

Center for Bioimaging Informatics

www.bioimage.ucsb.edu

Supported by NSF ITR #0331697



UCSB Bioimaging and OME

April 20 2006

- Manjunath (UCSB) & Murphy(CMU)
- 5 Years bioimaging effort
- 2 1/2 years in
- Biology + Image Processing + Catabases

- Diverse users
 - UCSB Neurosciences institute
 - Retinal detachment : Fischer et al
 - Microtubule dynamics : Feinstein and Wilson
 - CMU Murphy Lab
 - Flybase
 - *Univ. of Utah Marc Lab* (internal development)
- Dataset challenges
 - Multiple types and collection techniques
 - Complex images (5D) and metadata
 - Acquisition and management of large sets
 - Security and Sharing of experimental data

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- Datasets challenges
 - Multiple types and collection techniques
 - Complex images (5D) and metadata
 - Acquisition and management of large sets
 - Security and Sharing of experimental data
- Analysis creates knowledge
 - Image analysis
 - Querying
 - Mining

- Experimental metadata capture
- Dataset management
 - Personal collections
 - Multiple organizations
 - Privacy and security
- Analysis design
- Analysis integration

- Kickoff Sep 2003
- Staffing Sep 2004
- 1st Prototype delivered Jan 2005
 - (mysql, php, collections)
 - 2nd prototype design begins
- Illya visits Feb 2005
- Internal Review Mar 2005
- Internal move to OME Oct 2005
- Review and BISQUE demo Mar 2006

System diagram

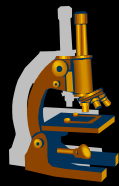


Image and
metadata capture

Ground truth
Collection

Image
Analysis
Collection
Analysis
Semantic
Analysis

DB
Storage

Browse Search
Content + metadata
Interactive
Enhancement
Knowledge
Discovery

- Current dataset collection
- BISQUE functionality
 - Data management
 - Ground truth acquisition
 - Analysis
- Architecture

Current collections

- UCSB Retinal Objects (confocal, EM)
- UCSB Microtubule Objects(light, AFM)

Type	Current	Backlog	Rate/y	Expected 4Yrs	2D Images
Retinal EM	500	22000	500	23,000	23K
Retinal confocal P	3000	600	2400	10,000	10K
Retinal confocal Z	600	14000	12000	10,000	50K
Microtubule light	3000	2500	2500	13,000	400K
Microtubule AFM	0	500	1200	5000	30K
Flybase	0	125K	0	125K	125K

- Analysis feature sets can be several times raw data
- Total estimated size in TBs and growingn for 1 Lab
- Complexity and analysis are the main issues

- Digital notebook
 - Capture experimental/image parameters
 - Direct import process
 - Reconfigurable (confocal, 4 x microtubule, etc)
- Web
 - Web access and browsing
 - Organize images and metadata
 - Data sharing environment
 - Search by metadata or content
 - Integrated analysis

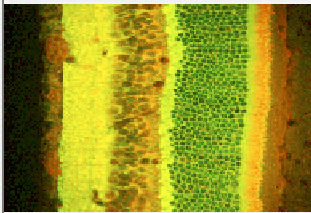
Screenshots (Digital Notebook)

Digital Notebook

Image Name:

Path:

Name	Modified
<input type="checkbox"/> NCXSY01_equalize.TIF	2004-02-12 12:04:06
<input type="checkbox"/> NCXSY01_normalize.TIF	2004-02-12 11:25:04
<input type="checkbox"/> NCXSY02_equalize.TIF	2004-02-12 12:02:30
<input type="checkbox"/> NCXSY02_normalize.TIF	2004-02-12 11:23:36
<input type="checkbox"/> NCXSY04_equalize.TIF	2004-02-12 12:02:30
<input type="checkbox"/> NCXSY04_normalize.TIF	2004-02-12 11:23:36
<input checked="" type="checkbox"/> NCXSY05_equalize.TIF	2004-02-12 12:04:08
<input type="checkbox"/> NCXSY05_normalize.TIF	2004-02-12 11:25:06
<input type="checkbox"/> NCXSY06_equalize.TIF	2004-02-12 12:02:24
<input type="checkbox"/> NCXSY06_normalize.TIF	2004-02-12 11:23:30
<input type="checkbox"/> NCXSY07_equalize.TIF	2004-02-12 12:02:24
<input type="checkbox"/> NCXSY07_normalize.TIF	2004-02-12 11:23:30
<input type="checkbox"/> NCXSY14_equalize.TIF	2004-02-12 12:03:40
<input type="checkbox"/> NCXSY14_normalize.TIF	2004-02-12 11:24:38
<input type="checkbox"/> NCXSY50_equalize.TIF	2004-02-12 12:04:16
<input type="checkbox"/> NCXSY50_normalize.TIF	2004-02-12 11:25:12
<input type="checkbox"/> NCXSY51_equalize.TIF	2004-02-12 12:03:34
<input type="checkbox"/> NCXSY51_normalize.TIF	2004-02-12 11:24:34
<input type="checkbox"/> NCXSY53_equalize.TIF	2004-02-12 12:02:08
<input type="checkbox"/> NCXSY53_normalize.TIF	2004-02-12 11:23:14
<input type="checkbox"/> NCXSY54_equalize.TIF	2004-02-12 12:02:10
<input type="checkbox"/> NCXSY54_normalize.TIF	2004-02-12 11:23:14



[Internal Metadata]

[Document Name]
D:\VTR\Cat\redgreen\section\normal\NCXSY05_equalize.TIF

[Software]
ImageMagick 5.4.9 09/01/02 Q16
<http://www.imagemagick.org>

[Date Time]
11-24-1992

[Artist]
1992 ACCUSOFT INC, ALL RIGHTS RESERVED

Species

Animal ID

Experimental Condition

Imaging date

Image Source ID

Image ID

File Name

View

Location

Magnification

Antibody Channel 1 (red)

