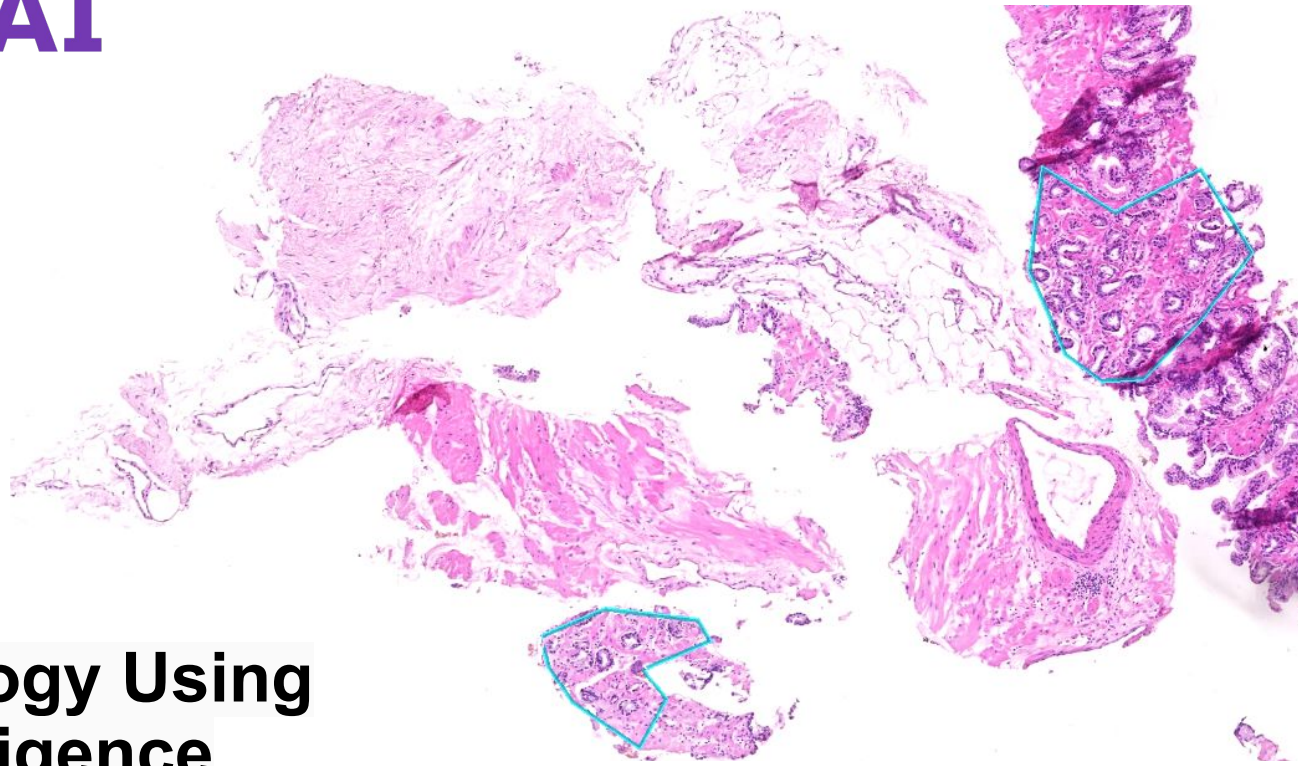
BioMedAI TWINNING

RationAI

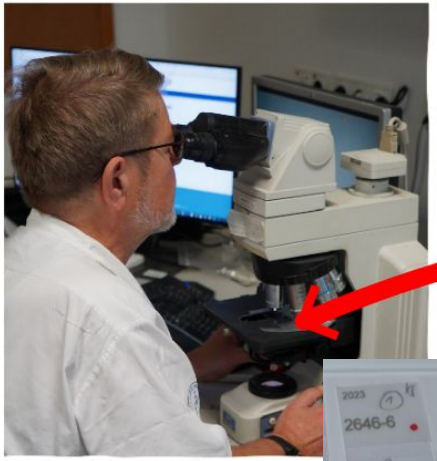


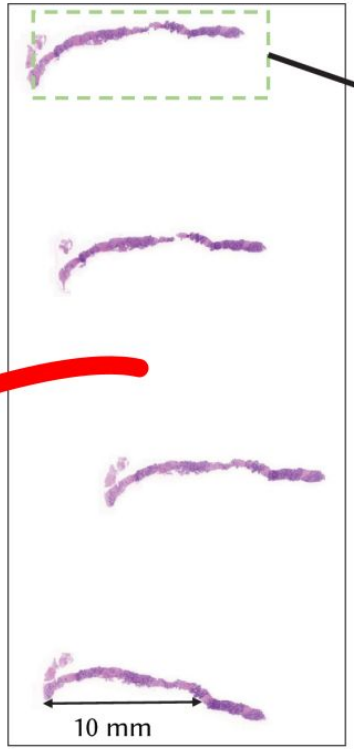
Digital Pathology Using Artificial Intelligence in Practice

