AI in Point-of-Care Histology: Opportunities and Obstacles

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Next Generation Dx Summit
Point-of-Care Histology Forum

August 19, 2024
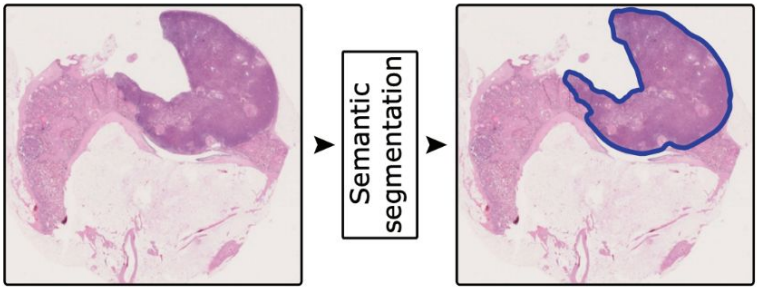
Pixel Scientia LABS

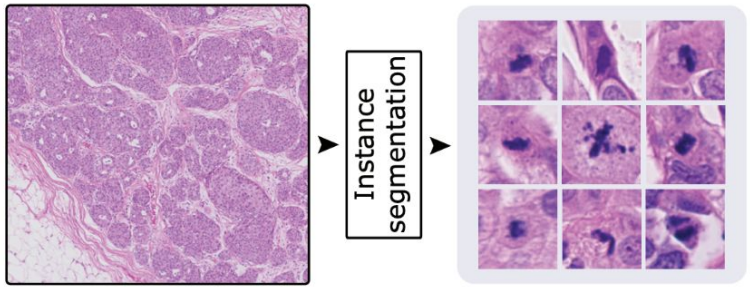# Advances in AI for Histology

Source: Shutterstock

Advances in AI for Histology: Automation

Tumor detection → Semantic segmentation →

Mitotic count → Instance segmentation →

Grading → MIL → Pattern 3, Pattern 4 ⋮
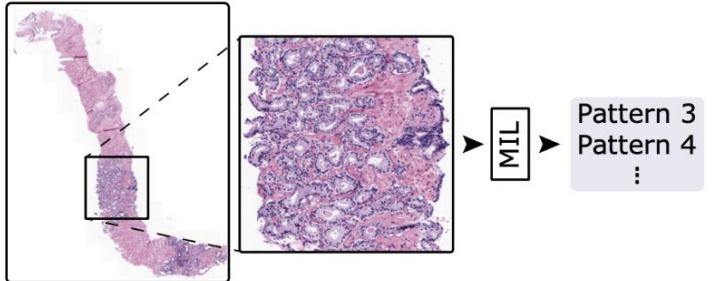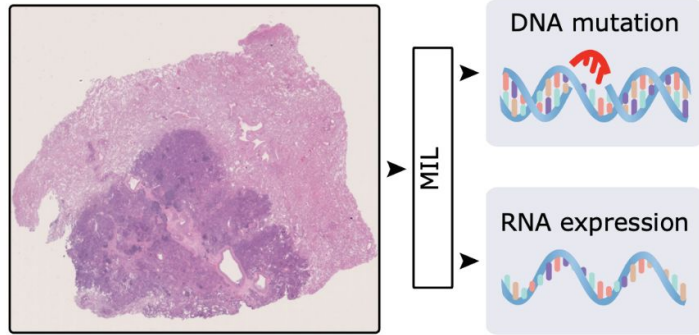
Applications
- Mitotic count
- TIL detection
- Virtual staining
- IHC quantification
- Cancer grading
- Cancer subtyping
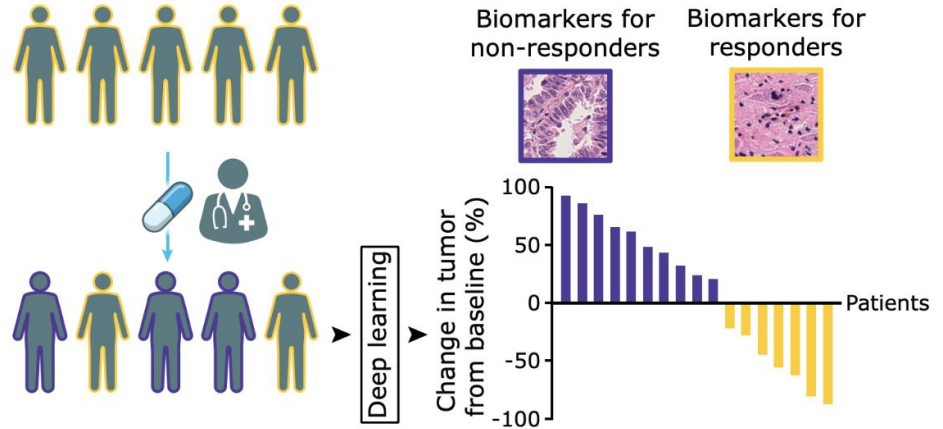- Metastasis origin determination
- . . .

