The AI we are developing

David Anglada Rotger

Image Processing Group (**GPI**)
Intelligent Data Science and Artificial Intelligence Research Center (**IDEAI**)
Universitat Politècnica de Catalunya (**UPC BarcelonaTECH**)

david.anglada@upc.edu

Structure of the presentation

1. **The research team**
2. **The project objective**
3. **The AI we are developing**
    3.1. Segmentation and classification over HER2, RE, RP, KI67
    3.2. Stroma detection over HER2, RE, RP, KI67
    3.3. Color normalization in HER2
4. **The expert in the loop**
5. **Conclusions**

Research group

GPI – Image Processing Group
Signal theory and communications Department
Universitat Politècnica de Catalunya. BARCELONATECH

- 10 Faculty Members
- 12 PhD Students
- https://imatge.upc.edu

IDEAI - Intelligent Data Science and Artificial Intelligence

- Center funded in 2017
- 7 Research Groups
- 67 Researchers
- https://ideai.upc.edu

Image Processing Group: DigiPatICS

Staff

- Josep Ramon Casas
- Ferran Marqués
- Montse Pardàs
- Philippe Salembier
- Verónica Vilaplana

Contracted

- Sonia Rabanaque
- David Anglada

Image Processing Group: DigiPatICS

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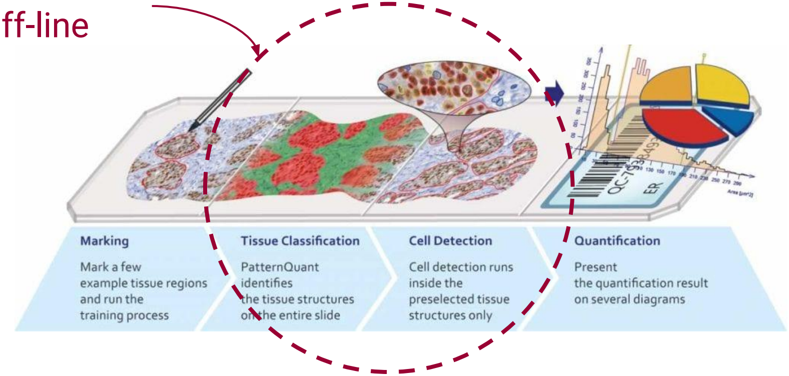
DigiPatICS: The project objective

Proposed paradigm

- **Off-line inference**
  - Automatically selecting the areas to be analyzed
  - Parameter computation inside given areas
  - Proposals to help pathologists
- **On-line pathologist's interaction**
  - Selecting the area(s) to be analyzed
- **On-line inference**
  - Pre-computed parameter computation
- **On-line pathologist's adjustment**
  - Use of sliders for classification refinement
- **On-line quantization**
  - Data computation and visualization

On **larger areas** and **off-line**



Marking

Mark a few example tissue regions and run the training process

Tissue Classification

PatternQuant identifies the tissue structures on the entire slide

Cell Detection

Cell detection runs inside the preselected tissue structures only

Quantification

Present the quantification result on several diagrams

https://www.3dhistech.com/research/quantcenter/

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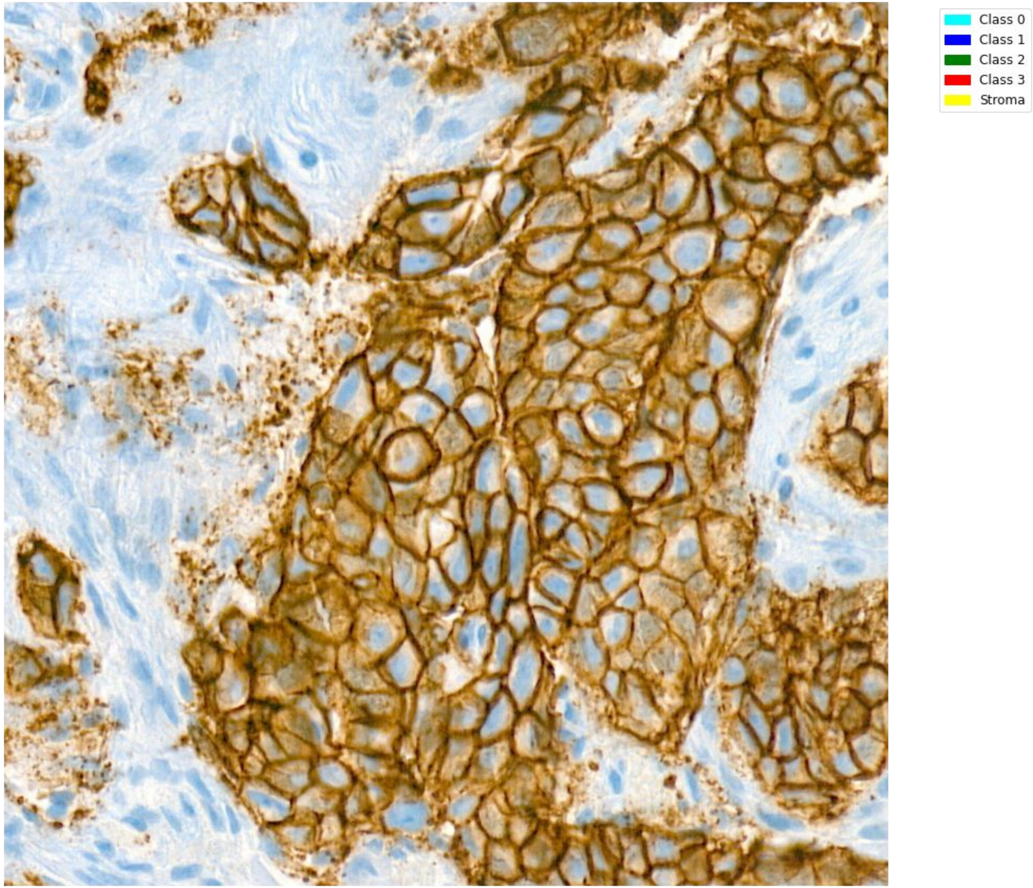
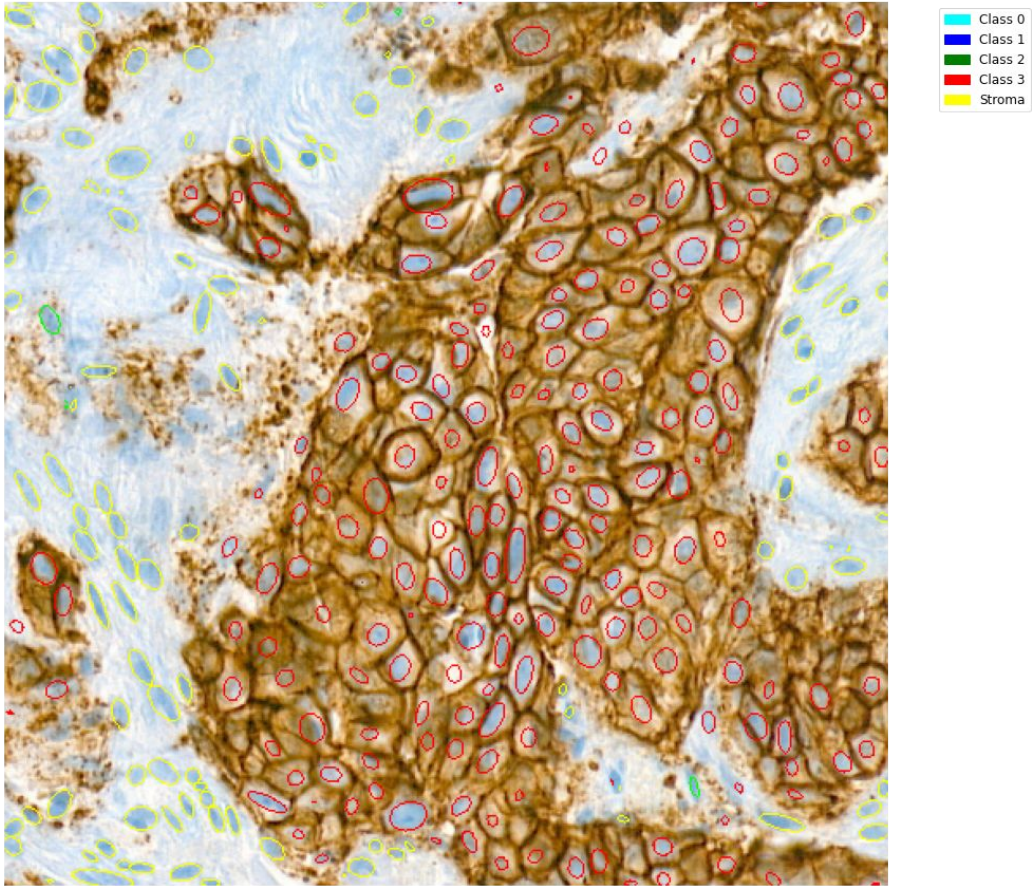
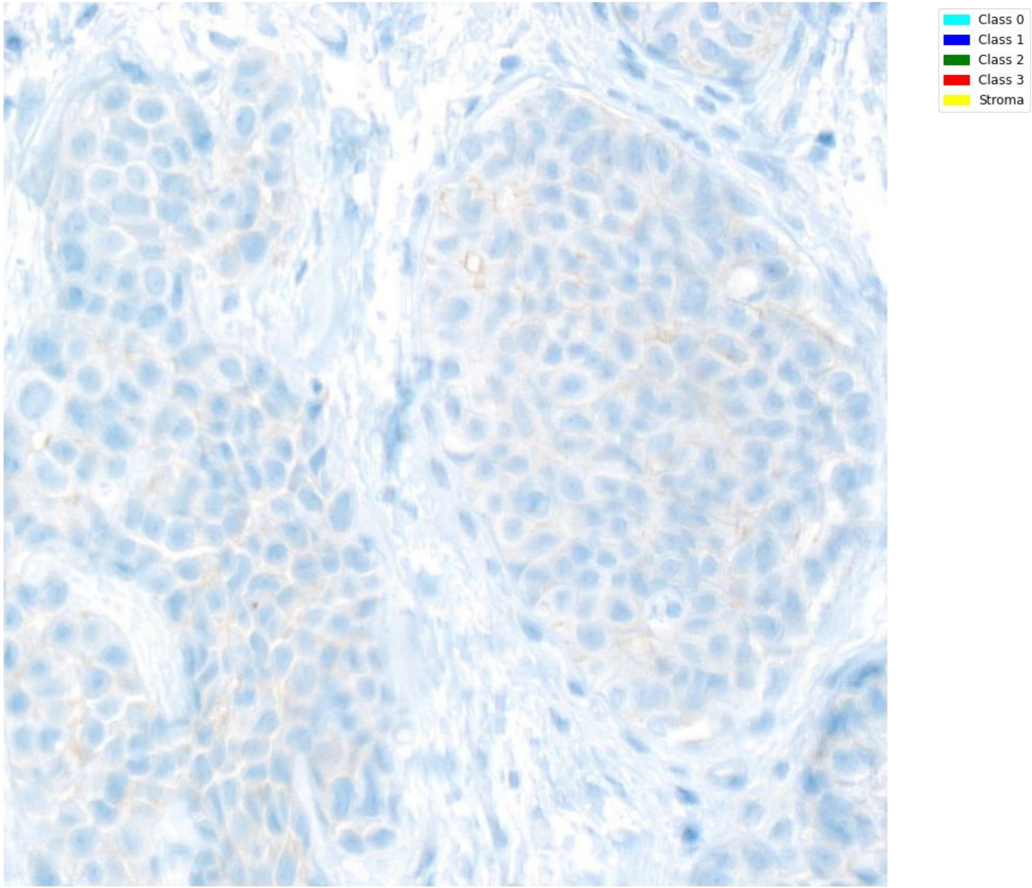
Segmentation and Classification algorithm


