OME Users Meeting at the Institut Pasteur Paris
June 2, 2015

Tissue Micro-Array and Whole Slide Image storage and manipulation using Omero server and API in a digital pathology context.

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ULB

cmmi
excellence in preclinical imaging

objective of this presentation

- to explain our needs
- to describe a framework (early prototype...)
- to show an example of application

Disclaimer

this is only a naive attempt

there is for sure a better way to do that

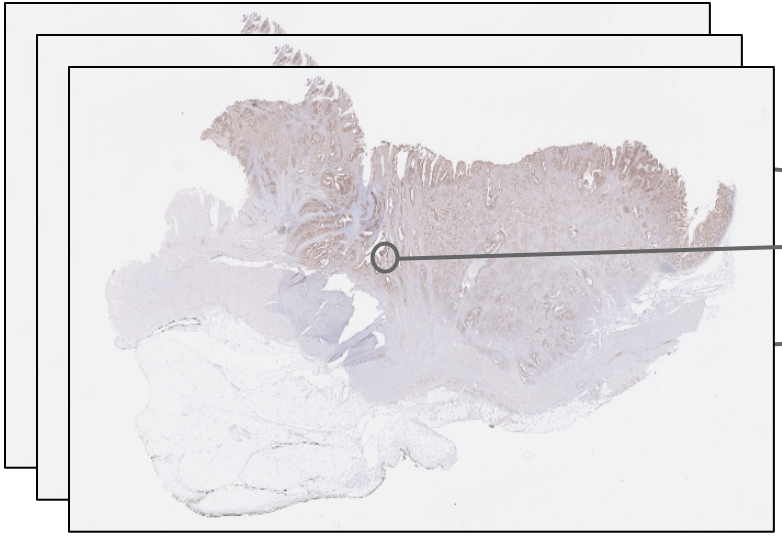
Zest is not a product, it is only a project name

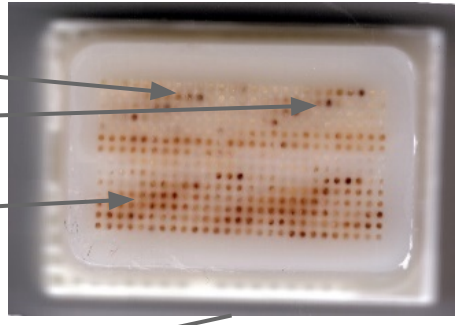
I am here to learn and get feedback

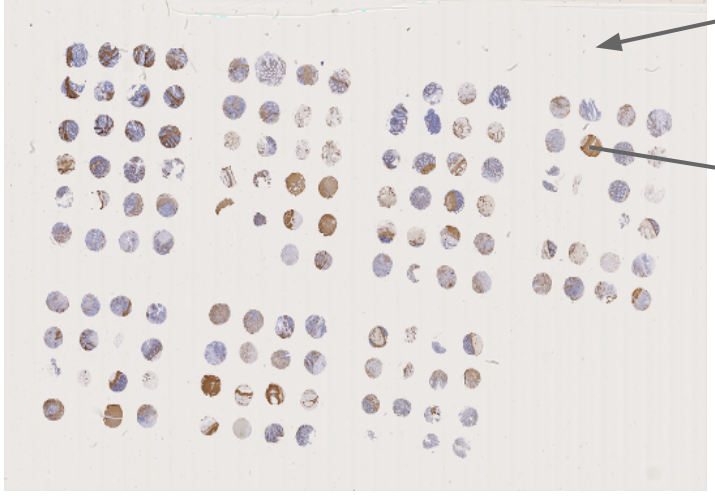
Tissue Micro-Array and Whole Slide Image storage and manipulation using Omero server and API in a digital pathology context.

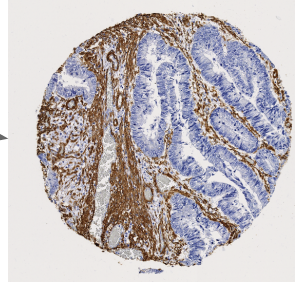
Tissue Micro-Array and Whole Slide

Tissue Micro-Array

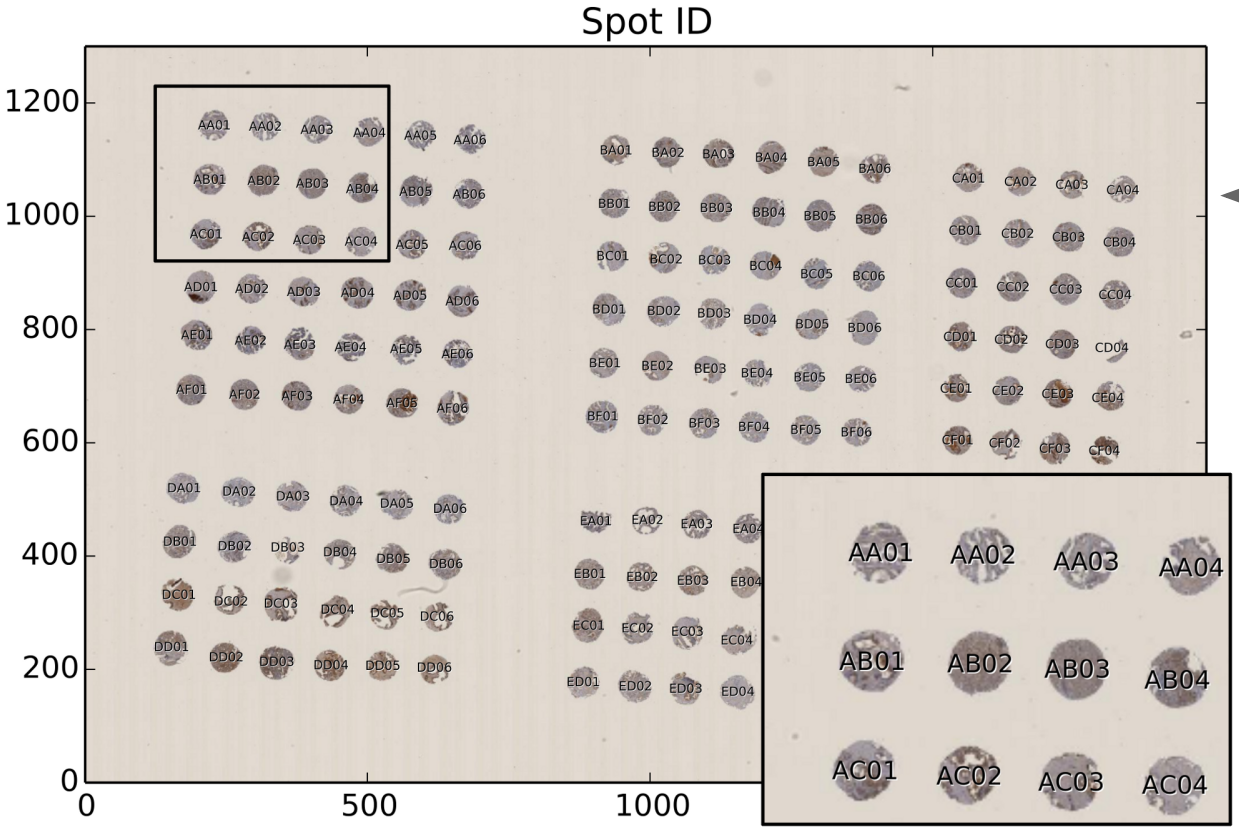








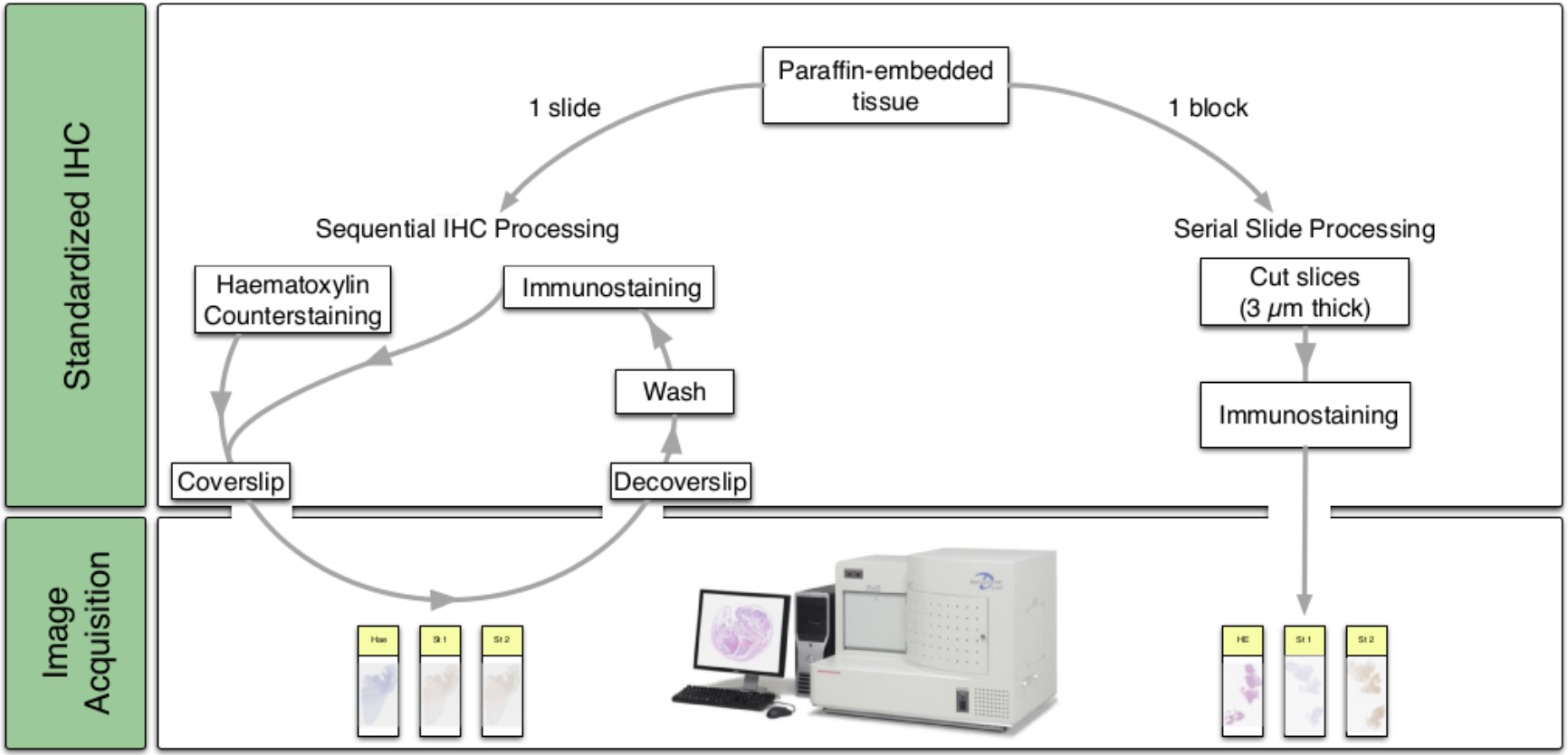
Tissue Micro-Array



Tissue Micro-Array and Whole Slide Image storage and manipulation using Omero server and API in a digital pathology context.

different experiment set up / different data organisation

digital pathology



Moles Lopez X et al.2014

example 1:
PROSTATE TMA

5 TMA blocks

5 XLS design files (1 per block)

→ grid description + core structure

1 slide per block

1 marker : IL8 (same batch)

