Breakout Session 3: Track A

Small Bowel Segmentation - Challenges and Directions

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Small Bowel Segmentation

Challenges and Directions

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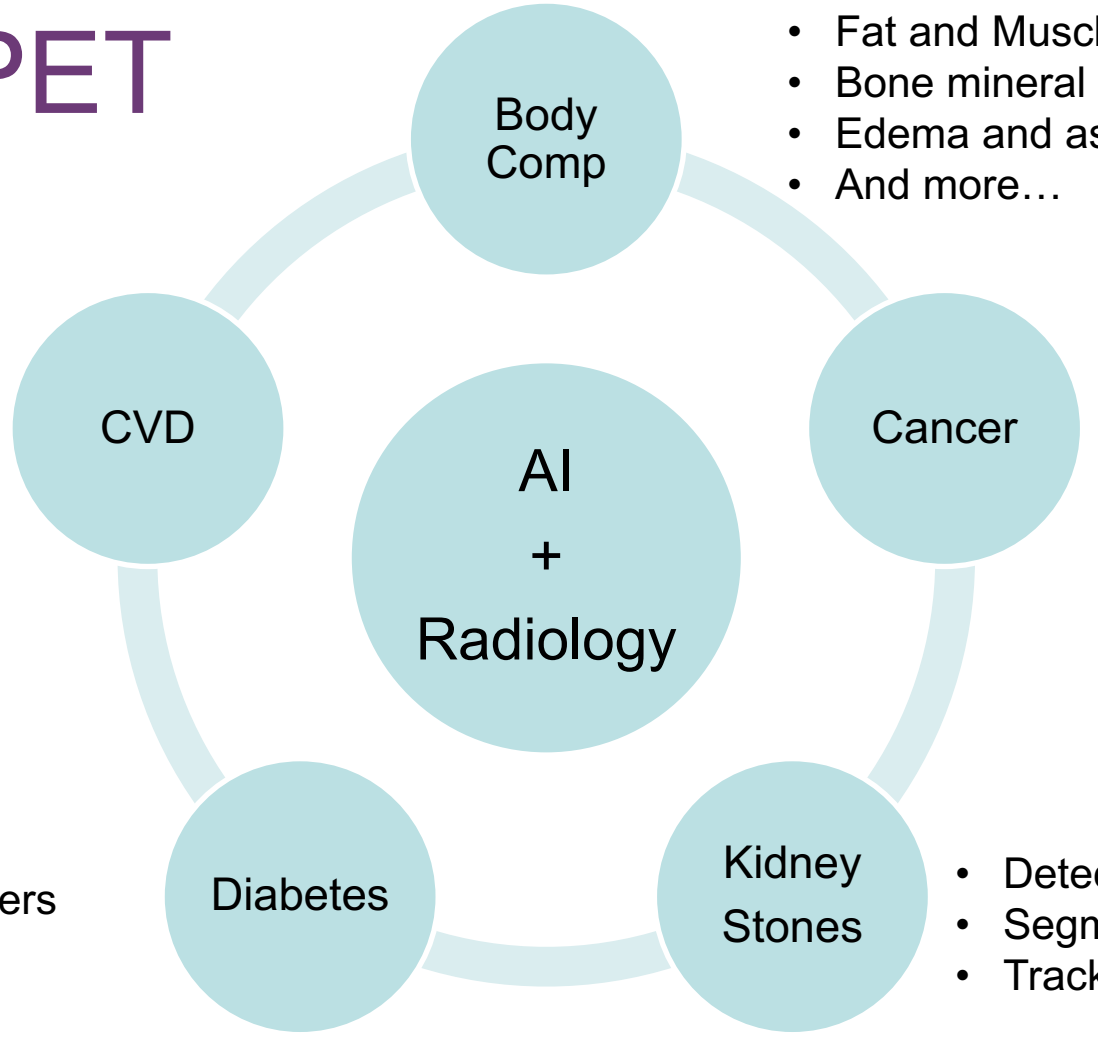
Pritam Mukherjee

Background: What We Do

CT, MRI, PET

- Atherosclerotic plaque
- Diagnosis on Chest X-rays
  - Pneumonia
  - Atelectasis
  - Cardiomegaly
  - …many more



