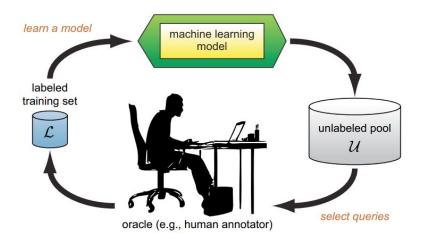
# A Comparative Survey of Deep Active Learning

Xueying Zhan\* Qingzhong Wang Kuan-Hao Huang Haoyi Xiong Dejing Dou Antoni B. Chan

- Problem / objective
- Several query strategies in active learning
- Contribution / Key idea
- Several query strategies in active learning

# **Active Learning**

- labeling cost 비싼 문제 해결하기 위해 등장한 학습 방법.
- 도움이 될것같은 최소한의 데이터만 라벨링하여 학습.



#### Overview

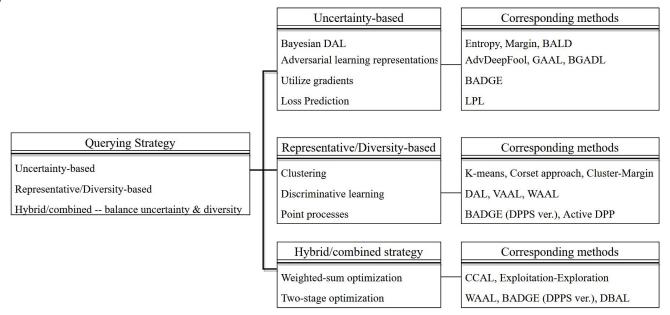


Figure 1: Categorization of DAL sampling/querying strategies.

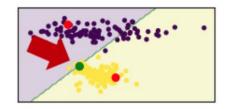
# A Comparative Survey of Deep Active Learning

arXiv 2022

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# **Uncertainty-Based Sampling Strategies**

- 모델이 헷갈려하는 데이터 샘플링



- 1. Maximum Entropy
  - a. 엔트로피가 큰 데이터 선택

$$\alpha_{\text{entropy}}(\mathbf{x}, \mathcal{M}) = H_{\mathcal{M}}[y|\mathbf{x}] = -\sum_{k} p_{\mathcal{M}}(y = k|\mathbf{x}) \log p_{\mathcal{M}}(y = k|\mathbf{x})$$

- 2. Margin
  - a. 마진이 작은 데이터 선택

$$\alpha_{\text{margin}}(\mathbf{x}, \mathcal{M}) = -[p_{\mathcal{M}}(\hat{y}_1|\mathbf{x}) - p_{\mathcal{M}}(\hat{y}_2|\mathbf{x})]$$

- 3. Least Confidence
  - a. Top-1 confidence 가 가장 낮은 데이터 선택

$$\alpha_{\text{LeastConf}}(\mathbf{x}, \mathcal{M}) = -p_{\mathcal{M}}(\hat{y}|\mathbf{x})$$

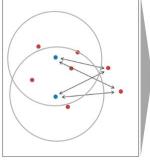
b. Variation Ratios

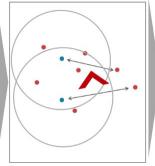
$$\alpha_{\text{VarRatio}}(\mathbf{x}, \mathcal{M}) = 1 - p_{\mathcal{M}}(\hat{y}|\mathbf{x})$$

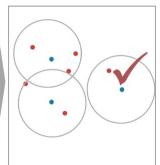
#### **Diversity-Based Sampling Strategies**

- 비슷한 샘플들 최대한 피해 다양한 데이터 샘플링
  - 1. KMeans
    - a. 각 클러스터의 중심점 선택

- 2. CoreSet <a href="https://arxiv.org/abs/1708.00489">https://arxiv.org/abs/1708.00489</a>
  - a. 기존 레이블 데이터와의 최소거리가 최대인 데이터 선택
  - b. 대표적으로, K-Center-Greedy algorithm







- 3. Cluster-Margin <a href="https://arxiv.org/abs/2107.14263">https://arxiv.org/abs/2107.14263</a>
  - a. 각 클러스터 내에서 마진이 작은 데이터 선택

