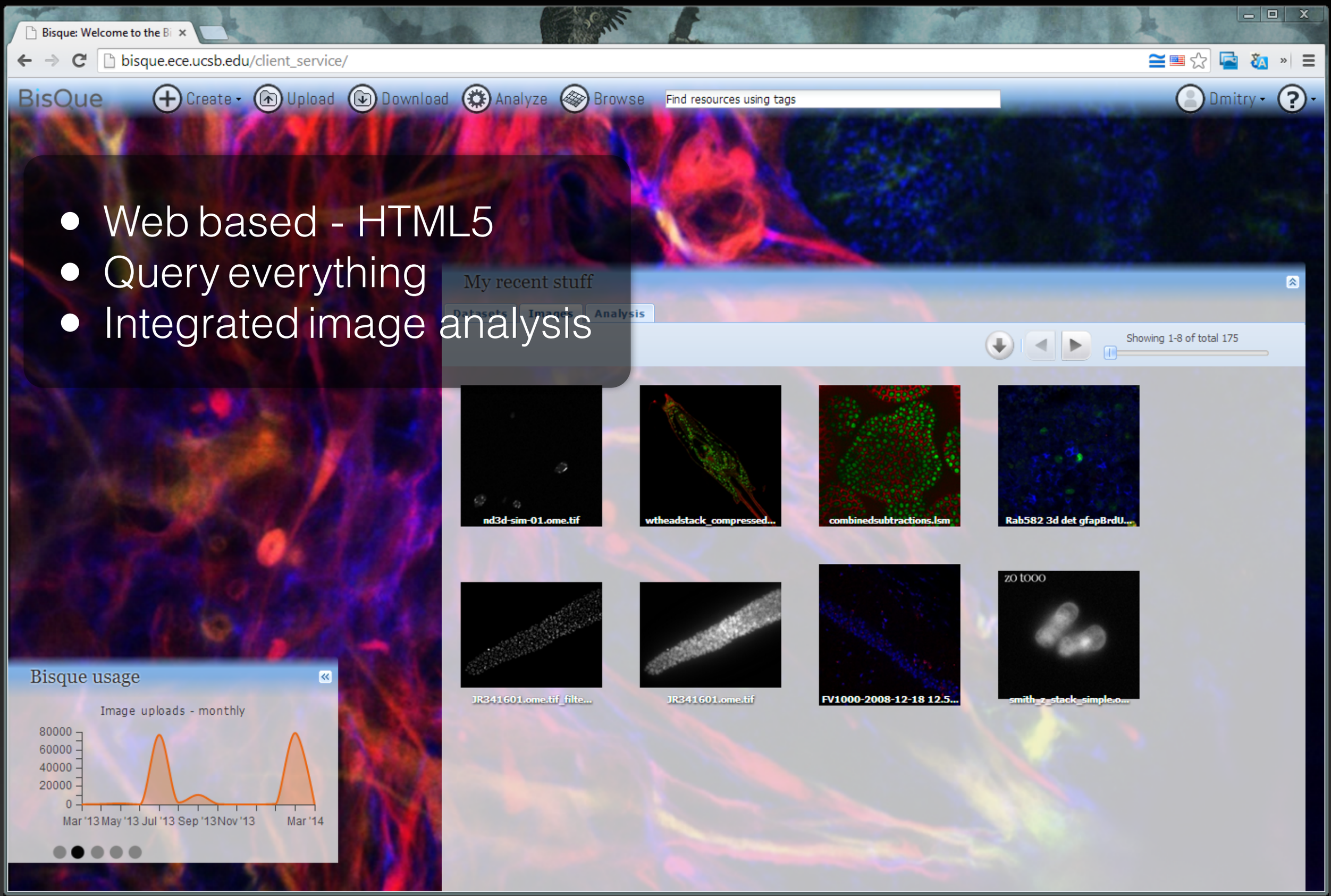


Image Viewer

- Very large images (our PanoJS3)
- 5D support – projections, navigation and movies
- Dynamic tiles – enhancement, channel fusion
- Pixel formats (up to 64bit integer, 80 bit float)
- Mobile support: gestures

Our PanoJS3 is used by many projects including OMERO and Journal Cell

2D viewer/editor

Bisque: Resource viewer

vidi.ece.ucsb.edu:9090/client_service/view?resource=http://vidi.ece.ucsb.edu:9090/data_service/image/...

BisQue | Create | Upload | Download | Analyze | Browse | Find resources using tags | Bisque admin

Download | Share | Visibility: published | Delete | View: 2D | Export | Operations | image: 13_06.lsm

Image: 512x512 Z:54 ch: 2/16bits Scale: 200%

Image planes [Z:54, T:1]

Intensity projection: None

Channels

Ch1 (514) R:0, G:255, B:0

Ch2 R:255, G:0, B:0

View

Fusion: Maximum

Enhancement: Data range

Negative: No

Image enhancements
Channel fusion
Projections

18.4570 um

Metadata

Annotations | Graphical | Embedded | Analysis | Map

Create custom

Graphical annotations

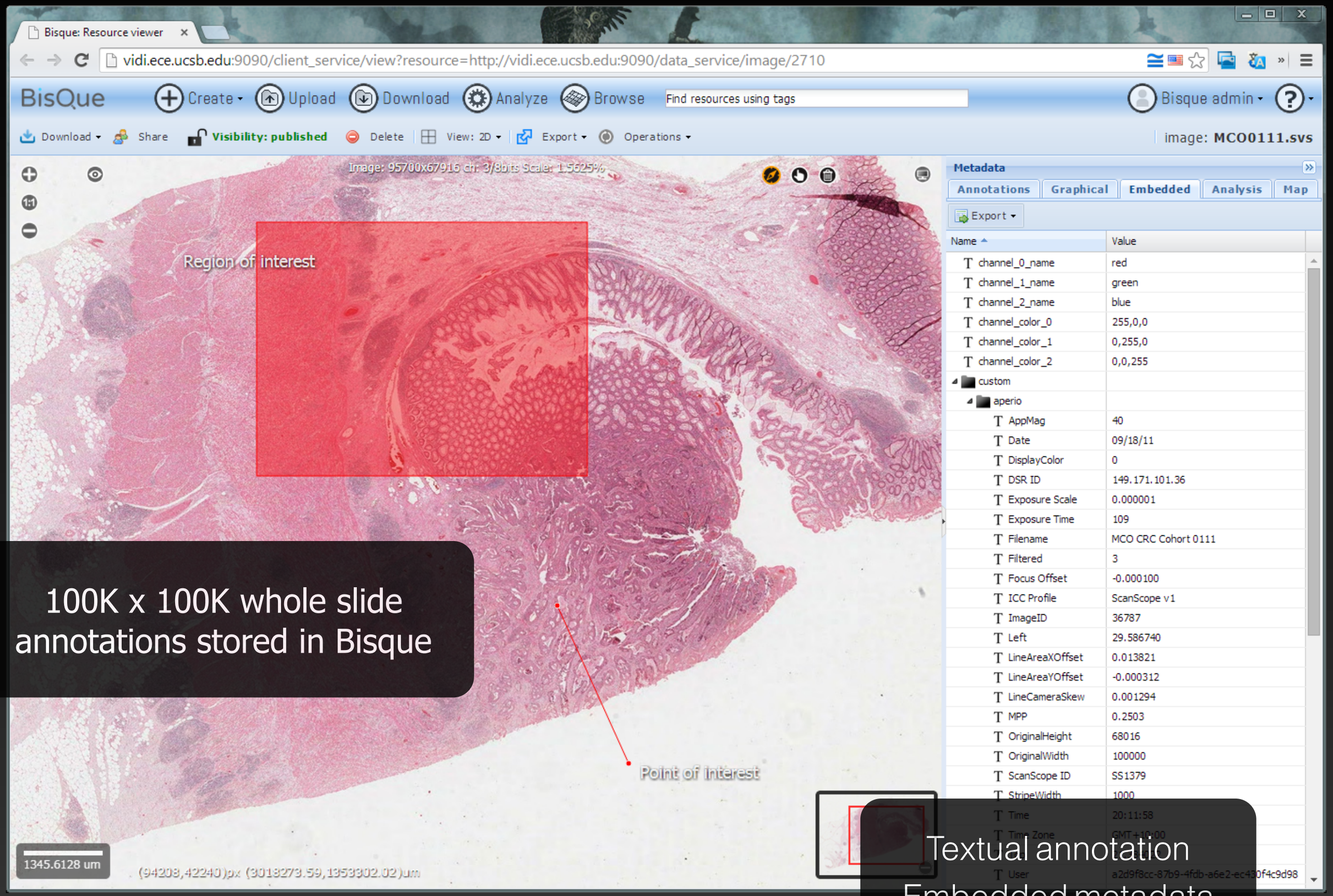
Type
circle
ellipse
label
line
point
polygon
polyline
rectangle
square

Tree of annotations

Visibility | Add | Delete | Color | Stats

Type:Name	Value
NuclearDetector3D	2014-02-22 08:50:20
Sepal: Sepal	
Cell: Cell	
circle	311,242,23,0,0; 322,242,23,0,0;
polygon	11,363,23,0,0; 71,232,23,0,0; 178,146,...

