

COMPUTATIONAL DIGITAL PATHOLOGY DIAGNOSIS: AI APPLICATIONS AND IMMUNOPATHOLOGY

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Contents

Overview of the research directions:

AI-based digital pathology diagnosis

ImmunoPathology:

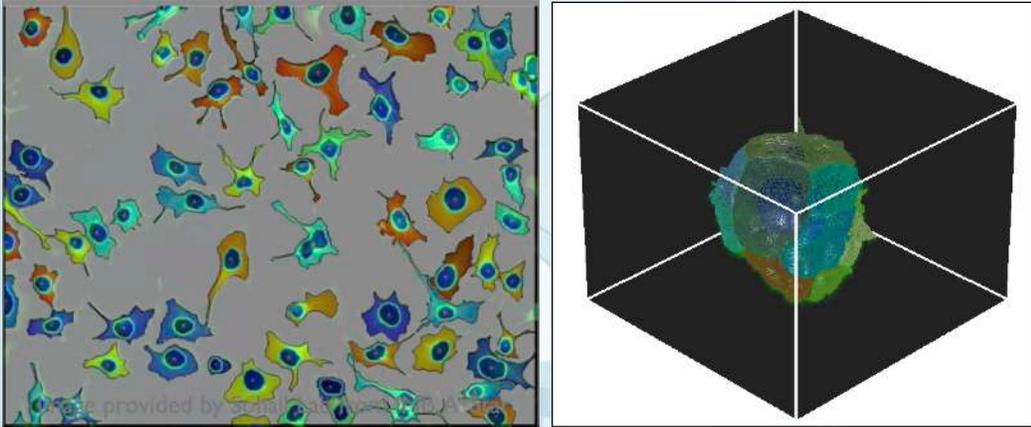
Acknowledgement

Q&A



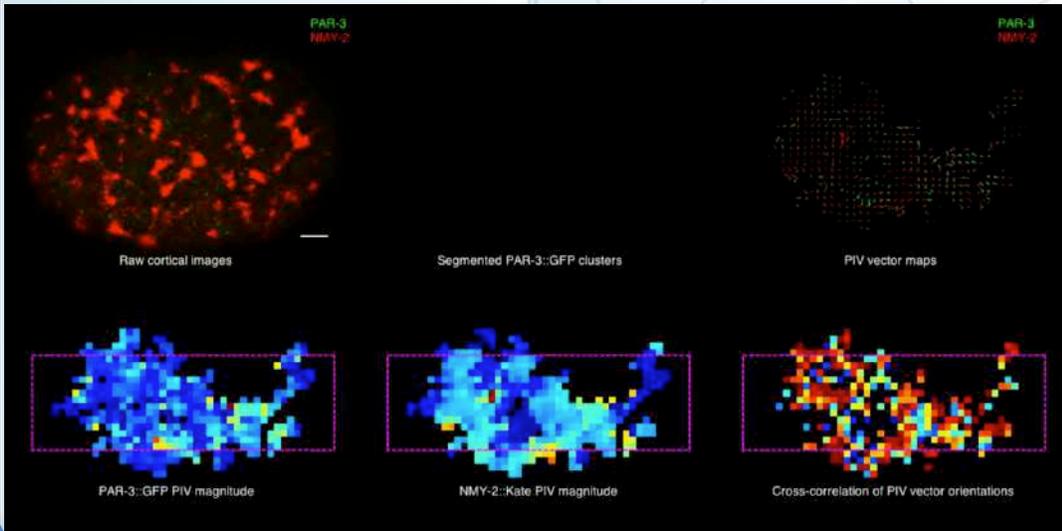
Overview of the research topics

2D/3D Cellular Segmentation: Cell-by-cell quantitative information



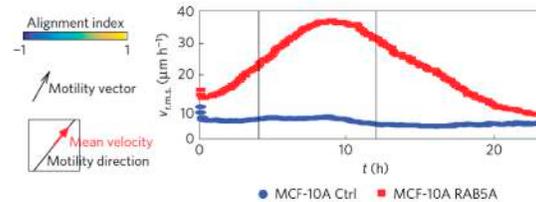
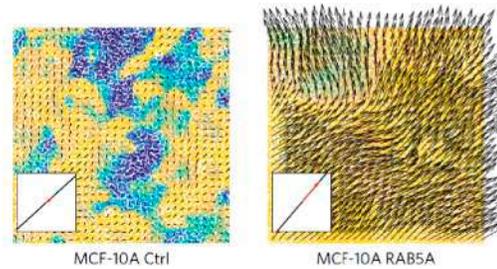
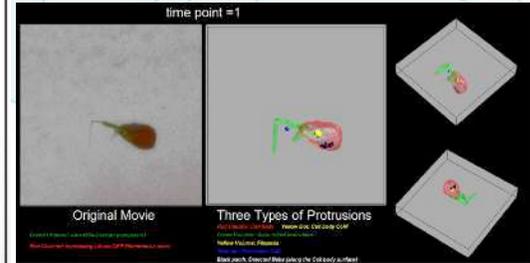
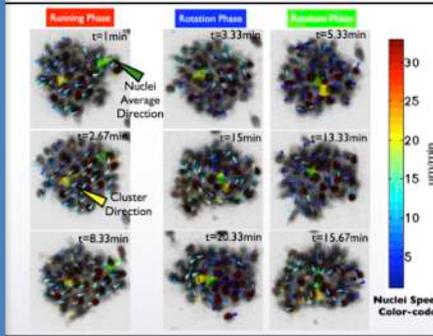
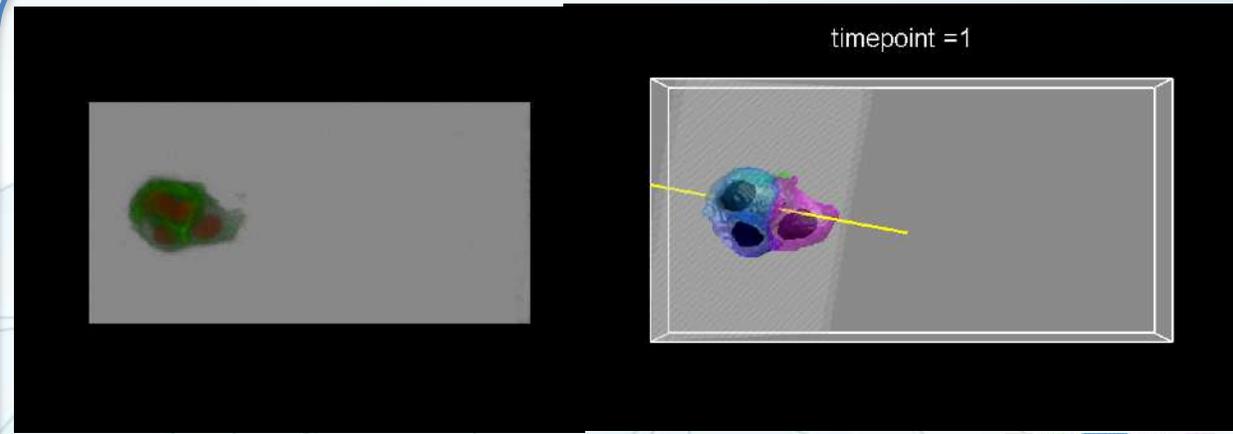
Published in **Cytometry Part A** and **Bioinformatics**

Understanding the Control mechanism of Embryonic Polarisation

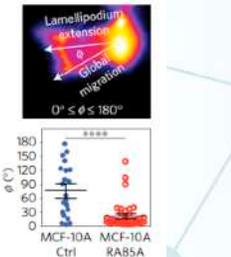
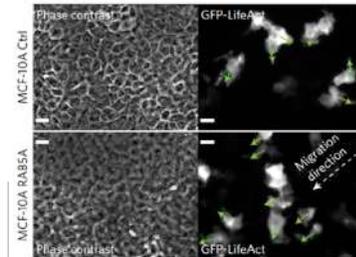


Published in **Nature Cell Biology**

Tracing the collective migrating cells in 5D



Published in **Nature Communication**, **Nature Material**, **Current Biology**, etc.