Cell Type Antibody Channel 1 (red)

Antibody Channel 2 (green)

Cell Type Antibody Channel 2 (green)

Antibody Channel 3 (blue)

Cell Type Antibody Channel 3 (blue)

notes

Data management capabilities

- Digital notebook
 - Capture experimental/image parameters
 - Direct Import process
 - Reconfigurable (confocal, 4 x microtubule, etc)
- Web
 - Web access and browsing
 - Organize images and metadata
 - Data sharing environment
 - Search by metadata or content
 - Integrated analysis

Screenshots (browsing)

UCSB Center for BioImage Informatics - Mozilla Firefox

http://biodiv.ice.ucsb.edu/#

University of California, Santa Barbara You are now logged in as kris kvilekval.

Center for BioImage Informatics

Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) Mode: [Dual](#)

Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Dataset Search Close

owner	group	name
All	All	description
kris kvilekval	OME	
swaroop	6193_searchat	
august	6193_downloa	

Search: in [left](#) | [right](#) pane results as XML

Dataset: Retina multichannel (294 images)

Group: OME
Owner: kris kvilekval
Description: These images were imported using the OME command-line tool on Mon Mar 6 19:43:02 2006. This description was auto-generated. Use the -D command-line parameter to specify your own descriptions during image import.

Transferring data from biodiv.ice.ucsb.edu...

Screenshots (search)

UCSB Center for BioImage Informatics - Mozilla Firefox
<http://bioimv.ucsb.edu/bequn/#>
 University of California, Santa Barbara
 You are now logged in as kris.kvilekval.
Center for BioImage Informatics
 Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) Mode: [single](#)
 Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Searching RedCy2+rod_opsin
 441 Result(s), Page 1 of 37
 << 1 2 3 4 5 6 7 8 9 10 >>

Image: D5-29
 Retinal Condition: 3days+28days(r)
 View: section
 Red Cell: microglia
 Green Cell: rod
 Blue Cell: muller
 Red: rod_opsin
 Green: isolectinB4
 Blue: GFAP
 Species:
 Animal Id: Q8D5
 Location: REST
 Magnification: 0.206239
 Tissue:
 CD Number: 113
 Notes: 206 DSP29.TIF 3days+28days(r) section rod_opsin isolectinB4 GFAP 0.2062388 3 microglia rod muller 1-21-03 113 Q8D5 REST RetinalImage

Image: 28D-41
 Retinal Condition: 28days
 View: section
 Red Cell: microglia
 Green Cell: rod
 Blue Cell: muller
 Red: rod_opsin
 Green: isolectinB4
 Blue: GFAP
 Species:
 Animal Id: 765
 Location: REIT
 Magnification: 0.309358
 Tissue:
 CD Number: 116
 Notes: 64 28DP41.TIF 28days section rod_opsin isolectinB4 GFAP 0.3093583 microglia rod muller 3-11-03

Searching GreenCy2+miniclin
 64 Result(s), Page 1 of 6
 << 1 2 3 4 5 >>

Image: 41VR-5
 Retinal Condition: 7days(1+6days_O2)
 View: section
 Red Cell: muller
 Green Cell: redgreen
 Blue Cell:
 Red: red_green_cone_opsin
 Green: vimentin
 Blue:
 Species:
 Animal Id: 141
 Location: REST
 Magnification: 0.220148
 Tissue:
 CD Number: 77
 Notes: 496 41VRP5.TIF 7days(1+6days_O2) section red_green_cone_opsin vimentin none 0.2201479 2 muller redgreen 9-27-01 77 141 REST RetinalImage

Image: 41VR-3
 Retinal Condition: 7days(1+6days_O2)
 View: section
 Red Cell: muller
 Green Cell: redgreen
 Blue Cell:
 Red: red_green_cone_opsin
 Green: vimentin
 Blue:
 Species:
 Animal Id: 141
 Location: REST
 Magnification: 0.236659
 Tissue:
 CD Number: 77
 Notes: 522 41VRP3.TIF 7days(1+6days_O2) section red_green_cone_opsin vimentin none 0.2366593 muller

Transferring data from bioimv.ucsb.edu...

Screenshots (search)

UCSB Center for Bioimaging Informatics - Mozilla Firefox

http://bioimv.ucsb.edu/bioim/#

Retina OME | ITR Database

(Included in dataset(s): Mon Mar 6 19:36:04 2006 Import Dataset , Retina multichannel)

581 Result(s), Page 1 of 49

Image: D5-29
Retinal Condition: 3days+28days(r)
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin
Green: isolectinB4
Blue: Glial Fibrillary Acid Protein
Species:
Animal Id: Q8D5
Location: REST
Magnification: 0.206239
Tissue:
CD Number: 113
Notes: 206 D5P29.TIF 3days+28days(r) section rod_opsin isolectinB4 GFAP 0.2062388 3 microglia rod muller 1-21-03 113 Q8D5 REST RetinalImage

Image: 28D-41
Retinal Condition: 28days
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin
Green: isolectinB4
Blue: Glial Fibrillary Acid Protein
Species:
Animal Id: 765
Location: REIT
Magnification: 0.309358
Tissue:
CD Number: 116
Notes: 64 28DP41.TIF 28days section rod_opsin isolectinB4 GFAP 0.3093582 3 microglia rod muller 2-11-03 116 765 REIT RetinalImage

Image: 7DMI-2
Retinal Condition: 7days
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin

ID: 1
Group: OME
Owner: kris kvilekval
Size X,Y,Z,T,C: (768, 512, 1, 1, 3)
Original Files: NCCNP1_normalize.TIF
[\[image\]](#) [\[download\]](#)
 NCCNP1_equalize.TIF
[\[image\]](#) [\[download\]](#)
 NCCNP1.TIF
[\[image\]](#) [\[download\]](#)