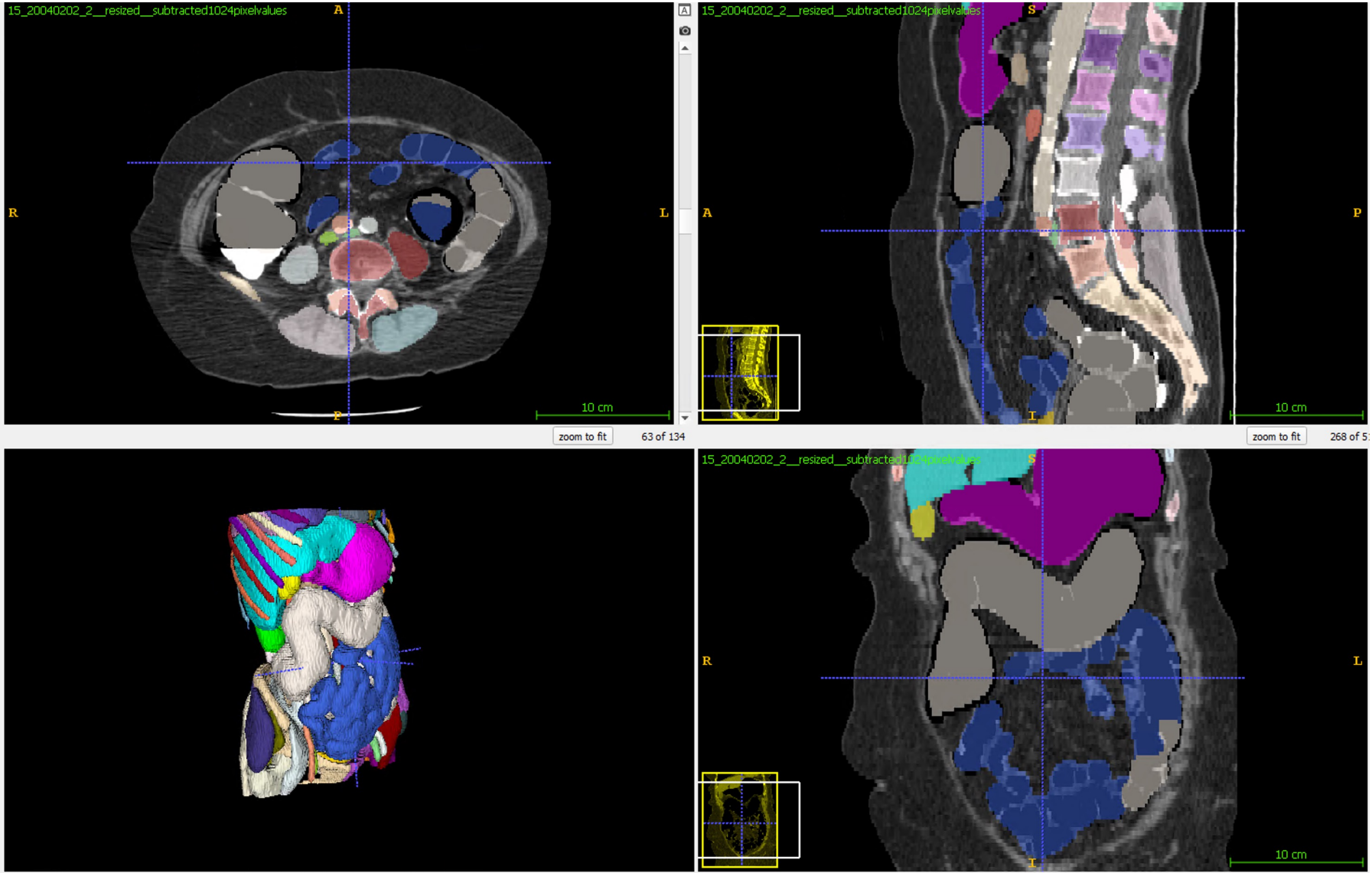
Quantification of:
- Fat and Muscle
- Bone mineral density
- Edema and ascites
- And more…