🟦 Class 0
🟦 Class 1
🟩 Class 2
🟥 Class 3
🟨 Stroma

Segmentation and Classification algorithm


Class 0
Class 1
Class 2
Class 3
Stroma

Segmentation and Classification algorithm


🟦 Class 0
🟦 Class 1
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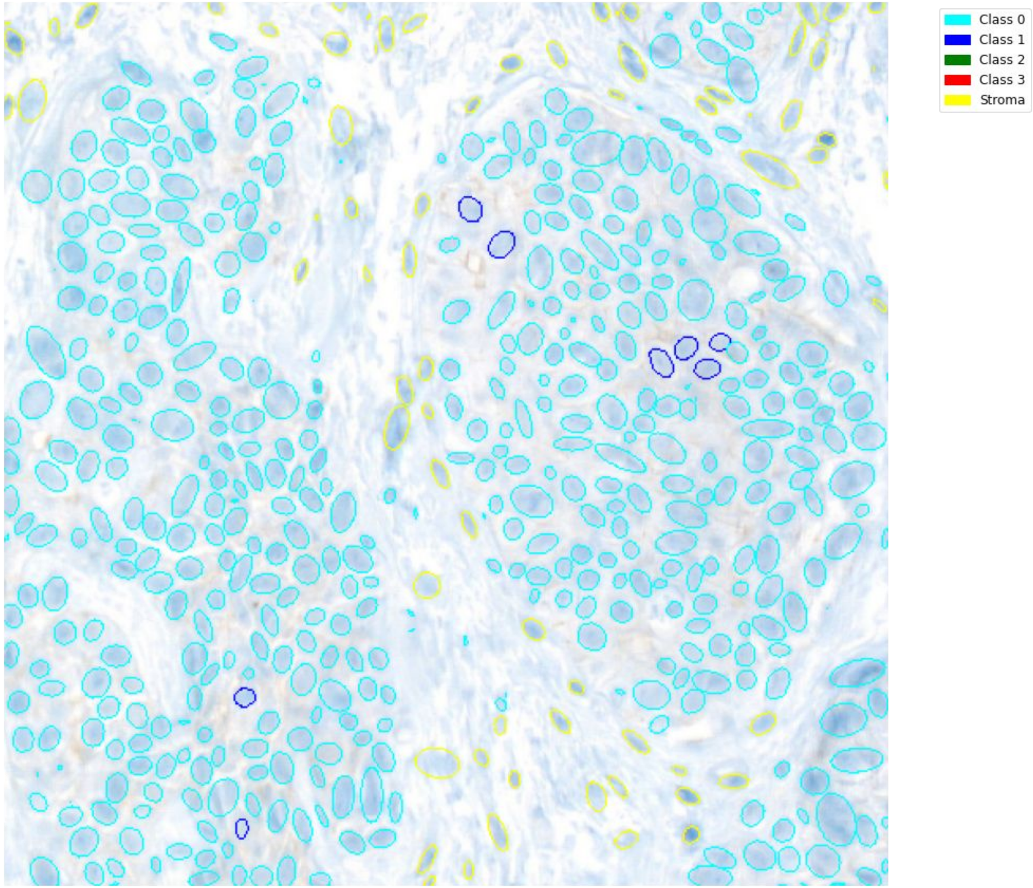
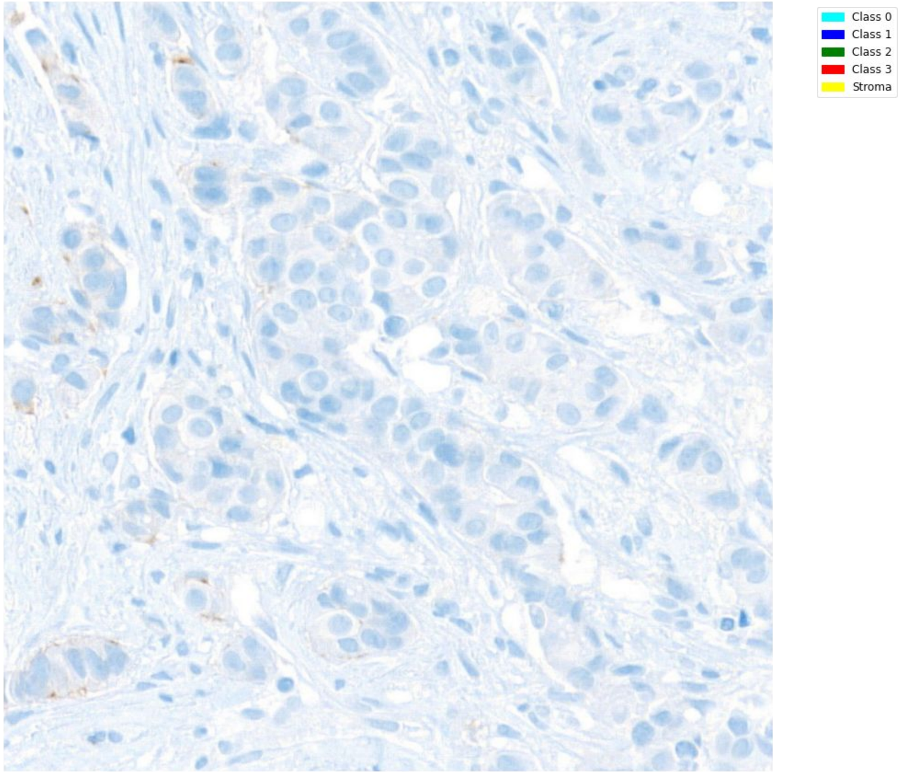
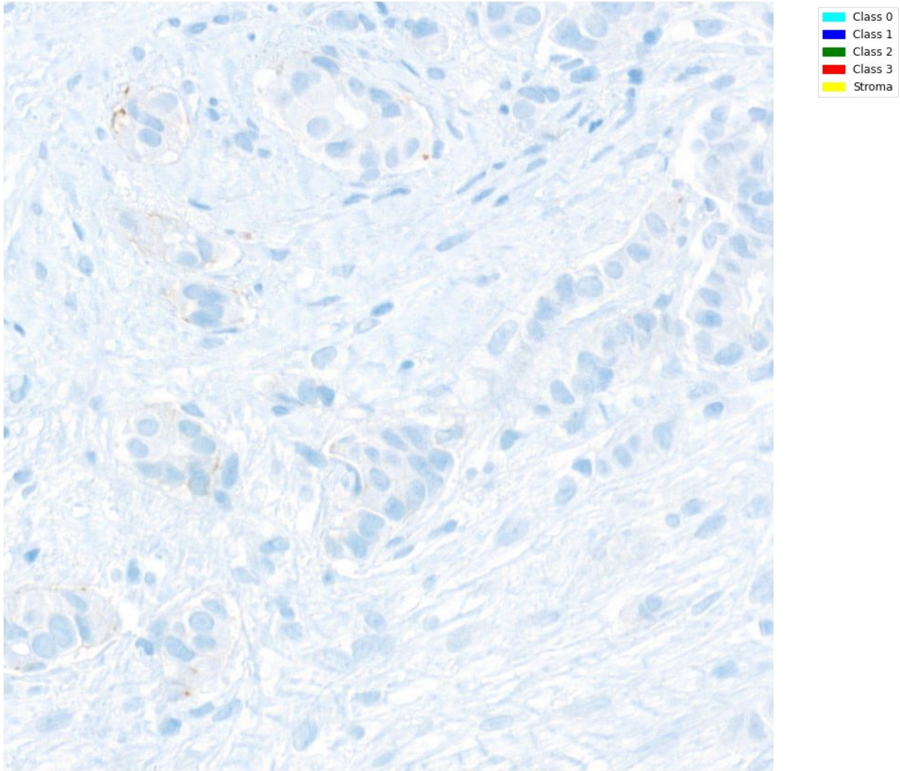
Segmentation and Classification algorithm