example 2: COLON co-expression

13 TMA blocks

13 XLS design files (1 per block)

→ grid description + core structure

7 Slides per block

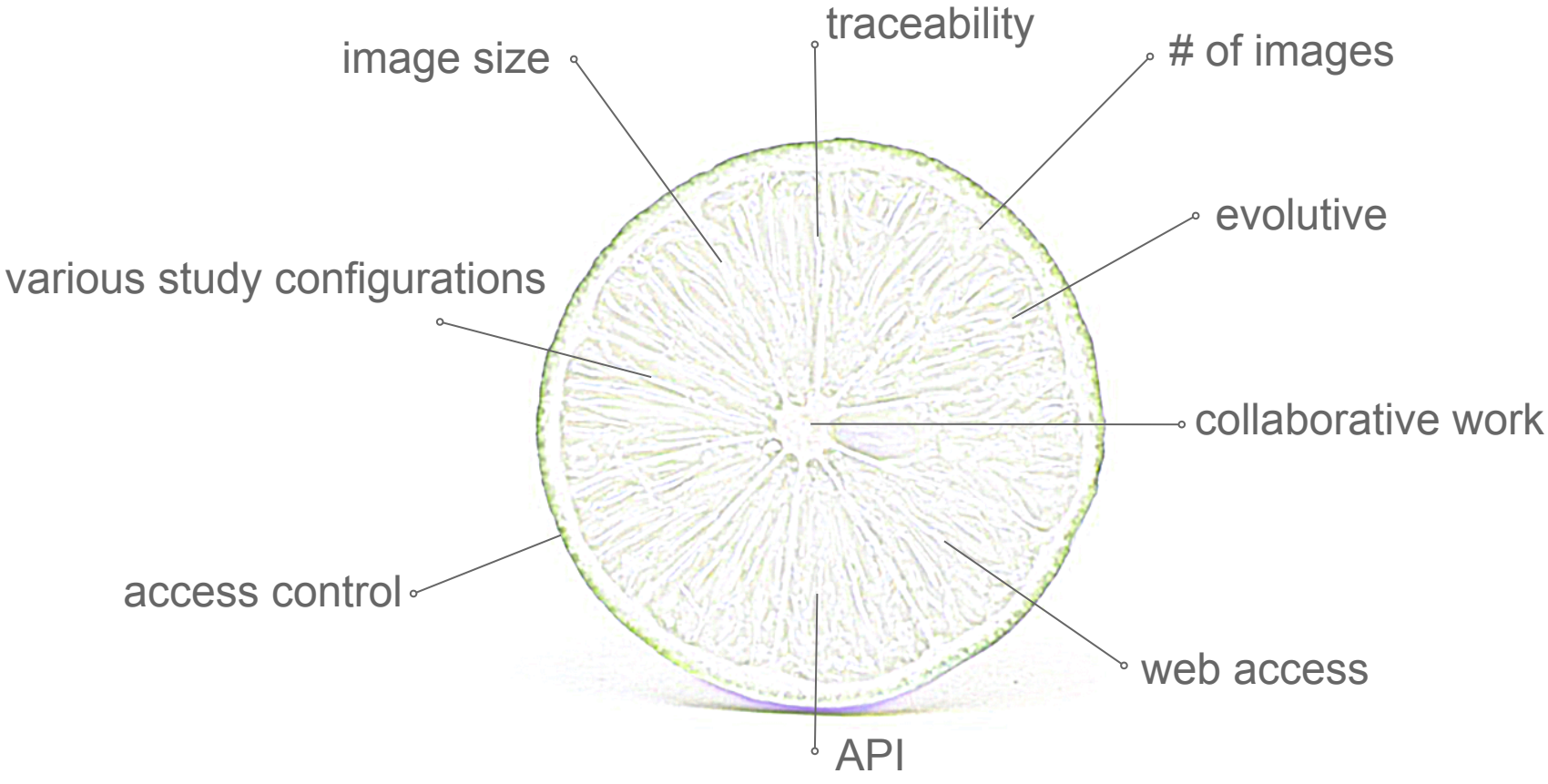
7 Batches

BAX,BCL2,IGF1,IGF1R,IGFBP2,KI67,SMA

13 Series (up to 7 slices)

requirements

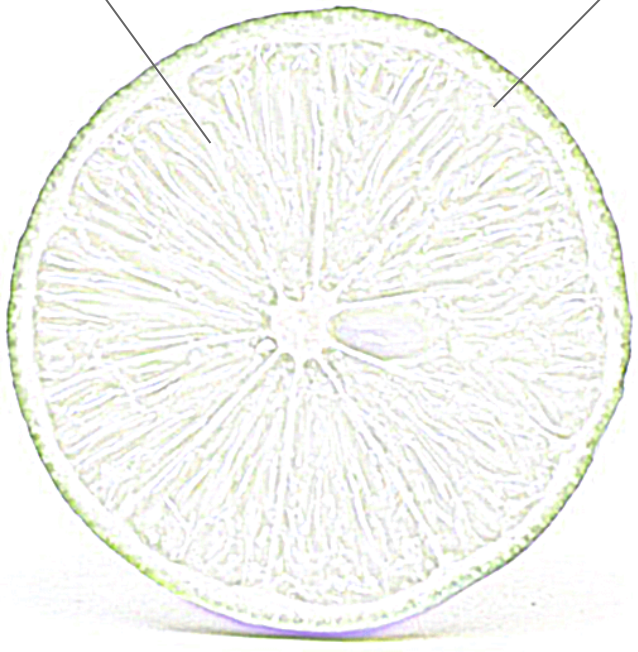
requirements



requirements

image size

# of images



1 image ≈ 30 GB

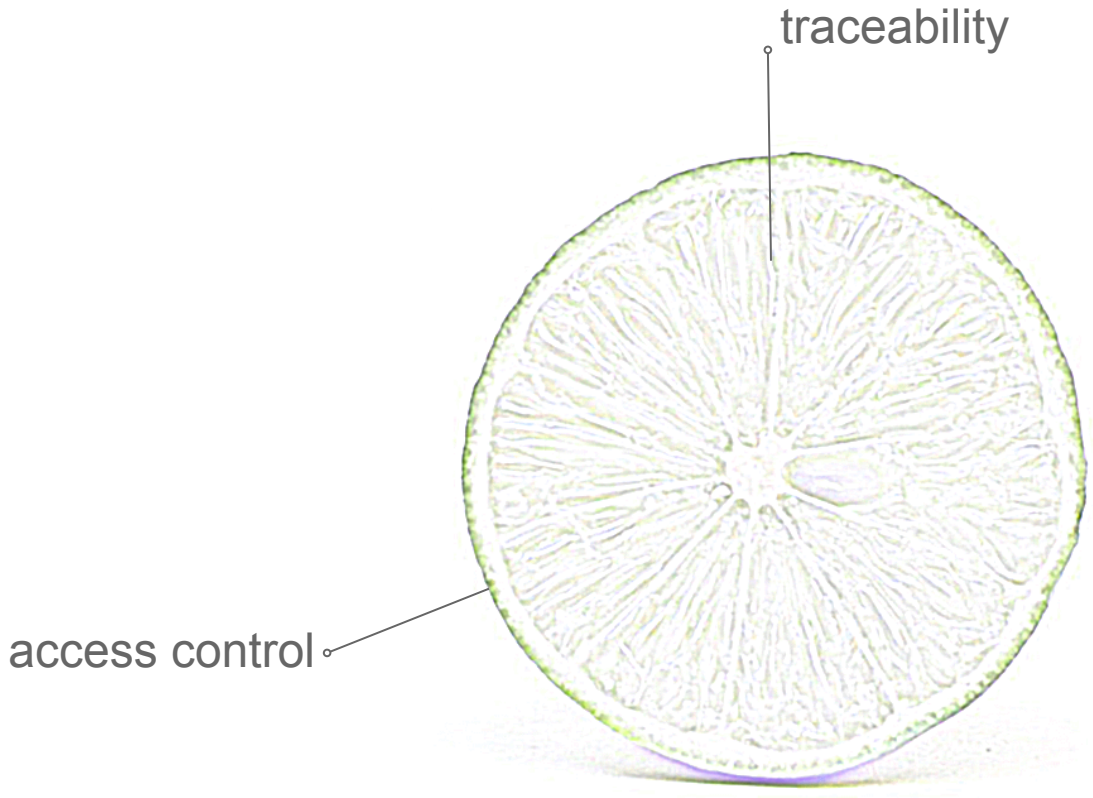
1 study > 100 images

plenty of study

several P.I.

1 scanner / several clients

requirements

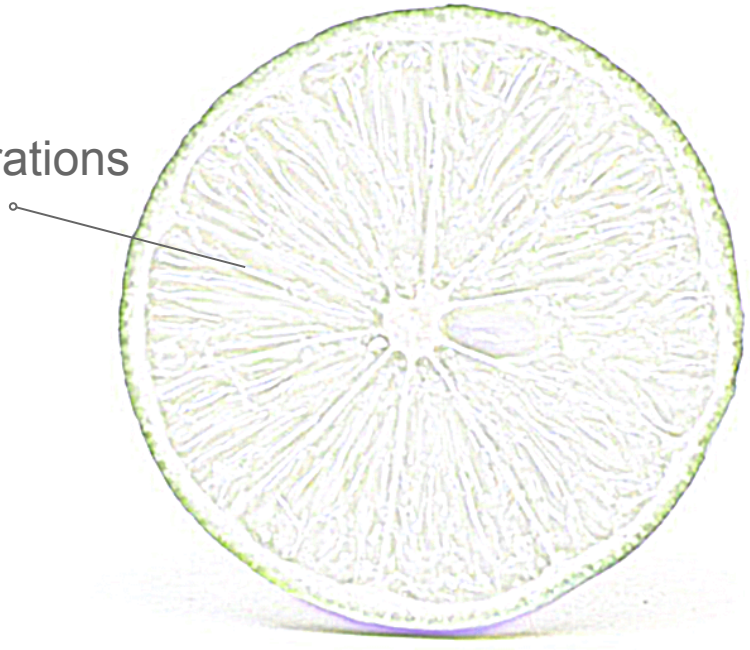


link data with other tracking systems (e.g. diamic)

restricted access per study

requirements

various study configurations



study defined inside diamic

single slide

test studies

WSI

TMA

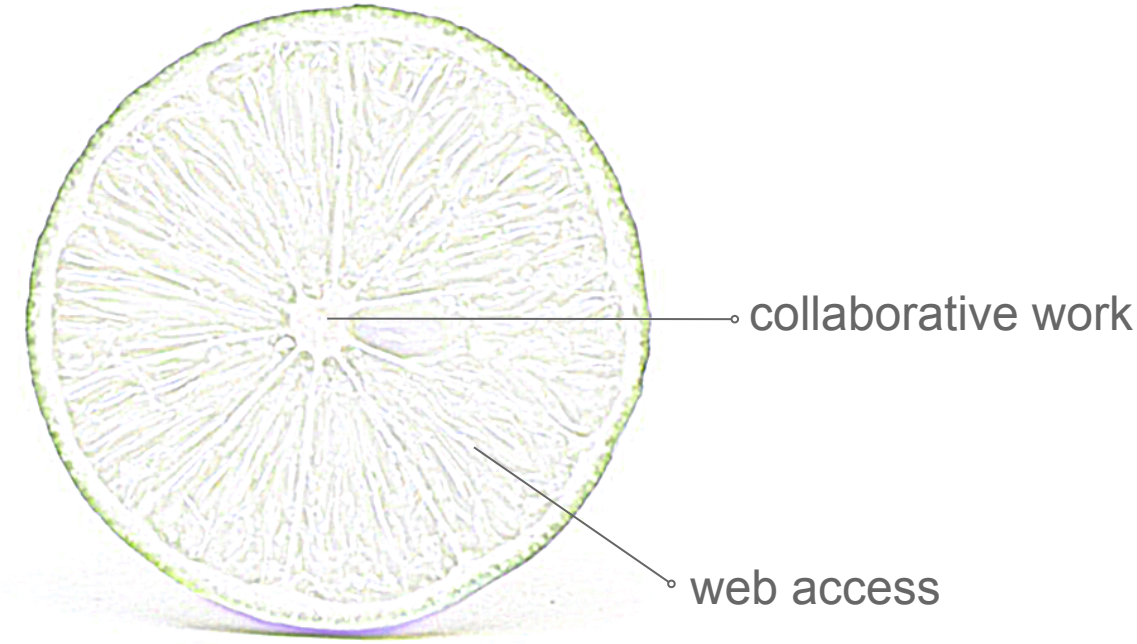
Serial / SIMPLE

internal / external users

requirements

several users / same data

limit installation burden



requirements

simple

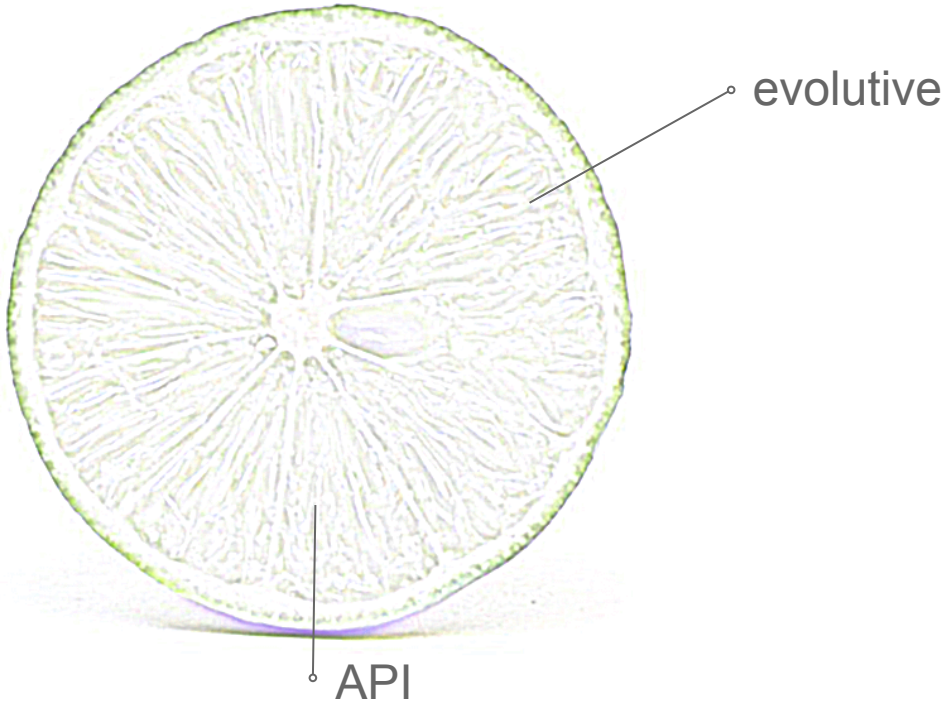
easy to maintain

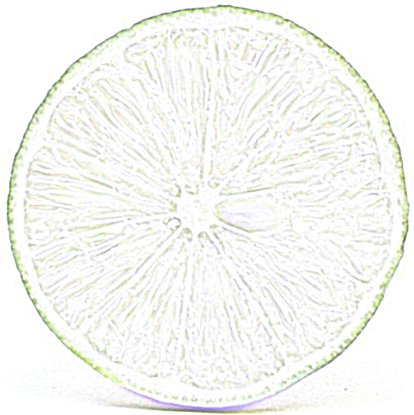
possible to automatize (application program interface)

no limitation

OS agnostic

open source





ZEST

our approach

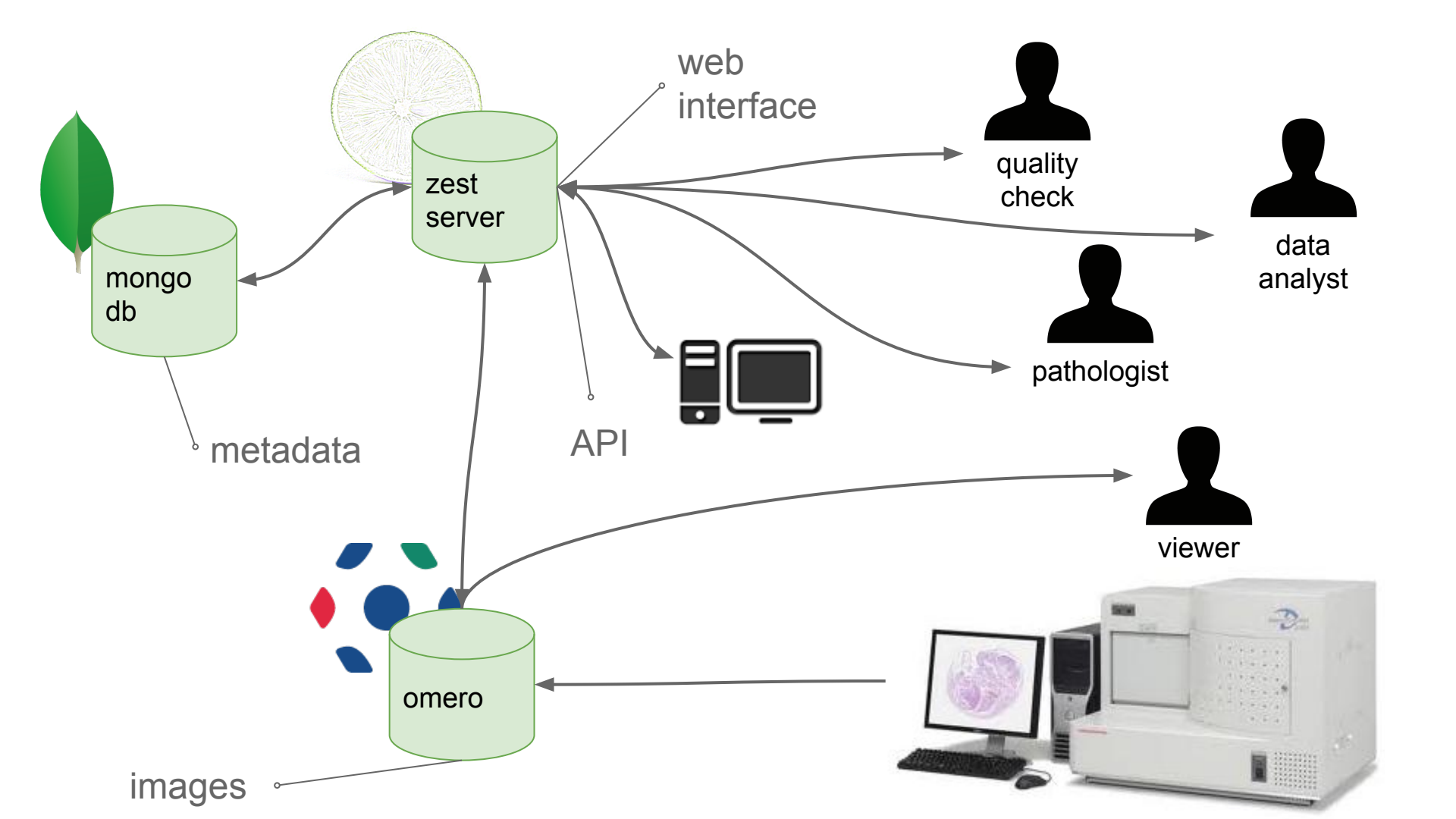
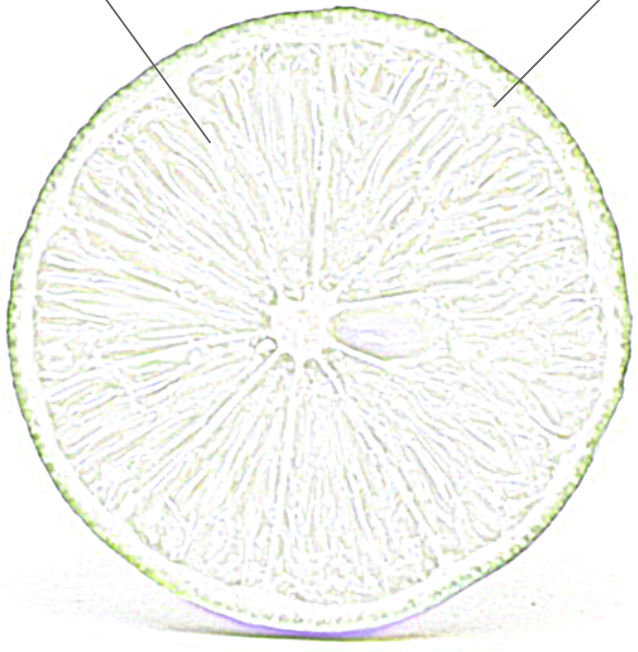

