Annotation-Efficient Deep Learning for Medical Image Analysis

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Statistics
6,458 citations
Top 2% of Scientists in 2022
24 first/corresponding authored papers

Significant

Applications

Methodologies

Impactful

2017-2021
Arizona State University
PhD Degree: Biomedical Informatics

Applications

Significant

Methodologies

Impactful

Bachelor‘s Degree: Computer Science
Dalian University of Technology
2012-2016

Postdoc: Computer Science
Johns Hopkins University
2021-present

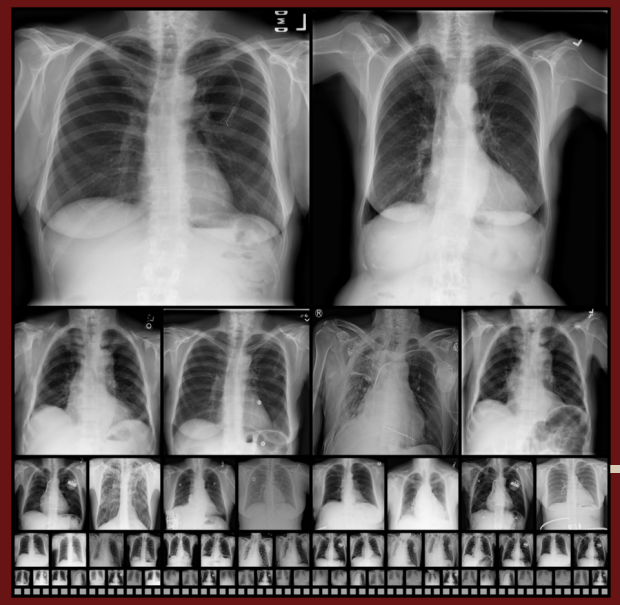
Internship: Mayo Clinic, Mila

Significant

Applications

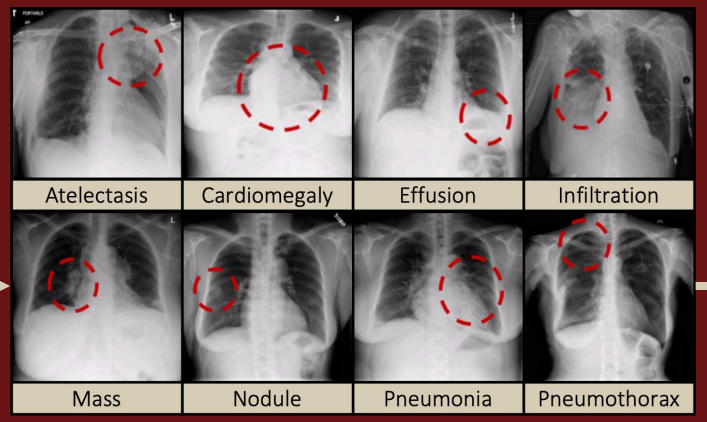
Methodologies

Impactful



Data

