PPF Report:
Adversarial Learning
-Diabetic Retinopathy

MSCV capstone project -- internal

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Contents

PAST:

- Reimplemented Adversarial Data Augmentation
- Detection Application: Diabetic Retinopathy(DR) Detection
- Improving DR detection

PRESENT:

- DR Lesion Segmentation

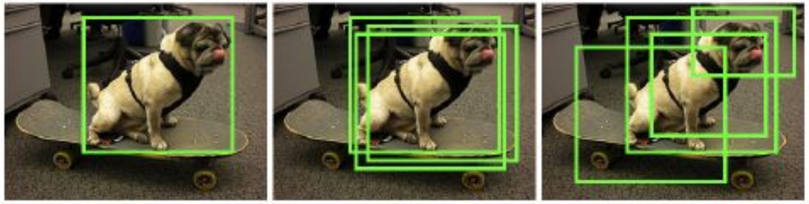
FUTURE:

- Submit to IPMI

PAST: Reimplemented Adversarial Data Augmentation

- Introduce an adversarial function to generate (some distribution of) maximally perturbed version of the groundtruth which is hardest for the predictor to learn.

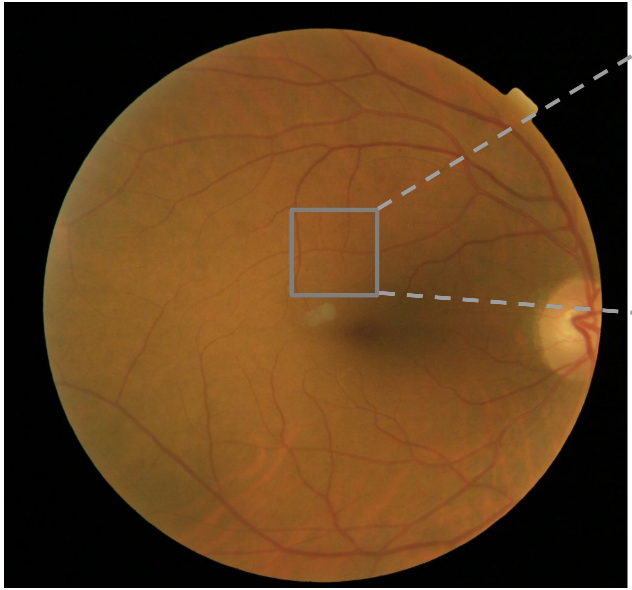
- First work to provide theoretic basis for data augmentation in terms of an adversarial two player zero-sum game.
  - predictor(maximize performance) *vs* constrained adversary(minimize expected performance).



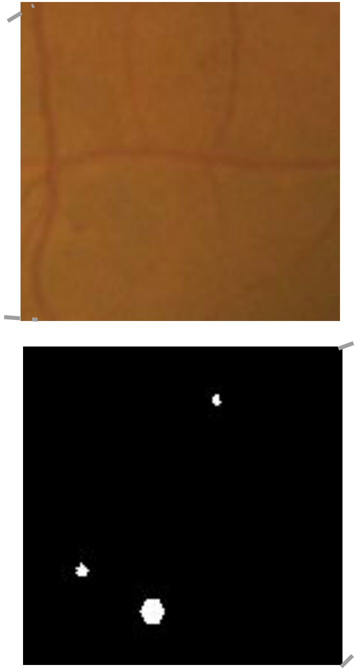
[Behpour, Sima, Kris M. Kitani, and Brian D. Ziebart. "ADA: A Game-Theoretic Perspective on Data Augmentation for Object Detection."]

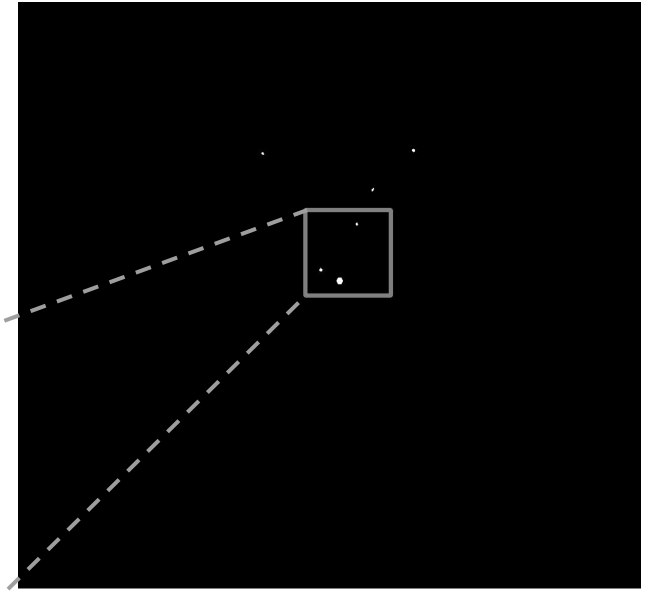
PAST: Diabetic Retinopathy(DR) Detection