Other Pixels

Tag: zseries
 X,Y,Z,T,C: (768, 512, 7, 1, 3)

Tag: normalize
 X,Y,Z,T,C: (770, 513, 1, 1, 3)

Tag: equalize
 X,Y,Z,T,C: (770, 513, 1, 1, 3)

Retinal Image Meta Data

Retinal Condition: normal
View: section
Red Cell: horizontal
Green Cell: ganglion
Blue Cell: amacrine
Red: calretinin
Green: neurofilament
Blue: calbindin
Species:
Animal Id: 097b
Location: LEST
Magnification: 0.228656
Tissue:
CD Number: 133
Notes: 852 NCCNP1.TIF normal section calretinin neurofilament calbindin 0.2286561 3 horizontal ganglion amacrine 7-21-03 133 097b LEST RetinalImage

Transferring data from bioimv.ucsb.edu...

Screenshots (search similar)

The screenshot displays a web browser window with the UCSB Center for Bioimaging Informatics website. The main content area features a search interface for retinal images. Below the search form, the results for image 28D-41 are shown, including three thumbnail images with 'find similar' links and a metadata section.

RetinalImage Search

Retinal Condition	Red Cell	Red Cy3	Species	Location	Magnification
Any	Any	rod_opsin	Any		
View	Green Cell	Green Cy2	Image Num	Notes	Tissue
Any	Any	Any			
	Blue Cell	Blue Cy5	Animal Id	CO Number	
	Any	Any			

Search: in left | right pane results as XML

Image: 28D-41

find similar

find similar

find similar

ID: 3
Group: OME
Owner: kris kvilekval

Screenshots (search similar)

The screenshot shows a web browser window displaying the UCSB Center for Bioimaging Informatics website. The browser's address bar shows the URL <http://biodiv.ecs.ucsb.edu/biqaq/index.html>. The website has a search interface with several dropdown menus and input fields. Below the search interface, there are two main image thumbnails. The first thumbnail is titled "Image: 28D-41" and shows a grid of yellow rectangles overlaid on a blue and green image. Below this thumbnail, the following metadata is displayed:

- ID: 3
- Group: OME
- Owner: Irits Intelekal
- Retinal Condition: 28days
- View: section
- Red Cell: microglia
- Green Cell: rod
- Blue Cell: muler
- Red: rod_opsin
- Green: isolectinB4
- Blue: GFAP

Below the metadata, it says "Number of results searched 3". There is a link "Render Rectangles" and another image thumbnail titled "Image: D-4MI-3" which also shows a grid of yellow rectangles overlaid on a blue and green image. Below this second thumbnail, the following metadata is displayed:

- ID: 161
- Group: OME
- Owner: Irits Intelekal

The browser's taskbar at the bottom shows the system time as 12:21 and the date as April 22nd, 2007. The taskbar also includes icons for various applications, including Microsoft PowerPoint and the UCSB Center for Bioimaging Informatics website.

Screenshots (personal collection)

UCSB Center for BioImage Informatics - Mozilla Firefox

http://bioimaging.ucsb.edu/biqa/#

University of California, Santa Barbara
Center for BioImage Informatics
 Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) Mode: [single](#)

Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Edit Image, ID=2

You are not the owner of this image, editing will be prohibited

Name:

Description:

Permissions: Private
 Search enabled for: All Group
 Download enabled for: All Group

[Submit](#) | [Cancel](#)

