Breakout Session 3: Track A

Small Bowel Segmentation - Challenges and Directions

Dr. Pritam Mukherjee
Clinical Center, Staff Scientist, NIH

Small Bowel Segmentation
Challenges and Directions

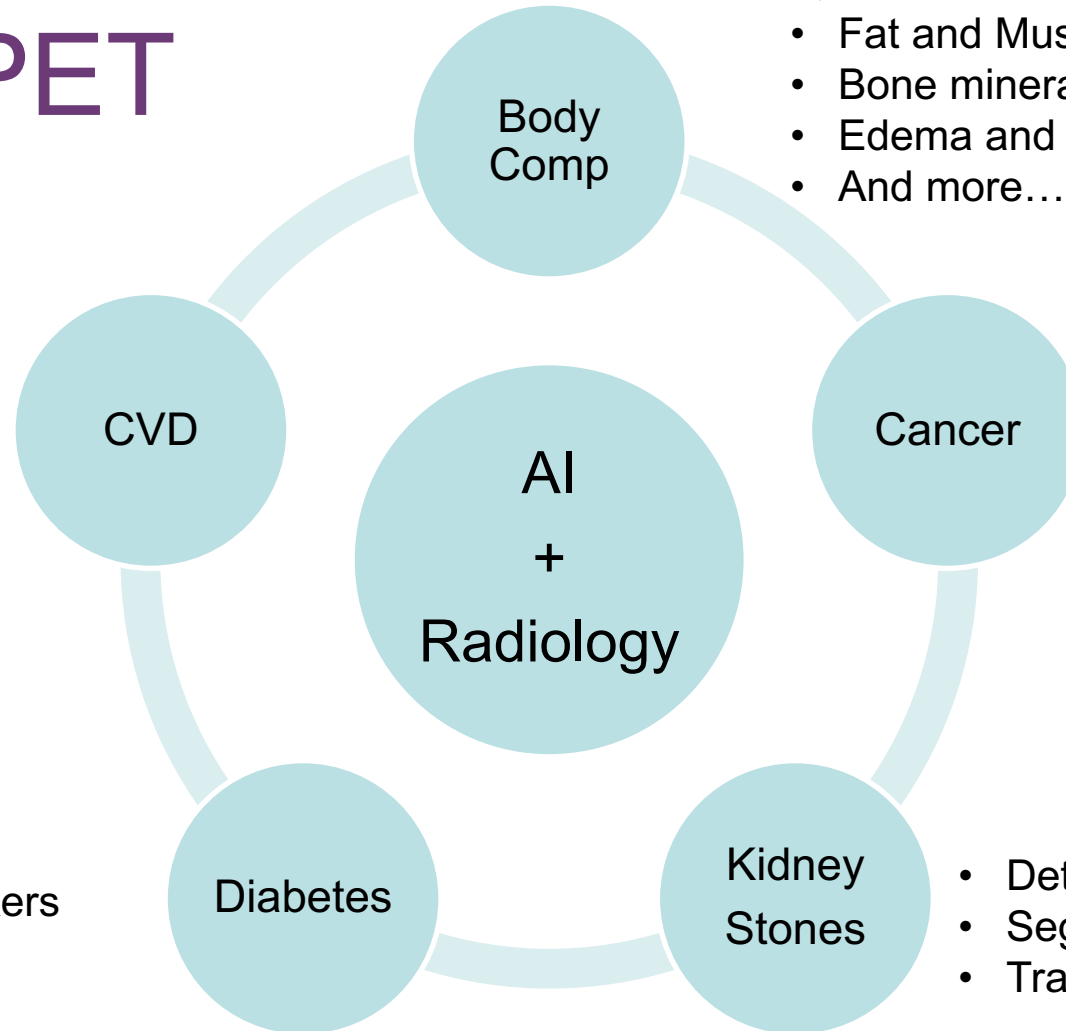### PI: Dr. Ronald Summers

Pritam Mukherjee

Background: What We Do

CT, MRI, PET

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

Body Comp