web
interface
zest
server
mongo
db
metadata
API
quality
check
data
analyst
pathologist
viewer
omero
images

image size

# of images



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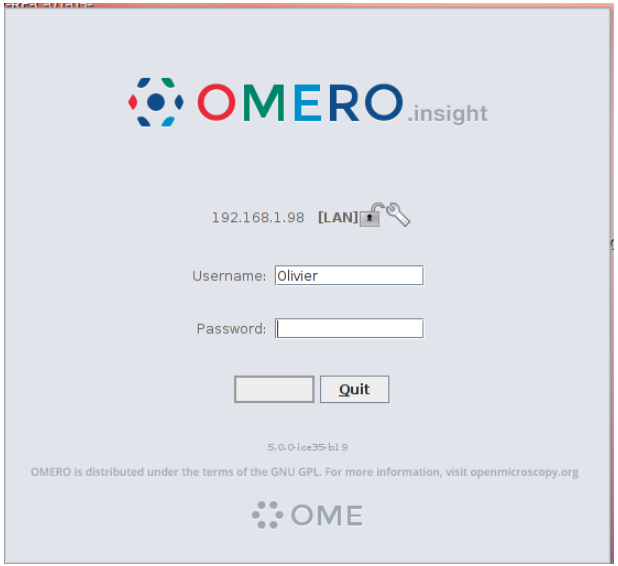
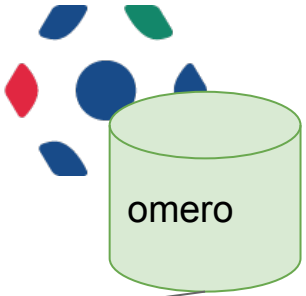




images

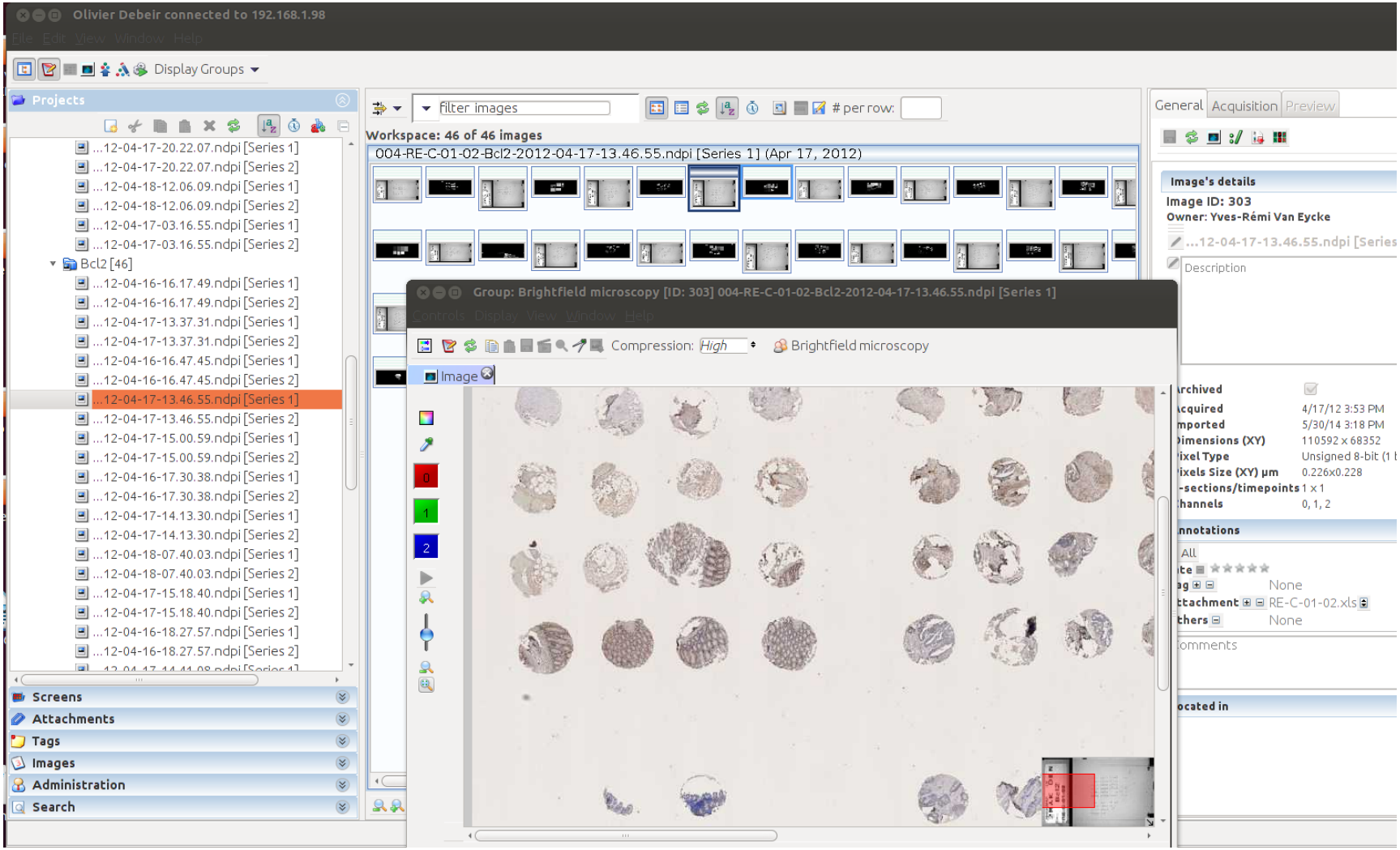
other ULB

CMMI

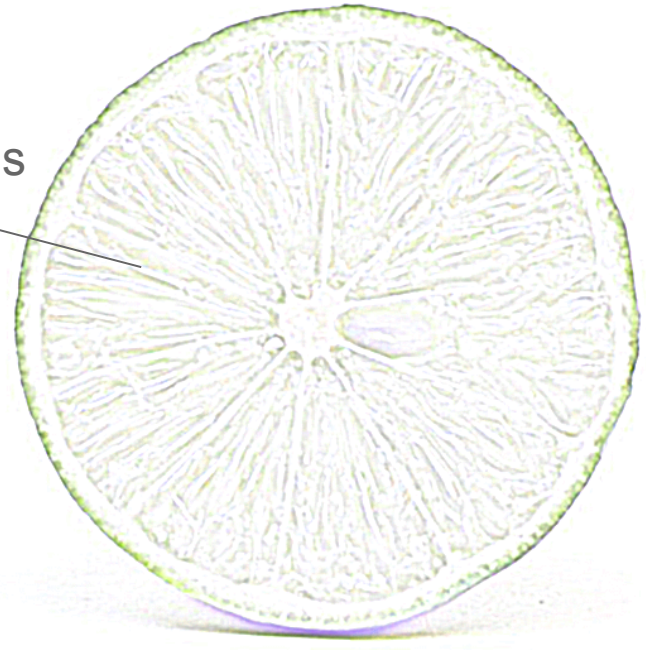
non ULB

LISA-Image

Erasme


Olivier Debeir connected to 192.168.1.98
File Edit View Window Help
Display Groups
Projects
...12-04-17-20.22.07.ndpi [Series 1]
...12-04-17-20.22.07.ndpi [Series 2]
...12-04-18-12.06.09.ndpi [Series 1]
...12-04-18-12.06.09.ndpi [Series 2]
...12-04-17-03.16.55.ndpi [Series 1]
...12-04-17-03.16.55.ndpi [Series 2]
Bcl2 [46]
...12-04-16-16.17.49.ndpi [Series 1]
...12-04-16-16.17.49.ndpi [Series 2]
...12-04-17-13.37.31.ndpi [Series 1]
...12-04-17-13.37.31.ndpi [Series 2]
...12-04-16-16.47.45.ndpi [Series 1]
...12-04-16-16.47.45.ndpi [Series 2]
...12-04-17-13.46.55.ndpi [Series 1]
...12-04-17-13.46.55.ndpi [Series 2]
...12-04-17-15.00.59.ndpi [Series 1]
...12-04-17-15.00.59.ndpi [Series 2]
...12-04-16-17.30.38.ndpi [Series 1]
...12-04-16-17.30.38.ndpi [Series 2]
...12-04-17-14.13.30.ndpi [Series 1]
...12-04-17-14.13.30.ndpi [Series 2]
...12-04-18-07.40.03.ndpi [Series 1]
...12-04-18-07.40.03.ndpi [Series 2]
...12-04-17-15.18.40.ndpi [Series 1]
...12-04-17-15.18.40.ndpi [Series 2]
...12-04-16-18.27.57.ndpi [Series 1]
...12-04-16-18.27.57.ndpi [Series 2]
Screens
Attachments
Tags
Images
Administration
Search
filter images
per row:
Workspace: 46 of 46 images
004-RE-C-01-02-Bcl2-2012-04-17-13.46.55.ndpi [Series 1] (Apr 17, 2012)
Group: Brightfield microscopy [ID: 303] 004-RE-C-01-02-Bcl2-2012-04-17-13.46.55.ndpi [Series 1]
Controls Display View Window Help
Compression: High
Brightfield microscopy
Image
0
1
2
General
Acquisition
Preview
Image's details
Image ID: 303
Owner: Yves-Rémi Van Eycke
...12-04-17-13.46.55.ndpi [Series
Description
Archived
Acquired 4/17/12 3:53 PM
Imported 5/30/14 3:18 PM
Dimensions (XY) 110592 x 68352
Pixel Type Unsigned 8-bit (1 t
Pixels Size (XY) µm 0.226x0.228
Z-sections/timepoints 1 x 1
Channels 0, 1, 2
Annotations
All
Tag None
Attachment RE-C-01-02.xls
Others None
Comments
Located in

various study configurations



study defined inside diamic

single slide

test studies

WSI

TMA

Serial / SIMPLE

internal / external users

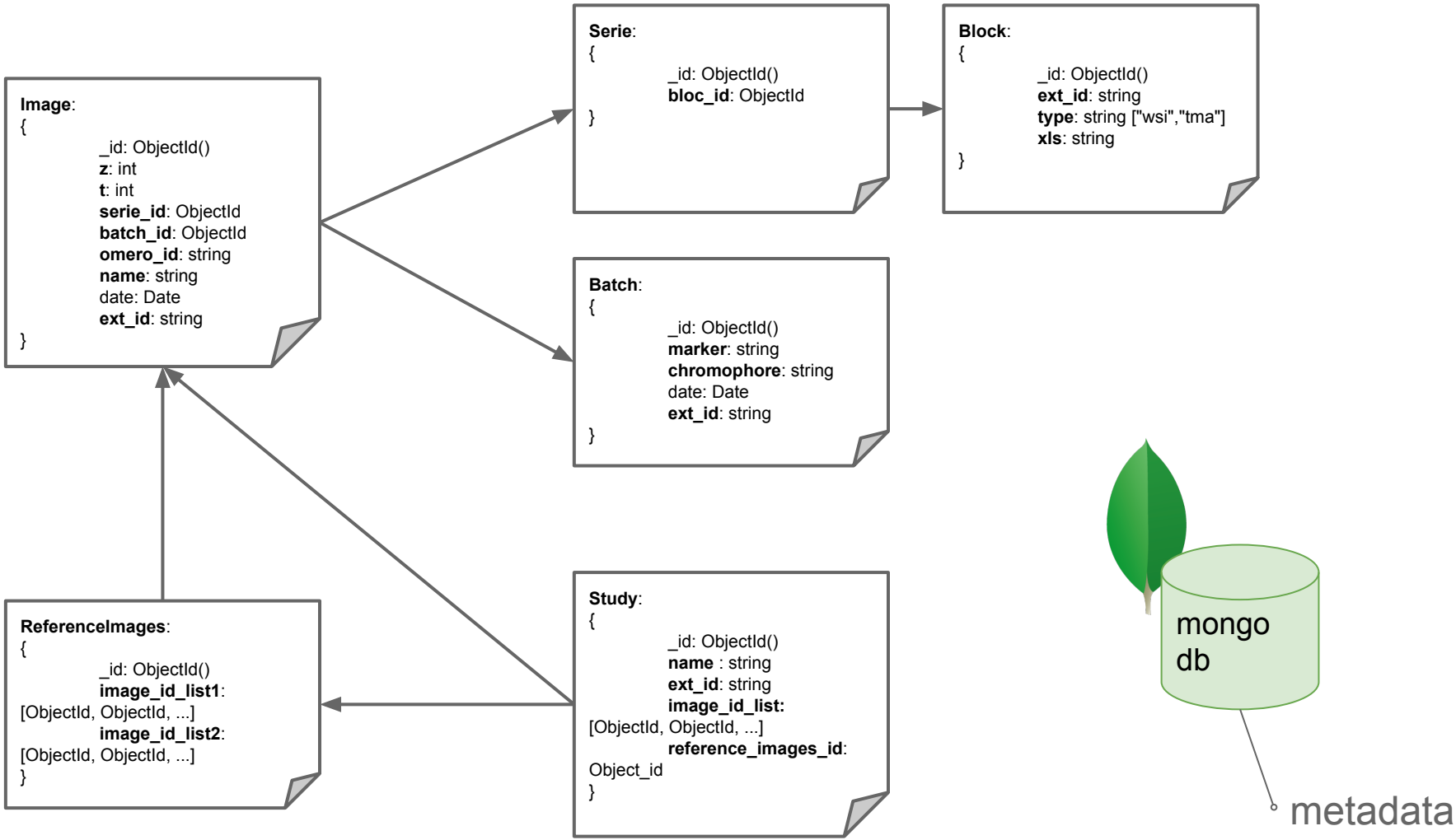


Image:
{
_id: ObjectId()
z: int
t: int
serie_id: ObjectId
batch_id: ObjectId
omero_id: string
name: string
date: Date
ext_id: string
}
Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}
Block:
{
_id: ObjectId()
ext_id: string
type: string ["wsi","tma"]
xls: string
}
Batch:
{
_id: ObjectId()
marker: string
chromophore: string
date: Date
ext_id: string
}
ReferenceImages:
{
_id: ObjectId()
image_id_list1:
[ObjectId, ObjectId, ...]
image_id_list2:
[ObjectId, ObjectId, ...]
}
Study:
{
_id: ObjectId()
name : string
ext_id: string
image_id_list:
[ObjectId, ObjectId, ...]
reference_images_id:
Object_id
}
mongo
db
metadata