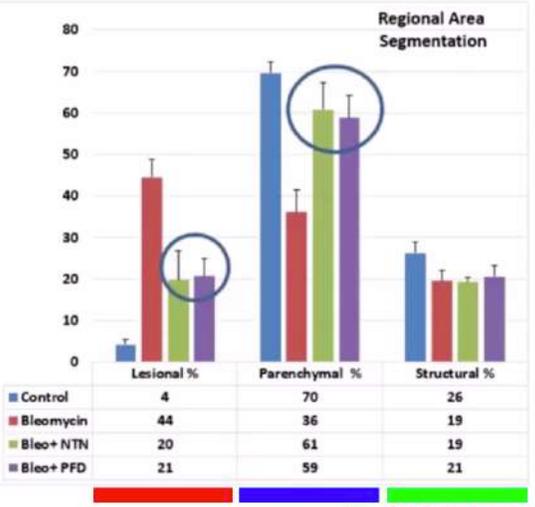
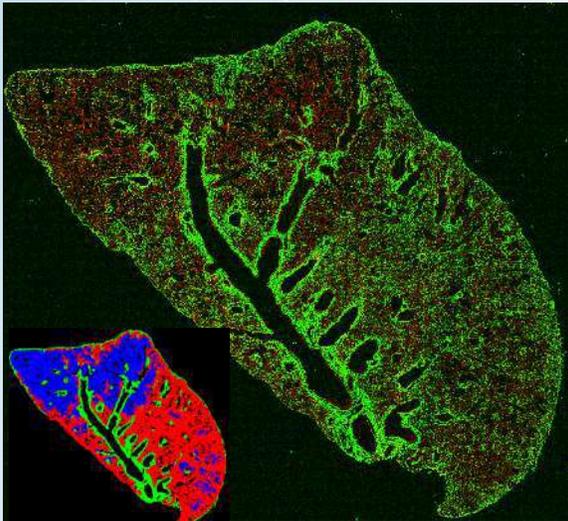


Overview of the research topics



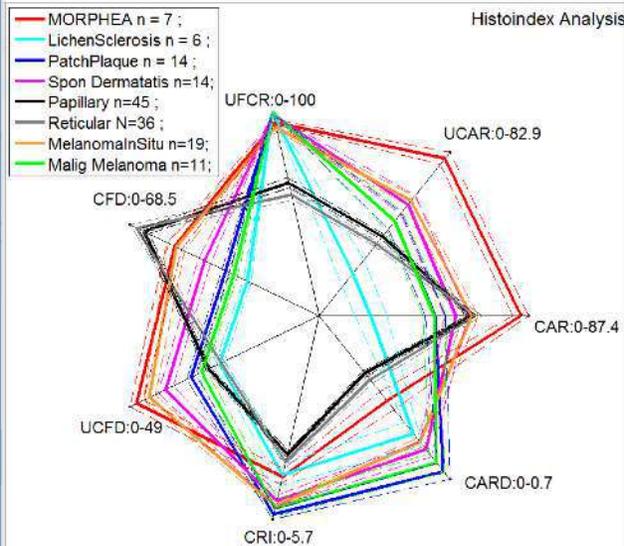
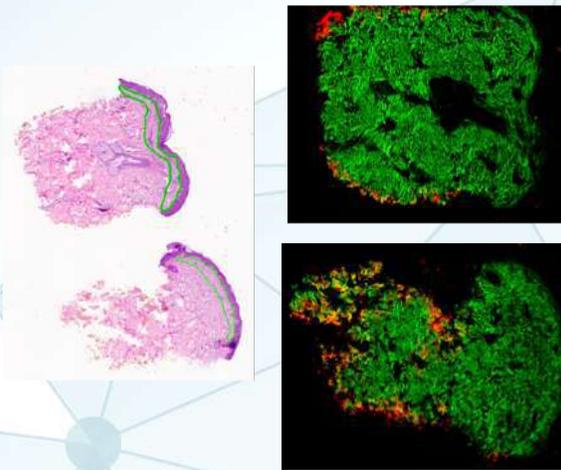
CREATING GROWTH, ENHANCING LIVES

Quantify the lung Fibrosis



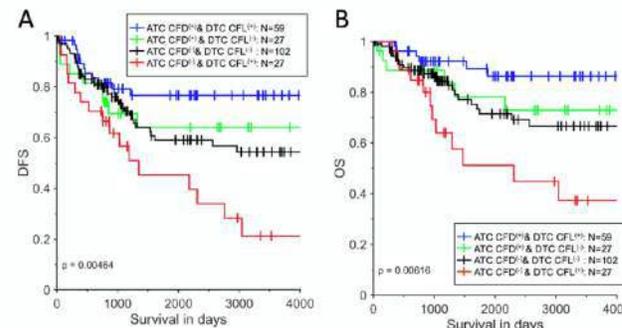
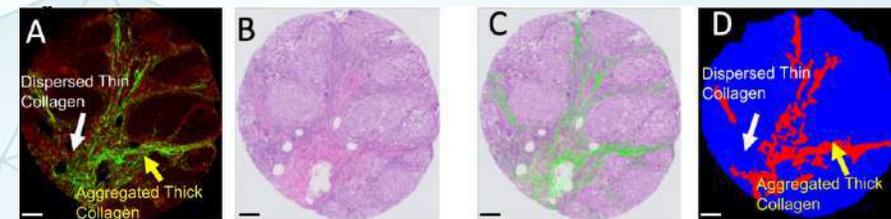
Licensed to Singapore Biotech Company

Skin Disease collagen Signature

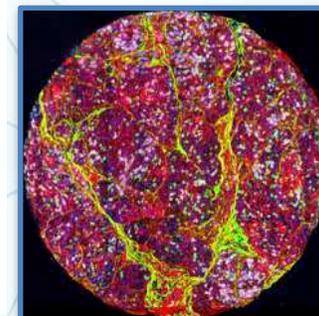


Licensed to Singapore Biotech Company

Discover the digital prognosis feature for TNBC patients

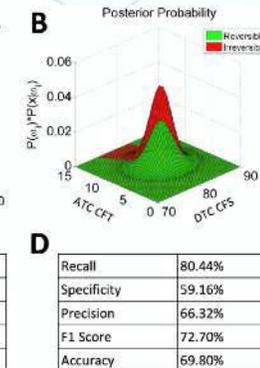
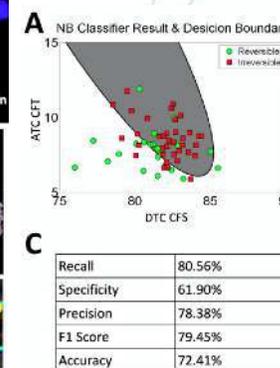
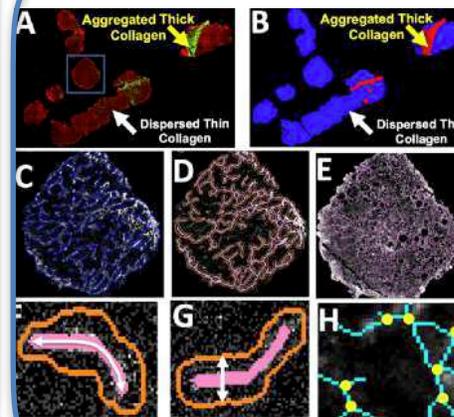


Beautiful Science by Strait times



Published in **Breast Cancer Research**, highlighted by **A*STAR Research**

Predict HCV Patient liver fibrosis reversibility

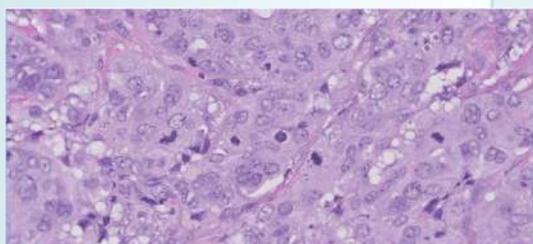
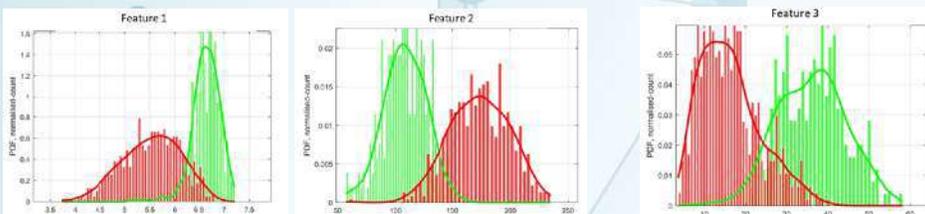
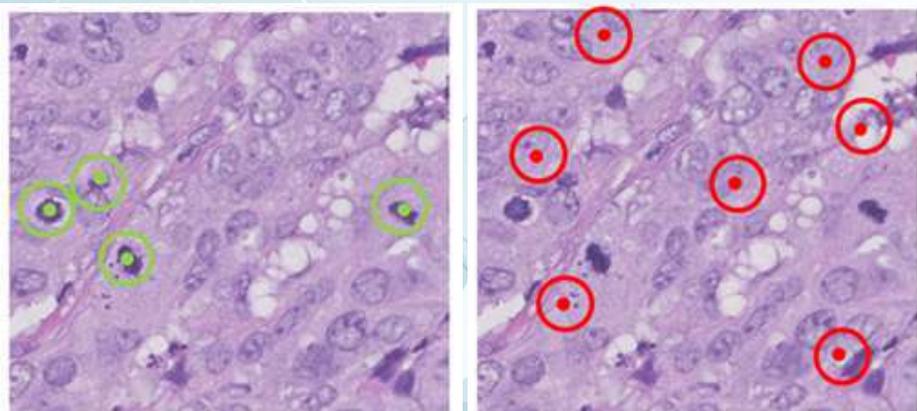