Source: Song, Artificial Intelligence for Digital and Computational Pathology, 2023

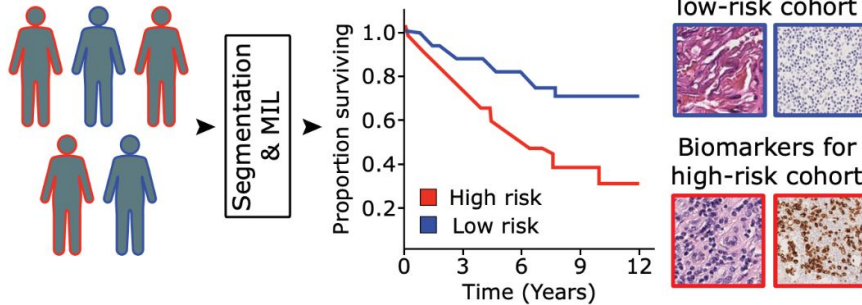# Advances in AI for Histology: Discovery

Source: Song, Artificial Intelligence for Digital and Computational Pathology, 2023
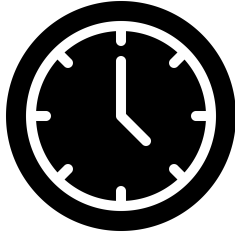
From the Lab to Point-of-Care

- New imaging techniques
- Often lower resolution imaging
- Less controlled environments
- Limited computational power
- Rapid processing needed

Challenges in AI Implementation:
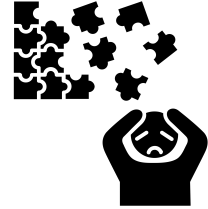# New Imaging Technique → Scarce Data

Data collection and labeling can be...
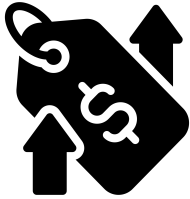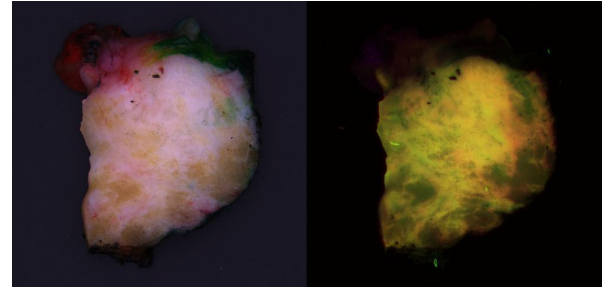
Expensive

Time-consuming

Difficult

Challenges in AI Implementation:
New Imaging Technique → Scarce Data

ImageNet

1.2 million   vs.   100 images
(732-1300/class)

