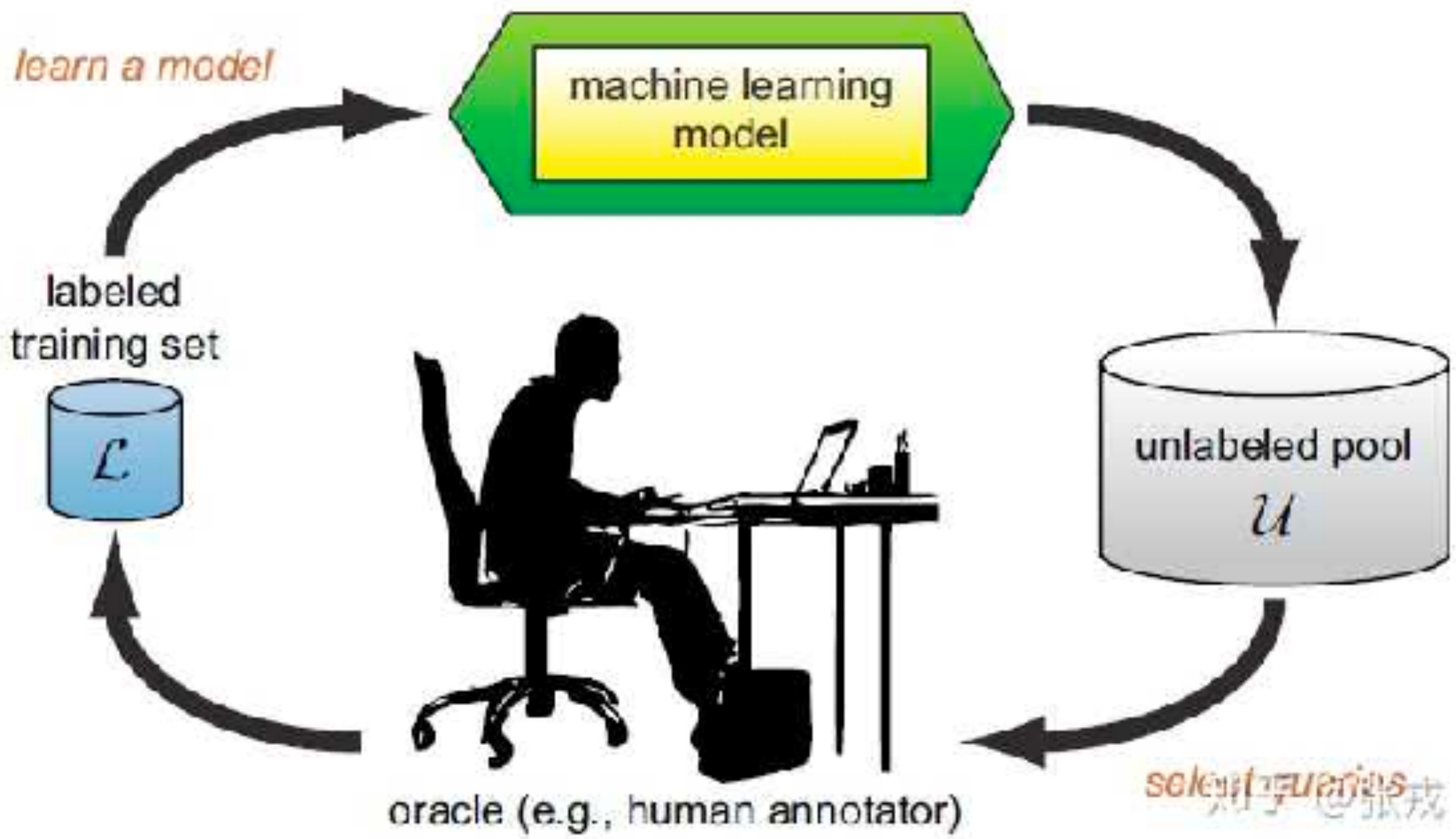
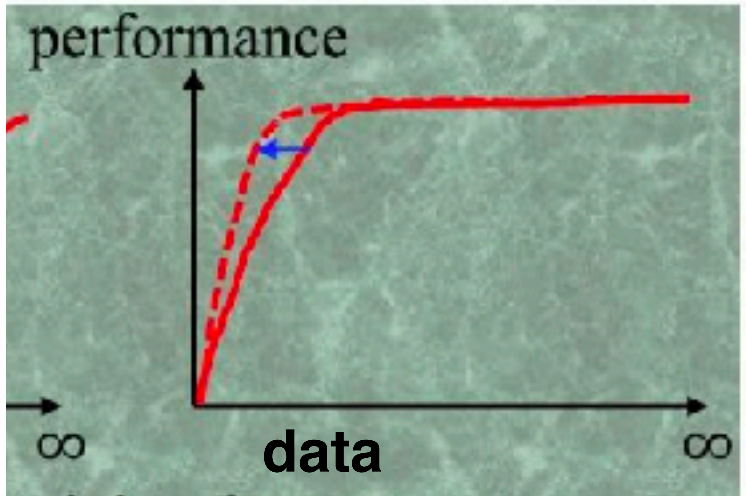
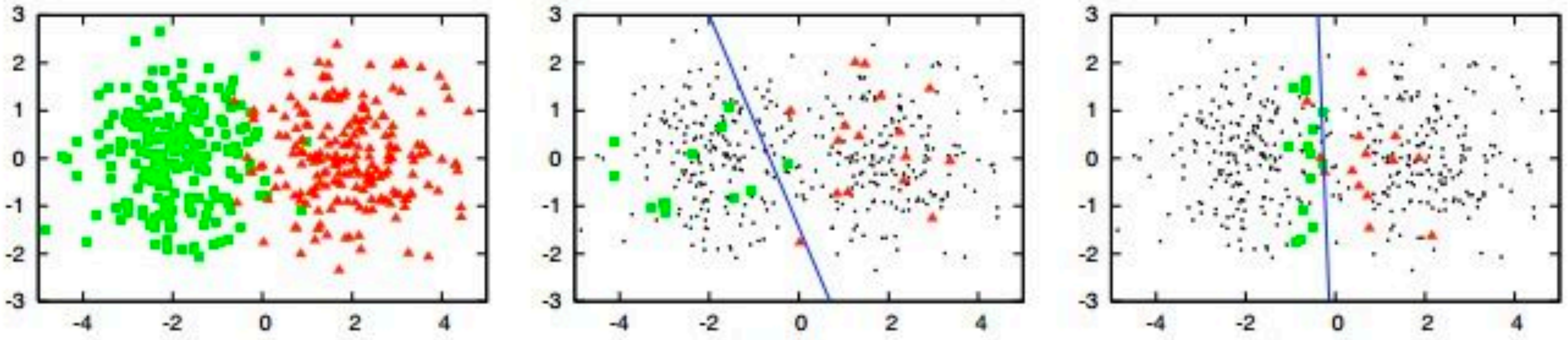
Survey of Active Learning







