Artificial Intelligence in Digital Pathology

Tomáš Brázdil

MUNI

Masarykův onkologický ústav

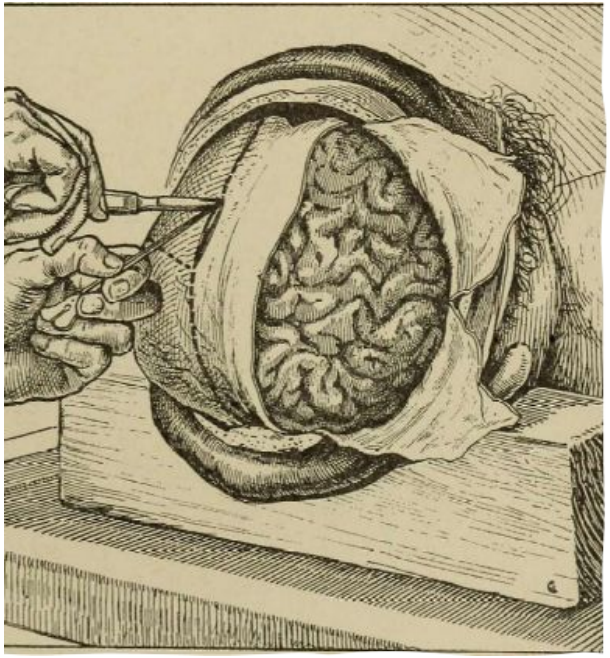
From the perspective of

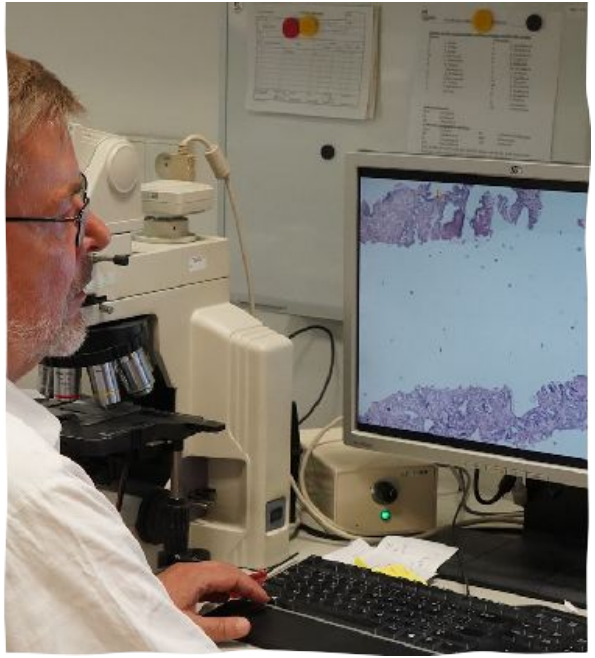
- a small university research group
  approx 30 members
- a small startup
  less than 20 emplyees
- In Europe
  extremely conservative environment

RationAI

aigopath

Evolution of Pathology





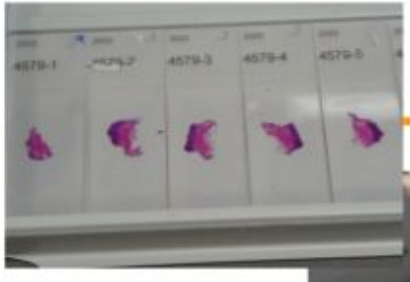
… from cutting dead bodies to advanced diagnostics

What pathologists do?

