

Development of software tools to foster collaboration with open source & open data:

Cytomine (image analysis) [2010-...]
&
Shareish (citizen mutual aid) [2021-...]

ULiège Open Science Day
27th October 2023

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PhD in Computer Science

Senior researcher @ Montefiore Institute, University of Liège

<https://people.montefiore.uliege.be/maree/>

<https://uliege.cytomine.org/> <https://shareish.org/>



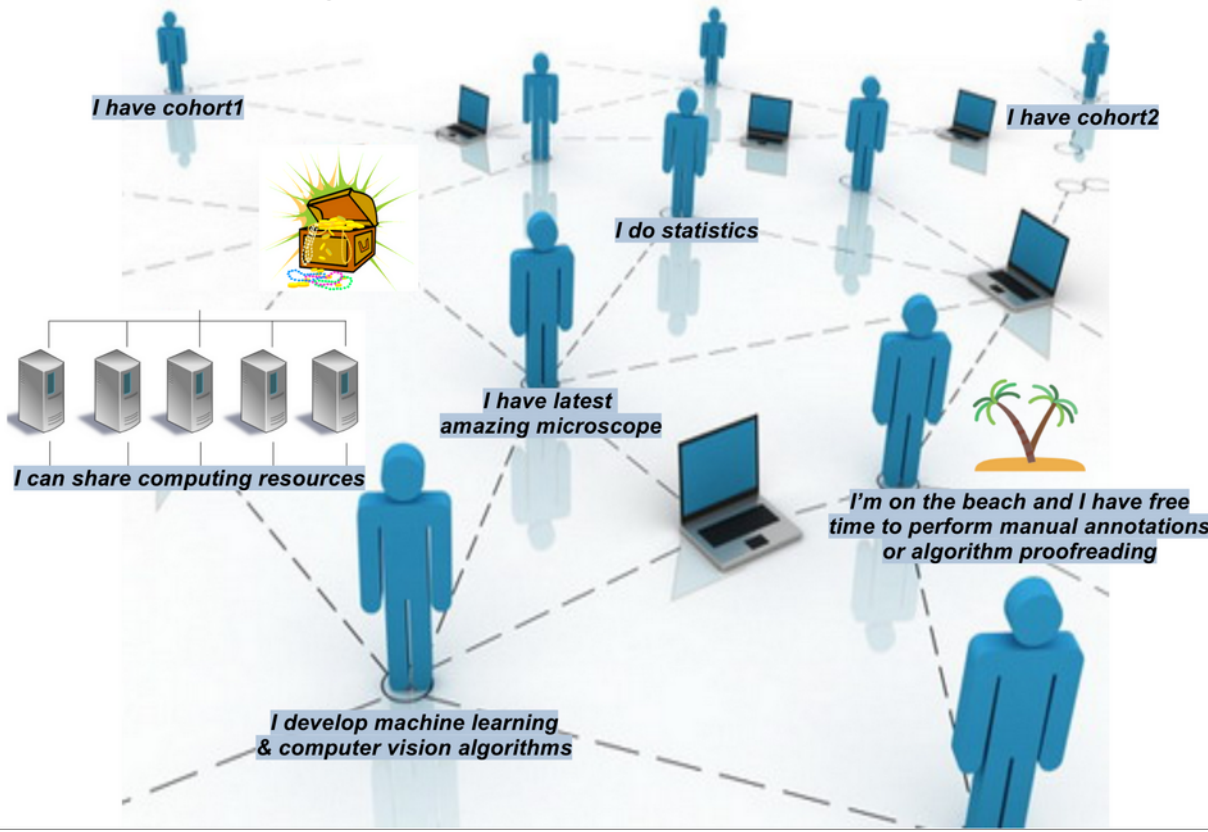
Collaboration tools (Computer-Supported Cooperative Work)

« [...] The goal of CSCW is to help promote and utilize technology in a collaborative way, and help create new tools to succeed in that goal. » (Wikipedia)

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Cytomine for collaborative image-based (biomedical) research



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Cytomine for collaborative image-based (biomedical) research

I have cohort1

I have cohort2

I do statistics

I have latest amazing microscope

I can share computing resources

I develop machine learning & computer vision algorithms

CURRENT SELECTION

Area	156096.850 micron ²
Perimeter	2.009 mm
Description	A nice one.
Terms	Bronche
Tags	No tag
Properties	Intensity 0, Circularity 0.7
Attached files	No attached file

ANNOTATION LAYERS

- Natacha Rocks (nricks) (238)
- Raphaël Marée (rmaree) (18)
- Loïc Rollus (lrollus) (19)
- Christine Fink (cfink) (0)

TERMS

- Marquage
 - Alpha-smooth
 - muscle actin
 - Collagen
- Tumeurs
 - Adénocarcinomes
 - Cellules tumorales
 - Foyer hyperplasie

Annotation comments

Raphaël Marée Nov 17, 2009 1:52 PM
This is another test comment.2.

Raphaël Marée Nov 17, 2009 1:52 PM
This is a test comment. How are you?

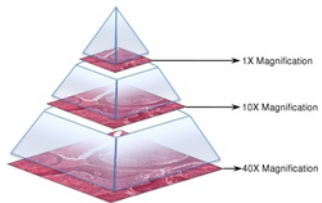
cyt_omine enables collaboration through the web

(Sharing of images, annotations, algorithms, results)

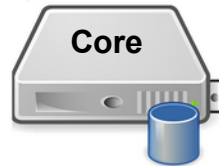
(Marée et al., Bioinformatics 2016 ; Rubens et al., Proteomics Clin Appl. 2019 ; Rubens et al., Cell Patterns, 2020)



+ Start upload



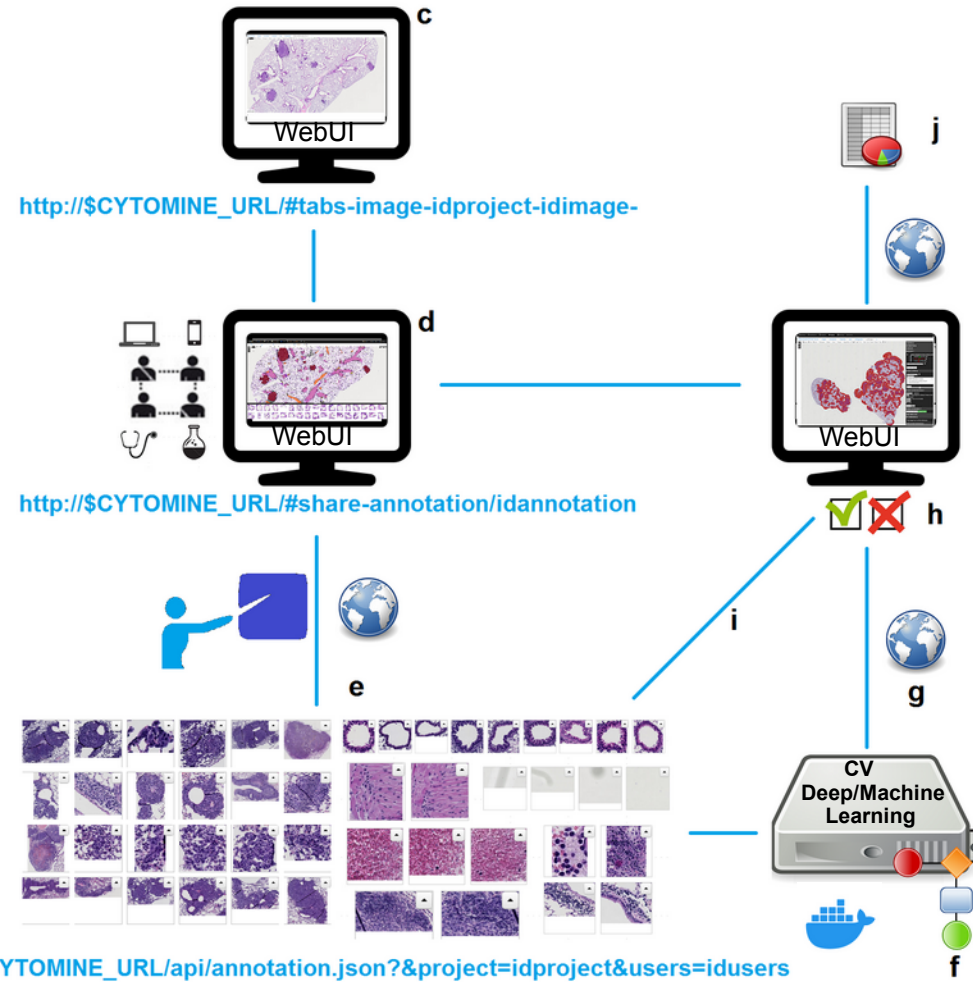
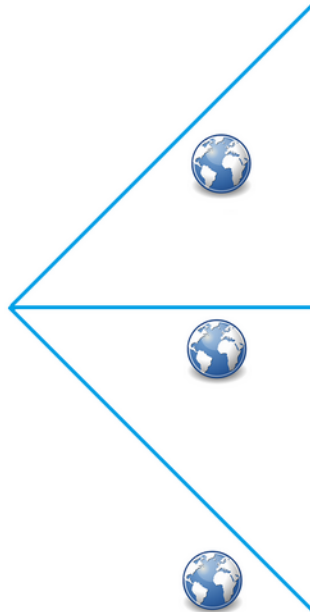
e.g.
100K x 100K pixels,
0.23µm/pixel



