Deep Learning for Histopathological Image Segmentation

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Introduction

Colorectal Cancer: 3rd worldwide

- (a) Large Scale Images
- (b) Artifacts
- (c) Sparse label
- (d) Small labelled samples

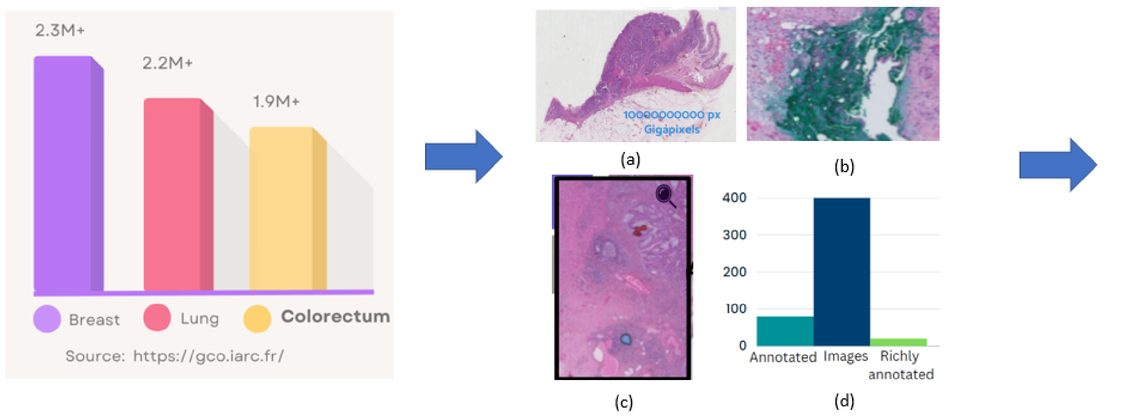


Fig. 1: Deep Learning for Histology Image Classification and Segmentation

Deep Learning: Image Segmentation and Mutation Classification

Methodology

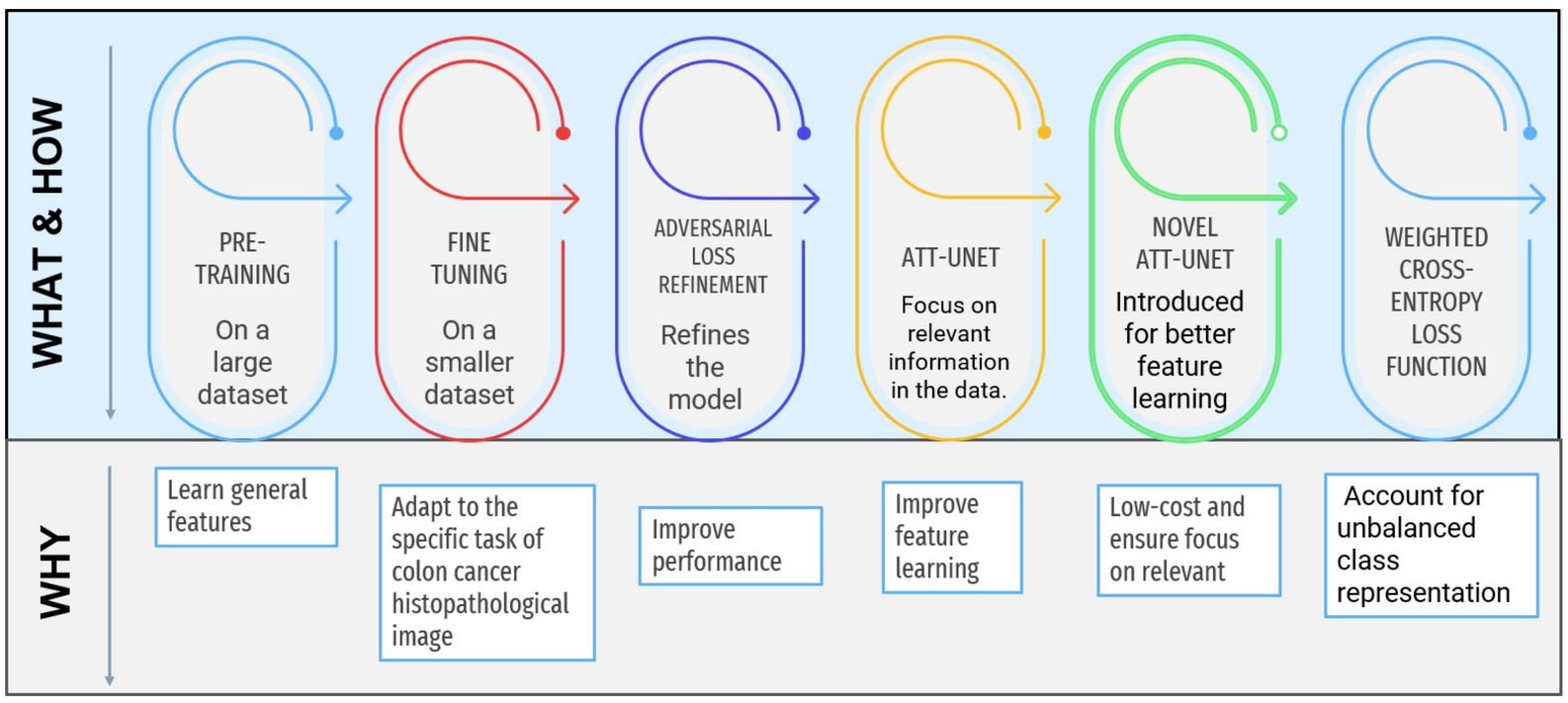
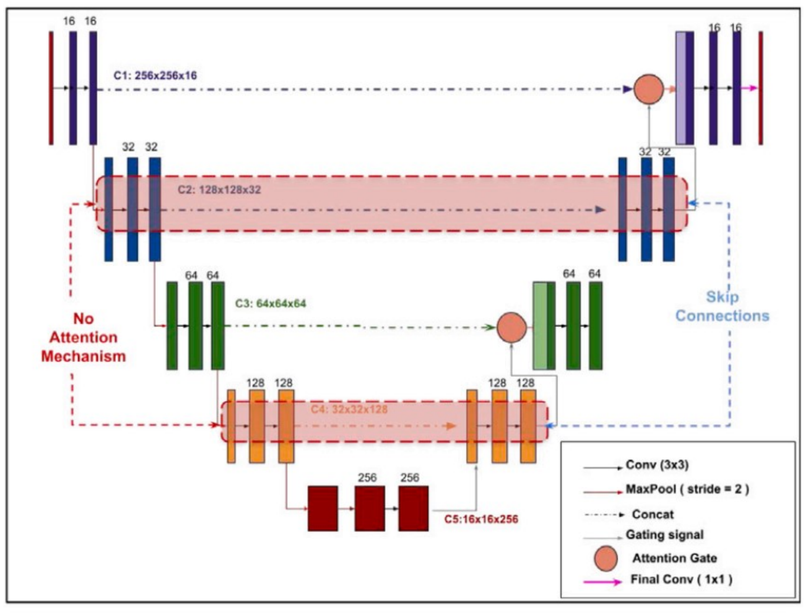