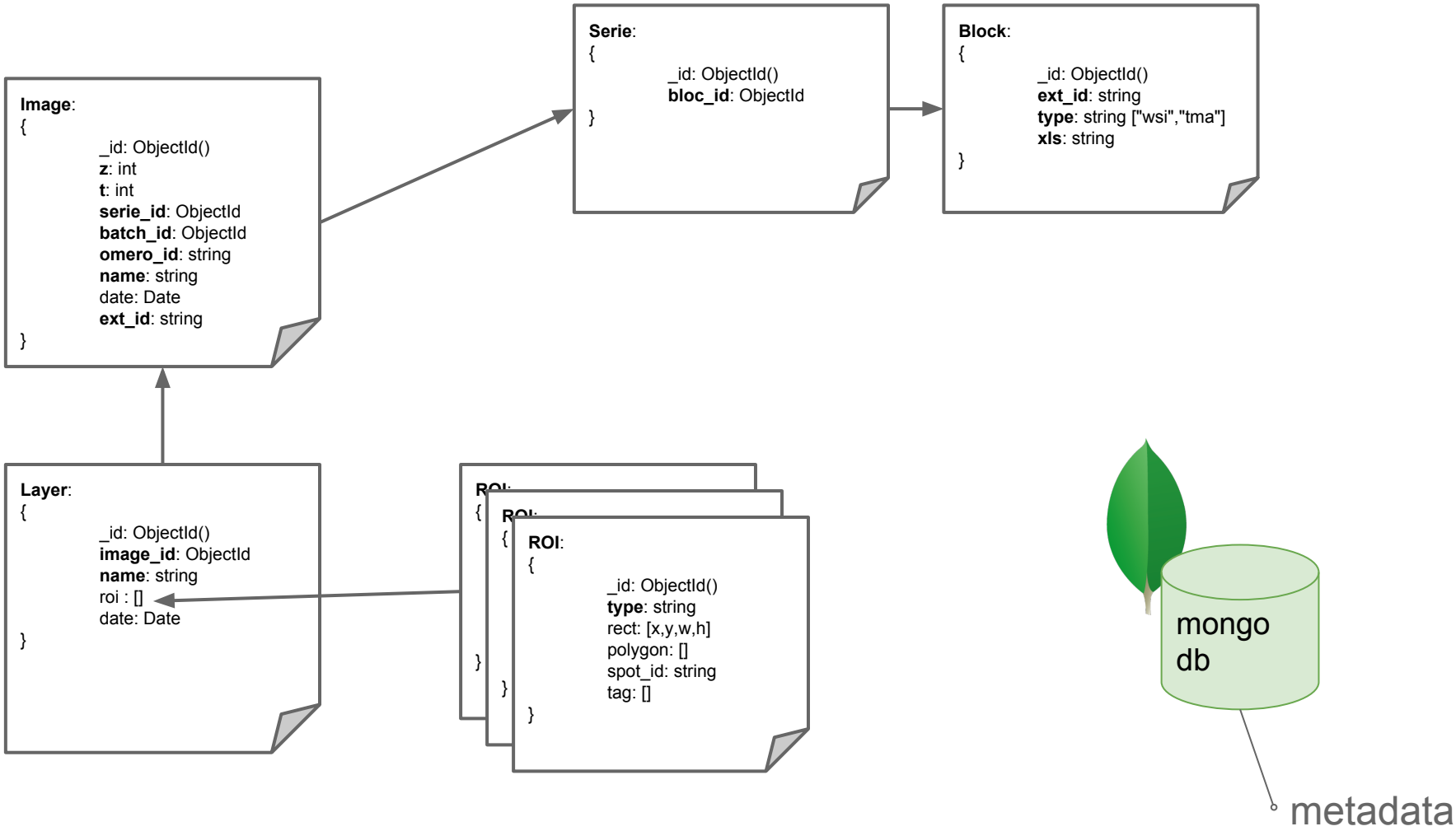


Image:
{
_id: ObjectId()
z: int
t: int
serie_id: ObjectId
batch_id: ObjectId
omero_id: string
name: string
date: Date
ext_id: string
}
Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}
Block:
{
_id: ObjectId()
ext_id: string
type: string ["wsi","tma"]
xls: string
}
Layer:
{
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name: string
roi : []
date: Date
}
ROI:
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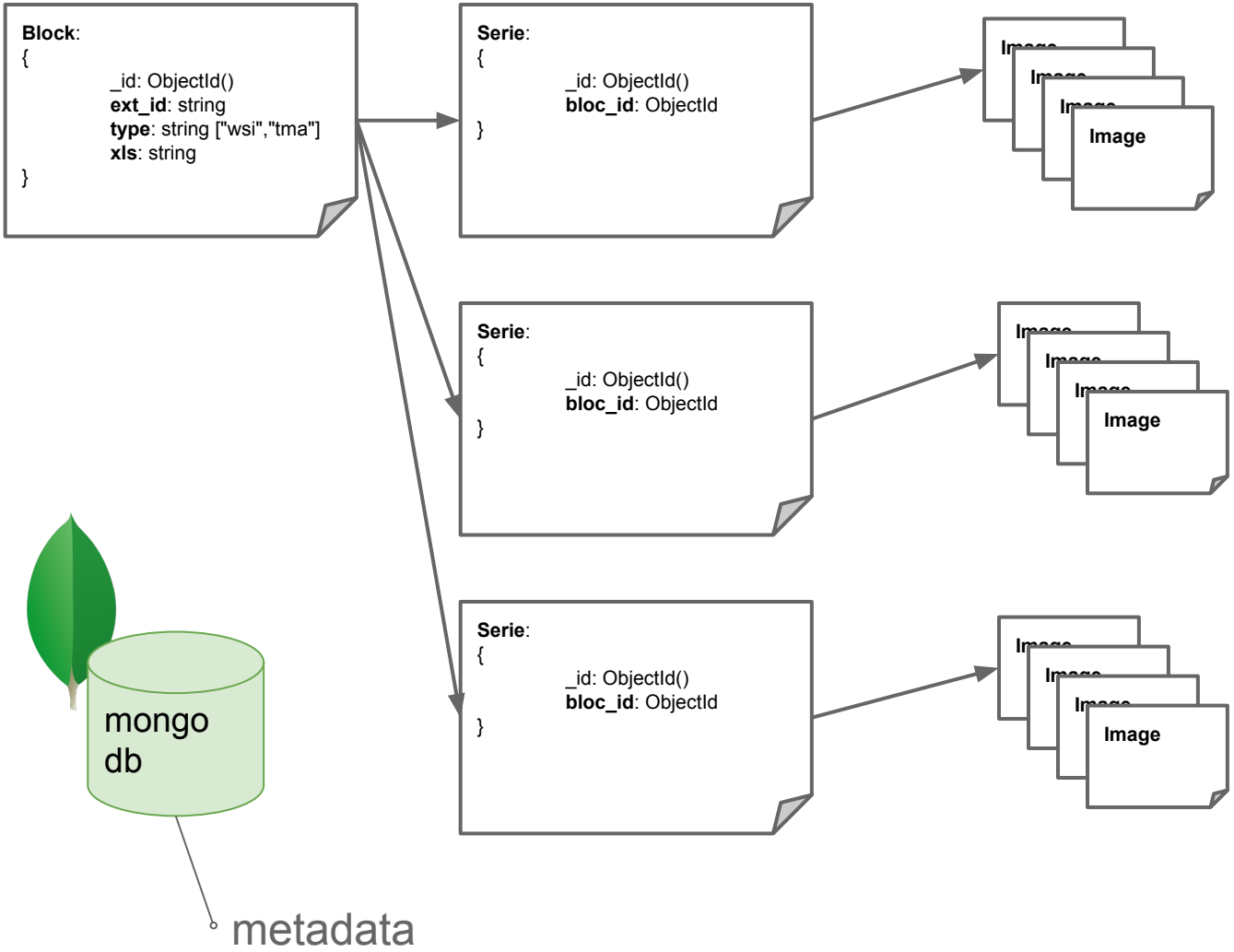
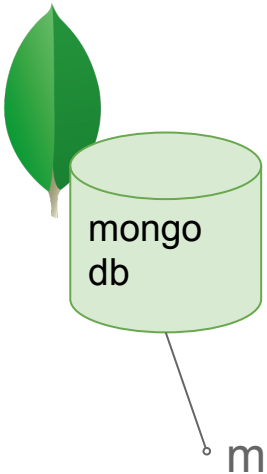
type: string
rect: [x,y,w,h]
polygon: []
spot_id: string
tag: []
}
mongo
db
metadata


Block:
{
_id: ObjectId()
ext_id: string
type: string ["wsi","tma"]
xls: string
}
Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}
Image
Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}
Image
Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}
Image
mongo
db
metadata

metadata

example 1:
PROSTATE TMA

- Prostate IL8 study (2)
- blocs (5)
  - TMA: PRO_HYP_02_01.xls (1)
    - serie (1)
      - Il8-PRO-HYP-02-01-2013-02-05-14.03.54.ndpi [Series 1] (4)
  - TMA: PRO_ADC_02_01a_importation.xls (1)
    - serie (1)
      - Il8-PRO-ADC-02-01a-2013-02-05-14.11.19.ndpi [Series 1] (1)
  - TMA: PRO_ADC_02_02a_importation.xls (1)
    - serie (1)
      - Il8-PRO-ADC-02-02a-2013-02-05-14.26.15.ndpi [Series 1] (1)
  - TMA: PRO_ADC_02_03a_importation.xls (1)
    - serie (1)
      - Il8-PRO-ADC-02-03a-2013-02-05-14.40.07.ndpi [Series 1] (1)
  - TMA: PRO_ADC_02_04a_importation.xls (1)
    - serie (1)
      - Il8-PRO-ADC-02-04a-2013-02-05-14.53.29.ndpi [Series 1] (1)
- series (5)
- batches (1)
- orphan (4)

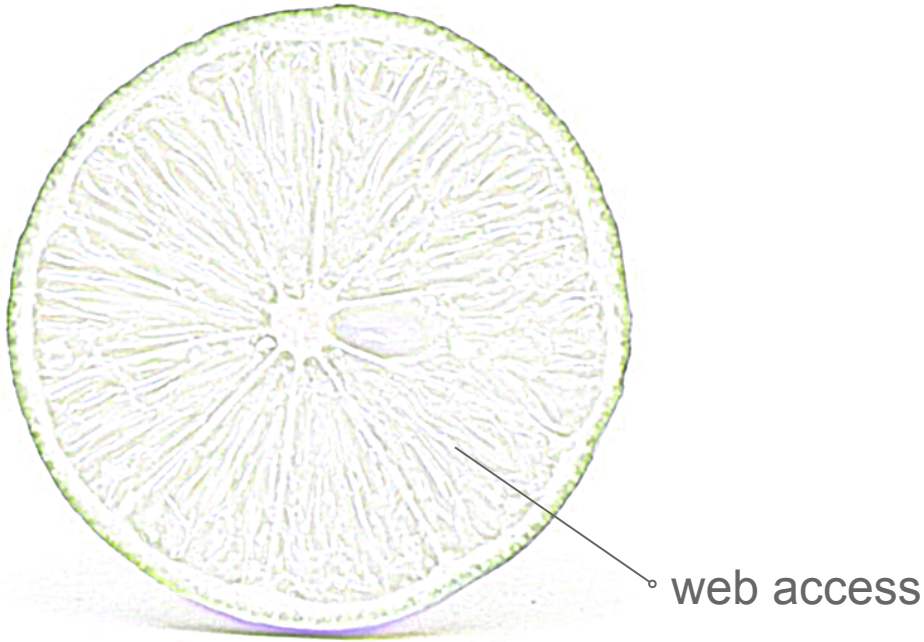


example 2: COLON co-expression

- yr phd (2)
- blocs (13)
  - TMA: RE-C-01-01.xls (1)
    - serie (5)
      - 049-RE-C-01-01-Ki67-2012-04-17-03.43.04.ndpi [Series 1] (1)
      - 003-RE-C-01-01-IGF1-2012-04-13-12.47.26.svs [Series 1] (1)
      - 003-RE-C-01-01-IGF1-2012-04-13-12.47.26.ndpi [Series 1] (1)
      - 028-RE-C-01-01-IGFBP2-2012-04-12-14.00.39.ndpi [Series 1] (1)
      - 003-RE-C-01-01-Bcl2-2012-04-16-16.47.45.ndpi [Series 1] (1)
  - TMA: RE-C-01-02.xls (1)
  - TMA: RE-C-01-03.xls (1)
  - TMA: RE-C-01-04.xls (1)
  - TMA: RE-C-01-05.xls (1)
  - TMA: RE-C-01-06.xls (1)
  - TMA: RE-C-01-07.xls (1)
  - TMA: RE-C-01-09.xls (1)
  - TMA: RE-C-01-10.xls (1)
  - TMA: RE-C-01-11.xls (1)

several users / same data

limit installation burden

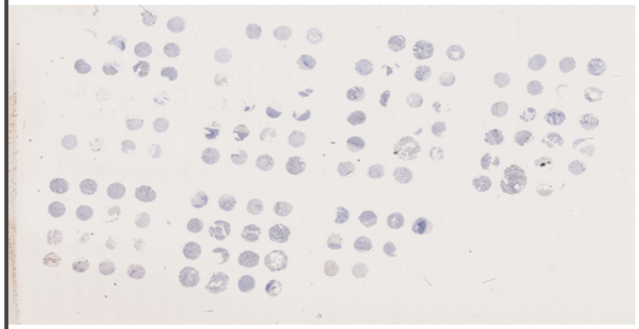


Serie view

Serie 54f5e58ee8a9945c8653ca6c

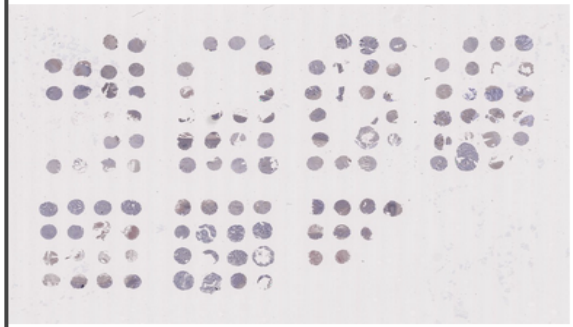
049-RE-C-01-01-Ki67-2012-04-17-03.43.04.ndpi [Series 1] 54f5cf71e8a9945c8664ca5e layers:

grid [✗ 140]