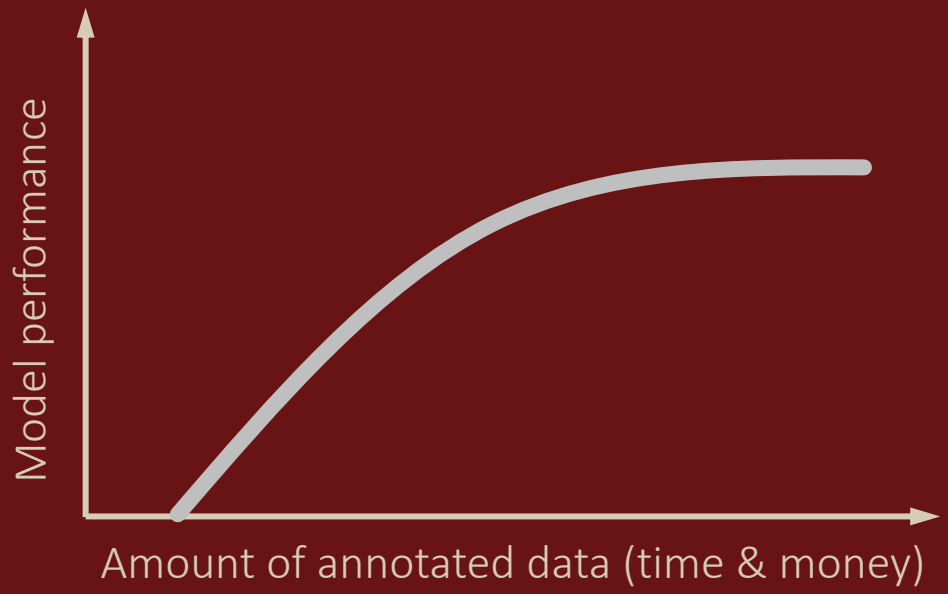
Annotate

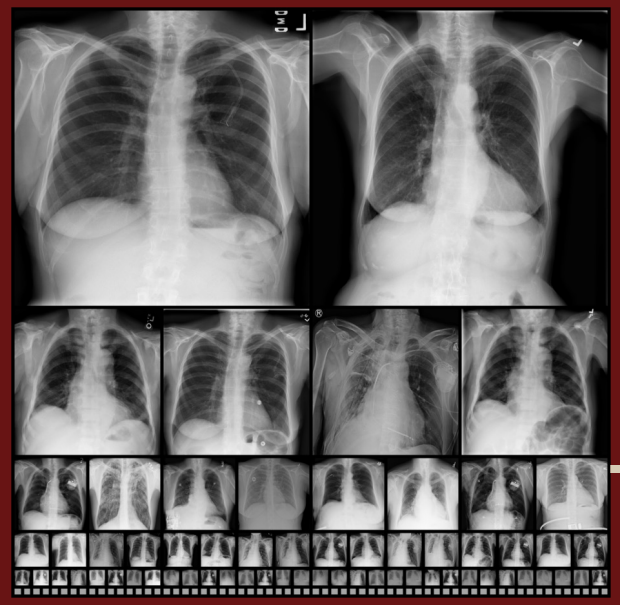


Data & Annotation

Model

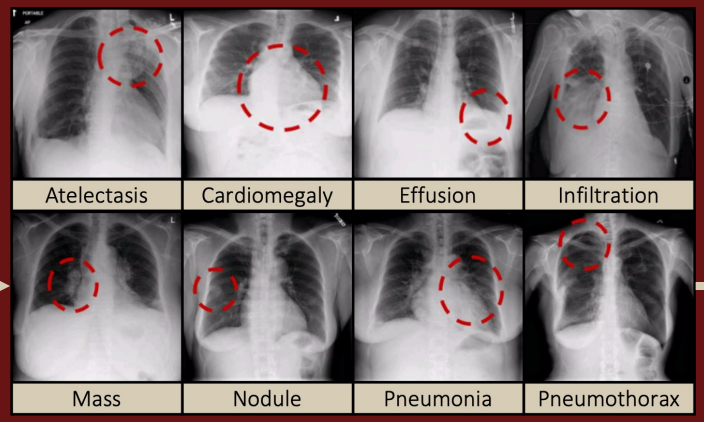
Applications





Data

Annotate

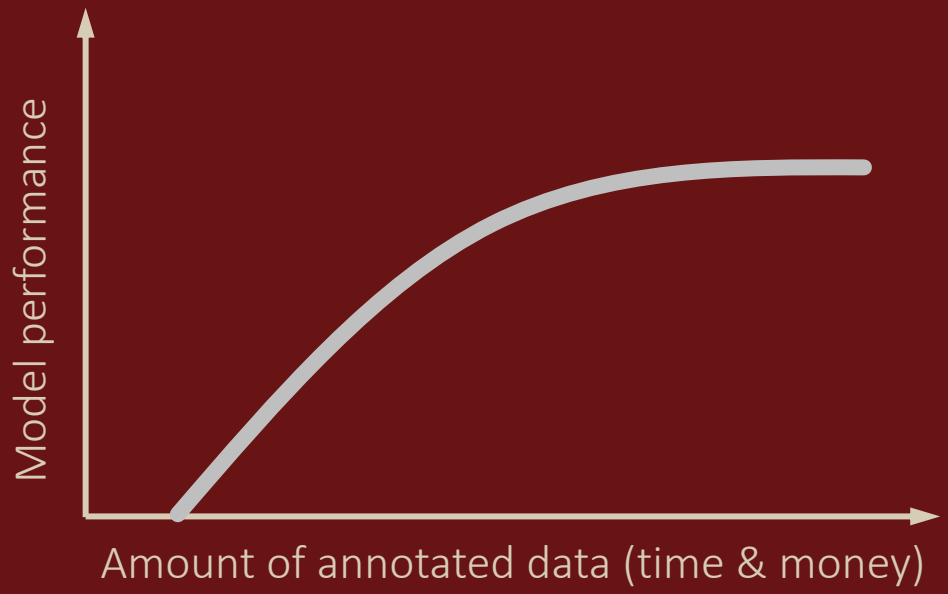


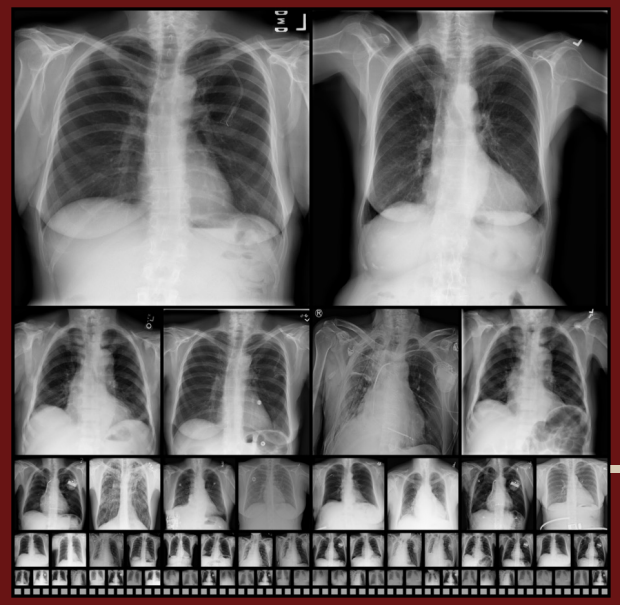
Data & Annotation

Model

Applications

Goal: Minimize manual annotation efforts for rapid, precise computer-aided diagnosis systems.





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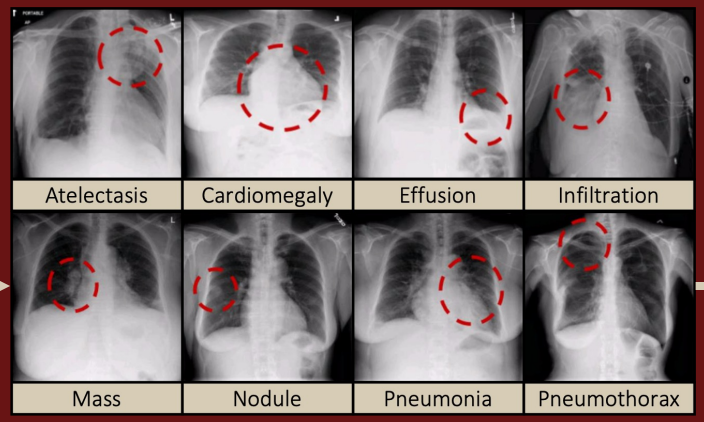


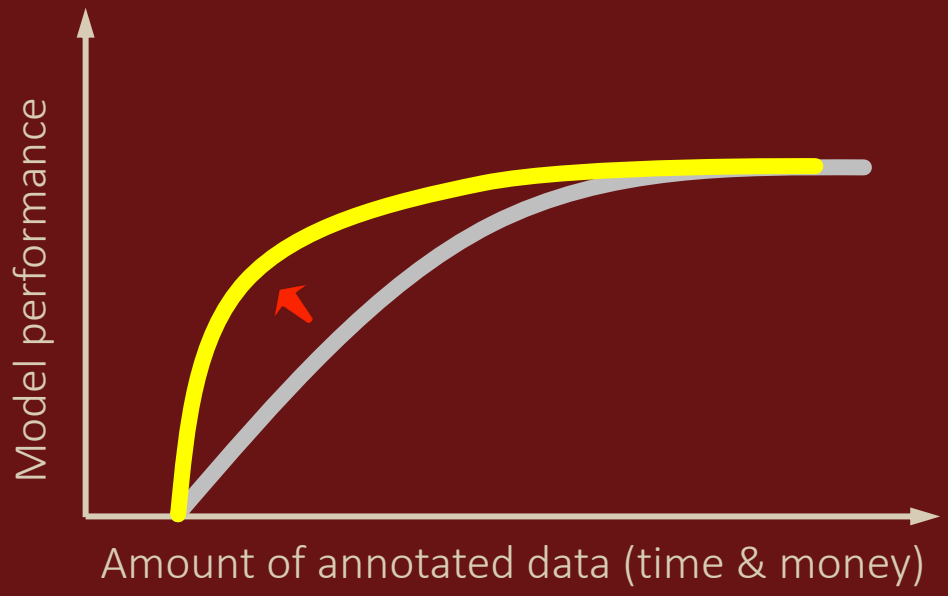
Data & Annotation

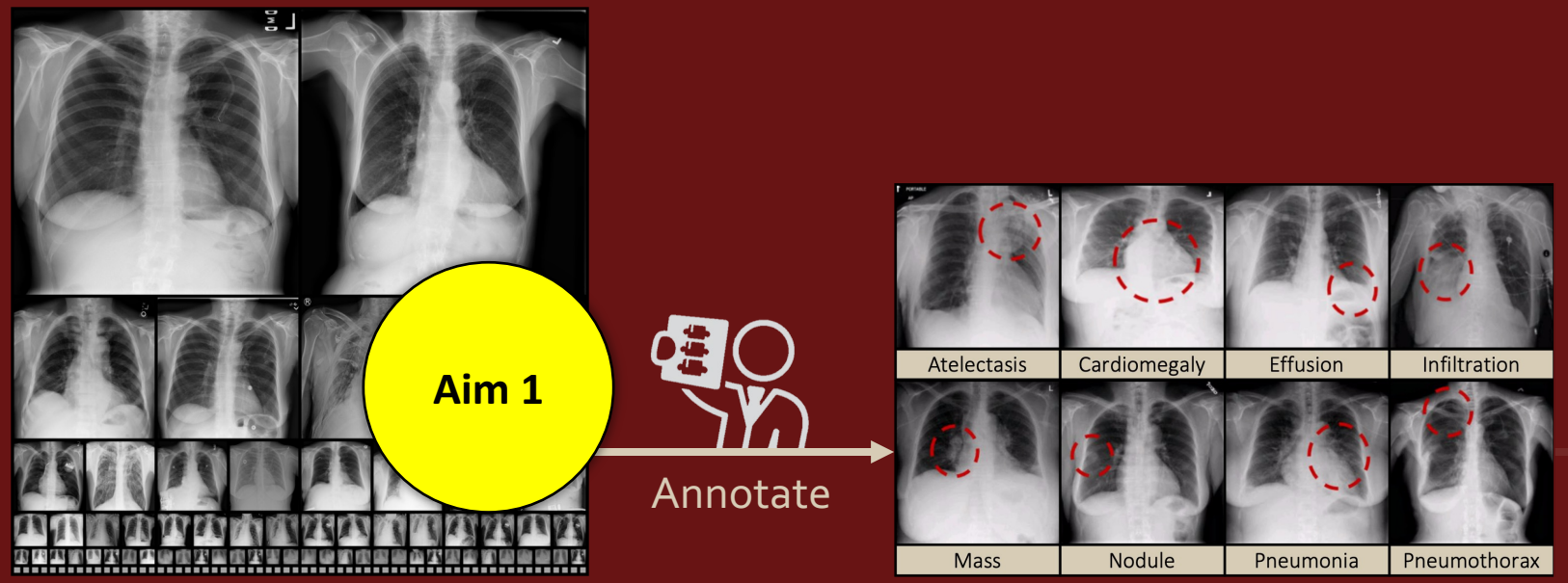
Model

Applications

Goal: Minimize manual annotation efforts for rapid, precise computer-aided diagnosis systems.