(a) (b) (c)

- **membership query synthesis**：learner请求标注任何未标注样本，包括learner自身随机生成的样本
- **stream-based**：基于某种query strategy依次检验样本究竟是否需要标注；
- **pool-based**：每次根据query strategy排序整个数据集，确定一批未标注样本

Fine-tuning Convolutional Neural Networks for Biomedical Image Analysis: Actively and Incrementally

CVPR 2017

- **Continuous fine-tuning**

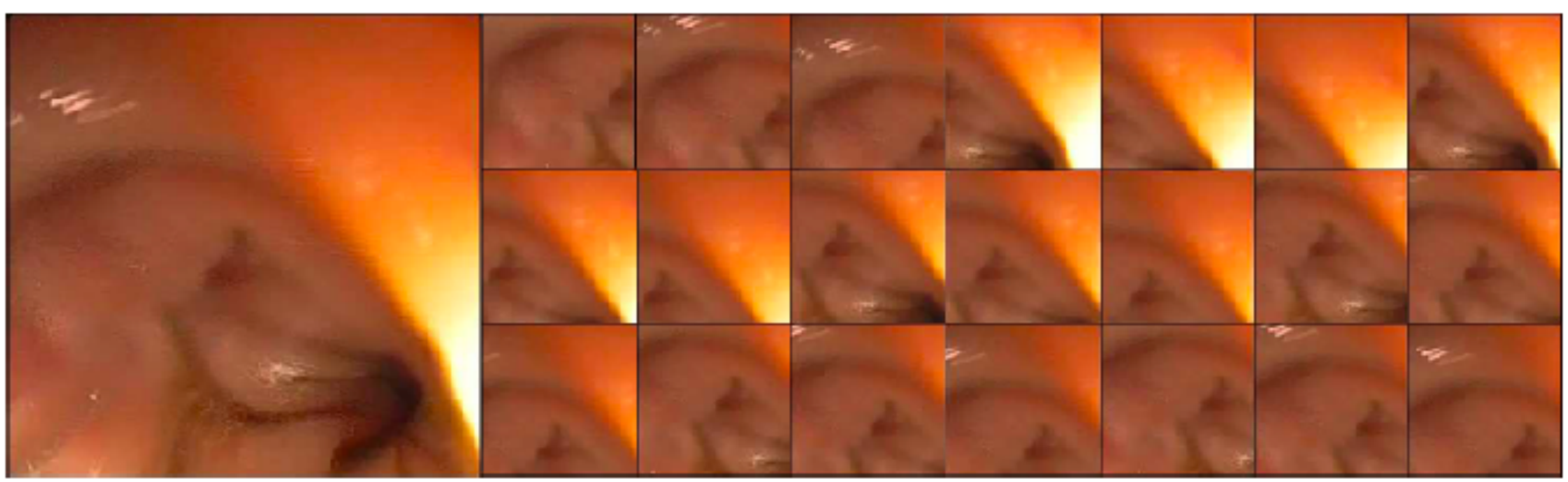
Start from AlexNet pre-trained on ImageNet, fine-tune with enlarged dataset.