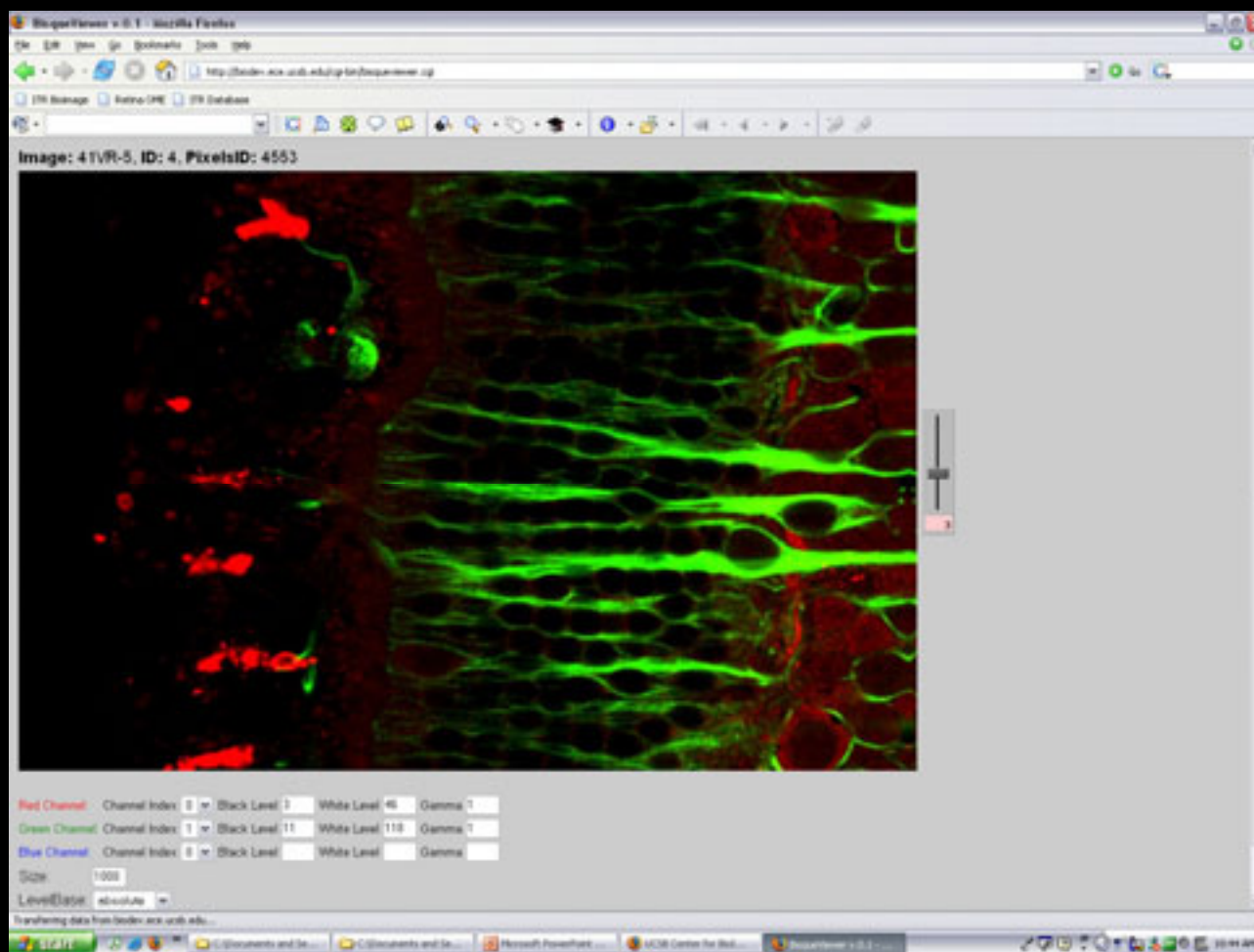
Searching: GreenCy2+vimentin

64 Result(s), Page 1 of 6

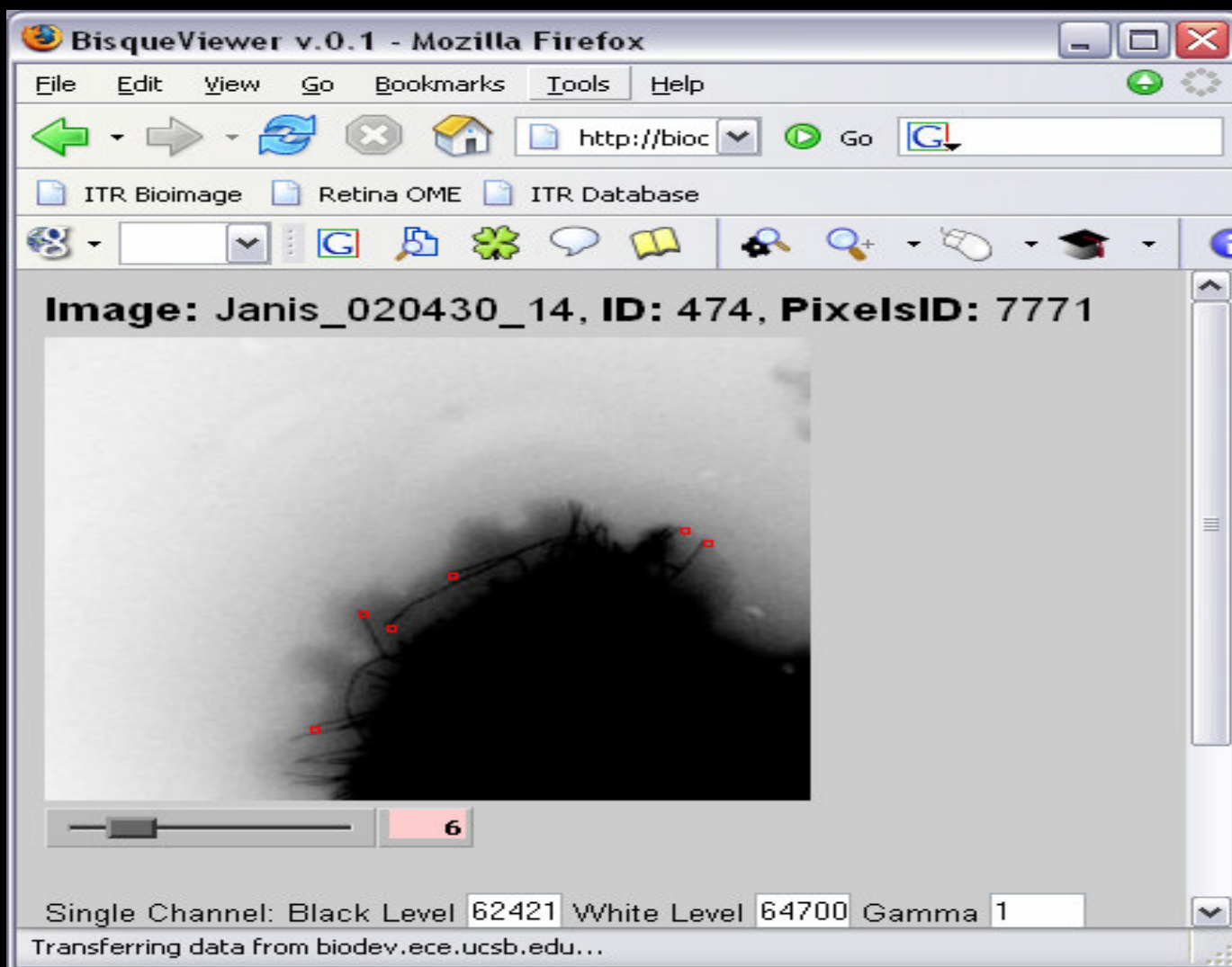
Image: 41VR-5
 Retinal Condition: 7days(1+6days_O2)
 View: section
 Red Cell: muller
 Green Cell: redgreen
 Blue Cell:
 Red: red_green_cone_opsin
 Green: vimentin
 Blue:
 Species:
 Animal Id: 141
 Location: REST
 Magnification: 0.220148
 Tissue:
 CD Number: 77
 Notes: 496 41VRP5.TIF 7days(1+6days_O2) section
 red_green_cone_opsin vimentin none 0.2201479 2 muller
 redgreen 9-27-01 77 141 REST RetinaImage