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

AI + Radiology

CVD

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

Diabetes
- Imaging Biomarkers
- Risk prediction

Kidney Stones
- Detection
- Segmentation
- Tracking and follow-up

Background: Organ and structure segmentation
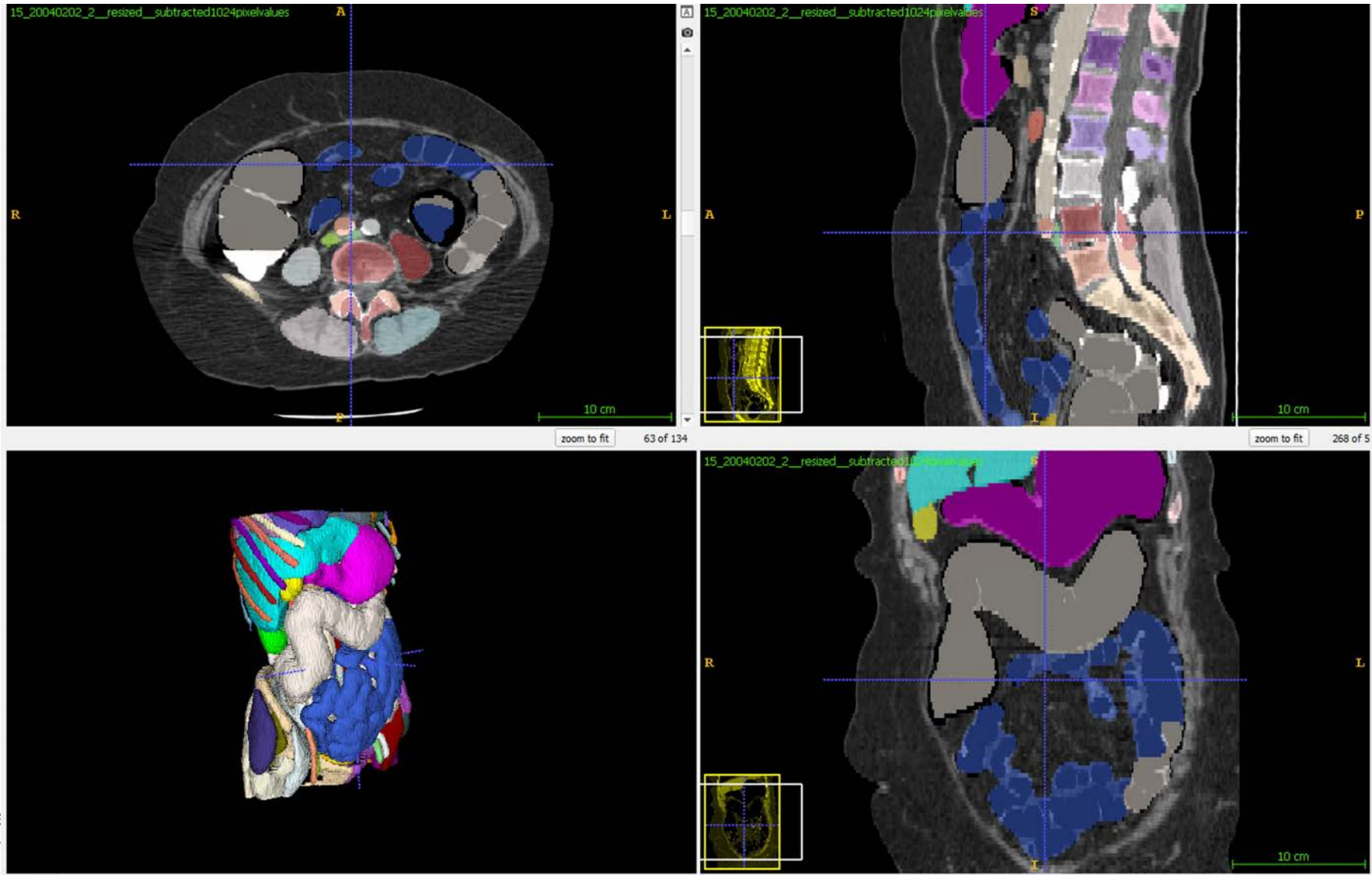
Background: Small bowel segmentation project