Under Review

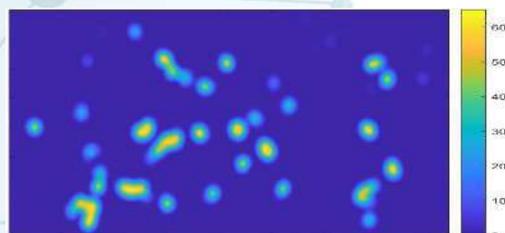


Overview of the research topics

Detect the Mitosis for Breast Cancer Sample assessment

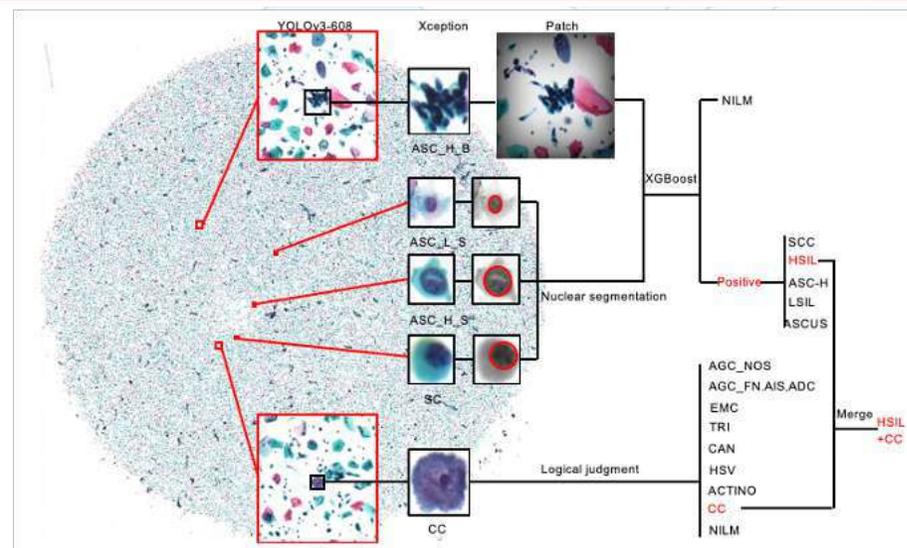
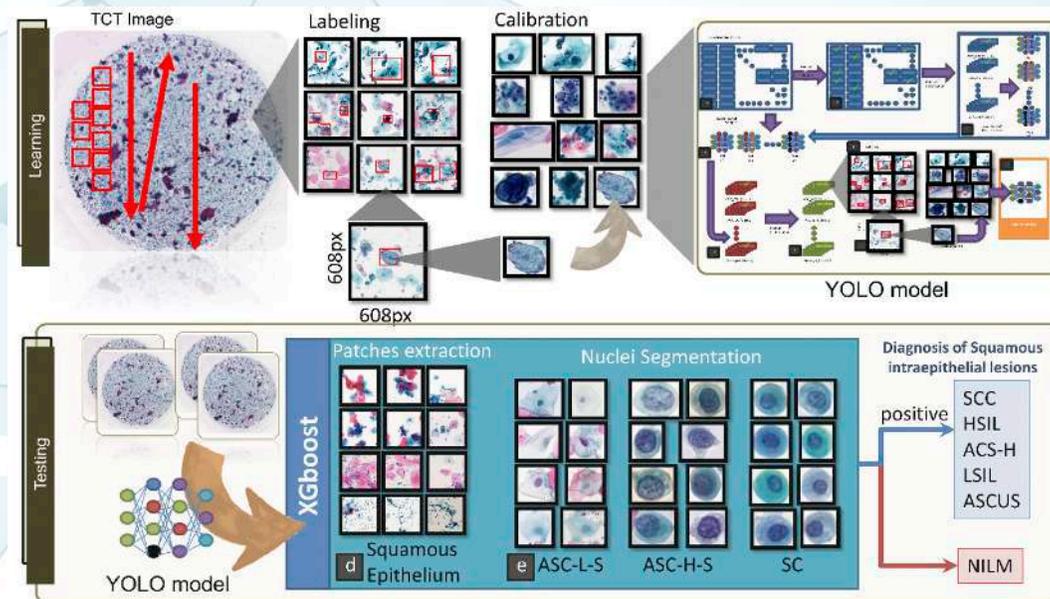


Calculate feature 1. feature 2. feature 3



Under Clinical validation

AI based completed diagnosis pipeline for TCT diagnosis



Under Revision of Nature Communication



Current landscape of AI DP and future development

PROBLEM

Missing capabilities within AI-based digital Pathology

WSI Scanning

H&E and IHC Staining

Clinical Samples

Existing Clinical Pathology Pipelines

AI-Based Learning

Data and Annotation

Image QC for WSI

06

05

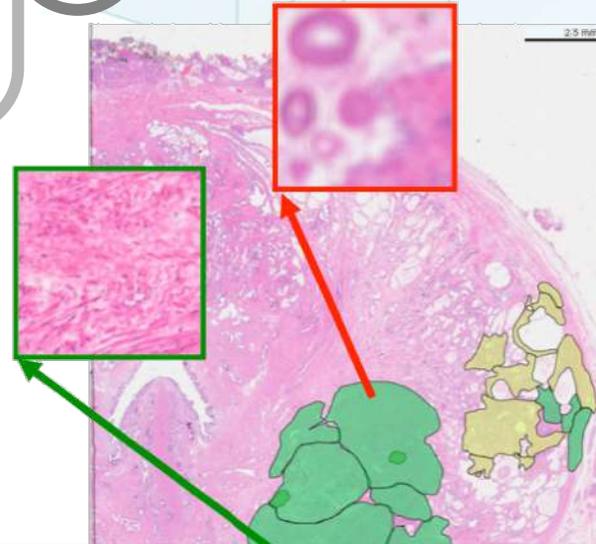
04

03

02

01

Future / In Development Pathology Pipelines



Lack of automated image QC to identify degraded pathology data e.g. out-of-focus images **adversely impact AI learning process**

Developed tools, partners and application fields



Developed Tools Library	
Image Management <ul style="list-style-type: none"> • Archiving • Compression • Image Stitching • Image Overlap 	Image Analysis <ul style="list-style-type: none"> • Annotation • Segmentation • Feature extraction • Profiling
Apps Library – Disease Oriented Solutions	
 <p>Mitosis detection Cancer</p> <p>Gleason Grade Prostate cancer</p> <p>TMN Stage Breast cancer</p>	 <p>PD-1 & PDL-1 analysis Prostate cancer</p> <p>Prognosis</p> <p>Subtype</p>

Partnership	
	Equipment Suppliers <ul style="list-style-type: none"> • Perkin Elmer • Leica • Phillips
	Reagent Suppliers <ul style="list-style-type: none"> • Ultivue • Akoya • Leica • Perkin Elmer
	Pathology Labs <ul style="list-style-type: none"> • NUH • SGH • TTSH • Parkway • Etc

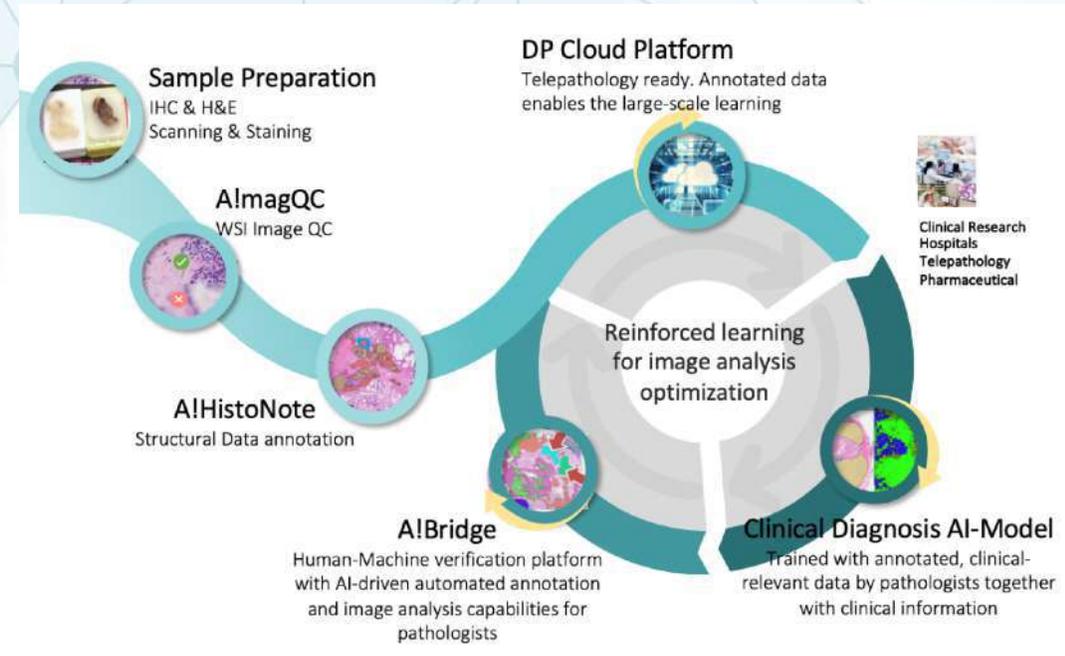
Target Market
Research Academic & Pharma
Clinical Confirmation Diagnostics Prognosis Treatment Selection Prediction of Response
Commercial Instrument Companies AI Biotech Companies Cloud Providers



Hardware platform and the technical closed loop



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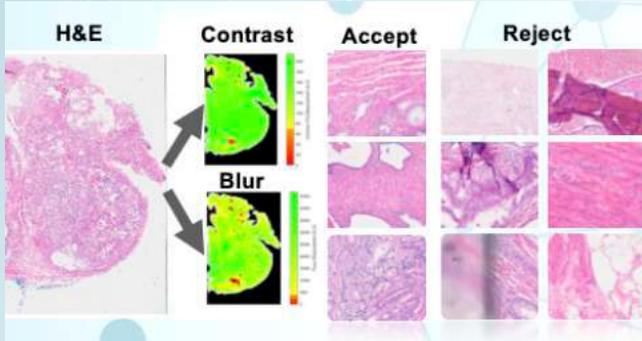


Structural annotation of large DP images with quality control



Dr Hue Swee Shan Susan
Dr Lau Kah Weng

DP image quality control

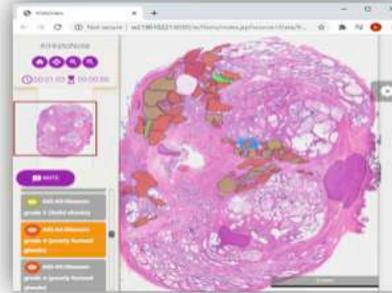


DP annotation



Example: Gleason score: 7(3+4)