- Detection of lesions
- Segmentation
- Tracking and follow-up

- Detection
- Segmentation
- Tracking and follow-up

- Imaging Biomarkers
- Risk prediction

Background: Organ and structure segmentation



Background: Small bowel segmentation project

- Small bowel: largest is the longest section of the digestive tract
  - long (20 ~ 30 ft)
  - convoluted
- Segmentation and path tracking is very useful for
  - Detecting blockages
  - Detecting other abnormalities such as lesions (particularly, small **carcinoid tumors**)
  - Guiding surgery
- Difficult to do manually

Aims

Primary Goal

- Develop an AI model to automatically segment the small bowel in CT scans

Key bottleneck

- Lack of annotated data
  - no public datasets,
  - requires lot of time and effort to annotate, and is difficult without scale

Approach

- Use crowdsourcing to create a HVD dataset

Roadmap

- **Key personnel: Dr. Seungyeon Shin**, (postdoc, now faculty at Hanyang University)
- Curating an anonymized CT dataset
  - Data from the clinical center
  - Select DICOMs which contain suitable CT images (noncontrast, contrast, etc)
  - Convert DICOMs to niftis
  - Manual verification that images do not contain any PHI/PII
- Create interface for crowd-sourced annotation
  - Use Amazon Mechanical Turk
  - Tutorials and quality checks

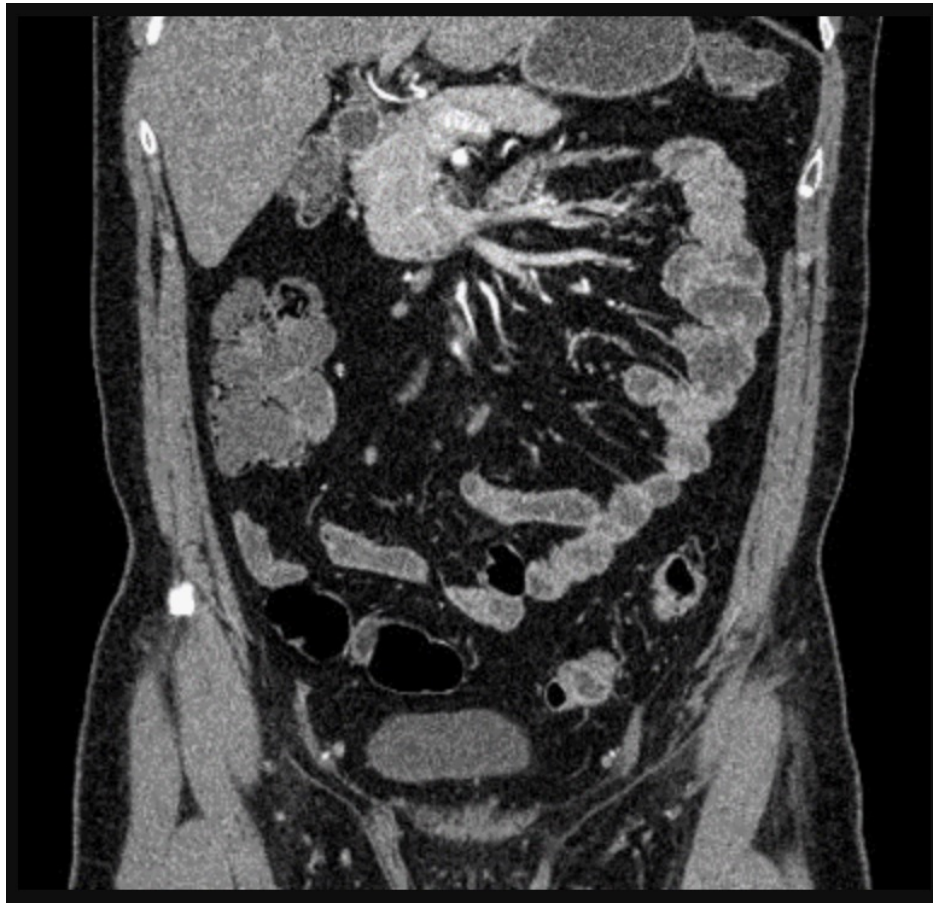
Roadmap (contd.)