b



open source



We use \$CYTOMINE_URL = <https://research.uliege.cytomine.org/>

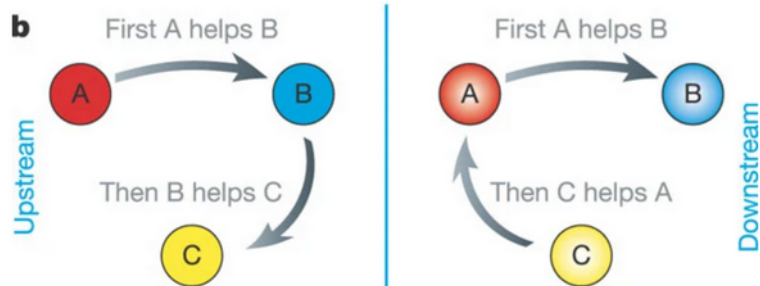
Collaboration tools (Computer-Supported Cooperative Work)

« [...] The goal of CSCW is to help promote and utilize technology in a collaborative way, and help create new tools to succeed in that goal. » (Wikipedia)

Shareish to foster diverse solidarity practices in civil society



(Shutterstock)



[Nowak & Sigmund]

Collaboration tools (Computer-Supported Cooperative Work)

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Shareish to foster diverse solidarity practices in civil society

The illustration shows several windows with people engaged in various activities: one person is watering a plant, another is reading, and others are holding plants or tools. Below the illustration are two diagrams. Diagram 'b' shows a circular flow of help: A (red circle) helps B (blue circle), B helps C (yellow circle), and C helps A. A vertical line labeled 'Upstream' is on the left. Diagram 'Nowak' shows a linear flow: A (red circle) helps B (blue circle), and then B helps C (yellow circle). A vertical line labeled 'Nowak' is on the right.

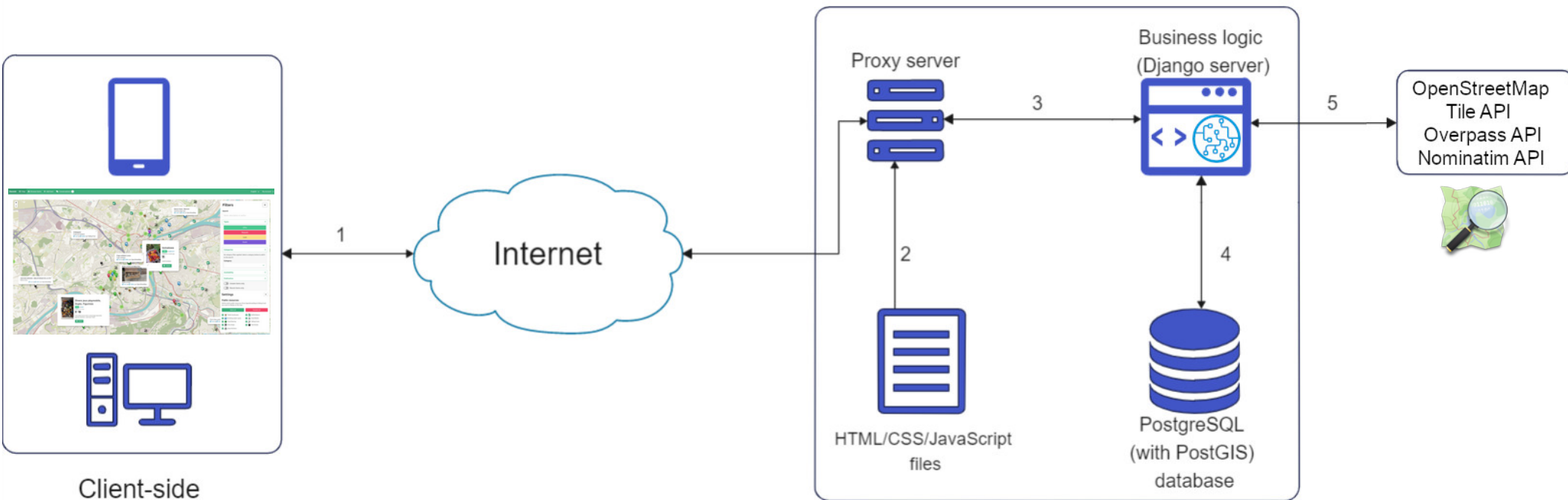
The screenshot of the Shareish web application shows a map interface with various markers and pop-up cards. The cards include:

- tomatoes**: Offered by @Anouch, published 4 months ago. Description: small tomatoes.
- Frigo solidaire Laveu**: Frigo solidaire.
- Boîte à livres du Betty Parc**: Boîte à livres.
- Divers jeux playmobils, Duplo, Figurines**: Jeux à la vente. Description: Tous les jeux de joues divers personnages playmobils, figurines d'animaux, cubes type "Duplo".
- Châtaignier**: Fruits qui tombent.
- Boite à livres**: Boîte à livres.
- GIVE BOX SERANG - BIBLIOTHEQUE DE LA CITE**: Boîte à livre.
- Boite à livres**: Boîte à livres.
- Point d'eau public**: Point d'eau public.

The interface includes a navigation bar with 'Shareish', 'Map', 'Browse items', '+ Add item', and 'Conversations'. A 'Filters' panel on the right allows filtering by Name, description or author; Types (Offer, Request, Loan, Event); Categories; Availability; and Publication (Unseen items only, Recent items only). A 'Settings' panel allows defining public resources to display on the map, with options for Public bookcases, Drinking water spots, Food Sharing, Free shops, Soup kitchens, Defibrillators, Food Banks, Falling Fruits, and Give boxes.

Shareish to foster diverse solidarity practices

(non-monetary sharing, mutual aid, network-generalized exchange, gift economy, indirect reciprocity, third party altruism, random acts of kindness, community economy, stooping, gleaning, grafteria/donnerie,...) [Kropotkin; Spade ; Ekeh; Yamagishi and Cook; Lampinen et al. ; Mauss ; Graeber ; Nowak & Sigmund ; Trivers ; Herbert; Bellotti et al. ; Gibson-Graham];



Client-side

Server-side

<https://shareish.org>



open source

Repair Café Awans
Repair Café Jeter ? Pas question ! Nos bénévoles vous accueillent à la Maison des Villages d'Awans (Rue Noël Heine,3)....
Free event by @rm
Published 12 hours ago
Available in 2 months
Ends in 2 months
At ± 4.76 km
Do-it-yourself and making
Helping hands and Manual Labor

Troc de plantes et de graines
Le prodi 30 juillet 2023 à partir de 17h
Free event by @rm
Published 12 hours ago
Available in 7 days
Ends in 7 days
At ± 4.17 km
Garden, Nature, and Environment

Glanage haricots verts
Champ de haricots verts à glâner (raison: surproduction et trop gros calibre pour conserves).
Chemin du Bois Lasso à Fournes...
Free event by @rm
Published a month ago
Ends in 12 hours
At ± 182.84 km
Food and Supplies
Garden, Nature, and Environment

Reference address Uliège - Campus de Liège Sart Tilman, Boulevard du Rect

Notification radius (in km) 48

Items	<input checked="" type="checkbox"/> Instantly	<input type="checkbox"/> Daily	<input type="checkbox"/> Weekly	<input type="checkbox"/> Never
Free events	<input checked="" type="checkbox"/> Instantly	<input type="checkbox"/> Daily	<input type="checkbox"/> Weekly	<input type="checkbox"/> Never
Public resources (OSM)	<input checked="" type="checkbox"/> Daily	<input type="checkbox"/> Weekly	<input type="checkbox"/> Monthly	<input type="checkbox"/> Never
Conversations	<input checked="" type="checkbox"/> Instantly	<input type="checkbox"/> Daily	<input type="checkbox"/> Never	
General info	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Never		

Cytomine & Shareish are



github.com/cytomine-uliege
doc.uliege.cytomine.org/
github.com/shareish

(permissive license)



(opensource.com)

The recipe (source code) is public.