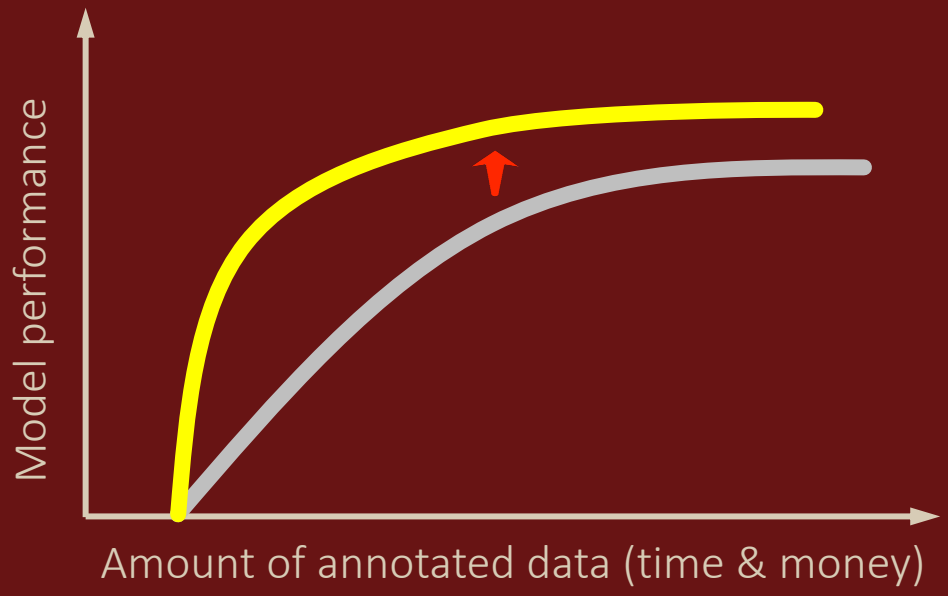
1. Acquiring necessary annotation efficiently from human experts.
    - Active, Continual Fine-Tuning (ACFT)
    - CVPR-2017, MedIA-2021, MIDL-2023

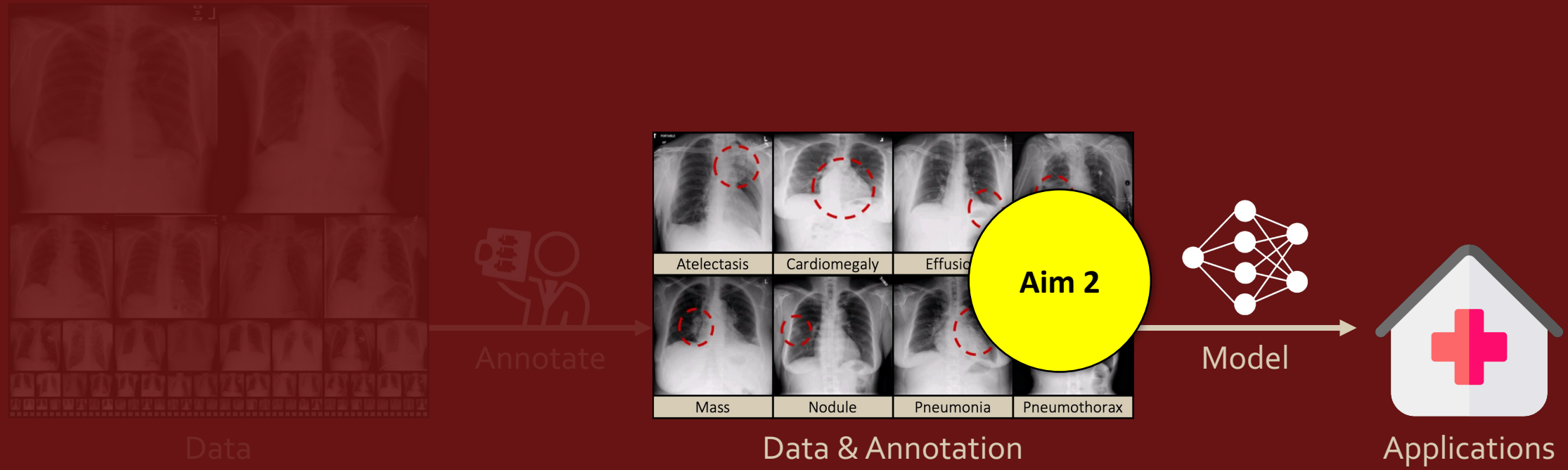




Goal: Minimize manual annotation efforts for rapid, precise computer-aided diagnosis systems.

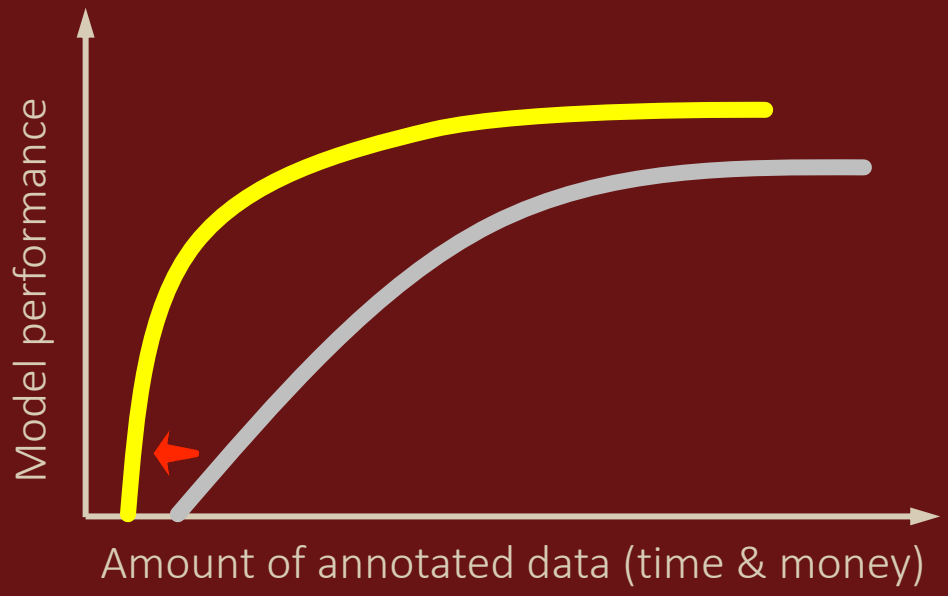
1. Acquiring necessary annotation efficiently from human experts.
2. Utilizing existing annotation effectively from advanced models.
    - UNet++
    - MICCAIW-2018, IEEE TMI-2019 (*Most Popular Articles*)

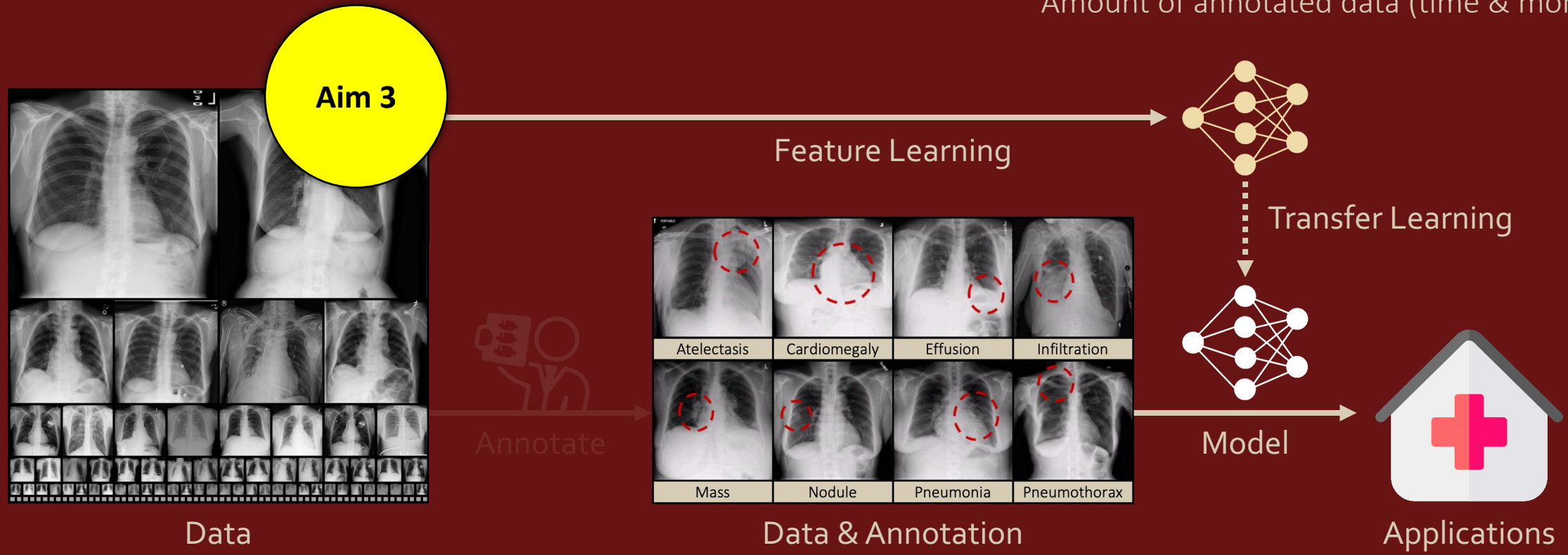




Goal: Minimize manual annotation efforts for rapid, precise computer-aided diagnosis systems.