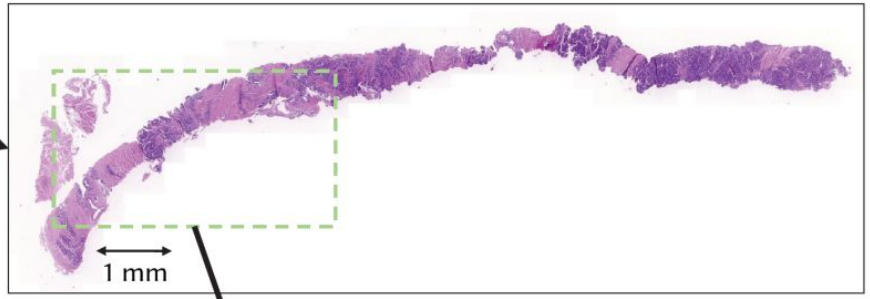
Tomáš Brázdil

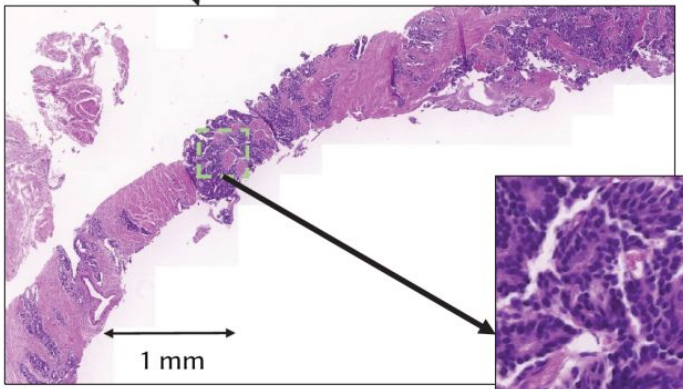
MUNI

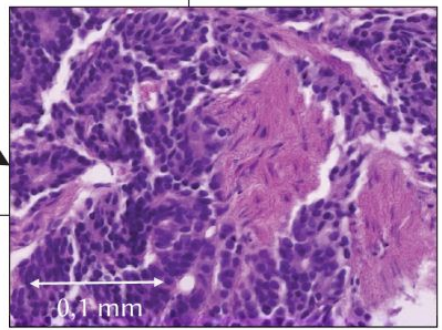
Histopathology



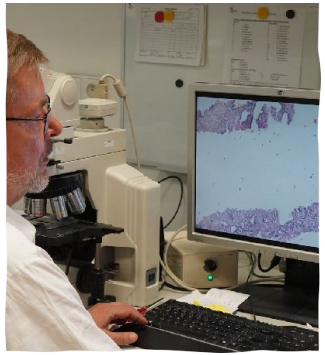




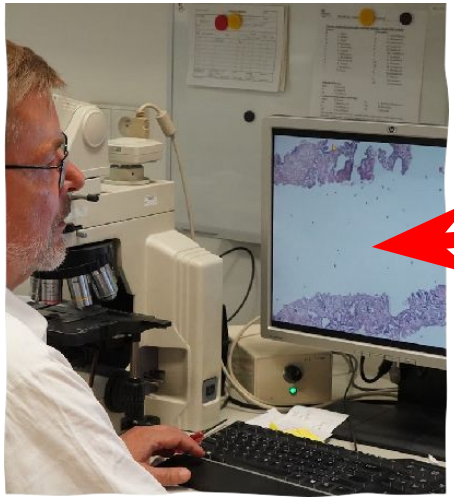


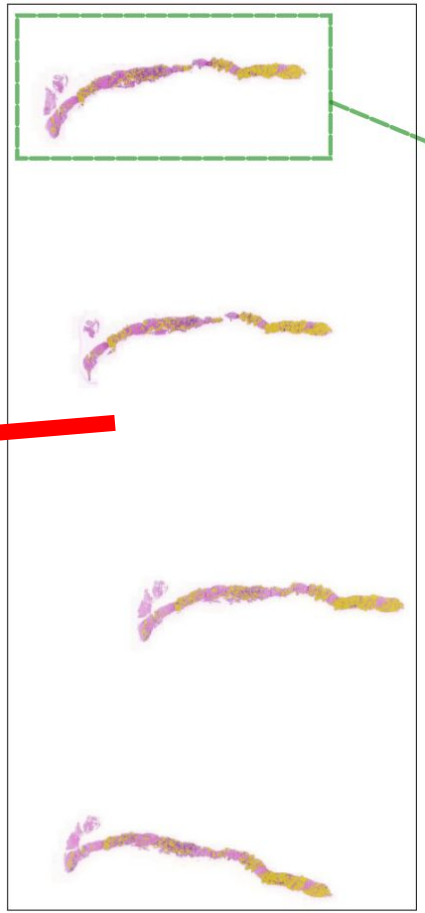


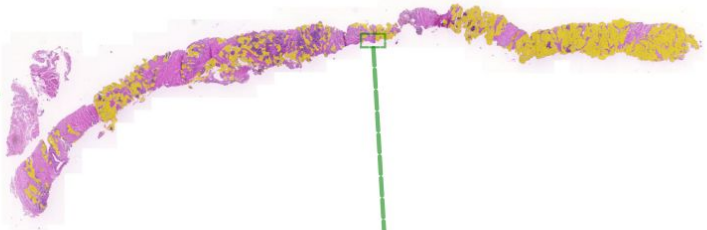
Digital pathology

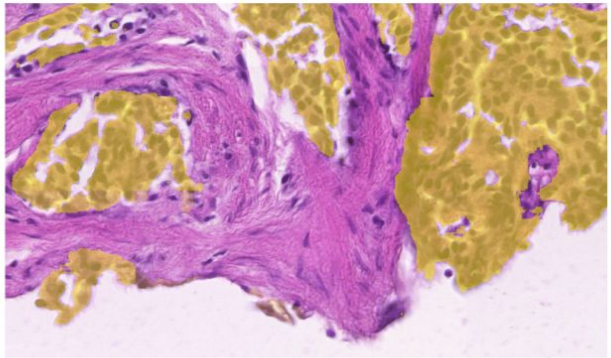


AI in DP









AI learns from data: Here microscopic images (WSI) of tissue labeled with cancer

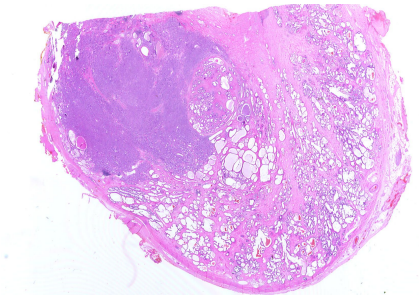
AI training workflow

- The **pathologist formulates** the **medical problem**

  E.g. detect prostate cancer in whole-slide images (WSI) of prostate needle biopsies
- The **pathologist selects** the appropriate **cases/slides** for AI training
- The **slides** are **scanned**
  - No standard of WSI format
  - Various scanning parameters
- **Metadata** collected and processed
- The resulting data handed over to computer scientists
  - smaller projects = thousands of WSI (terabytes)
  - large projects = hundreds of thousands/millions of WSI (petabytes)
- Training/evaluation results **evaluated** by the **pathologist**