- **Active candidate selection（query strategy）**

Entropy and diversity.

- **Handling noisy label via majority selection**

Data augmentation generate hard samples. Use top 1/4 confident part



Classification uncertainty

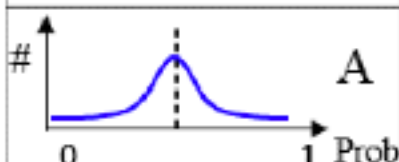
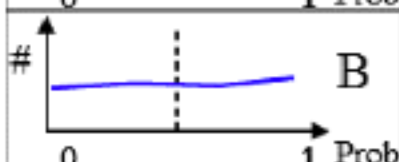
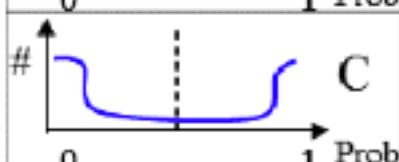
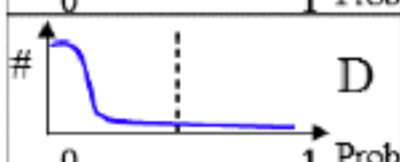
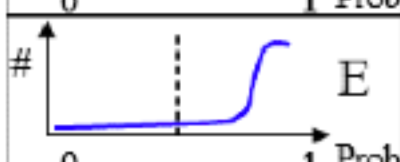
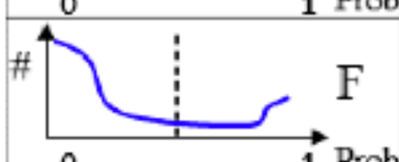
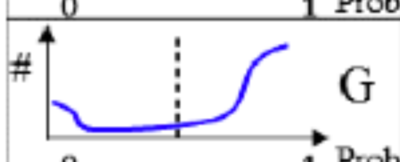
Entropy