1. Acquiring necessary annotation efficiently from human experts.
2. Utilizing existing annotation effectively from advanced models.
3. Extracting generic knowledge directly from unannotated images.
    - Models Genesis
    - MICCAI-2019 (*Young Scientist Award*), MedIA-2020 (*Best Paper Award*)





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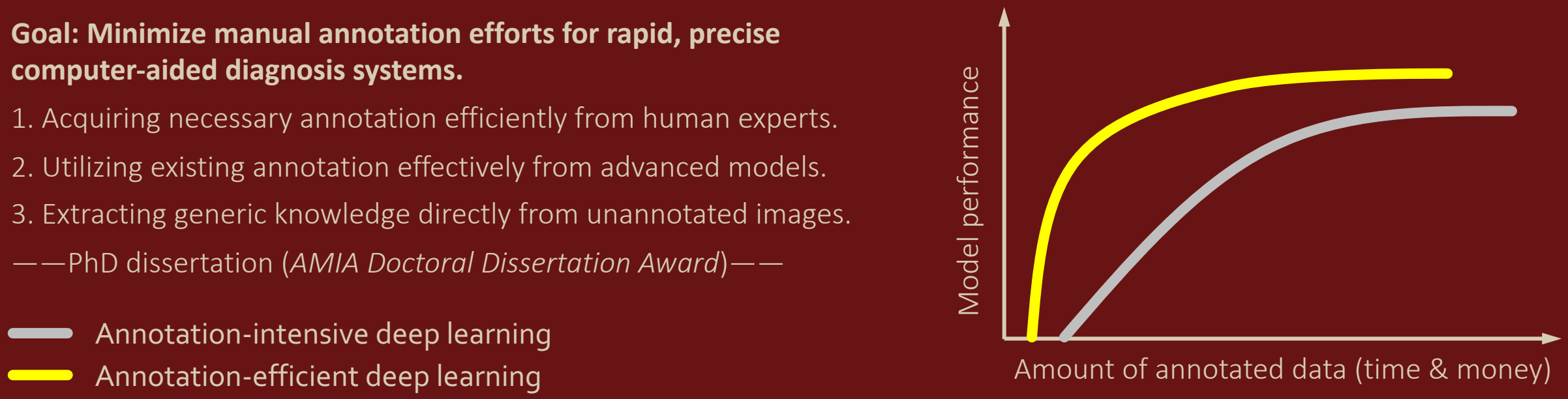
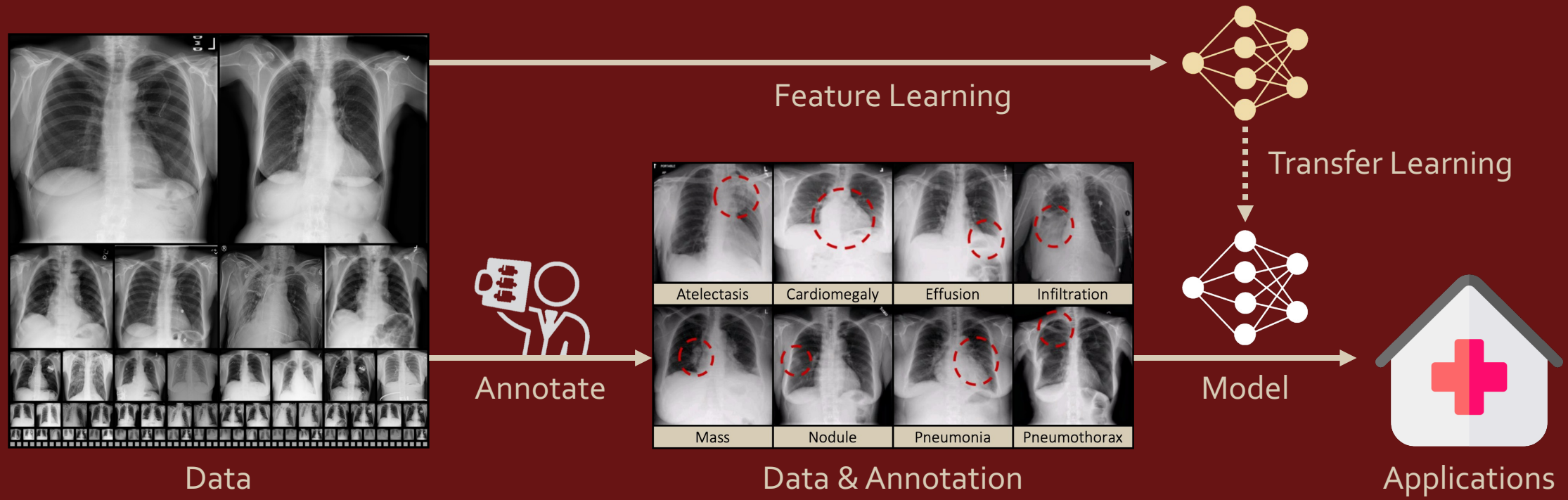
——PhD dissertation (*AMIA Doctoral Dissertation Award*)——