Data characteristics

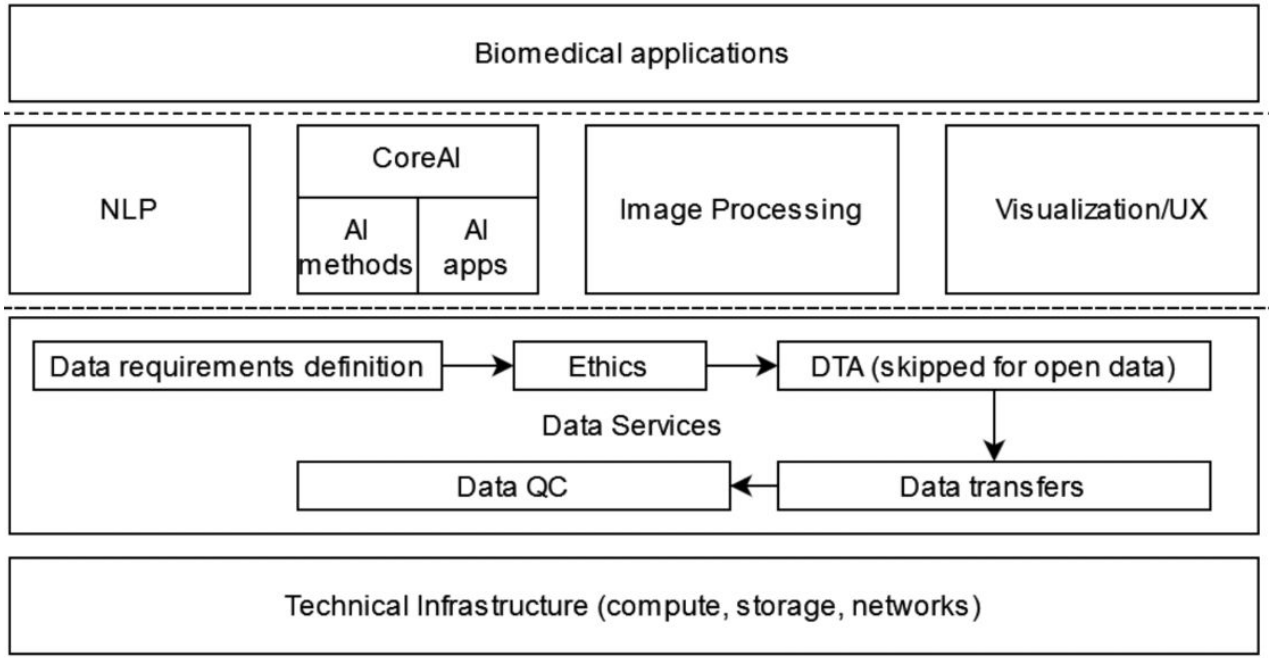
- *Image data*: **Whole-slide images**
  - gigapixel images of tissue
  - several images per case
- *Textual data*: **Medical reports**
  - unstructured, differ in style, language etc.
  - medical jargon
- *Tabular data*: **Clinical, genomic, etc.**
  - Not standardized across institutions



Microscopic Description: Histologic examination reveals a soft tissue specimen consisting of keratinized stratified squamous epithelium and underlying connective tissue. The epithelium exhibits a thin surface layer of parakeratin subjacent to which the spinous cell layer varies in thickness. The basal cell layer is disorganized or nonexistent throughout much of the specimen. The underlying connective tissue is comprised of delicate to dense bundles of intertwining collagen fibers interspersed by varying numbers of fibrocytes and small blood vessels. Prominent within this framework is a band-like infiltrate of lymphocytes present immediately subjacent to the epithelium and focally obscuring the epithelial/connective tissue junction. In some of these areas, the epithelium is artifactually separated from the underlying connective tissue. Superficially, bacterial colonies are adherent to the epithelium.

Patient no.	Harvey–Bradshaw index	Inflammatory Bowel Disease Questionnaire	C-reactive protein (mg/L)	Highest CTE score	Highest SUVmax	Highest SUVmax ratio	Highest simplified endoscopic score	Highest pathology inflammation grade
1	4	125	15.8	7	6.4	4.6	4	4
2	3	156	8.9	0	3.6	1.2	3	2
3	5	167	1.9	5	5.8	3.4	3	3
4	3	196	29	5	7.5	4.0	NA*	4
5	10	181	NA	5	6.6	3.3	NA	4
6	11	138	NA	9	5.9	4.9	NA	4
7	2	188	NA	0	3.4	1.2	1	2