New imaging technology
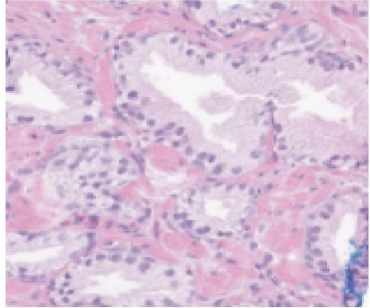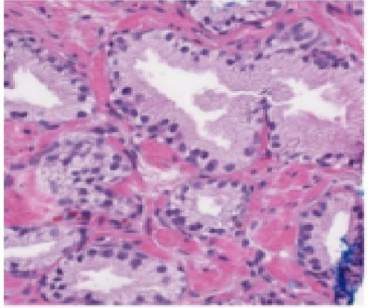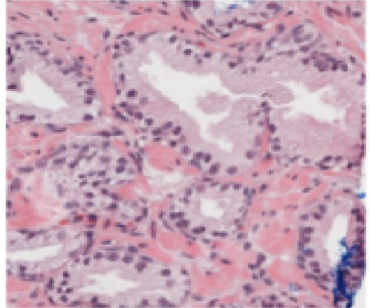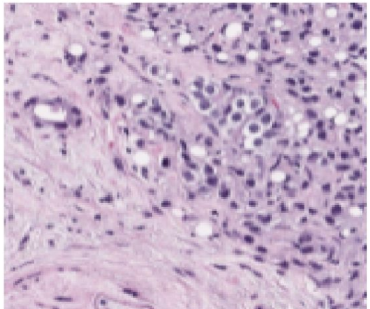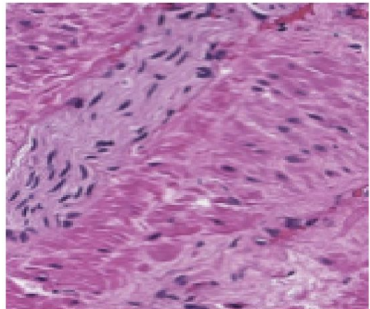
Challenges:
- Few training images
- Limited labels
- Weak labels
- Lack of diverse patient samples

Implications:
- Lower model accuracy
- Potential for bias

Challenges in AI Implementation:
Less Controlled Environments → More Variations

- Inconsistent tissue preparation
- Differences in imaging equipment and protocols
- Artifacts
- Batch effects

Source: Javed, Rethinking Machine Learning Model Evaluation in Pathology, 2022

Challenges in AI Implementation:
Less Controlled Environments → More Variations

Distribution Shift

Source: https://www.nannyml.com/blog/6-ways-to-address-data-distribution-shift
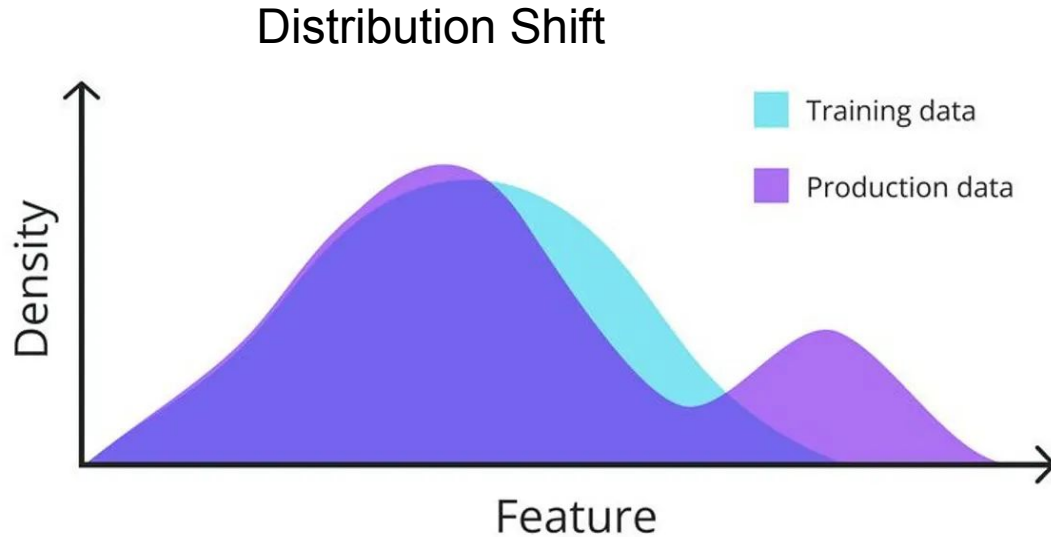
Challenge:
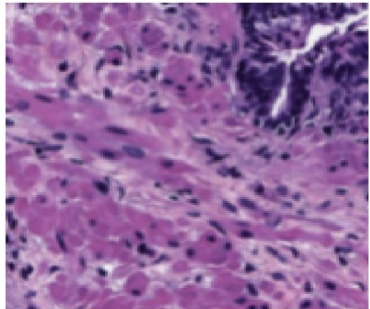- AI is more sensitive than a pathologist to image variations