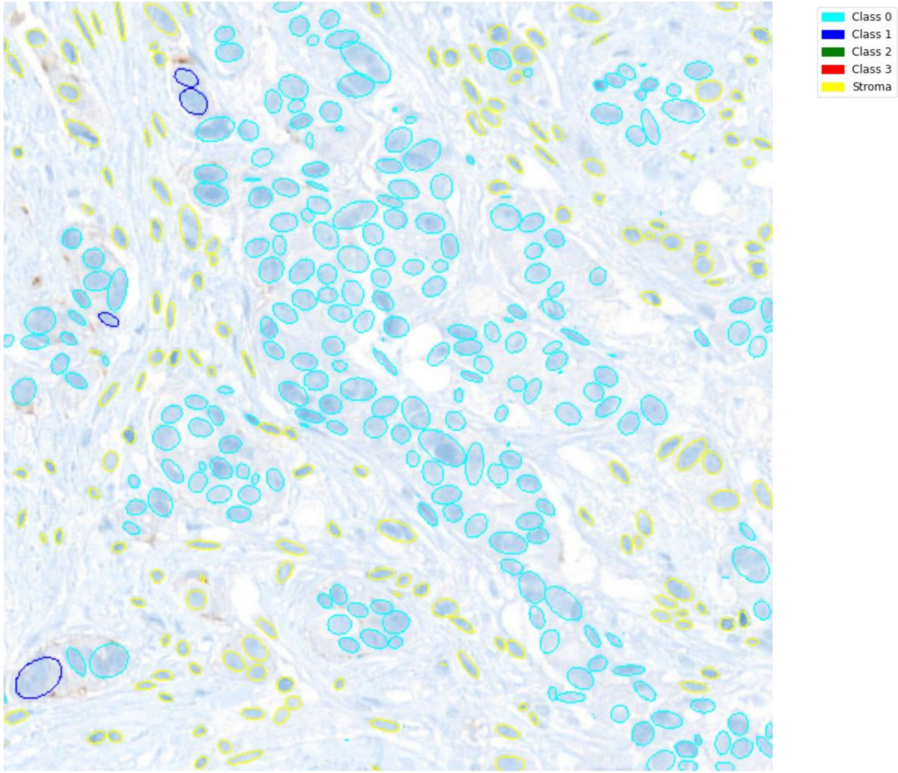

Class 0
Class 1
Class 2
Class 3
Stroma

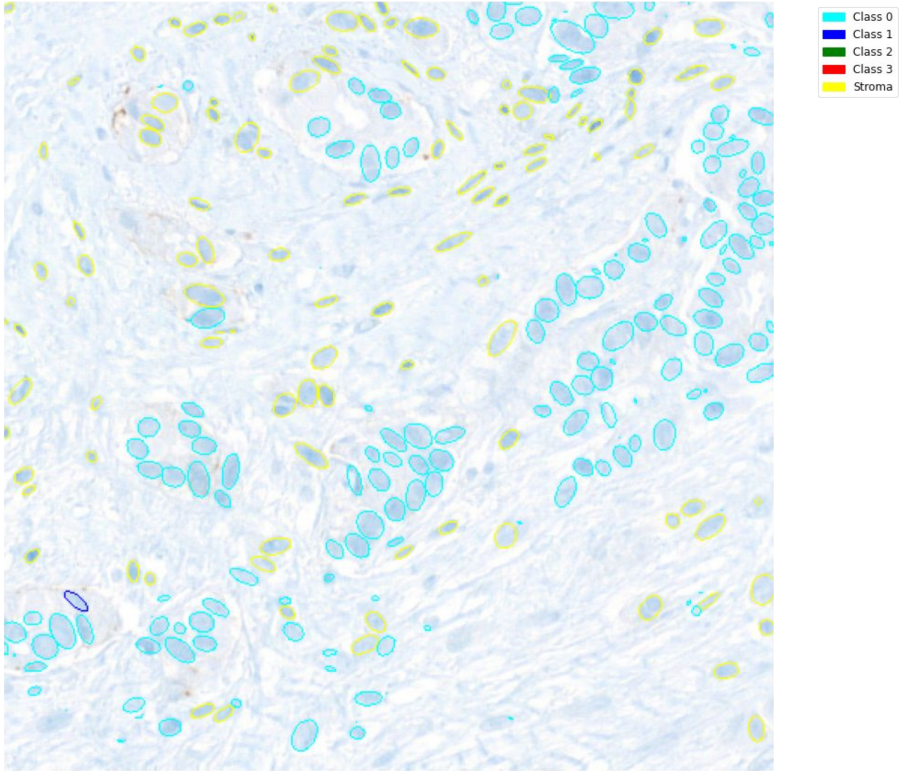
Stroma Detection


Class 0
Class 1
Class 2
Class 3
Stroma


Class 0
Class 1
Class 2
Class 3
Stroma

Stroma Detection


Class 0
Class 1
Class 2
Class 3
Stroma


Class 0
Class 1
Class 2
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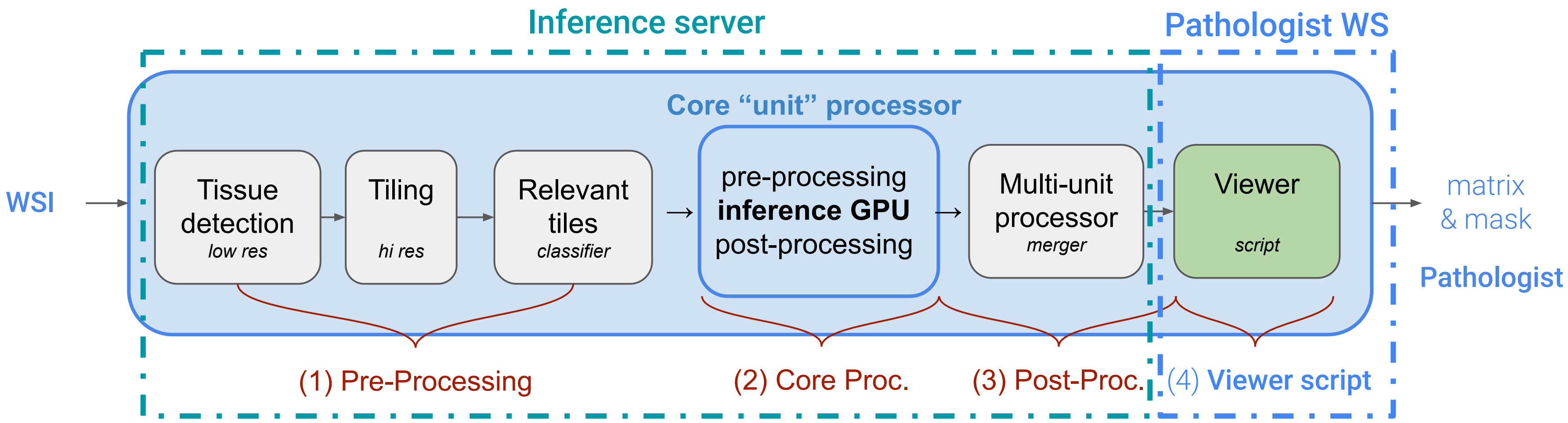
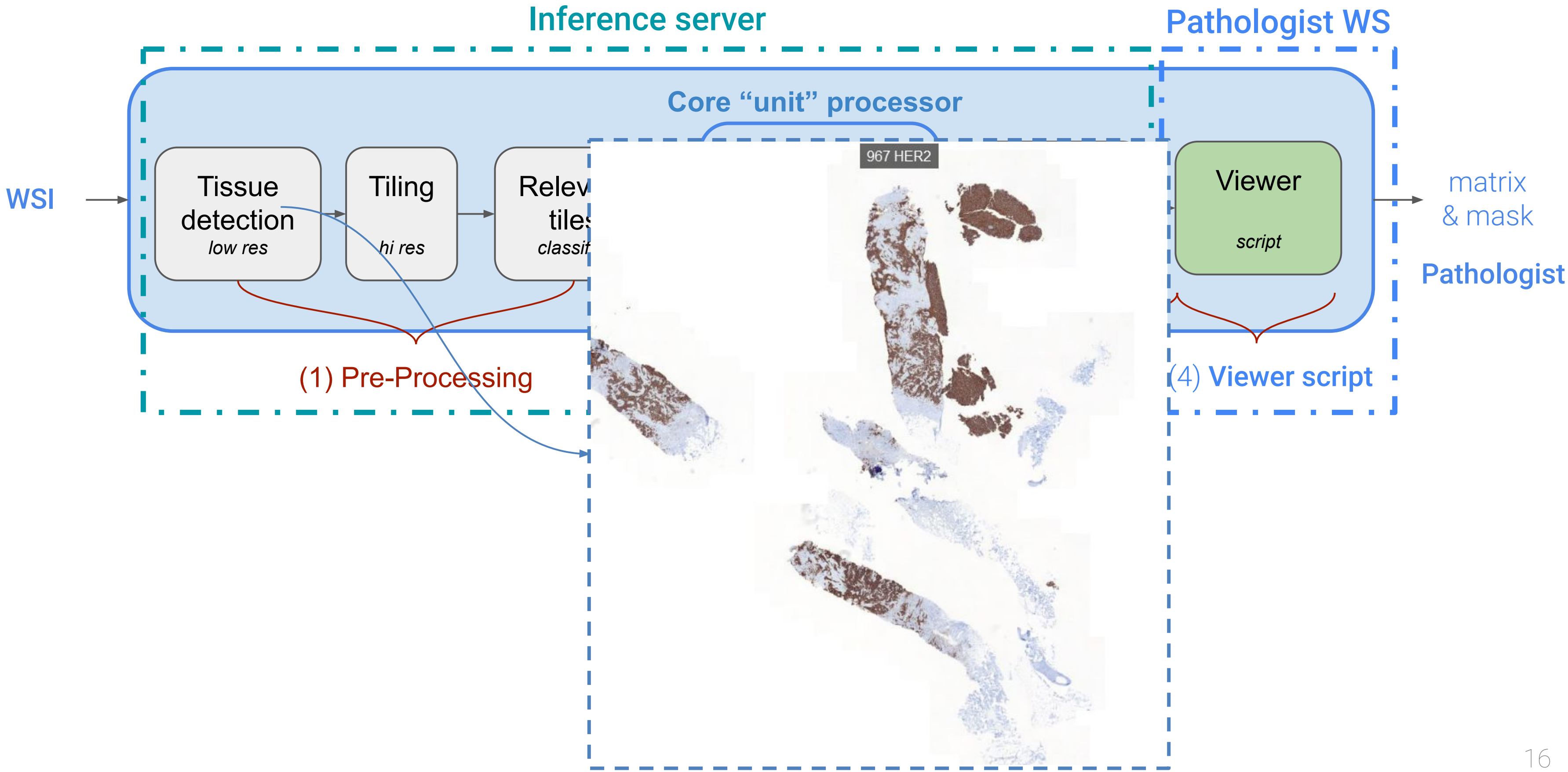
Segmentation and Classification algorithm



Inference server
Pathologist WS
Core "unit" processor
WSI
Tissue detection
low res
Tiling
hi res
Relevant tiles
classifier
pre-processing
inference GPU
post-processing
Multi-unit processor
merger
Viewer
script
matrix & mask
Pathologist
(1) Pre-Processing
(2) Core Proc.
(3) Post-Proc.
(4) Viewer script