1 Initial Step Manual Annotation



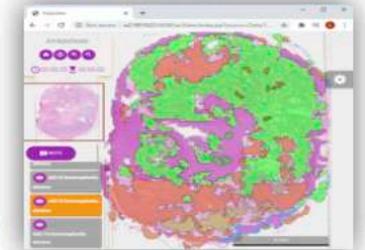
Patch
Extraction
& Training



Patch
Extraction

Iterative Process
Improve AI Mode

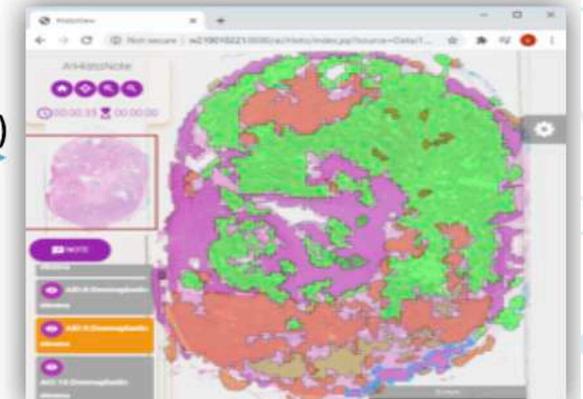
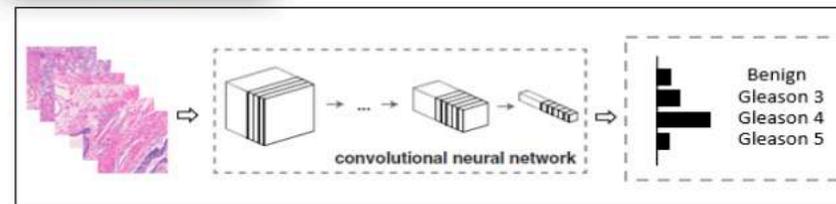
Deep AI Model
& ROI output



2 Iterative Step Semi-auto Annotation (Pathologist's adjustment)



3 Fully-auto Annotation a.k.a Fully-auto Diagnosis (Pathologist's decision making)





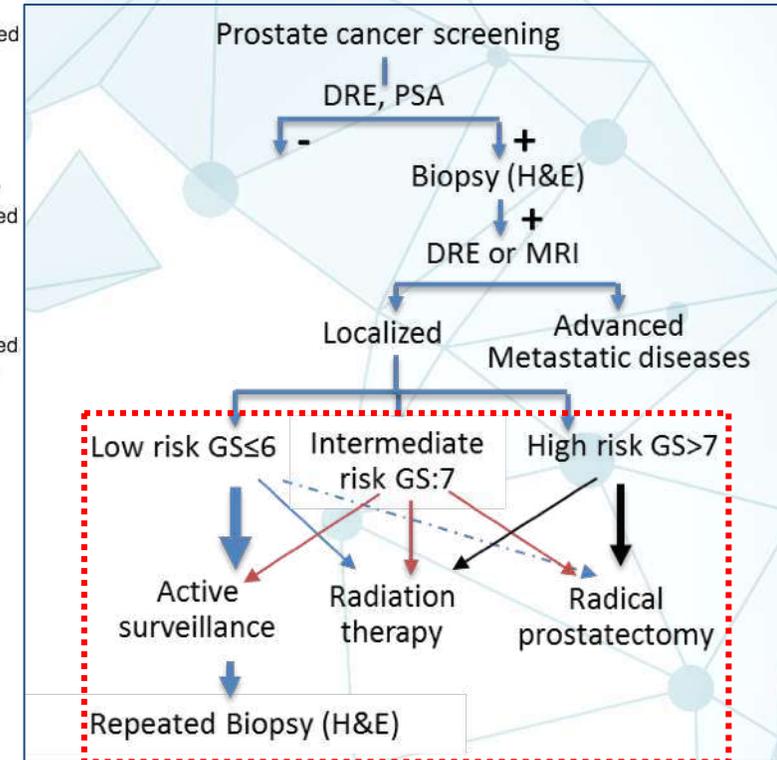
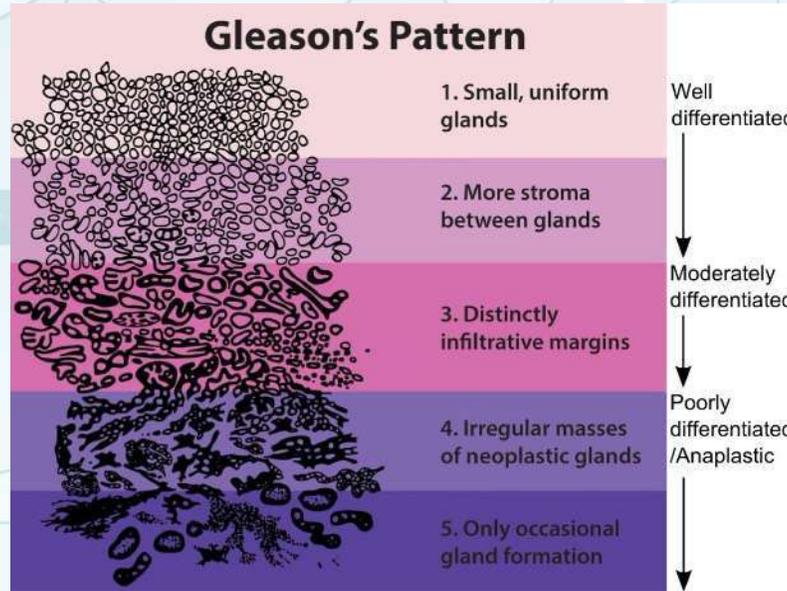
Prostate Cancer and problem statement

Prostate cancer biopsies are time consuming and tedious routine job in clinical pathology department. The needs in clinical:

1. Differentiate malignant and benign biopsy samples, which is often of large amount.
2. Provide prediction using AI to guild the pathologist to provide more accurate and reliable staging score.

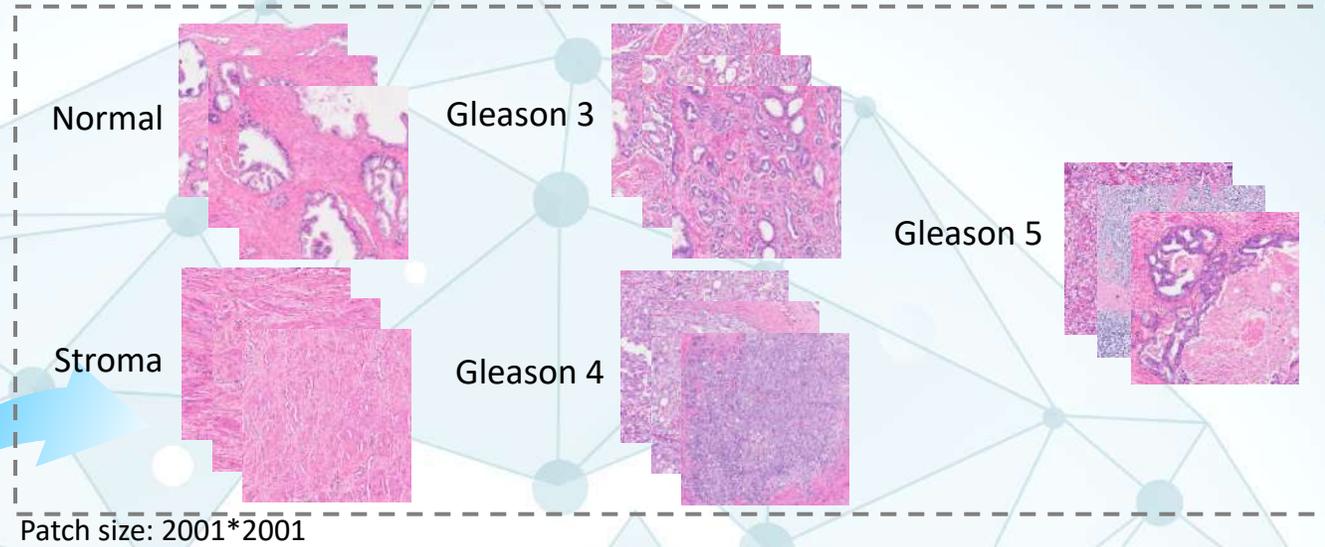
Gleason score

The sum of the most commonly found pattern and the second most commonly found pattern



<p>Prostate cancer risk assessment</p> <p><u>Gleason Score</u>: established pathology scoring system for disease prognosis</p> <ul style="list-style-type: none"> • High Gleason Score (HGS): > 6 • Low Gleason Score (LGS): ≤ 6 <p>Other factors: Age, PSA, etc</p>		<p>Medical Treatment</p> <ul style="list-style-type: none"> • Active surveillance • Radiation therapy • Radical prostatectomy • Others
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Learning data preparation



All 88 slides					
	G3	G4	G5	N	S
No. of patches	8492	17371	1391	3545	5286
	G3	G4	G5	N	S
Train (62 slides)	6109	12282	1038	2638	3699
Test (26 slides)	2383	5089	353	907	1587