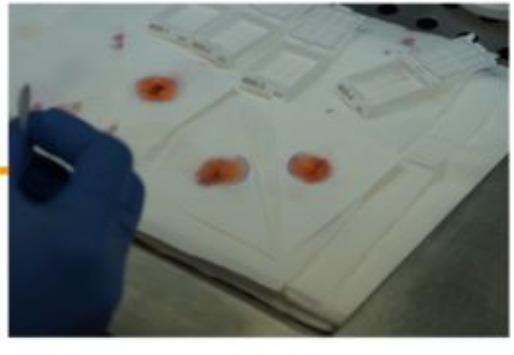
Scanner

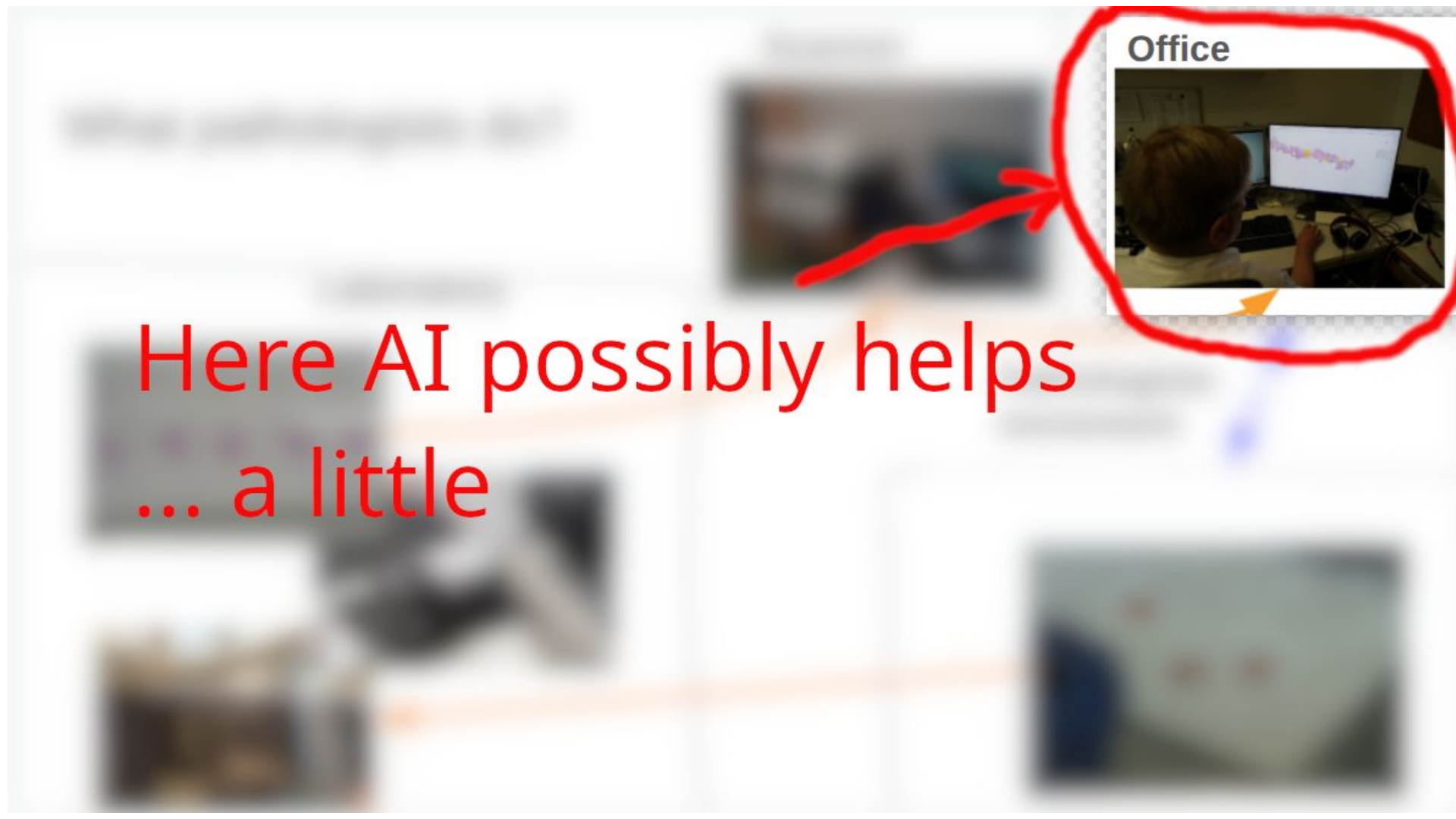
Office

Laboratory

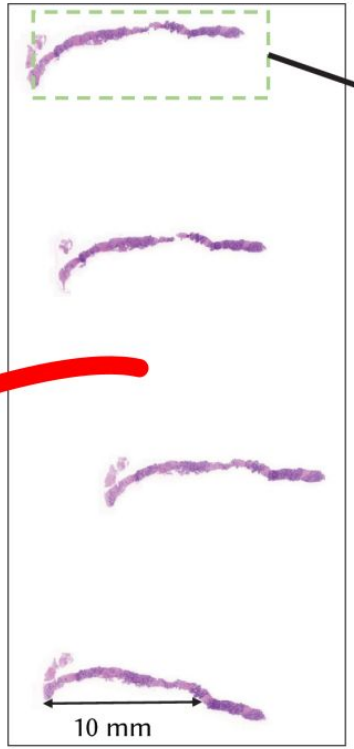


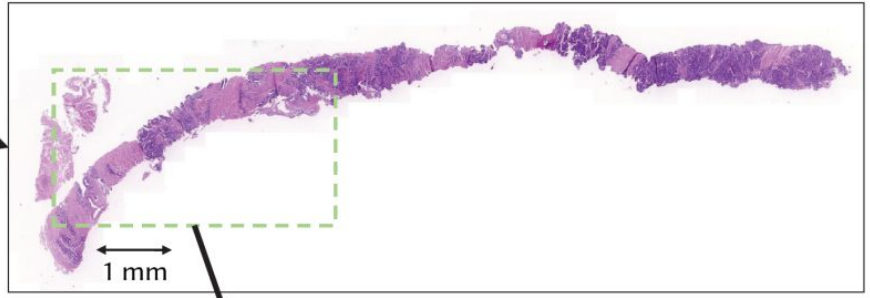