- a worldwide leading cause of preventable blindness;
- affecting more than 25% of the estimated 425 million diabetic patients;



retinal image example



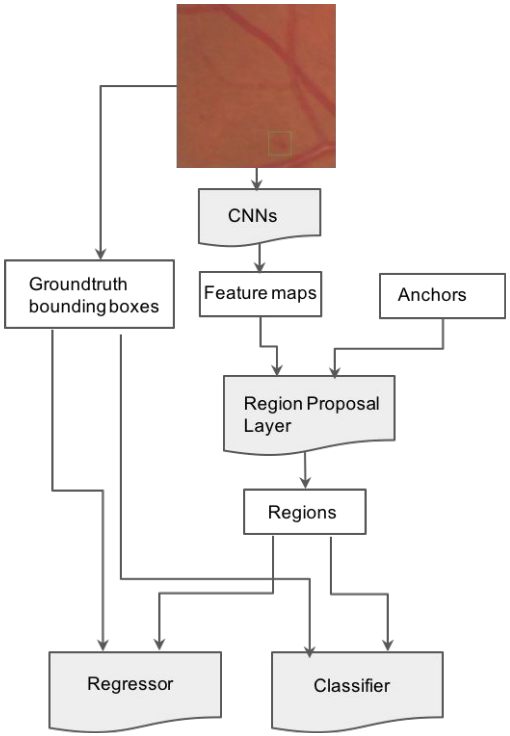


segmentation labels

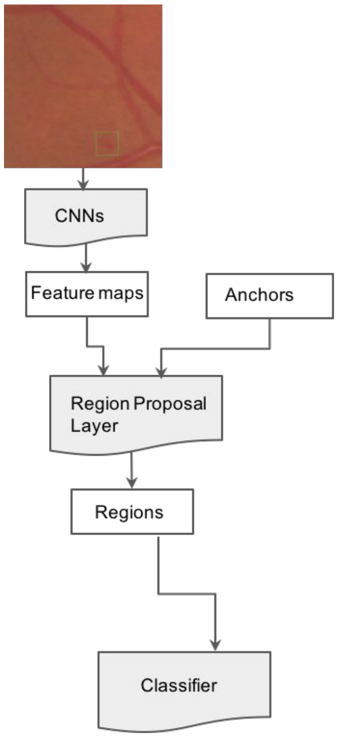
PAST: Improving DR detection

Inclusion of negative samples

- *positive samples:* patches containing at least one microaneurysm;
- *negative samples:* patches without microaneurysms;



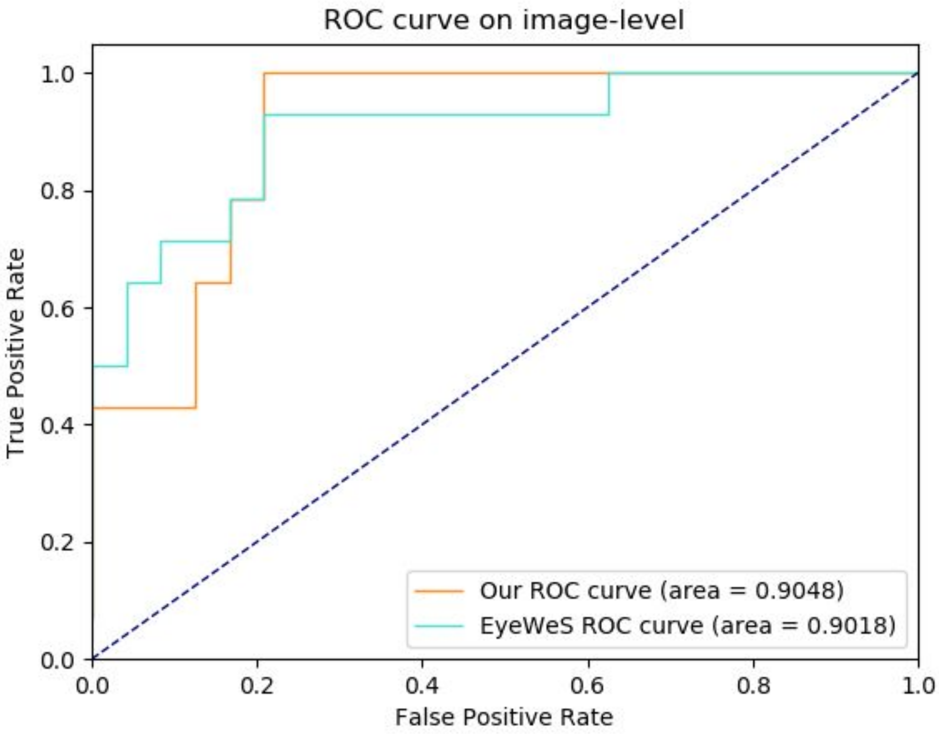
Faster RCNN, can only train on positive samples