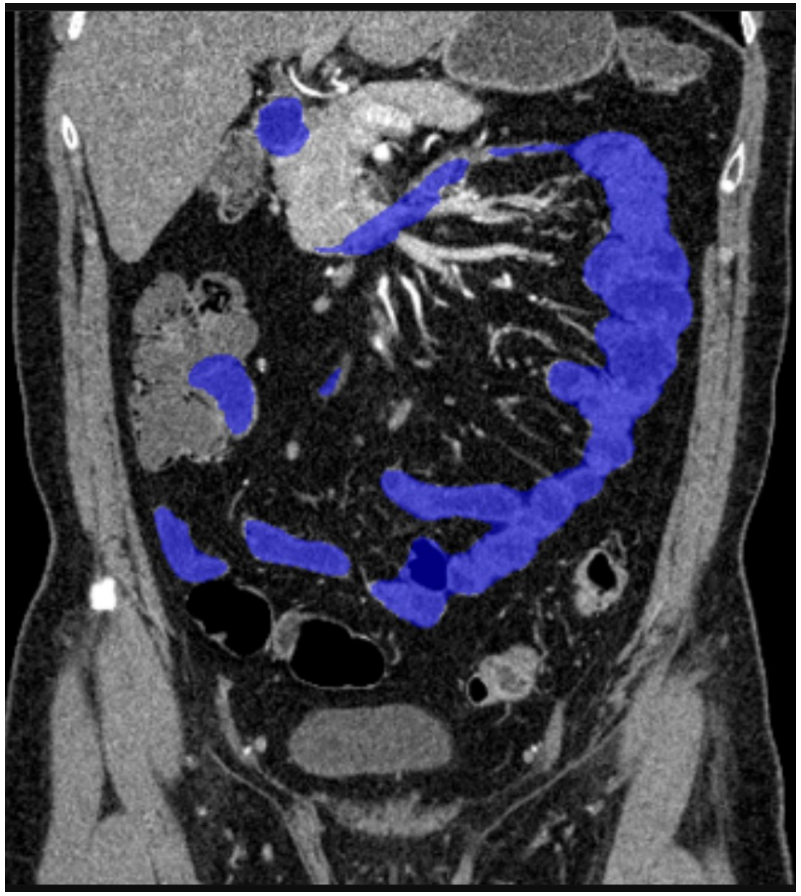
- Quality checks
  - Manually annotated samples (n = 5), by a radiologist
  - Agreement with radiologist annotations would be used to assess
- Get crowdsourced annotations
- Perform additional quality checks
- Outputs:
  - HVD: annotated dataset
  - Model trained on annotated data

Progress

- ✓ Dataset curation
  - 60 scans downloaded from PACS, anonymized
  - Verified no PII/PHI
  - Converted 3D volumes to multiple (~50) 2D slices
  - 5 scans manually segmented
- ✓ Interface on AWS
  - Explored options on AWS SageMaker Ground Truth
  - Create 2D labeling job

Progress and Challenges (contd.)





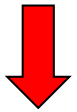
Challenges

- **Challenging to get accurate segmentations based on 2D slices!**
  - I and another staff scientist tried out sample cases – failed miserably!
  - Even our PI, Dr. Summers, an experienced radiologists found it hard to do it accurately without being able to scroll through slices
  - Probably not feasible without medical training
- Possible solution: some 3D segmentation interface?