Pathologist's movement

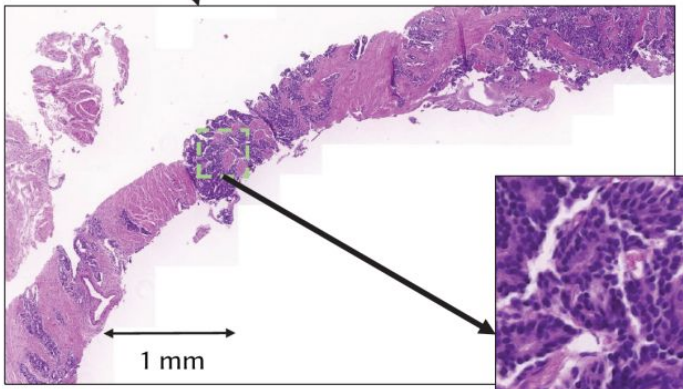


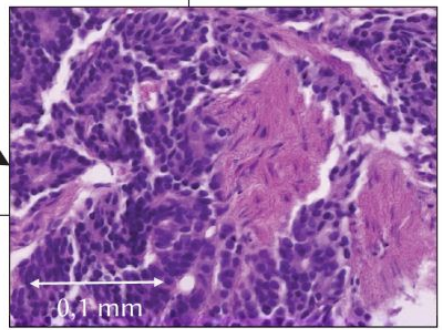

Office
Here AI possibly helps
… a little

What does a pathologist see?

