

ANNUAL

**Advances and Innovations in Endoscopic Oncology
and Multidisciplinary Gastrointestinal Cancer Care**

Maximizing Insights: Leveraging Artificial Intelligence to Extract Unseen Value from Pathology Slides in GI Cancer

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Disclosures

- I am an inventor of U.S. Patent 10,832,406 (assigned to Harvard University).

This presentation and/or comments will provide a balanced, non-promotional, and evidence-based approach to all diagnostic, therapeutic and/or research related content

Cultural Linguistic Competency (CLC) & Implicit Bias (IB)

STATE LAW:

The California legislature has passed Assembly Bill (AB) 1195, which states that as of July 1, 2006, all Category 1 CME activities that relate to patient care must include a cultural diversity/linguistics component. It has also passed AB 241, which states that as of January 1, 2022, all continuing education courses for a physician and surgeon **must** contain curriculum that includes specified instruction in the understanding of implicit bias in medical treatment.

The cultural and linguistic competency (CLC) and implicit bias (IB) definitions reiterate how patients' diverse backgrounds may impact their access to care.

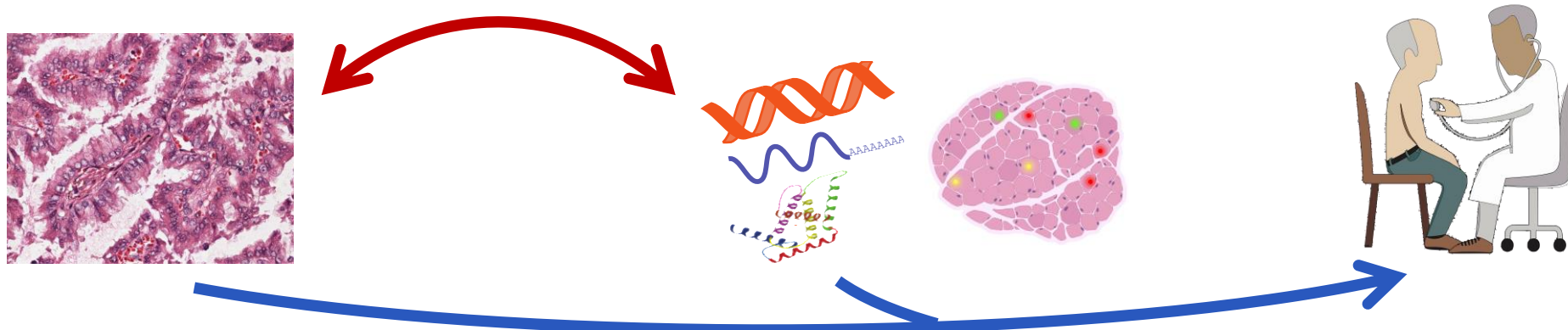
EXEMPTION:

Business and Professions Code 2190.1 exempts activities which are dedicated solely to research or other issues that do not contain a direct patient care component.

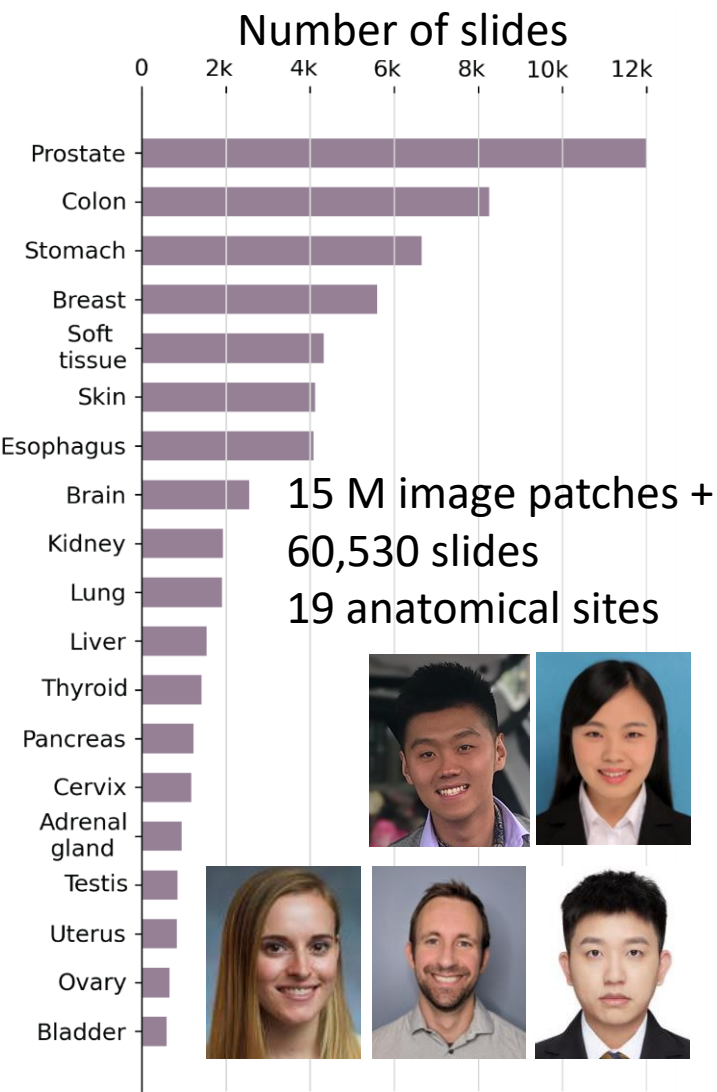
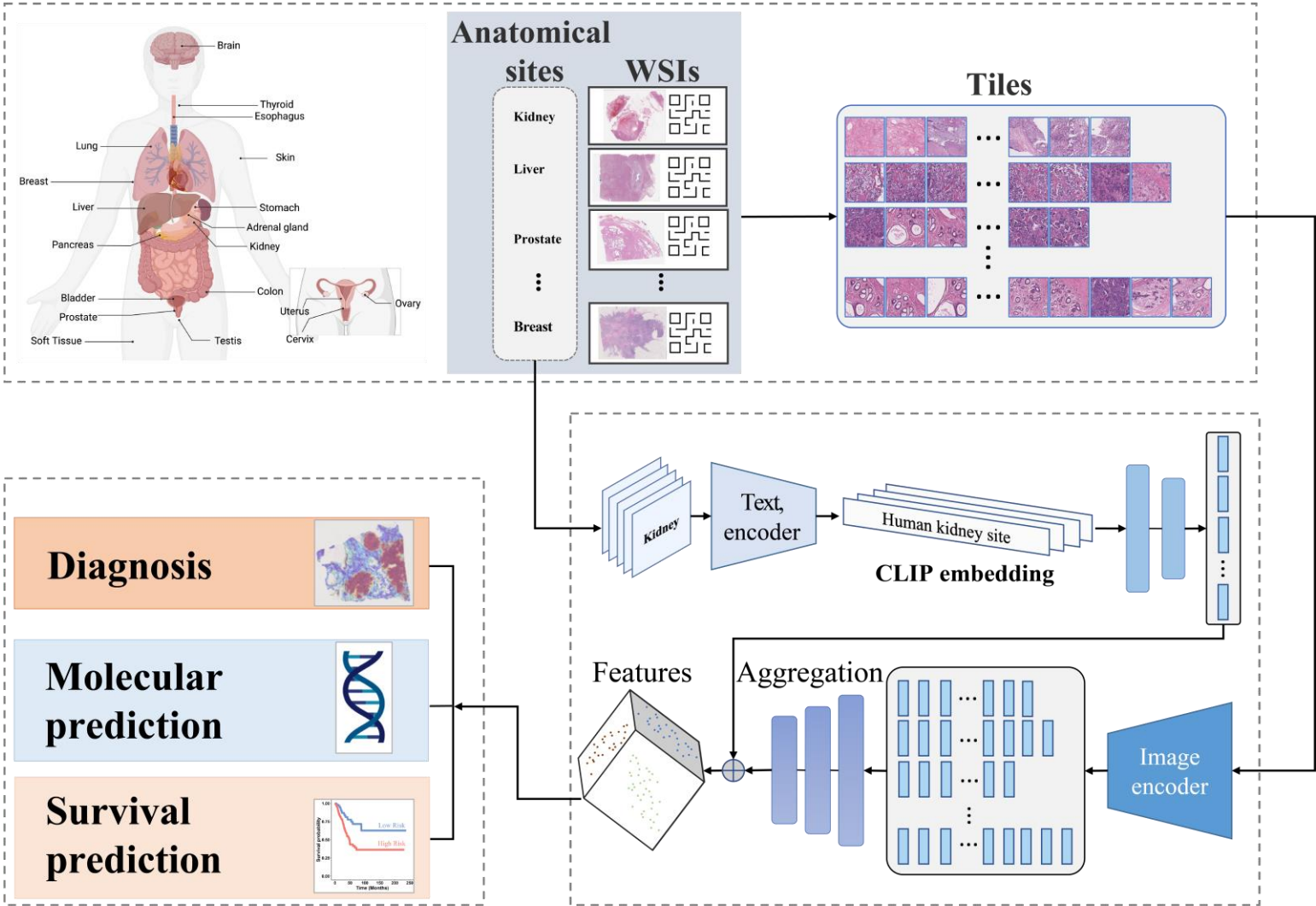
This presentation is dedicated solely to research or other issues that do not contain a direct patient care component.