$$e_i^j = -\sum_{k=1}^{|Y|} p_i^{j,k} \log p_i^{j,k}$$

Inconsistency among patches

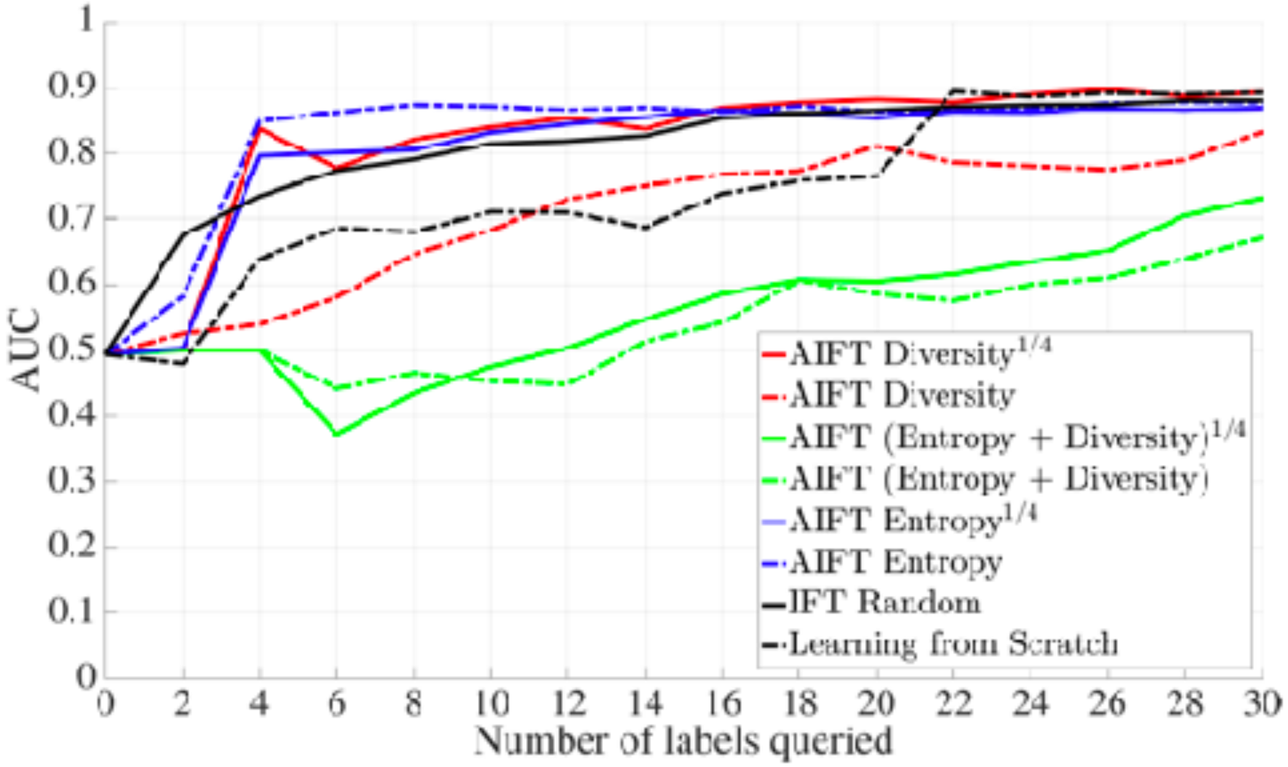
Diversity

$$d_i(j,l) = \sum_{k=1}^{|Y|} (p_i^{j,k} - p_i^{l,k}) log \frac{p_i^{j,k}}{p_i^{l,k}}$$

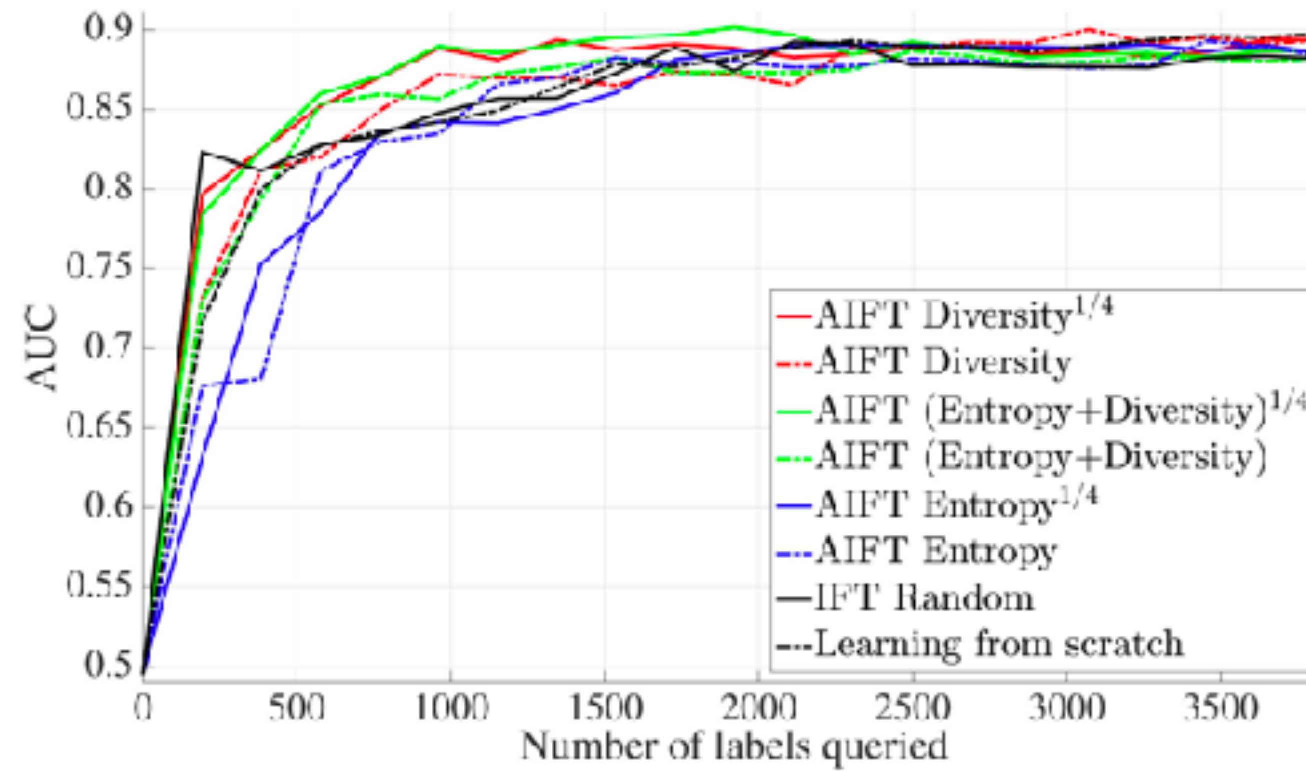
Prediction Pattern	Example	Entropy	Entropy$^{1/4}$	Diversity	Diversity$^{1/4}$	(Entropy+ Diversity)	(Entropy+ Diversity)$^{1/4}$
 A	{0.4 0.4 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.6 0.6}	7.52	2.02	4.38	0.00	11.90	2.02
 B	{0.0 0.1 0.2 0.3 0.4 0.4 0.6 0.7 0.8 1.0 1.0}	4.57	0.83	1237.21	20.79	1241.77	21.62
noisy label  C	{0.0 0.0 0.0 0.1 0.1 0.9 0.9 1.0 1.0 1.0 1.0}	1.30	0.00	2816.66	0.00	2817.96	0.00
 D	{0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.1 0.1 0.1 0.1}	1.30	0.00	189.54	0.00	190.84	0.00
 E	{0.9 0.9 0.9 0.9 1.0 1.0 1.0 1.0 1.0 1.0 1.0}	1.30	0.00	189.54	0.00	190.84	0.00
 F	{0.0 0.0 0.1 0.1 0.1 0.1 0.2 0.2 0.3 0.9 1.0}	3.24	0.33	1076.87	13.54	1080.11	13.86
 G	{0.0 0.1 0.7 0.8 0.8 0.9 0.9 0.9 0.9 1.0 1.0}	3.24	0.33	1076.87	13.54	1080.11	13.86