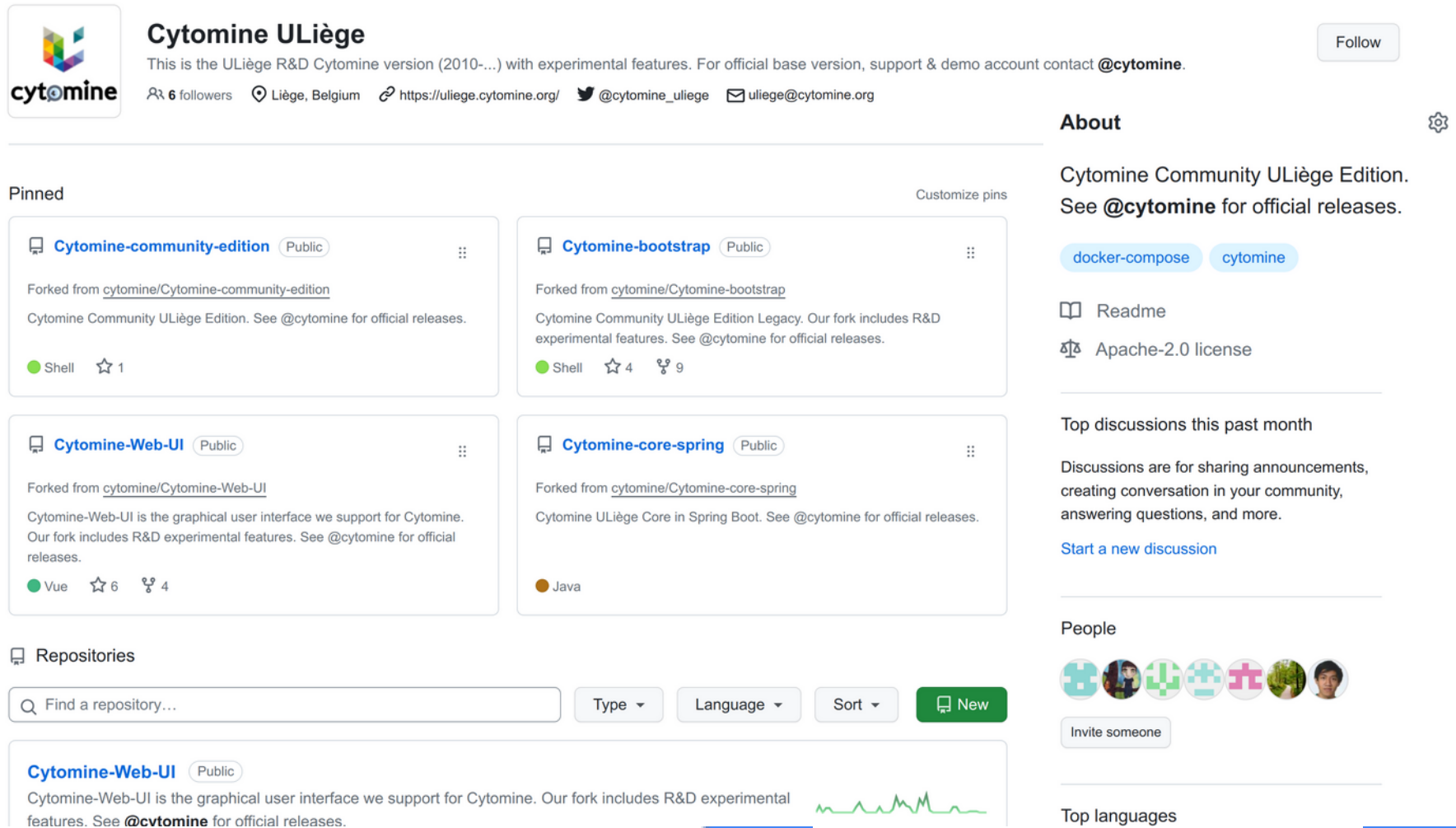
```
all_votes_class = Parallel(n_jobs=n_jobs)(
    delayed(_parallel_confidence_map)(
        pixels[starts[i]:starts[i + 1]],
        _Y[starts[i]:starts[i + 1]],
        starts[i],
        boxes,
        width,
        height,
        pyxit.base_estimator.n_classes_[0],
        pyxit_target_width,
        pyxit_target_height)
    for i in xrange(n_jobs))
```

(figure adapted from opensource.com)

→ Freedom to install, inspect, extend, improve, reproduce, redistribute

Cytomine & Shareish are

² Code: <https://github.com/cytomine-uliege>. Demo server with datasets: <http://research.uliege.cytomine.org/> username: eccv2022bic password: deep-fish.



Cytomine ULiège Follow

This is the ULiège R&D Cytomine version (2010-...) with experimental features. For official base version, support & demo account contact [@cytomine](#).

6 followers · Liège, Belgium · <https://uliege.cytomine.org/> · [@cytomine_uliege](#) · uliege@cytomine.org

Pinned

Customize pins

- Cytomine-community-edition** (Public) Shell ☆ 1
- Cytomine-bootstrap** (Public) Shell ☆ 4 🍴 9
- Cytomine-Web-UI** (Public) Vue ☆ 6 🍴 4
- Cytomine-core-spring** (Public) Java

About

Cytomine Community ULiège Edition. See [@cytomine](#) for official releases.

[docker-compose](#) [cytomine](#)

[Readme](#)

[Apache-2.0 license](#)

Top discussions this past month

Discussions are for sharing announcements, creating conversation in your community, answering questions, and more.

[Start a new discussion](#)

People

[Invite someone](#)

Top languages

```
pyxit_target_height)
for i in xrange(n_jobs))
```

(figure adapted from opensource.com)

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Why open-source ?

A need for research/civil community autonomy while existing tools were proprietary and subject to arbitrary/unpredictable decisions (« vendor lock-in », « data lock-in », limited impact, ...)

<https://optics.org/news/3/10/16>

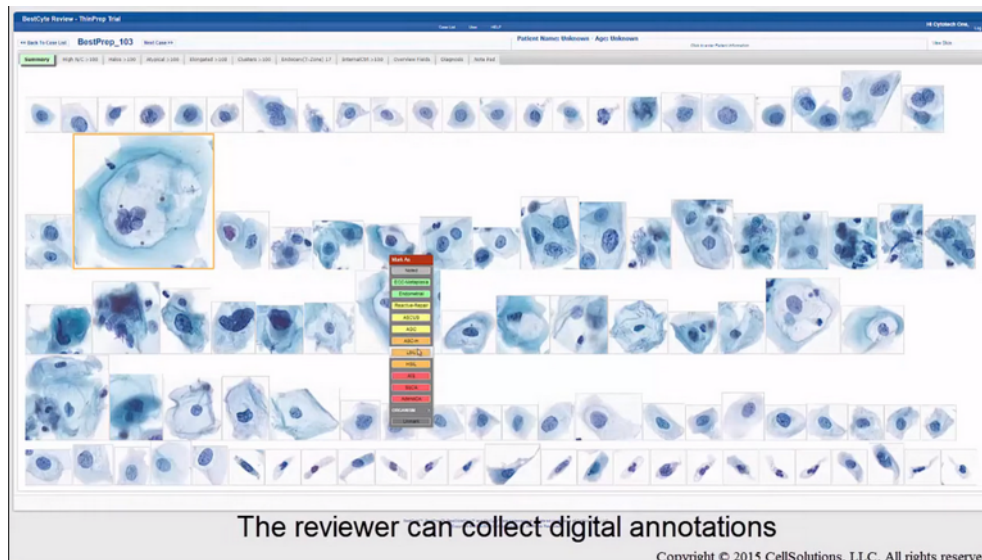
Definiens closes funding round for digital pathology expansion

15 Oct 2012 ... Investment of €10 million proves that image analysis techniques have potential to transform cancer diagnosis, company believes.