Image: 41VR-3
 Retinal Condition: 7days(1+6days_O2)
 View: section
 Red Cell: muller
 Green Cell: redgreen
 Blue Cell:
 Red: red_green_cone_opsin
 Green: vimentin
 Blue:
 Species:
 Animal Id: 141
 Location: REST
 Magnification: 0.236659
 Tissue:
 CD Number: 77
 Notes: 522 41VRP3.TIF 7days(1+6days_O2) section

Screenshots (5D Viewer)



Screenshot (5D with tracks)

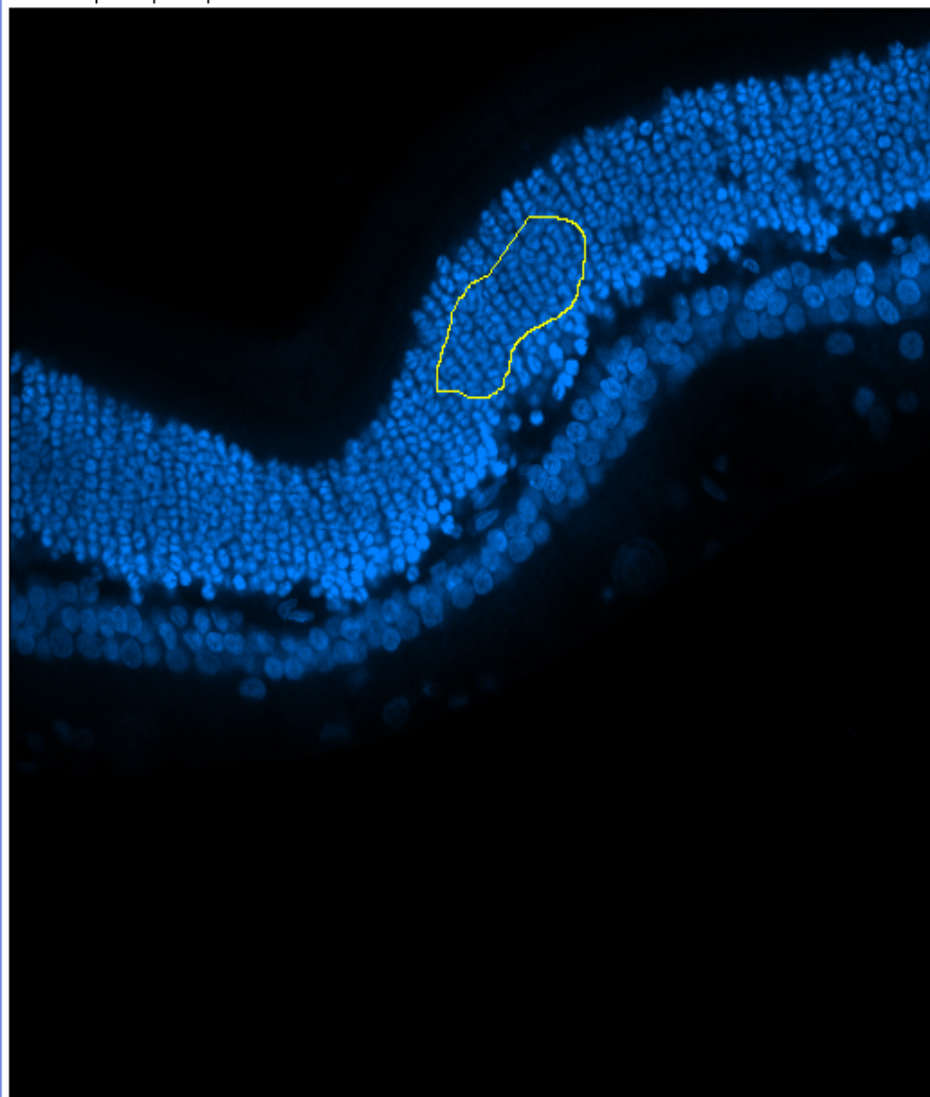


- Integrated image analysis
 - Advanced image processing
 - Cell counter (ImageJ)
 - Quantify microtubule dynamics
 - Track identification
- Integration in progress
 - *Segmentation and classification*
 - *Microtubule tracker*
 - *Modeling microtubule dynamics*
 - *Modeling uncertain data*
 - *Relevance feedback improving search*

Screenshots (Image Analysis)

