# PanTS The Pancreatic Tumor Segmentation Dataset

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## Hold on to your PanTS—there's a new pancreatic cancer detection dataset in town

Developed by a Johns Hopkins-led research team, the Pancreatic Tumor Segmentation Dataset may be the key for training AI models to detect pancreatic cancer early enough to make a difference in patients' survival. Pancreatic cancer is the third leading cause of cancer-related deaths in the U.S., with **80-85%** of cases diagnosed too late for effective treatment. *"I was confused when radiologists and surgeons gave me completely different answers,"* recalls a JHU student who benefited from early detection and timely surgery. *"Pinning down the ground truth at early stages is difficult."*
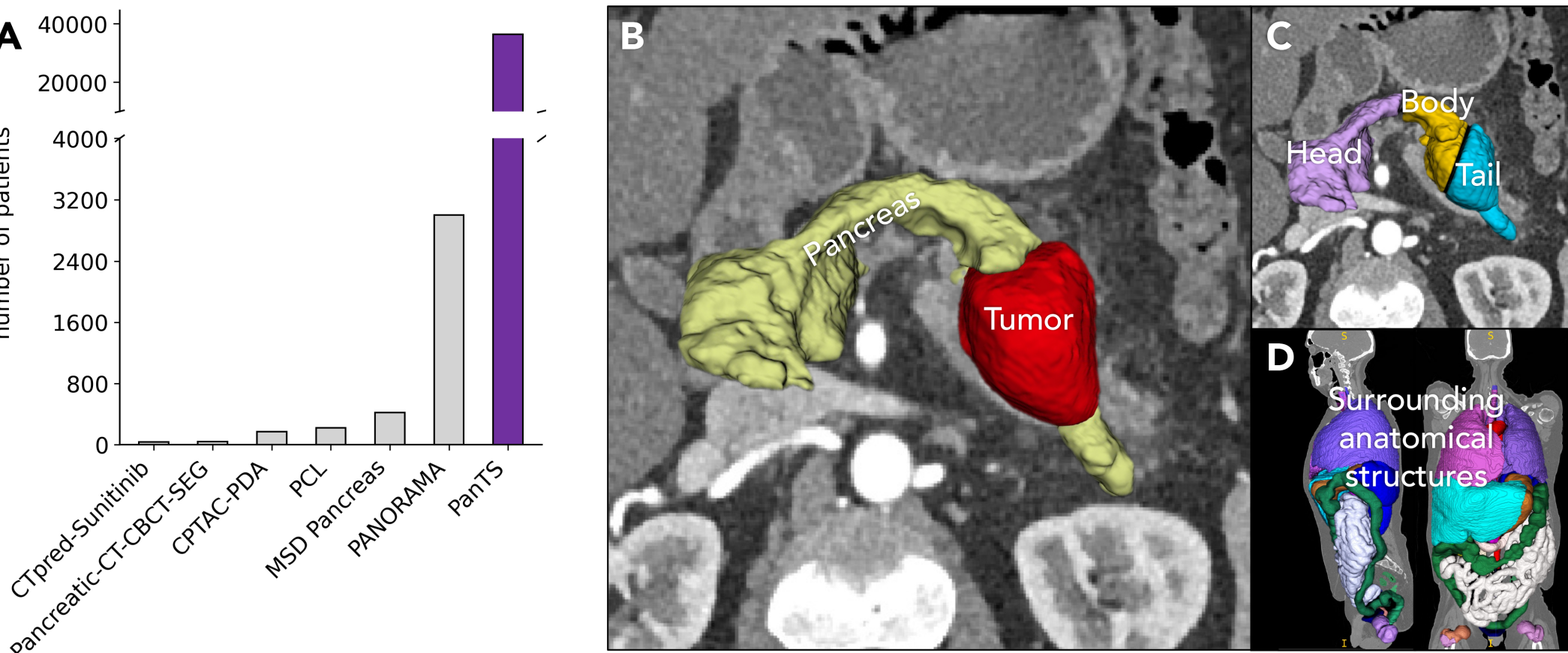


PanTS is a large-scale, multi-institutional dataset, containing **36,390** CT scans from **145** centers, with expert-validated, voxel-wise annotations of over **993,000** anatomical structures, including *pancreatic tumors, pancreas head, body, and tail, and 24 surrounding anatomical structures such as vascular, skeletal structures and abdominal, thoracic organs.* PanTS offers rich metadata—*such as patient age, sex, diagnosis, and more— and information about imaging protocols and biomarkers,* the largest CT dataset ever released. PanTS was annotated using **MONAI Label**.

