

An open-source rich internet application for collaborative analysis of multi-gigapixel images

Speaker : Raphaël Marée (PhD), University of Liège, Belgium



cytomine



@cytomine



github.com/cytomine



www.cytomine.be



info@cytomine.be

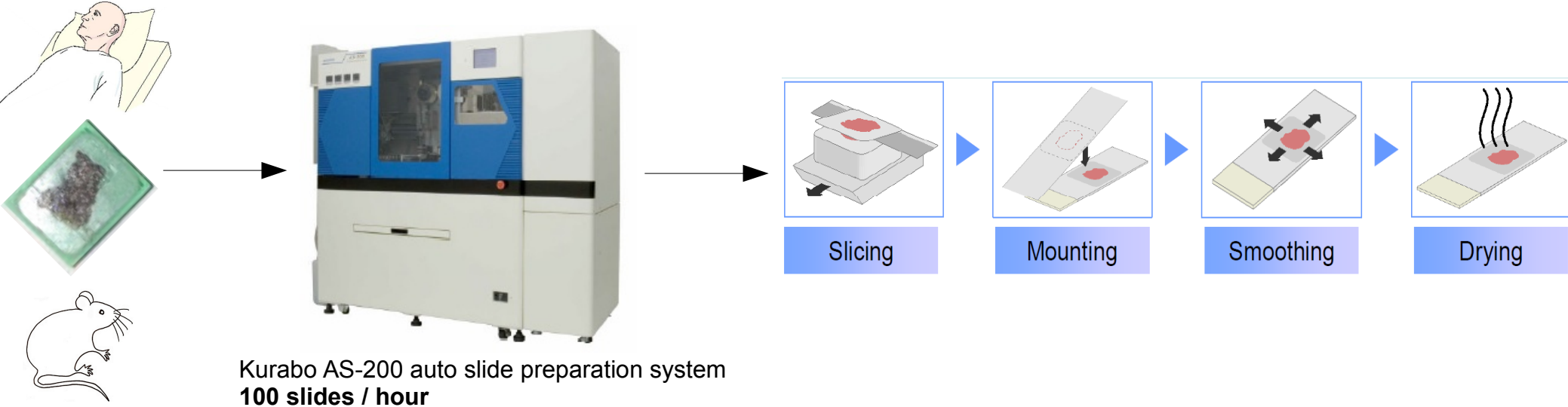


+32 4 366 26 44



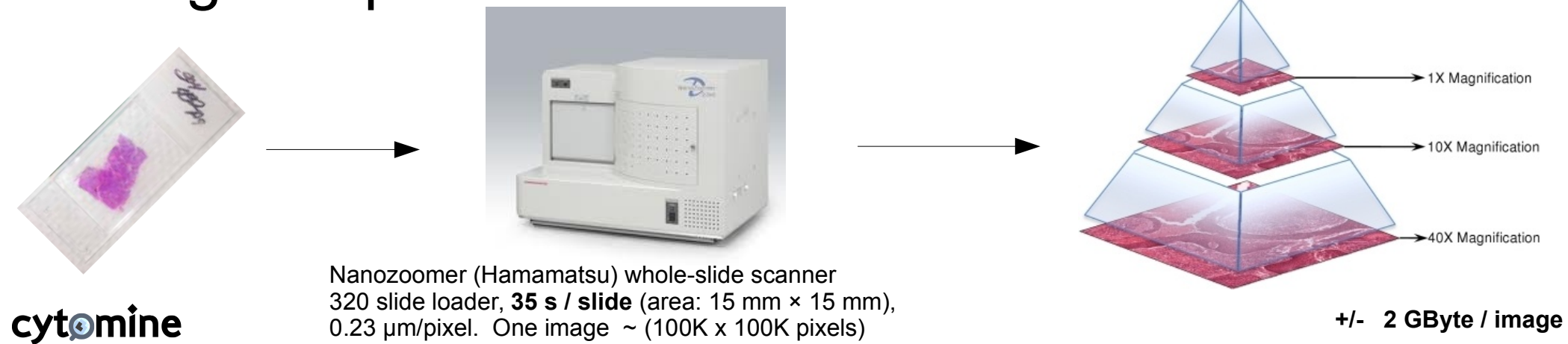
Digital pathology : Big image Data

Sample preparation



200 GByte/hour → 5TByte/day

Image acquisition



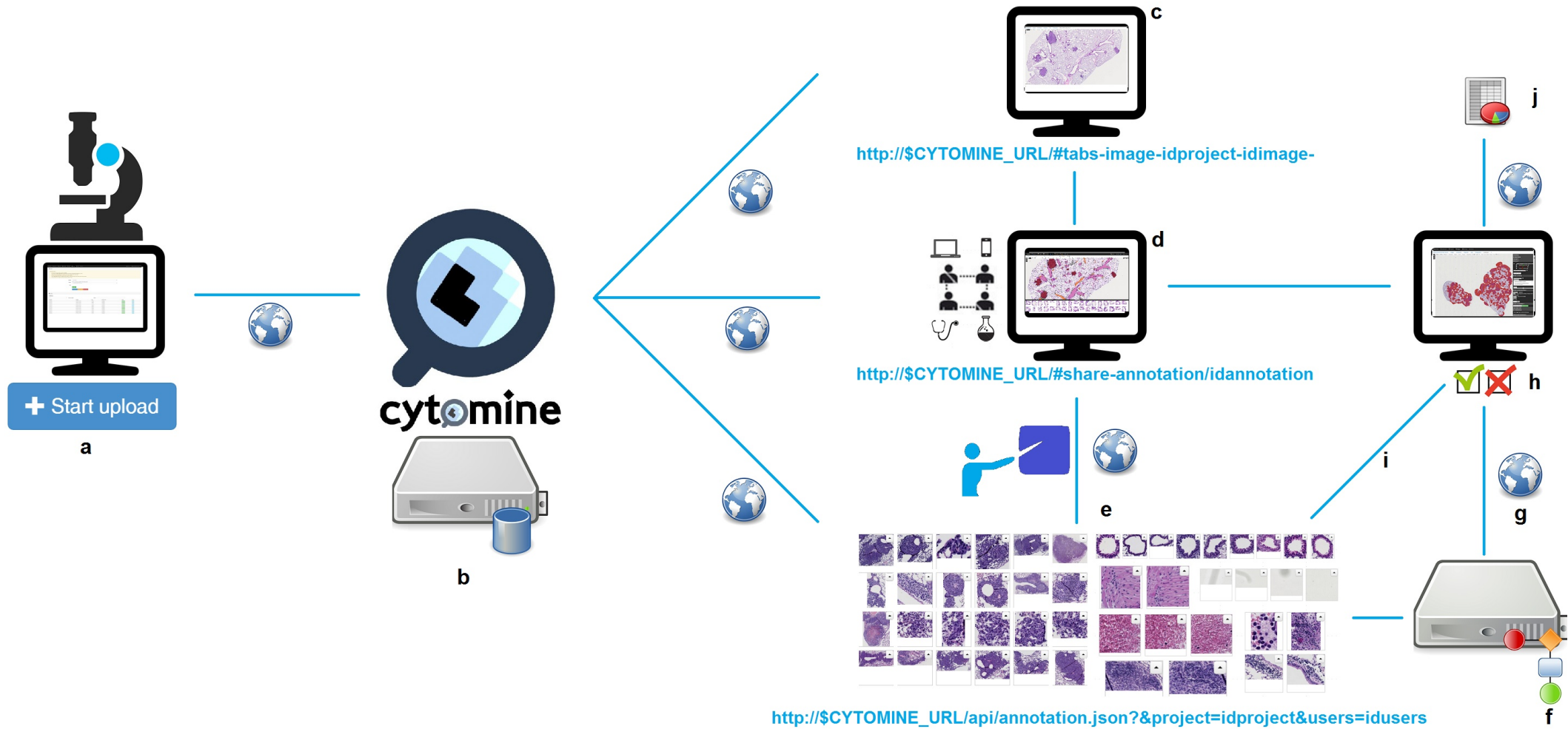


Objective : *to make life easier for both life scientists, pathologists, and computer scientists*

- Continuous development since 2010
- Academic project but **industrial-grade software**
(modern & proven software libraries, user-driven, code quality control,...)
- **General-purpose**
- A rich internet application (**web-based**)
 - Google Maps-like visualization of digital slides
 - **Collaborative, semantic**, annotation of regions of interest
 - **Semi-automated analysis**
 - Generic machine learning algorithms
 - Proofreading
- User-authentication for **secure sharing** of images, annotations, results
- Documented, **Free and Open-source since January 2016** (www.cytomine.be)
*A computer software with its **source code** made available with a license in which the copyright holder provides the **rights to study, change, and distribute the software to anyone and for any purpose.***



cyt@mine



cytominine : Fully open

- Documentation wiki (doc.cytomine.be)
- User guide
- Open REST API
- Open source code
- Extensible
- Interoperable

JSONDoc <http://current.cytomine.be/jsondoc/apiprod#> Get documentation

API INFO
Base path: <http://localhost:8080/api>
Version: 1.0

GENERIC ANNOTATION SERVICES
Methods for managing an annotation created by a software

PLAYGROUND
[#imageinstance/{idimage}/annotation/included.json](#)

Accept
application/json

Query parameters

idimage	idimage
geometry	geometry
annotation	annotation
user	user
terms	terms
max	max
offset	offset

API INFO

APIs

- [abstract image services](#)
- [algo annotation services](#)
- [annotation filter services](#)
- [annotation index service](#)
- [annotation term service](#)
- [discipline services](#)
- [generic annotation services](#)
- [image group services](#)
- [image instance services](#)
- [image sequence services](#)
- [nested image services](#)
- [ontology services](#)
- [project services](#)
- [property services](#)