<https://www.astrazeneca.com/media-centre/press-releases/2014/medi...>

MedImmune completes acquisition of Definiens - AstraZeneca

26 Nov 2014 ... **Definiens** is the leading provider of image analysis and data mining solutions for tissue diagnostics and clinical **digital pathology**. **Definiens** ...



Why open-source ?

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¹E.g. the Jaspr Trades for "cash-free swap community in Berlin" suddenly ended its activity, the renting platform Usitoo in Belgium did not find a sustainable business model and was discontinued, the Kassi online forum "with the aim of linking those who can give something to those who are in need" [41] became as a start-up company the "Sharetribe online marketplace to sell, buy, and lend stuff", ...

Twitter announces new API pricing, posing a challenge for small developers



/ After announcing it would be changing its API rules in February, Twitter has now detailed how free access to its API will work in the future.

Home > Tech

Twitter's API keeps breaking, even for developers paying \$42,000

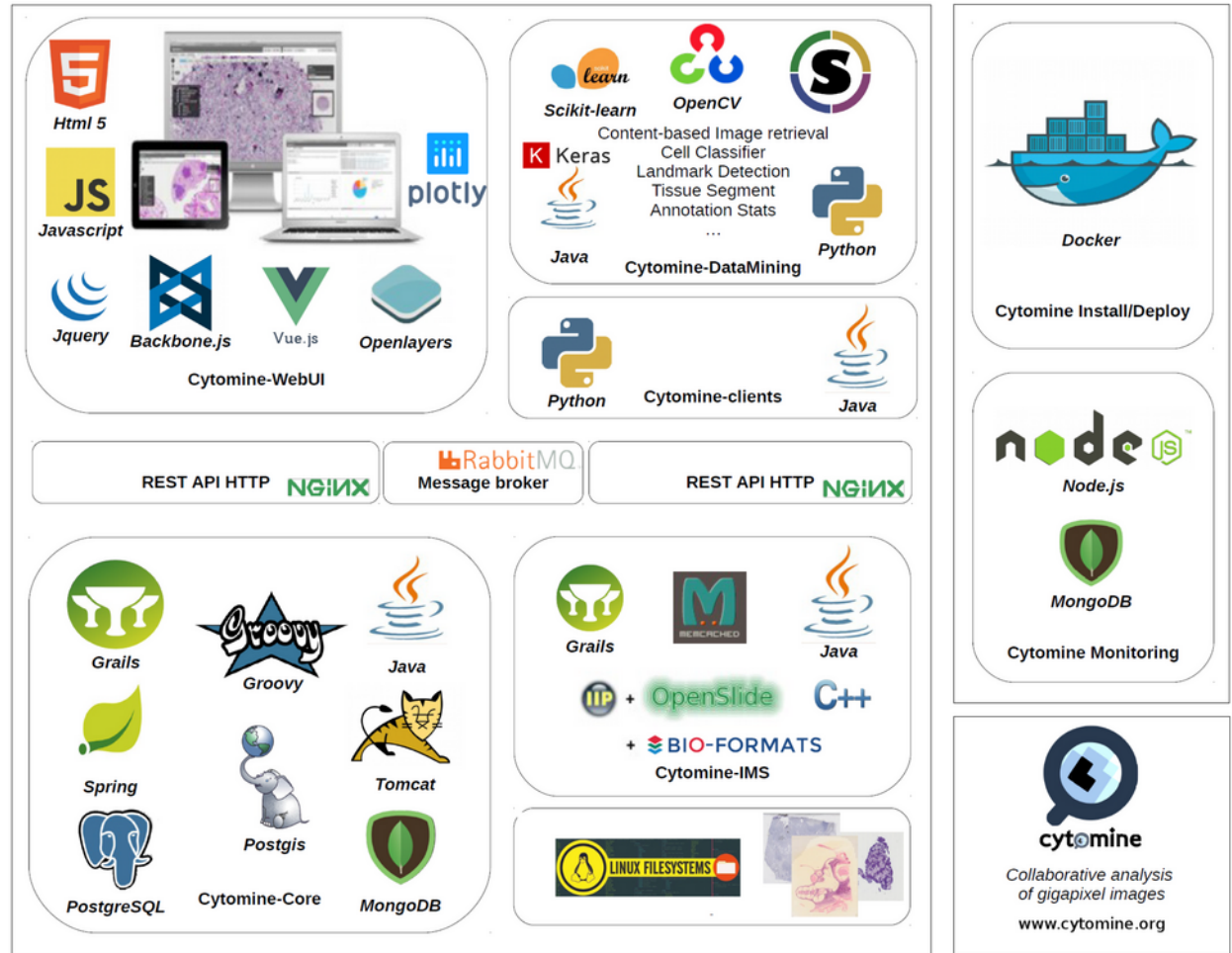
Everything worked fine until Elon Musk took over.

By [Matt Binder](#) on June 29, 2023



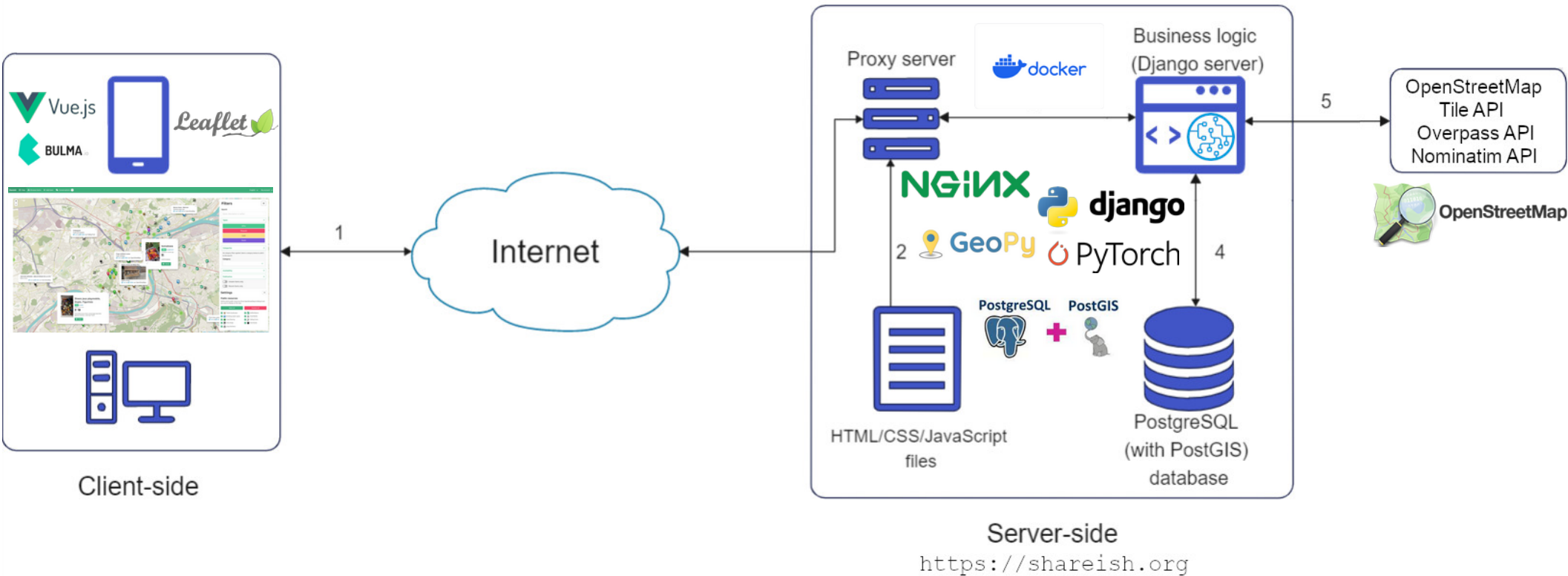
Why open-source ?