Implications:
- Failure to generalize to different devices/facilities
- Difficulty in standardizing AI solution

Development of Robust AI Solutions

Problem selection: Define task and success metrics

Data collection: Develop standard imaging protocol
Ensure consistent image quality

Model development: Understand data challenges
Select algorithms to handle known challenges
Experiment and iterate

Validation: Use an external cohort (different patients, devices, facilities)
Assess real-world use

Deployment: Integrate AI model into product

Monitoring & maintenance: Detect degradation over time
Periodically retrain with new data

Point-of-Care Case Study: Cancer Margins

Source: Pandey, AI-Powered Biomolecular-Specific and Label-Free Multispectral Imaging Rapidly Detects Malignant Neoplasm in Surgically Excised Breast Tissue Specimens, 2023
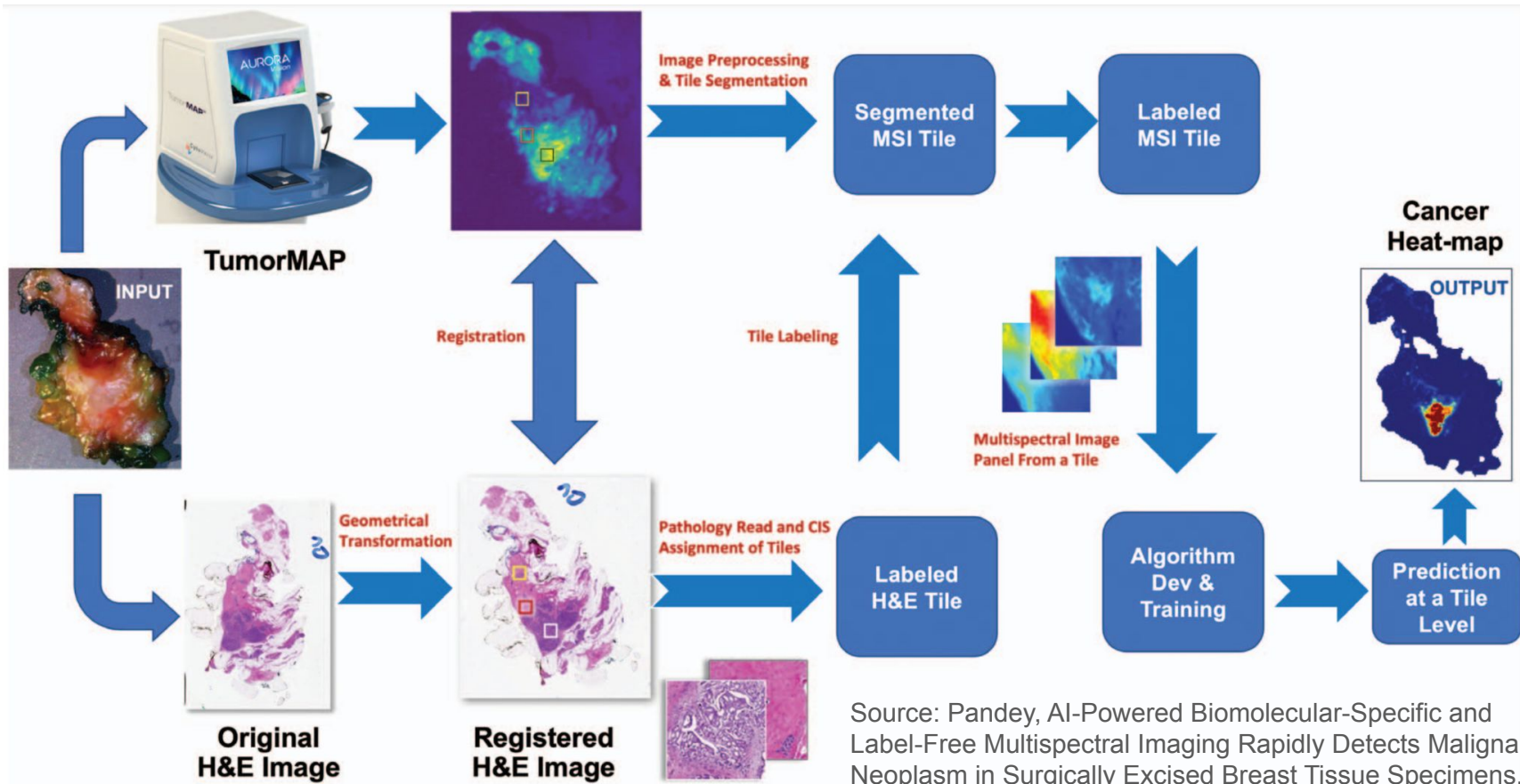
Point-of-Care Case Study: Virtual Staining
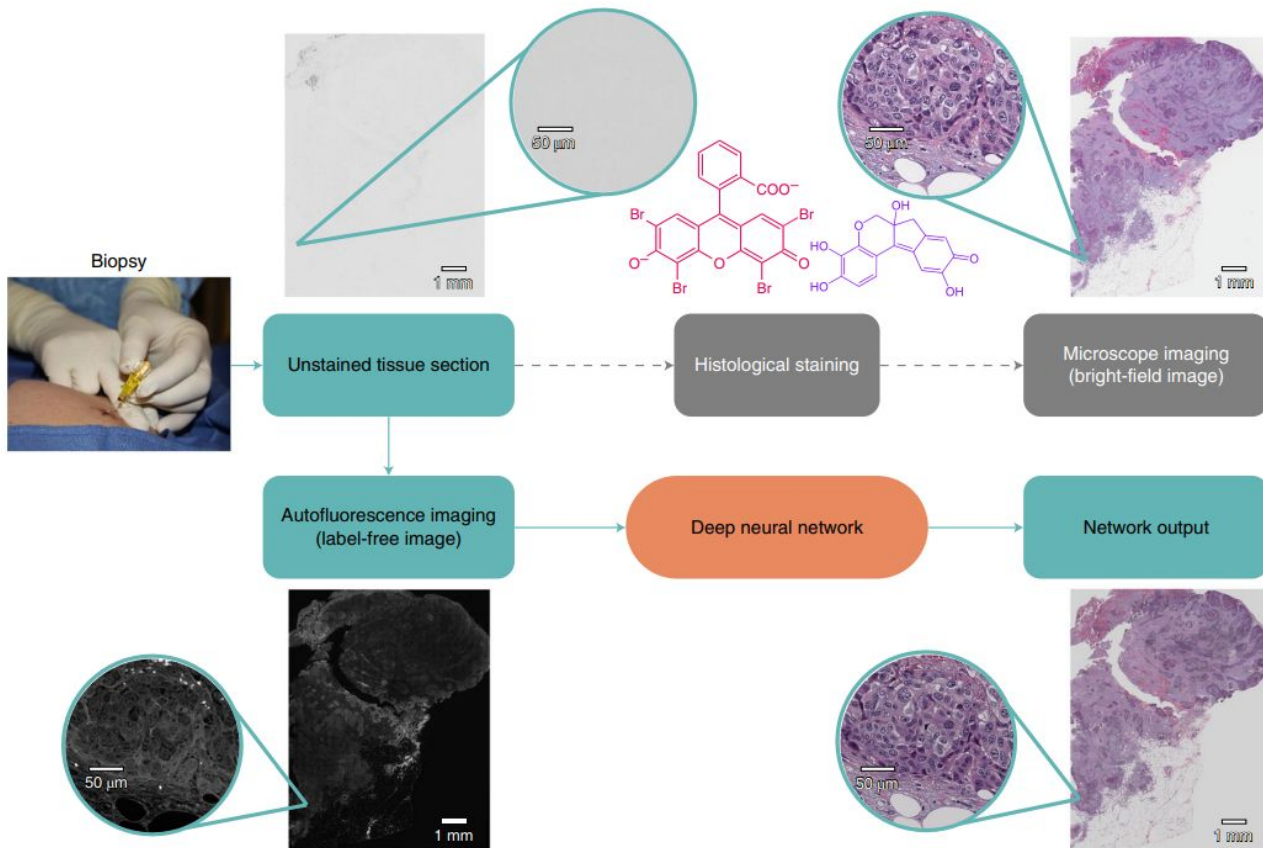
Can lab-trained AI model be used with synthetic H&E?