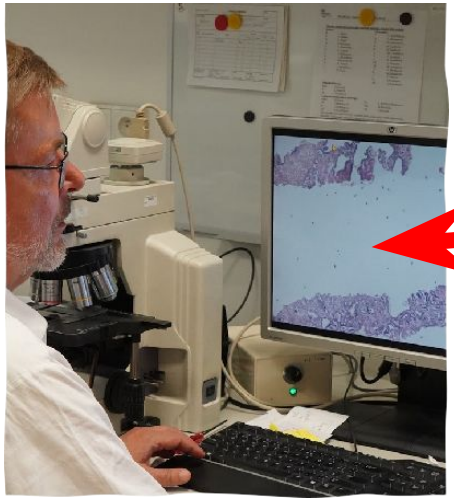


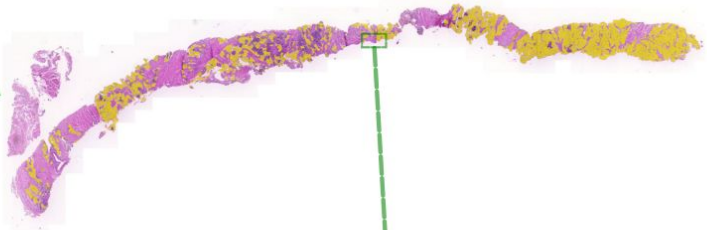


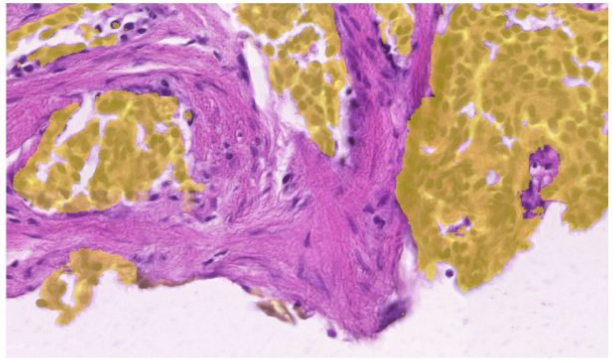




AI power!