Segmentation and Classification algorithm



Inference server

Pathologist WS

Core “unit” processor

WSI

Tissue detection *low res*

Tiling *hi res*

Relev tiles *classif*

Viewer *script*

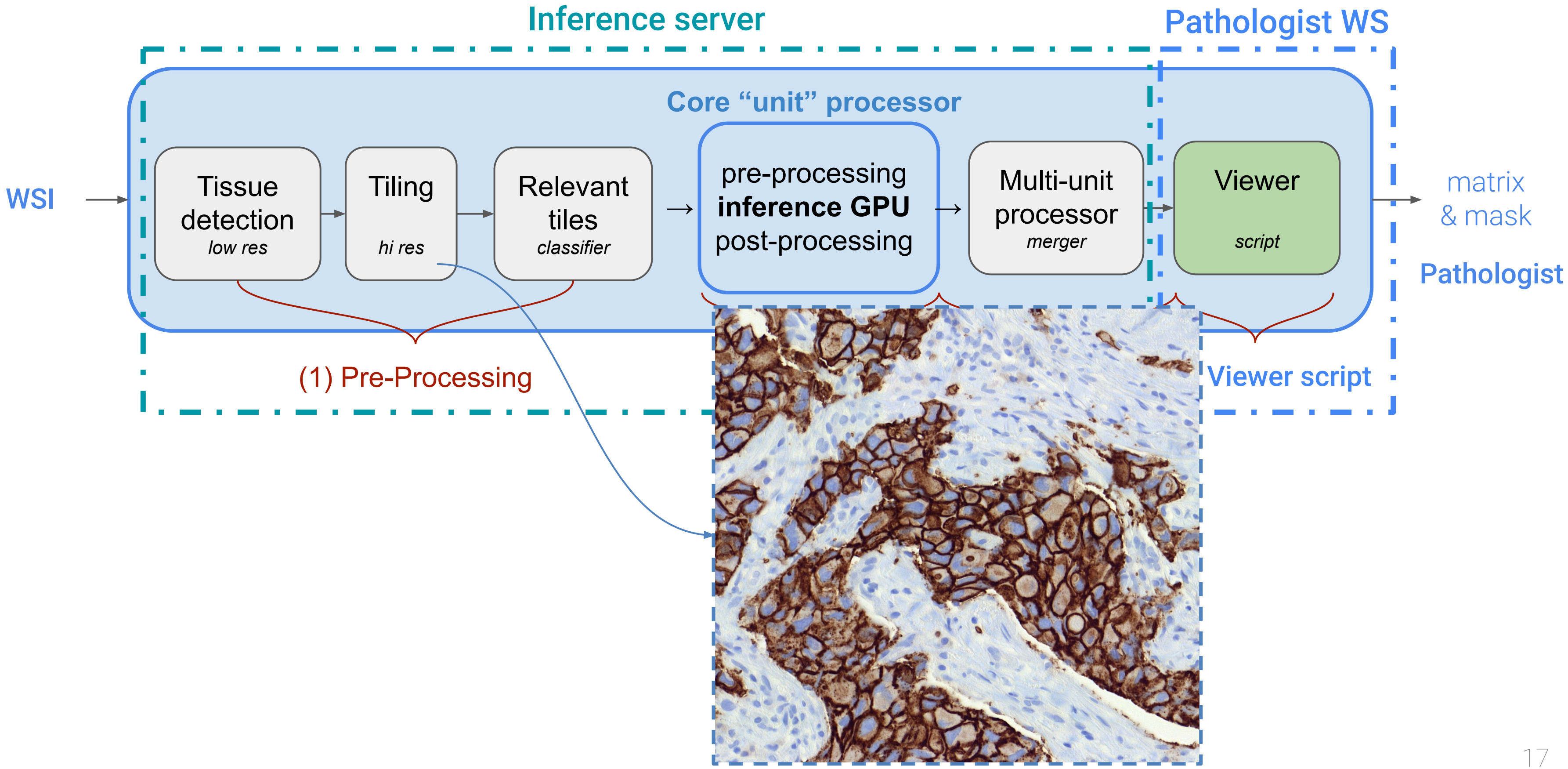
matrix & mask

Pathologist

(1) Pre-Processing

(4) Viewer script

Segmentation and Classification algorithm



Inference server

Pathologist WS

Core “unit” processor

WSI

Tissue detection
low res

Tiling
hi res

Relevant tiles
classifier

pre-processing
inference GPU
post-processing

Multi-unit processor
merger

Viewer
script

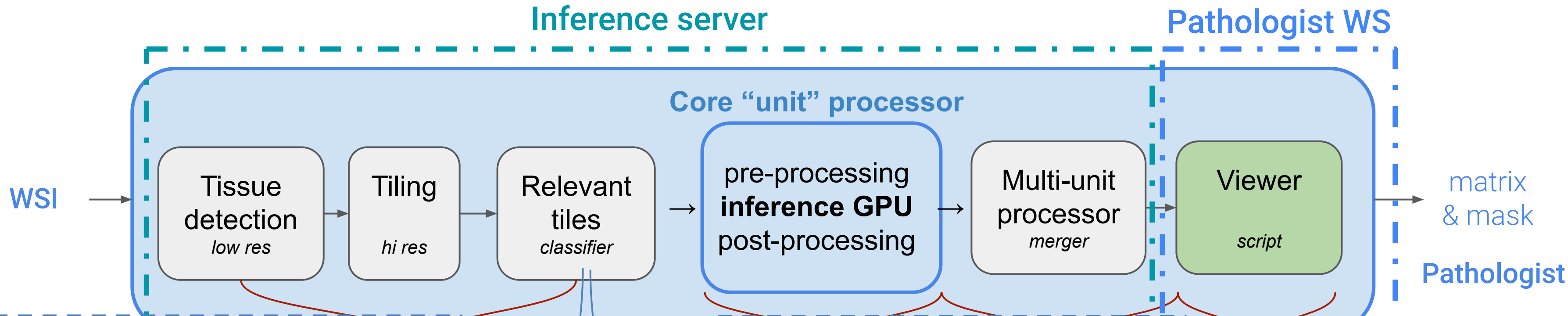
matrix
& mask

Pathologist

(1) Pre-Processing

Viewer script

Segmentation and Classification algorithm



Inference server

Pathologist WS

Core “unit” processor

WSI

Tissue detection
low res

Tiling
hi res

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Multi-unit processor
merger

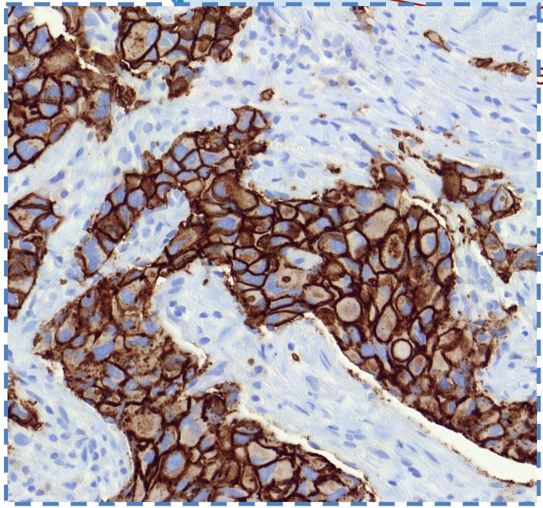
Viewer
script

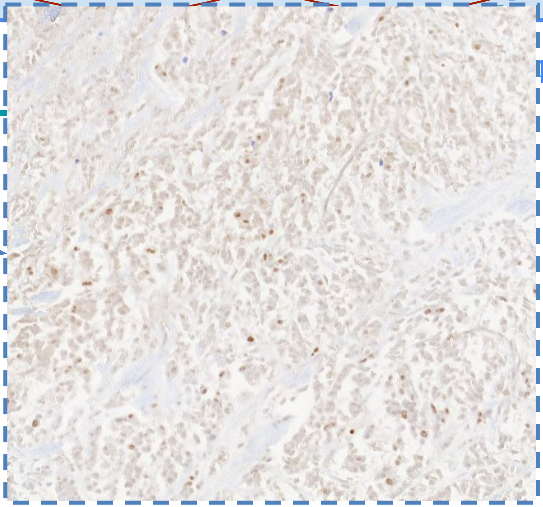
matrix
& mask

Pathologist

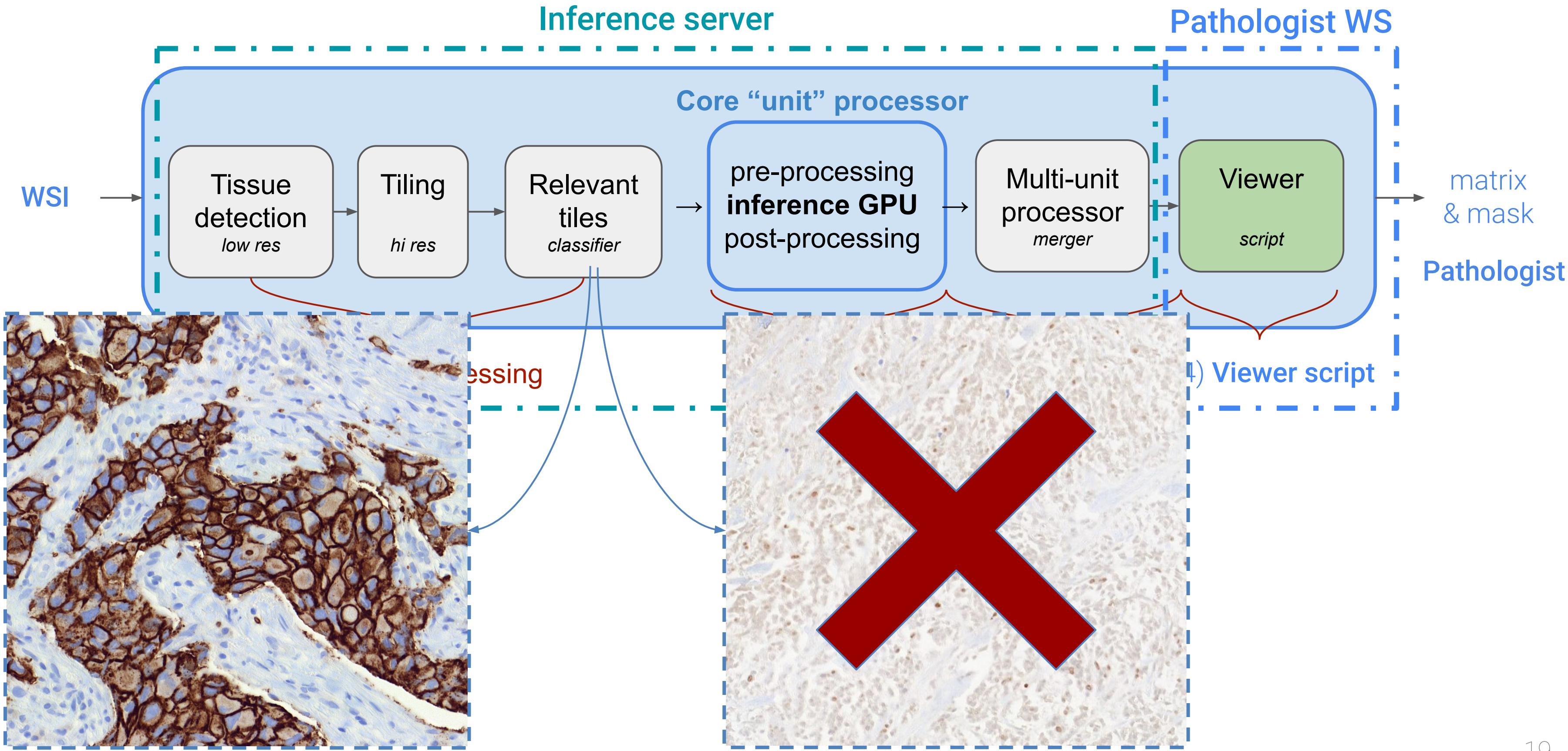
essing

4) Viewer script





Segmentation and Classification algorithm



Inference server

Pathologist WS

Core “unit” processor

WSI →

Tissue detection *low res* → Tiling *hi res* → Relevant tiles *classifier* → pre-processing **inference GPU** post-processing → Multi-unit processor *merger* → Viewer *script* →