Binary Classification

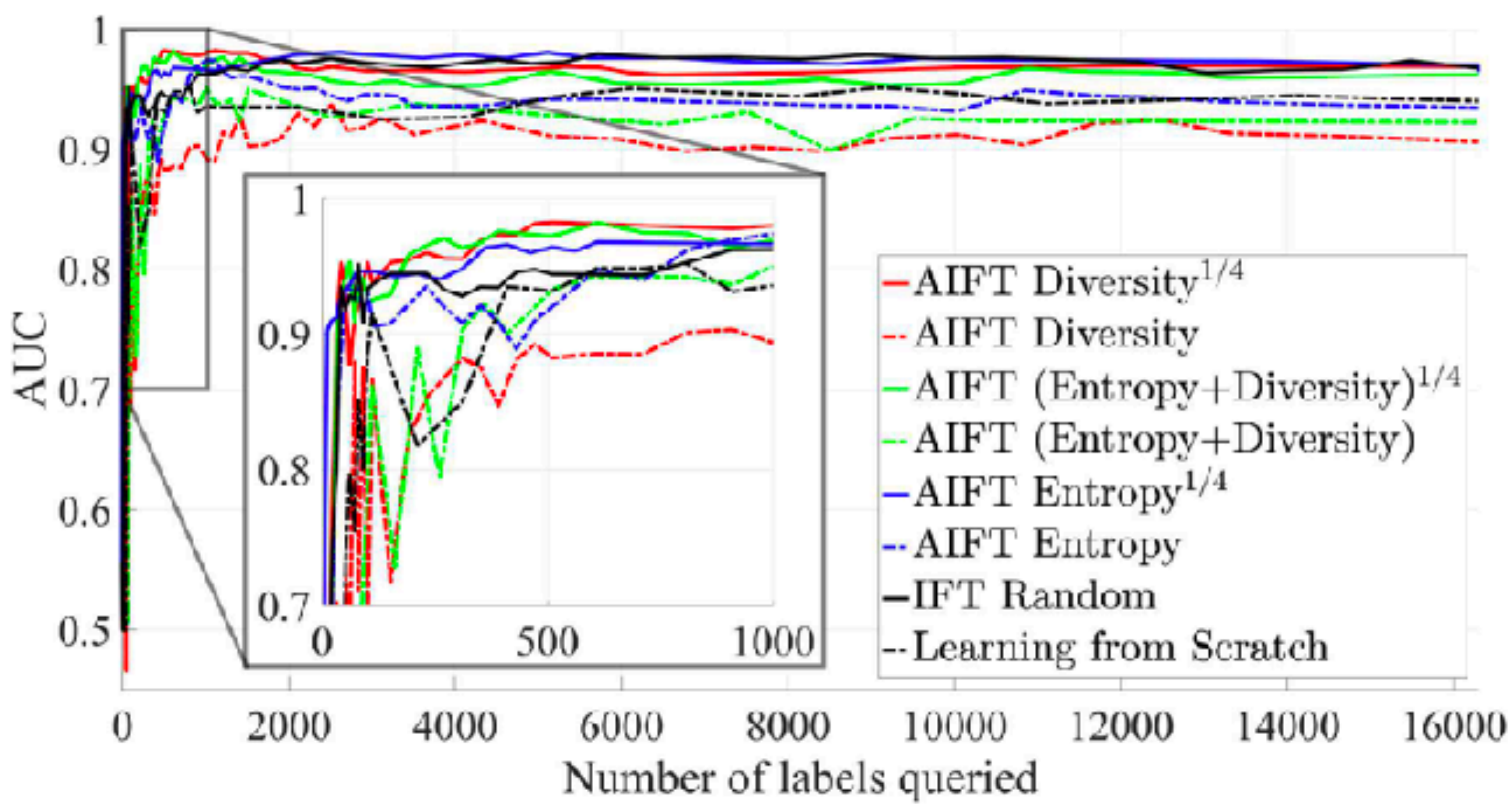
Colonoscopy Frame Classification



Pulmonary Embolism（肺栓塞） Detection

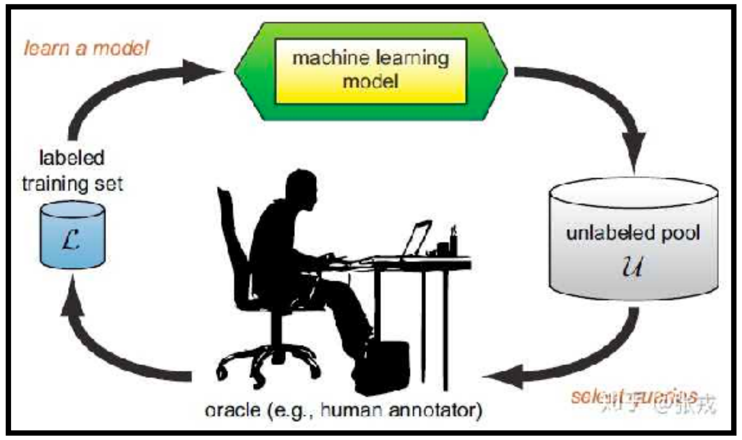