Modified Faster RCNN, allow training on negative samples

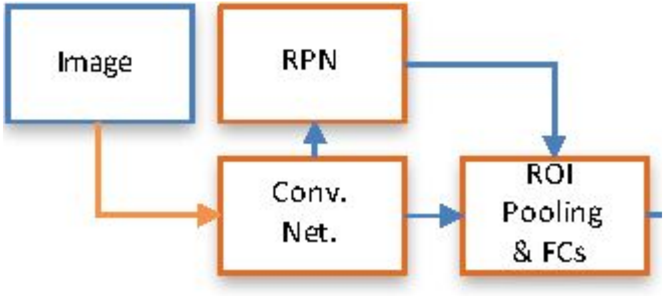
PAST: Improving DR Detection

Compare the approach to the already implemented baseline?

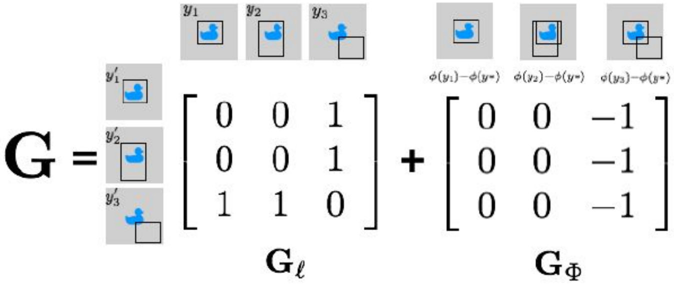


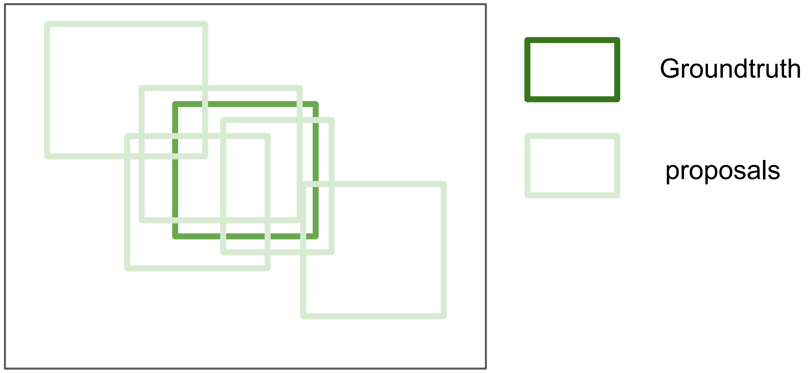
- Both with VGG16;
- Our method can simply transform the bounding box results into image scores(by summing up all the bounding-box scores, and then normalize all the scores to [0, 1]);
- Our method does not directly train for image-level classification.