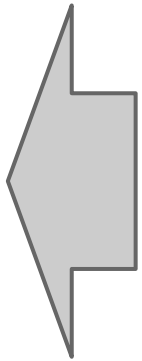
003-RE-C-01-01-IGF1-2012-04-13-12.47.26.svs [Series 1] 54f594d1e8a9945c86183c50 layers:

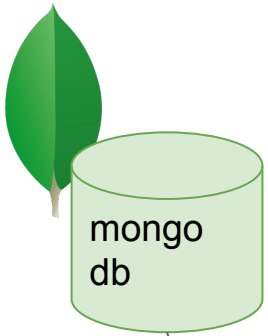
grid [✗ 140]



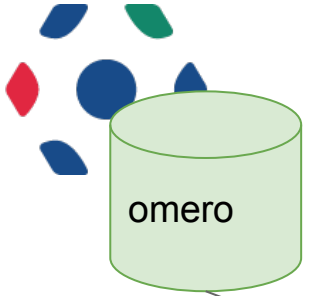
003-RE-C-01-01-IGF1-2012-04-13-12.47.26.ndpi [Series 1] 54f594d1e8a9945c86183c4e layers:

grid [✗ 140]



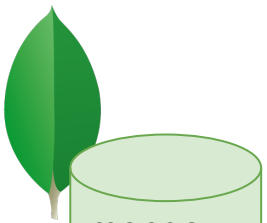


metadata



images

Layers and ROIs



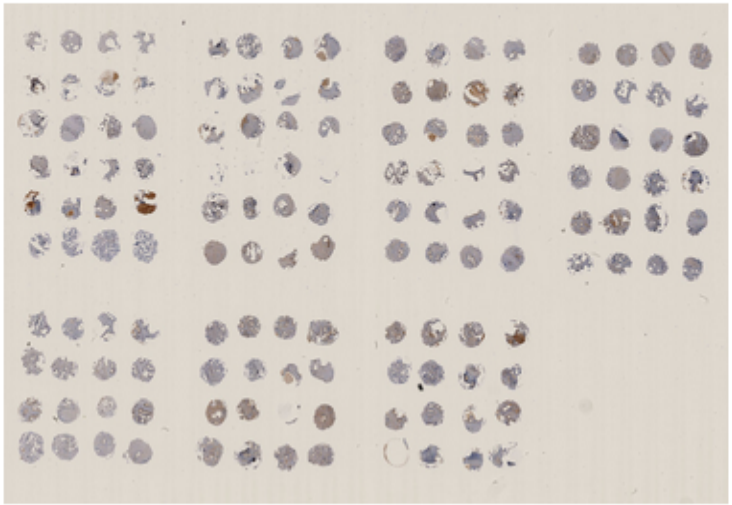
metadata

- Prostate IL8 study (2)
- blocs (5)
  - TMA: PRO_HYP_02_01.xls (1)
    - serie (1)
      - Il8-PRO-HYP-02-01-2013-02-05-14.03.54.ndpi [Series 1] (4)
        - layer:grid (144)
        - layer:invalid (10)
        - layer:tiles (407)
        - layer:tissue (139)

Image with several layers

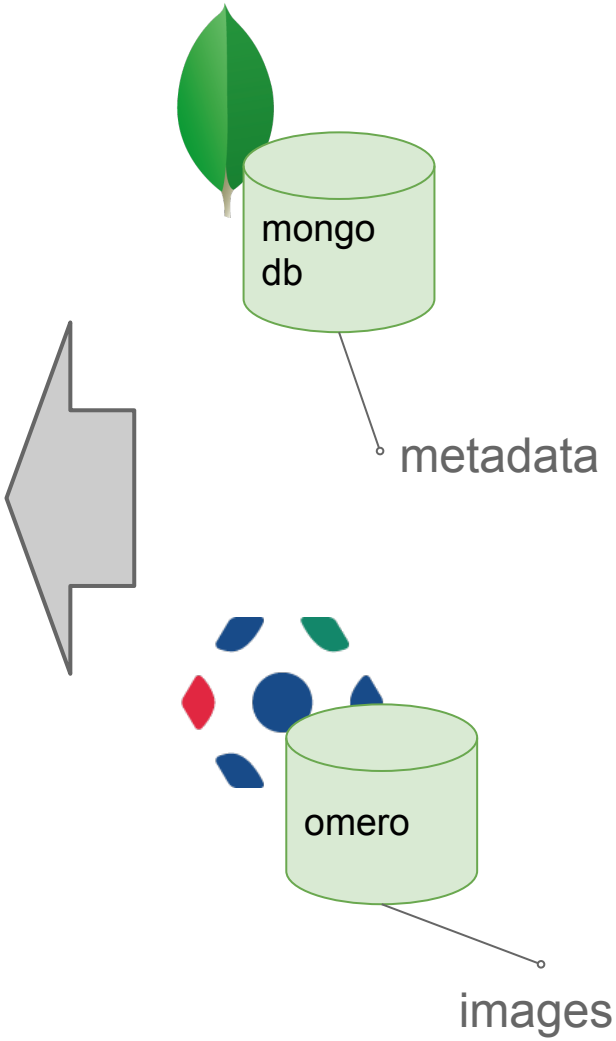
Serie 54f487e0e8a9945c863d236a

Il8-PRO-HYP-02-01-2013-02-05-14.03.54.ndpi [Series 1] 54f487e0e8a9945c863d236b

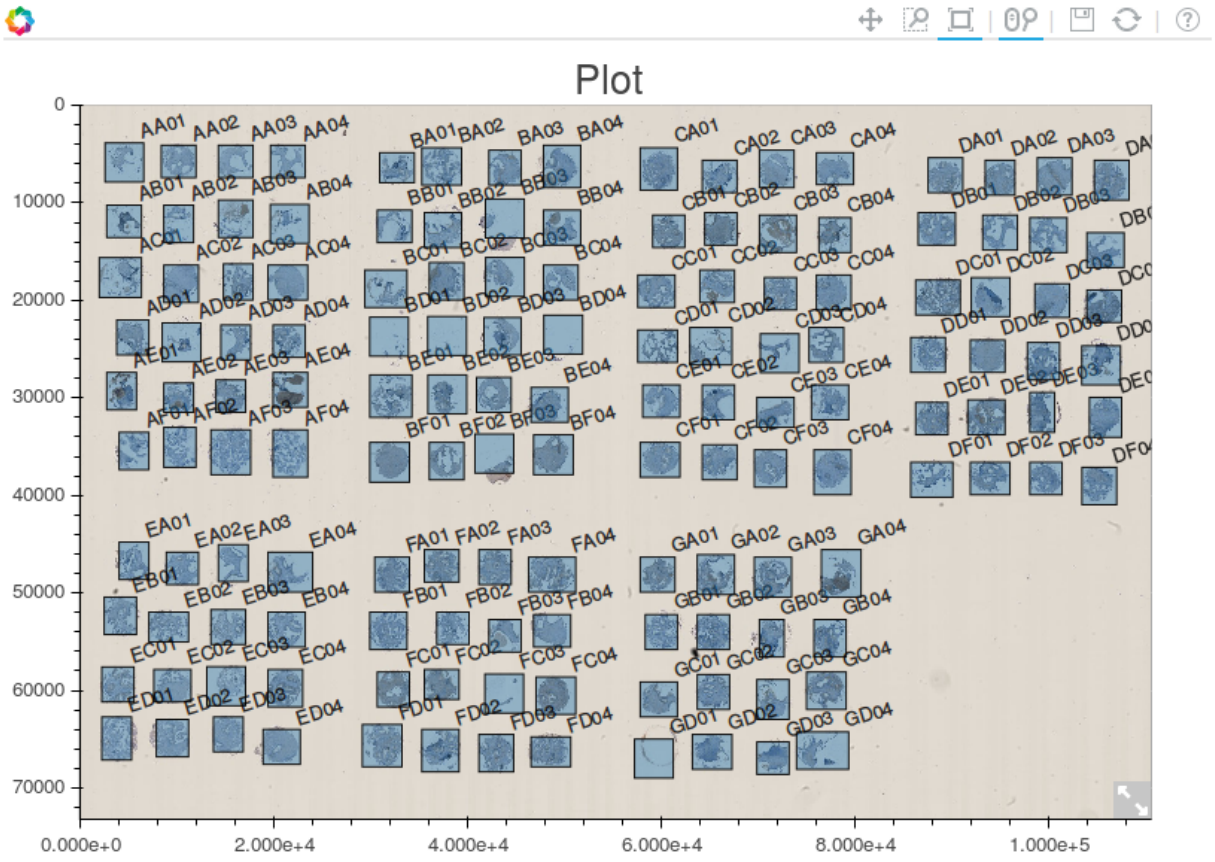


layers:

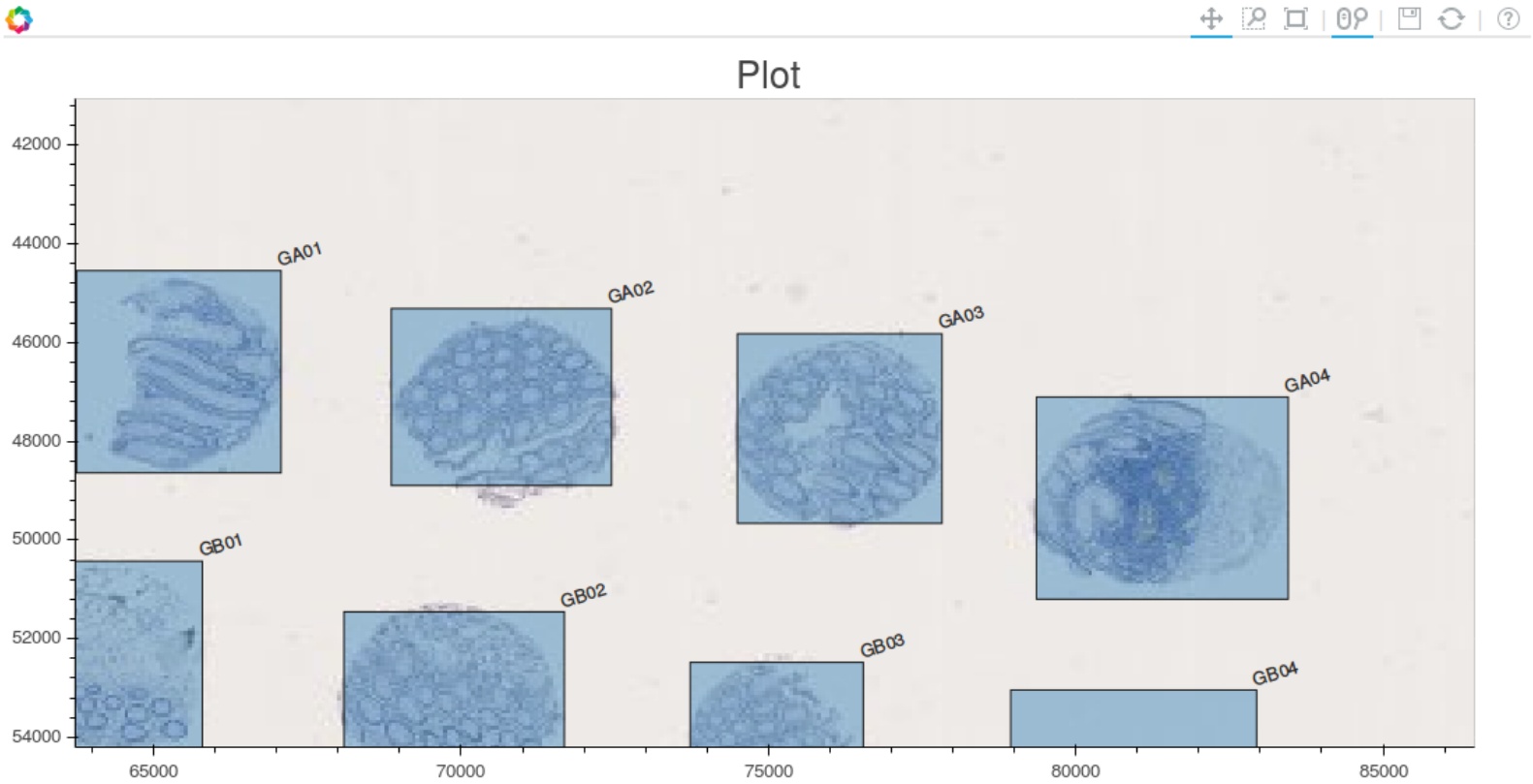
tiles [✗ 407]
tissue [✗ 139]
grid [✗ 144]
invalid [✗ 10]