Large Scale is not able to detect the high grade

- Patch level

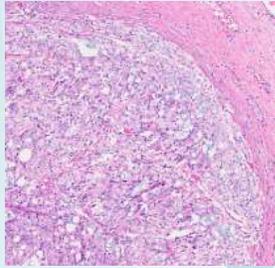
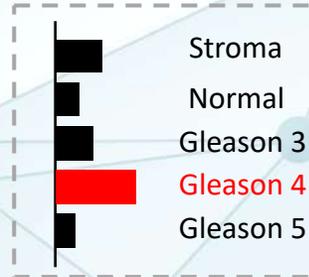
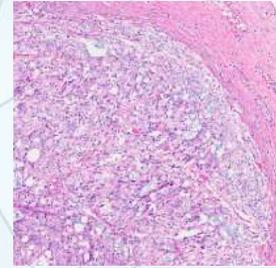


Image patches in testing set



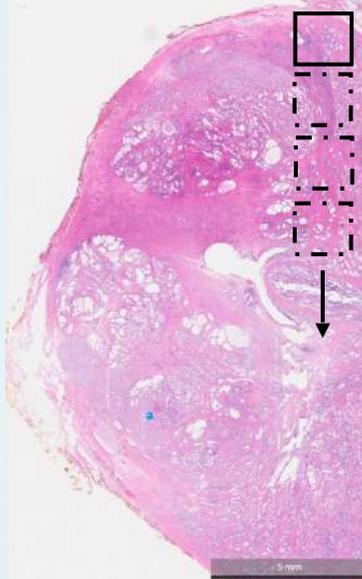
Prediction



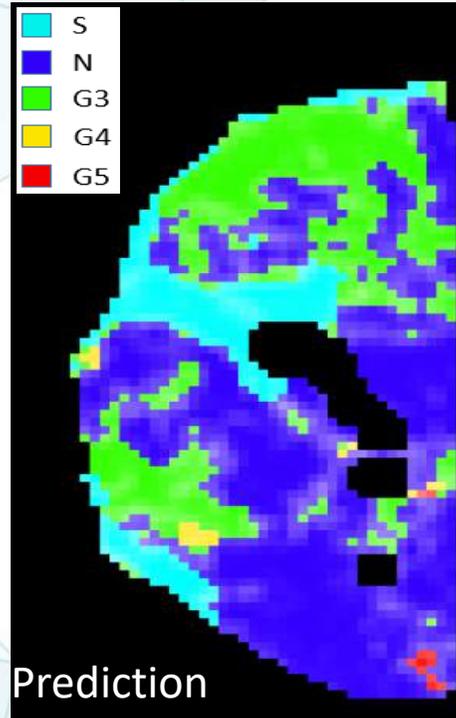
Ground Truth: G4

- Slide level

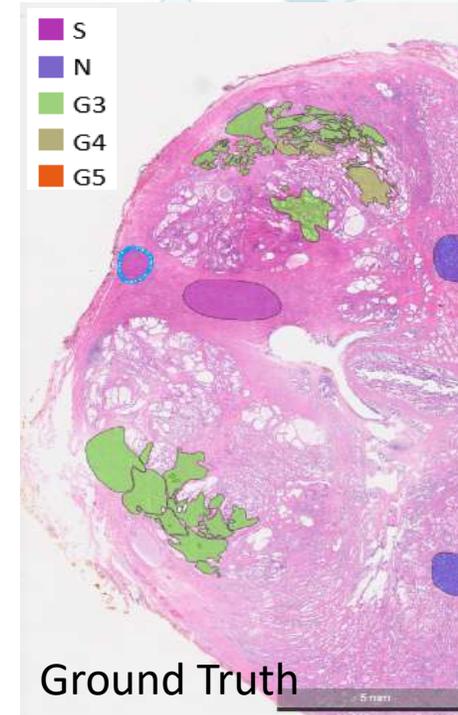
P8274_A21_Scan1



Whole slide image in testing set

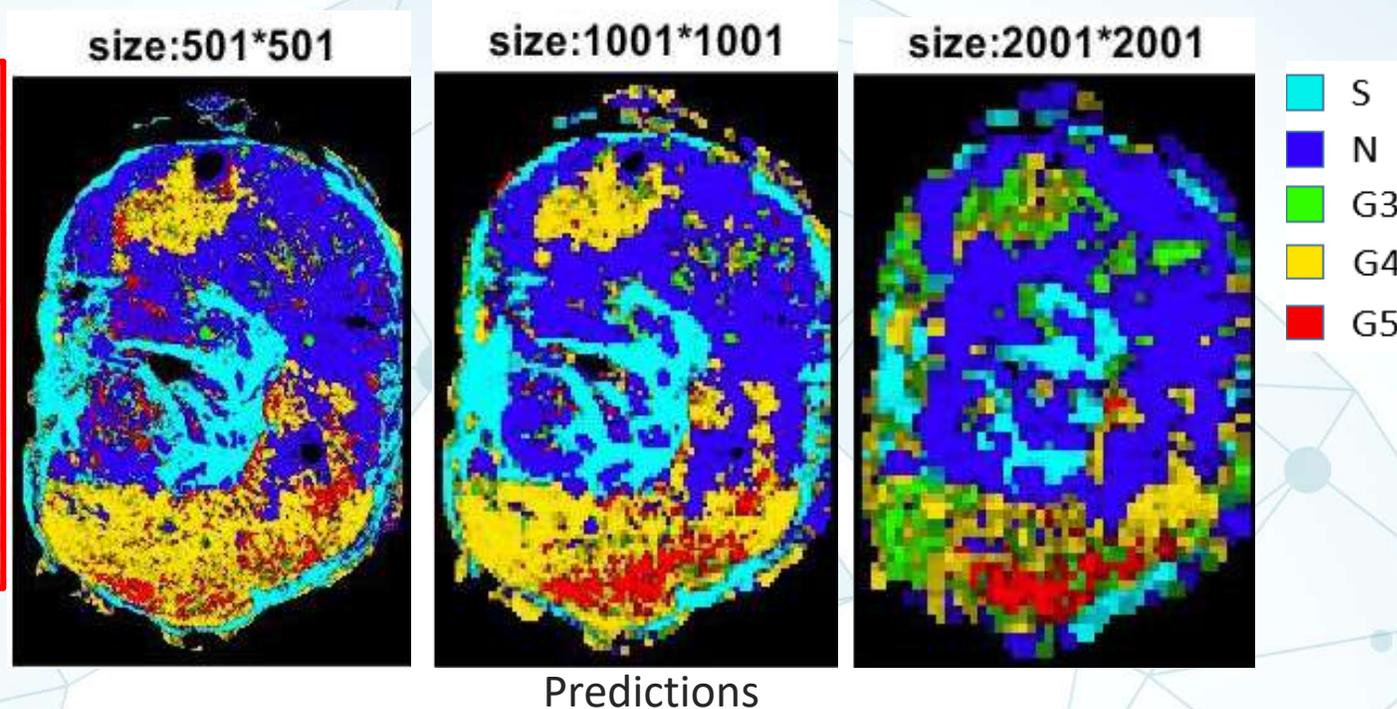
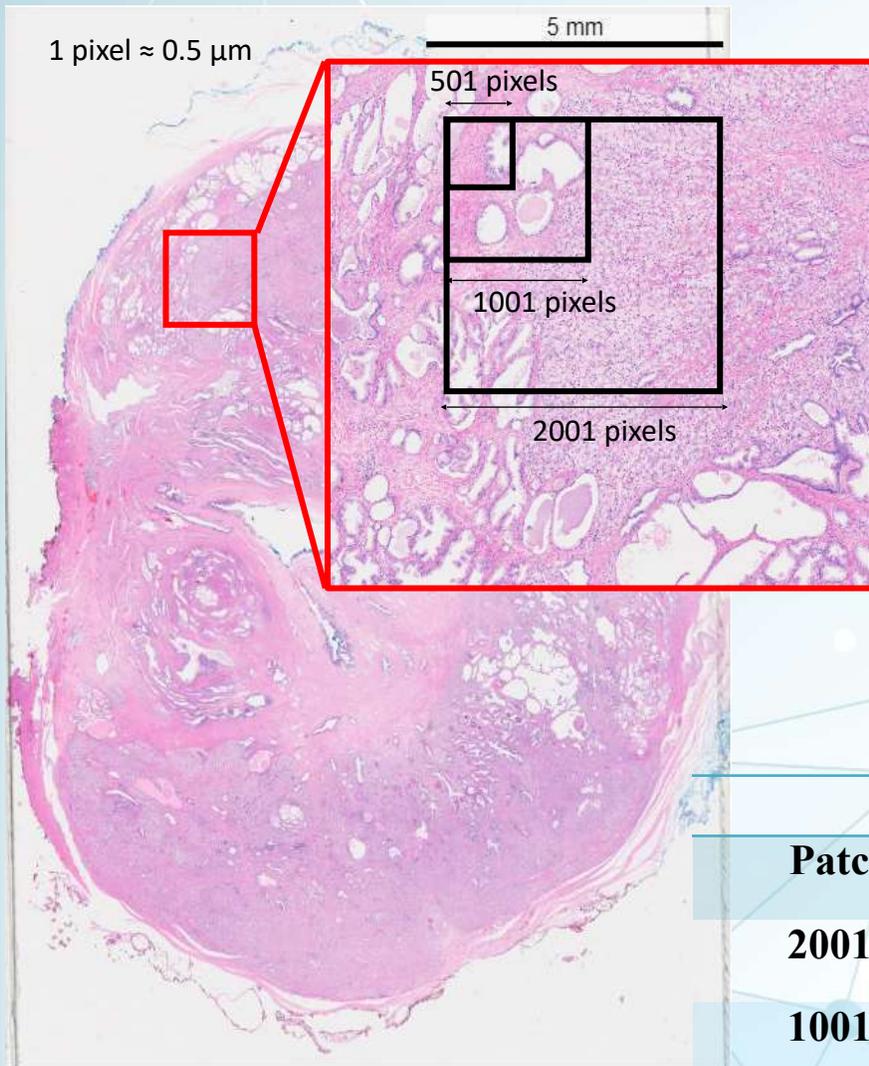