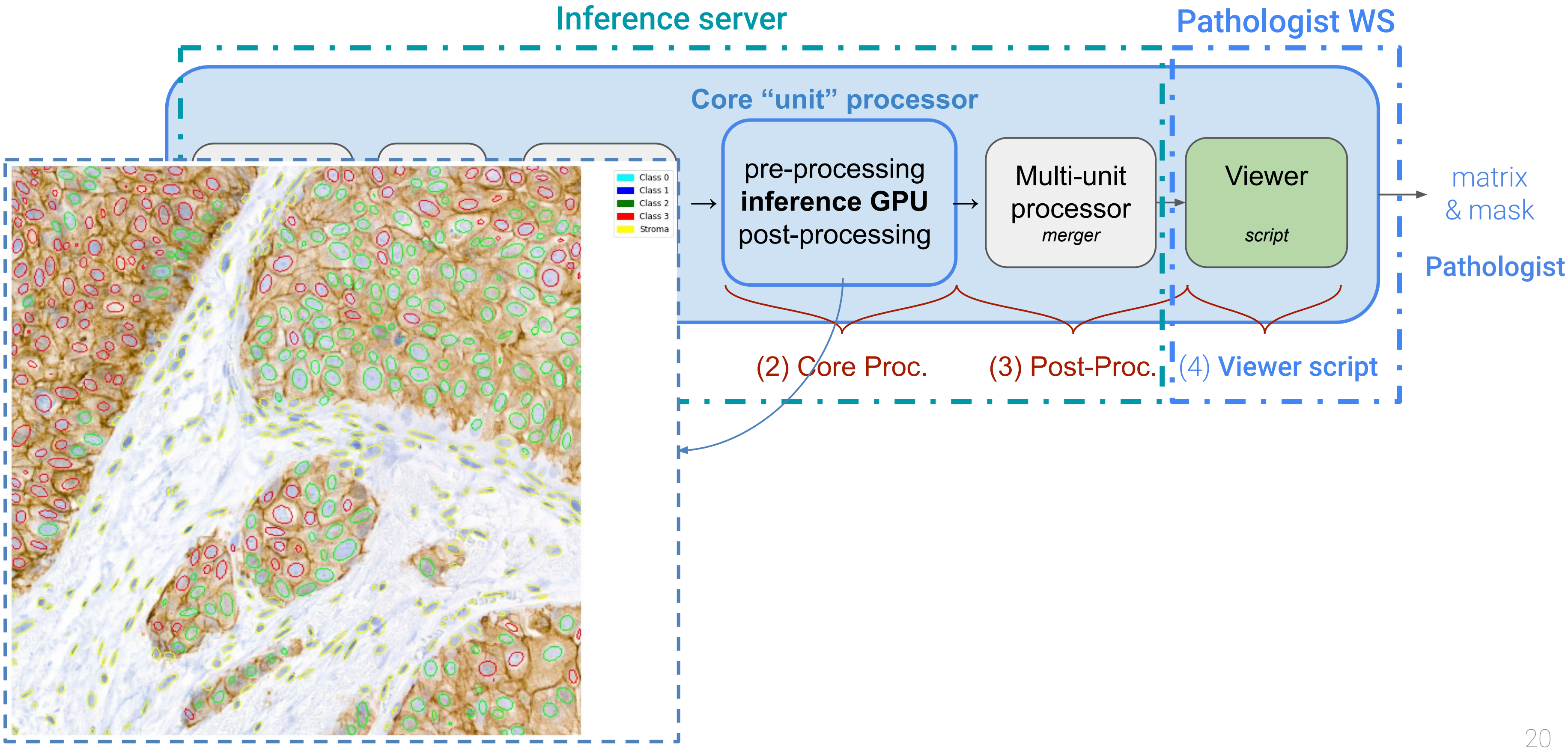
matrix & mask

Pathologist

essing

) Viewer script

Segmentation and Classification algorithm



Inference server

Pathologist WS

Core “unit” processor

pre-processing
inference GPU
post-processing

Multi-unit processor
merger

Viewer
script

matrix
& mask

Pathologist

(2) Core Proc.

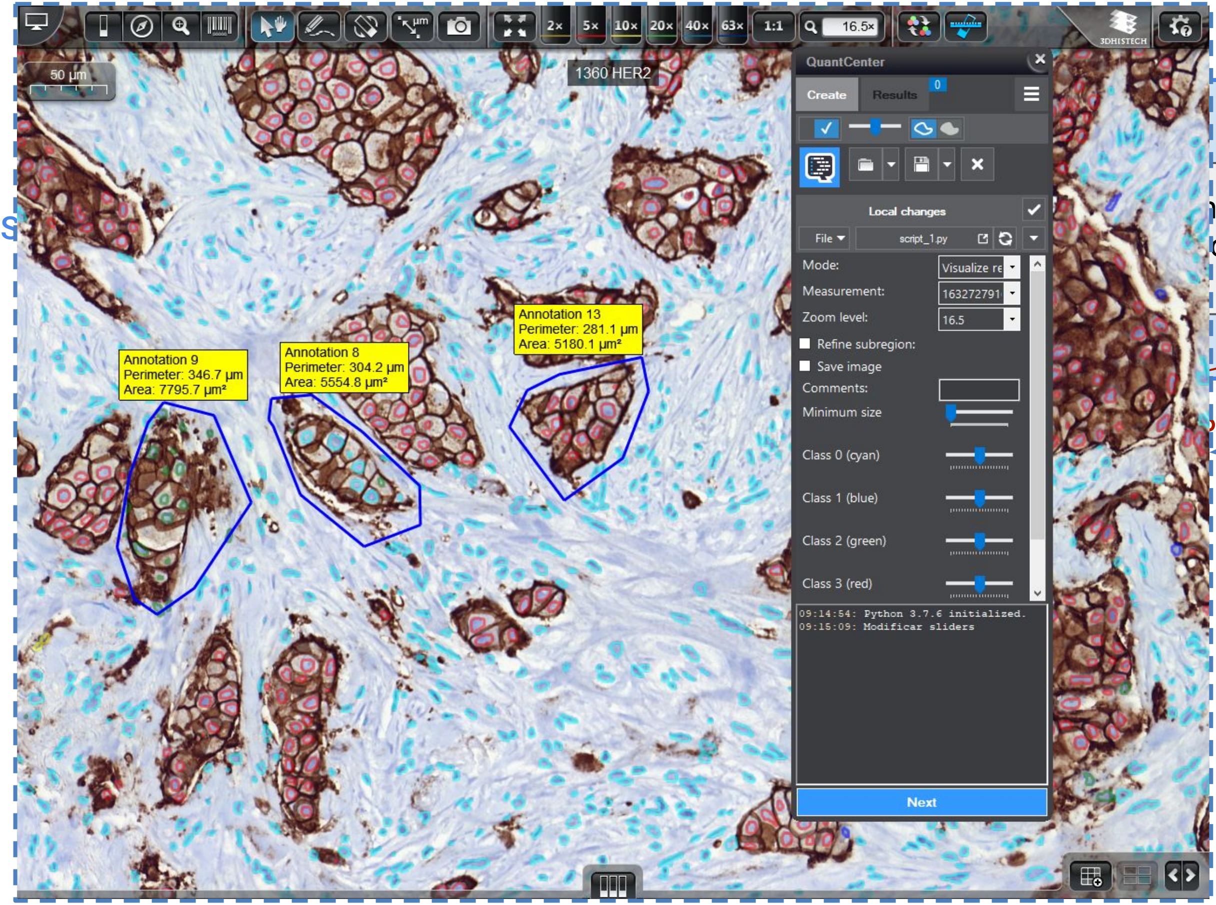
(3) Post-Proc.

(4) **Viewer script**

🟦 Class 0
🟦 Class 1
🟩 Class 2
🟥 Class 3
🟨 Stroma

Segmentation and Classification algorithm

WS


50 µm
1360 HER2
2×
5×
10×
20×
40×
63×
1:1
16.5×
3DHISTECH
QuantCenter
Create
Results
0
Local changes
File
script_1.py
Next

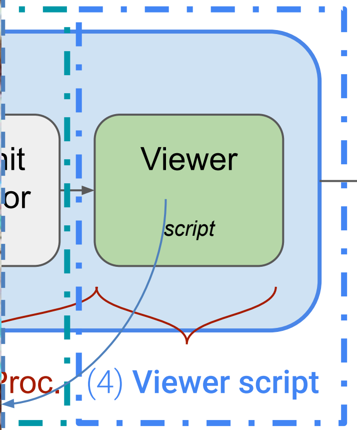
Annotation 9
Perimeter: 346.7 µm
Area: 7795.7 µm²

Annotation 8
Perimeter: 304.2 µm
Area: 5554.8 µm²

Annotation 13
Perimeter: 281.1 µm
Area: 5180.1 µm²

Mode: Visualize re
Measurement: 163272791
Zoom level: 16.5
☐ Refine subregion:
☐ Save image
Comments:
Minimum size
Class 0 (cyan)
Class 1 (blue)
Class 2 (green)
Class 3 (red)

```
09:14:54: Python 3.7.6 initialized.
09:15:09: Modificar sliders
```