5D graphical annotations
Analysis results

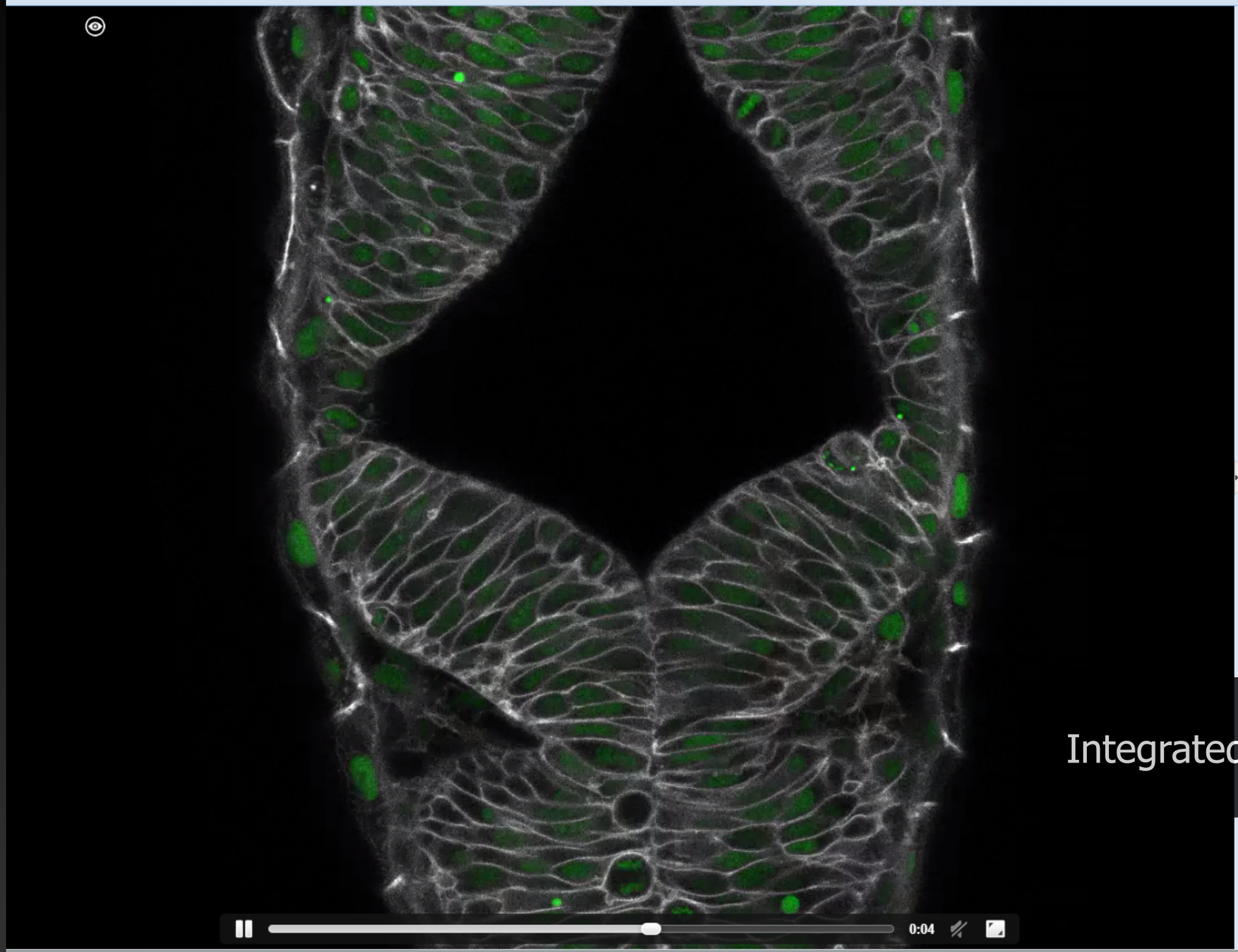


100K x 100K whole slide annotations stored in Bisque

Textual annotation
Embedded metadata

BisQue Create Upload Download Analyze Browse Find resources using tags Bisque admin

Download Share Visibility: published Delete View: Movie Export Operations image: **movieNLO_2.lsm**



Metadata

Annotations | Graphical | Embedded | Analysis | Map

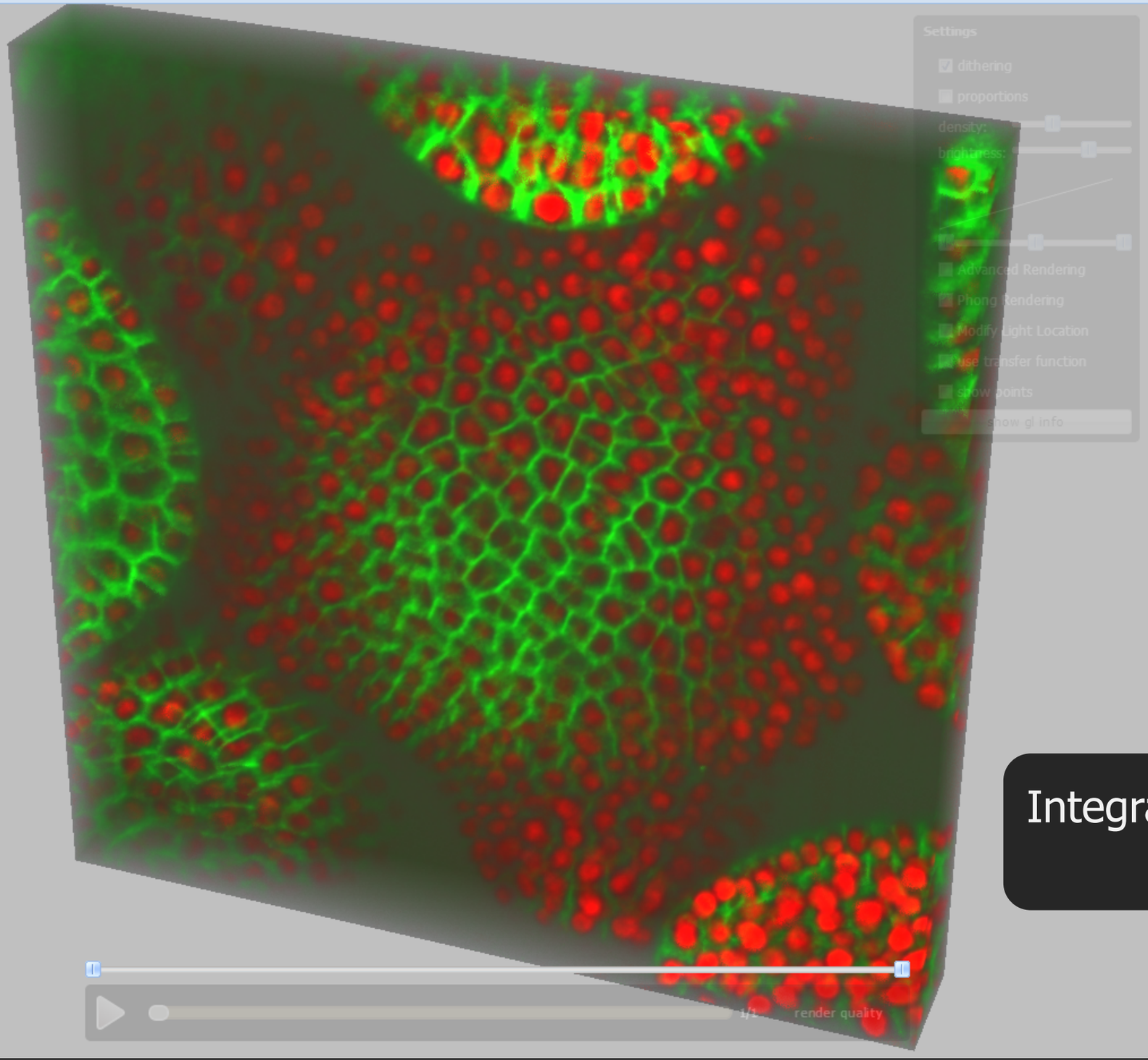
Add Delete Import Export

Name	Value
filename	movieNLO_2.lsm
upload_datetime	2014-05-08 22:14:57.886000
owner	rjduran@dough