## Annotation Protocol, Standard, and Quality Control



The **inter-annotator agreement** was evaluated using the DSC between the two independent annotators (*junior radiologists*). Most annotations demonstrate high agreement, confirming their reliability. A minimum threshold of DSC=20% is used to flag low-agreement cases, which are reviewed by *senior radiologists* for further quality assurance. ***Low-agreement cases often are small or ambiguous tumors.***

## Justification of Annotating Large-Scale Tumor Datasets

### R1. Benchmark on open leaderboard, Medical Segmentation Decathlon (MSD)

### R2. Benchmark on the PanTS-test leaderboard



**R1.** AI trained on our PanTS vs. AI trained on publicly available datasets. The performance is tested on the official MSD-Pancreas test set (third-party evaluation).
**R2.** The ROC curve of AI trained on different scale of datasets, i.e., MSD-Pancreas (n=281), PANORAMA (n=2,238), and our PanTS dataset (n=9,901).
*Observation: the larger training set, the higher voxel-wise annotation quality, the better pancreatic tumor detection performance on out-of-distribution test sets.* PanTS enables tasks of semantic segmentation, vision-language models, metadata prediction, and many more.
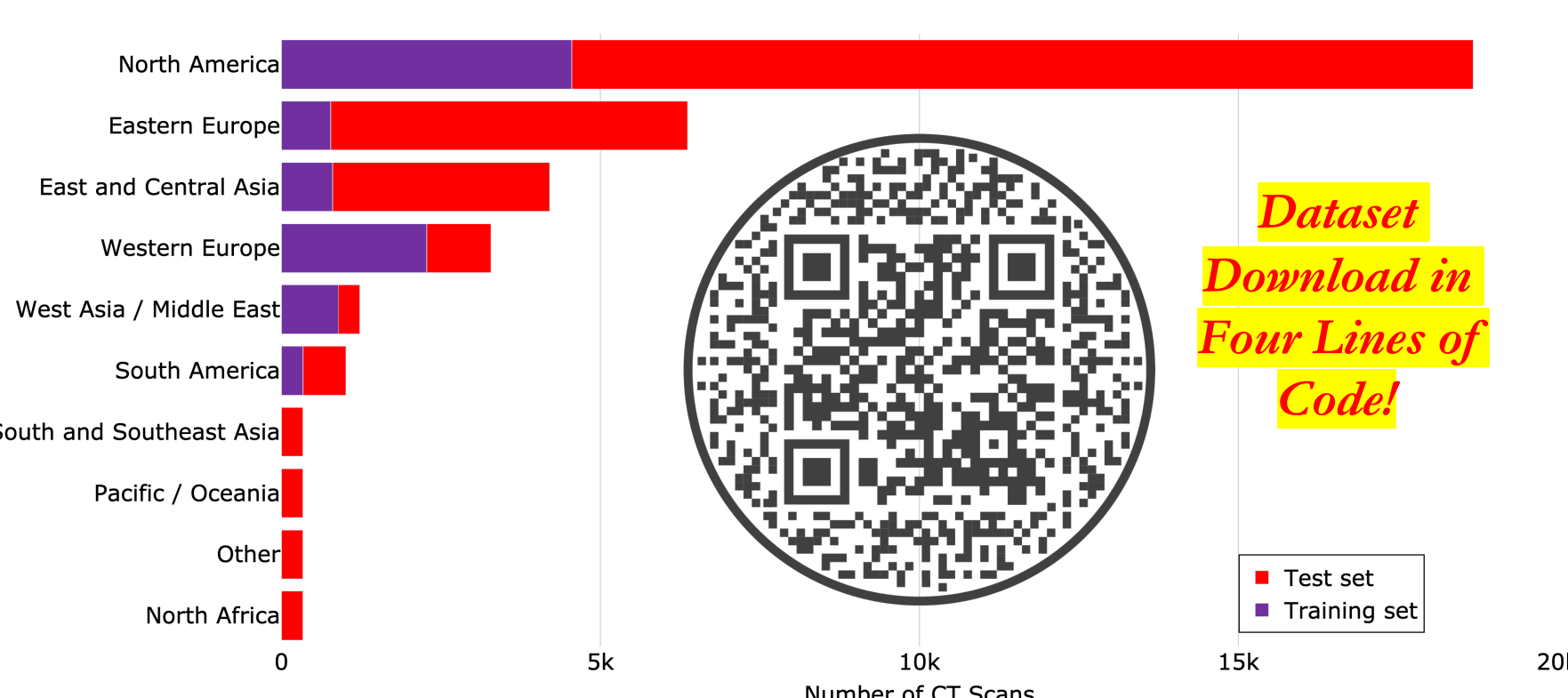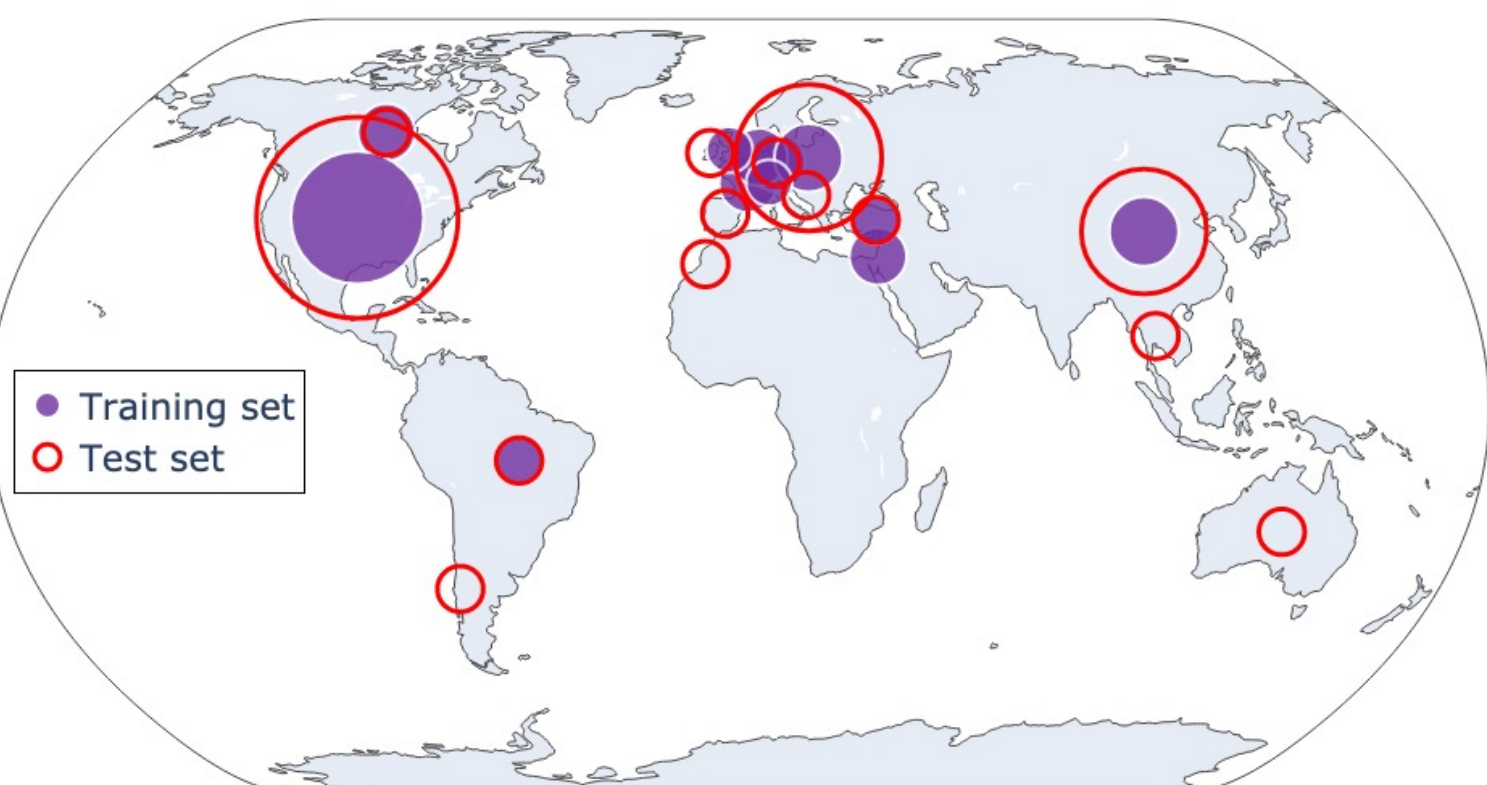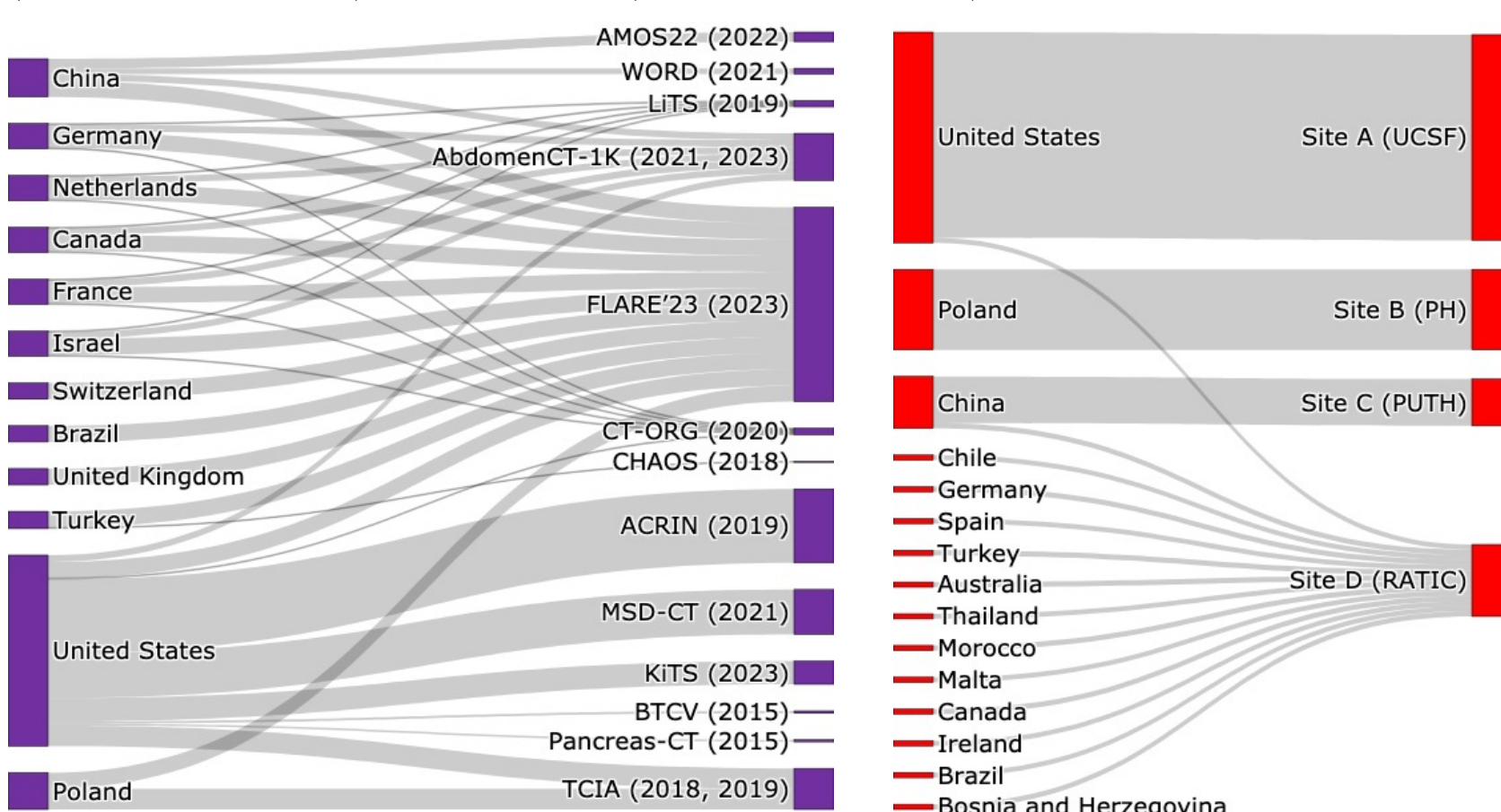
## Training set 9,901 CT scans + 28 classes masks + metadata
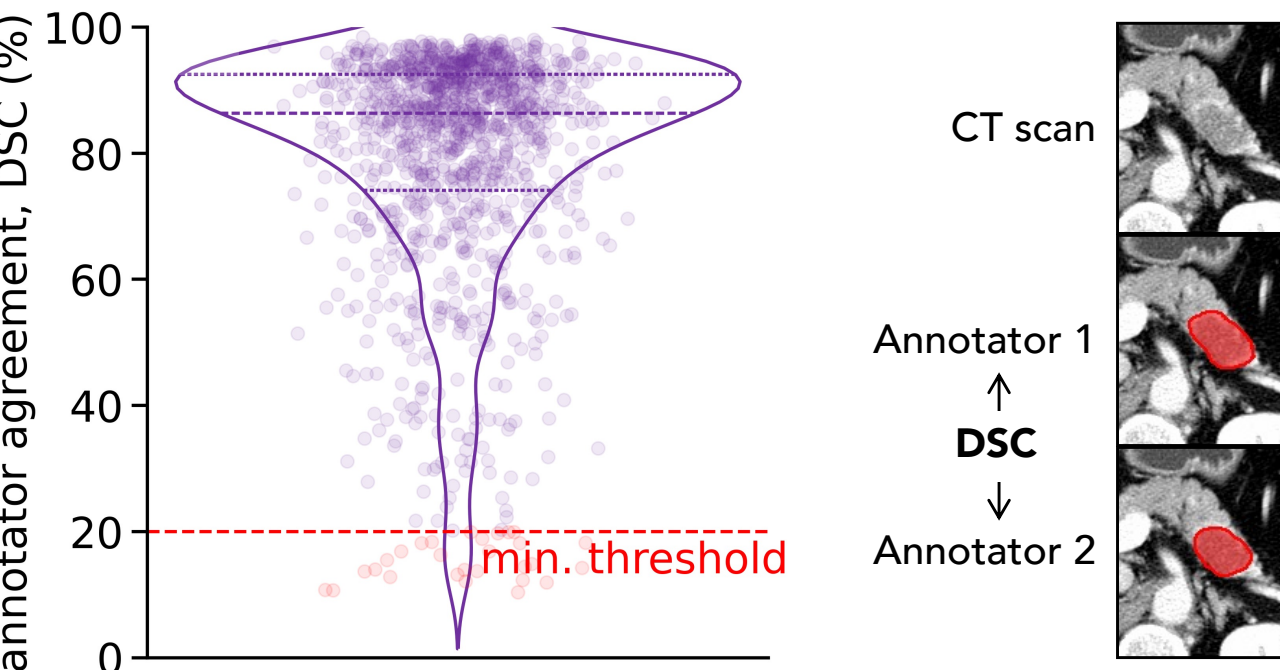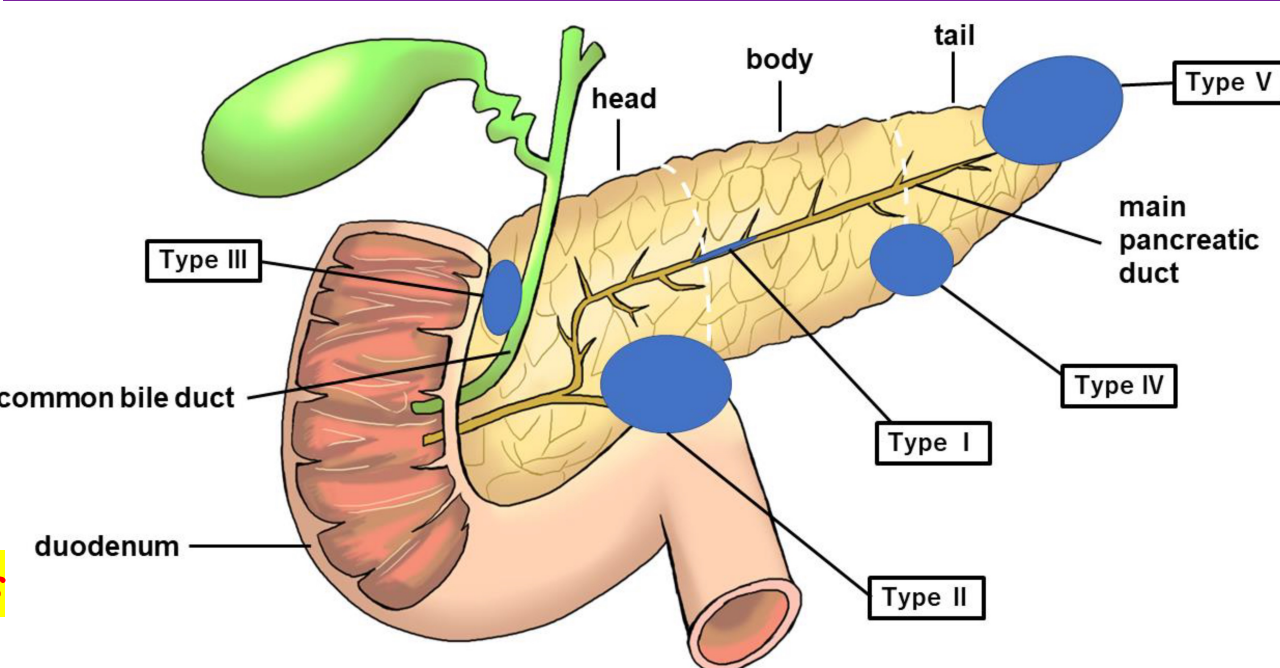*New* structured reports are now publicly available!