AI-Empowered Pathology

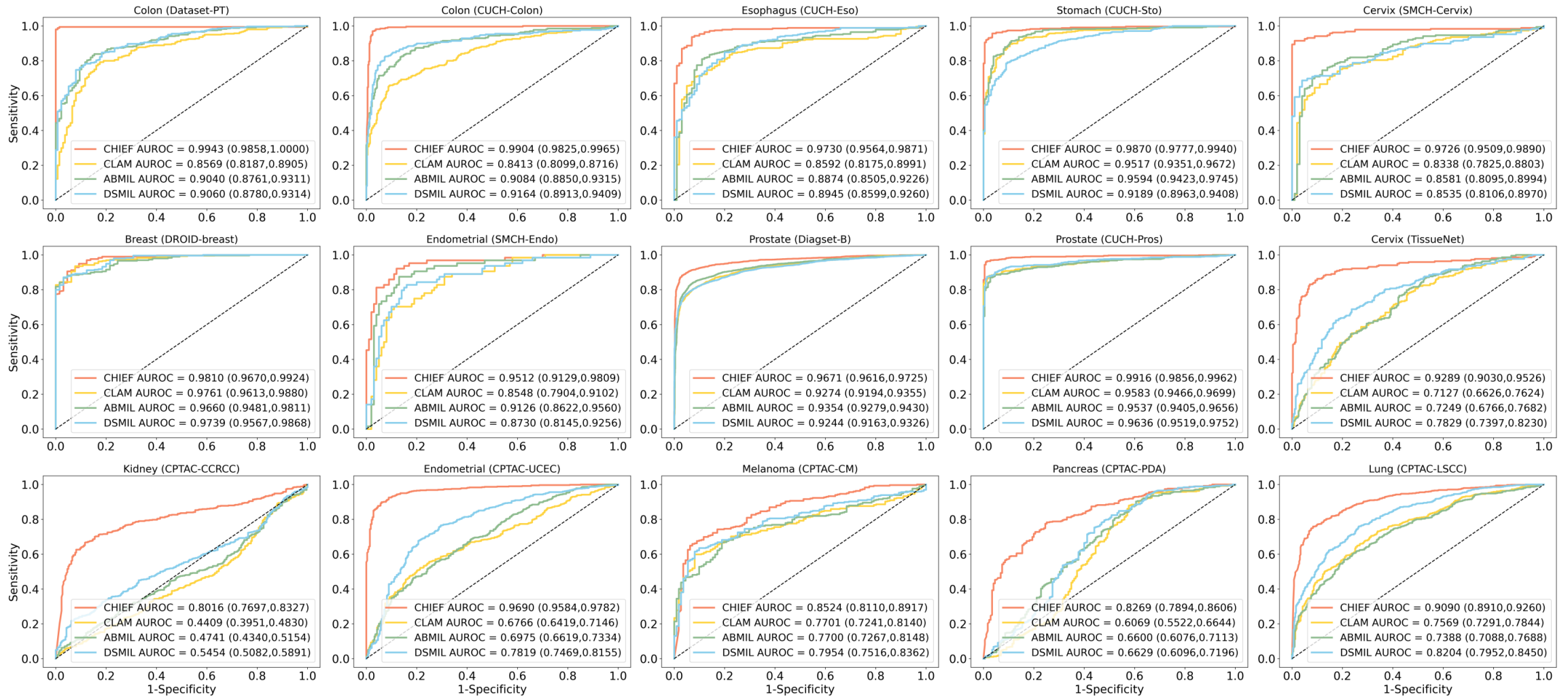
- A **multi-modal AI foundation system** for multi-omics and survival outcome prediction
- **Clinical applications** of pathology AI models for real-time cancer evaluation
- Challenges and **the road ahead**



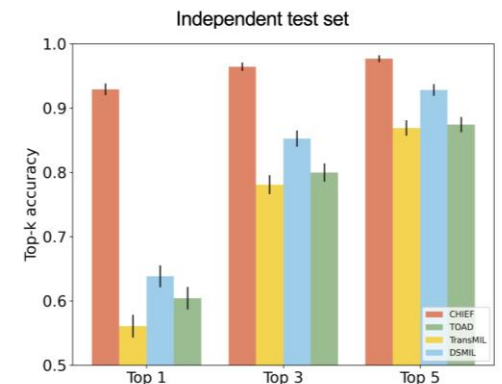
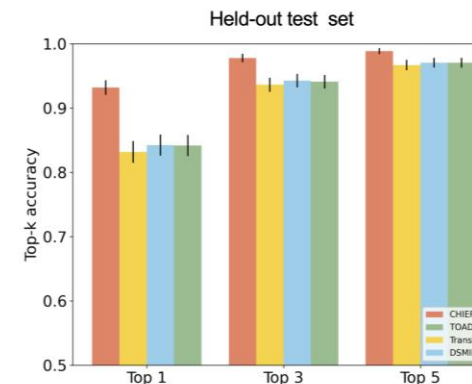
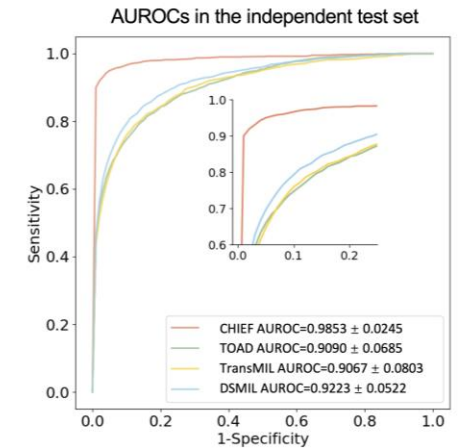
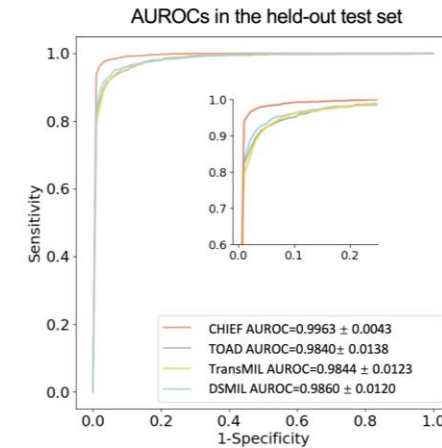
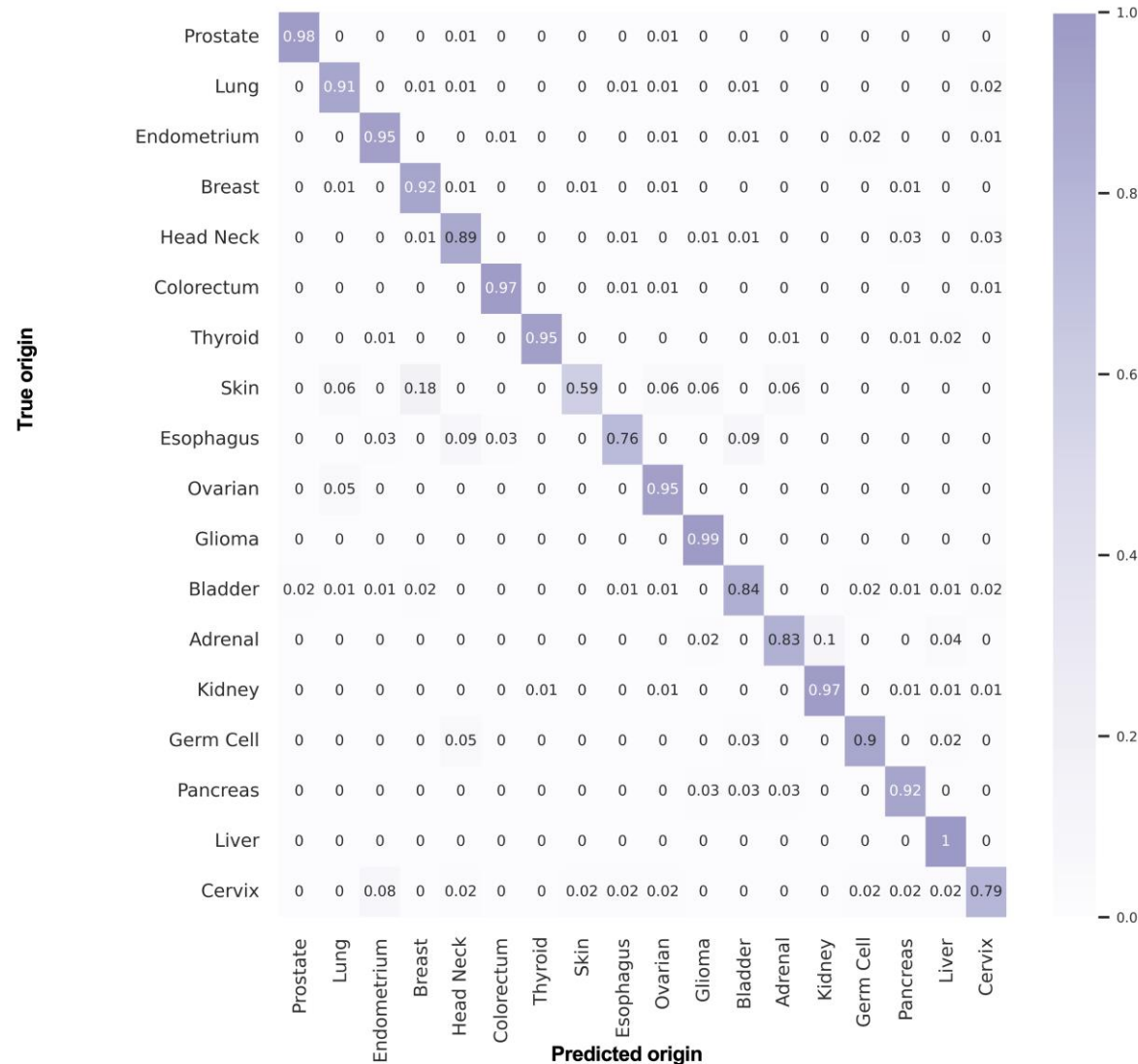
Clinical Histopathology Imaging Evaluation Foundation (CHIEF) Model