- [relation services](#)
- [relation term services](#)
- [reviewed annotation services](#)
- [sample services](#)
- [storage abstract image services](#)
- [term services](#)
- [uploaded file services](#)
- [user annotation services](#)

OBJECTS

- [\[annotation_listing\]](#)
- [\[project_sharing_same_image\]](#)
- [\[sequence_possibilities\]](#)
- [abstract image](#)
- [algo annotation](#)
- [anno_annotation term](#)

Path [/imageinstance/{idimage}/annotation/included.json](#)

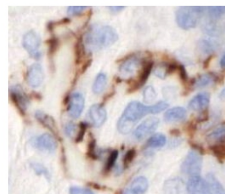
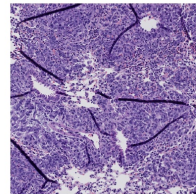
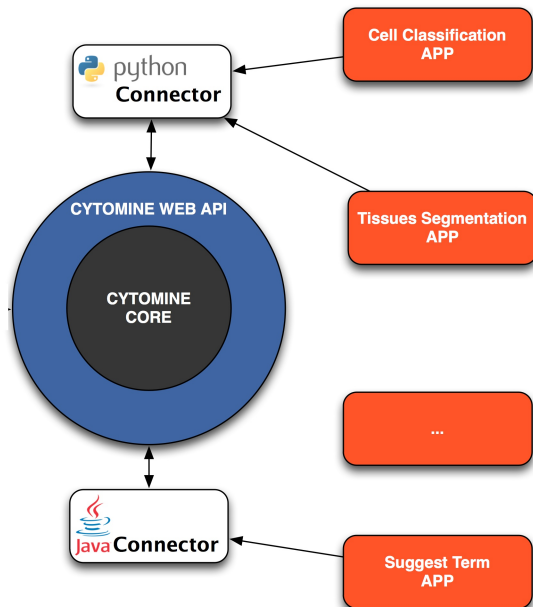
Description Get all annotation that intersect a geometry or another annotation. See /annotation/search for extra parameter (show/hide).

Method GET

Produces application/json

Query parameters

idimage	Required: true Type: long Description: The image id
geometry	Required: true Type: string Description: (Optional) WKT form of the geometry (if not set, set annotation param)
annotation	Required: true Type: long Description: (Optional) The annotation id for the geometry (if not set, set geometry param)
user	Required: true Type: long Description: The annotation user id (may be an algo)
terms	Required: true Type: list Description: The annotation terms id
max	Required: false Type: int Description: Limitation: Number of report per page (default 0 = no pagination)



```
{
  "class": "be.cytomine.ontology.UserAnnotation",
  "id": 95189319,
  "created": "1390233213025",
  "location": "POLYGON ((83409.75 96490.375, 83412.75 96492.375, 83409.75 96481.375, 83411.75 96476.375, 83408.75 96473.375 ... 96489.375, 83409.75 96490.375))",
  "image": "95062074",
  "project": "94152784",
  "container": "94152784",
  "user": "94115159",
  "area": 8953.0,
  "perimeterUnit": "mm",
  "areaUnit": "micron",
  "perimeter": 1.0,
  "centroid": {
    "x": 83426.59663300458,
    "y": 96382.22057123308
  },
  "term": "95062790",
  "cropURL": "http://beta.cytomine.be/api/userannotation/95189319/crop.jpg",
  "reviewed": true
}
```

[http://\\$HOST/api/imageinstance/7889452/window-10000-10000-1500-1500.jpg](http://$HOST/api/imageinstance/7889452/window-10000-10000-1500-1500.jpg)

[http://\\$HOST/api/userannotation/95189319/crop.png?zoom=0](http://$HOST/api/userannotation/95189319/crop.png?zoom=0)

[http://\\$HOST/api/userannotation/95189319/crop.png?mask=true](http://$HOST/api/userannotation/95189319/crop.png?mask=true)