Integrated html5 movie view

BisQue | Create | Upload | Download | Analyze | Browse | Find resources using tags | Bisque admin

Download | Share | Visibility: private | Delete | View: 3D | Export | Operations | image: **combinedsubtractions.lsm**



Metadata

Annotations | Graphical | Embedded | Analysis | Map

Add | Delete | Import | Export

Name	Value
filename	combinedsubtractions.lsm
upload_datetime	2014-07-15 19:09:23.816000

Integrated html5 5D volume renderer

Bisque: Resource viewer

bisque.ece.ucsb.edu/client_service/view?resource=http://bisque.ece.ucsb.edu/data_service/image/3976100

BisQue | Create | Upload | Download | Analyze | Browse | Find resources using tags | Dmitry

Download | Share | Visibility: private | Delete | View: 2D | Export | Operations | image: Rab582 3d det gfapBrdUmib1z24Live9-14-2007_11-55-58_AM copy.tif

Image: 512x512 ch: 3/16bits Scale: 200%

Measurements:

via graphical objects

10.4409 um

(487,289)px (60.53,35.92)um

Metadata

Annotations | Graphical | Embedded | Analysis | Map

Create custom

Graphical annotations

Type
circle
ellipse
label
line
point
polygon
polyline
rectangle
square

Tree of annotations

Visibility | Add | Delete | Color | Stats

Type:Name	Value
line	283,278,0,0,0; 298,247.5,0,0,0;

Bisque: Resource viewer

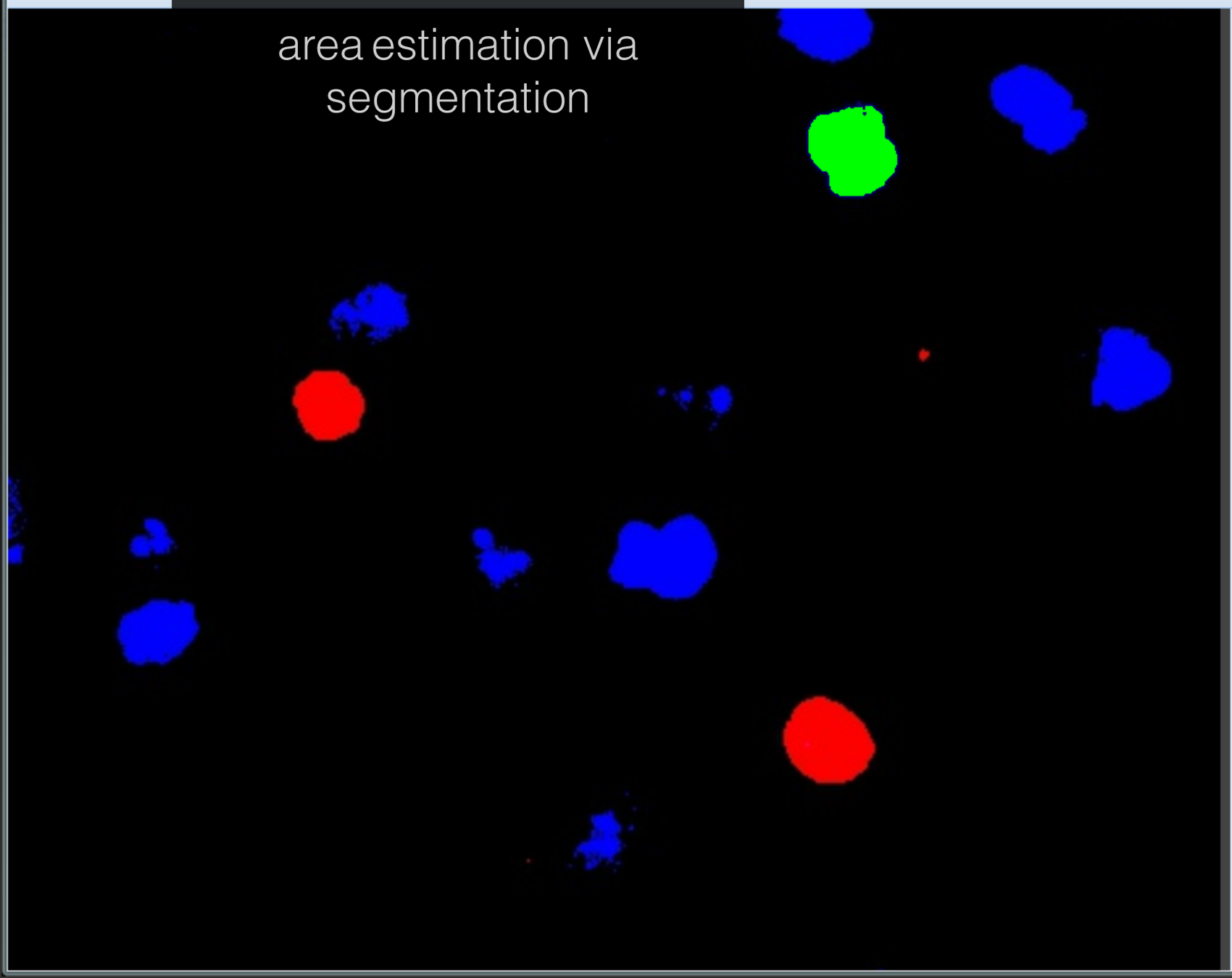
bisque.ece.ucsb.edu/client_service/view?resource=http://bisque.ece.ucsb.edu/data_service/image/3976100

BisQue | Create | Upload | Recent | Analyze | Browse | Find resources using tags | Dmitry

Download | Share | Visibility: private | Delete | View: 2D | Export | Operations | image: **Rab582 3d det gfapBrdUmib1z24Live9-14-2007_11-55-58_AM copy.tif**

Measurements:

area estimation via segmentation



Pixel Counter

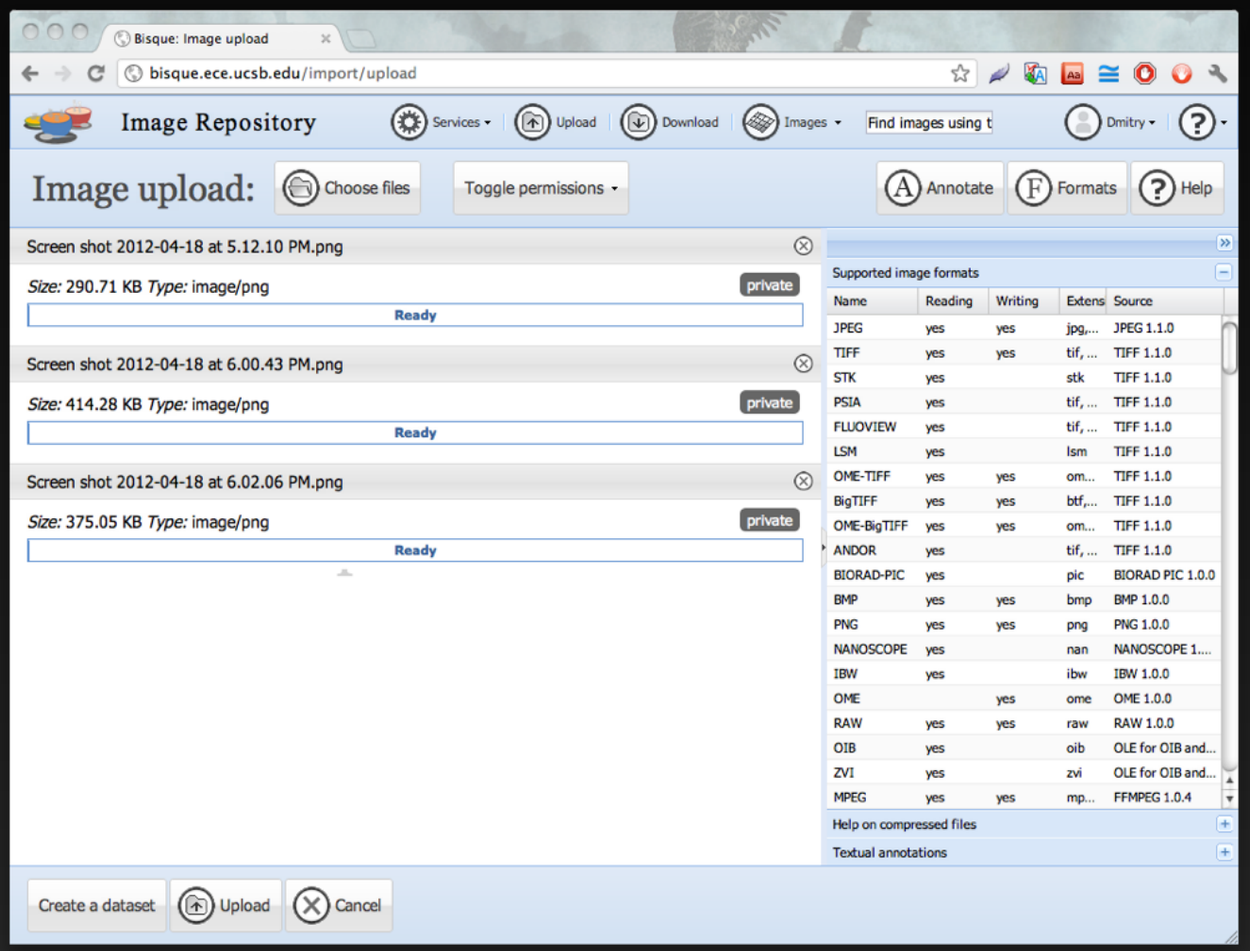
Regional counts | Close

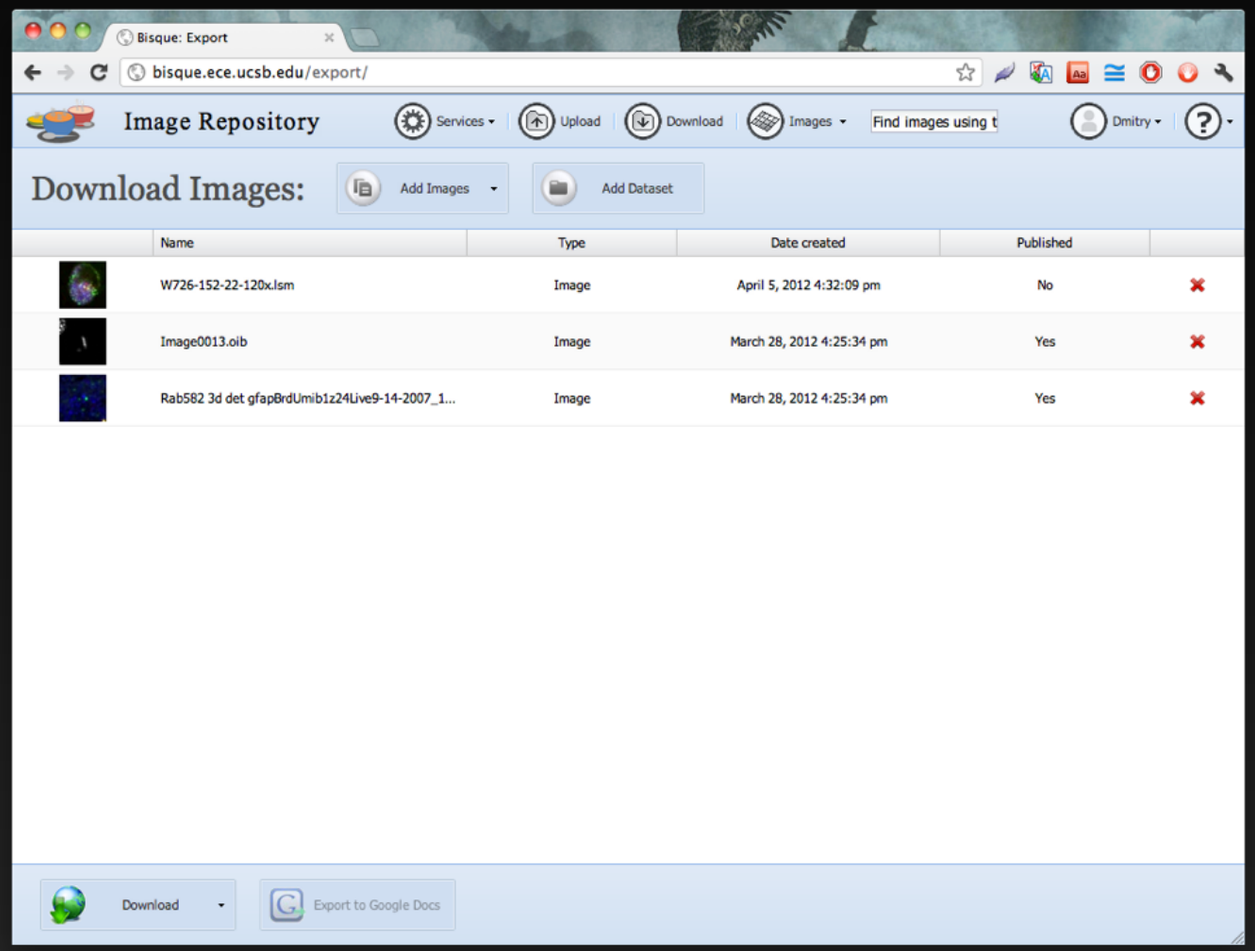
Regional Counts

Click on any part of the image to segment out a region. The pixel count will be displayed below.

centroid	pixels	microns^2
363,106	986	60.93

Import and Export





- support for many large files, directories
- plugin free HTML5 uploads
- drag/drop
- import annotations
- processing compressed files
- compose 5D from multiple files

- on the fly streaming export
- dataset export
- export annotations
- Formats: Zip, Tar, GZip, BZip

- Share images, analysis and annotation with collaborators (Google style)
- Publish data for public access and search
- No headache about formats and location
- Simple import of 5D images and annotations
- Export sets of images and metadata
- Protected private data

Sharing

Modules on the Grid

Modules run on the cluster

- Scheduling with Condor grid
- Amazon EC2
- Low cost on-demand pricing (EC2)

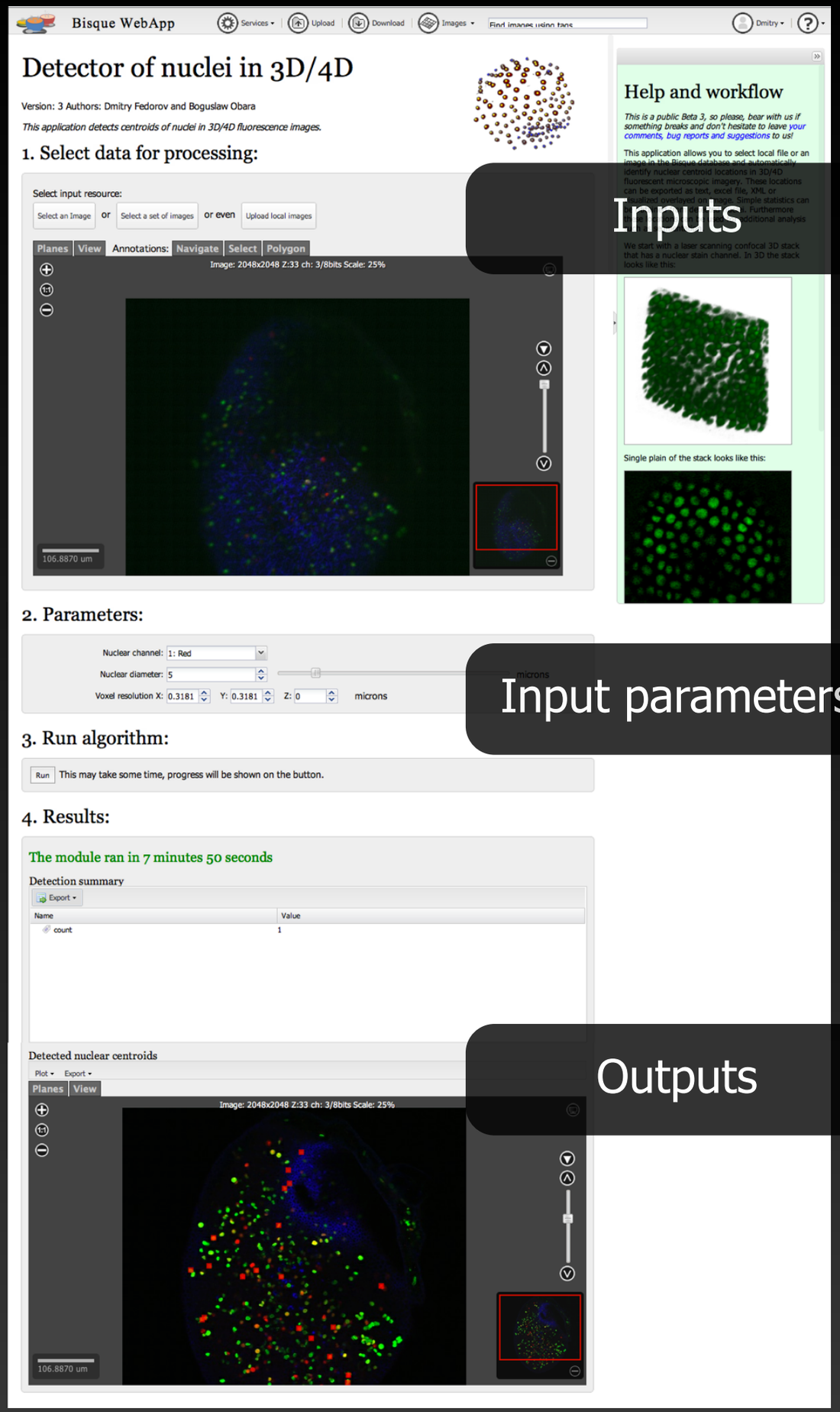
Automatic parallelization for datasets

Easy to create

- Wrapping binaries
- APIs: Matlab, Python, Java, C++
- Pipelines: ImageJ, CellProfiler
- Automated and rich web UI