- 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
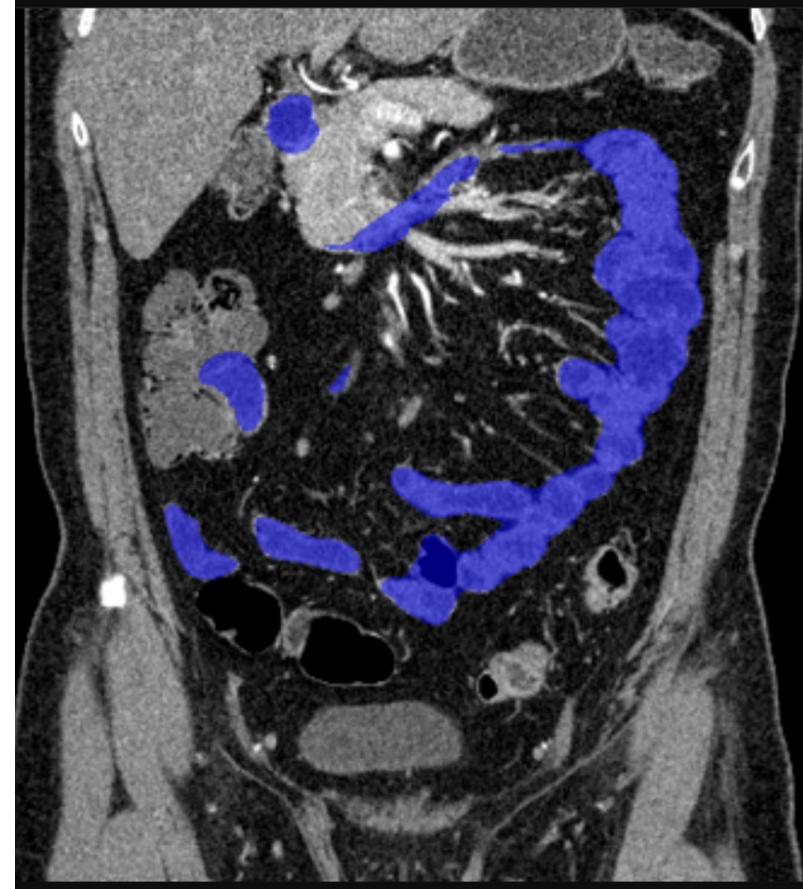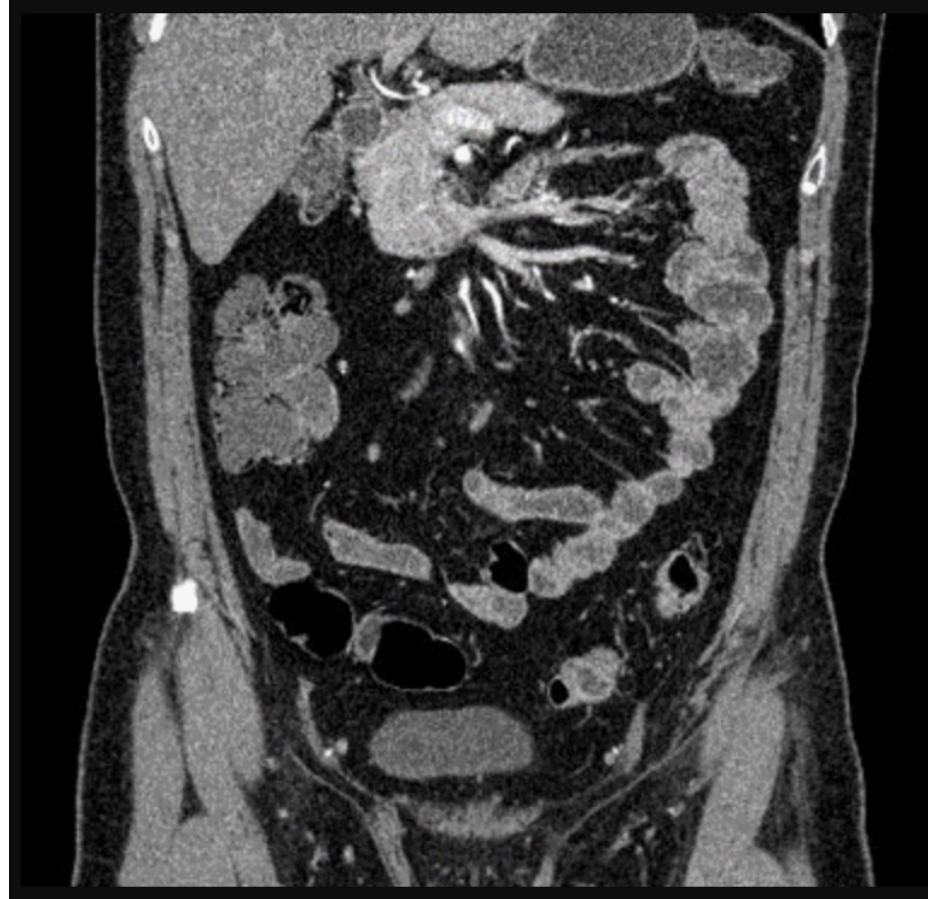
Progress

- ✓ 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

NIH ⟩ Intramural Research Program
Our Research Changes Lives

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!!

Radiology

Latest Articles | All Issues | Collections ▼ | For Authors ▼ | Diagnosis Please | Multime

Feasibility of Using the Privacy-preserving Large Language Model Vicuna for Labeling Radiology Reports

Pritam Mukherjee, Benjamin Hou, Ricardo B. Lanfredi, Ronald M. Summers ✉

Conclusions

- AWS – an amazing resource

- Can fill gaps in infrastructure for resource hungry projects

- **Challenge: lack of expertise/guidance**

Questions or Suggestions?

Contact: pritam.mukherjee@nih.gov