[http://\\$HOST/api/userannotation/95189319.json](http://$HOST/api/userannotation/95189319.json)

cyt@mine features :

Organize and centralize on the web

Create and manage multiple **projects** :

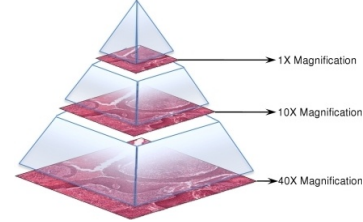
- **Upload** images to centralized server or keep data local (distributed image tile servers)
- Support for **various formats** (TIFF, JP2000, Aperio SVS, Hamamatsu NDPI/VMS, 3DHistech MRXS, Leica SCN, Roche TIF...)
- Users with **authentication** (e.g. LDAP), **access rights**, and **roles**
- **Specific ontologies** with user-defined, vocabulary terms

The screenshot displays the cyt@mine web interface, which is a centralized platform for organizing and managing biological data. The interface is organized into a grid of project cards, each representing a specific dataset. A 'New project' button is visible in the top-left corner. Each project card contains the following information:

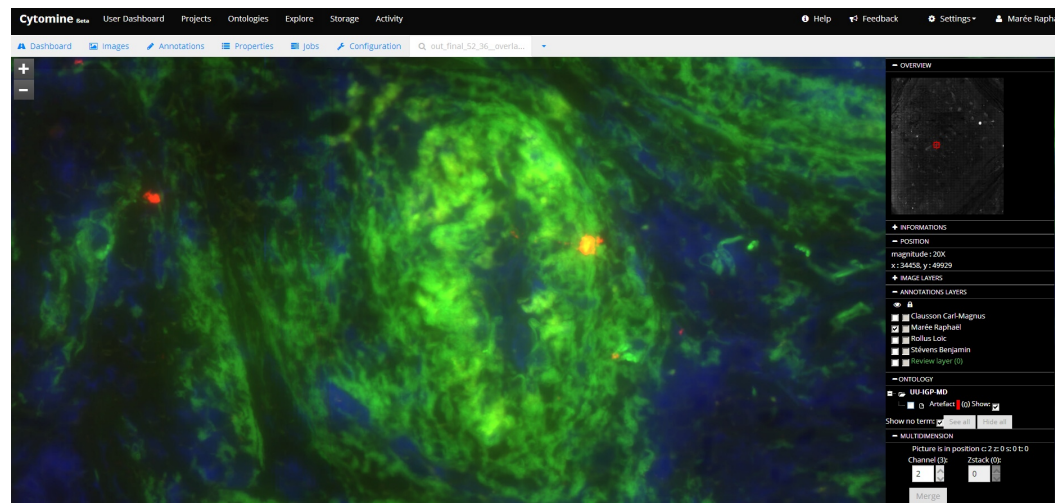
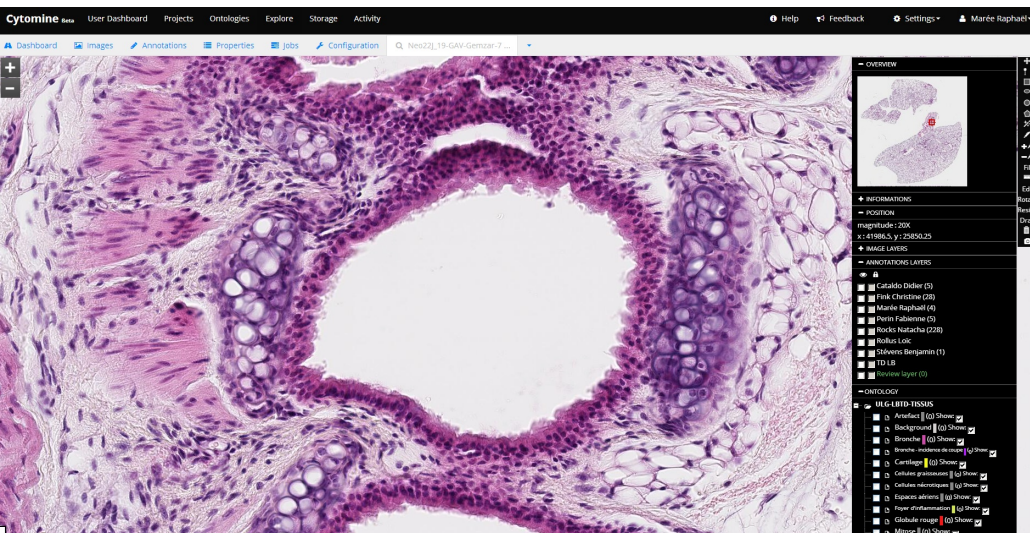
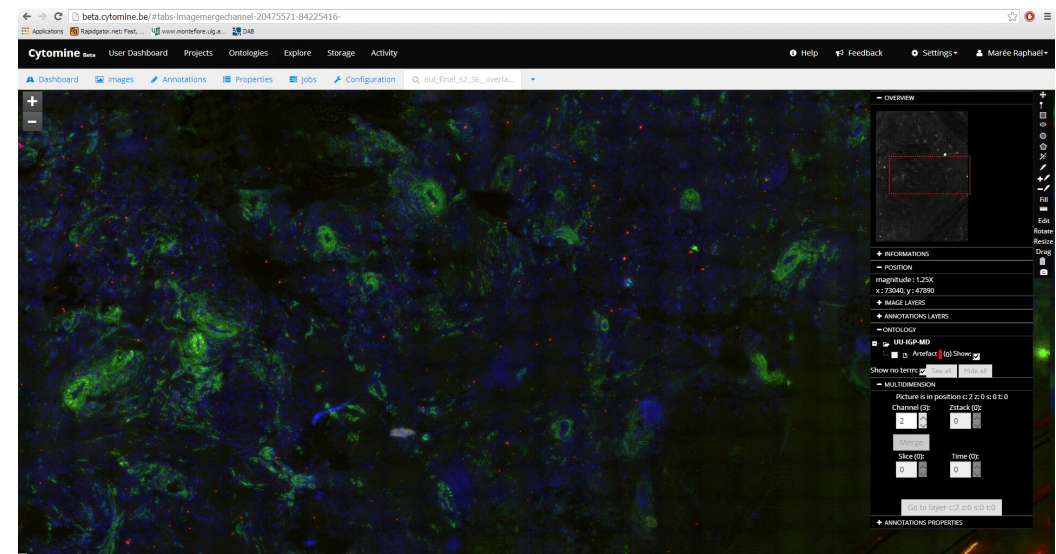
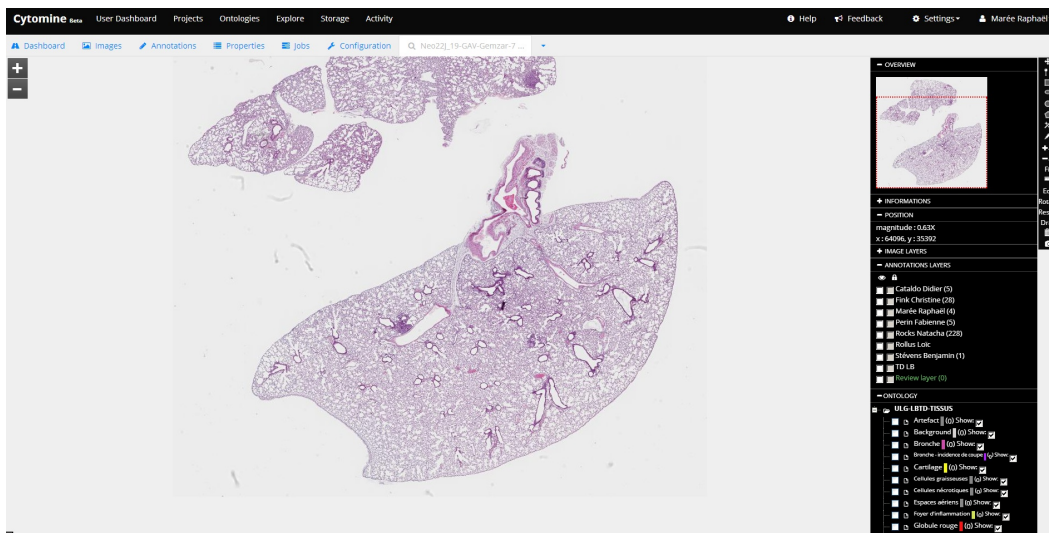
- Name:** The project name, often including a date or identifier (e.g., 'ULG-LBTD-E2B-NOV2013').
- Discipline:** The field of study, such as 'HISTOLOGY'.
- Ontology:** The vocabulary used for annotations (e.g., 'ULG-LBTD-TISSUS').
- Statistics:** A summary of the data, including the number of images, user annotations, job annotations, and validated annotations. These are often accompanied by small colored bars indicating the count.
- Actions:** Buttons for 'Info', 'Edit', 'Delete', and 'Open' to manage the project.