Bisque infrastructure

- Basic image access
- Storage and retrieval of textual and graphical annotations
- Basic statistics and plotting



Module lifetime

Private module

Developer

Development cycles

module

Bisque data

Known users

amazon web services | S3

i·R·O·D·S

Storage

publish

Published module

execution

module

All users

+ Scores, Comments, Reviews

curate

Curated module

BisQue

module

+ Access to all Bisque computational resources

Condor
High Throughput Computing

Cloud

Execution

Running in Bisque

ImageJ pipelines

- Pipelines (scripts) runnable through Bisque
- Support for clusters and datasets
- Results stored and visualized in Bisque

CellProfiler pipelines

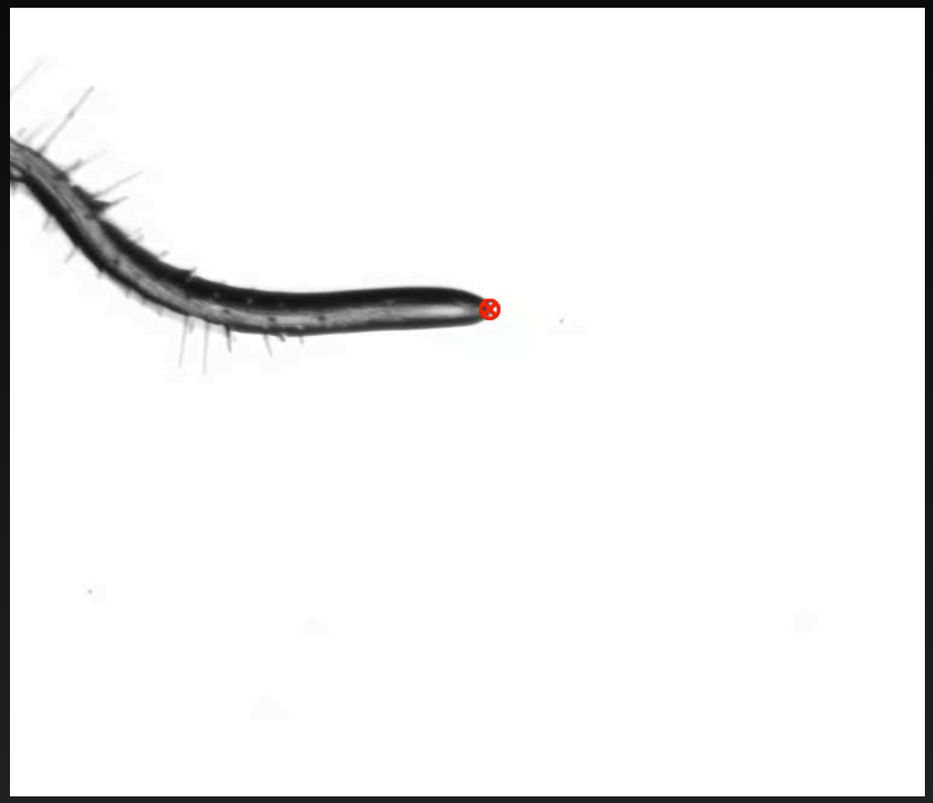
- Exiting pipelines runnable through Bisque
- Support for clusters and datasets
- Results stored and visualized in Bisque

