Scalable AI training and inference of cancer images for in-situ surgery support

Attila Gyulassy, Valerio Pascucci, Giorgio Scorzelli @ University of Utah - J. Quincy Brown, Brian Summa @ Tulane University

We introduce key innovations in microscopy, sample automation, cyberinfrastructure, ML model co-design & training on petascale data, practical & rapid ML model deployment, and cancer detection and visualization.

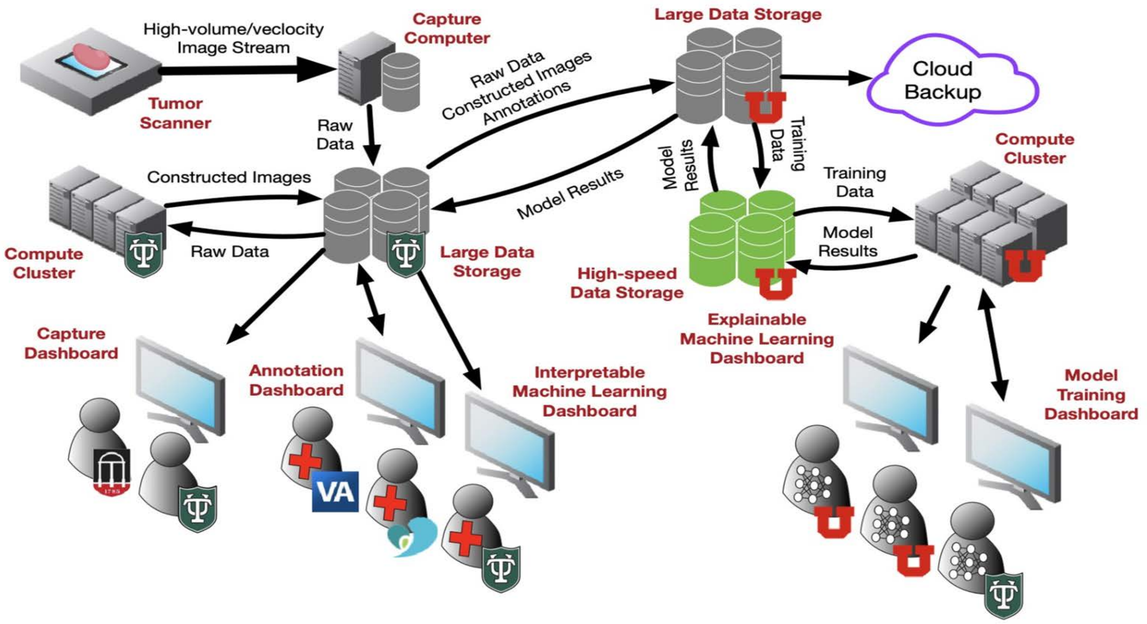
We will build a high-performance computing cyberinfrastructure capable of developing and training new, accurate models over petascale data on a scale of days.

We adopt novel strategies for lightning-fast image processing and ML inference at the edge, processing TB of data in minutes within the constraints of rural hospital operating rooms.

GOALS

- intraoperative pathology have not solved the persistent problem of incomplete tumor removal
- Several technologies have been tried over the past 20 years,
- no existing technology that can deliver the technical performance needed to fully address this problem and "survive in the wild."
- Create the world's **fastest** high-resolution tissue scanner
- automatically prepare, handle, and scan the complete surface of removed cancerous organs at 0.5 µm resolution
- **automatically detect** the presence of any residual cancer cells map their location on the specimen surface
- surgeon **visualization** in the operating room within 15 minutes.

Our work transforms cancer surgery as we know it and end the worry of incomplete tumor removal for every American facing cancer operation. This would have tremendous health, economic, and societal benefits.