Watch out for:
- Image quality
- Hallucinations
- Distribution shift
- Careful validation

Source: Rivenson, Virtual histological staining of unlabelled tissue-autofluorescence images via deep learning, 2019

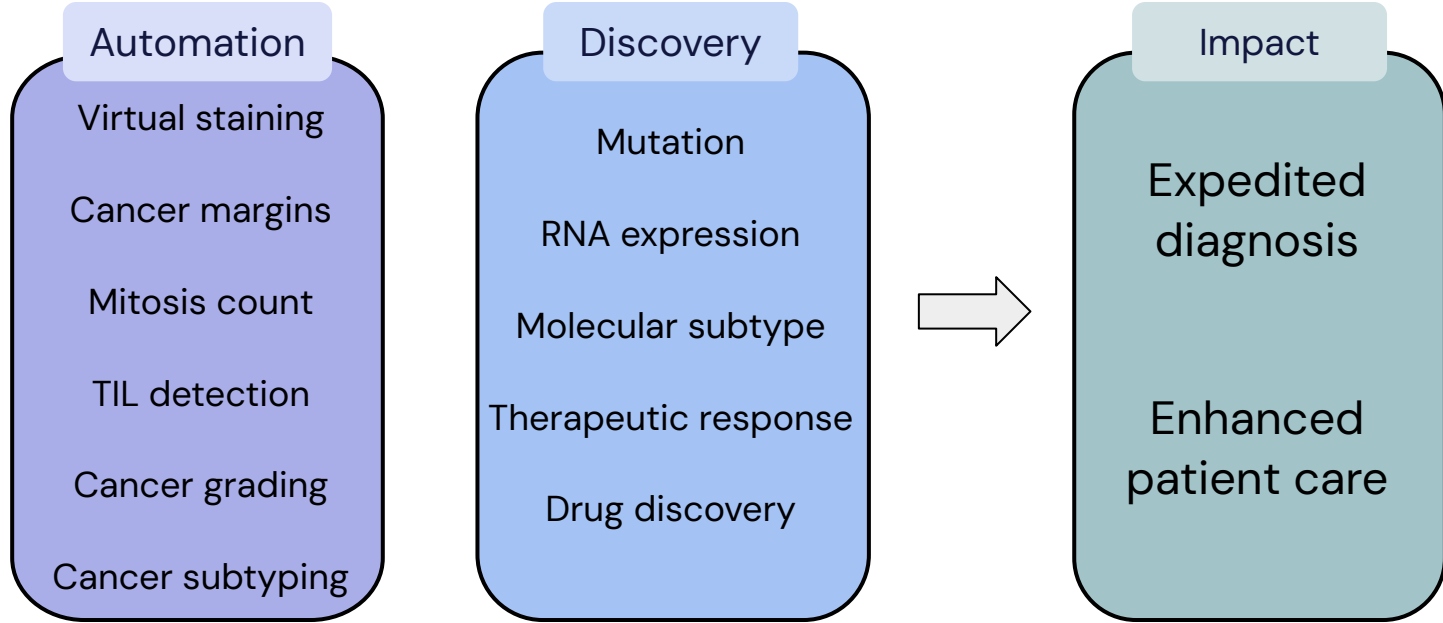# Future Directions in AI for POC Histology

Automation
- Virtual staining
- Cancer margins
- Mitosis count
- TIL detection
- Cancer grading
- Cancer subtyping

Discovery
- Mutation
- RNA expression
- Molecular subtype
- Therapeutic response
- Drug discovery

Impact

Expedited diagnosis

Enhanced patient care

Resources

Links to these slides, articles, podcasts, and other resources.

Computer Vision Insights Newsletter

A biweekly newsletter that often features the latest research in AI for histology.

Impact AI Podcast

Learn how to build a mission-driven machine, learning-powered company from the innovators and entrepreneurs who are leading the way.

Pixel Scientia LABS