Sinai Health | Lunenfeld-Tanenbaum Research Institute

Validation of the Sybil Deep Learning Lung Cancer Risk Prediction Model in Three Independent Screening Studies

Renzo Phellan Aro, PhD

Lunenfeld-Tanenbaum Research Institute, Sinai Health, Canada

Introduction

- **Relevance:** Sybil, state-of-the-art deep learning model to predict future lung cancer risk
  - Single low-dose computed tomography (LDCT) image without segmentation
  - Predicting lung cancer risk 1 to 6 years after image acquisition
  - Potential to be integrated into the clinical workflow for early cancer detection
- **Challenge:** Need for extensive validation before clinical implementation, in various scenarios
- **Objective:** Validate Sybil using three independent screening studies

*Mikhael, Peter G., et al. "Sybil: a validated deep learning model to predict future lung cancer risk from a single low-dose chest computed tomography." *Journal of Clinical Oncology* 41.12 (2023).

Sybil validation method

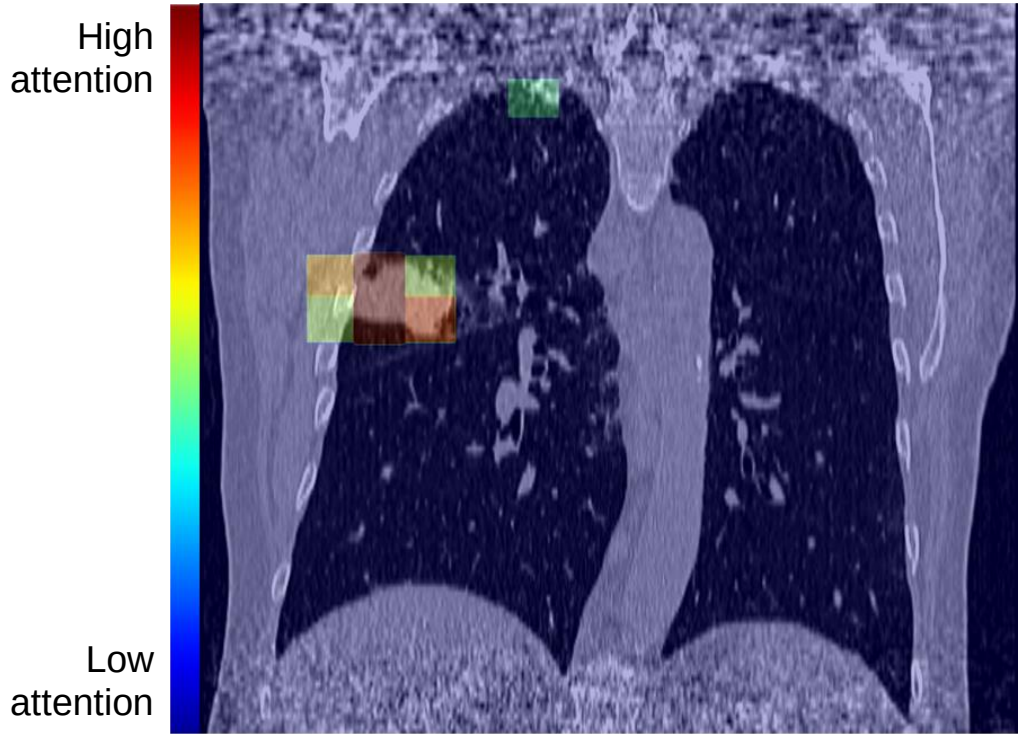
- **Our data:**
  - 39,861 LDCT images
  - 3,164 LDCT images with confirmed lung cancers
  - From three studies: Pan-Canadian Early Detection of Lung Cancer Study, Pittsburgh Lung Screening Study, and Toronto Lung Screening Program
- **Metric:** Area under the receiving operating characteristics curve (AUC)
- **Outcome:** Risk of developing lung cancer within 1 to 6 years
- **Stratification:** By nodule diameter and presence

Results

Area under the receiver operating characteristic curves (AUC) values obtained from Sybil evaluation						
	Risk of developing cancer within					
	1 year	2 years	3 years	4 years	5 years	6 years
No. LDCT images analyzed	37 394	37 683	37 975	38 236	38 508	38 693
No. confirmed lung cancer	697	986	1 278	1 539	1 811	1 996
Overall AUC	0.93	0.88	0.85	0.83	0.80	0.79
By maximum diameter						
<= 10 mm	0.85	0.75	0.64	0.62	0.62	0.61
> 10 mm	0.91	0.87	0.83	0.79	0.78	0.76
By nodule presence						
Absent	0.77	0.68	0.70	0.69	0.65	0.64
Present	0.95	0.90	0.86	0.85	0.84	0.82

Interpretability

- Sybil's **attention mechanism**.
  - What is Sybil looking at to take a decision?
  - Give more weight to some image regions when calculating lung cancer risk score
  - Trained on annotated data on lung cancer laterality and nodule bounding boxes.
- **Regions with nodules** are given more attention



Sybil's attention map of a coronal slice of an LDCT scan. *High attention reflects regions in the image that are given more weight when estimating lung cancer risk.*

Conclusions

- Sybil's best performance based on 3 independent validation studies

  → Predicting lung cancer risk within 1 year

- Decline in accuracy for predictions after 3 years
- Sybil may not be able to accurately predict lung cancer risk without the presence of nodules
  - Limited clinical use for fast-growing nodules, not present at baseline
- Future work: Improve Sybil's accuracy by including more features

Acknowledgements

Integrative Molecular Epidemiology Research Group


Rayjean Hung


Kiera Murison
Yonathan Brhane
Elham Khodayari
Matthew Warkentin

National Institutes of Health

Canadian Cancer Society

BC CANCER INTEGRATIVE ONCOLOGY RESEARCH
Provincial Health Services Authority


Stephen Lam
Sukhinder Katthra


Renelle Myers
Rafael Meza


Brenda Diergaarde
Jian-Min Yuan
David Wilson

University of Pittsburgh
UPMC | HILLMAN CANCER CENTER

RESEARCH AT UHN


Geoffrey Liu