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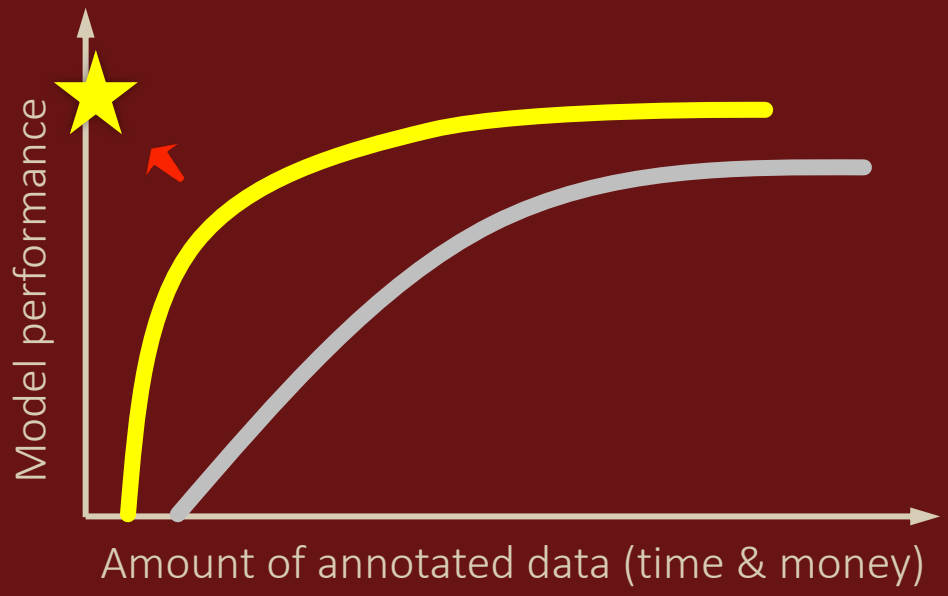
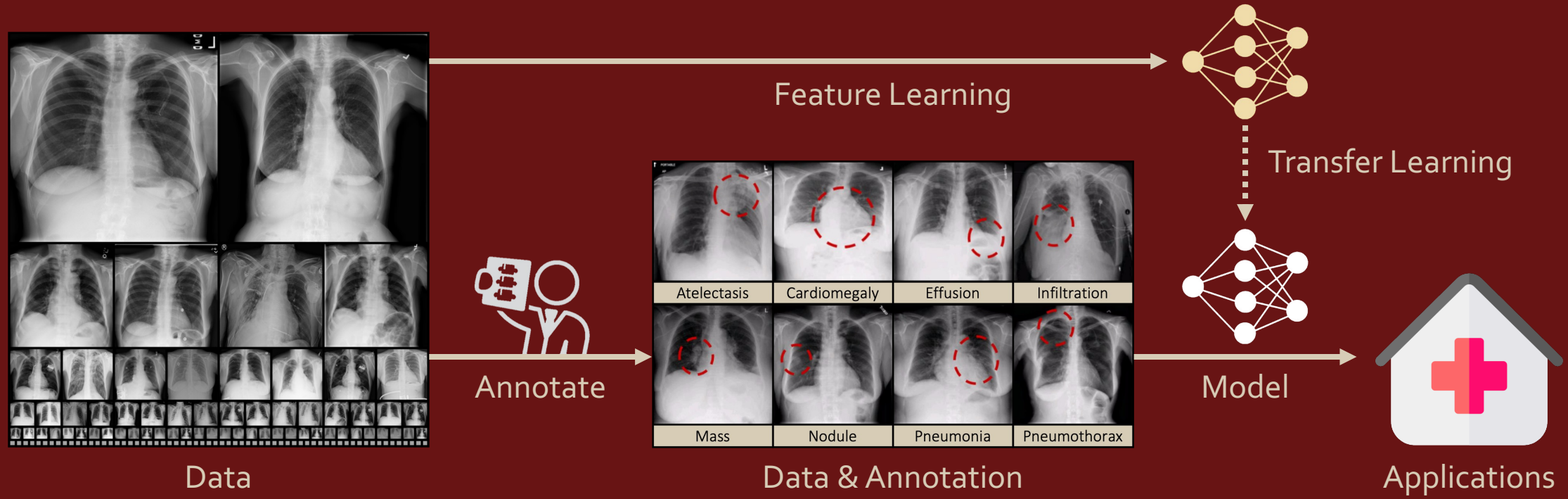
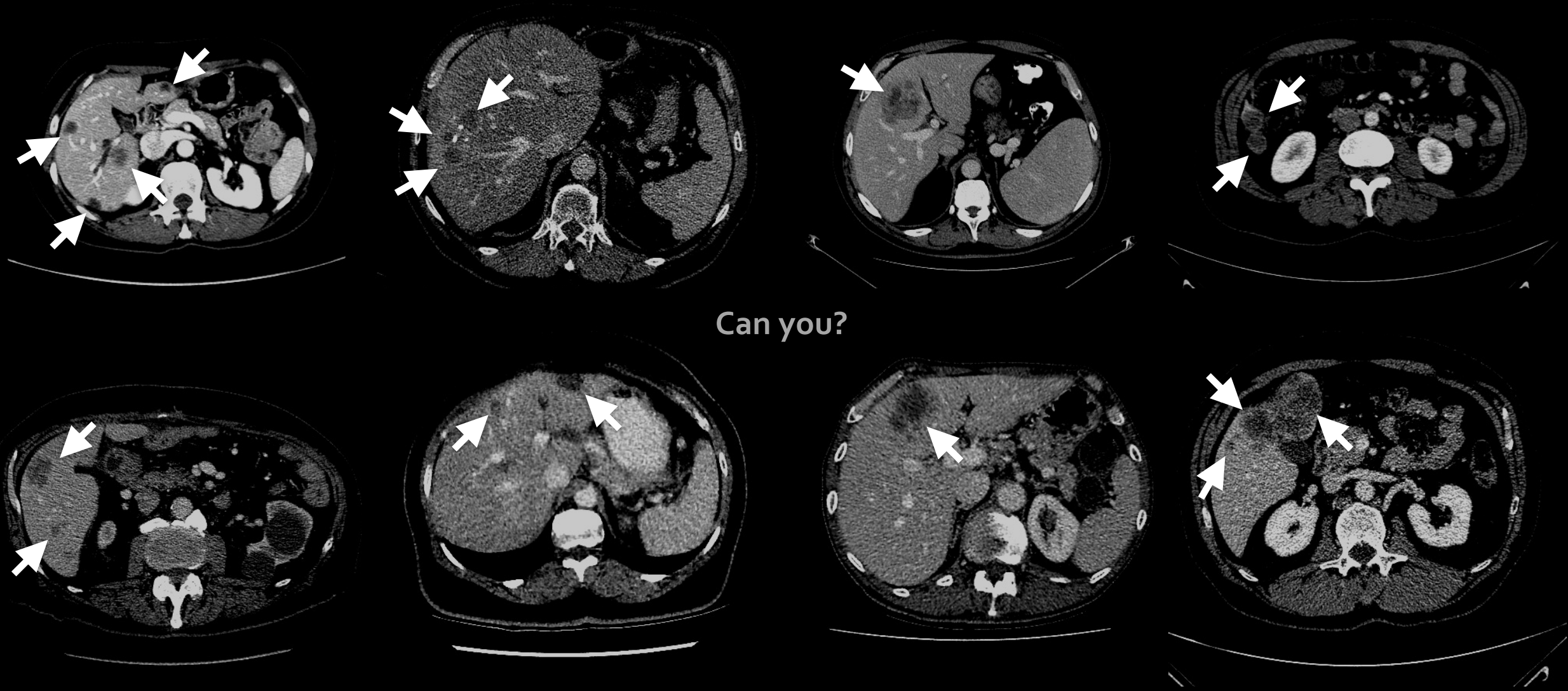
4. Exploring ultra-weak annotation (radiology reports, synthetic data).

★ Annotation-free deep learning





Medical professionals with over 6-year experience cannot tell which are real and which are synthetic tumors with an accuracy of 20% (lower than random guess)



Hu, Qixin, Yixiong Chen, Junfei Xiao, Shuwen Sun, Jieneng Chen, Alan Yuille, and Zongwei Zhou. "Label-Free Liver Tumor Segmentation." CVPR-2023.

Training AI on synthetic tumors performs almost as well as training it on real tumors.

CT

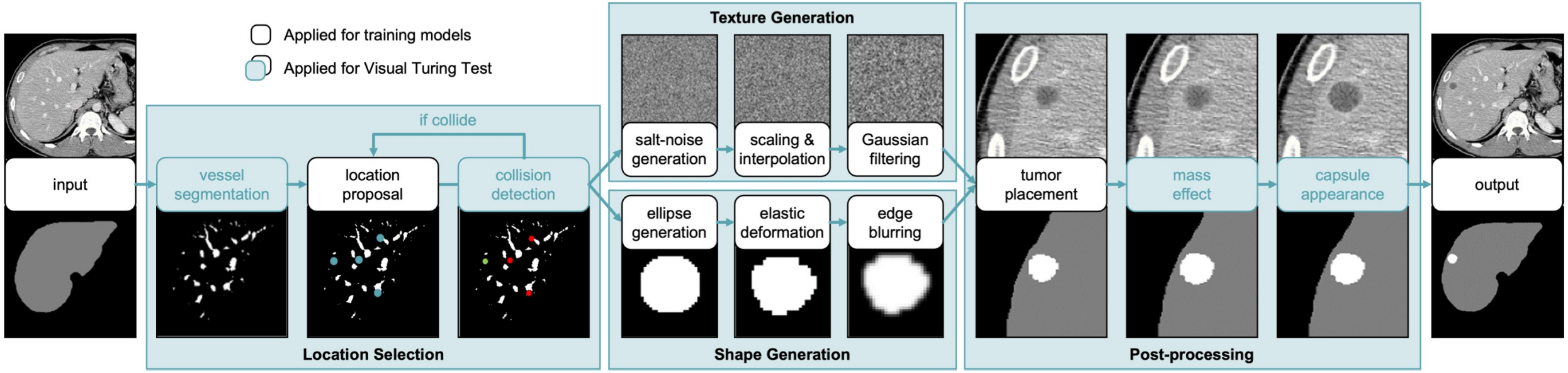
AI prediction
trained on real tumors
with per-voxel annotation
DSC = 58% [52% - 63%]

AI prediction
trained on synthetic tumors
with no annotation
DSC = 60% [55% - 65%]

