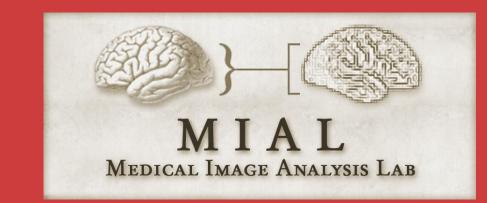


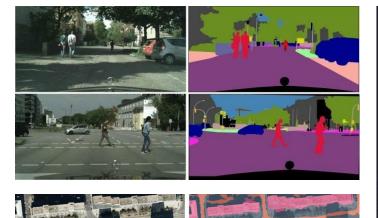
# Deep Semantic Segmentation of Natural & Medical Images: A Review

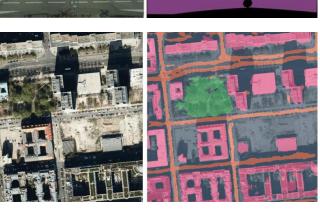
SA Taghanaki\*, K Abhishek\*, JP Cohen, J Cohen-Adad, G Hamarneh



### IMAGE SEGMENTATION

Partitioning an image into multiple segments or regions, such that, given an image I, each pixel/voxel  $v_i$  is assigned a label  $L_i$ .



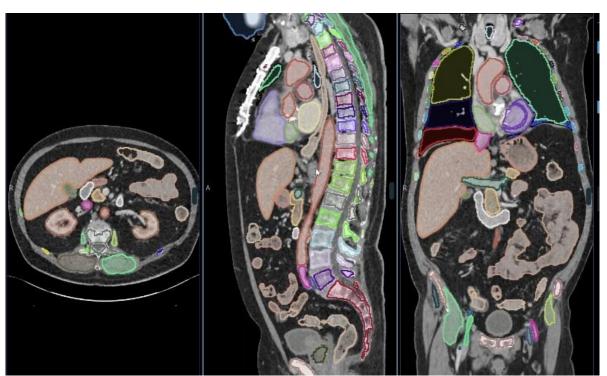


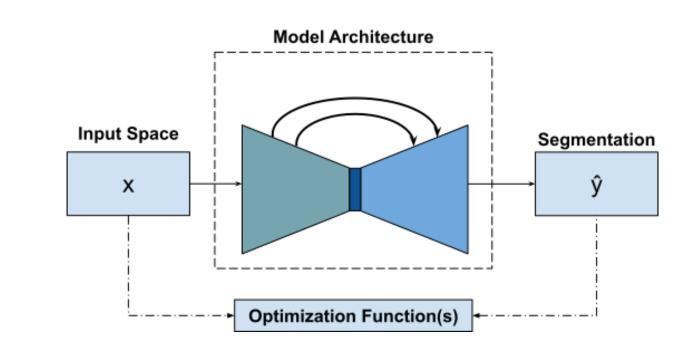
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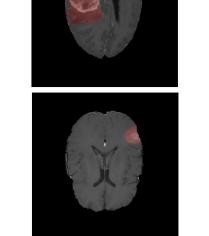
Supervision Levels

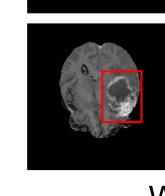
aluation

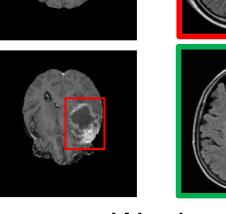
Intelligence Review

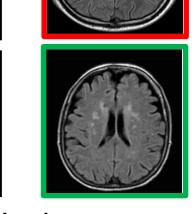












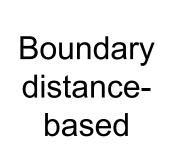


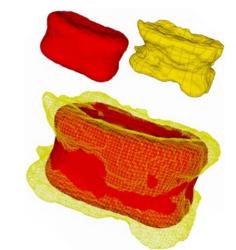
Full

Weak

Self/No

Overlapbased





# CONTRIBUTION

Survey of 250+ papers on deep learning-based semantic segmentation of natural & medical images.

- Springer Al Review journal (2024 IF: 13.9).
- **1000+ citations** (October 2025).

### **KEY OBSERVATIONS**

### Architecture

- U-Net-like encoderdecoder models & skip connections.
- Attention mechanisms.

Synthesis-based

Weak supervision.

Multi-task learning

augmentation.

paradigms.

Multi-scale representations.

**Training** 

- Public challenges-driven progress.