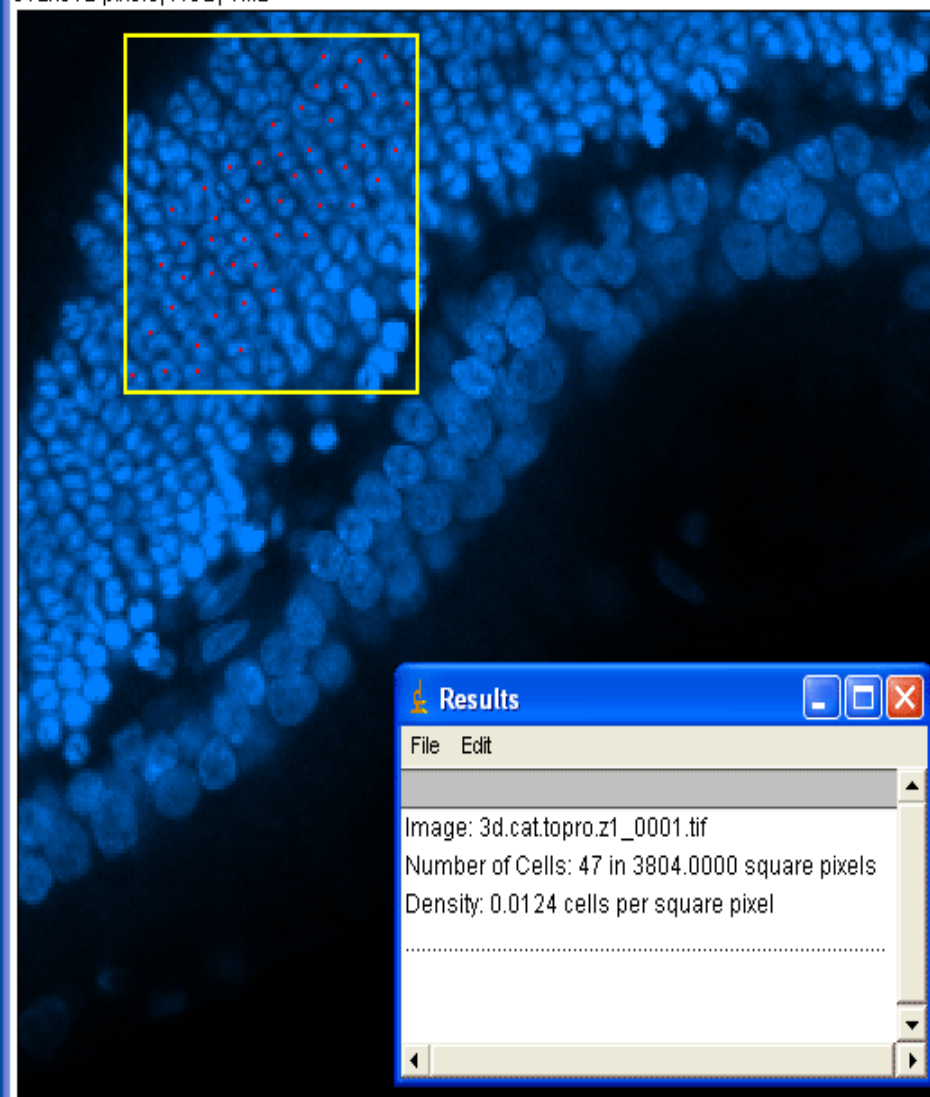
3d.cat.topro.z1_0001.tif

512x512 pixels; 8-bit; 256K



Results 3d.cat.topro.z1_0001.tif (200%)

512x512 pixels; RGB; 1MB



Results

File Edit

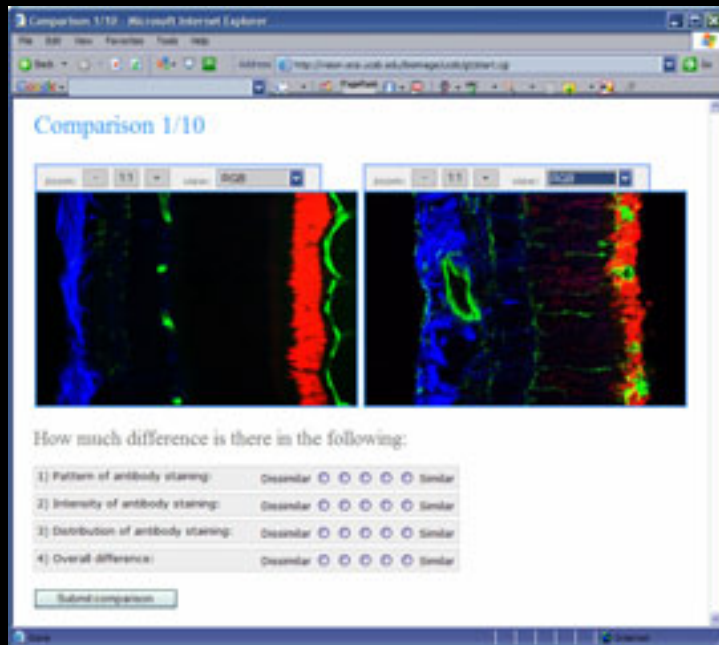
Image: 3d.cat.topro.z1_0001.tif

Number of Cells: 47 in 3804.0000 square pixels

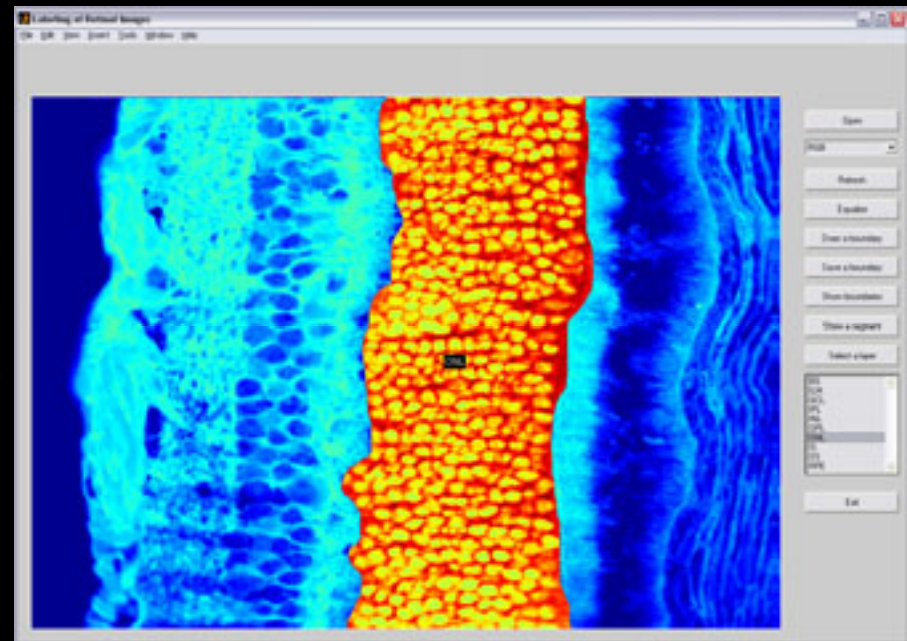
Density: 0.0124 cells per square pixel

Ground truth acquisition tools

Image processing and infrastructure teams are developing universal “ground truth” collection tools able to retrieve data from data-base and feed user defined information back to the database. The main communication vehicle is XML interchange format.