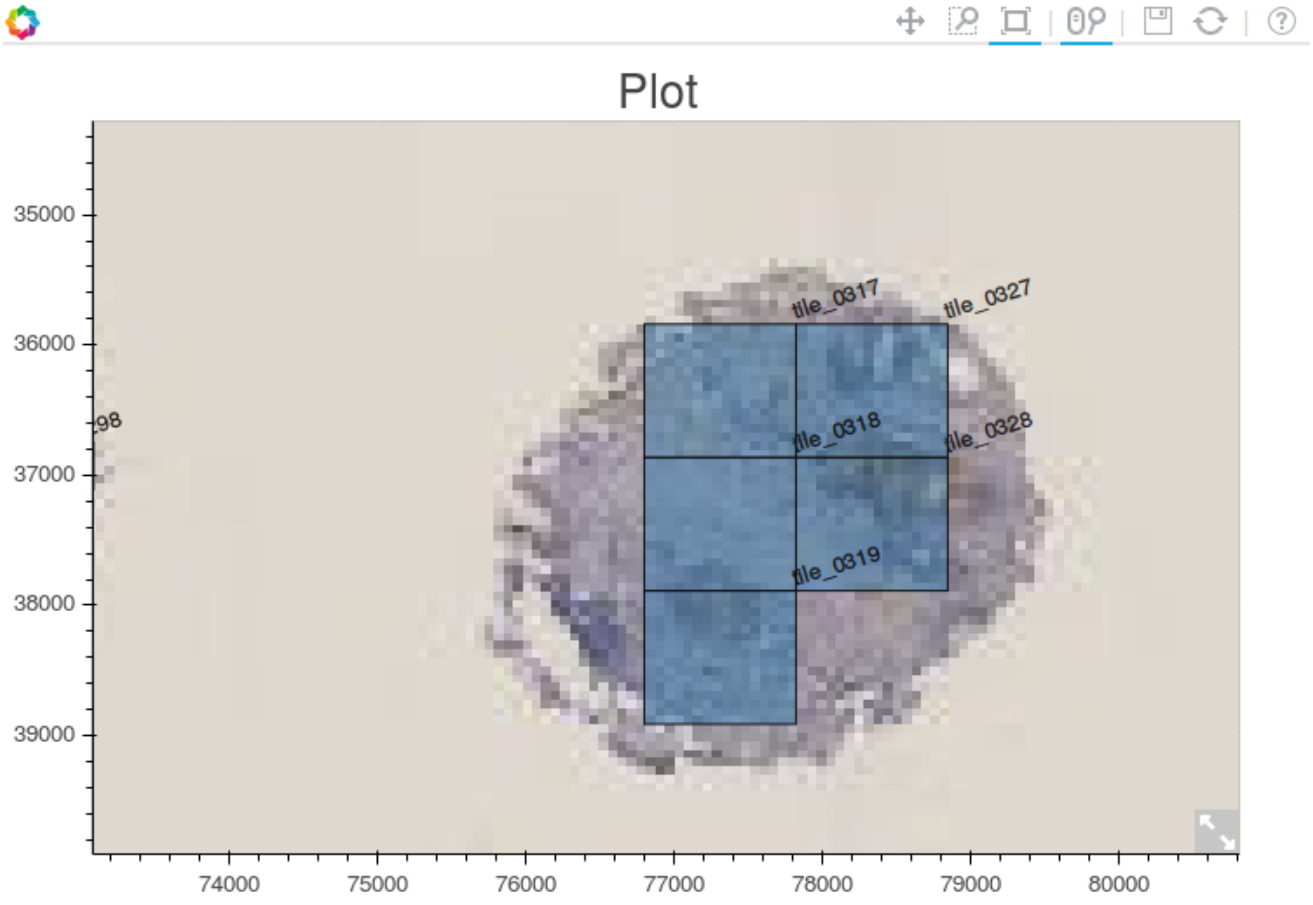
Layer view (TMA grid)



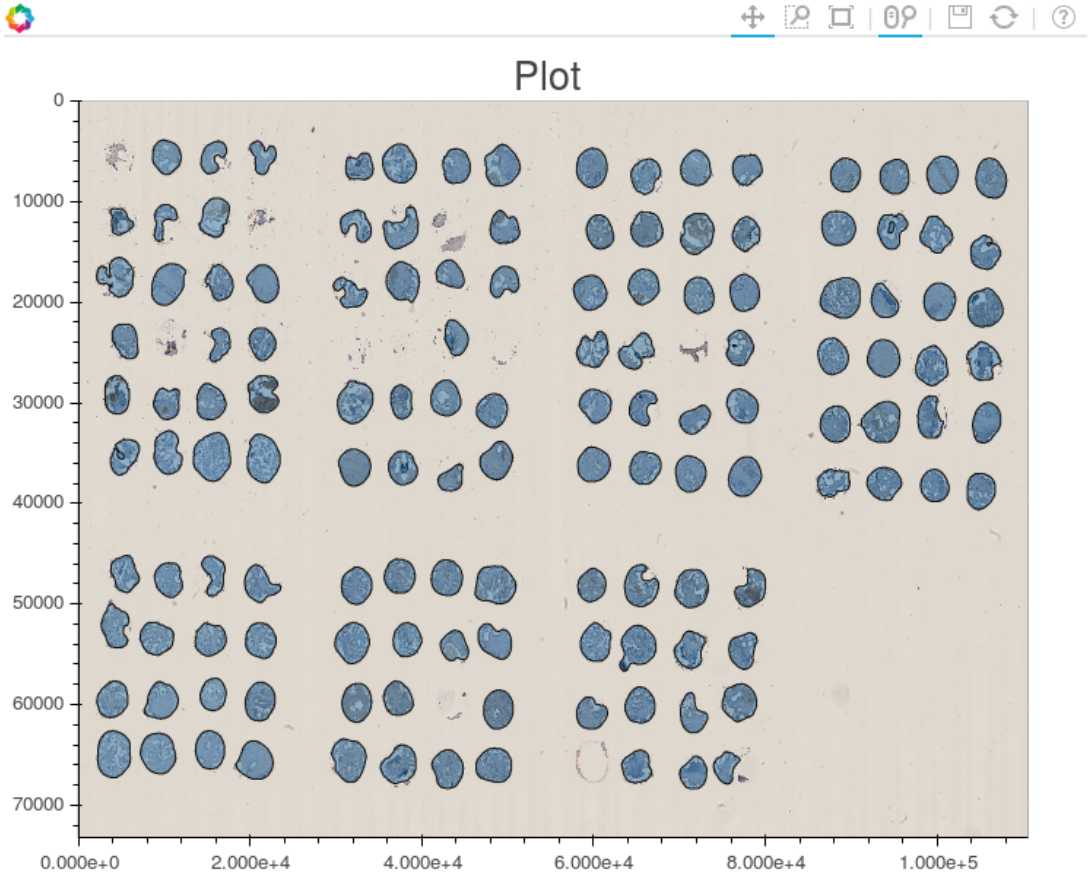
Low res pixels + vector graphics



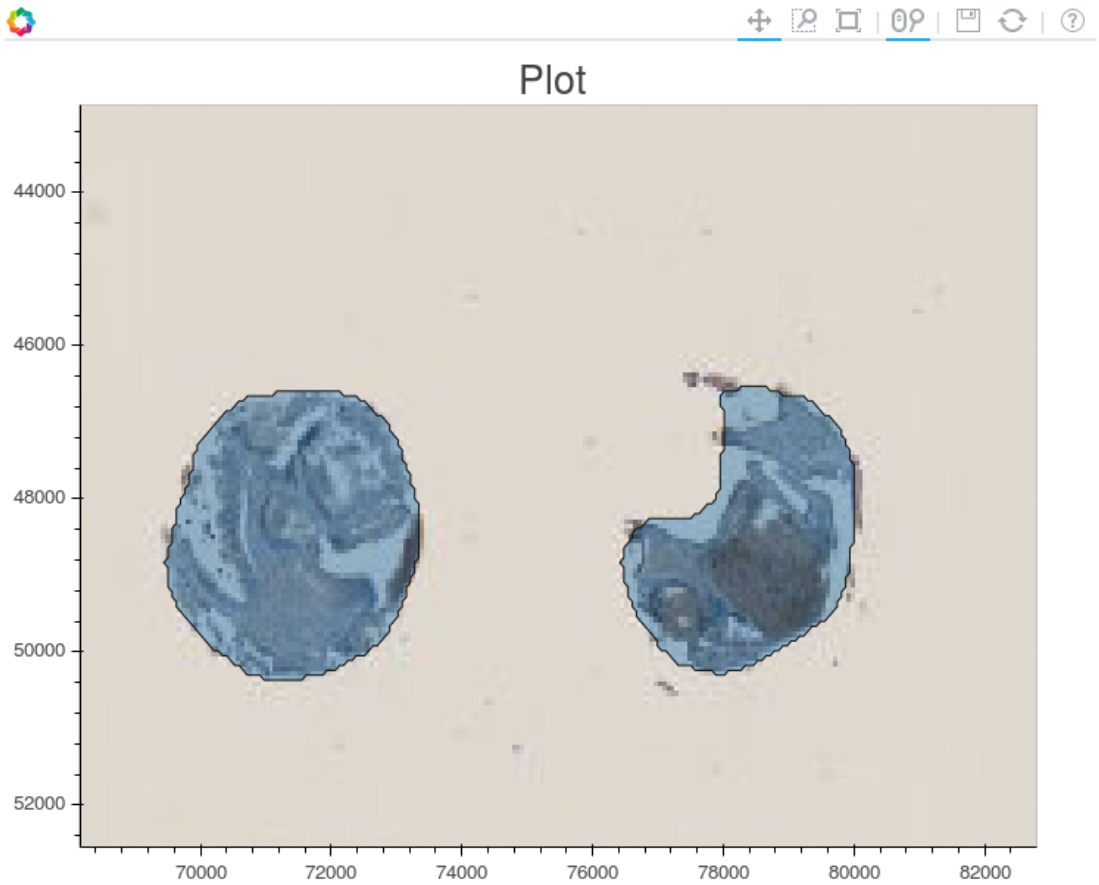
Layer view (tissue tiles)



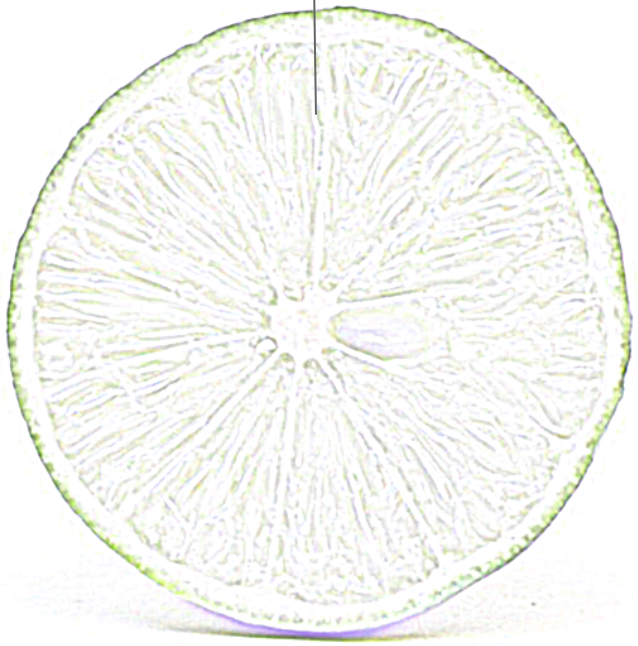
Layer view (tissue area)



Layer view (tissue area)



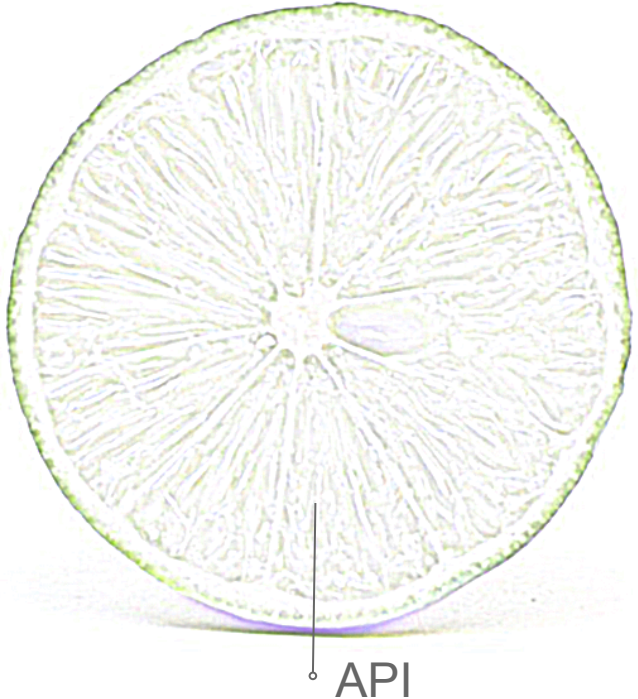
traceability



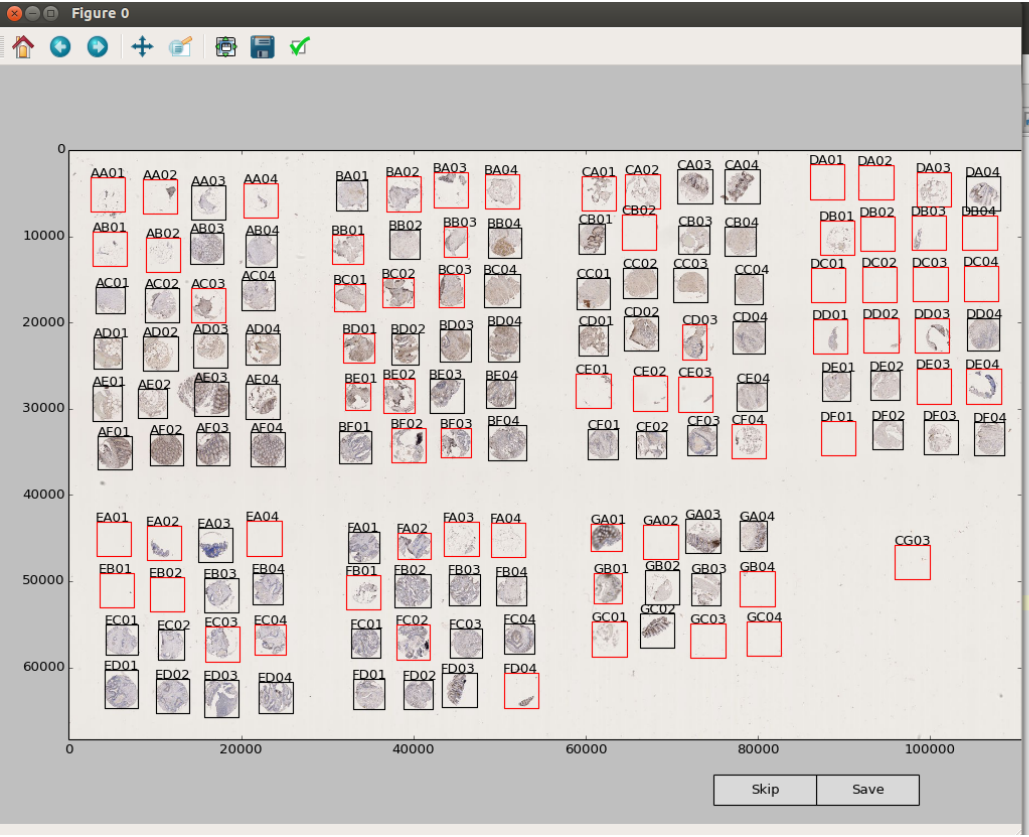
link data with other tracking systems (e.g. diamic)