Direct way to « give back » to society (« commons ») as we relied on public funds and we re-used many existing open-source libraries / open data



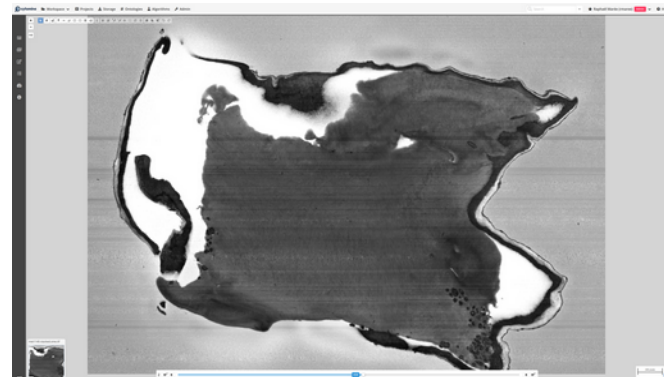
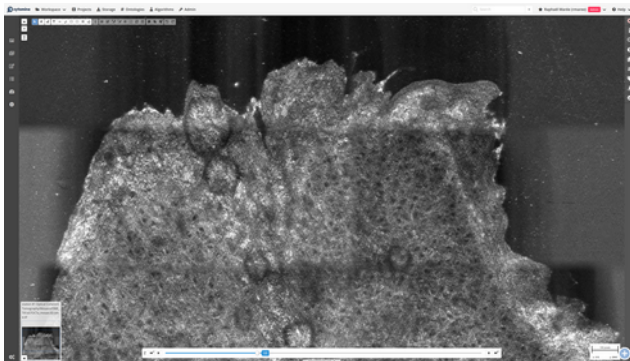
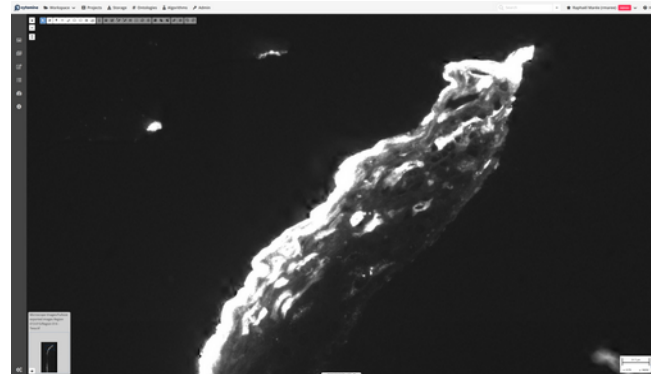
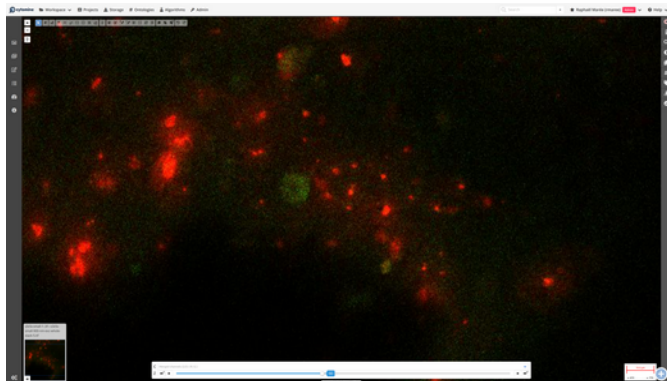
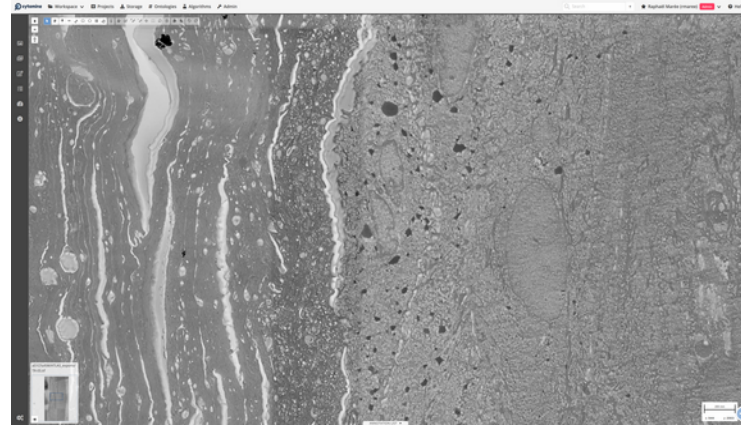
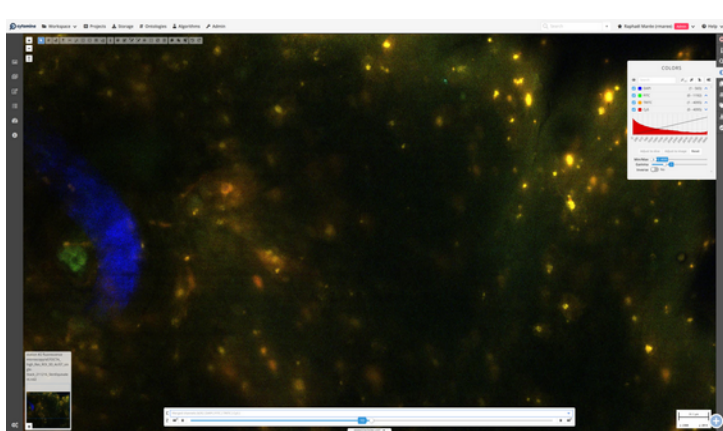
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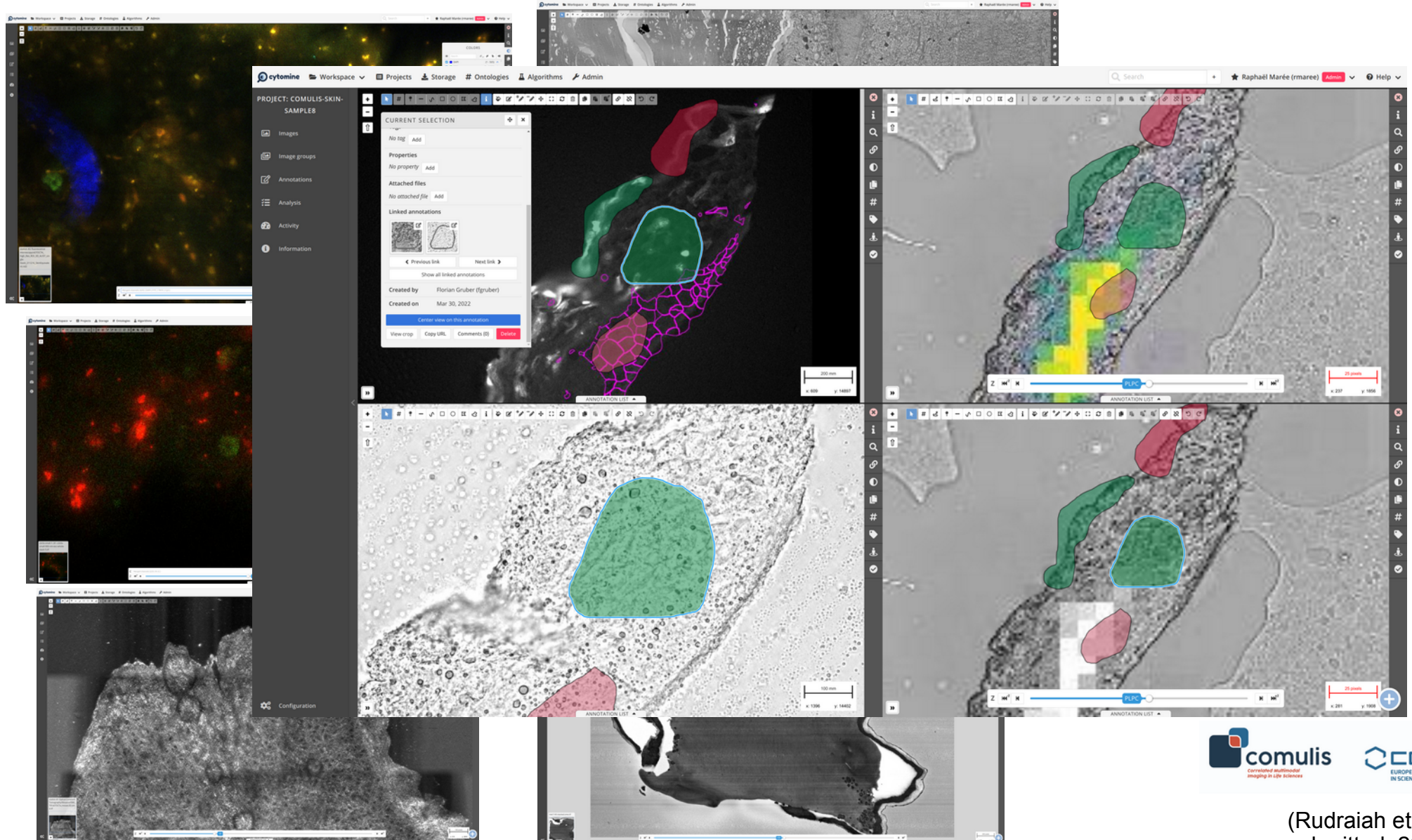
Open-source impact

Eases collaboration, adoption and replication by other researchers, and extension to other application domains (beyond initial scope, by others)



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(Rudraiah et al.,
submitted, 2023)

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NUCLEI-TRACKING-DIVISION
This project illustrates the 2D tracking of cell nuclei. The time-lapses are derived from Fluor-N2DH-SIM+ datasets from [Cell Tracking Challenge](#).