+



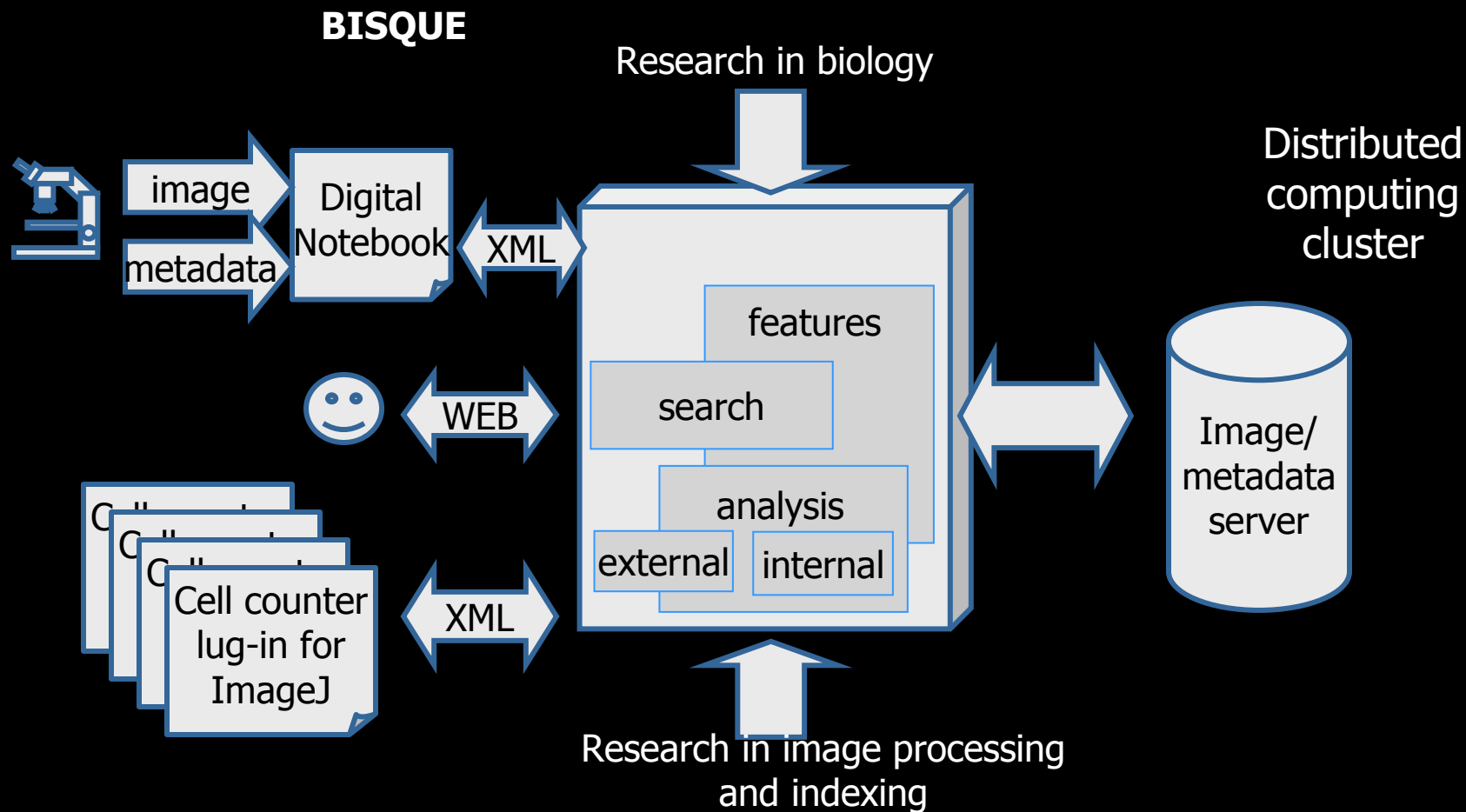
At the current stage stand alone tools are being developed and tested that later on will be grouped in the universal application able to communicate directly to the data-base.

- Current dataset collection
- Current functionality
 - Data management
 - Ground truth acquisition
 - Analysis
- **Architecture**