Challenges

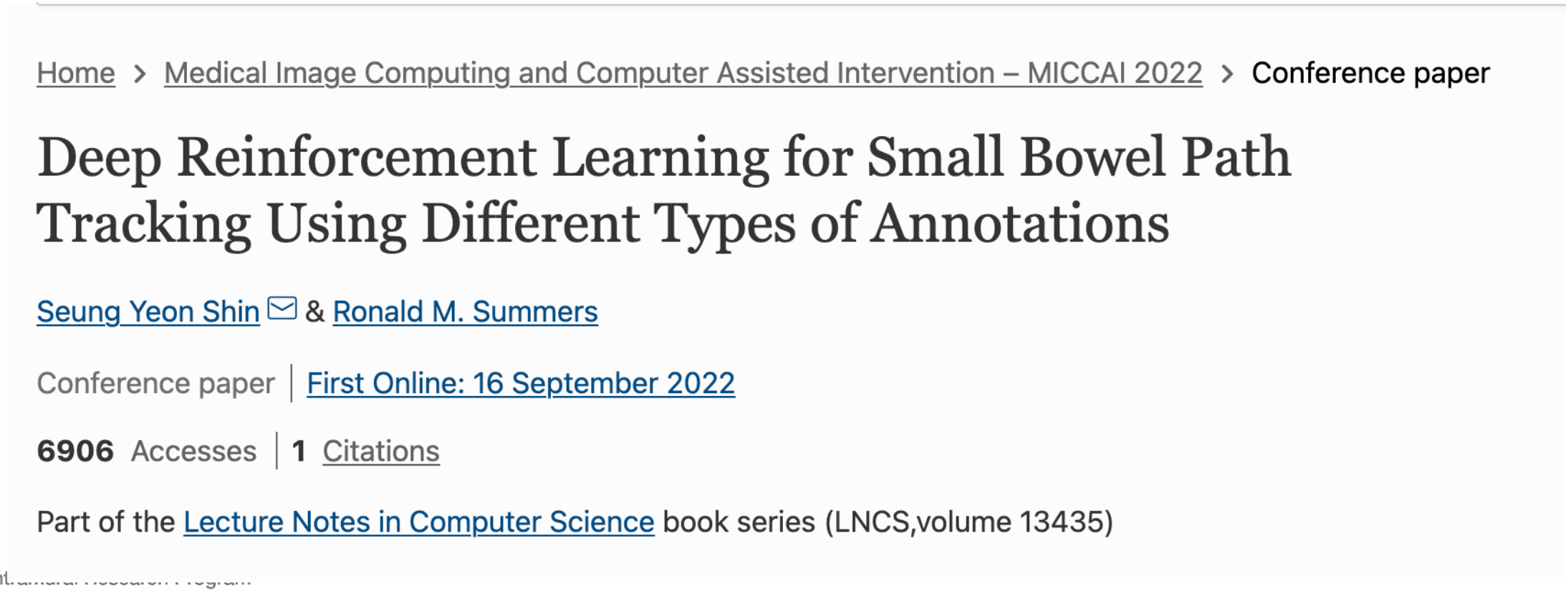
- **Lack of expertise!**
  - No 3D segmentation interface built into AWS SageMaker
  - Lacking expertise to build a custom interface
  - Invest time and effort to learn it ourselves? Hire someone with expertise?
  - Immediate solution: hire expertise – advertised for a temp position – very few takers
  - A few interviews, but no suitable candidates
  - I and another staff scientist started the learning process – few hands-on resources for the specific task

Challenges

- **Missed opportunity!**
  - A group in Switzerland published TotalSegmentator: a segmentation tool
  - TotalSegmentator could segment the small bowel very well
  - A dataset of 1024 scans with small bowel segmentations made publicly available
  - Value of proposed dataset 

Pivot to related projects

- **Path tracking for small intestine**
  - Reinforcement learning based approach – some preliminary work



Home > Medical Image Computing and Computer Assisted Intervention – MICCAI 2022 > Conference paper

Deep Reinforcement Learning for Small Bowel Path Tracking Using Different Types of Annotations

Seung Yeon Shin & Ronald M. Summers

Conference paper | First Online: 16 September 2022

6906 Accesses | **1** Citations

Part of the Lecture Notes in Computer Science book series (LNCS,volume 13435)

Pivot to related projects

- **Detecting carcinoid tumors in the small intestine – last project for Dr. Shin**
  - Deep learning based approach – some preliminary work

MEDICAL PHYSICS
The International Journal of Medical Physics Research and Practice

RESEARCH ARTICLE | Full Access

Fully-automated detection of small bowel carcinoid tumors in CT scans using deep learning

Seung Yeon Shin, Thomas C. Shen, Stephen A. Wank, Ronald M. Summers

First published: 29 March 2023 | https://doi.org/10.1002/mp.16391

Other ideas

- **Exploring large language models on the cloud**
  - LLMs, like ChatGPT and GPT-4 have shown incredible promise
  - Open-source privacy-preserving LLMs may be suitable for our use cases
  - Very resource hungry – example, Falcon -180B requires **8 80GB A100** GPUs for inference!!

Conclusions

- AWS – an amazing resource
- Can fill gaps in infrastructure for resource hungry projects
- **Challenge: lack of expertise/guidance**

Questions or Suggestions?

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