Fig. 2: Overall methodology for determine Colon Cancer Clasification using UNet and Att-UNet



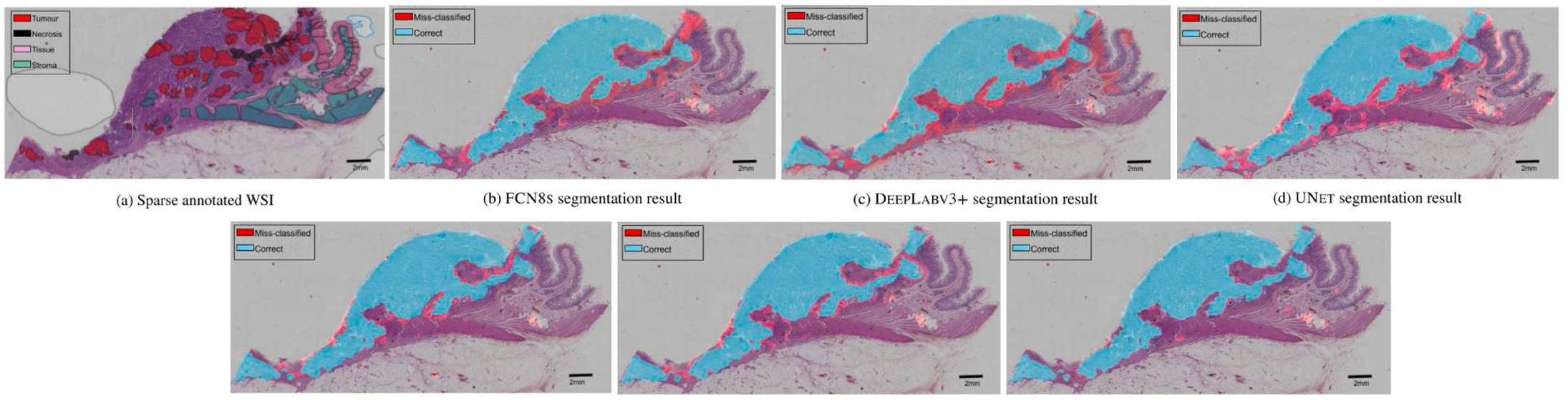
(a) The ALTER-ATTUNET architecture

Fig. 3: Example of one of the CNN architechtures proposed

This methodology involves a multi-step training strategy that combines pre-training, fine-tuning, and adversarial loss refinement with attention-based UNet models and weighted cross-entropy loss functions to improve performance in colon cancer digital pathology tasks.

Results

The novel enhanced model called Alter-AttUNet outperforms the other state-of-the-art algorithms in the colon cancer WSI segmentation task using AiCOLO dataset with low number of annotated samples (Fig. 4).



(a) Sparse annotated WSI (b) FCN8S segmentation result (c) DEEPLABV3+ segmentation result (d) UNET segmentation result

(e) ATT-UNET segmentation result (f) ATTUNET-AUTOENCODER segmentation result (g) ALTER-ATTUNET segmentation result

Fig. 4: Segmentation maps of the FCN8s, DeepLabv3+, UNet, Att-UNet, AutoEncoder-AttUNet and Alter-AttUNet models.

Discussion and Prospectives

The low number of annotated samples, unbalanced and full of artifacts increases the challenge in WSI segmentation task. However, the novel enhanced model called Alter-AttUNet outperformed the state-of-the-art methods in this task, in terms of accuracy, specificity, sensitivity and F1-Score, generating therefore, the best balance between accurate results and light network, when used in AiColo, NCT-CRC-HE-100K, CRC-5000 and Warwick datasets. **Next step:** Train the algorithm to identify mutations in human cells using histopathological images.

Bibliography

[1] Hamida, A. Ben, et al. "Weakly Supervised Learning using Attention gates for colon cancer histopathological image segmentation."Artificial Intelligence in Medicine 133 (2022): 102407.; [2]Gunduz-Demir Cigdem, Kandemir Melih, Tosun Akif Burak, Sokmensuer Cenk. Automatic segmentation of colon glands using object-graphs. Med Image Anal 2010;14(1):1–12.; [3] Srinidhi Chetan L, Ciga Ozan, Martel Anne L. Deep neural network models for computational histopathology: A survey. Med Image Anal 2021;67:101813.