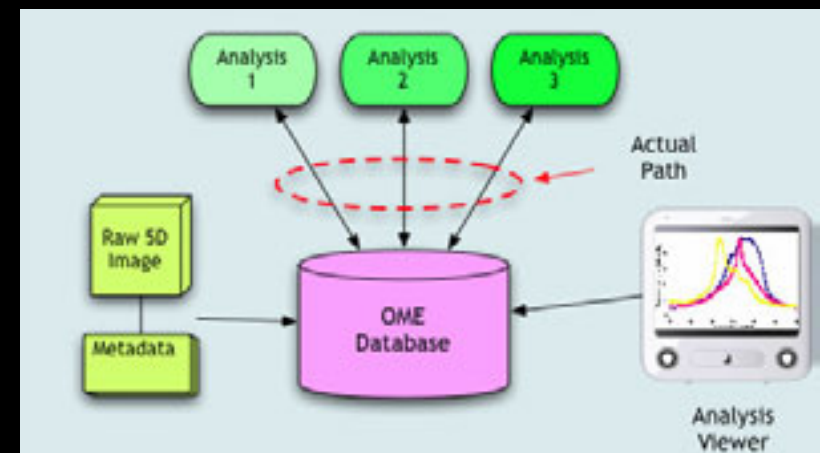
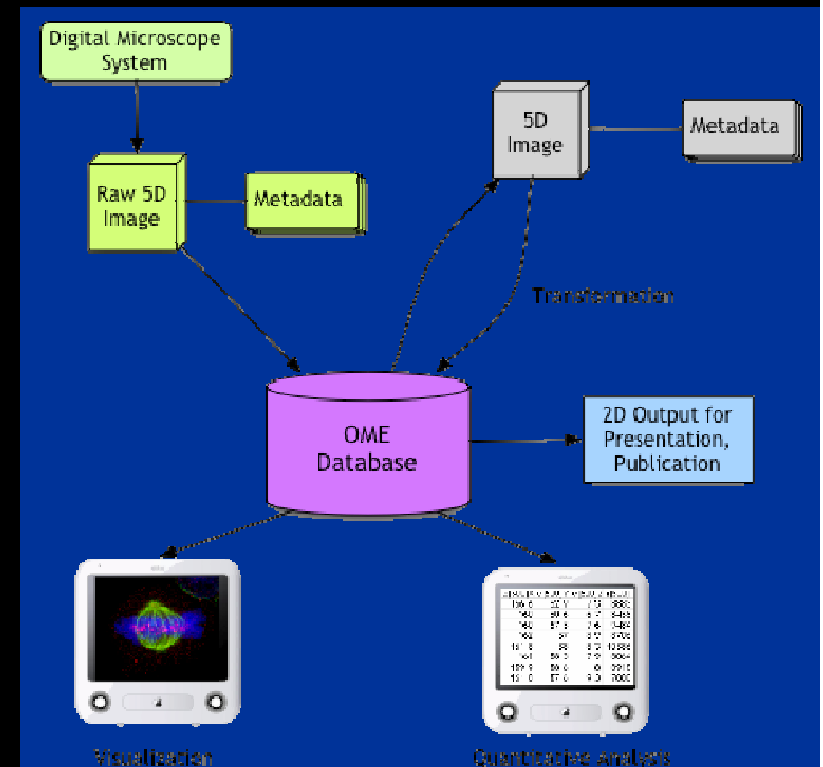
- Hardware
 - 16 node Cluster
 - dual Intel Xeon 3GHZ
 - Gigabit network switch
 - 2 TB Storage
- Software
 - Linux
 - OME (Apache, Postgresql)
 - Bisque

Bisque Architecture

Bio-Image Semantic Query User Environment

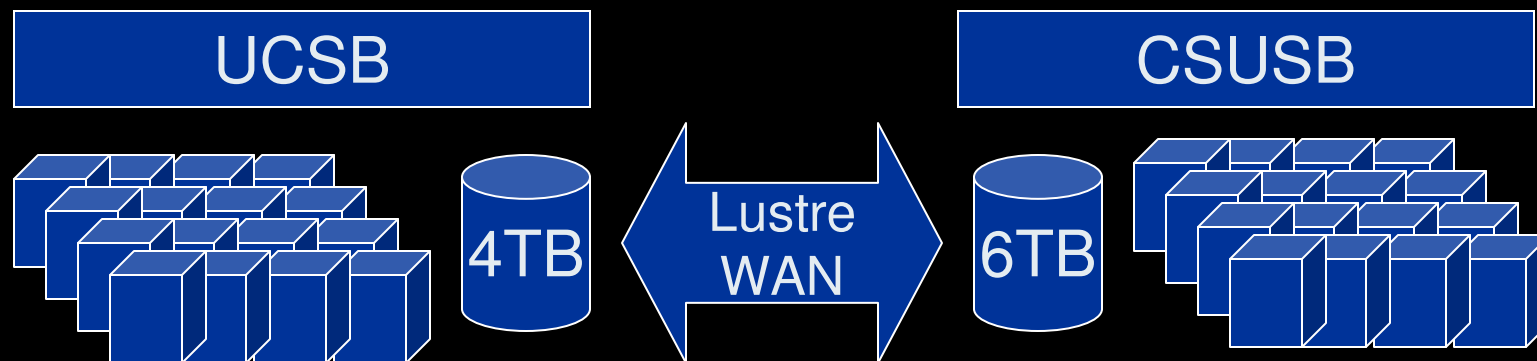


- Open Microscopy Environment
 - “OME is an open source software project to develop a database-driven system for the quantitative analysis of biological images. OME is a collaborative effort among academic labs and a number of commercial entities”.
- Provides base for image/metadata storage and analysis integration
- [Boston: Sorger Lab](#)
- [Baltimore: Goldberg Lab](#)
- [Dundee: Swedlow Lab](#)
- [Madison: LOCI](#)



- Ongoing extensions with OME
 - Content based search
 - Analysis integration with OME
 - Segmentation
 - Cell Counting
 - Etc.
 - Front end dataset and analysis support
 - Schema additions for image types and analysis
 - Uncertainty modeling and queries

- Scalable Distributed System for collaboration
- Cluster for analysis
- Distributed storage
 - Lustre filesystem
 - Shared Postgres metadata
 - Local image servers
- Bisque/OME over file system



- Built 1st generation w/ >4000 images
 - Integrated several *useful* analyses
 - Being used internally
 - External Interest
- Immediate future
 - Continued development
 - analysis integration
 - Dataset integration
 - Local user feedback
 - Expand user base
 - Remote deployments
 - Integration with other projects
 - Flybase : Integration of schema/datasets in progress
 - BIRN :Mediation framework: when available

- Please visit:
 - <http://bioimage.ucsb.edu/bisque>
 - User: guest/bioimage
- Team:
 - H. Alagud, A. Black, D. Fedorov, S. Jagadish, S. Jagannath, R. Kumar, T. Kuo, W. Smith