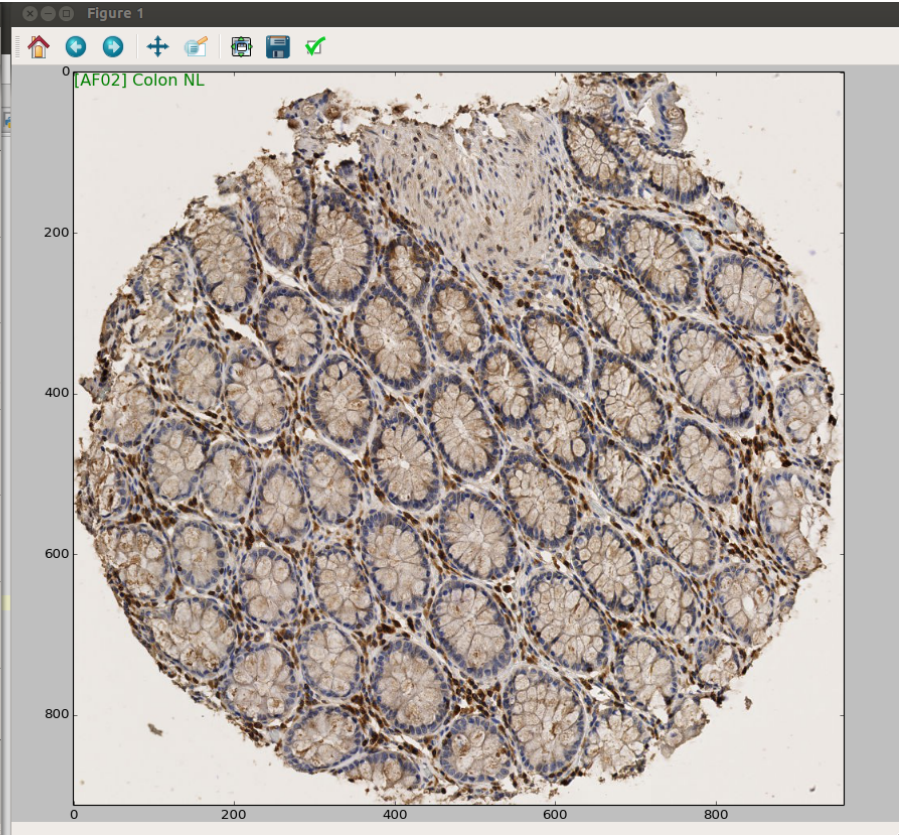
Traceability

- yr phd (2)
- blocs (13)
- series (13)
- batches (7)
  - BAX/DAB (21)
    - 029-RE-C-04-BAX-2012-04-16-23.03.32.ndpi [Series 1]
    - 043-RE-C-018-BAX-2012-04-17-02.42.24.ndpi [Series 1]
    - 030-RE-C-05-BAX-2012-04-17-17.36.41.ndpi [Series 1]
    - 031-RE-C-06-BAX-2012-04-17-17.53.31.ndpi [Series 1]
    - 046-T+BAX-2012-04-17-03.16.55.ndpi [Series 1]
    - 032-RE-C-07-BAX-2012-04-18-10.26.57.ndpi [Series 1]
    - 033-RE-C-08-BAX-2012-04-17-18.26.07.ndpi [Series 1]
    - 034-RE-C-09-BAX-2012-04-17-18.39.25.ndpi [Series 1]
    - 035-RE-C-010-BAX-2012-04-17-00.43.27.ndpi [Series 1]
    - 044-RE-C-019-BAX-2012-04-17-20.22.07.ndpi [Series 1]
    - 036-RE-C-011-BAX-2012-04-18-10.55.14.ndpi [Series 1]
    - 042-RE-C-017-BAX-2012-04-18-12.28.45.ndpi [Series 1]
    - 037-RE-C-012-BAX-2012-04-18-10.38.41.ndpi [Series 1]
    - 038-RE-C-013-BAX-2012-04-17-01.27.12.ndpi [Series 1]
    - 041-RE-C-016-BAX-2012-04-18-11.36.11.ndpi [Series 1]

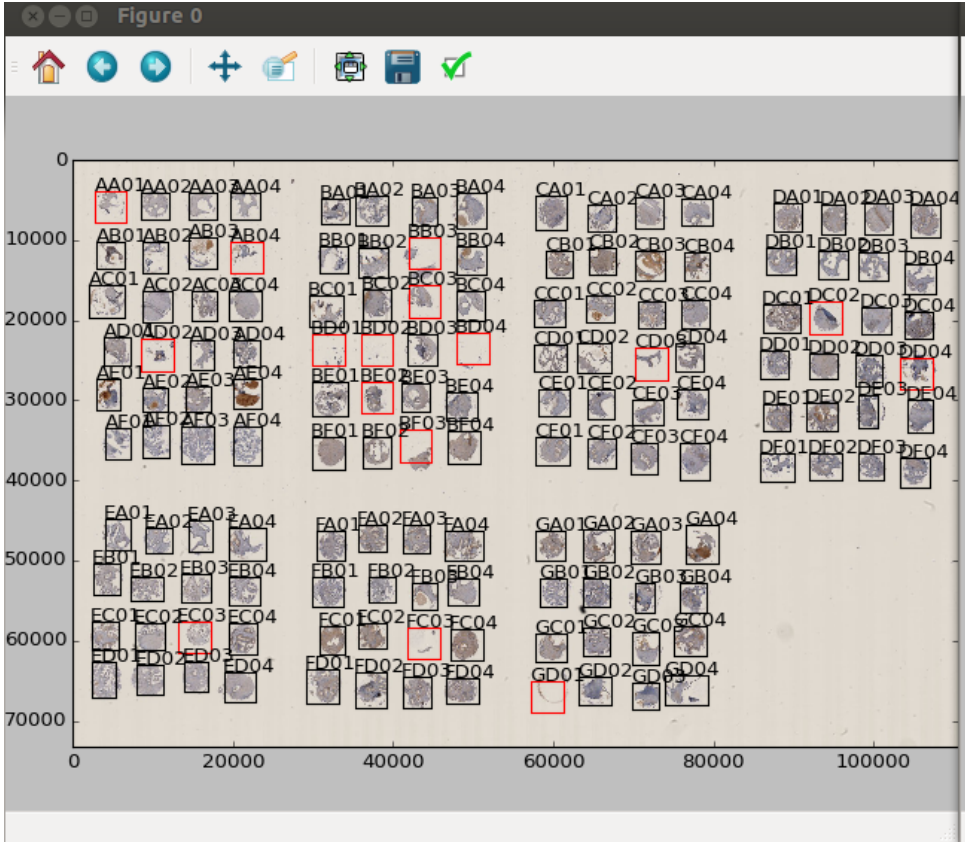

API

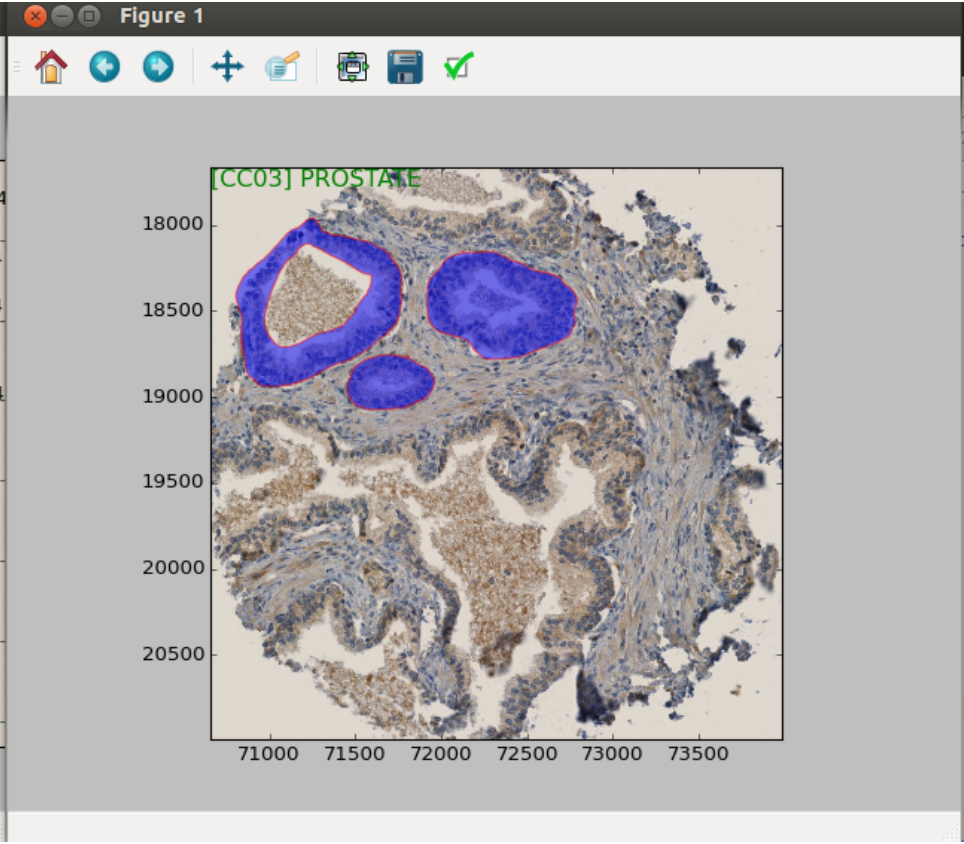
python application (using API)



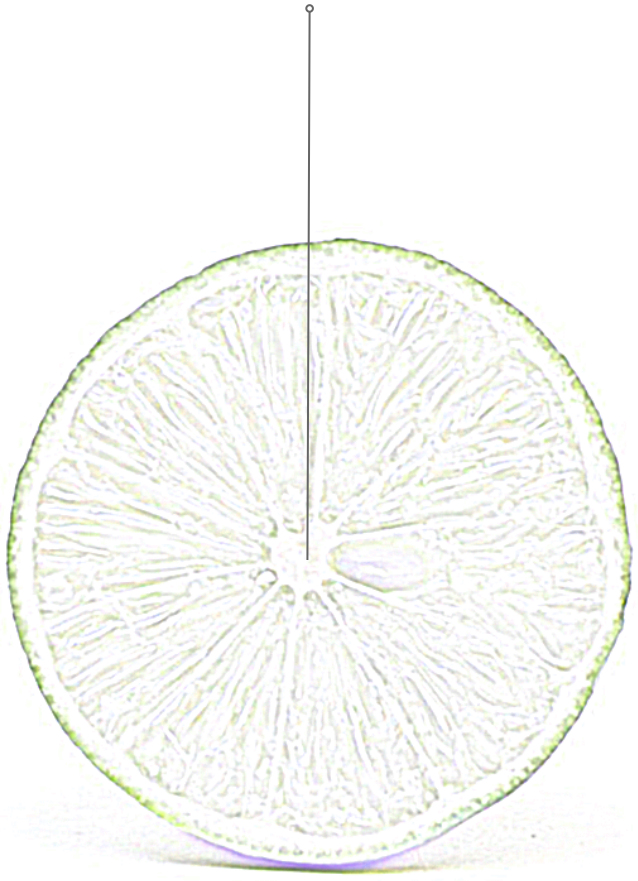


python application (using API)





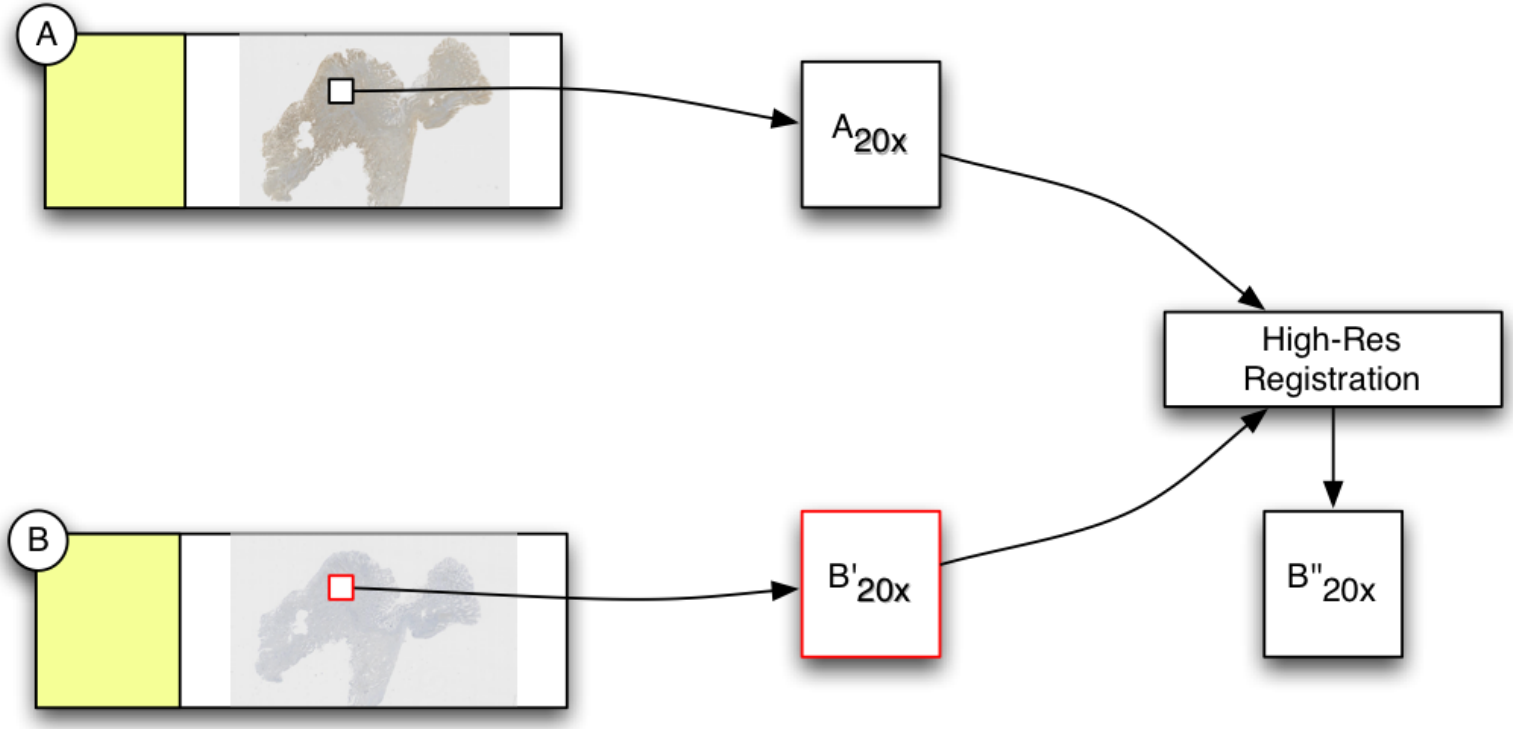
a little bit of science … TMA registration



previous study :