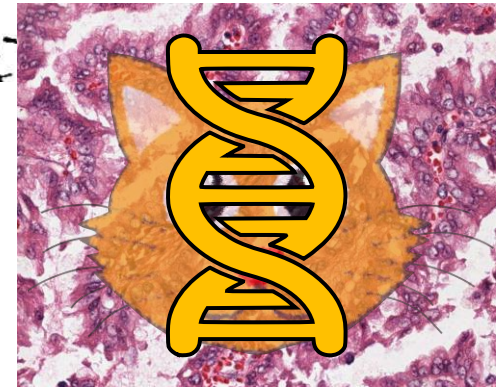
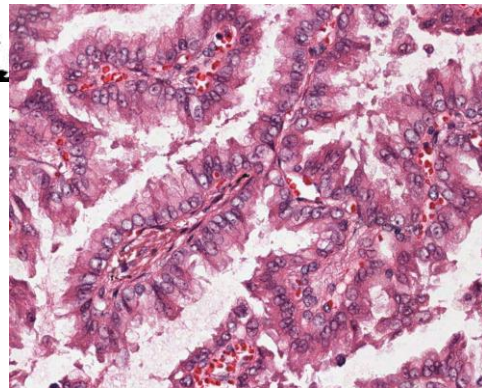
CHIEF Outperforms Existing Methods in Cancer Cell Detection



CHIEF Identified the Origin of Cancers



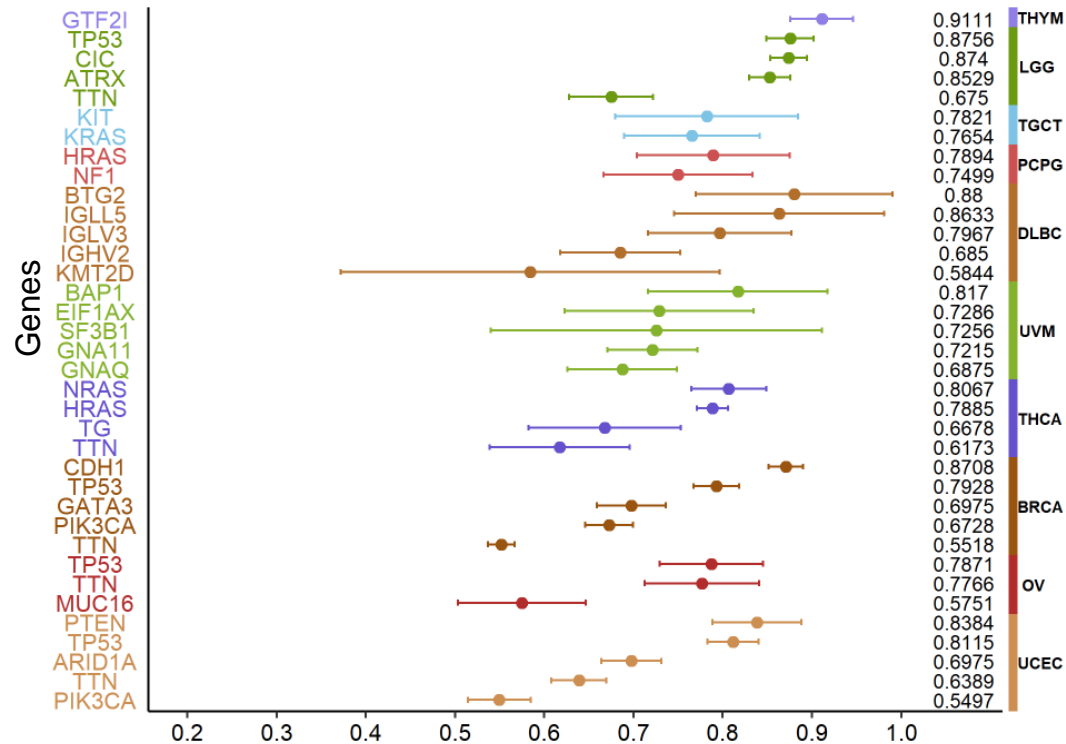
- Is there *hidden* information in histopathology images?
 - e.g., **genomic variations**?