On the right side of the interface, there are two sets of image thumbnails. The top set shows four small, square images of tissue sections, with an arrow pointing from the first project card to them. The bottom set shows four larger, circular images of tissue sections, with an arrow pointing from the fifth project card to them. This visual representation demonstrates the types of data that can be stored and managed in the system.

cyt^omine features : Visualize multi-gigapixel images



- Explore **large** (>gigabyte) images at multiple resolutions, **remotely**
- GoogleMaps/OpenStreetmap browsing style (zoom in/out, pyramid tile-based)

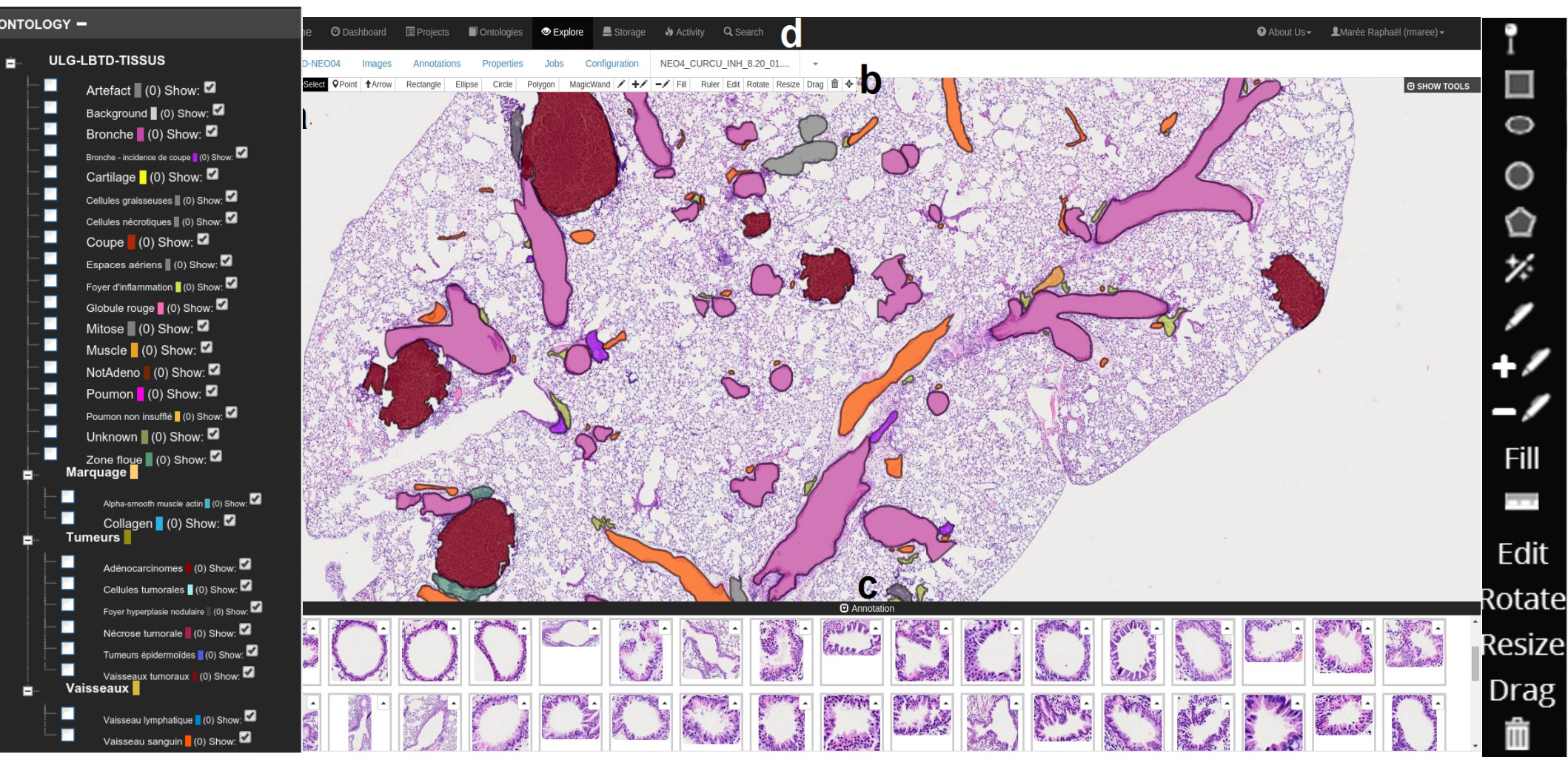


1 tissue slice = 35000 x 30000 pixels (0.23µm/pixel)

4 fluo channels 83000 x 100 000 pixels = 4 x 16GB image
(image from O.Söderberg group, Uppsala)