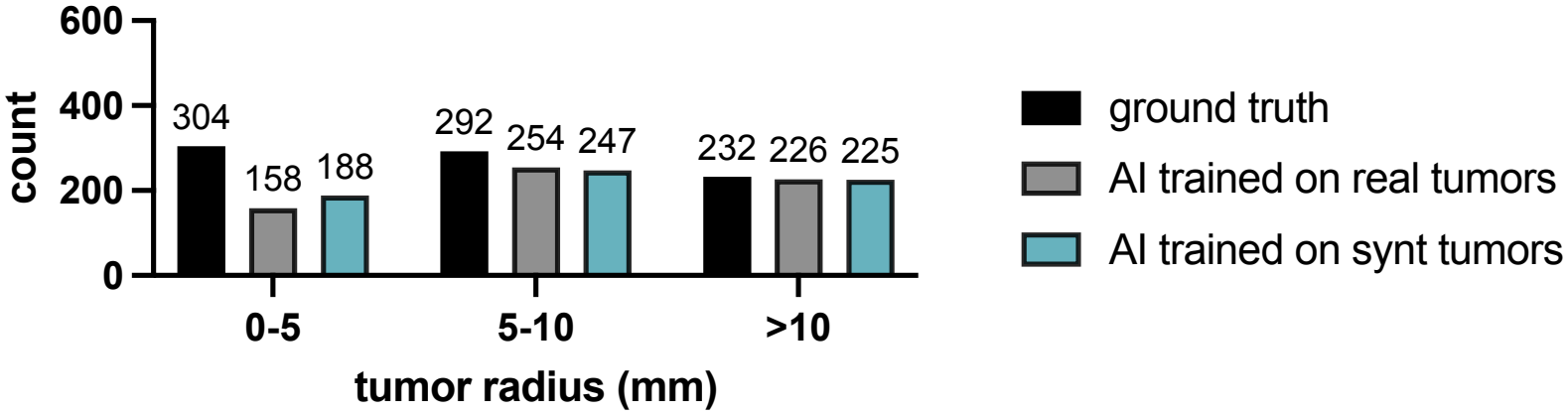
Liver

Liver tumor

Hu, Qixin, Yixiong Chen, Junfei Xiao, Shuwen Sun, Jieneng Chen, Alan Yuille, and Zongwei Zhou. "Label-Free Liver Tumor Segmentation." CVPR-2023.



Code &
Awesome Tumor Synthesis



Hu, Qixin, Yixiong Chen, Junfei Xiao, Shuwen Sun, Jieneng Chen, Alan Yuille, and Zongwei Zhou. "Label-Free Liver Tumor Segmentation." CVPR-2023.

Significant

Applications

Methodologies

Impactful

Earlier detection of cancer

Significant

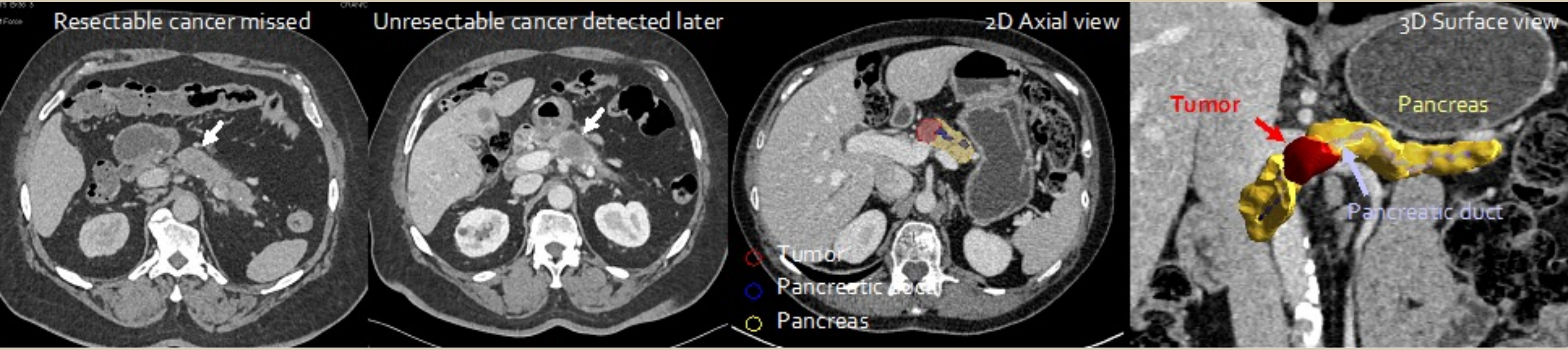
Applications

Methodologies

Impactful

Goal: Earlier detection of pancreatic neoplasms in CT scans using deep learning.

- 40,000,000 abdominal CT scans are performed each year in the United States.
- 1/3 of PDACs in these scans are missed by Radiologists. Early signs of PDAC can be subtle.
- Deep Learning can see things in images that most humans miss.
  - Pancreas tumors: 5,038 annotated CT scans in Johns Hopkins ☛ Sensitivity=97%, Specificity=99%
  - *This dataset took 15 years to annotate for a human.*



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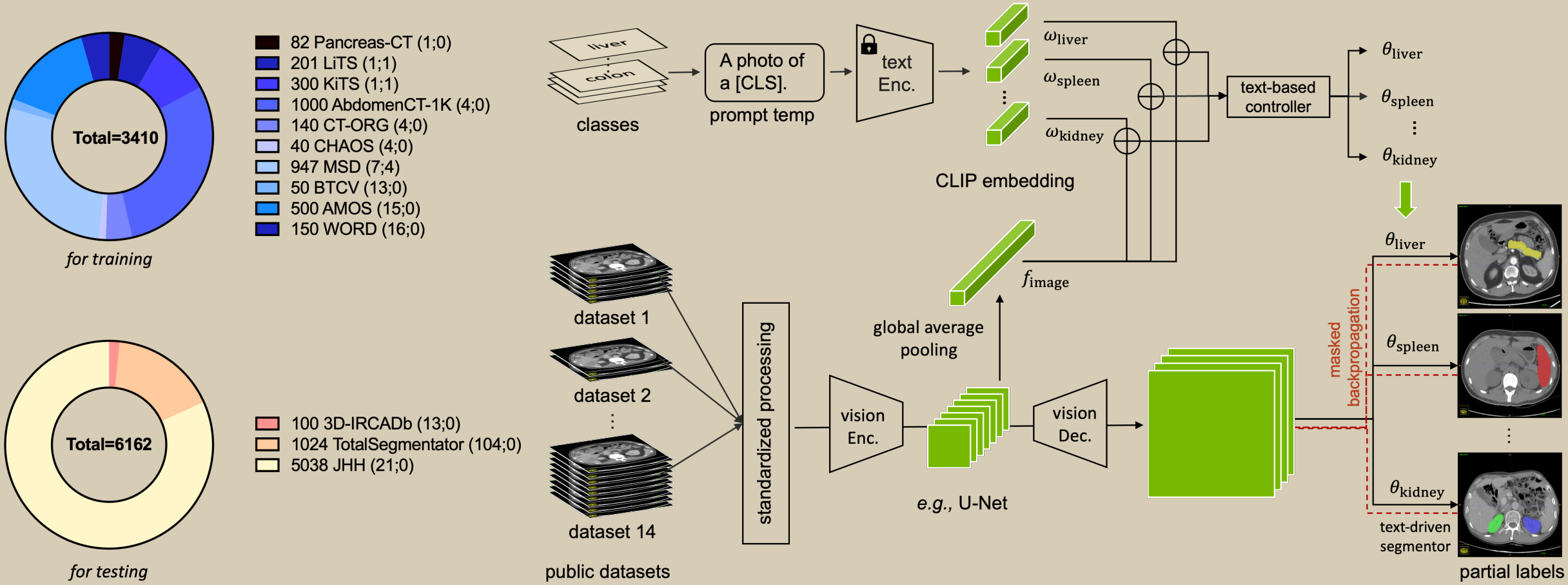
Goal: Earlier detection of ~~pancreatic neoplasms~~ cancers in CT scans using deep learning.

- Body Maps: This concept is similar to Google Maps, but it focuses on human anatomy rather than the Earth's geography. Body Maps offer several features:
  - (1) In-depth segmentation of anatomical structures.
  - (2) Disease screening across various structures.
  - (3) Language interaction between users and systems.