GLAND-SEGMENTATION-TRAIN
The images are crops of histopathology slides taken from the [2015 MICCAI challenge of gland segmentation](#) (GLaS 2015). The aim of the problem is to classify pixels as belonging to a gland or not. These images were used to train machine learning based workflows.

LANDMARKS-DROSO
Landmark detection in Drosophila wings, data from UPMC ([Vandaele et al., Nature Scientific Reports, 2018](#)).

VESSEL-TRACING-3D
This project illustrates the 3D tracing of blood vessels. The images were generated by [VascuSynth ITK](#), a biological image simulator, and some artificial noise was added.

img_0005_Nuc_Norm.tif

img_0003_Nuc_Norm.tif

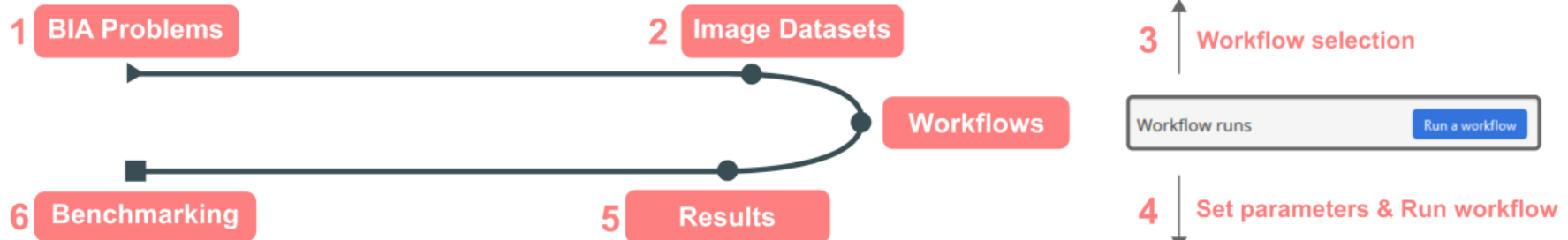
img_0004_Nuc_Norm.tif

img_0002_Nuc_Norm.tif

New workflow run

Workflow: Select options

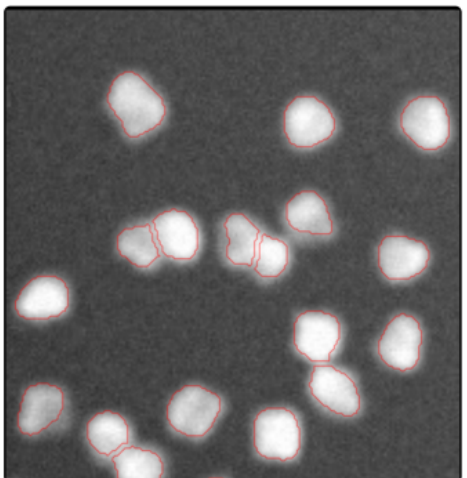
- NucleiSegmentation-Python (v1.1)
- NucleiSegmentation-CellProfiler (v1.4.1)
- NucleiSegmentation-ImageJ (v1.10.1)
- NucleiSegmentation-MaskRCNN (v1.3)
- NucleiSegmentation-ilastik (v1.0)



Workflow runs Run a workflow

Aggregated results Detailed results per image

Workflow run	Dice coefficient		
	MIN	MAX	AVG
★ NucleiSegmentation-ilastik (v1.0) #1 on Mar 25, 2019 1:19 PM	0.58	0.637	0.614
★ NucleiSegmentation-MaskRCNN (v1.3) #1 on Mar 25, 2019 9:16 AM	0.587	0.649	0.633
★ NucleiSegmentation-ImageJ (v1.10.1) #2 on Mar 19, 2019 10:37 AM	0.613	0.67	0.641
★ NucleiSegmentation-Python (v1.1) #6 on Mar 18, 2019 4:10 PM	0.554	0.613	0.586
★ NucleiSegmentation-CellProfiler (v1.4.1) #2 on Mar 11, 2019 9:22 AM	0.558	0.637	0.595



New workflow run

Workflow: NucleiSegmentation-ImageJ (v1.10.1)

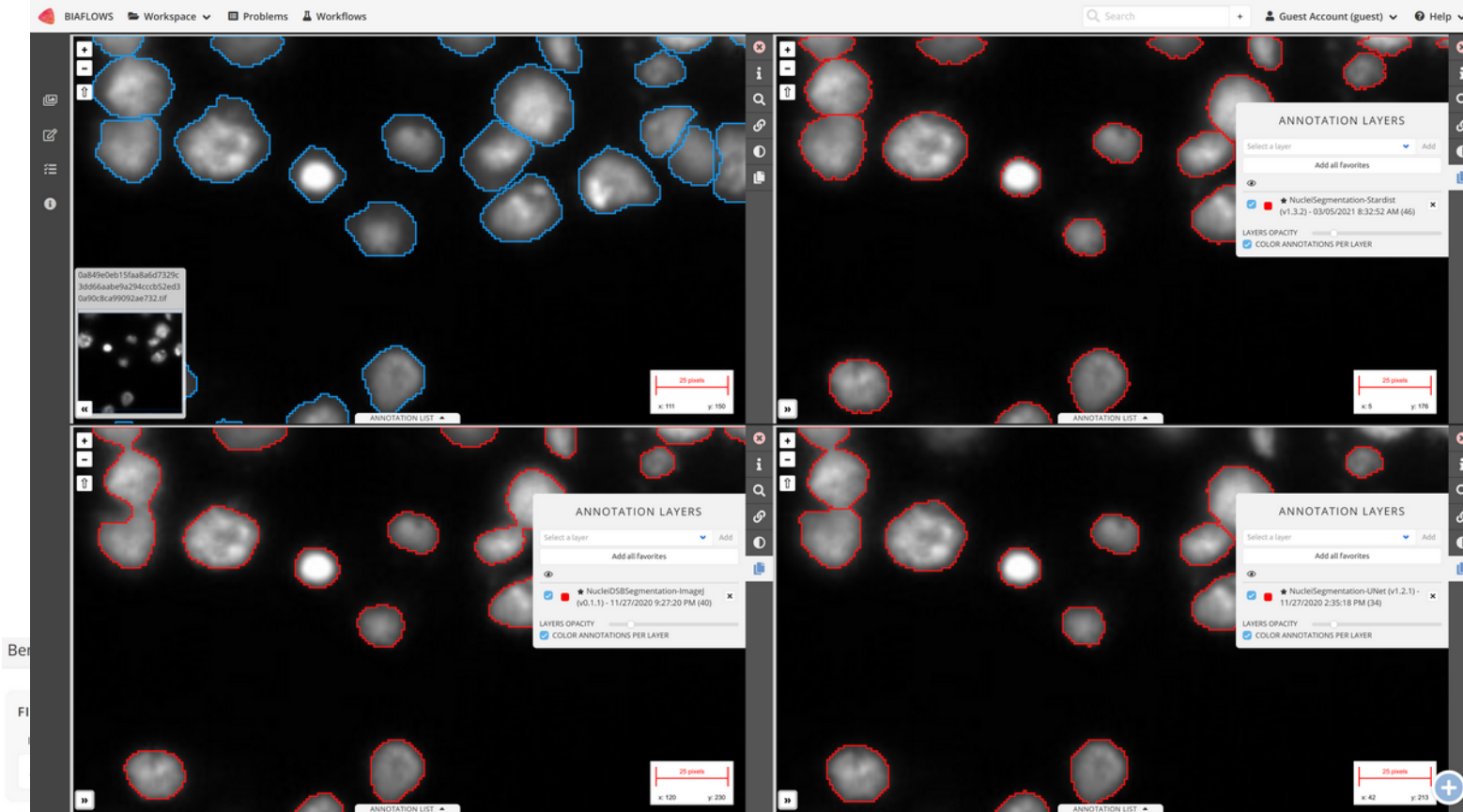
Name	Value
Radius	5
Threshold	-0.5

Cancel Run a workflow



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Aggregated results Detailed results per image