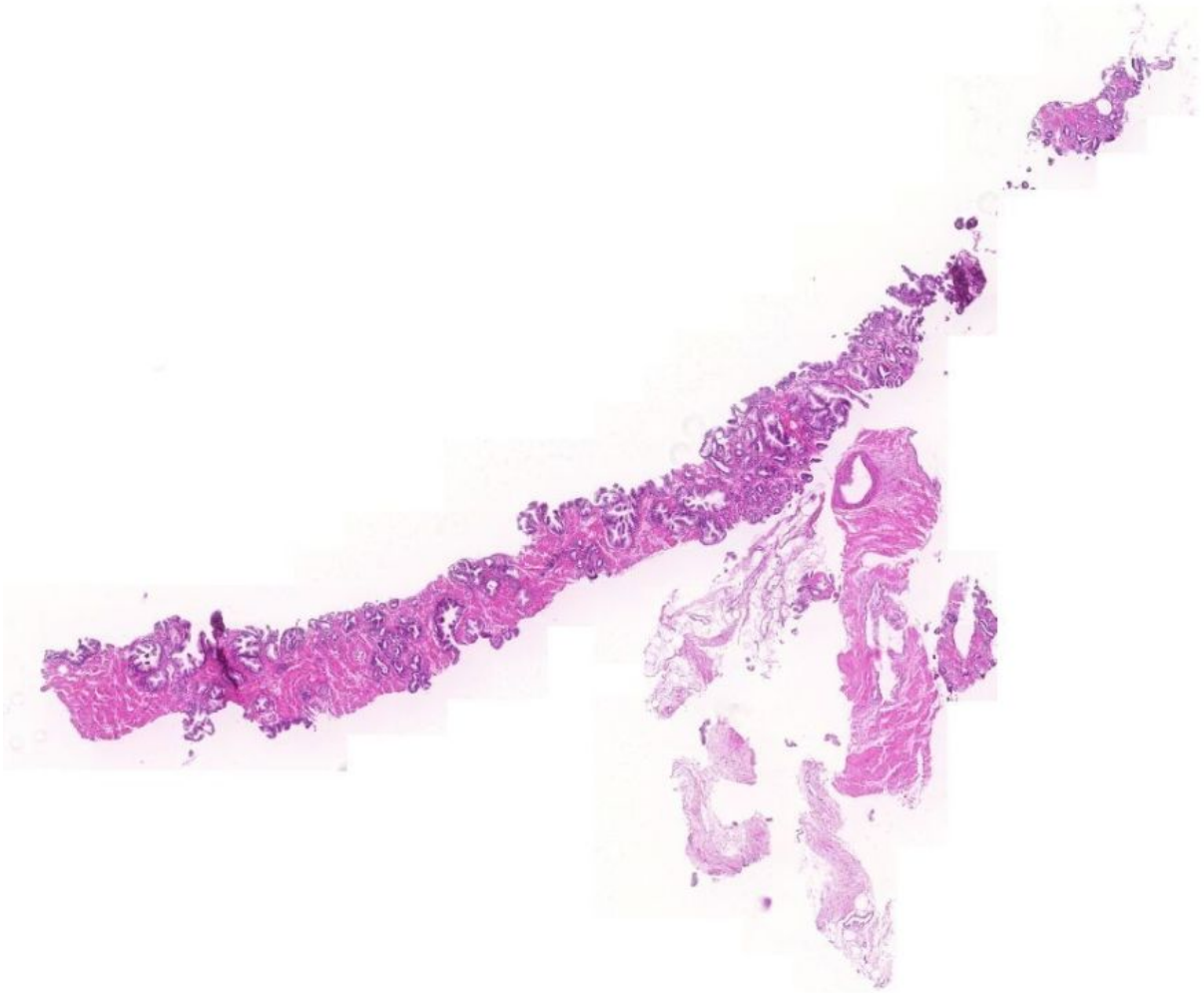




Data

Where is the cancer?

Beware, huge image!!

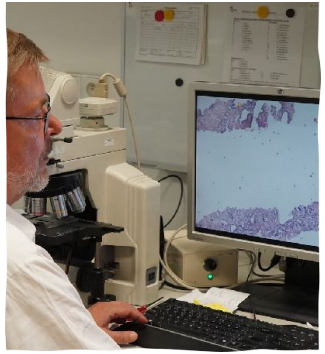


Data

Cancer is approx. here

Train AI to find the cancer!