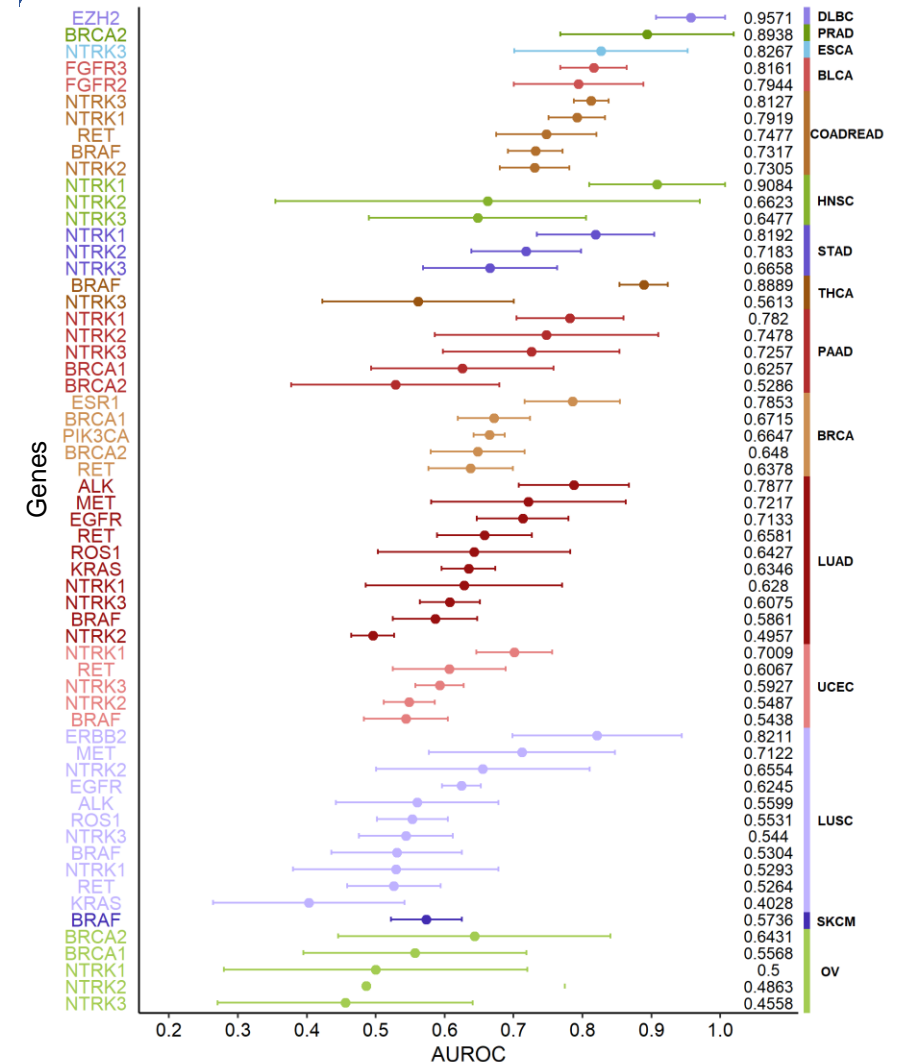
?