Workflow run	Mean Average Precision [Main metric]	Dice coefficient	Average Hausdorff distance	Fraction Overlap Pred
	AVG	AVG	AVG	AVG
★ NucleiSegmentation-Cellpose (v1.2.2) #1 on Mar 5, 2021 8:08 PM	0.312	0.701	10.545*	0.552
★ NucleiSegmentation-Stardist (v1.3.2) #2 on Mar 5, 2021 8:32 AM	0.397	0.845	1.584	
★ NucleiSegmentation-Ilastik (v1.4.2) #1 on Nov 28, 2020 11:52 AM	0.208	0.725	3.843	
★ NucleiSegmentation-MaskRCNN (v1.5.4) #1 on Nov 28, 2020 11:35 AM	0.394	0.798	2.702	
★ NucleiDSBSegmentation-ImageJ (v0.1.1) #1 on Nov 27, 2020 9:27 PM	0.235	0.734	3.57	
★ NucleiSegmentation-UNet (v1.2.1) #1 on Nov 27, 2020 2:35 PM	0.282	0.754	8.485	

Patterns



Descriptor
BIAFlows: A Collaborative Framework to Reproducibly Deploy and Benchmark Bioimage Analysis Workflows

Ulysse Rubens,^{1,10} Romain Mormont,^{1,10} Lassi Paavolaianen,² Volker Bäcker,³ Benjamin Pavie,⁴ Leandro A. Scholz,⁵ Gino Michiels,⁶ Martin Maska,⁷ Devrim Ünay,⁸ Graeme Ball,⁹ Renaud Hoyoux,¹⁰ Rémy Vandaele,¹¹ Ofra Golani,¹¹ Stefan G. Stanciu,¹² Natasa Sladoje,¹³ Perrine Paul-Gilloteaux,¹⁴ Raphaël Maréchal,¹⁵ and Sébastien Tosi^{14,17,18,*}

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cytomine / S_CellDetect_Stardist_HE_ROI

Code Issues Pull requests Actions Projects Wiki Security Insights

FROM cytomine/software-python3-base:v2.2.0

Dockerfile

```

# -----
# Install Stardist and tensorflow
RUN pip install tensorflow==2.2.0
RUN pip install stardist==0.6.0
RUN mkdir -p /models && \
    cd /models && \
    mkdir -p 2D_versatile_HE
ADD config.json /models/2D_versatile_HE/config.json
ADD thresholds.json /models/2D_versatile_HE/thresholds.json
ADD weights_best.h5 /models/2D_versatile_HE/weights_best.h5
RUN chmod 444 /models/2D_versatile_HE/config.json
RUN chmod 444 /models/2D_versatile_HE/thresholds.json
RUN chmod 444 /models/2D_versatile_HE/weights_best.h5

# -----
# Install scripts
ADD descriptor.json /app/descriptor.json
RUN mkdir -p /app
ADD run.py /app/run.py

ENTRYPOINT ["python3", "/app/run.py"]
    
```

geektortoise integration to cytomine repository

- Dockerfile: integration to cytomine repository (7 months ago)
- LICENSE: Initial commit (11 months ago)
- README.md: Update README.md (11 months ago)
- config.json: CellDetection with Stardist (initial version with models) (11 months ago)
- descriptor.json: integration to cytomine repository (7 months ago)
- run.py: Batch mode to process multiple images (11 months ago)
- screenshot-detections.jpg: better illustrative screenshots (11 months ago)
- screenshot-launch.jpg: better illustrative screenshots (11 months ago)
- screenshot.jpg: Example screenshot (11 months ago)
- thresholds.json: CellDetection with Stardist (initial version with models) (11 months ago)
- weights_best.h5: CellDetection with Stardist (initial version with models) (11 months ago)

README.md

S_CellDetect_Stardist_ROI

Descriptor

```

{
  "id": "stardist_prob_t",
  "value-key": "@ID@",
  "command-line-flag": "--@id@",
  "name": "Stardist Probability Threshold",
  "description": "Probability Threshold in range [0.0, 1.0] - higher values lead to fewer segmented objects, but will likely miss some objects.",
  "default-value": 0.5,
  "set-by-server": false,
  "optional": true,
  "type": "Number"
},
{
  "id": "stardist_nms_t",
  "value-key": "@ID@",
  "command-line-flag": "--@id@",
  "name": "Stardist Non-Maximum Suppression Overlap threshold",
  "description": "Overlap threshold in range [0.0, 1.0] - higher values allow segmented objects to overlap substantially.",
  "default-value": 0.5,
  "set-by-server": false,
  "optional": true,
  "type": "Number"
},
}
    
```

Code (e.g. Python)

```

#Stardist model prediction with thresholds
labels, details = model.predict_instances(img,
                                         prob_thresh=conn.parameters.stardist_prob_t,
                                         nms_thresh=conn.parameters.stardist_nms_t)

print("Number of detected polygons: %d" % len(details['coord']))
cytomine_annotations = AnnotationCollection()
#Go over detections in this ROI, convert and upload to Cytomine
for pos, polygroup in enumerate(details['coord'], start=1):
    #Converting to Shapely annotation
    points = list()
    for i in range(len(polygroup[0])):
        #Cytomine cartesian coordinate system, (0,0) is bottom left corner
        #Mapping Stardist polygon detection coordinates to Cytomine ROI in whole slide image
        p = Point(minx+polygroup[1][i], miny-polygroup[0][i])
        points.append(p)

    annotation = Polygon(points)
    #Append to Annotation collection
    cytomine_annotations.append(Annotation(location=annotation.wkt,
                                          id_image=id_image, #conn.parameters.cytomine_id_image,
                                          id_project=conn.parameters.cytomine_id_project))
    
```

	AVG	AVG	AVG	AVG
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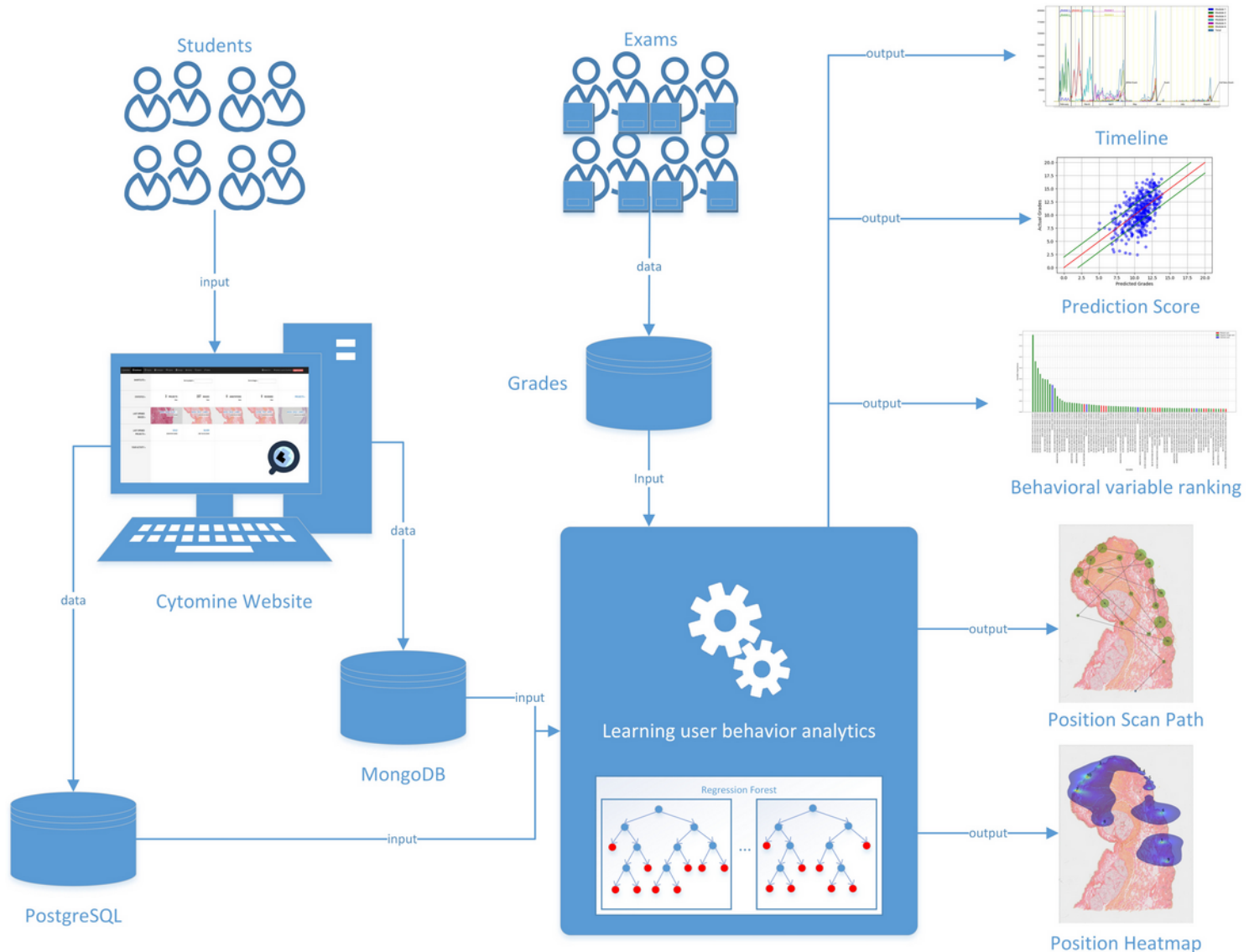
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CellPress OPEN ACCESS