Digital pathology



RationAI

Masarykův onkologický ústav

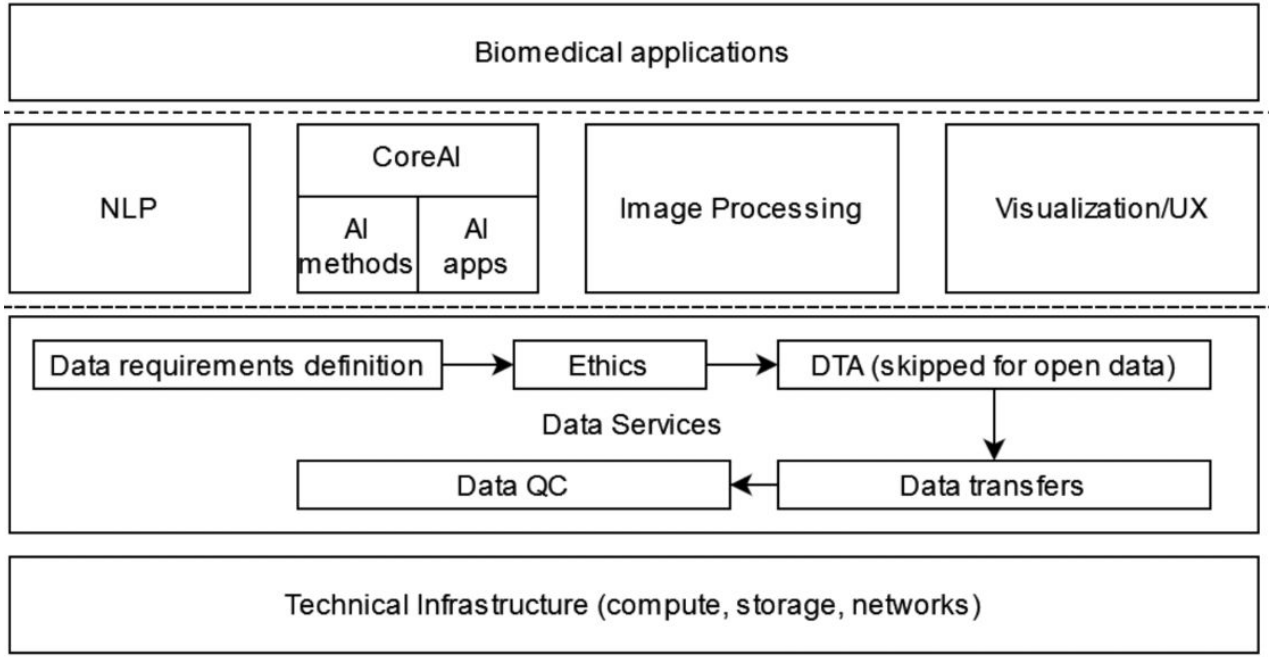
IKEM

FAKULTNÍ NEMOCNICE BRNO

Med Uni Graz

MUNI FI

MUNI ICS



cerit scientific cloud

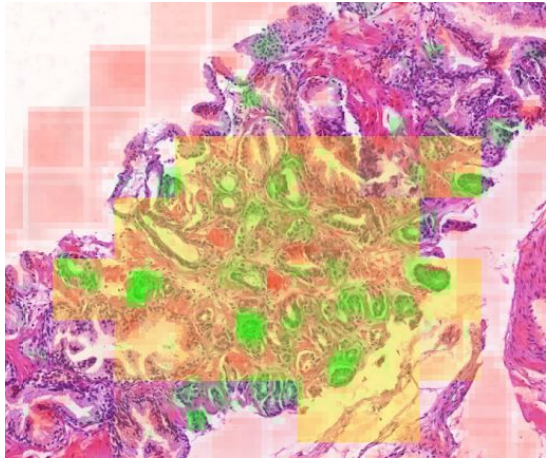
e-INFRA CZ

BioMedAI TWINNING project

Example: Cancer segmentation model

- *Prostate, breast, colon* tumor segmentation
- Explainable AI
- Using foundation models

  Prov-GigaPath, etc.
- Tested on multi-centric data



There are many models like this one in academia

To be practical: **Deployment, integration, cerftification**

Pathology 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

Pathology 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

What is expected from a clinical solution?

End users (pathologists, lab technicians) usually need

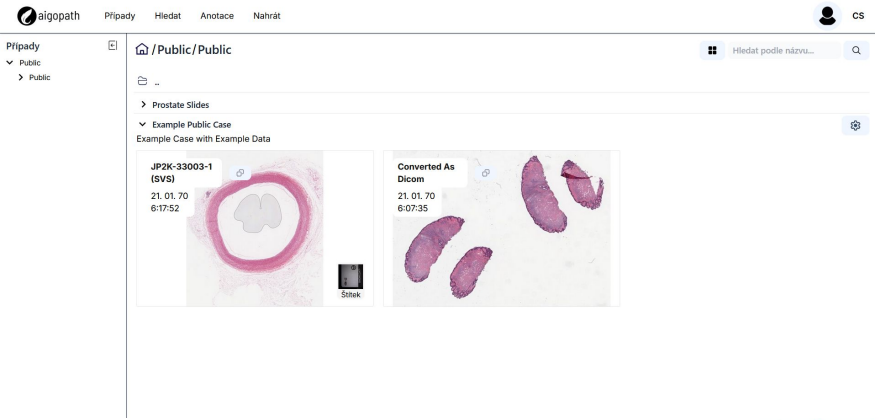
- “Invisible” connection between scanner and the user interface

  assuming the pathology is already digitized!
- Ergonomy, clarity, reliability of the user interface