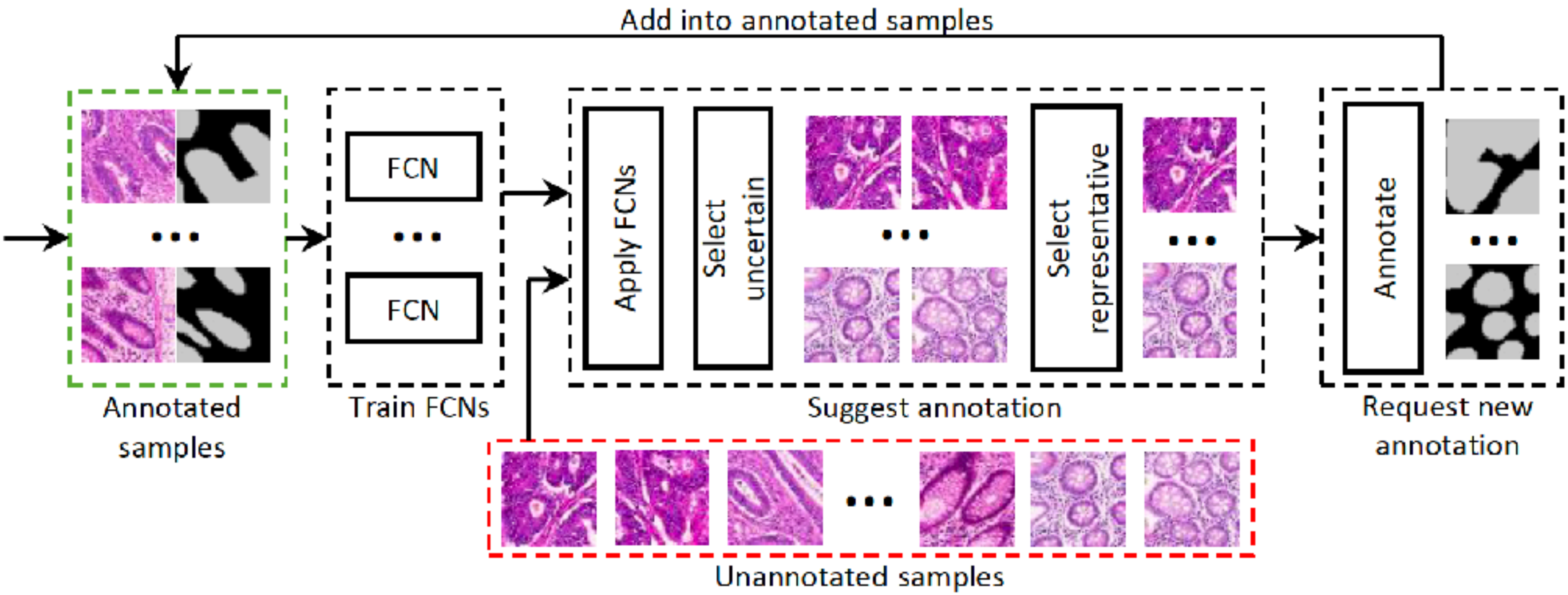
Polyp Detection



Suggestive Annotation: A Deep Active Learning Framework for Biomedical Image Segmentation