# A Comparative Survey

Xueying Zhan\* Qingz Haoyi Xiong Dejing

# **Experiments**

		MNIST		FashionMNIST		EMNIST		SVHN		PneumoniaMNIST	
	Model	AUBC	F-acc	AUBC	F-acc	AUBC	F-acc	AUBC	F-acc	AUBC	F-acc
	Full	_	0.9916	-	0.9120	-	0.8684	-	0.9190		0.9039
	Random	0.9570	0.9738	0.8313	0.8434	0.8057	0.8377	0.8110	0.8806	0.8283	0.9077
	LeastConf	0.9677	0.9892	0.8377	0.8820	0.8113	0.8479	0.8350	0.9094	0.8520	0.9097
	LeastConfD	0.9750	0.9915	0.8450	0.8744	0.8117	0.8483	0.8320	0.9083	0.8243	0.8654
Unc	Margin	0.9733	0.9881	0.8427	0.8772	0.8103	0.8468	0.8373	0.9138	0.8580	0.8859
	MarginD	0.9703	0.9899	0.8417	0.8756	0.8197	0.8472	0.8357	0.9104	0.8230	0.9149
	Entropy	0.9723	0.9883	0.8397	0.8660	0.8090	0.8458	0.8297	0.9099	0.8570	0.9132
	EntropyD	0.9683	0.9887	0.8417	0.8784	0.8167	0.8507	0.8290	0.9091	0.8177	0.8710
	BALD	0.9697	0.9885	0.8423	0.8888	0.8197	0.8448	0.8333	0.9020	0.8270	0.9204
	MeanSTD	0.9713	0.9735	0.8457	0.8766	0.8110	0.8426	0.8323	0.9087	0.7827	0.8802
	VarRatio	0.9717	0.9841	0.8410	0.8754	0.8107	0.8497	0.8357	0.9079	0.8530	0.8672
	CEAL(Entropy)	0.9787	0.9889	0.8477	0.8826	0.8163	0.8459	0.8430	0.9142	0.8543	0.9179
Repr/Div	KMeans	0.9640	0.9813	0.8260	0.8525	0.7903	0.8264	0.8027	0.8671	0.8243	0.9044
	KMeans (GPU)	0.9637	0.9747	0.8343	0.8657	0.7990	0.8362	0.8120	0.8688	0.8333	0.9155
	KCenter	0.9740	0.9877	0.8353	0.8466	*	*	0.8283	0.9000	0.8130	0.9189
	VAAL	0.9623	0.9573	0.8297	0.8535	0.8027	0.8363	0.8117	0.8813	0.8393	0.9064
	BADGE(KMeans++)	0.9707	0.9904	0.8437	0.8662	*	*	0.8377	0.9057	0.8340	0.9066
Enhance	AdvBIM	0.9680	0.9840	0.8437	0.8729	#	#	#	#	0.8297	0.9197
	LPL	0.8913	0.9732	0.7600	0.8471	0.5640	0.6474	0.8737	0.9452	0.8593	0.9346
	WAAL	0.9890	0.9946	0.8703	0.8984	0.8293	0.8423	0.8603	0.9135	0.9663	0.9564
		CIFAR10		CIFAR100		CIFAR10-imb		Tiny ImageNet		BreakHis	
		CIF		CIFA		CIFAR		Tiny In		Bree	
	Full	-	0.8793	-	0.6062	-	0.8036	-	0.4583	-	0.8306
	Random	0.7967	$0.8793 \\ 0.8679$	0.4667	$0.6062 \\ 0.5903$	0.7103	0.8036 $0.8105$	0.2577	0.4583 $0.3544$	0.8010	$0.8306 \\ 0.8150$
_	Random LeastConf	- 0.7967 0.8150	0.8793 $0.8679$ $0.8785$	-0.4667 $0.4747$	0.6062 0.5903 0.6072	- 0.7103 0.7330	0.8036 <b>0.8105</b> 0.8022	$\begin{array}{c} - \\ 0.2577 \\ 0.2417 \end{array}$	0.4583 0.3544 0.3470	- 0.8010 0.8213	0.8306 0.8150 0.8302
_	Random LeastConf LeastConfD	- 0.7967 0.8150 0.8137	0.8793 0.8679 0.8785 <b>0.8825</b>	-0.4667 $0.4747$ $0.4730$	0.6062 0.5903 <b>0.6072</b> 0.5997	$ \begin{array}{r} -\\ 0.7103\\ 0.7330\\ 0.7323 \end{array} $	0.8036 0.8105 0.8022 0.8065	- 0.2577 0.2417 0.2620	0.4583 0.3544 0.3470 0.3698	- 0.8010 0.8213 0.8140	0.8306 0.8150 0.8302 0.8313
	Random LeastConf LeastConfD Margin	- 0.7967 0.8150 0.8137 0.8153	0.8793 0.8679 0.8785 0.8825 0.8834	-0.4667 $0.4747$ $0.4730$ $0.4790$	0.6062 0.5903 0.6072 0.5997 0.6010	$     \begin{array}{r}       - \\       0.7103 \\       0.7330 \\       0.7323 \\       0.7367     \end{array} $	0.8036 0.8105 0.8022 0.8065 0.8029	- 0.2577 0.2417 0.2620 0.2557	0.4583 $0.3544$ $0.3470$ $0.3698$ $0.3611$	- 0.8010 0.8213 0.8140 0.8217	0.8306 0.8150 0.8302 <b>0.8313</b> 0.8289
	Random LeastConf LeastConfD Margin MarginD	0.7967 0.8150 0.8137 0.8153 0.8140	0.8793 0.8679 0.8785 0.8825 0.8834 0.8837	$\begin{array}{c} - \\ 0.4667 \\ 0.4747 \\ 0.4730 \\ 0.4790 \\ 0.4777 \end{array}$	0.6062 0.5903 <b>0.6072</b> 0.5997 0.6010 0.6000	0.7103 0.7330 0.7323 0.7367 0.7260	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128	0.2577 0.2417 0.2620 0.2557 0.2607	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541	- 0.8010 0.8213 0.8140 0.8217 0.8253	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364
nc	Random LeastConf LeastConfD Margin MarginD Entropy	- 0.7967 0.8150 0.8137 0.8153 0.8140 0.8130	0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784	- 0.4667 0.4747 0.4730 0.4790 0.4777 0.4693	0.6062 0.5903 <b>0.6072</b> 0.5997 0.6010 0.6000 0.6048	0.7103 0.7330 0.7323 0.7367 0.7260 0.7320	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187	0.2577 0.2417 0.2620 0.2557 0.2607 0.2343	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251
Unc	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD	- 0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8140	0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784	$ \begin{array}{c} -0.4667 \\ 0.4747 \\ 0.4730 \\ 0.4790 \\ 0.4777 \\ 0.4693 \\ 0.4677 \end{array} $	0.6062 0.5903 <b>0.6072</b> 0.5997 0.6010 0.6000 0.6048 0.6004	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346 0.3716	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115