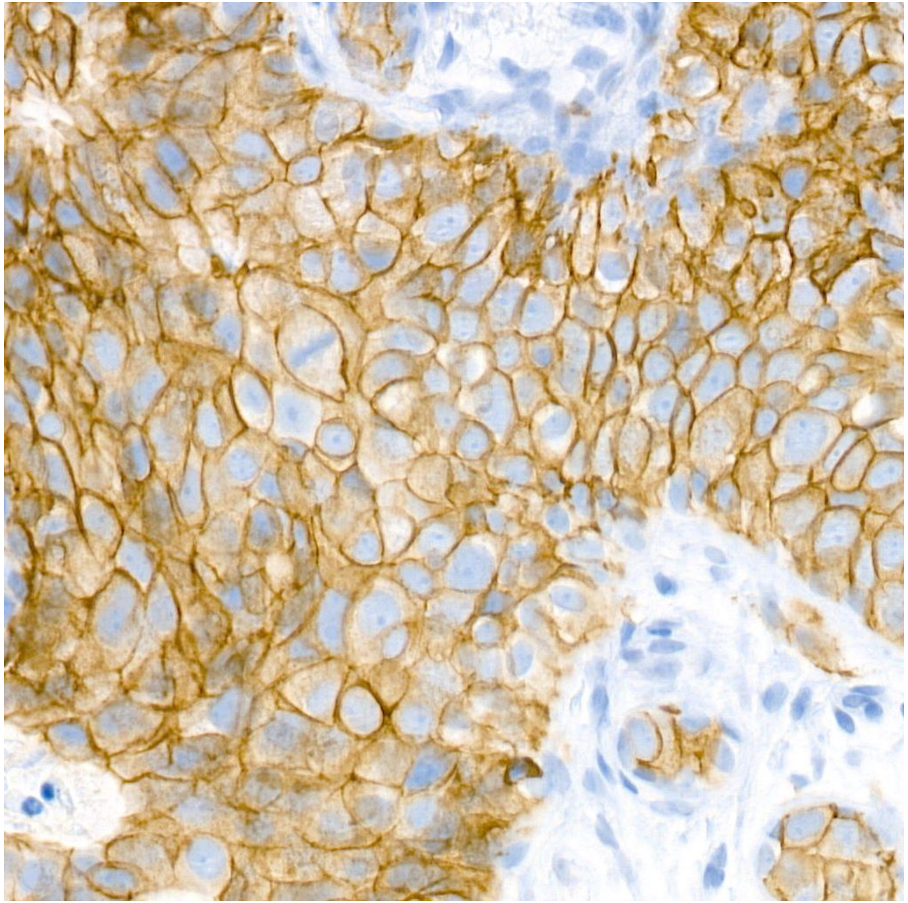

it
or
Viewer
script
roc.
(4) Viewer script

Pathologist WS

matrix
& mask

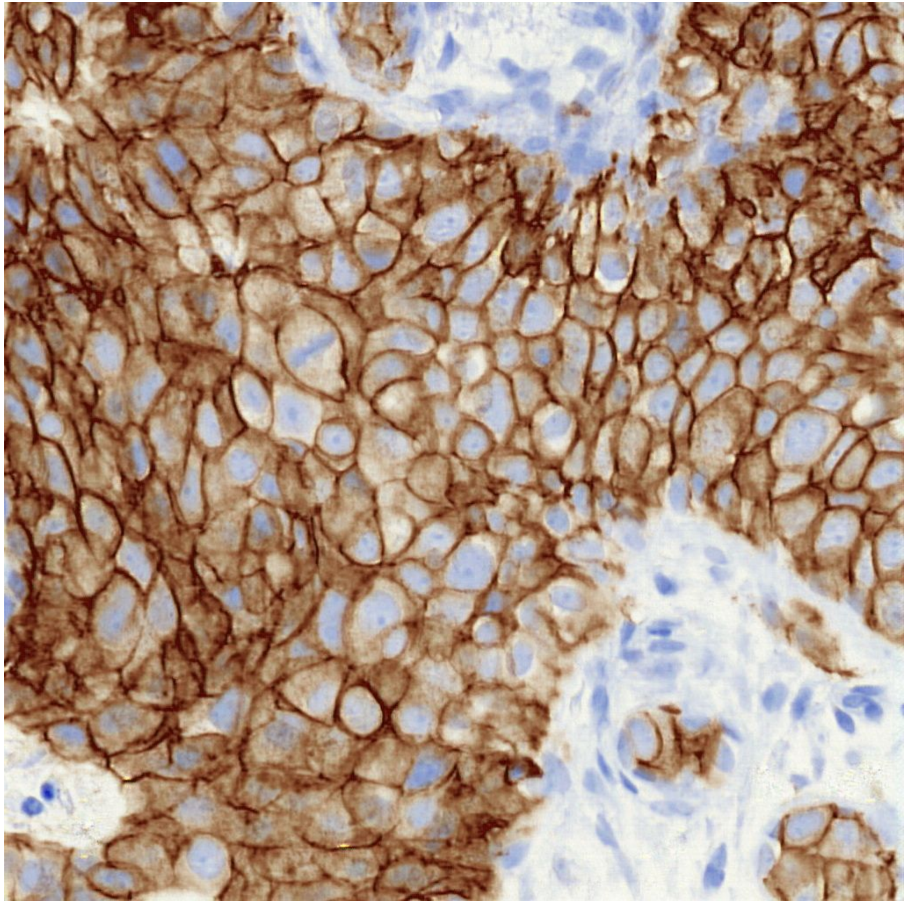
Pathologist

Color Normalization



HER2 tile

Color Normalization



Fake HER2 tile

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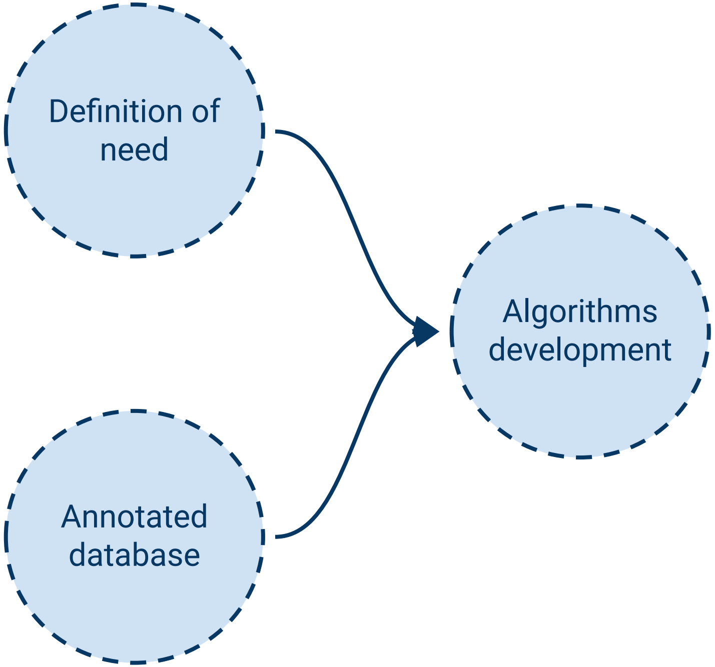
5. **Conclusions**