MICCAI 2017



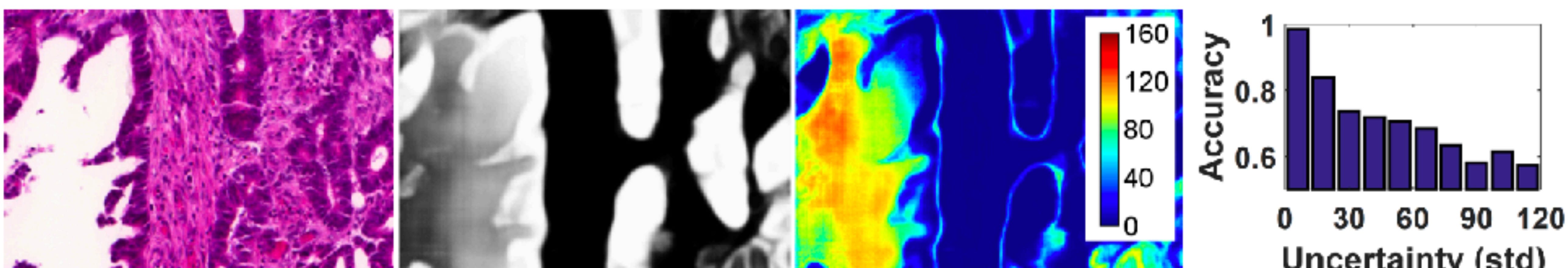


- A new FCN for active learning

achieve state-of-the-art performance when all training data is used,
while still able to produce reasonable results when very little training data is available.

- Query strategy 1: Uncertainty

Bootstrapping: train a set of models while restricting each of them to use a subset of the training data (generated by sampling with replacement) and calculate the variance (disagreement) among these models.



(a) (b) (c) (d)

probability map by one FCN uncertainty test accuracy

- Query strategy 2: Similarity

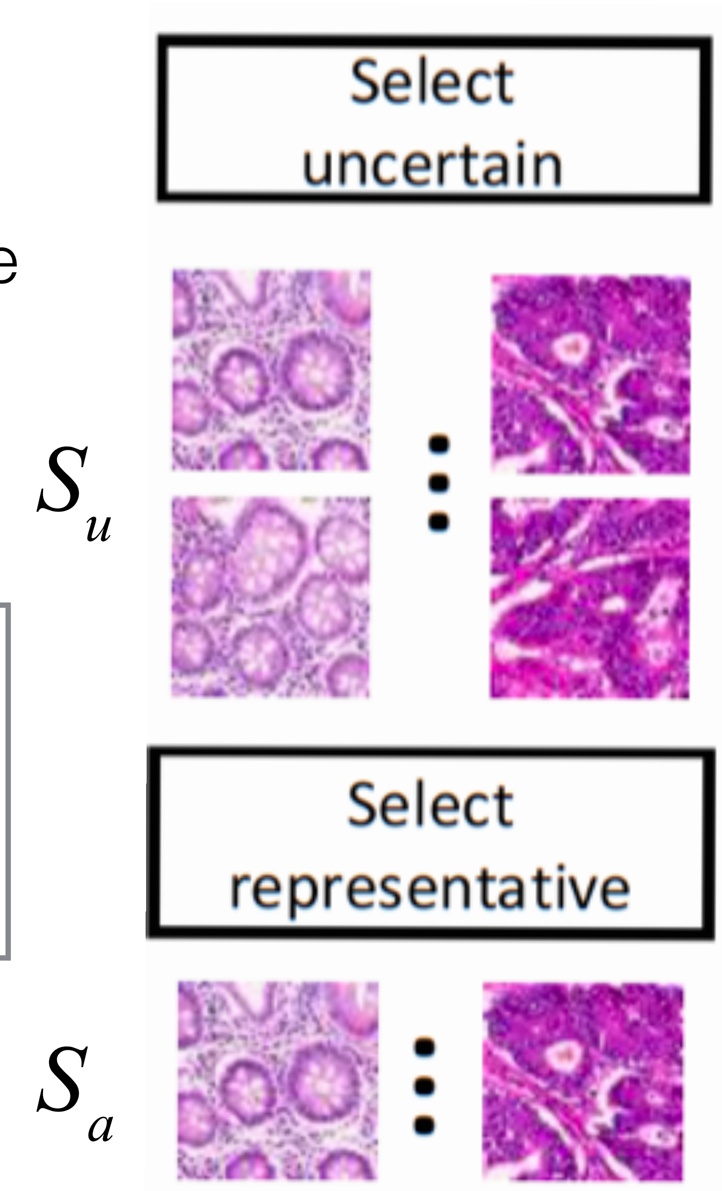
Select representative subset: deep learning models tend to be uncertainfor similar types of instances