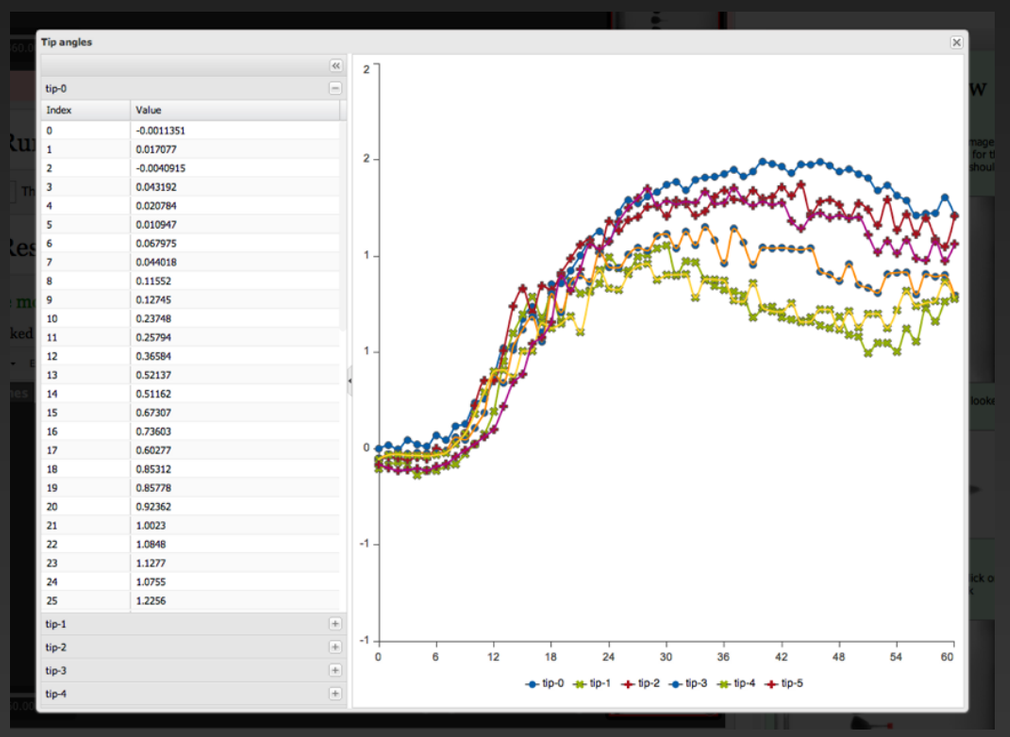
- Future:
  - Customizable pipelines

Our analysis

BQPhytomorph

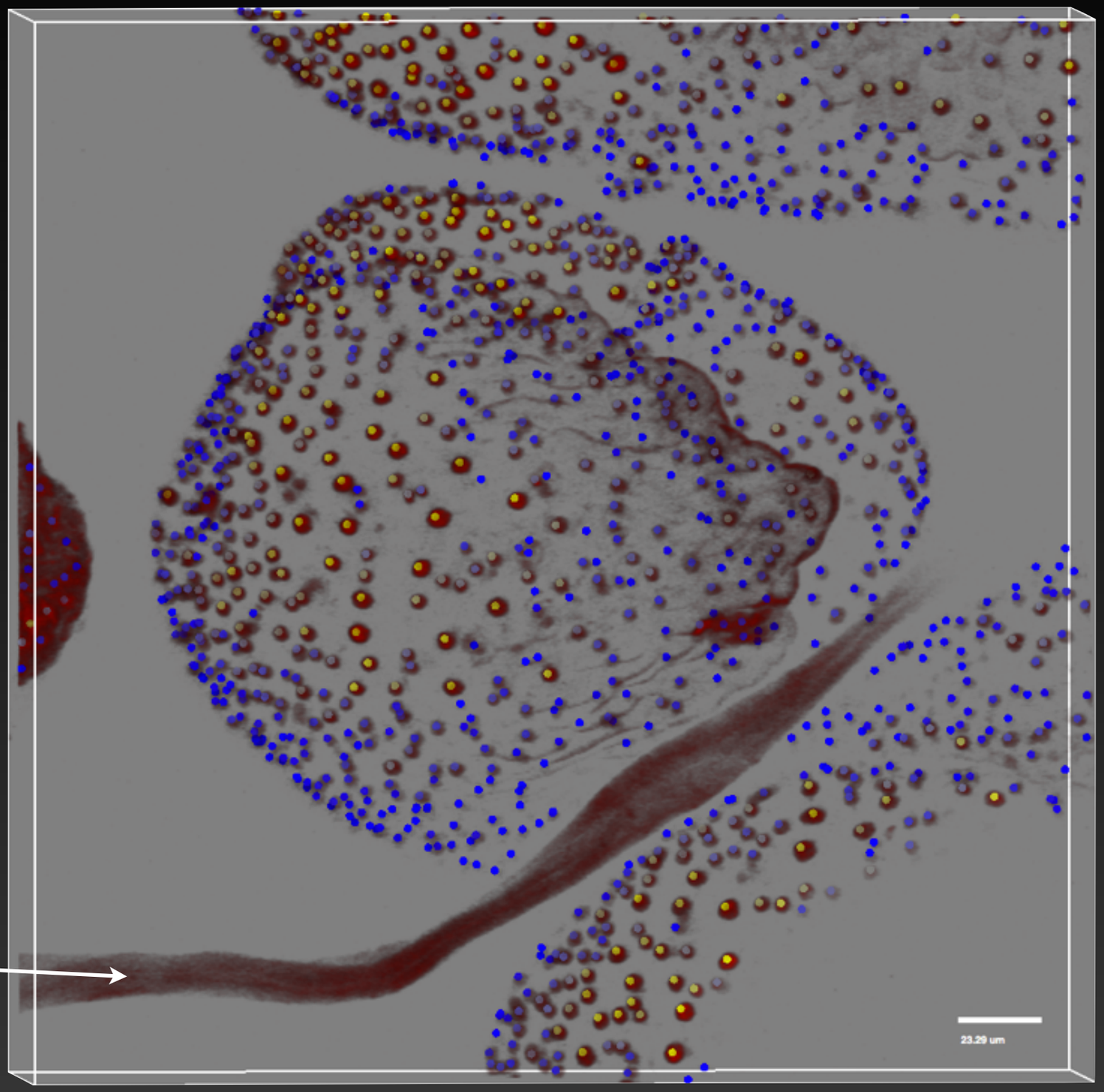
1. Whole seed-size analysis
2. Root tip angle / Multi-tip and growth-rate
3. Root branching





Collaboration with Spalding Lab, University of Wisconsin and iPlant

Detection of nuclei in 3D/4D



Nuclear channel pre-filtered with membrane channel

Centroids color coded by confidence from blue to yellow (highest)

Image contributed by Adrienne Roeder, Cornell

Rendered with bioView3D

Collaboration with Meyerowitz lab @ Caltech and Roeder Lab @ Cornell

Detection of nuclei in 3D/4D

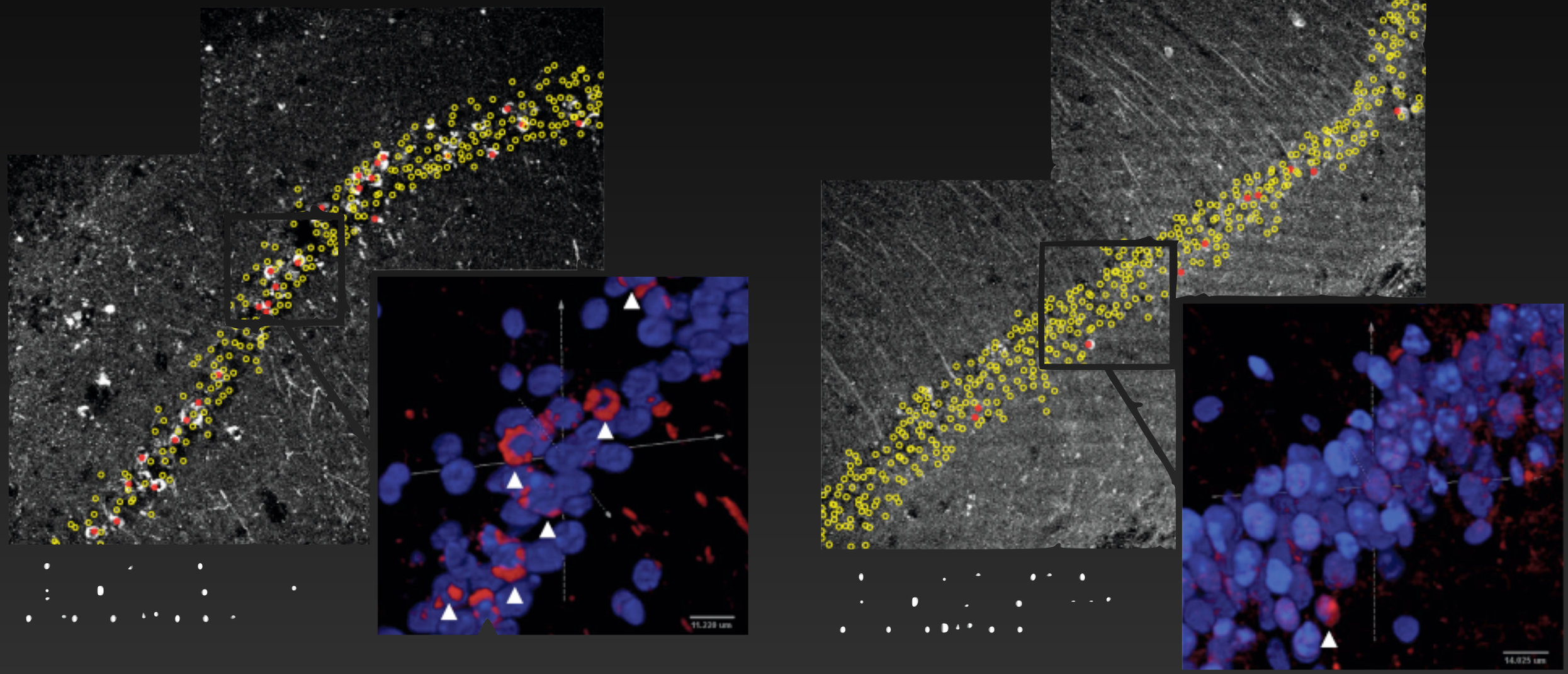
- Detects nuclei in up to 4D
- Supports GPU acceleration*
- Filtering with uncorellated channels
- Works on images of any size
- Each centroid has confidance