The expert in the loop

Definition of need

Annotated database

The expert in the loop

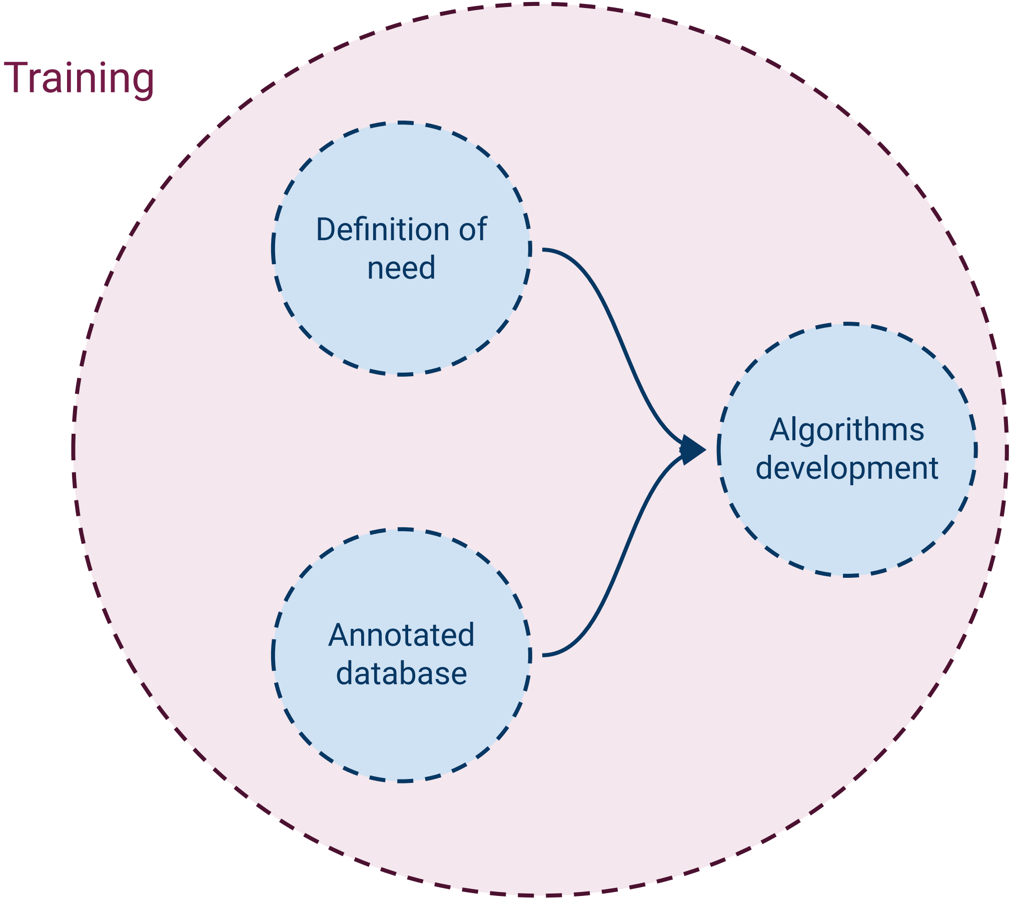


Definition of need

Annotated database

Algorithms development

The expert in the loop



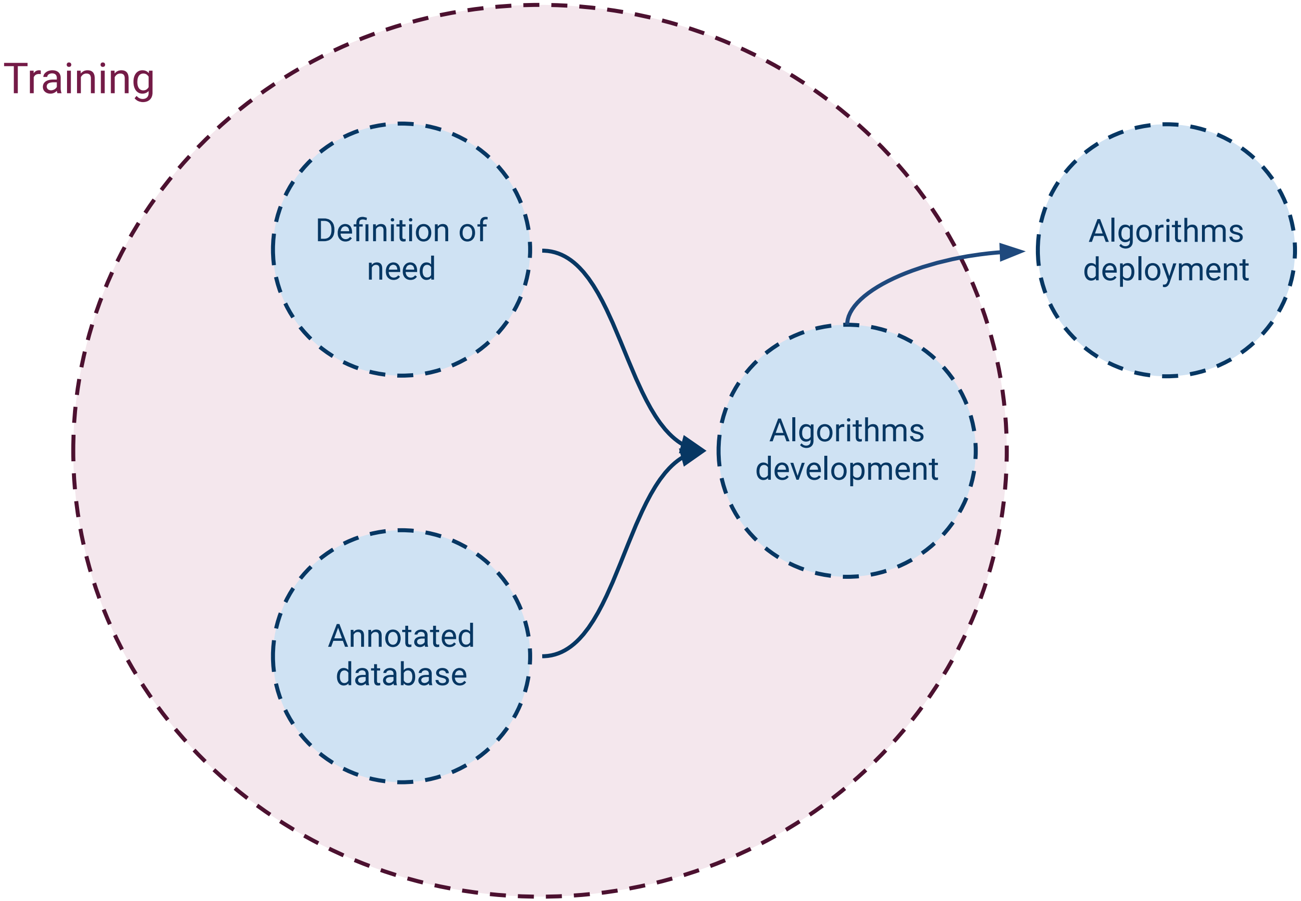
Training

Definition of need

Annotated database

Algorithms development

The expert in the loop



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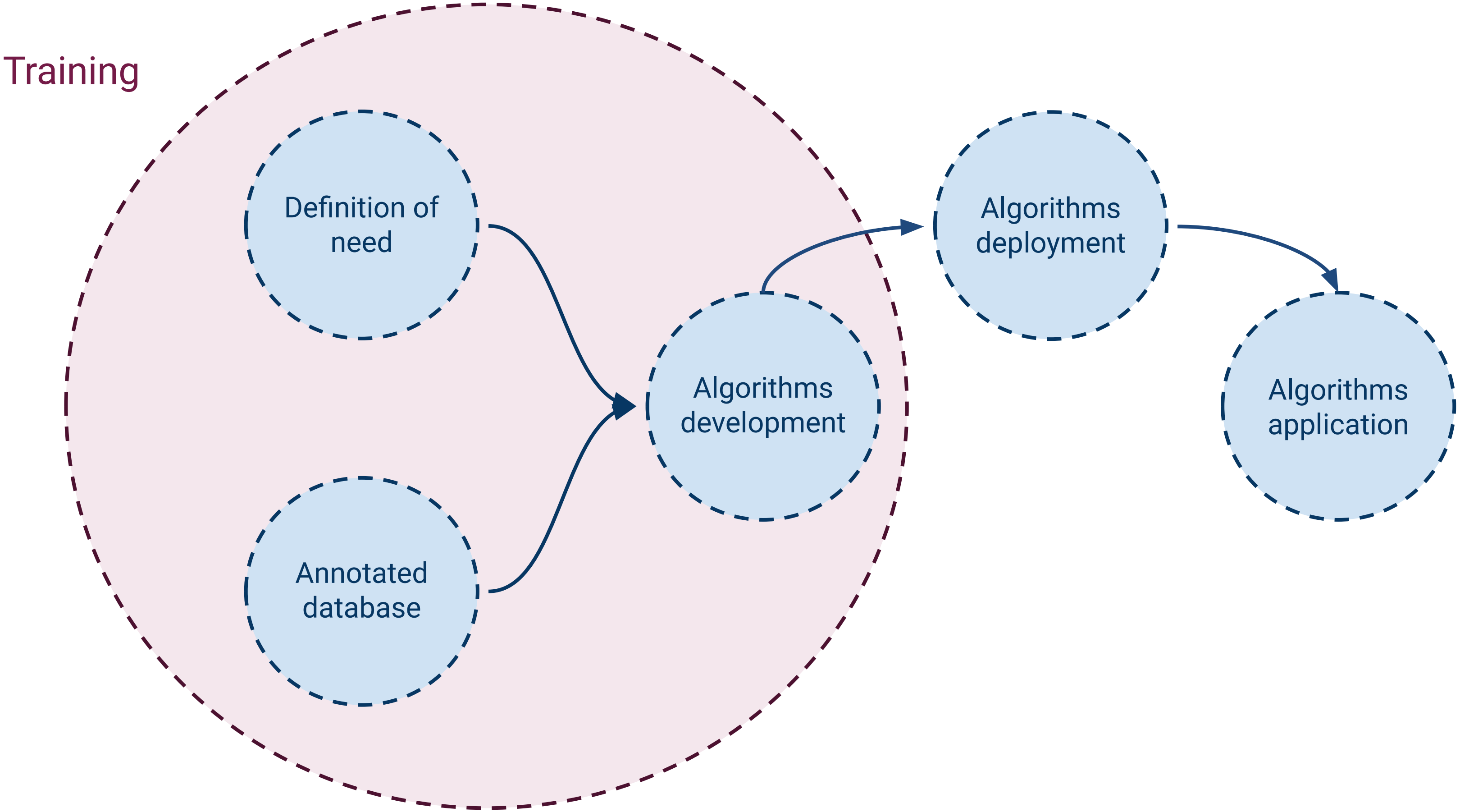
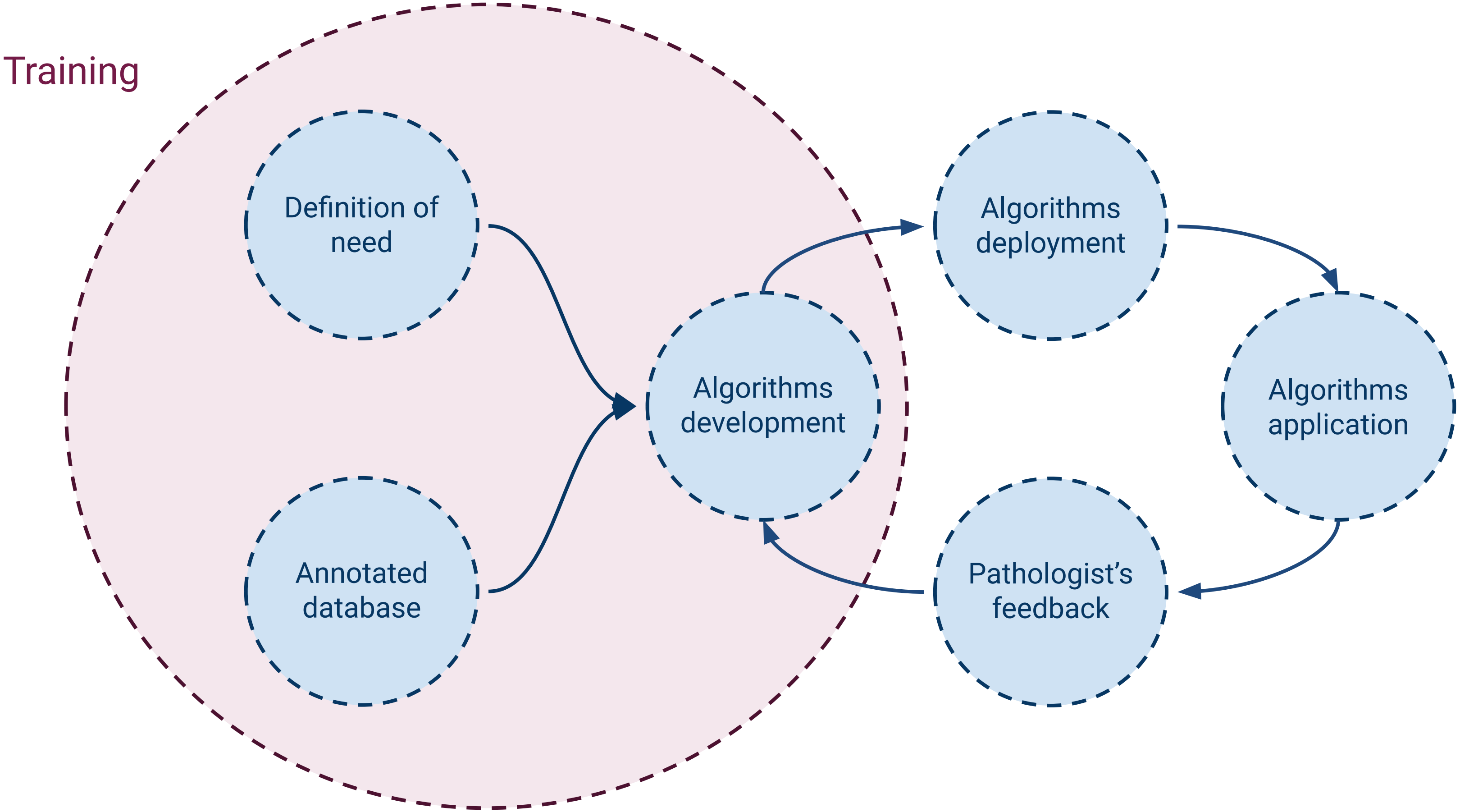
Algorithms deployment

The expert in the loop


Training
Definition of need
Annotated database
Algorithms development
Algorithms deployment
Algorithms application