CHIEF Predicts the Mutation Statuses of Clinically Important Genes

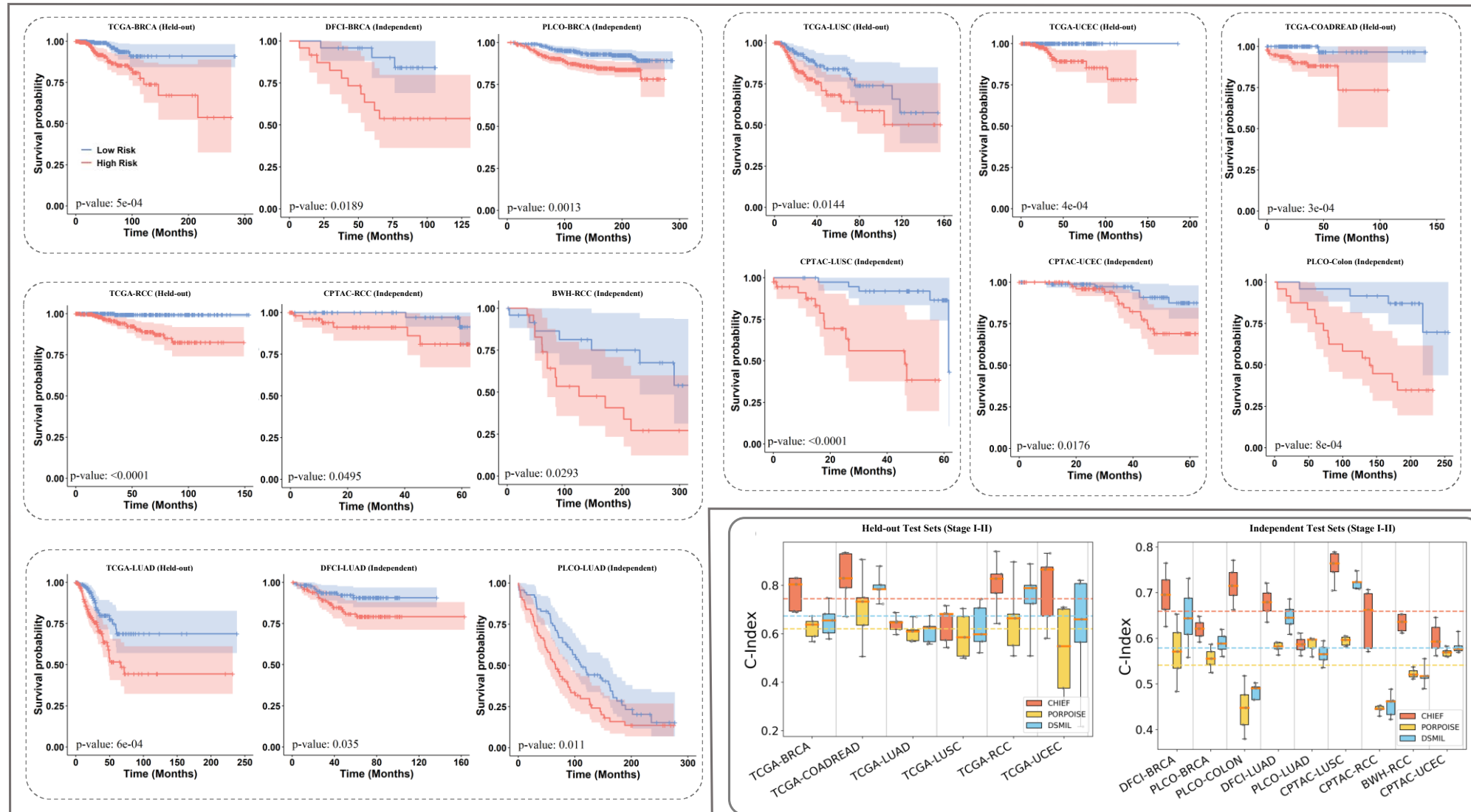
Prevalent mutations



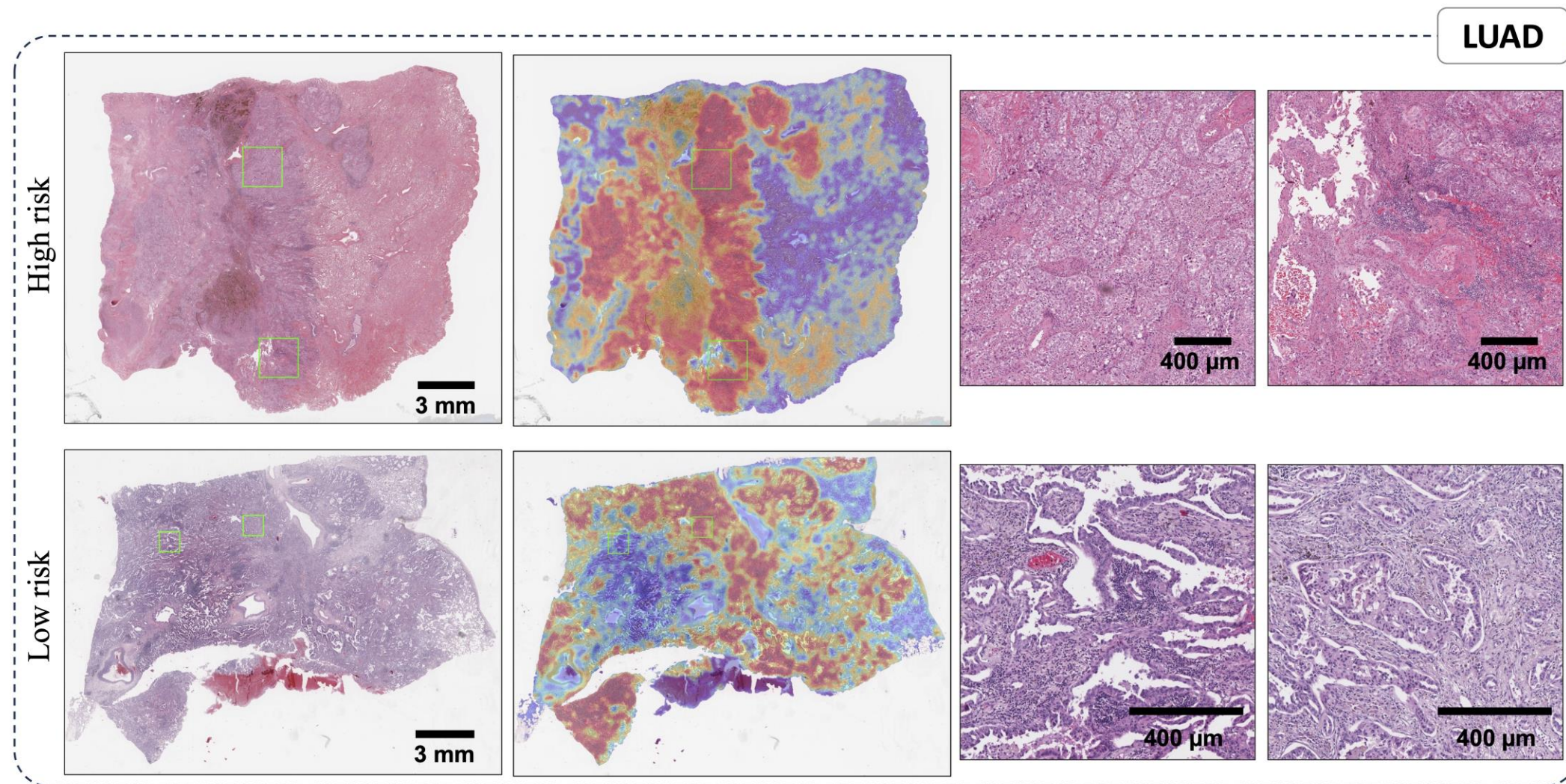
Mutations related to targeted therapies

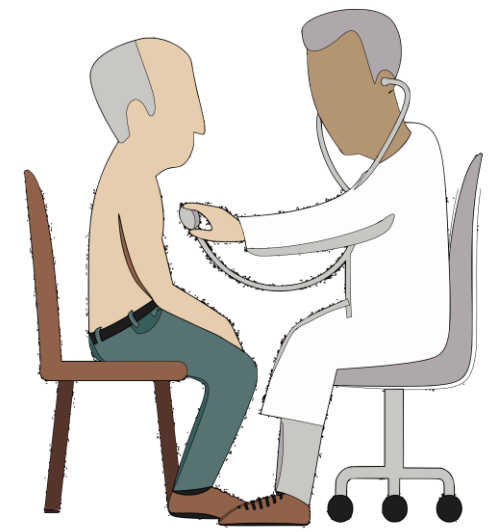


CHIEF Predicts Cancer Patients' Survival Outcomes



CHIEF Discovers **Tumor Microenvironment** Patterns Associated with **Survival Outcomes**

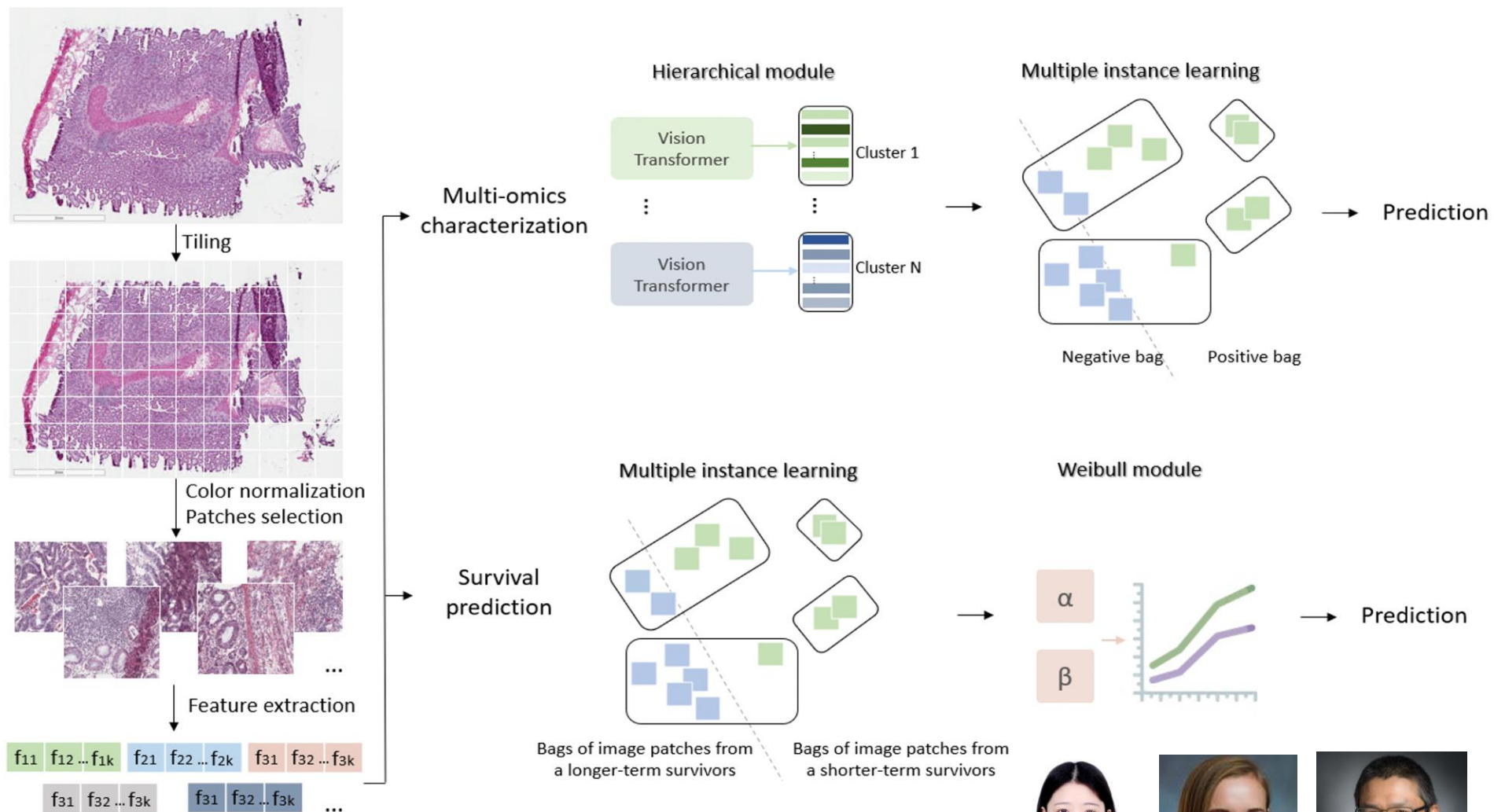




How Can AI Assist in **Real-World Clinical Settings?**

Multi-omics prediction for personalized colorectal cancer treatments

Example: Multi-Omics Multi-cohort Assessment (MOMA) Platform for Molecular and Prognostic Prediction



- The Cancer Genome Atlas (TCGA)
- PLCO Cancer Screening Trial
- Nurses' Health Study (NHS)
- Health Professional Follow-Up Study (HPFS)

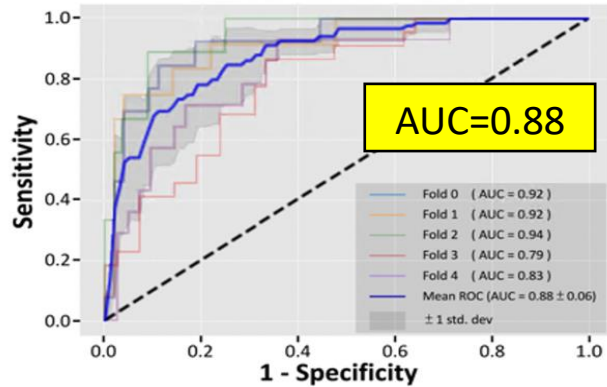
Whole-slide images



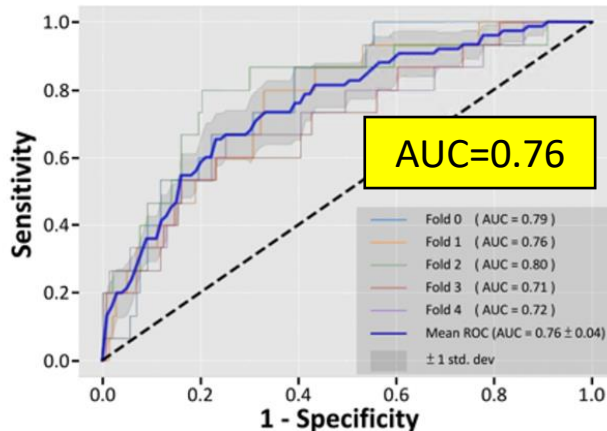
AI Predicts Multi-Omics Profiles from Pathology Images