Unc	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD	-0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8140 0.8103	0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8787	-0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4760	0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317 0.7210	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7927	- 0.2577 0.2417 0.2620 0.2557 0.2607 0.2343 0.2627 0.2623	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346 0.3716 0.3648	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017 0.8147	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296
Unc	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD	-0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8140 0.8103 0.8087	0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8787 0.8762 0.8821		0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942 0.5963	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317 0.7210 0.7203	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7927 0.7996	- 0.2577 0.2417 0.2620 0.2557 0.2607 0.2343 0.2627 0.2623 0.2510	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346 0.3716 0.3648 0.3551		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202
Unc	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio		0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8787 0.8762 0.8821 08780		0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942 0.5963 0.5959	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317 0.7210 0.7203 0.7353	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7927 0.7996 0.8165	- 0.2577 0.2417 0.2620 0.2557 0.2607 0.2343 0.2627 0.2623 0.2510 0.2407	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346 0.3716 0.3648 0.3551 0.3426	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017 0.8147 0.8053 0.8197	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264
	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy)		0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8762 0.8821 08780 0.8794		0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942 0.5963 0.5959 0.6043	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317 0.7210 0.7203 0.7353 0.7327	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7927 0.7996 0.8165 0.8187	0.2577 0.2417 0.2620 0.2557 0.2607 0.2343 0.2627 0.2623 0.2510 0.2407 0.2347	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3346 0.3716 0.3648 0.3551 0.3426 0.3400	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017 0.8147 0.8053 0.8197 0.8163	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181
	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans		0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8782 0.8762 0.8821 0.8780 0.8794		0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942 0.5963 0.5959 0.6043	- 0.7103 0.7330 0.7323 0.7367 0.7260 0.7320 0.7317 0.7210 0.7203 0.7353 0.7327	0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.79927 0.7996 0.8165 0.8187		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3648 0.3551 0.3426 0.3400	- 0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017 0.8147 0.8053 0.8197 0.8163	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181
	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU)		0.8793 0.8679 0.8785 0.8825 0.8834 0.8837 0.8784 0.8762 0.8821 08780 0.8794 0.8713	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4760 0.4717 0.4747 0.4693 0.4570 0.4687	0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5942 0.5963 0.5959 0.6043 0.5834		0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7927 0.7996 0.8165 0.8187 0.7908		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3648 0.3551 0.3426 0.3400 0.3385 0.2288		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394
	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU) KCenter		0.8793 0.8679 0.8785 0.8825 0.8834 0.8784 0.8762 0.8762 0.8762 0.8794 0.8713 0.8718 0.8718		0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.5942 0.5963 0.5959 0.6043 0.5834 0.5834 0.5993		0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8187 0.7963 0.7997 0.7996 0.8165 0.8187 0.7908 0.7921 0.7826		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3648 0.3551 0.3426 0.3400 0.3385 0.2288 0.346		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8289