The expert in the loop



Training

Definition of need

Annotated database

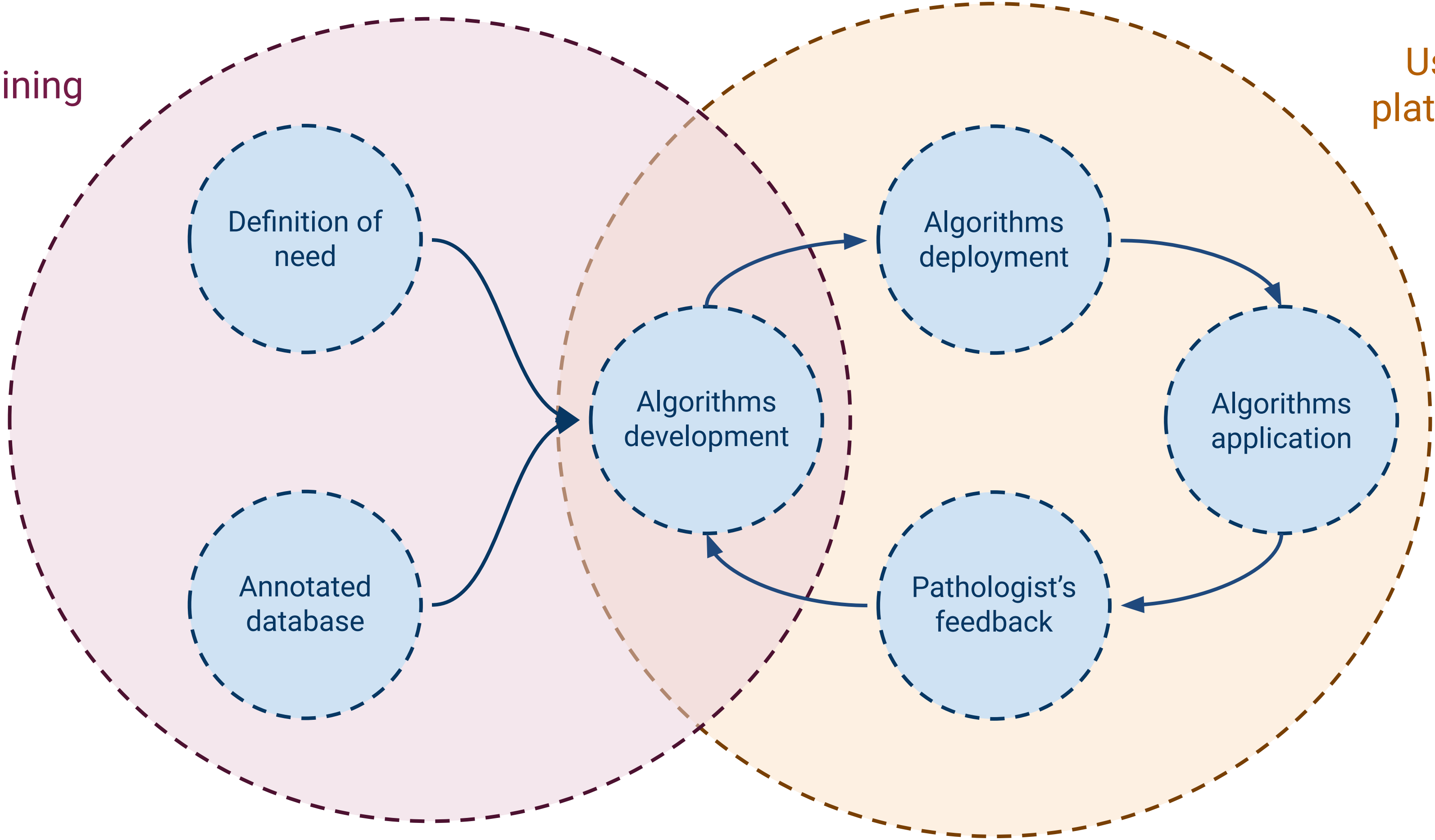
Algorithms development

Algorithms deployment

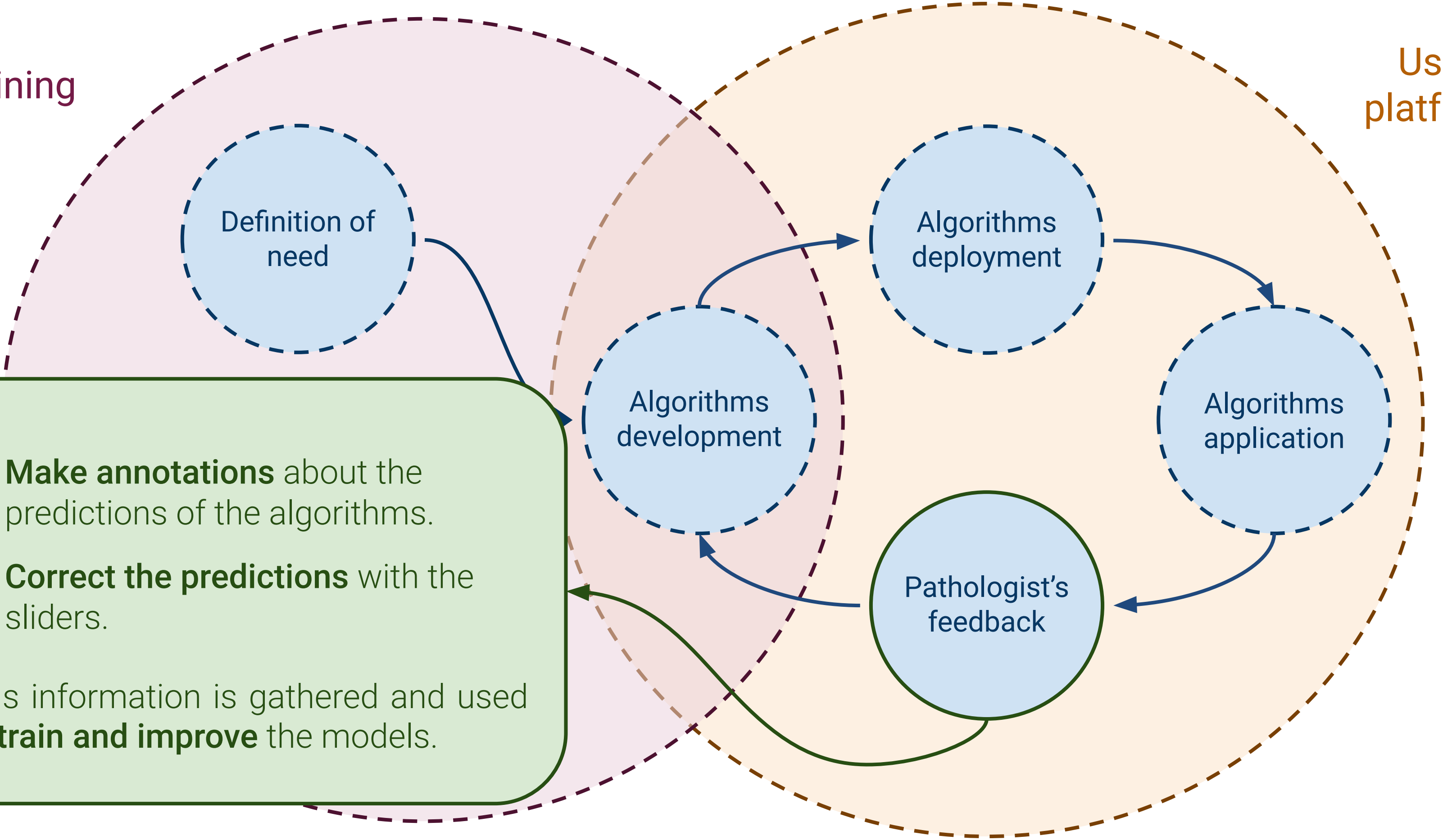
Algorithms application

Pathologist's feedback

The expert in the loop


Training
User platform
Definition of need
Annotated database
Algorithms development
Algorithms deployment
Algorithms application
Pathologist's feedback

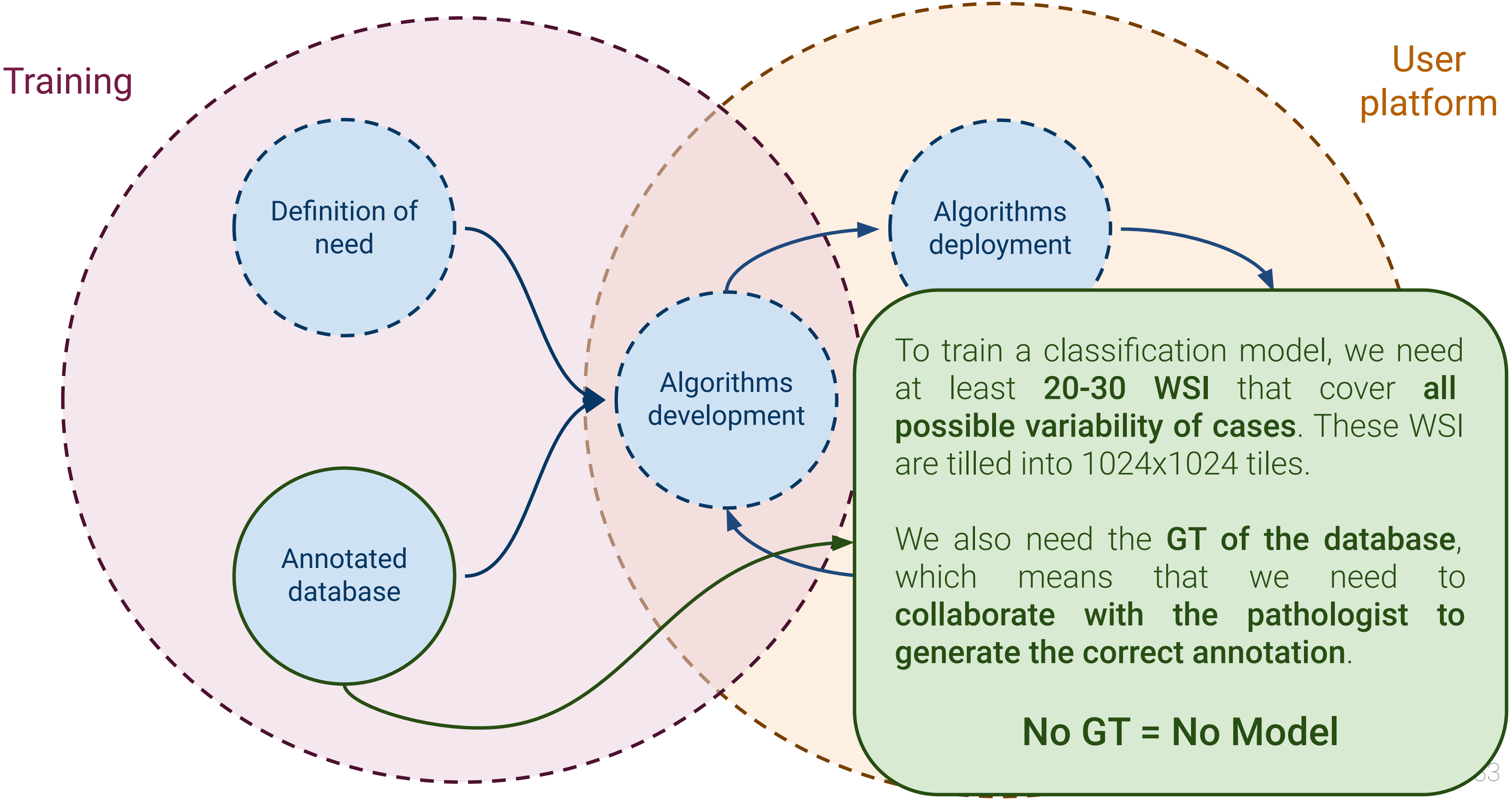
The expert in the loop


Training
User platform
Definition of need
Algorithms development
Algorithms deployment
Algorithms application
Pathologist's feedback

- **Make annotations** about the predictions of the algorithms.
- **Correct the predictions** with the sliders.

All this information is gathered and used to **re-train and improve** the models.

The expert in the loop


Training
User platform
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Algorithms deployment
Annotated database

To train a classification model, we need at least **20-30 WSI** that cover **all possible variability of cases**. These WSI are tilled into 1024x1024 tiles.

We also need the **GT of the database**, which means that we need to **collaborate with the pathologist to generate the correct annotation**.

No GT = No Model

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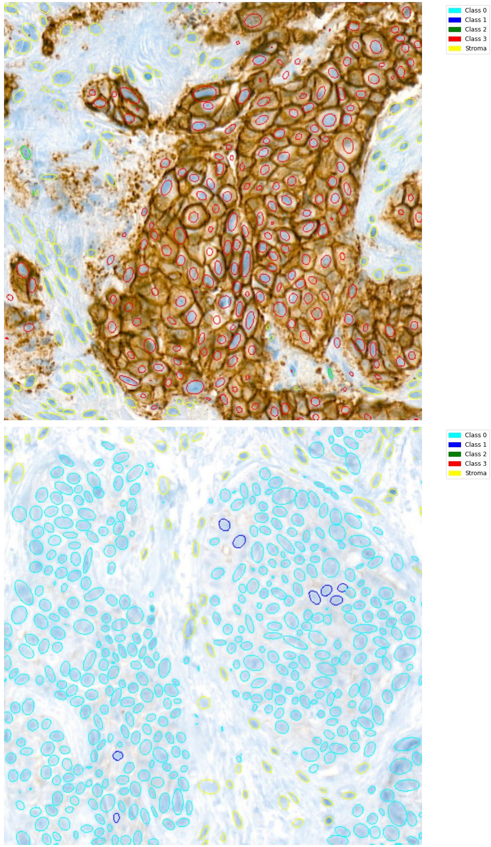
Summary

- **Need of (large) annotated databases**
  - Multidisciplinary Research Team
  - Experts in the loop
  - Creation of databases of increasing quality
  - Include the annotation in the clinical routine
- **Definition of a useful structure for the pathologists**
  - Reduce the time, increase the usefulness of proposals
- **Analysis of different strategies for image analysis**
  - Develop / Test the correct algorithms for each need
- **Is that AI?**
  - Can you really use AI?


Class 0
Class 1
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