- MSI prediction

The Cancer Genome Atlas

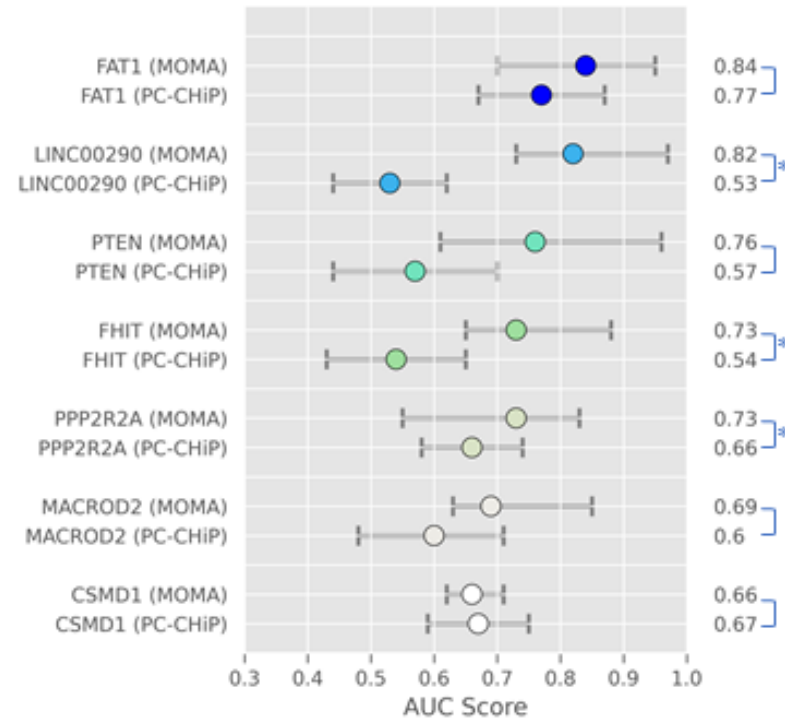


NHS and HPFS

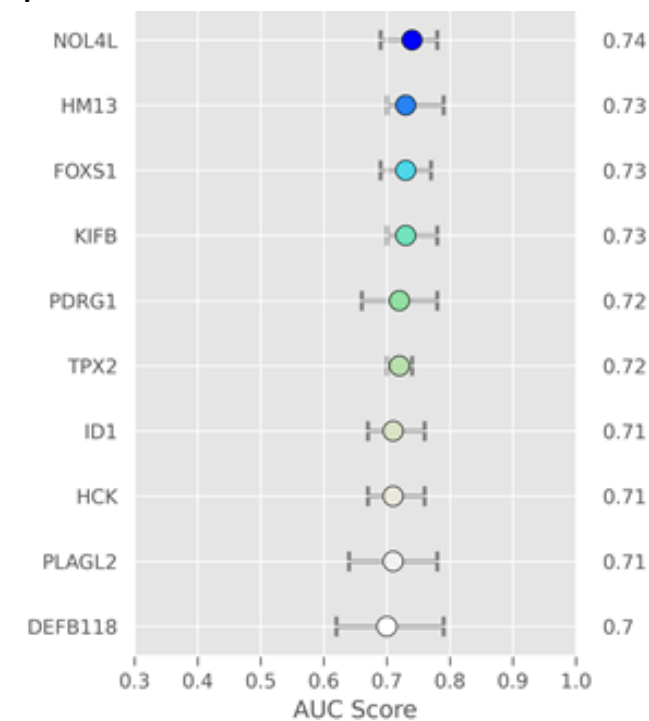


- Copy number alteration

Deletion

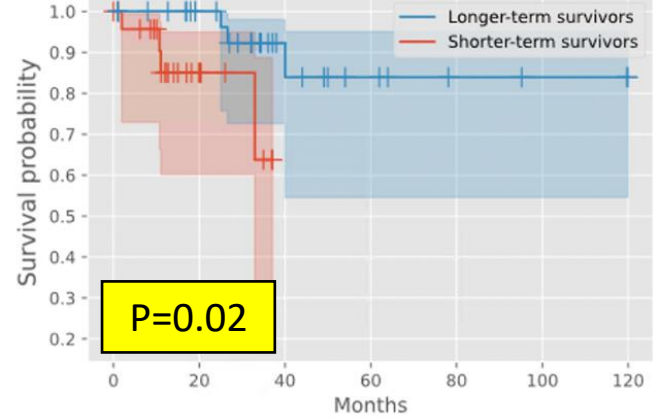


Amplification

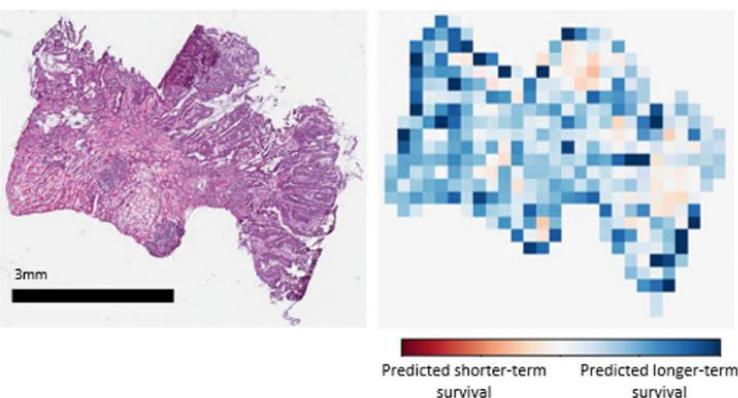


AI Predicts Overall Survival and Disease-Free Survival of Colorectal Cancer Patients in Multiple Cohorts

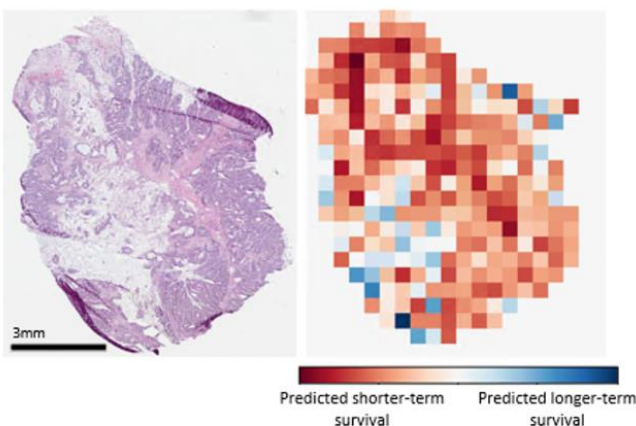
The Cancer Genome Atlas



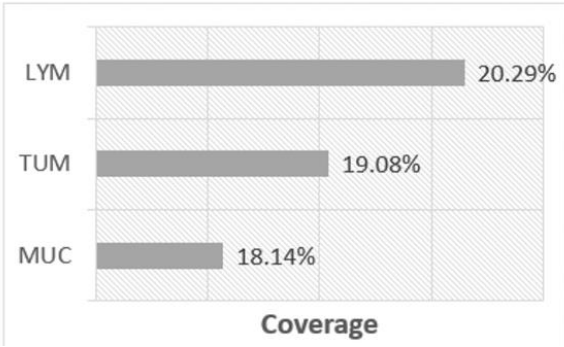
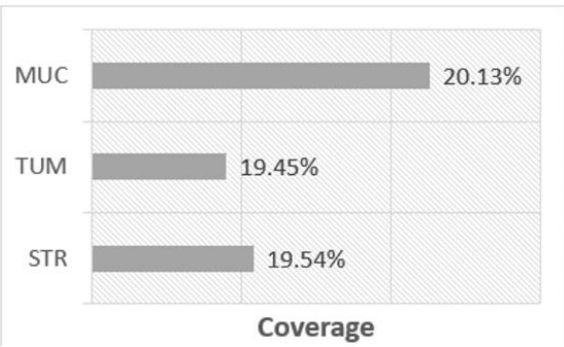
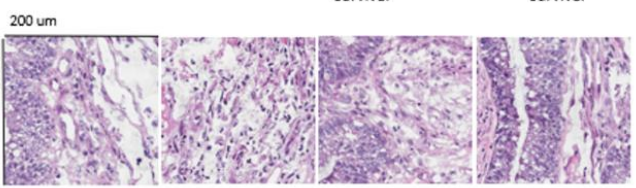
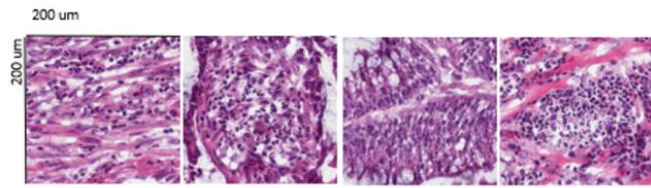
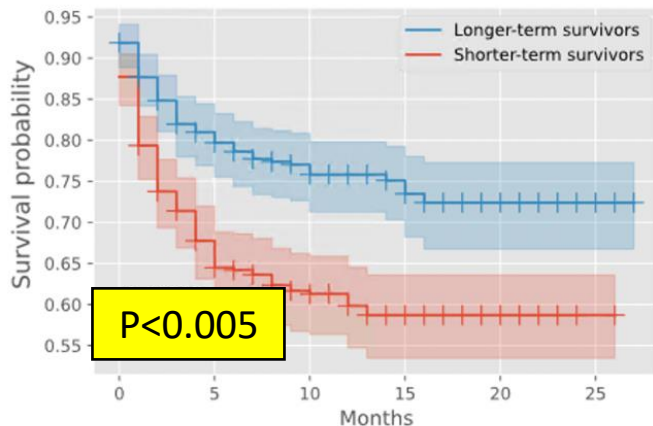
Long-term survivor (124.27 months)