WSI two-step registration

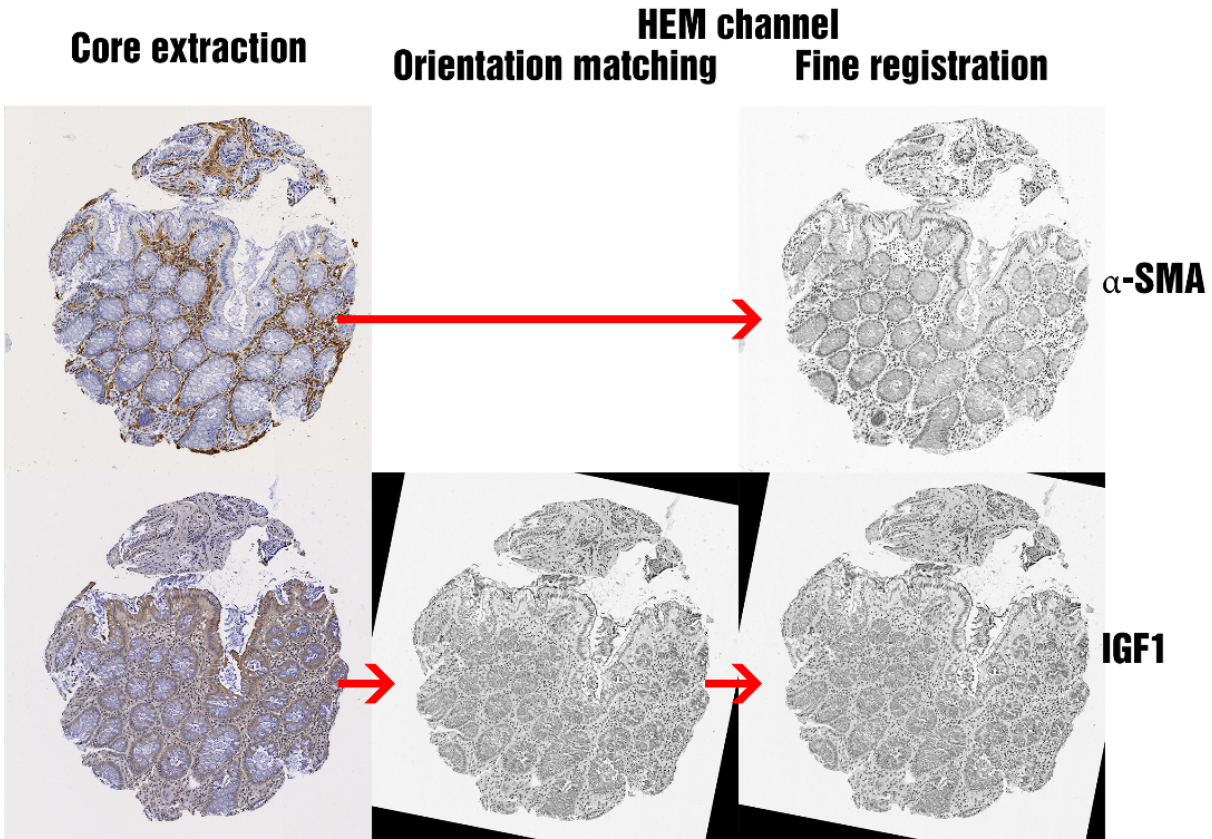
- low-resolution of the whole slide
- high-resolution fields of view



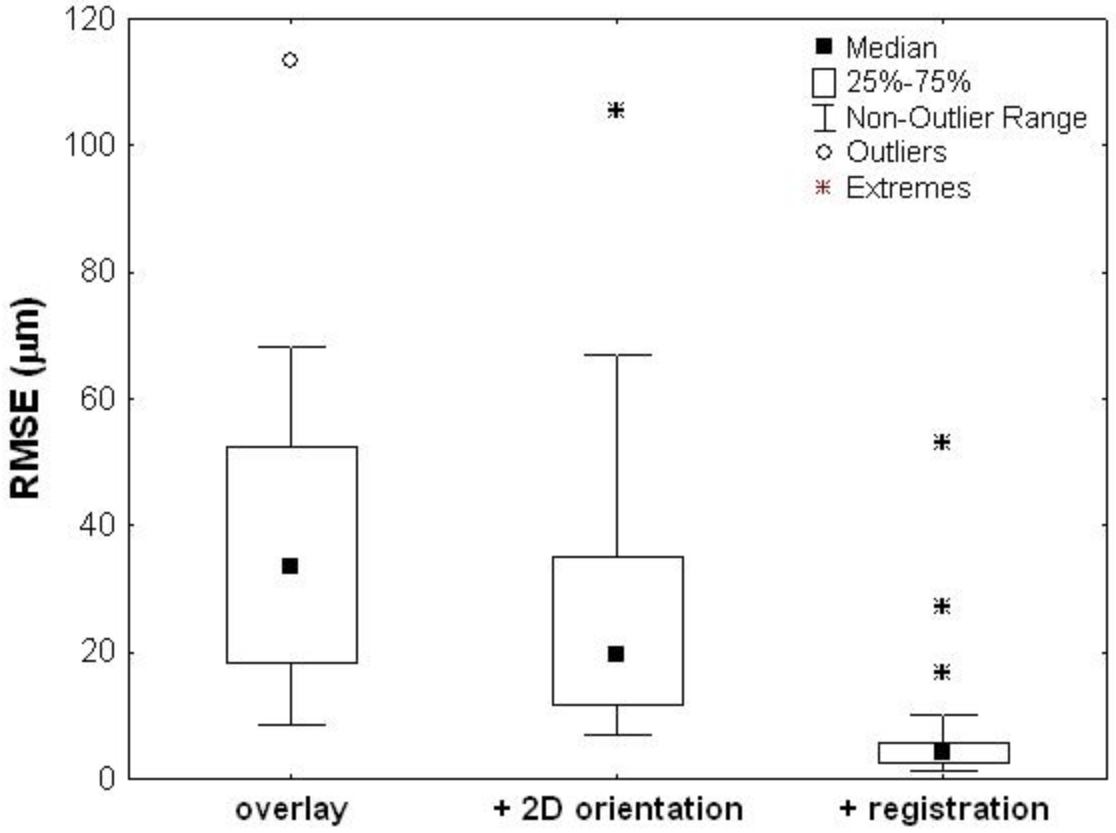
Moles Lopez, X. et al. (2015). Registration of whole immunohistochemical slide images: an efficient way to characterize biomarker colocalization.
Journal of the American Medical Informatics Association, 22(1), 86-99. doi:10.1136/amiajnl-2014-002710

TMA coarse registration

TMA fine registration (Elastix)

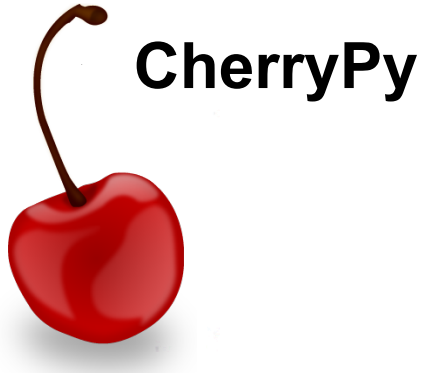


registration results

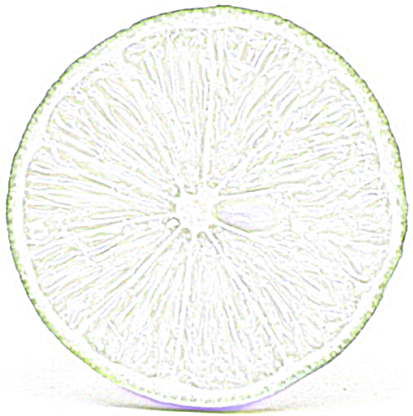



python


OME


CherryPy

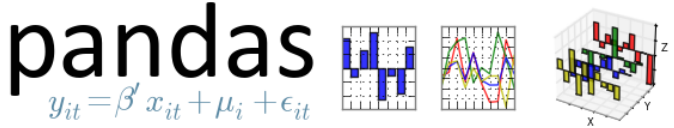

django




ZEST


Jinja


mongoDB


pandas
$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$

thank you !

fnrs
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Hôpital Erasme | ULB

Fonds Yvonne Boël ASBL

cmmi
excellence in preclinical imaging

FEDER
UNION EUROPEENNE
Wallonie
LE FONDS EUROPEEN DE DEVELOPPEMENT REGIONAL ET LA WALLONIE INVESTISSENT DANS VOTRE AVENIR.

what is still missing:

web annotation of slides

proper credentials (users/groups/study etc)

documentation

review and software maintenance process

Batch:
{
_id: ObjectId()
marker: string
chromophore: string
date: Date
ext_id: string
}

Block:
{
_id: ObjectId()
ext_id: string
type: string ["wsi","tma"]
xls: string
}

Serie:
{
_id: ObjectId()
bloc_id: ObjectId
}

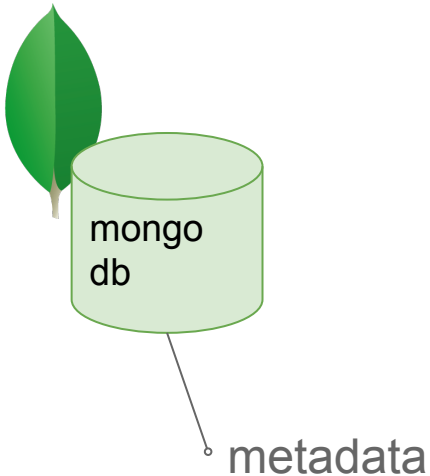
Image:
{
_id: ObjectId()
z: int
t: int
serie_id: ObjectId
batch_id: ObjectId
omero_id: string
name: string
date: Date
ext_id: string
}

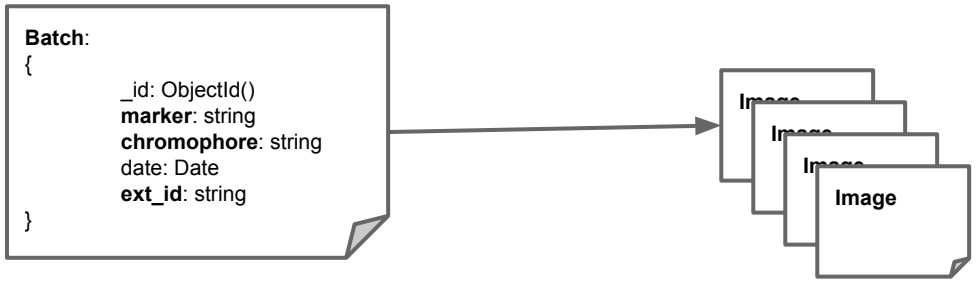
ReferenceImages:
{
_id: ObjectId()
image_id_list1: [ObjectId, ObjectId, ...]
image_id_list2: [ObjectId, ObjectId, ...]
}

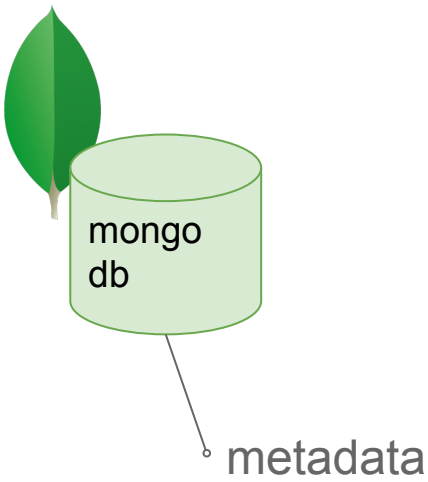
Study:
{
_id: ObjectId()
name : string
ext_id: string
image_id_list: [ObjectId, ObjectId, ...]
reference_images_id: Object_id
}

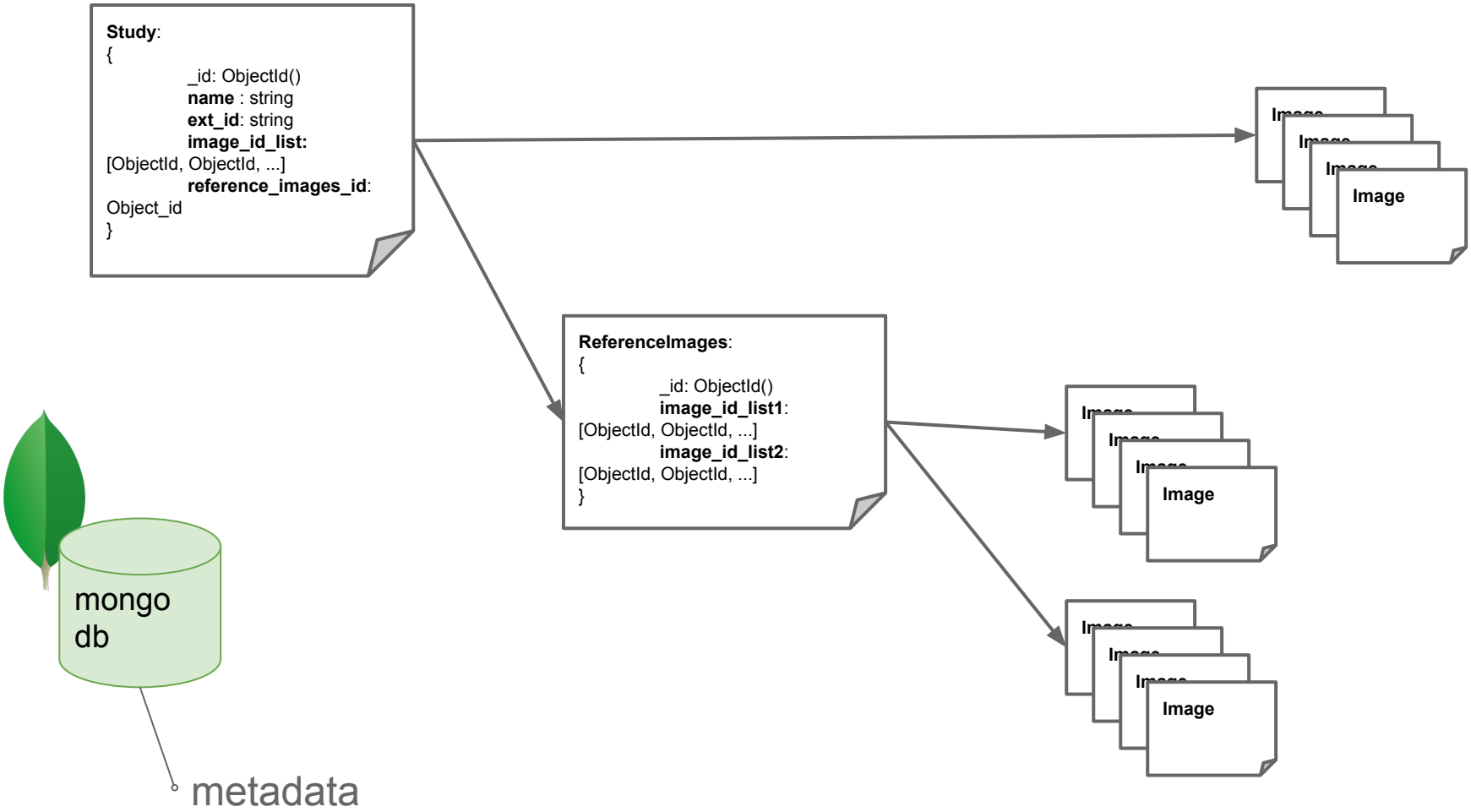
Run:
{
_id: ObjectId()
git_repo: string
git_bash: string
image_id_list: [ObjectId, ObjectId]
date: Date
command: string
param: string
}

Result:
{
_id: ObjectId()
run_id: ObjectId
type: string
... (hdf5...)
}




Batch:
{
_id: ObjectId()
marker: string
chromophore: string
date: Date
ext_id: string
}
Image


mongo
db
metadata


Study:
{
_id: ObjectId()
name : string
ext_id: string
image_id_list:
[ObjectId, ObjectId, ...]
reference_images_id:
Object_id
}
Image
Image
Image
Image
ReferenceImages:
{
_id: ObjectId()
image_id_list1:
[ObjectId, ObjectId, ...]
image_id_list2:
[ObjectId, ObjectId, ...]
}
Image
Image
Image
Image
Image
Image
Image
Image
mongo
db
metadata