** GPU support partially sponsored by Nvidia with hardware donation*

Cell classification

Control

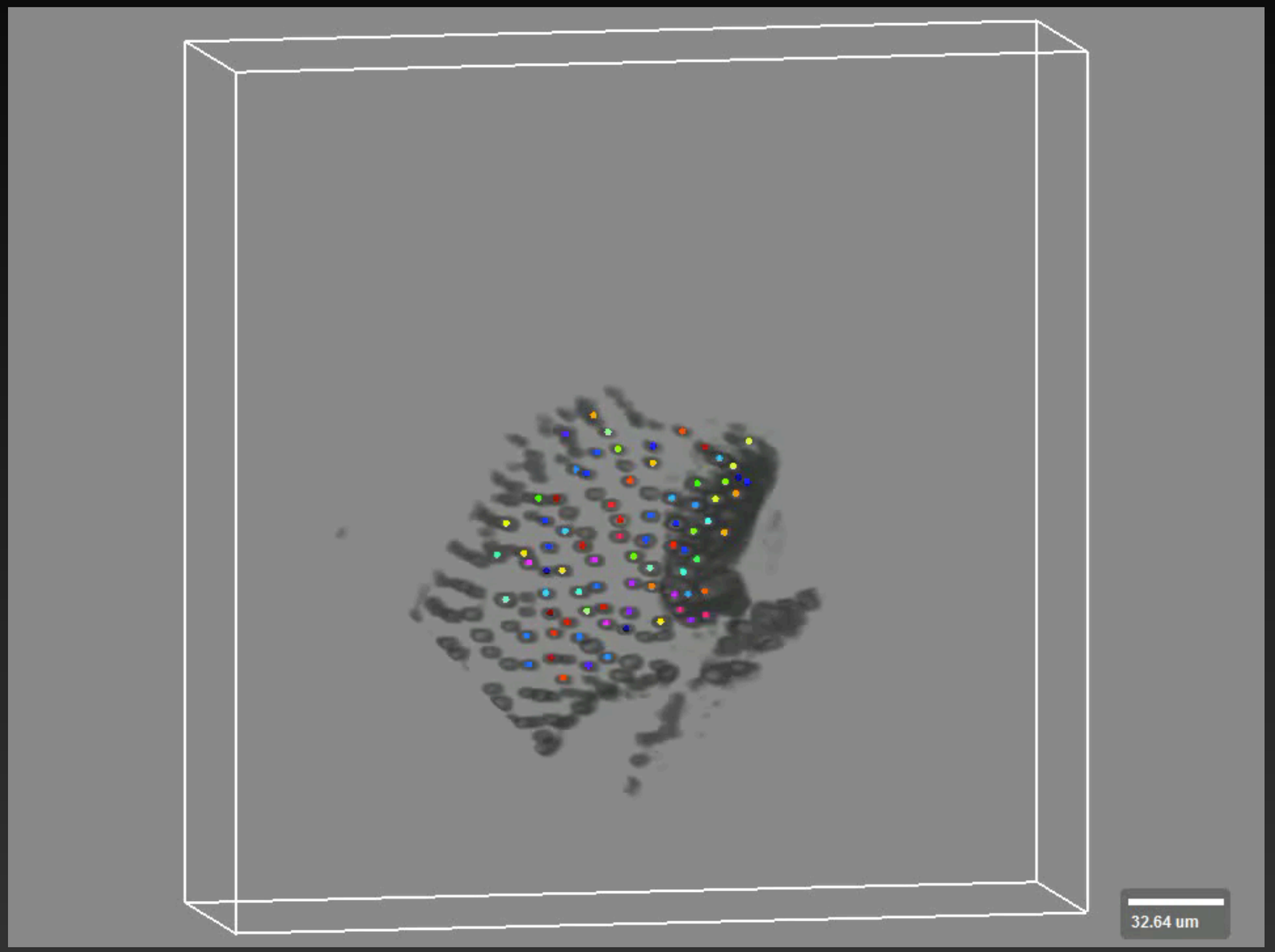
Treatment



Classified nuclei overlaid on PHF Z projection: Red – PHF positive, Yellow – not PHF positive

Diego Piedrahita, Israel Hernandez, Alejandro Lopez-Tobon, Dmitry Fedorov, Boguslaw Obara, B. S. Manjunath, Ryan L. Boudreau, Beverly Davidson, Frank LaFerla, Juan Carlos Gallego-Gomez, Kenneth S. Kosik, and Gloria Patricia Cardona-Gomez, "Silencing of CDK5 Reduces Neurofibrillary Tangles in Transgenic Alzheimer's Mice", Journal of Neuroscience, vol. 30, no. 42, pp. 13966-13976, Oct. 2010.

Cell tracking

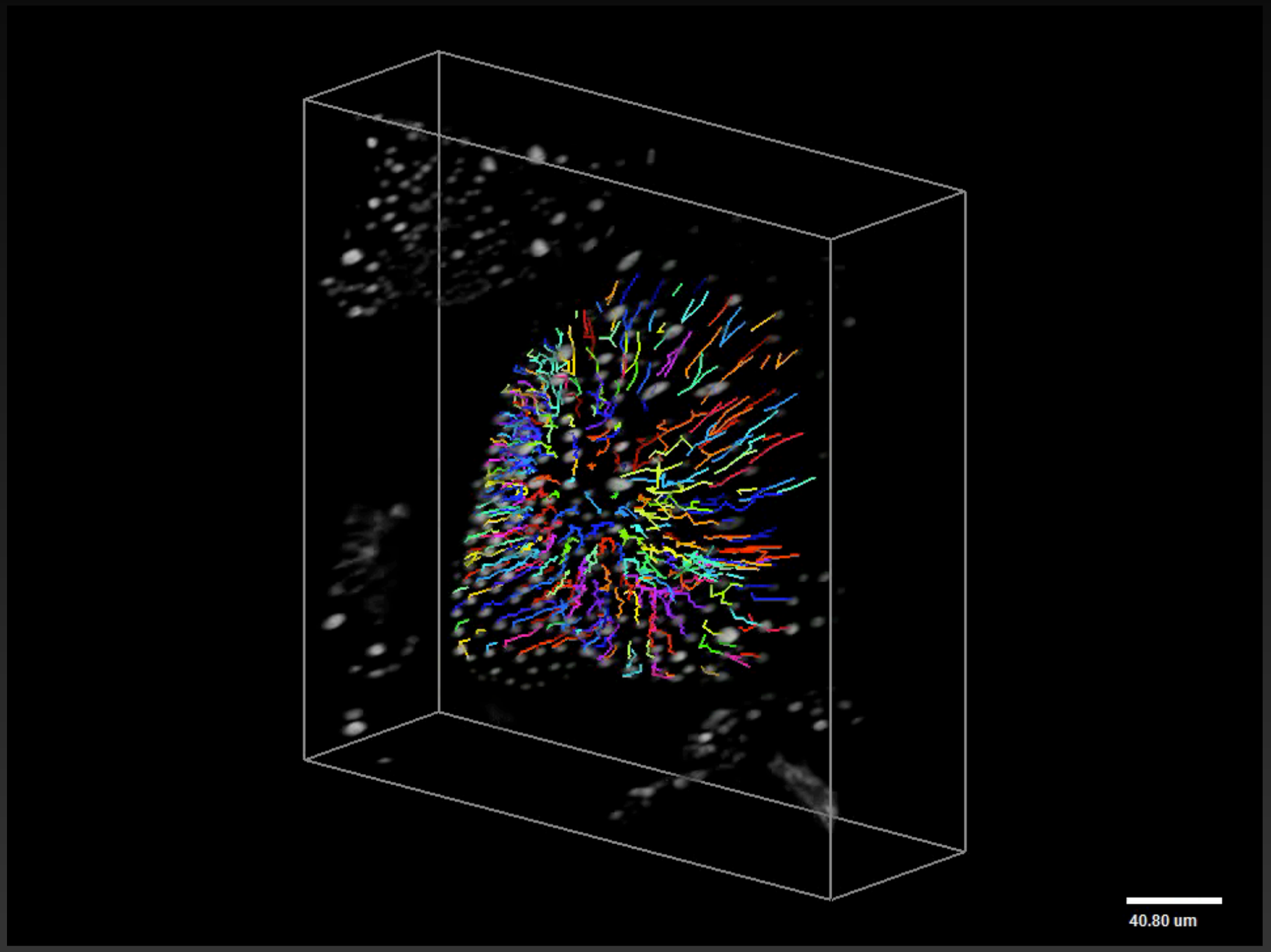


Centroids color coded by lifeline

4D datastet contributed by Adrienne Roeder, Cornell

Movie rendered with bioView3D

Cell tracking



Lifelines projected onto last time point

4D datastet contributed by Adrienne Roeder, Cornell

Movie rendered with bioView3D

Indexing and feature descriptors

XML + binary

Query Services

Query dialects and extensions: XQuery, SPARQL, BisQue,...

Index Services

Feature Services

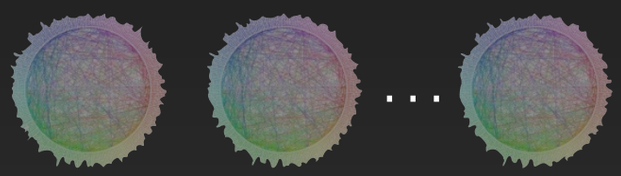
Extractors: Shape, Color, Location, Texture, etc...