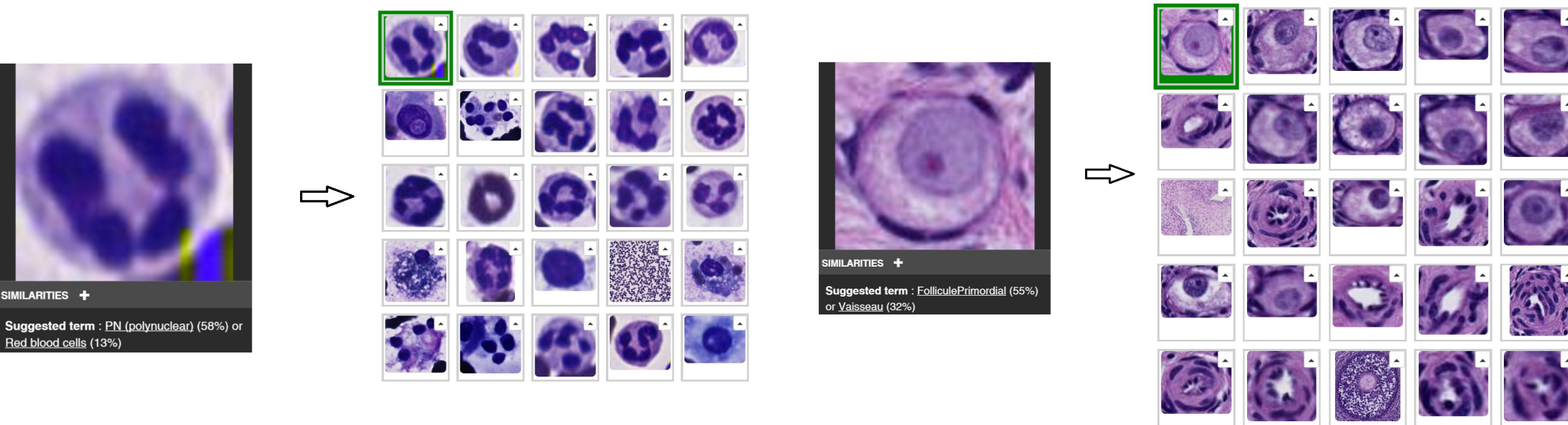
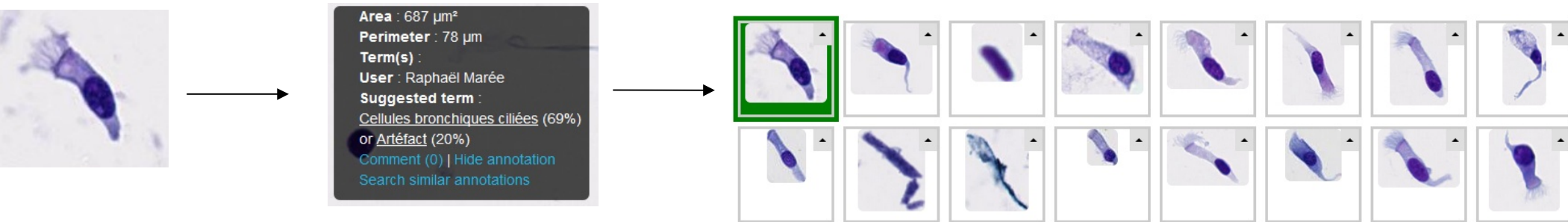
cyt@mine features : Semantic annotation

- **Annotate** images using various **drawing tools**, with **user-specific layers**
- Describe ROIs with **ontology terms**
- Describe images and ROIs with any **key-value properties** or **text description**



cyt@mine features : Search

- **Text search** (projects, images, annotations)
- **Visual search** (CBIR) of regions of interest and **ontology term suggestion**



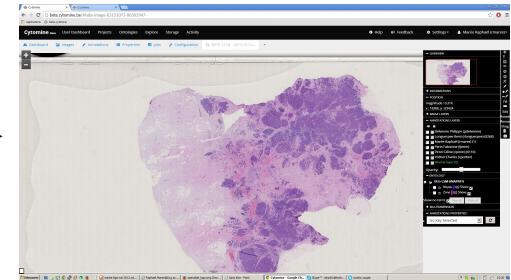
cyt@mine features : Share

- **Share images** through simple URLs

<http://beta.cytomine.be/#tabs-image-83151073-86503947->

Sign in to Cytomine

Username
Password
Sign in ☒ Remember me



- **Share and comment annotations** through simple URLs & e-mail mechanisms

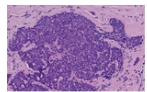
<http://beta.cytomine.be/#share-annotation/77044>

Comment/Share an annotation

What do you think it is ?

Delvenne Philippe (pdelvenne)
Longuespee Remi (rlonguespee)
Marée Raphaël (rmaree)
Perin Fabienne (fperin)
Piron Celine (cpiron)
Pottier Charles (cpottier)

Comments



Cancel Share



From: cyt@mine.ulg.ac.be To: raphael.maree@ulg.ac.be
Subject: Cytomine : Marée Raphaël (rmaree) shared an annotation with you Date: Fri, 29 Nov 2013 23:12:05 +0100 (CET)

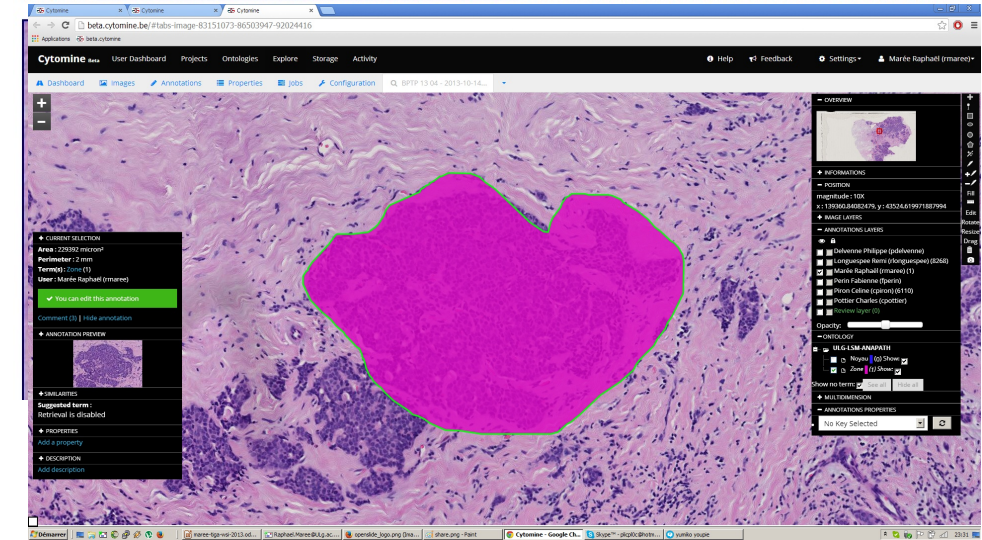
Dear Marée Raphaël (rmaree),

Marée Raphaël (rmaree) shared an annotation with you and said :