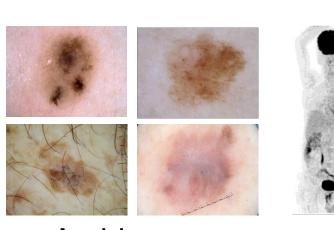
- (Soft) **Dice** Loss.
- Uncertainty-aware losses.
- Hybrid combinations of loss functions.

Loss

# Domain-specific

- Integrating clinical priors.
- 3D volumetric segmentation.

## WHY IS MEDICAL IMAGE SEGMENTATION HARD?



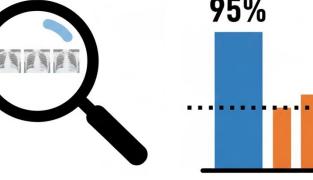




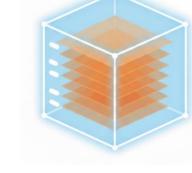




Domain variability







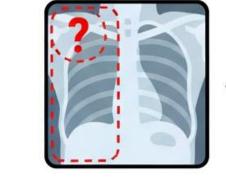
Volumetric (3D/4D) data

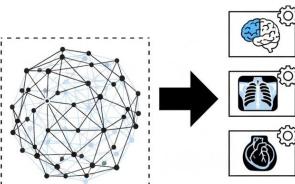


Patient privacy and regulations

## RECENT ADVANCES SINCE THIS REVIEW

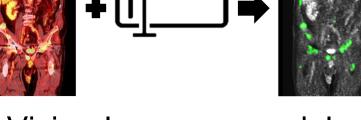


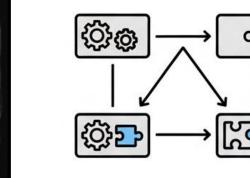




Self-supervised training methods

Foundation models



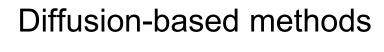






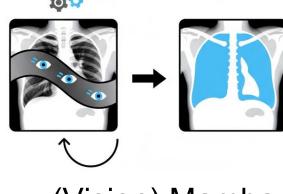
nnU-Net Vision-language models

Segment Anything Models

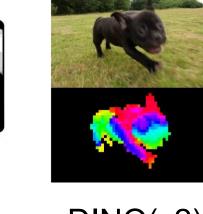




Interactive segmentation



(Vision) Mamba



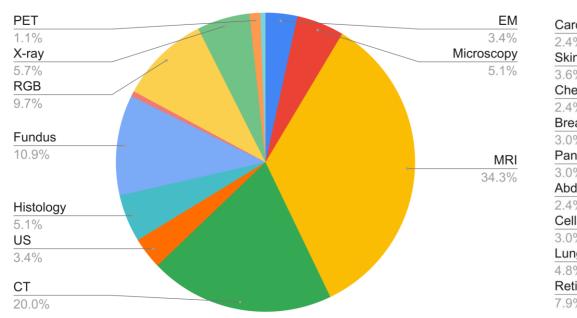
DINO(v2)



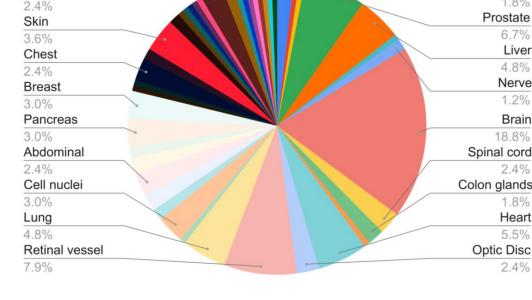




# MEDICAL IMAGE SEGMENTATION: TRENDS IN RESEARCH AND COMPETITIONS



Distribution of imaging modalities



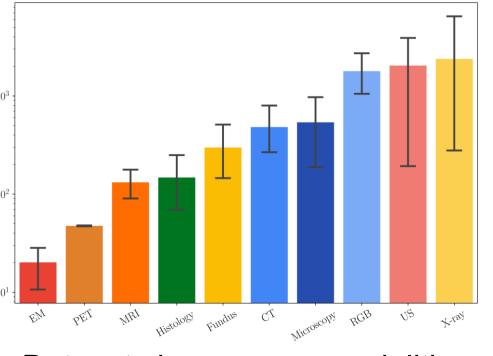
Distribution of anatomical regions

Modalities in competitions

(https://grand-challenge.org/)

US RGB

■ EM/Microscopy



Dataset sizes across modalities