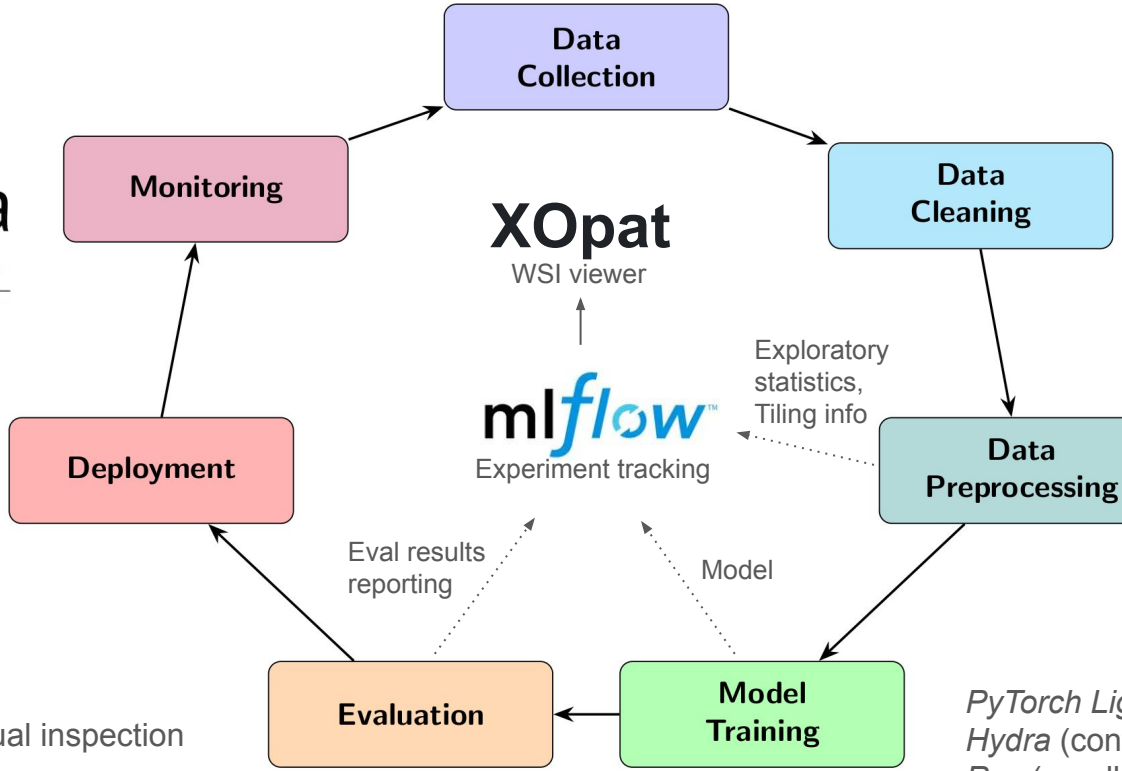
BioMedAI


Biomedical applications
NLP
CoreAI
AI methods
AI apps
Image Processing
Visualization/UX
Data requirements definition
Ethics
DTA (skipped for open data)
Data Services
Data QC
Data transfers
Technical Infrastructure (compute, storage, networks)

WSI processing AI

Transferring WSI and metadata from hospitals
*Storing at **Cerit-SC***

empaia
International e.V.
ecosystem for pathology diagnostics with AI assistance



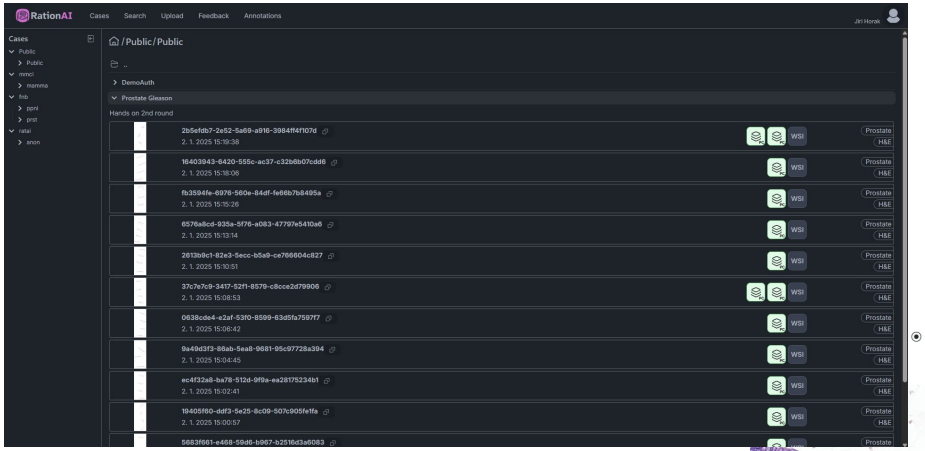
WSI reading (OpenSlide)
WSI format unification
Metadata quality check
WSI quality check
Staining consistency, folds, blurring, etc.