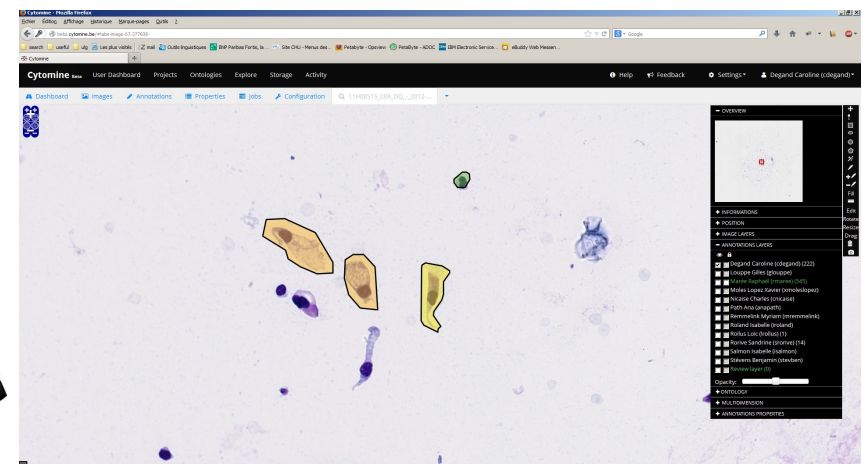
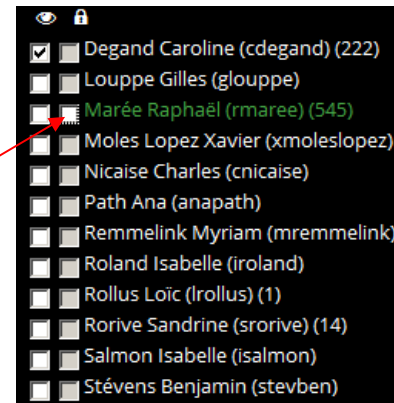
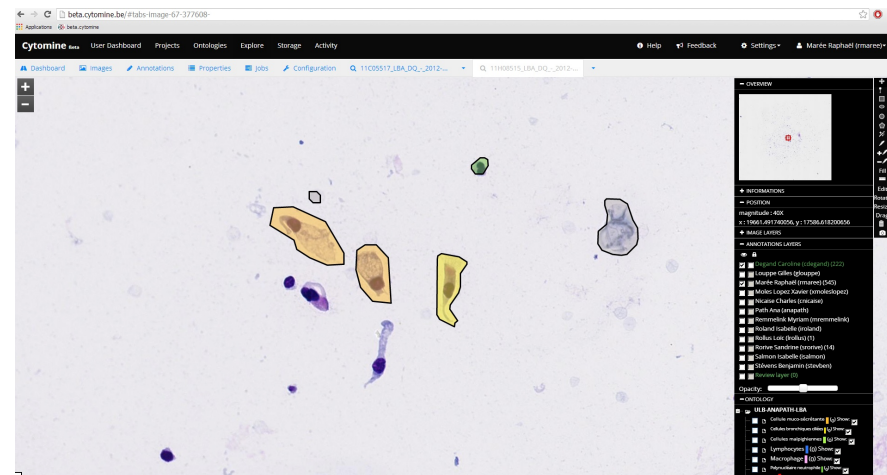
Dear colleague, Do you think it is grade C ?

Navigate to <http://beta.cytomine.be/#share-annotation/92024416> in order to reply.

Navigate to <http://beta.cytomine.be/#tabs-image-83151073-86503947-92024416> in order to view the annotation within its context, or click on the thumbnail.



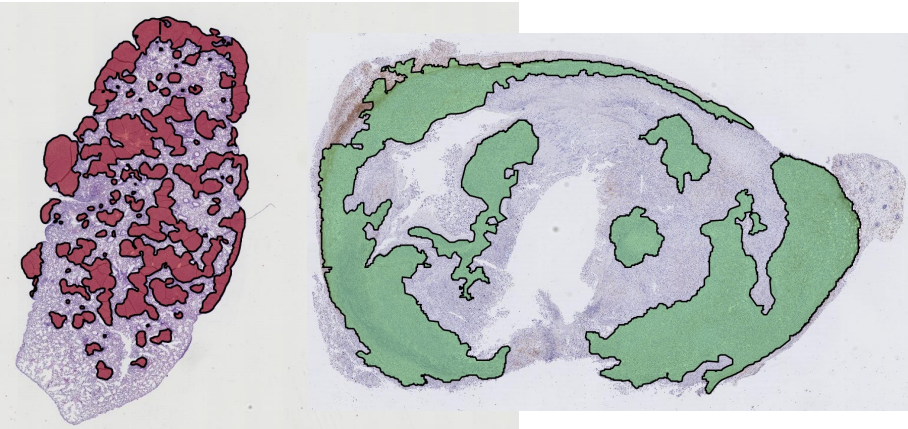
cyt~~o~~mine features : Live broadcast



Start following Marée Raphaël (rmaree)

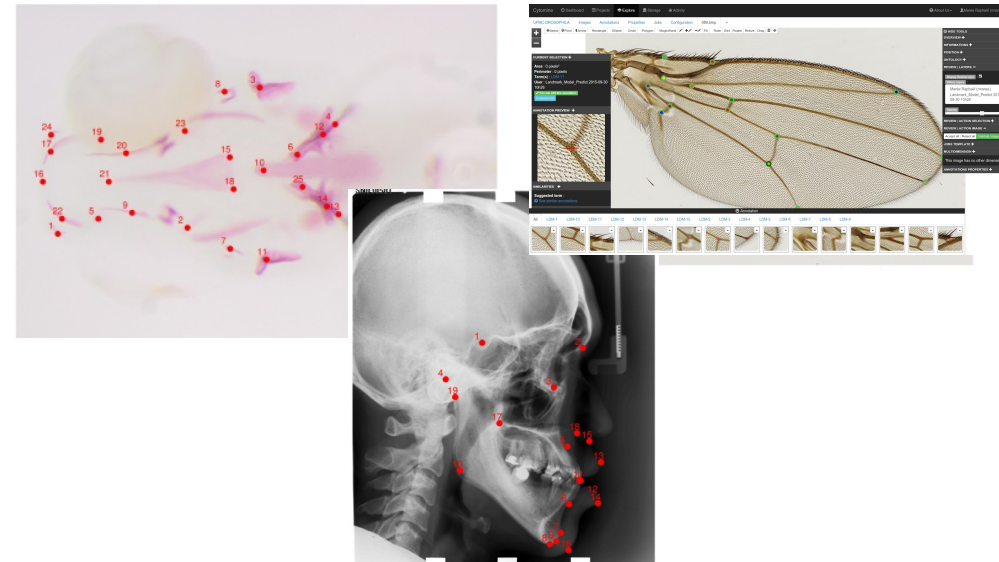
cyt_omine features :