Short-term survivor (2.99 months)

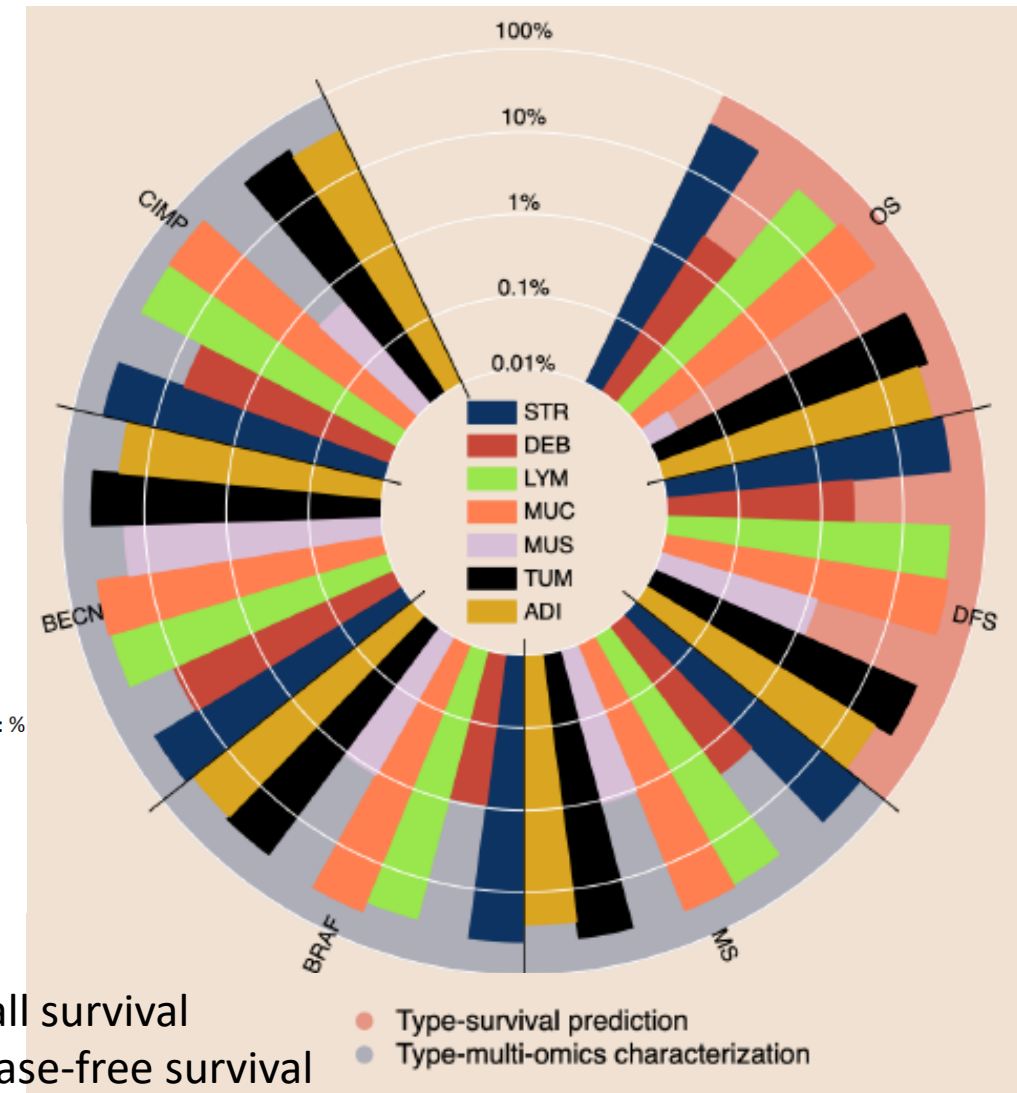
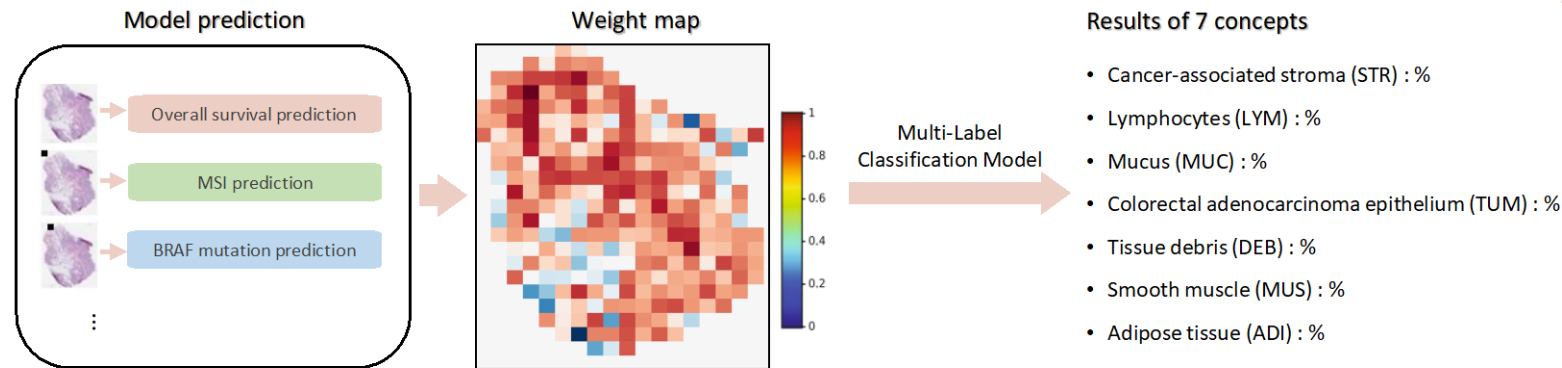


NHS and HPFS



Explainable AI Describes Novel Imaging Patterns Using Pathology Concepts

- Connecting pathology knowledge with AI-derived features using the weight map



Challenges and the road ahead

The Problem of Context

AI and the Problem of Context

- “The Frame Problem”: It is challenging to identify a set of axioms to properly describe the environment for autonomous agents



Steveskittles

I was convinced without a shadow of a doubt that was a tiger



319



Share

Report

Save



mordinxx

With the shadow of doubt it was a tiger but without the shadow of doubt it is a dog.



5



Share

Report

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bigfoot1291

Seems shady.



3



Share

Report

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A Tiger or a Dog?

Yu KH et al. *NEJM*. 2024 May 30;390(20):1895-1904.

McCarthy J, Hayes PJ. *Readings in artificial intelligence*. 1969:431-50. Image credit: chucho-jones-fan

AI and the Problem of Context

- “The Frame Problem”: It is challenging to identify a set of axioms to properly describe the environment for autonomous agents



Siberian Tiger	94%
Bengal Tiger	93%
Tiger	88%
Carnivore	86%
Fawn	82%

Results:

Classification successful!

Label	Confidence
Tiger	99.5603256225586
Animal	99.5603256225586
Mammal	99.5603256225586
Wildlife	99.5603256225586
Table	60.7860221862793
Furniture	60.7860221862793

A **Tiger** or a **Dog**?