Prediction



Ground Truth

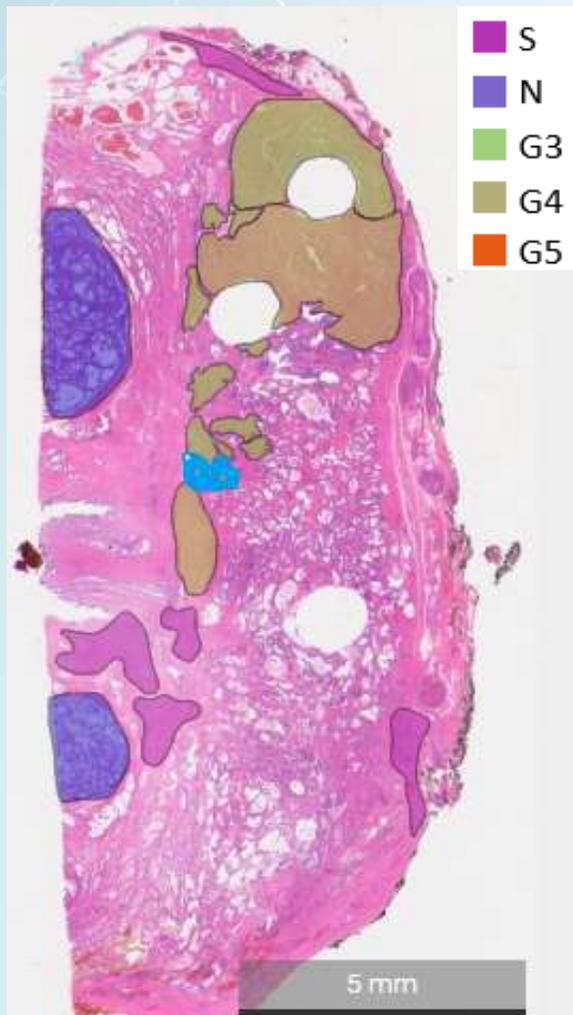
Impact of the scale



Patch Size	Recall (%)				
	Gleason 3	Gleason 4	Gleason 5	Normal	Stroma
2001*2001	82.1	76.3	28.9	70.0	97.1
1001*1001	79.6	76.8	38.9	74.6	97.1
501*501	78.2	67.1	64.9	74.5	91.6

Example: 11257_14_A13
Gleason Score: 9 (4+5)

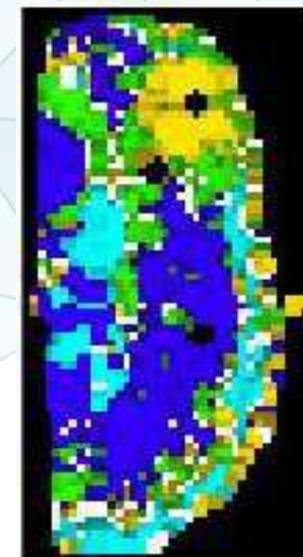
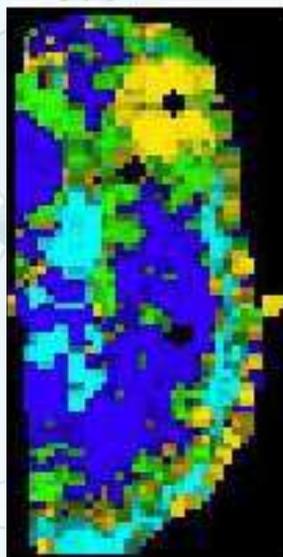
Impact of confidence level



Gleason score : 8(4+4)

17045_08_S1

Ground Truth



Confidence Level >0.5

Confidence Level >0.7

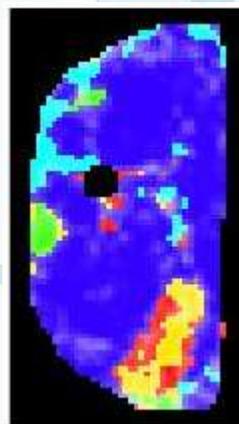
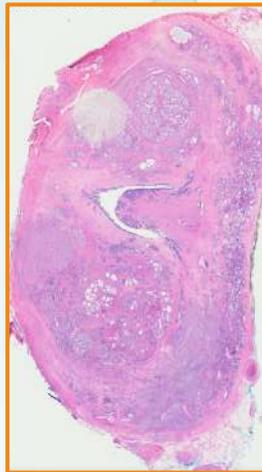
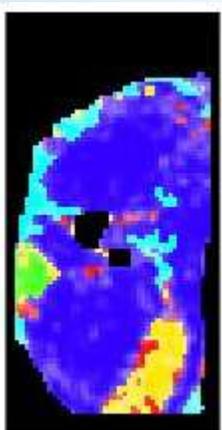
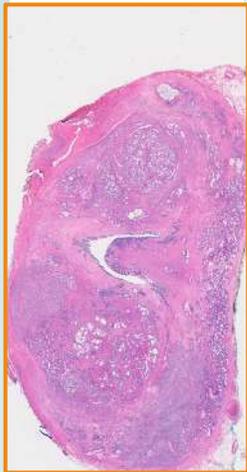
Confidence Level >0.9

Predictions

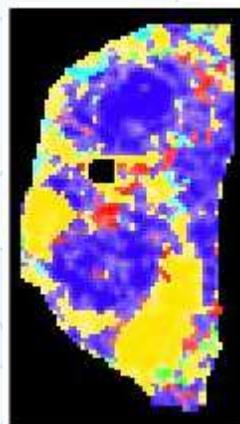
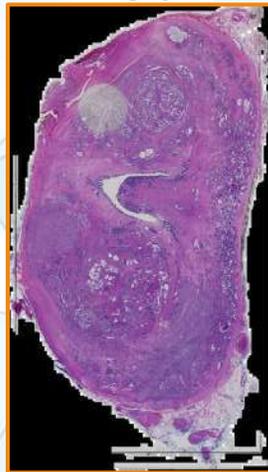
Impact of scanners



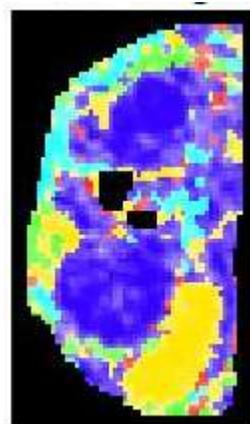
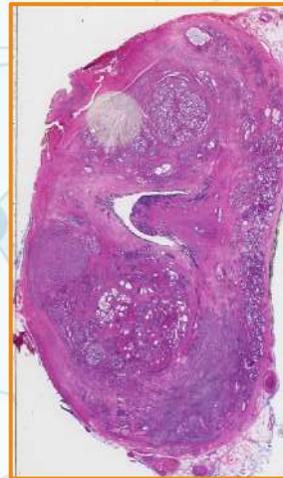
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Seeing beyond



technology for health.



Example: P9099_D18_Scan1
Gleason score: 7(3+4)

Impact of the scanners



CREATING GROWTH, ENHANCING LIVES

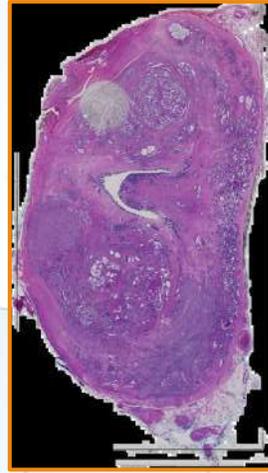
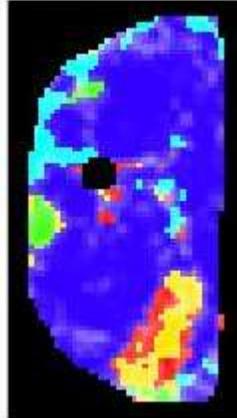
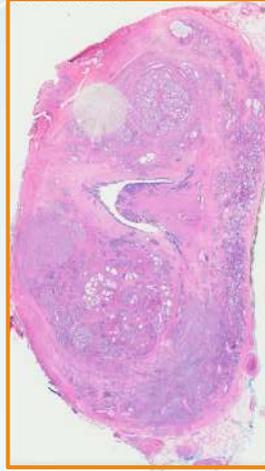
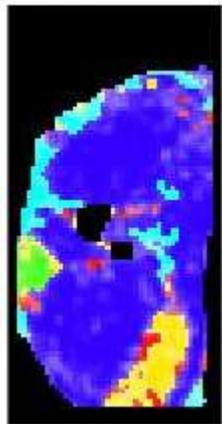