Data exploration
Tiling
Augmentations

TorchMetric
xOpat viewer for visual inspection

PyTorch Lightning
Hydra (config management)
Ray (parallel computing)

Experimental clinical deployment at MMCI

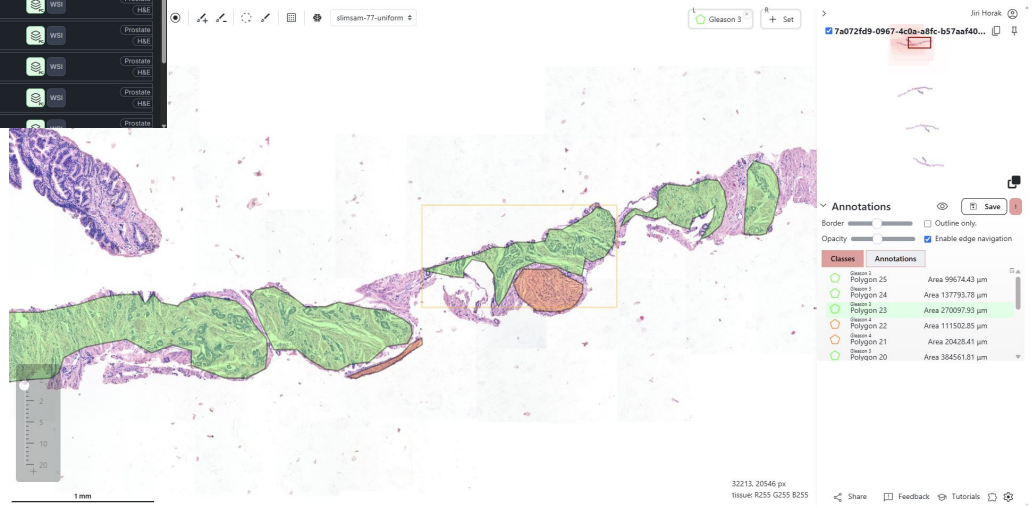


Case browser

- Execution of AI models
- Metadata examination

xOpat viewer

- Display scanned samples
- Annotations, model outputs



Solved by AI?

Pathologist's view: It does not bother me and sometimes it's helpful

IT expert's view: In 2018

cancer patients with clinicopathological and outcome data available. The results show that deep learning-based outcome prediction with only small tissue areas as input outperforms (hazard ratio 2.3; CI 95% 1.79–3.03; AUC 0.69) visual histological assessment performed by human experts on both TMA spot (HR 1.67; CI 95% 1.28–2.19; AUC 0.58) and whole-slide level

Bychkov et al (2018). Deep learning based tissue analysis predicts outcome in colorectal cancer. *Scientific Reports*, 8

Solved by AI?

IT expert's view: In 2024 (and still in 2025)

> Researchers have published many promising algorithmic solutions.[11,12] However, the path to wide clinical adoption is difficult. A core problem is a lack of standardization and interoperability for the seamless integration of image analysis methods into diverse image management and laboratory information systems. Commercialization and clinical implementation of pathology AI must overcome additional hurdles,[13,14] namely the transformation of an idea into an AI prototype (which requires data acquisition), a validation process towards market readiness, and certification as a medical product. Finally, reimbursement and billing issues must be solved to generate revenue.

Zerbe et al (2024). Joining forces for pathology diagnostics with AI assistance: The EMPAIA initiative. *Journal of Pathology Informatics*, 15

Our team and collaborations

RationAI research group

- More than 30 members at FI MU (including students)
- A team at Cerit-SC (ICS MU): Data and computing infrastructure development

Collaborations:

- *Med Uni Graz* - senior partner in BioMedAI Twinning
- *Masaryk Memorial Cancer Institute* - the main hospital collaboration
- *IKEM* - starting serious collaboration
- *FN Brno*, etc.
- BBMRI