Blob + Image Services

Blob and pixel operations

Data Services

Annotations & queries



Analysis Services

Module execution

Bisque scalable services

Geometry

Full text

Graph

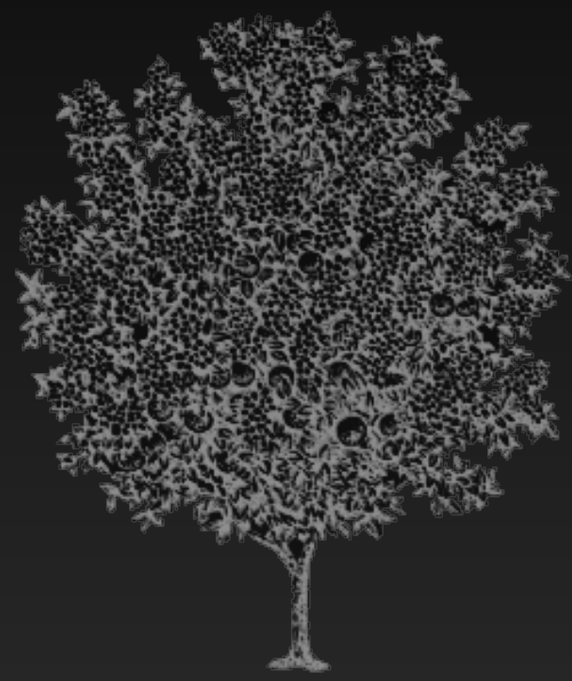
Image similarity

Near duplicates

Indices

Feature service

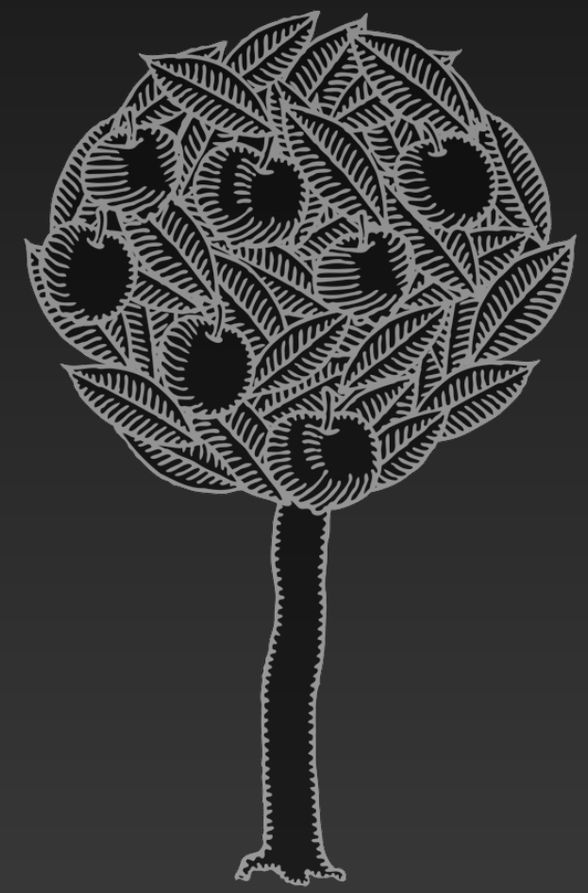
- Uniform access to feature descriptor computations
- Distributed computation
- Efficiently cached
- Feature descriptor libraries:
  - MPEG7 (6: DCD, CSD, CLD, RSD, EHD, HTD)
  - OpenCV (4: SIFT, SURF, ORB, BRISK)
  - Mahotas (5: DCD, CSD, CLD, RSD,EHD)
  - WNDCharm (100+: Radon, Chebyshev, Gabor, Histograms, Moments, Tamura, Edge stats, Otsu objects, Zernike, Haralick, ...)



Index services

- Multi-modal case-based index structures

  (custom clustering/indexing, distance measures, etc...)
- Use feature services for descriptor computations
- Designed to answer specific searches:
  - Full text
  - Graph
  - Geometry
  - Image similarity



Query service

- Aggregates multi-modal index services

  ex: return images with compound X and cell density > 40um and nuclear texture similar to Y

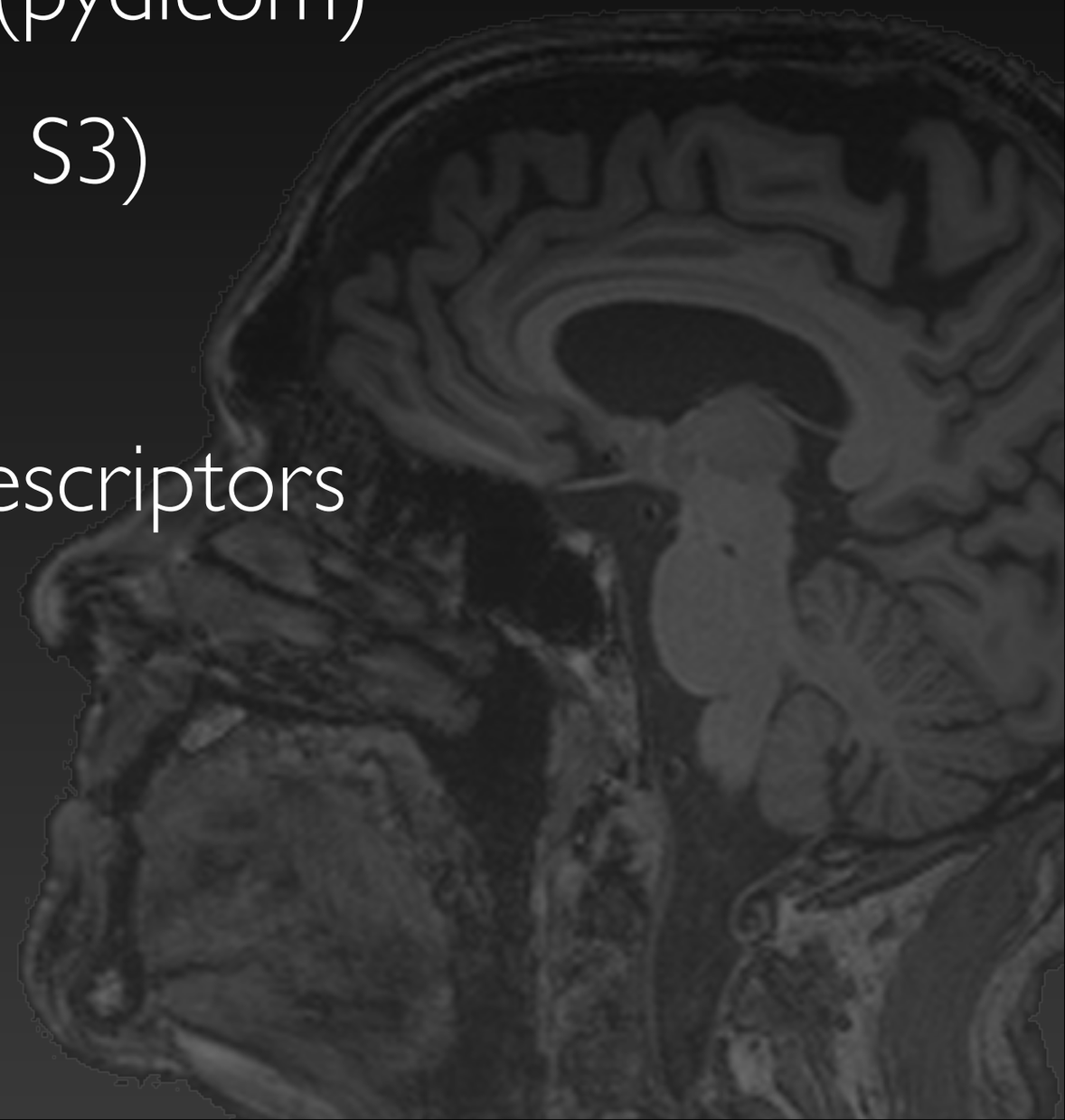
- Understands query dialects:

  XQuery, SPARQL, BisQue

Bio-Medical extensions

Bio-medical extensions

- Improved DICOM support (pydicom)
- Encrypted storage (Amazon S3)
- Graph-based queries
- Extended medical feature descriptors
- Anonymization techniques
- Specific analysis modules



1000+ Bisque users

Pfizer

iPlant Collaborative™

UNIVERSITY OF HELSINKI

J. Craig Venter INSTITUTE

CALIFORNIA INSTITUTE OF TECHNOLOGY 1891

CORNELL UNIVERSITY FOUNDED A.D. 1865

THE HEALTH AND LIFE SCIENCES UNIVERSITY private universität für gesundheitswissenschaften, medizinische informatik und technik UMIT HALL/TYROL

UNIVERSITY OF CALIFORNIA SANTA BARBARA LET THERE BE LIGHT

BITPLANE explore the next dimension

Yale UNIVERSITY

RARECYTE

UNIVERSIDADE FEDERAL DO ESPÍRITO SANTO DOCETE OMNES GENTES

CSH Cold Spring Harbor Laboratory

Bisque sponsors

NSF

NATIONAL INSTITUTES OF HEALTH

iPlant Collaborative™

powered by amazon web services™

Google

NVIDIA®

RIGHTSCALE® CLOUD MANAGEMENT

Pfizer

BITPLANE explore the next dimension

Hungry for Bisque

- Use a public Bisque:
  - iPlant: http://iplantcollaborative.org
  - UCSB: http://bisque.ece.ucsb.edu

- Get your own (source and documentation): http://bioimage.ucsb.edu/bisque

- Run on Amazon AWS:
  RightScale.com: "Bisque Server Template"

Get in the Kitchen

- http://biodev.ece.ucsb.edu/projects/bisque
  - Developer wiki and bug reports
  - Browse source
  - Get source and installation instructions

- Join our mailing list:
  http://groups.google.com/bisque-bioimage

- Chat with the developers (Google Talk or Jabber):
  bisque@partychapp.appspotchat.com