Repr/Div Unc	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CCEAL(Entropy) KMeans KMeans (GPU) KCenter VAAL		0.8793 0.8679 0.8785 0.8825 0.8834 0.8787 0.8784 0.8787 0.8782 0.8780 0.8794 0.8713 0.8713 0.8714 0.8679	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4761 0.4717 0.4763 0.4570 0.4687 0.4770 0.4693	0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.6004 0.5963 0.5963 0.5959 0.6043 0.5834 0.5834 0.5993		0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.8128 0.7963 0.7996 0.8165 0.8187 0.7998 0.7992 0.7826 0.7950		0.4583 0.3544 0.3698 0.3611 0.3541 0.3716 0.3635 0.3426 0.3400 0.3426 0.3400 0.3485 0.2288 0.346 0.2191		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8289
Repr/Div	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU) KCenter VAAL BADGE(KMeans++)		0.8793 0.8679 0.8785 0.8825 0.8825 0.8834 0.8787 0.8762 0.8787 0.8762 0.8794 0.8713 0.8718 0.8748 0.8679	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4717 0.4760 0.4717 0.4763 0.4570 0.4687 0.47693 0.4570	0.6062 0.5903 0.6072 0.6070 0.6000 0.6004 0.6004 0.5942 0.5963 0.5959 0.6043 0.5834 0.5842 0.5959 0.6034		0.8036 0.8105 0.8022 0.8029 0.8128 0.8128 0.7927 0.7966 0.8165 0.8165 0.8187 0.7908 0.7921 0.7926 0.7950 0.8126		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3648 0.3551 0.3420 0.3400 0.3385 0.2288 0.346 0.2191		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8289 0.8344
Repr/Div	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU) KCenter VAAL BADGE(KMeans++) AdvBIM	0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8143 0.8103 0.8087 0.8150 0.7977 0.8047 0.7973 0.8143 0.7997	0.8793 0.8679 0.8785 0.88834 0.8837 0.8784 0.8762 0.8762 0.8762 0.8791 0.8713 0.8713 0.8714 0.8741 0.8749	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4760 0.4717 0.4747 0.4687 0.4687 0.4770 0.4683 0.4803 0.4813	0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.5942 0.5963 0.5959 0.6043 0.5834 0.5842 0.5993 0.5870 0.6034		0.8036 0.8105 0.8022 0.8029 0.8128 0.8128 0.7927 0.7996 0.8165 0.8187 0.7996 0.8165 0.7998 0.7921 0.7826 0.7926 0.7921		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3716 0.3648 0.3551 0.3426 0.3400 0.3335 0.2288 0.346 0.2191		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8289 0.83444 0.8470
Repr/Div	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU) KCenter VAAL BADGE(KMeans++) AdVBIM LPL	0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8140 0.8103 0.8087 0.8150 0.8150 0.7910 0.7973 0.8143 0.7993 0.8143 0.7993	0.8793 0.8679 0.8785 0.8825 0.8834 0.8787 0.8762 0.8781 0.8794 0.8713 0.8713 0.8714 0.8679 0.8794 0.8794 0.8750 0.8794	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4760 0.4717 0.4693 0.4570 0.4693 0.4683 0.4683 0.4683 0.4683 0.4683 0.4683 0.4693 0.4790 0.4693 0.4790 0.4693 0.4790 0.4693 0.4790 0.4693 0.4790 0.4693 0.4790 0.4693 0.4790	0.6062 0.5903 0.6072 0.6010 0.6000 0.6004 0.5942 0.5963 0.5959 0.6043 0.5834 0.5842 0.5993 0.5870 0.6034 0.5870		0.8036 0.8105 0.8022 0.8065 0.8029 0.8128 0.7963 0.7927 0.7996 0.8165 0.8187 0.7998 0.7926 0.7950 0.8126 #	0.2577 0.2417 0.2620 0.2557 0.2607 0.2623 0.2513 0.2627 0.2623 0.2510 0.2407 0.2347 0.1340 0.1313 # # 0.0090	0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3541 0.3648 0.3516 0.3426 0.3400 0.3385 0.2288 0.346 0.2191 #	0.8010 0.8213 0.8140 0.8217 0.8253 0.8213 0.8017 0.8147 0.8053 0.8197 0.8163 0.8027 0.8197 0.8197 0.8243 0.8243 0.8247	0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8289 0.8344 0.8470
	Random LeastConf LeastConfD Margin MarginD Entropy EntropyD BALD MeanSTD VarRatio CEAL(Entropy) KMeans KMeans (GPU) KCenter VAAL BADGE(KMeans++) AdvBIM	0.7967 0.8150 0.8137 0.8153 0.8140 0.8130 0.8143 0.8103 0.8087 0.8150 0.7977 0.8047 0.7973 0.8143 0.7997	0.8793 0.8679 0.8785 0.88834 0.8837 0.8784 0.8762 0.8762 0.8762 0.8791 0.8713 0.8713 0.8714 0.8741 0.8749	0.4667 0.4747 0.4730 0.4790 0.4777 0.4693 0.4677 0.4760 0.4717 0.4747 0.4687 0.4687 0.4770 0.4683 0.4803 0.4813	0.6062 0.5903 0.6072 0.5997 0.6010 0.6000 0.6048 0.5942 0.5963 0.5959 0.6043 0.5834 0.5842 0.5993 0.5870 0.6034		0.8036 0.8105 0.8022 0.8029 0.8128 0.8128 0.7927 0.7996 0.8165 0.8187 0.7996 0.8165 0.7998 0.7921 0.7826 0.7926 0.7921		0.4583 0.3544 0.3470 0.3698 0.3611 0.3541 0.3716 0.3716 0.3648 0.3551 0.3426 0.3400 0.3335 0.2288 0.346 0.2191		0.8306 0.8150 0.8302 0.8313 0.8289 0.8364 0.8251 0.8115 0.8296 0.8202 0.8264 0.8181 0.8394 0.8323 0.8323 0.8344 0.8337