| Variable | Training set (n = 9,901) | Test set (n = 26,489) | p-value |
|---|---|---|---|
| Age, mean (SD) | 60.6 (13.0) | 58.5 (17.0) | $1.78 \times 10^{-7}$ |
| Sex | | | $7.87 \times 10^{-27}$ |
| Female, no. (%) | 2,358 (23.8) | 13,090 (49.4) | |
| Male, no. (%) | 2,923 (29.5) | 11,714 (44.2) | |
| Unknown, no. (%) | 4,620 (46.7) | 1,685 (6.4) | 0.00 |
| In-plane spacing, mm (IQR) | 0.81 (0.74, 0.98) | 0.75 (0.70, 0.83) | $5.13 \times 10^{-169}$ |
| Slice thickness, mm (IQR) | 1.25 (0.80, 2.50) | 1.25 (1.25, 2.50) | 0.00 |
| Contrast phase | | | 0.00 |
| Non-contrast, no. (%) | 4,488 (45.3) | 3,920 (14.8) | |
| Portal venous, no. (%) | 2,895 (29.2) | 20,296 (76.6) | |
| Arterial, no. (%) | 2,450 (24.7) | 2,273 (8.6) | |
| Delayed, no. (%) | 68 (0.7) | 0 (0.0) | |
| Pancreatic tumor | | | |
| Yes, no. (%) | 1,077 (10.9) | 2,829 (10.7) | |
| No, no. (%) | 8,824 (89.1) | 23,660 (89.3) | |
| Dilated duct | | | |
| Yes, no. (%) | 3,387 (34.2) | 11,180 (42.2) | |
| No, no. (%) | 6,514 (65.8) | 15,309 (57.8) | |
| Tumors per positive CT, no. (IQR) | 1.00 (1.00, 1.00) | 1.00 (1.00, 2.00) | $1.48 \times 10^{-65}$ |
| Tumor volume, mm³ (IQR) | 4,749 (1,658, 11,479) | 12,667 (3,347, 32,238) | $4.07 \times 10^{-53}$ |
| Tumor HU value, mean (SD) | 57.3 (30.7) | 78.2 (59.0) | $1.54 \times 10^{-10}$ |
| Pancreas volume, mm³ (IQR) | 74,669 (52,806, 95,892) | 74,480 (56,676, 92,892) | $8.75 \times 10^{-2}$ |
| Pancreas HU value, mean (SD) | 56.8 (36.4) | 85.6 (54.8) | 0.00 |