Image
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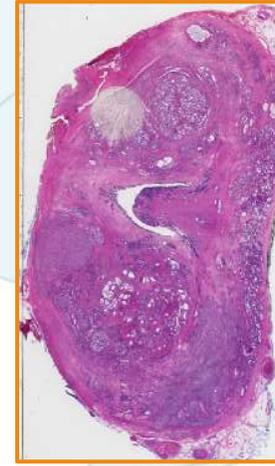
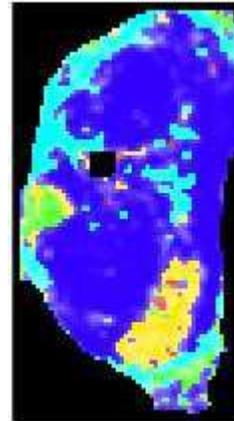
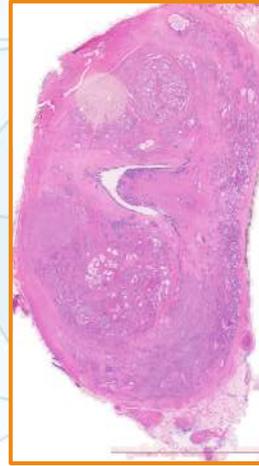
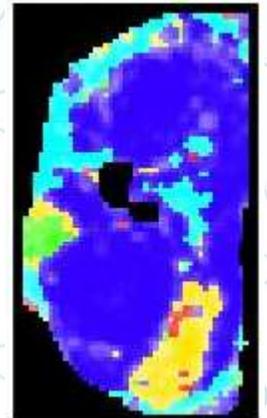


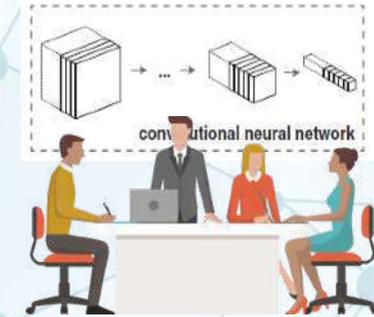
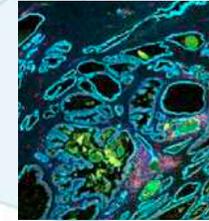
Image
processing



ImmunoPathology Diagnosis



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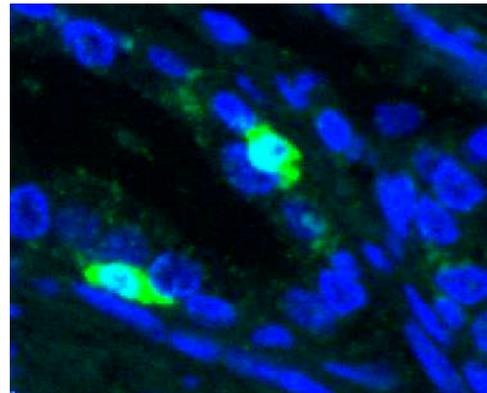
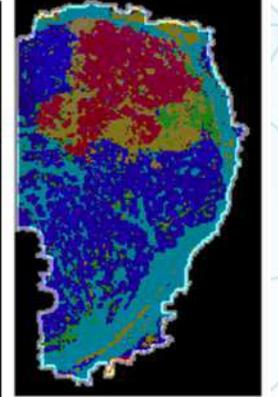
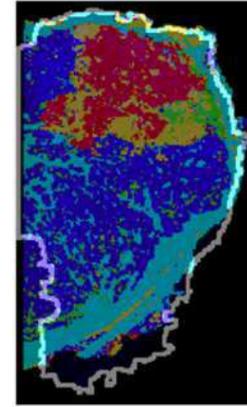
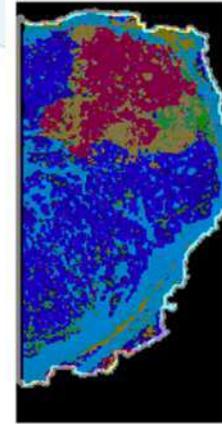
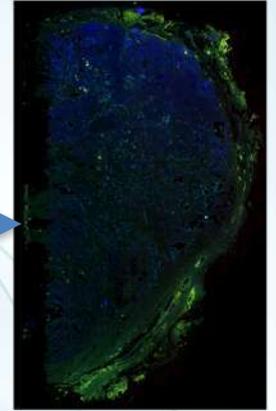
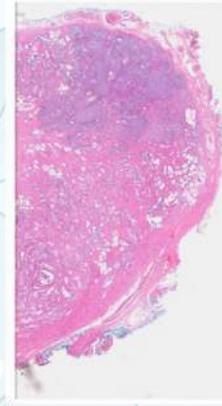
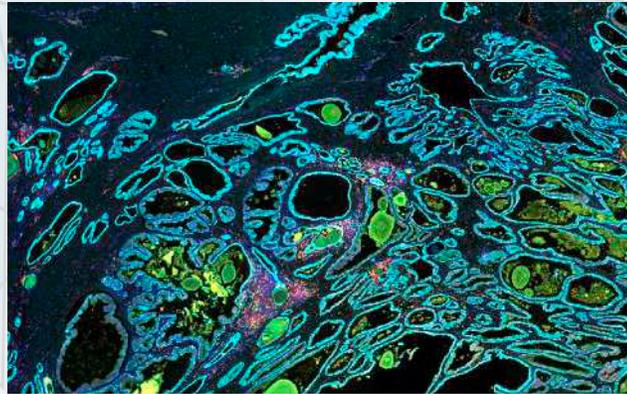
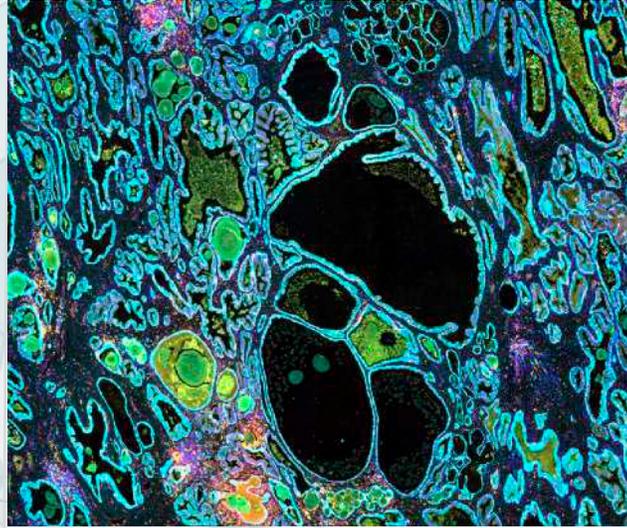
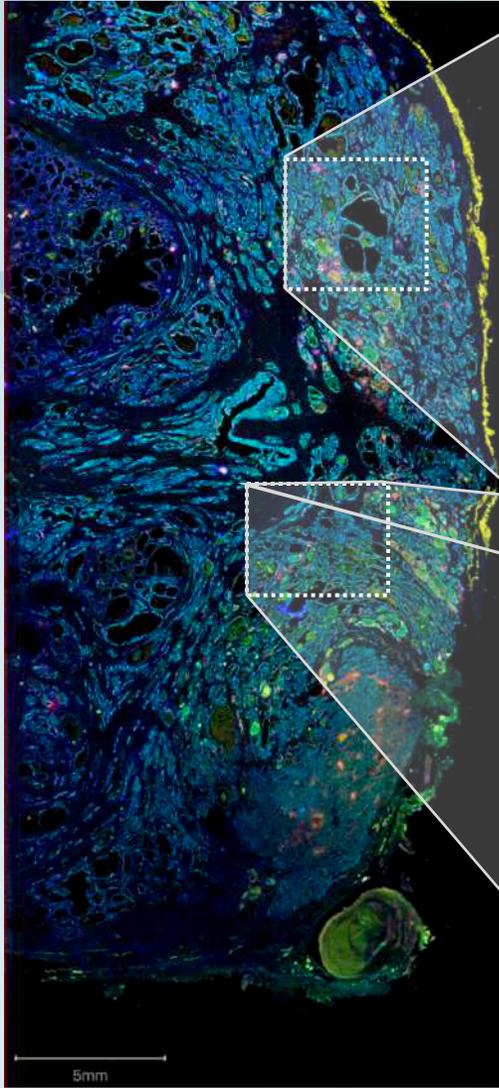
Biomedical Research & Development

- High quality sample & data generation for R&D
- Customised service for big Pharma and local Biotech