Two recently awarded grants: McGovern ($400,000) and Lustgarten ($1,922,421), where I served as Team Investigator.

The first-place solution in Medical Segmentation Decathlon (MSD)



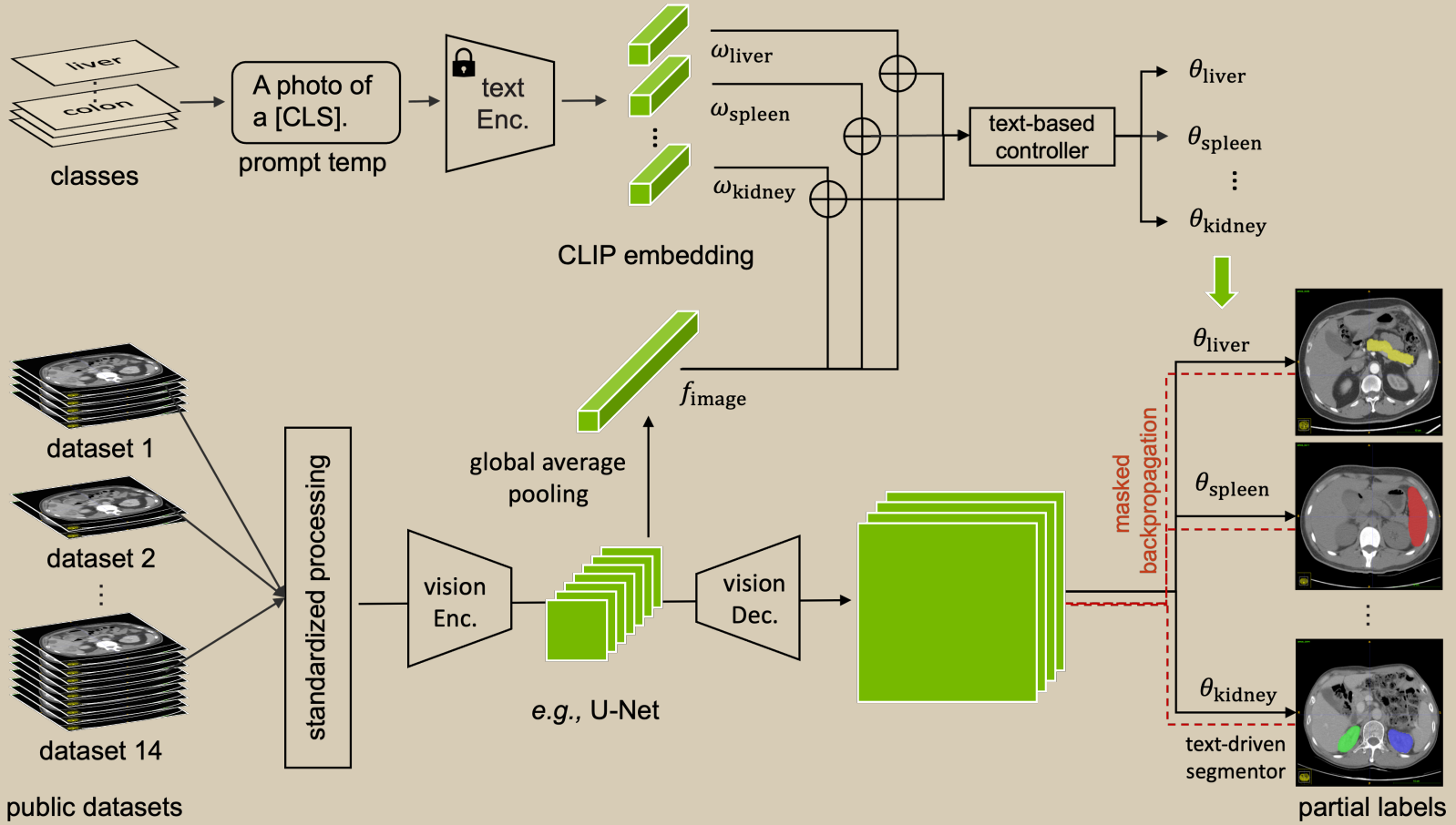
Liu, Jie, Yixiao Zhang, Jie-Neng Chen, Junfei Xiao, Yongyi Lu, Bennett A. Landman, Yixuan Yuan, Alan Yuille, Yucheng Tang, and Zongwei Zhou. "CLIP-Driven Universal Model for Organ Segmentation and Tumor Detection." arXiv preprint arXiv:2301.00785 (2023).

The first-place solution in Medical Segmentation Decathlon (MSD)

Code &
Awesome Medical Universal Models

25 Organs &
Six Types of Cancer

Kidney Tumor
Liver Tumor
Pancreas Tumor
Hepatic Vessel Tumor
Lung Tumor
Colon Tumor



Liu, Jie, Yixiao Zhang, Jie-Neng Chen, Junfei Xiao, Yongyi Lu, Bennett A. Landman, Yixuan Yuan, Alan Yuille, Yucheng Tang, and Zongwei Zhou. "CLIP-Driven Universal Model for Organ Segmentation and Tumor Detection." arXiv preprint arXiv:2301.00785 (2023).

Code &
Awesome Medical Universal Models

25 Organs &
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Kidney Tumor
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Lung Tumor
Colon Tumor