  Single system for everything - clinical/text data with images
- Necessary tools at hand

  Reporting system (possibly pre filled by the AI system)

Our deployment at MMCI

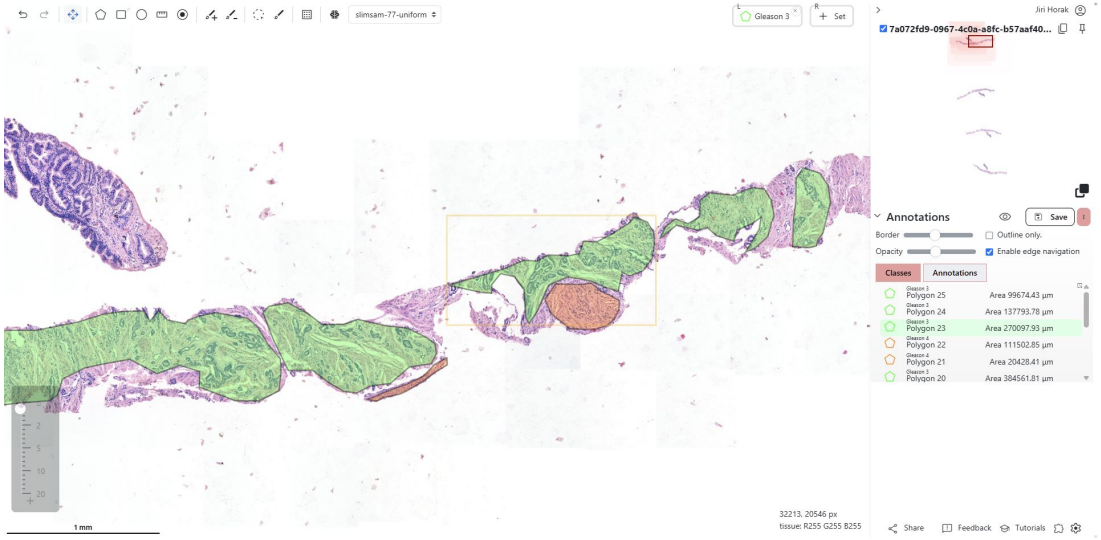


Case browser

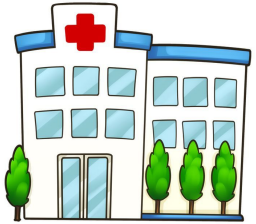
- Execution of AI models
- Metadata examination
- Integrated with LIS, HIS, etc.

xOpat viewer

- Fast and reliable
- Visualization of AI outputs
- Measurements, morphomentry



Institutional needs (laboratory, hospital)



- Security of processed data and data/AI access control (GDPR, AI Act)

  Expensive, legal nightmare
- Certification (ISO, MDR, IVDR)

  For small companies: Expensive, complicated, opaque
- Integration with existing processes

  User education, workflow integration, cooperation of IT departments, etc.

AI digital pathology market - AI company view

- The usual **clients**
  - Hospitals
  - Private labs
- The usual **providers**
  - Scanner manufacturers (Roche, Leica)
  - Companies from related disciplines (Sectra, Dedalus, Fujifilm)
  - Startups and dedicated companies (Ibex, Proscia, Smart In Media, Pathozoom)
  - Majority of LIS/NIS providers did NOT jump in yet!

- The **market** is relatively **small** - compared, e.g., with radiology
- *Specialized* - only larger institutions have pathology departments
- Tender based acquisition in state-owned hospitals

Conclusions

- We have considered **challenges** encountered by a research group in AI in digital pathology
- The research in the area is much faster than testing, deployment, certification, and market release
- AI will assist digital pathology only when sensibly integrated within processes of pathology departments and labs

Now comes LLM based

Agentic AI !