Input Augmentation with SAM: Boosting Medical Image Segmentation with Segmentation Foundation Model

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Background:

- The large language and vision models, such as GPT-3/GPT-4 and SAM (Segment Anything Model), are trained on massive amounts of data, primarily consisting of natural language and natural images.

- Large models can be considered as a form of general knowledge/information. How to efficiently and effectively utilize these general large models in medical image computing presents new opportunities and challenges in the field of medical image computing.

Overview:
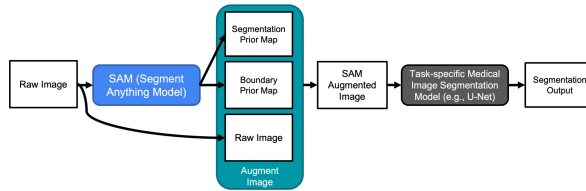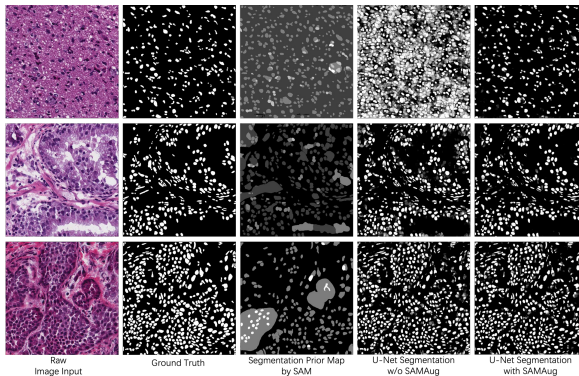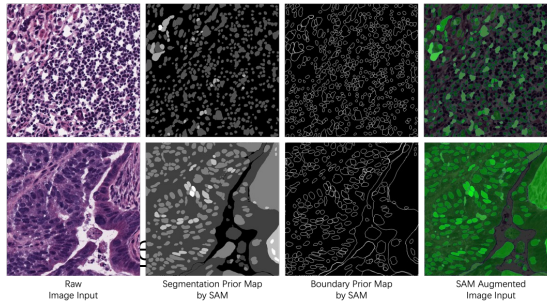
Code Snippet:

```python
import numpy as np
import skimage
from skimage.segmentation import find_boundaries
from segment_anything import SamAutomaticMaskGenerator, sam_model_registry
device='cuda'
sam = sam_model_registry["vit_h"](checkpoint="sam_vit_h_4b8939.pth")
sam.to(device=device)
mask_generator = SamAutomaticMaskGenerator(sam,crop_nms_thresh=0.5,box_nms_thresh=0.5,pred_iou_thresh=0.5)

def SAMAug(tI,mask_generator):
    masks = mask_generator.generate(tI)
    tI=skimage.img_as_float(tI)
    SegPrior=np.zeros((tI.shape[0],tI.shape[1]))
    BoundaryPrior=np.zeros((tI.shape[0],tI.shape[1]))
    for maskindex in range(len(masks)):
        thismask=masks[maskindex]['segmentation']
        stability_score =masks[maskindex]['stability_score']
        thismask_onp.zeros((thismask.shape))
        thismask_np.where(thismask==True)=1
        SegPrior[np.where(thismask_==1)]=SegPrior[np.where(thismask_==1)]+stability_score
        BoundaryPrior=BoundaryPrior+find_boundaries(thismask_,mode='thick')
        BoundaryPrior[np.where(BoundaryPrior>0)]=1
    tI[:,:,1]=tI[:,:,1]+SegPrior
    tI[:,:,2]=tI[:,:,2]+BoundaryPrior
    return tI
```

Please visit:
https://github.com/yizhezhang2000/SAMAug/
for the full training and testing codes.

Visual Examples:

Raw Image Input — Segmentation Prior Map by SAM — Boundary Prior Map by SAM — SAM Augmented Image Input

Raw Image Input — Ground Truth — Segmentation Prior Map by SAM — U-Net Segmentation w/o SAMAug — U-Net Segmentation with SAMAug

Experimental Results:

Table 1. Cell segmentation results on the MoNuSeg dataset.

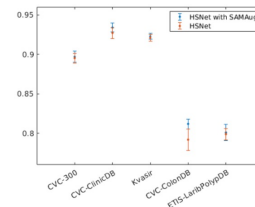| Model	SAMAug	AJI	F-score
Swin-UNet [2]	✗	61.66	80.57
U-Net [16]	✗	58.36	75.70
	✓	64.30	82.36
P-Net [23]	✗	59.46	77.09
	✓	63.98	82.56
Attention UNet [14]	✗	58.76	75.43
	✓	63.15	81.49

Fig. 3. Polyp segmentation results of the vanilla HSNet and SAMAug-enhanced HSNet.

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