Semi-automated analysis using machine learning and proofreading



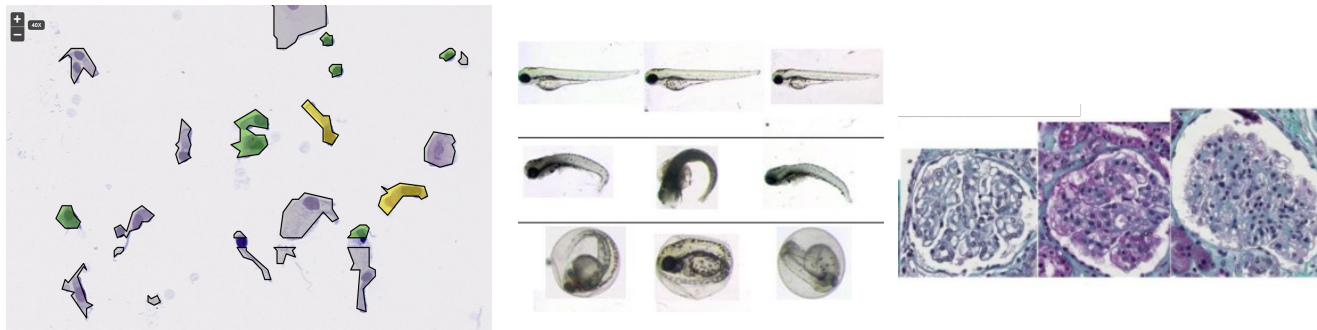
Tissue segmentation

Dumont et al., VISAPP 2009
Marée et al., ISBI 2014
Leroi et al., Oncotarget 2015



Landmark detection

Vandaele et al., Submitted
Huang et al., IEEE TMI 2015

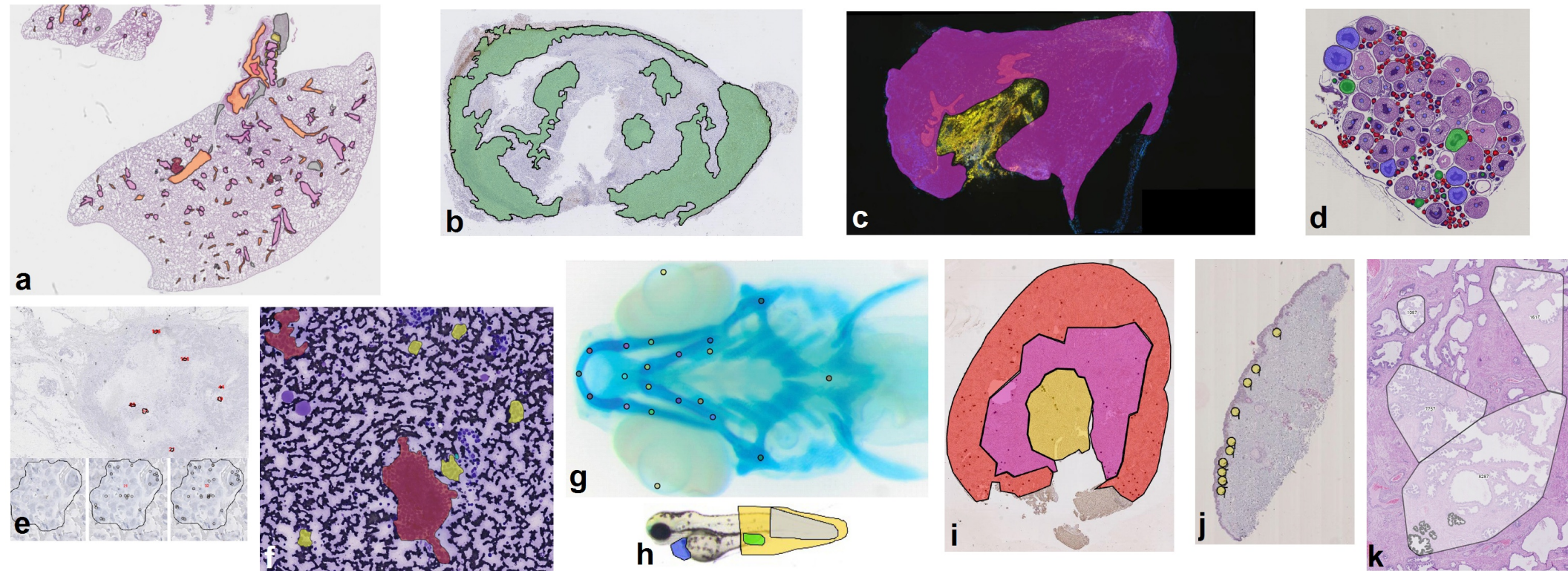


Object classification

Marée et al. Pattern Recognition Letters 2016 ; ISBI 2016
Delga et al., 2014 ; Jeanray et al., PLoS ONE 2015 ;

cyt@mine research applications :

As of March 2016 : > 200 registered users, > 300 projects,
 > 21 000 images, > 700 000 manual annotations
 > 6 000 000 algorithm annotations



- a:** H&E mice lung cancer research (D.Cataldo's lab, GIGA-Research) @ ISBI 2014.
- b:** IHC mice lung cancer research (P. Martinive's lab, GIGA-Research) @ OncoTarget 2015.
- c:** Immunofluorescent mouse ear sponge assays in tumor angiogenesis. @ Journal of Pathology 2015.
- d:** H&E Chondrostoma nasus sexual maturation research (Gennotte's lab, CEFRA).
- e:** in situ hybridization assays in human breast cancer research (C.Josse's lab, GIGA-Research) @ BMC Cancer 2015
- f:** Human thyroid cytology (I.Salmon's lab, ULB Anatomical Pathology Department) @ ECDP 2016.
- g:** Danio rerio embryo development (M. Muller's lab, GIGA-Research) @ PLoS ONE 2015.
- h:** Danio rerio toxicology research (M.Muller's lab, GIGA-Research) @ PLoS ONE 2015.
- i:** IHC renal ischemia/reperfusion research (F.Jouret's lab, GIGA-Research) @ Am J Transl Res. 2015.
- j:** IHC in melanoma microenvironment research (P.Quatresooz's lab, GIGA-Research).
- k:** H&E in human breast cancer research (R. Longuespée, GIGA-Research) @ Methods. 2016

cyt@mine education applications :

- Practical sessions in human & veterinary histology
- 2000 digital slides
- 50 « projects » (practical sessions)
- 4000 distinct students in 2014-2015
- 200 000 annotations created

MEDE0131-A-C : ...

Name : MEDE0131-A-C : TRAVAUX PRATIQUES
MULTIDISCIPLINAIR...