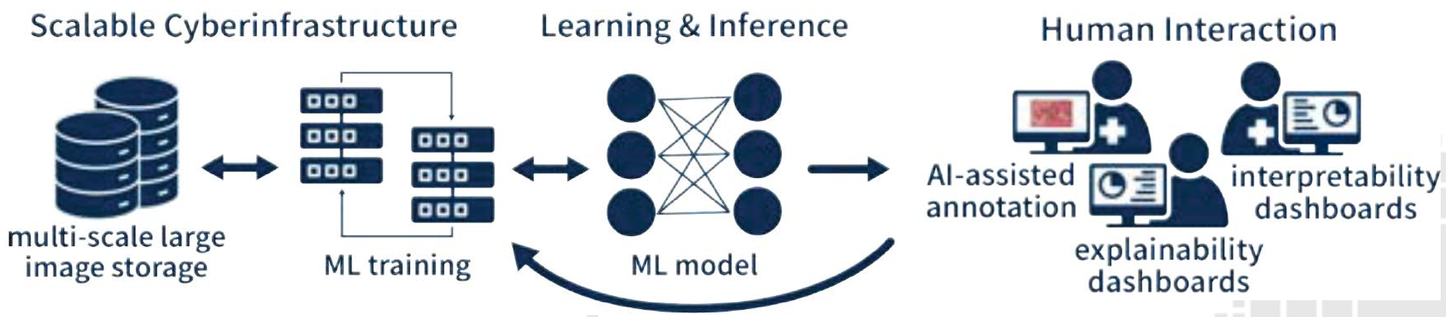


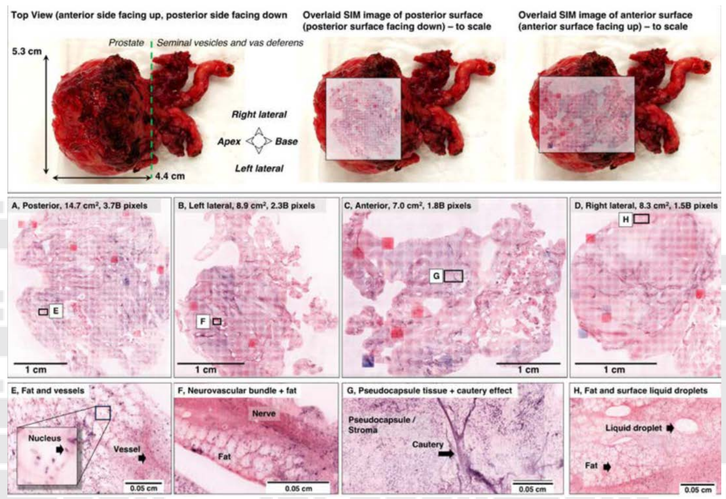
HUMAN-CENTERED INNOVATION

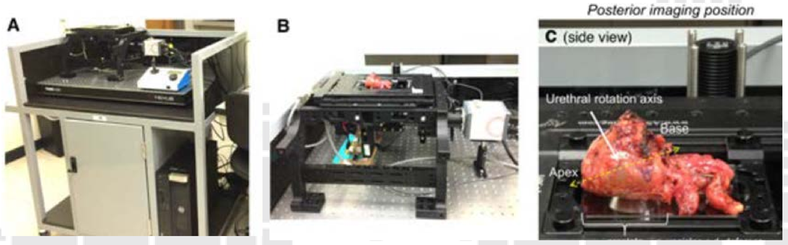
- design and development, involving end-users and stakeholders
- Address the iterative nature of the creation-evaluation process of ML cancer-classification models
- accomplish trustworthy, practical, capable, and cost-conscious product design
- optimizes benefits to physicians, payers, and patients.

MACHINE LEARNING

- WSI with 120,000 × 80,000 pixels
- equivalent of 191 thousand 224 × 224 images
- a typical size used in machine learning frameworks.
- **explainability** dashboard for exploring the performance of new topology-based **ML algorithms**
- comparison of models that vary by training data, **hyperparameters**, and allows a user to perturb data and see it's impact on the prediction







TECH DETAILS

We combine extreme- field- of-view optical-sectioning and super-resolution structured illumination microscopy (OS-SR-SIM) to obtain very high-speed virtual pathology imaging of cancer tumor margin surfaces at 2x the resolution allowed by diffraction.

THE UNIVERSITY OF UTAH

SCI www.sci.utah.edu