Yu KH et al. *NEJM*. 2024 May 30;390(20):1895-1904.

McCarthy J, Hayes PJ. *Readings in artificial intelligence*. 1969:431-50. Image credit: chucho-jones-fan

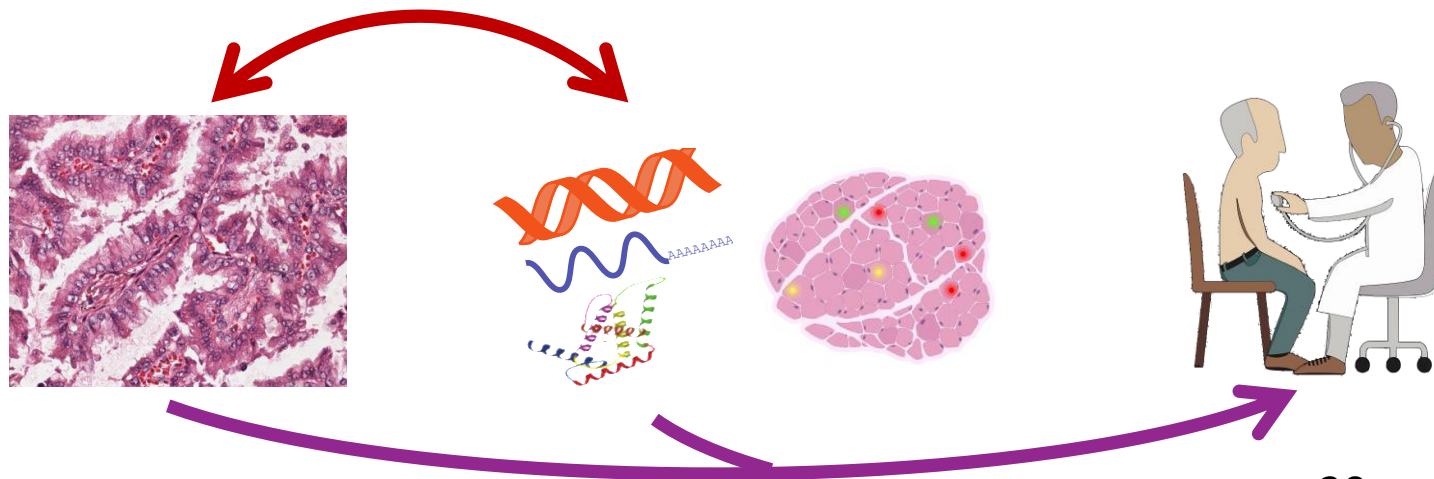
AI and the Problem of Context

- Various exceptions in pathology
 - Artifacts
 - Laboratory contexts
 - “Clinical correlations”
 - Scanner errors
 - ...
- Potential solutions
 - Out-of-distribution detection
 - Multi-modal learning
 - Human in the loop



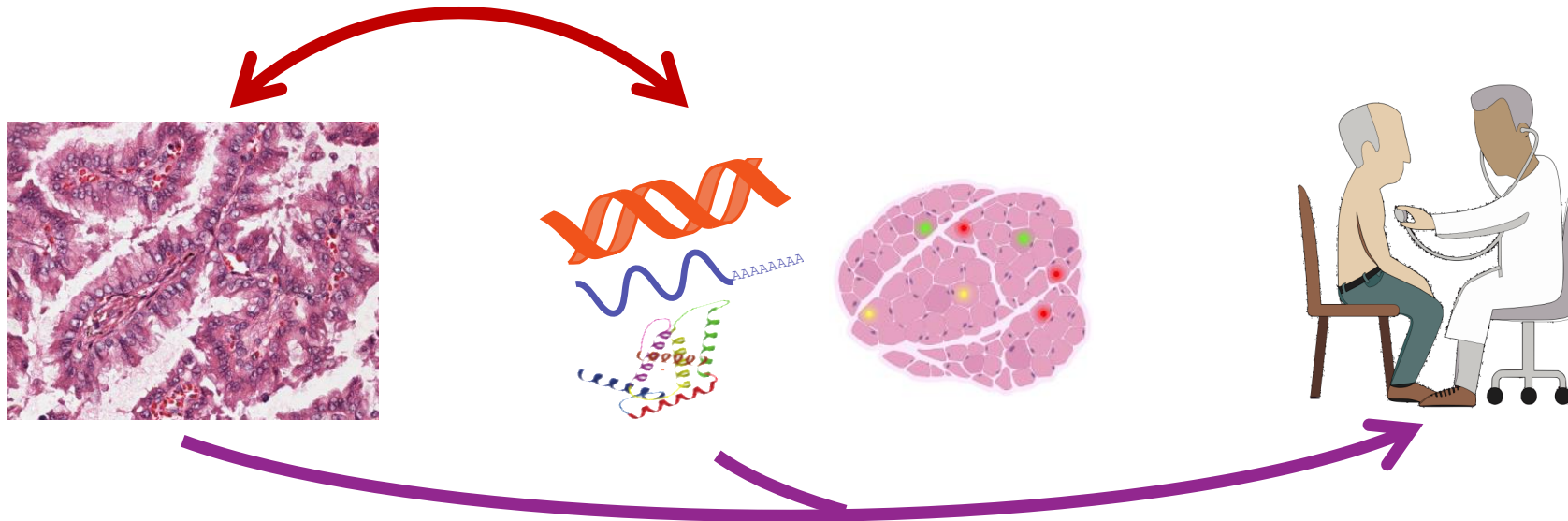
Summary

- Multi-modal foundation AI systems identify patients' **diagnoses**, **molecular profiles**, and **prognoses** using pathology images
- AI-empowered pathology imaging analyses facilitated accurate **brain cancer diagnosis during surgery**
- **Multi-disciplinary research** is required to further address the technical and implementation challenges



What's the future of AI in medicine?

The best way to **predict the future** is to **create it**.



Acknowledgements

We are hiring!

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- Junhan Zhao, PhD
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- Dmytro Vremenko

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- Deborah Dillon, MD

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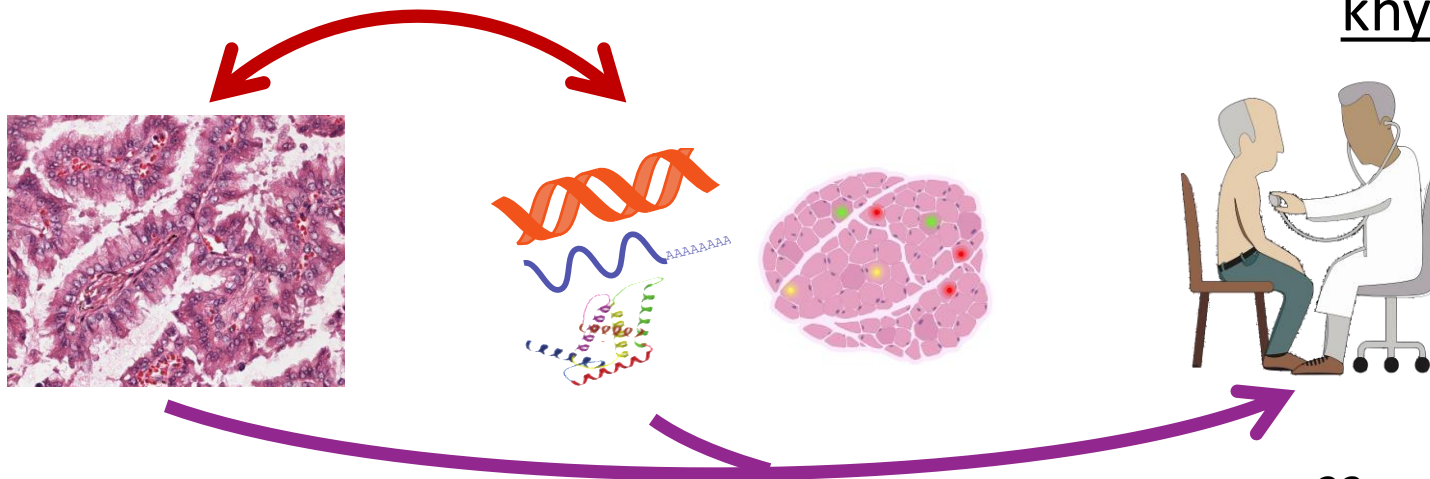
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- (NIH) 200816



Summary

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Thank you!