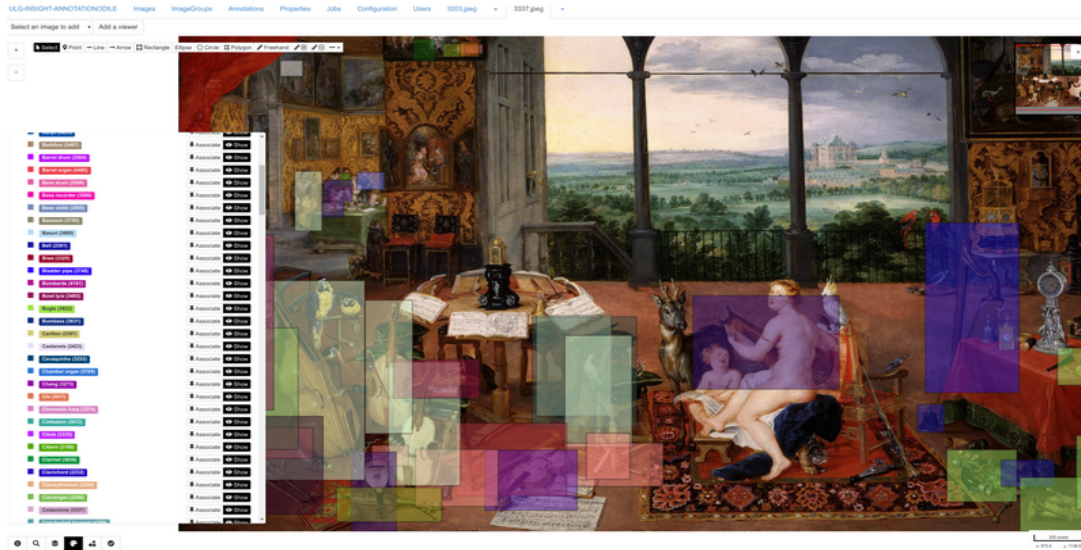
Open-source impact

Eases collaboration, adoption and replication by other researchers, and extension to other application domains (beyond initial scope, by others)

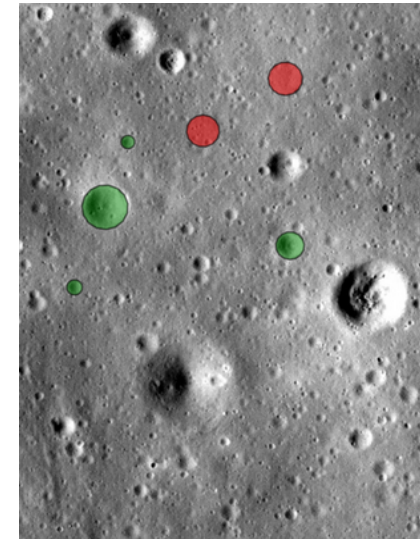


Open-source impact

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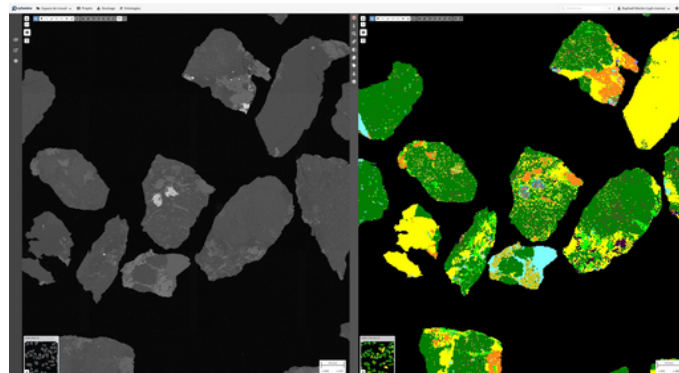
(Sabatelli et al., DHQ 2021)



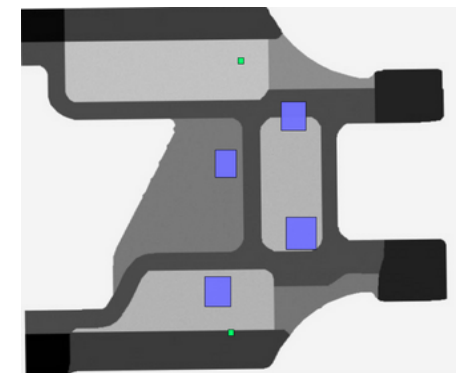
(Q. Glaude, Master Thesis 2017)



(SpaceBel, X. Song, Master Thesis 2019)



(Mineralogy/geology, E. Pirard & H. Bouzahzah)



(X-Ris, ADRIC project)

Open-source + open data (FAIR)

IMI2

18th Call for proposals



Topic 1: Central repository of digital pathology slides to support the development of artificial intelligence tools

- developed open-source, cross-platform software tools to:
 - upload, search and access slides and associated metadata;
 - visualise and annotate the slides;
 - download slide for data mining and model development.



BigPicture project (2021-2027) : building the largest european GDPR-compliant open-access repository of digital pathology slides (clinical & non-clinical) to support the development of artificial intelligence tools
(incl. hardware, software, legal, and ethical issues)

Open-source & valorization

- Permissive open-source licence eases scientific collaboration with researchers and companies
 - Researchers' international mobility and entrepreneurial activities
 - Commercial proprietary / non-proprietary releases
 - *Cytomine SCES* (<https://doc.cytomine.org>) [2017,...]
 - Open-source « Community edition » code maintenance, documentation, and community management
 - *Cytomine corporation* (<https://cytomine.com>) [2021, ...]
 - Services and development of software modules on top of the open-source software for diverse clients :



Other thoughts

- Cytomine might be useful @ ULiège level to share imaging data ?
 - Who ? How ? Image viewer for Dataverse & Oliver ?
- How to improve open-source practice & impact @ ULiège ?
 - Need for permanent research software engineers ?
- Share/mutualize open-source best practices ?
 - Code hosting, documentation
 - Attract contributors, organize hackathons & mini-conference, manage community,...
 - Target specific funding for open source software development & maintenance (NLNet Foundation,...)
 - → Jérémie Fays « Open Source academy » !

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Comulis & Neubias network : Florian Gruber, Martina Marchetti-Deschmann, Samuele Zoratto, Christopher Kremslehner, Rafael Camacho, Julia Fernandez-Rodriguez, Andreas Walter, Sebastian Munck, Natasa Sladoje, Sebastien Tosi, Benjamin Pavie, Volker Backer, Lassi Paavolainen, ... [comulis.eu & Neubias.org]

Shareish : Adrien Guilliams, Ulysse Rubens, Florent Banneux, Pierre Chapeau

Cytomine funding sources since 2010 :