Discipline : Undefined
Ontology : TEST

Number of images : 380
Number of user annotations : 962
Number of job annotations : 0
Number of validated annotations : 0

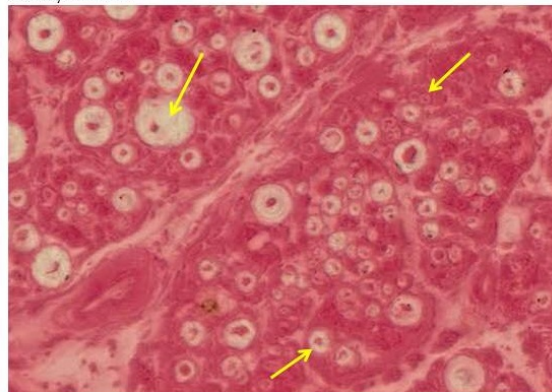
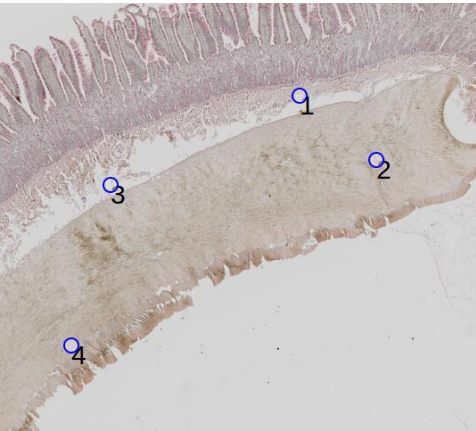
Info Images Edit Delete Open

DESCRIPTION +

1. Que peut-on remarquer au sujet de ces fibres nerveuses coupées transversalement ? x20

[See full text and edit](#)

Les flèches jaunes ci-dessous illustrent la diversité de diamètre des fibres nerveuses qui peuvent être myélinisées (avec une gaine +/- épaisse) ou non myélinisées.



2. Recherche

Projets

Type

★ Mots-clefs (séparés par ',')

Pour obtenir tout le contenu d'un projet, recherchez ''*

Liaison entre mots-clefs ☐ OU ☒ ET

Afficher uniquement les aperçus ☐

3. Résultats

Sauvegarder les critères de recherche au lieu des résultats ☐

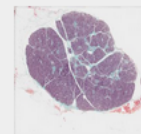


Pancréas Issac aaron (HISTOLOGIE)

Coupe de **pancréas** de Cobaye. Cette lame correspond à la coupe n° 20 de la boîte de TP d'histologie humaine.

Tags: îlots de Langerhans acini séreux canaux excréteur glande endocrine exocrine

Stévens Benjamin



Lame Histologique de Pancréas (DotSlide Scan) (HISTOLOGIE)

Coupe histologique de **pancréas** de chimpanzé. Coloration trichrome de Masson. Collection de la Faculté de médecine vétérinaire.

Tags: pancréas, Glandes annexes du Tube digestif, VDP01

Stévens Benjamin

cyt^omine summary :

- **Free and Open-source**



(www.cytomine.be)

- **General-purpose** using generic software design, web services, user-defined ontologies and machine learning for semantic annotation
- Fosters **collaboration** between life scientists, pathologists, teachers, and computer scientists
- Not universal but...
 - Many potential direct applications
(J. Pathol, Oncotarget, BMC Cancer, Am J Transl Res, PLoS ONE,...)
 - **Fully extensible** (documentation, open API, source code repository)
- Future :
 - Research projects
 - **Cooperative (social economy)** to provide services (support,...) and to coordinate development efforts

Acknowledgments

- Systems and Modeling (Montefiore Institute / GIGA-Research @ ULG):
 - Cytomine core development : Loïc Rollus, Renaud Hoyoux, Benjamin Stévens
 - Algorithms : Gilles Louppe, Jean-Michel Begon, Rémy Vandaele
Pierre Geurts, Louis Wehenkel
- Other collaborators :
 - GIGA/ULG : Didier Cataldo, Natacha Rocks, Fabienne Perin, Christine Fink,
Valérie Defaweux, Pascale Quatresooz
 - Students : Julien Confetti, Pierre Ansen, Olivier Caubo, Antoine Deblire, Romain Mormont
 - IFRES : Grégoire Vincke, Dominique Verpoorten
 - CRIFA : Brigitte Denis, Céline Snoeck, Christophe Laduron
 - ULB : Isabelle Salmon, Caroline Degand, Xavier Moles Lopez, Nicky D'Haene.
 - Pasteur Institute : Vannary Meas-Yedid, Jean-Christophe Olivo-Marin.
 - Medical University Graz : Philippe Kainz
 - UNamur : Patsy Renard, Eric Depiereux

Research grants of the Wallonia (DGO6) :

- **CYTOMINE** (2010-2016) n° 1017072
- **SMASH** (2012-2014) n° 1217606
- **HISTOWEB** (2014-2017) n° 1017072

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An open-source rich internet application for collaborative analysis of multi-gigapixel images

Speaker : Raphaël Marée



cytomine



@cytomine



github.com/cytomine



www.cytomine.be



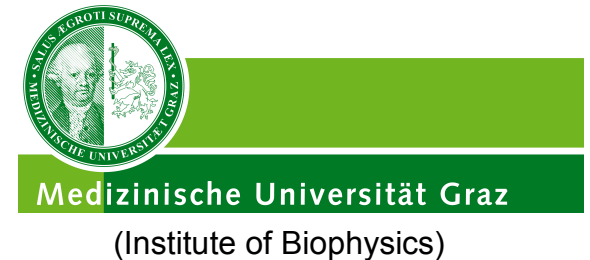
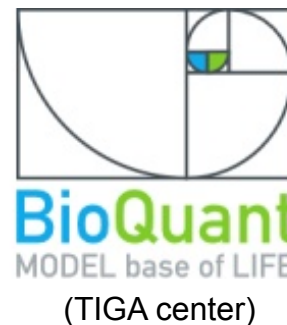
info@cytomine.be



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cyt^omine currently tested by ...



cyt@mine



Html 5



Javascript



Jquery



Backbone.js



AngularJS



Openlayers

Cytomine-WebUI



Scikit-learn



OpenCV



Redis



Java

Content-based Image retrieval
Cell Classifier
Landmark Detection
Tissue Segment
Annotation Stats
...

Cytomine-DataMining



Python



Python

Cytomine-clients



Java



Docker

Cytomine Install/Deploy

REST API HTTP

NGINX



Message broker

REST API HTTP

NGINX



Grails



Groovy



Java



Spring



Postgis



Tomcat



PostgreSQL

Cytomine-Core



MongoDB



Grails



+ OpenSlide



Java

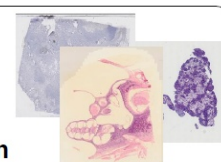
C++

Cytomine-IMS



GlusterFS

File system



Node.js



MongoDB

Cytomine Monitoring



cyt@mine

Collaborative analysis
of gigapixel images

www.cytomine.be