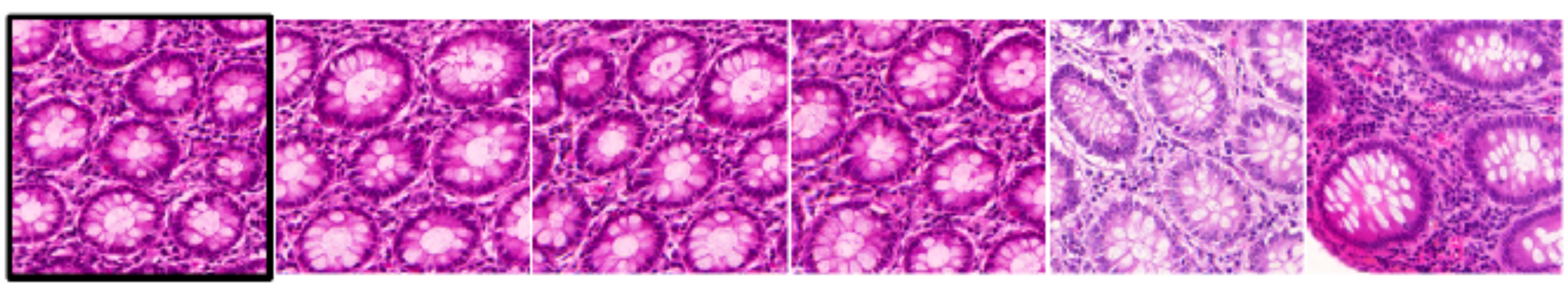
$$sim(I_i, I_j) = cosine\_similarity(I_i^c, I_j^c)$$

find S_a that maximize

$$\boxed{\begin{aligned} f(\mathcal{S}_a, I_x) &= \max_{I_i \in \mathcal{S}_a} sim(I_i, I_x) \\ F(\mathcal{S}_a, \mathcal{S}_u) &= \sum_{I_j \in \mathcal{S}_u} f(\mathcal{S}_a, I_j) \end{aligned}}$$

maximum set cover problem

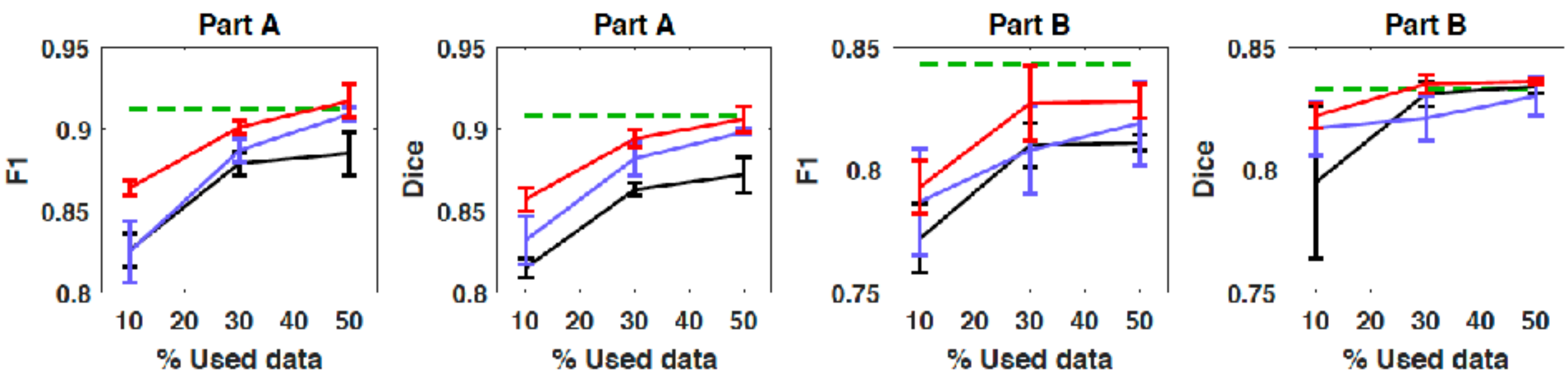




similar instance measured

Method	Mean IU	F1 score
Uncertainty 50%	0.858	0.849
Our method 50%	0.875	0.871
Our method full	**0.879**	**0.874**

lymph node ultrasound image segmentation



gland segmentation

Query strategy

- Uncertainty-based

Samples that are difficult for the classier to correctly classify

- **mutual information** *Bayesian active learning for classication and preference learning.*
- **distance between samples and the decision boundary**
- **information entropy and risk expectation**
- **dropout layers** *Deep bayesian active learning with image data.*
- **auxiliary loss prediction module** *Learning loss for active learning.*
- **combine GAN and VAE** *Dual Adversarial Network for Deep Active Learning*

- Representation-based

the most representative samples of the entire dataset