*Having **normal** scans helps reduce false positives from oversensitive AI models*

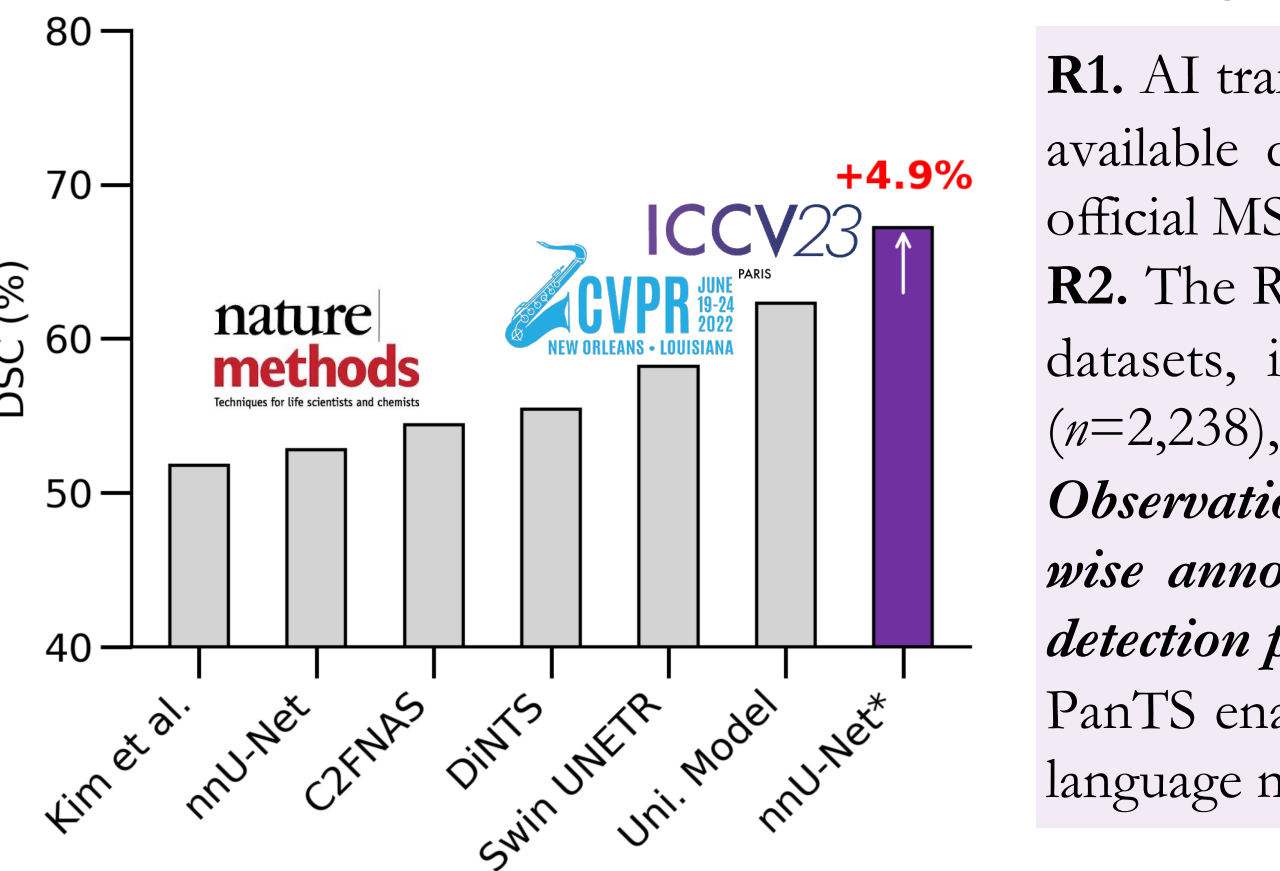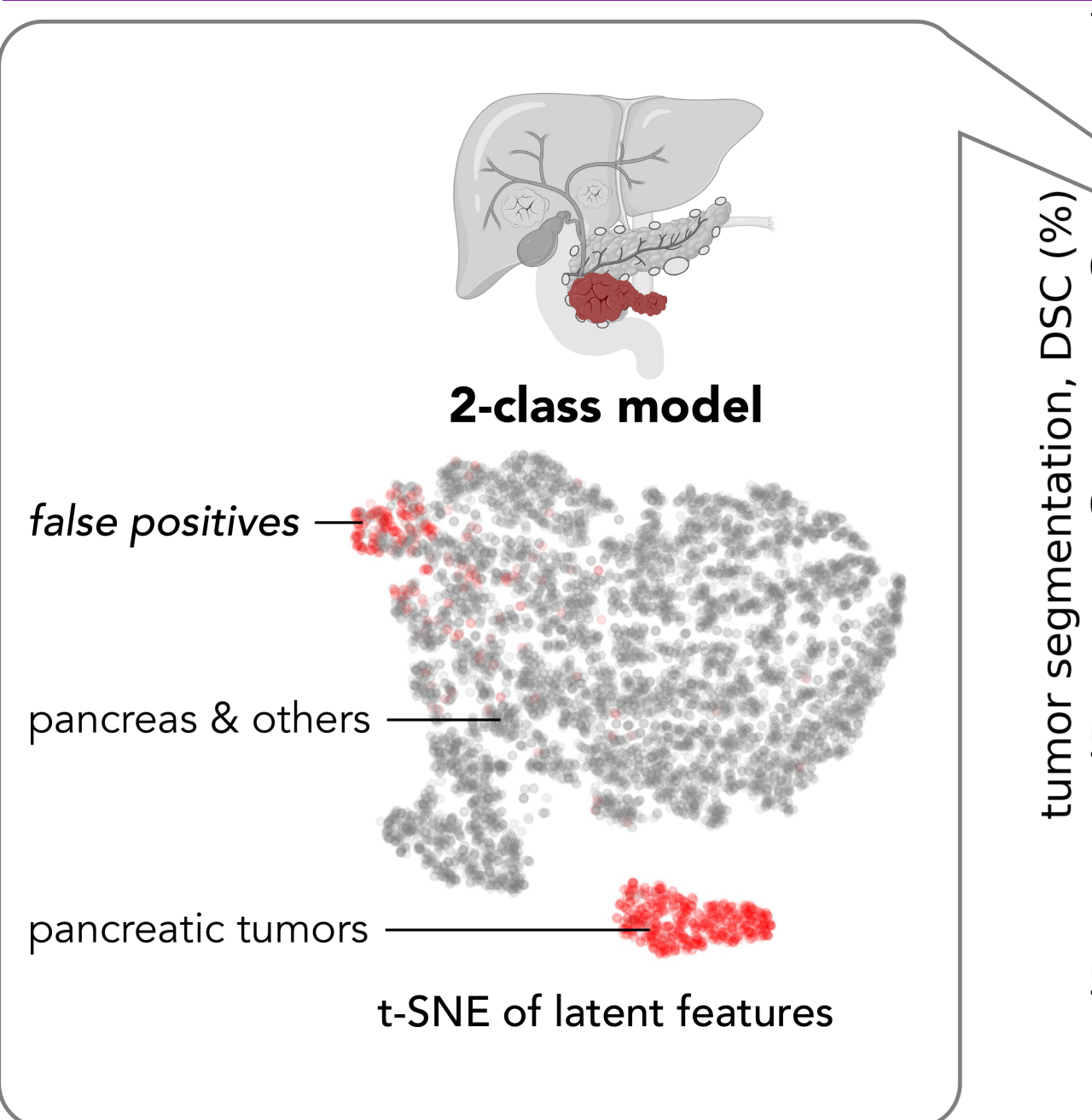## Test set UCSF (13,458 CT scans) & PH (5,259 CT scans) & PUTH (3,066 CT scans) & RATIC (4,706 CT scans)



*Dataset Download in Four Lines of Code!*



## Justification of Annotating 28 Anatomical Structures



**Annotated 28 anatomical structures in PanTS:** adrenal gland left · adrenal gland right · aorta · bladder · celiac artery · colon · common bile duct · duodenum · femur left · femur right · gall bladder · kidney left · kidney right · liver · lung left · lung right · pancreas · pancreas body · pancreas head · pancreas tail · pancreatic duct · postcava · prostate · spleen · stomach · superior mesenteric artery · veins · pancreatic lesion

**PanTS-XL** is available for early access, including **47,315** CT scans with voxel-wise annotated pancreatic tumors and **88** anatomical structures.

*Let's Connected!* BodyMaps is a rigorously mentored research program at the convergence of AI and Medicine hosted at **Johns Hopkins University, Johns Hopkins Medicine, University of California, San Francisco, and Nvidia**. We welcome students, researchers, clinicians, and developers around the world. The goal is to create comprehensive annotations of the entire human body, enabling us to build large-scale annotated datasets and develop effective AI algorithms. The BodyMaps Program has now contributed a total of **241,336** patients' CT scans with detailed, per-voxel annotations of **377** anatomical structures and their associated tumors.