FashionMNIST

**EMNIST** 

SVHN

PneumoniaMNIST

MNIST

Table 1: Overall results of DAL comparative experiments. We **bold** F-acc values that are higher than full performance. We rank F-acc and AUBC of each task with top 1st, 2nd and 3rd with red, teal and blue respectively. "\*" refers to the experiment needed too much memory, *e.g.*, **KCenter** on *EMNIST*. "#" refers to the experiment that has not been completed yet. Completed tables of all tasks are shown in Tables 4, 5, 6, 7, and 8 in Appendix.

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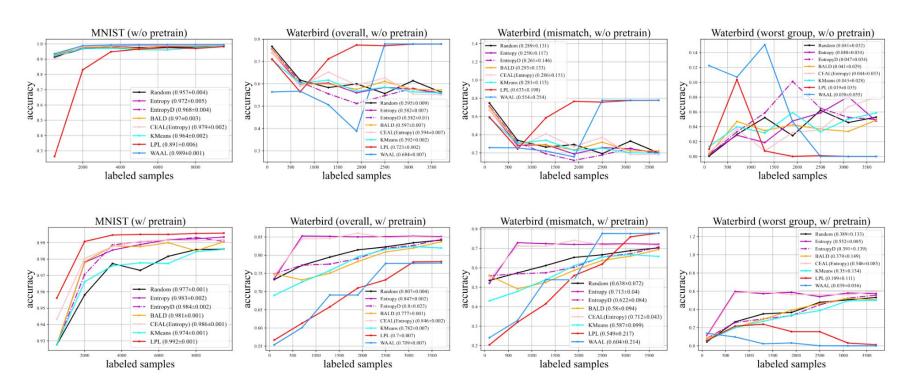


Figure 4: Overall (mismatch, worst group) accuracy vs. budget curves on MNIST and Waterbird datasets.