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Challenge

Challenge Leaderboard

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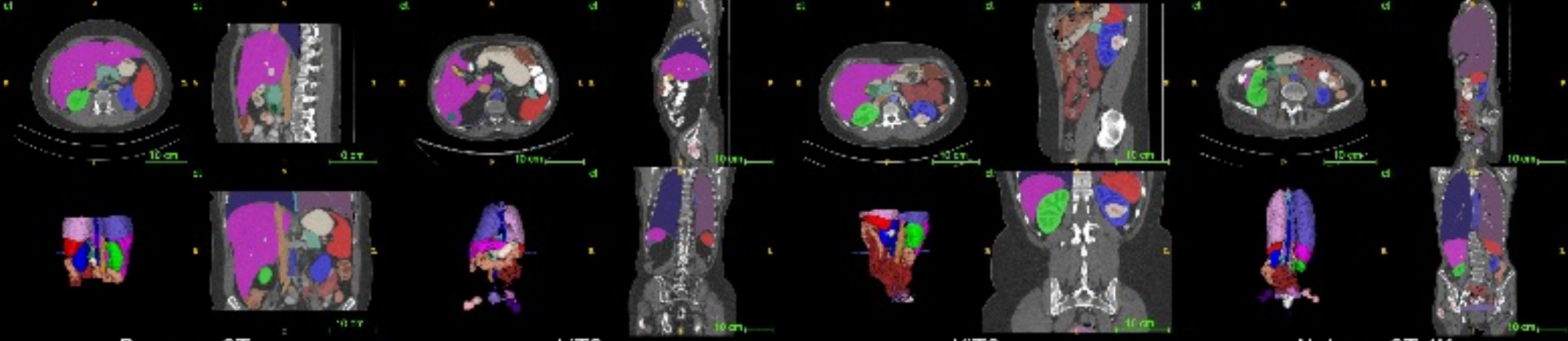
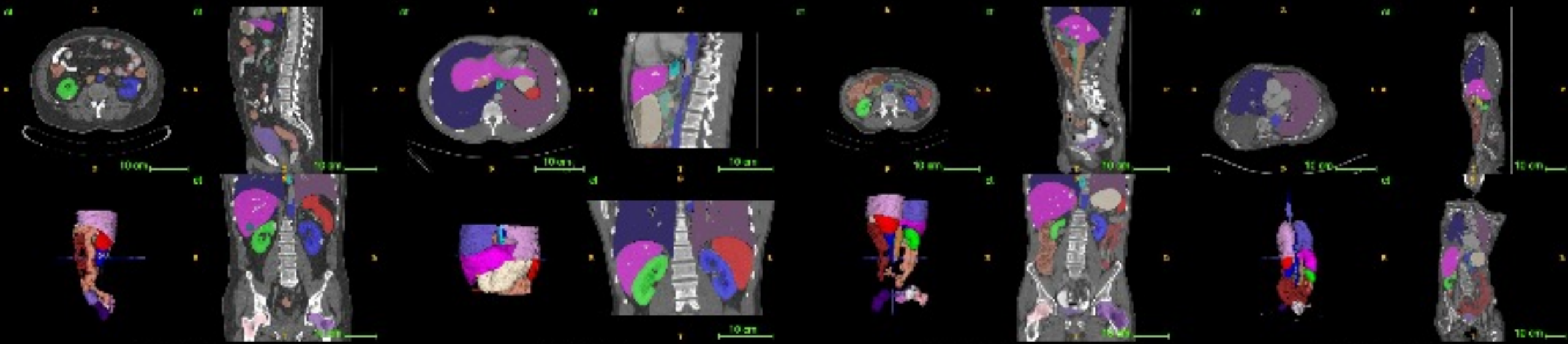
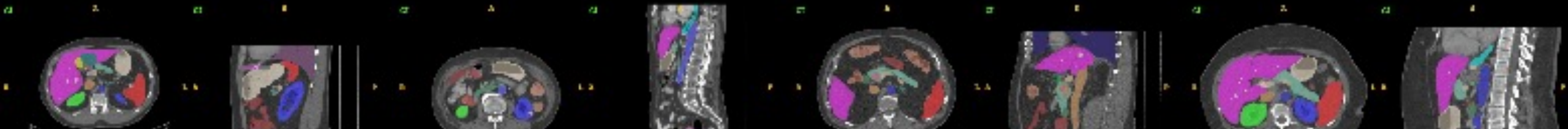
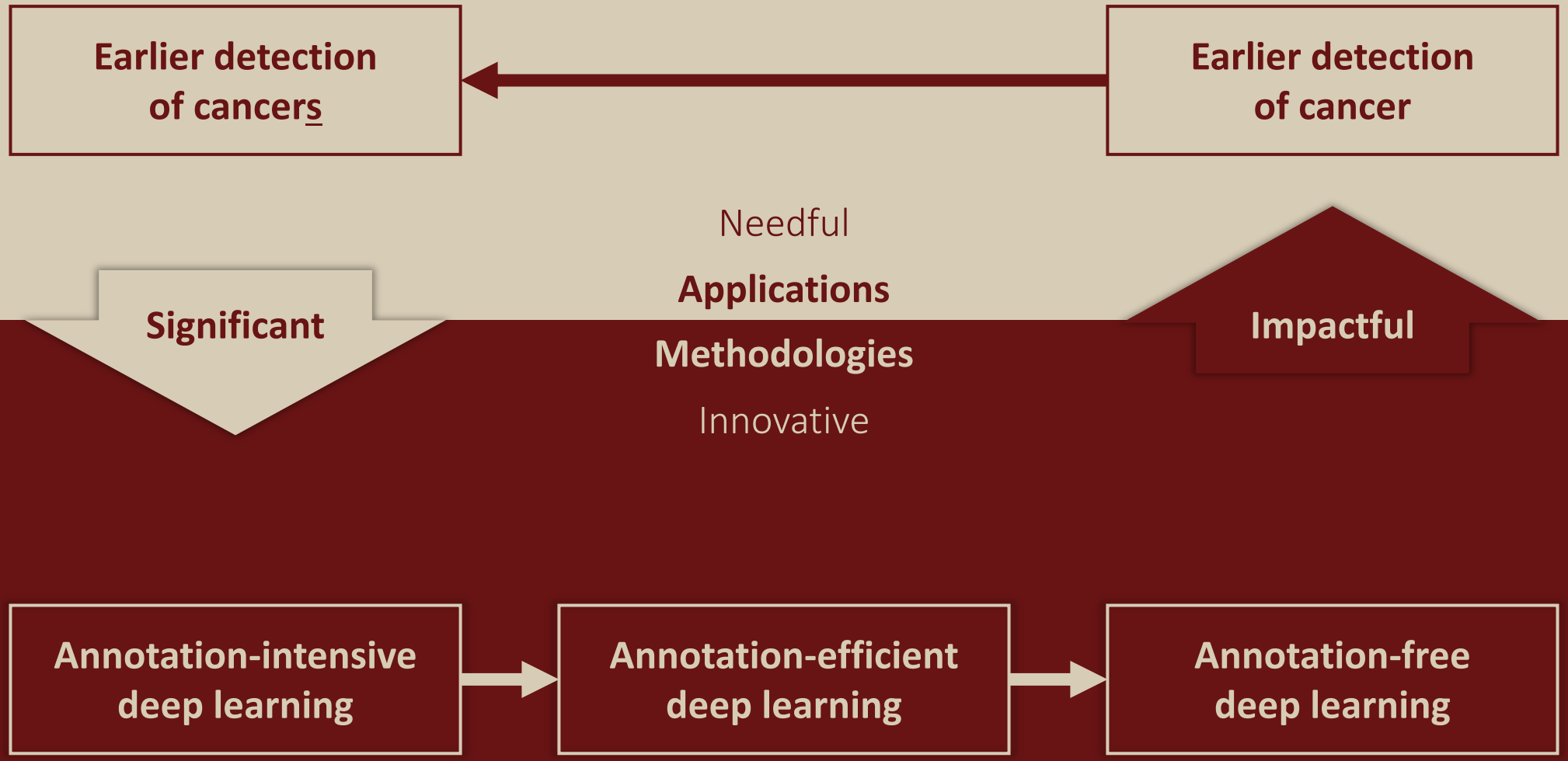
#	User (Team)		Created	Mean Position
1st	zongwei.zhou (universal_model)		13 Feb. 2023	5.6
2nd	Swin_UNETR	Swin UNETR *CVPR-2022*	13 Nov. 2021	10.1
3rd	ahatamiz2		12 Nov. 2021	10.1
4th	Isensee	nnU-Net *Nature Methods*	6 Dec. 2019	12.3
5th	AndyL		24 Nov. 2022	12.5
6th	heyufan1995	DiNTS *CVPR-2021*	30 Oct. 2020	12.8
7th	qsyeung		5 Jan. 2023	12.9
8th	tangy5		11 Nov. 2021	13.5
8th	vishwesh.nath		11 Nov. 2021	13.5
10th	shrajanbhandary		7 March 2023	13.6


Pancreas-CT
LiTS
KiTS
AbdomenCT-1K


CT-ORG
CHAOS
MSD-Liver
MSD-Lung




Earlier detection of cancers
Earlier detection of cancer
Needful
Applications
Methodologies
Innovative
Significant
Impactful
Annotation-intensive deep learning
Annotation-efficient deep learning
Annotation-free deep learning

2021 **BMI 505: Foundations of BMI Methods II** Position: Teaching Assistant, Instructor: Dr. Sen Peng
2020 **BMI 598: NLP Methods for Biomedical Text Mining** Position: Teaching Assistant, Instructor: Dr. Murthy Devarakonda
2020 **BMI 598: Imaging in Diagnostics** Position: Teaching Assistant, Instructor: Dr. Jianming Liang
2019 **BMI 507: Intro Digital Image Processing** Position: Teaching Assistant, Instructor: Dr. Jianming Liang
Possible topics: Medical Imaging Signals and Systems, Introduction to Bioengineering, etc.

Teaching Experience

Professional Service

Guest Editor:

- Journal of Imaging, Special Issue on "Imaging Informatics: Computer-aided Diagnosis"
- Applied Sciences, Special Issue on "Artificial Intelligence in Biomedical Image Processing"
- Machine Intelligence Research, Special Issue on "Multi-Modal Representation Learning"
- Frontiers in Radiology, Special Issue on "AI Applications for Cancer Diagnosis in Radiology"
- Sensors, Special Issue on "Advances of Deep Learning in Medical Image Interpretation"

Journal Reviewer: IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Neural Networks and Learning Systems, International Journal of Computer Vision, Medical Image Analysis, Artificial Intelligence in Medicine, Information Fusion, IEEE Transactions on Medical Imaging, Pattern Recognition, Computer Methods and Programs in Biomedicine, IEEE Transactions on Biomedical Engineering, Journal of Biomedical and Health Informatics, IEEE Access, Journal of Biomedical Informatics

Workshop Co-Organizer: ICML'23 and ICML'22 Workshop on Interpretable Machine Learning in Healthcare (IMLH)

Conference Program Committee: CVPR'22-23, ICCV'21-23, MICCAI'20-23, AAAI'20-23

Thank You!

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www.zongweiz.com

Statistics

6,458 citations
Top 2% of Scientists in 2022
24 first/corresponding authored papers