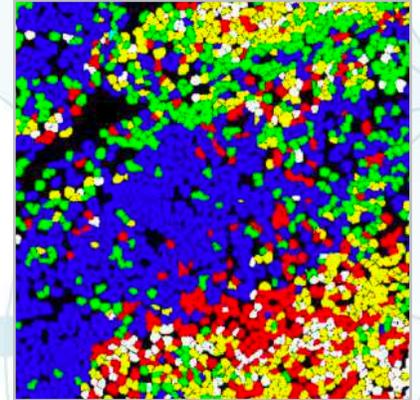
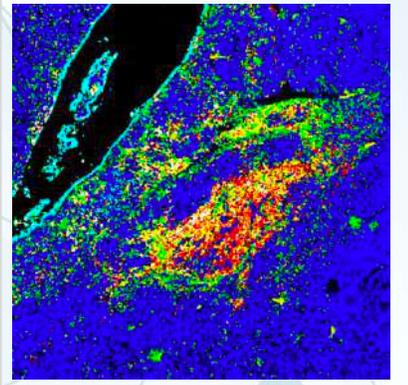
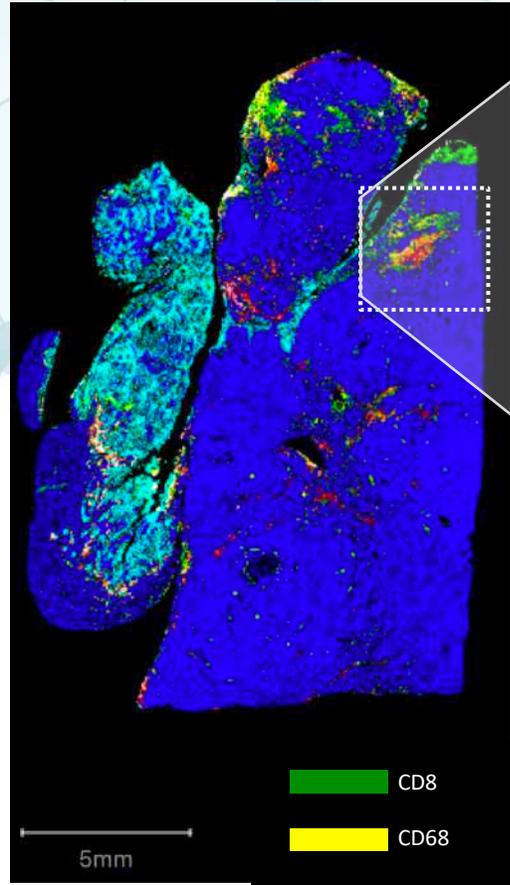
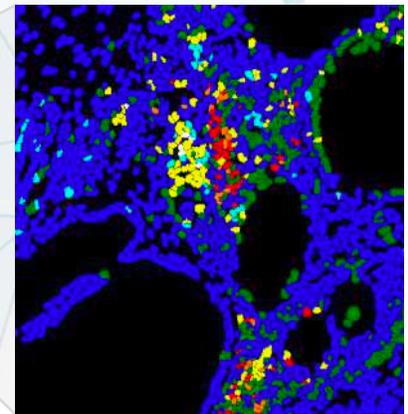
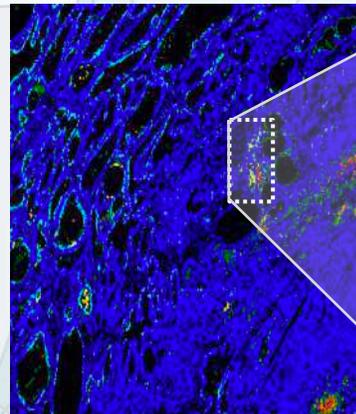
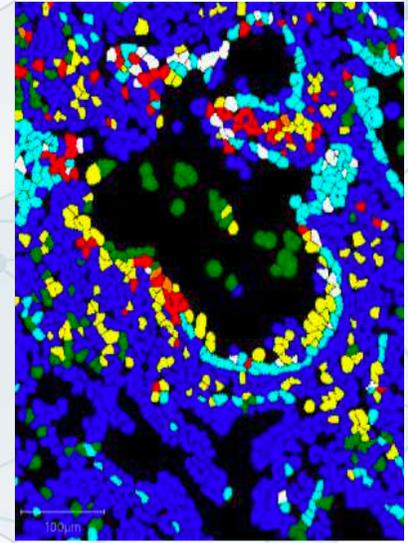
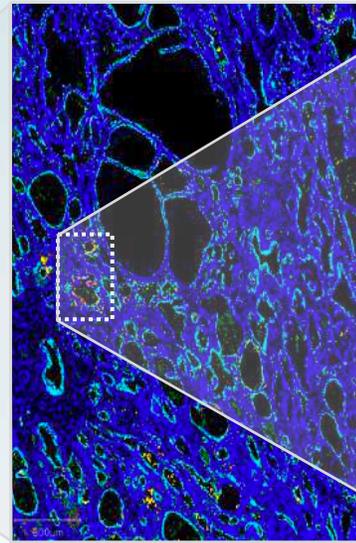
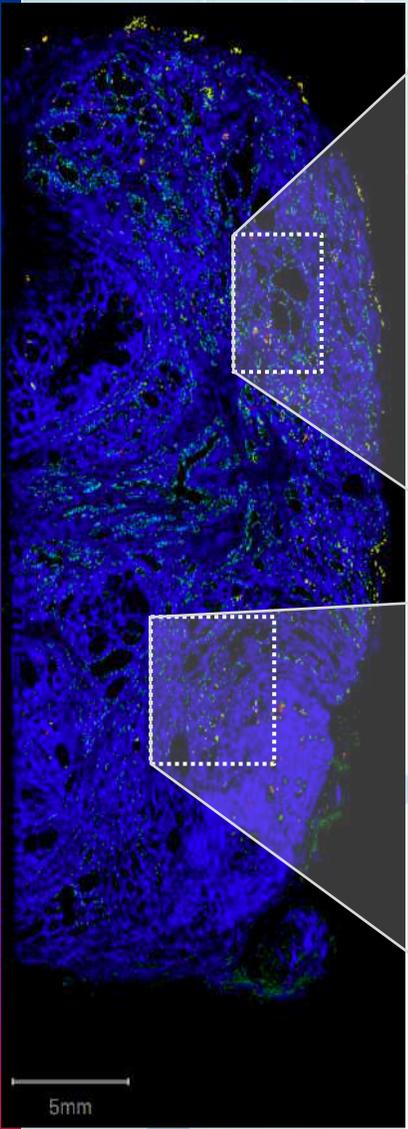
ImmunoPathology Diagnosis



ImmunoPathology Diagnosis



CREATING GROWTH, ENHANCING LIVES



- CD8
- CD68
- PD-L1
- PAN CK
- Pro Tumour Macrophage
- Immune Evading Carcinoma

- DAPI
- CD8
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Acknowledgement

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Seeing beyond



PHILIPS



LEO FOUNDATION

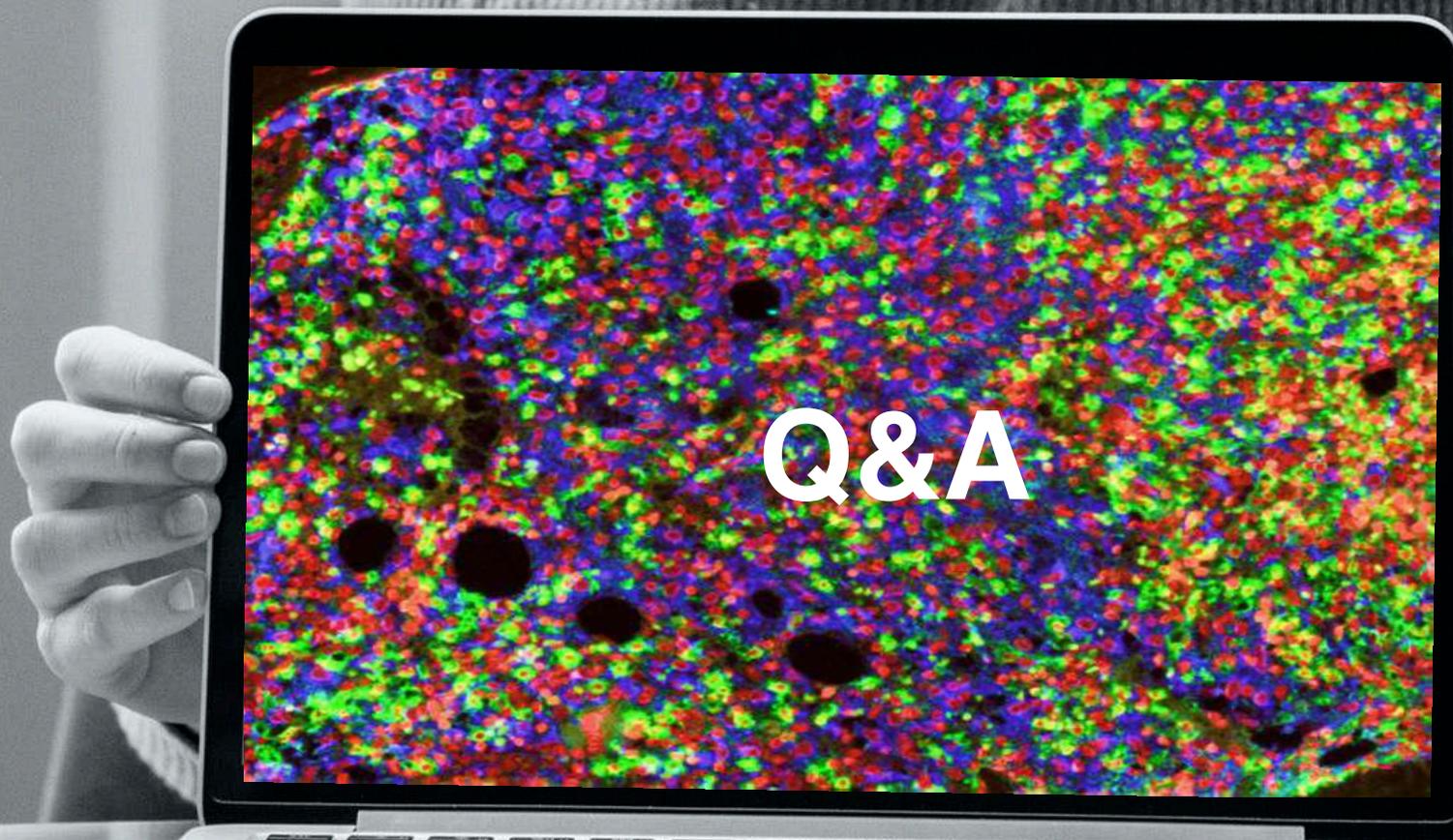


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