PAST PLAN: Applying ADA to DR detection

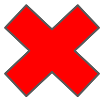


constraints

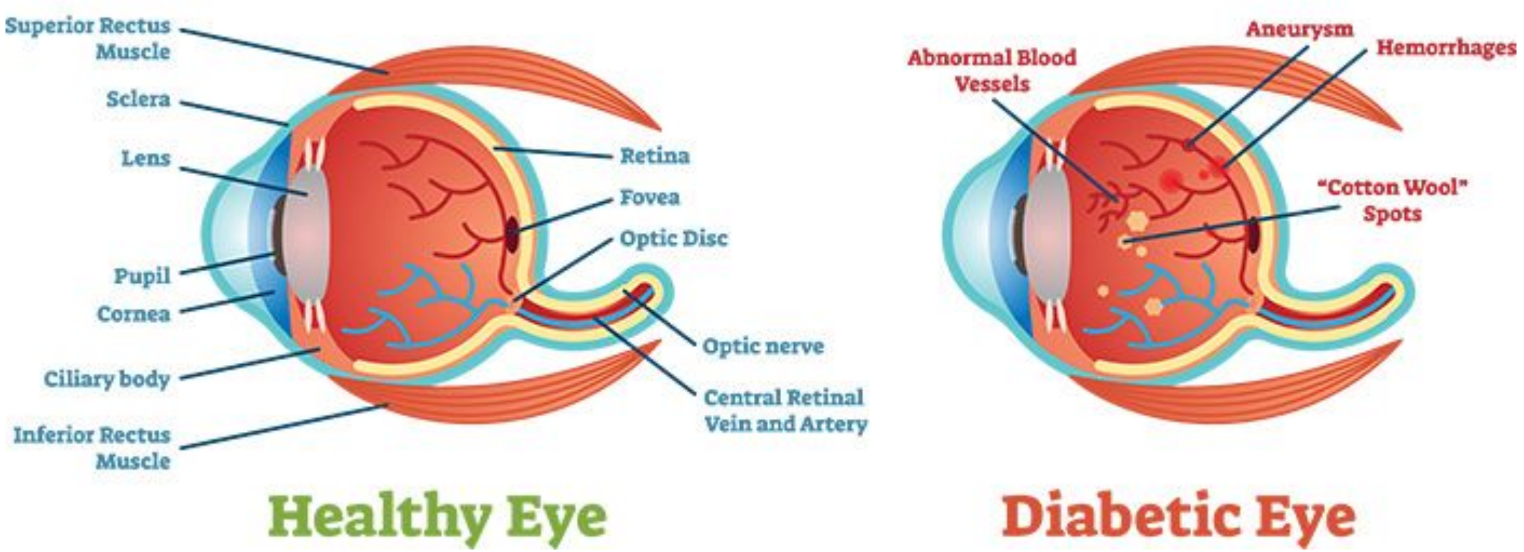




- ADA's Edge Box → Faster RCNN's RPN
- BCE+Regression Loss -> IOU Loss

Not end-to-end 

Diabetic Retionpathy



Diabetic Retionpathy

Disease Detection/Grading: Classification of fundus images according to the severity level of diabetic retinopathy and diabetic macular edema.

Lesion Segmentation: Segmentation of retinal lesions associated with diabetic retinopathy as microaneurysms, hemorrhages, hard exudates and soft exudates.

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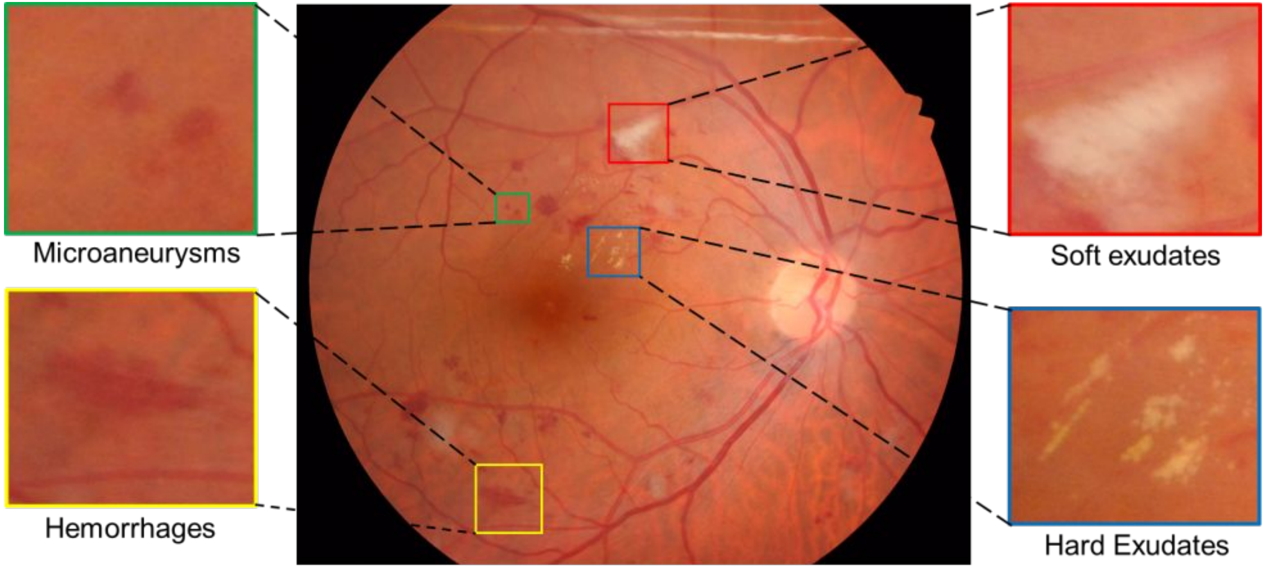
DR Lesion Segmentation

Segmentation of retinal lesions associated with diabetic retinopathy as microaneurysms, hemorrhages, hard exudates and soft exudates.



DR lesion segmentation dataset

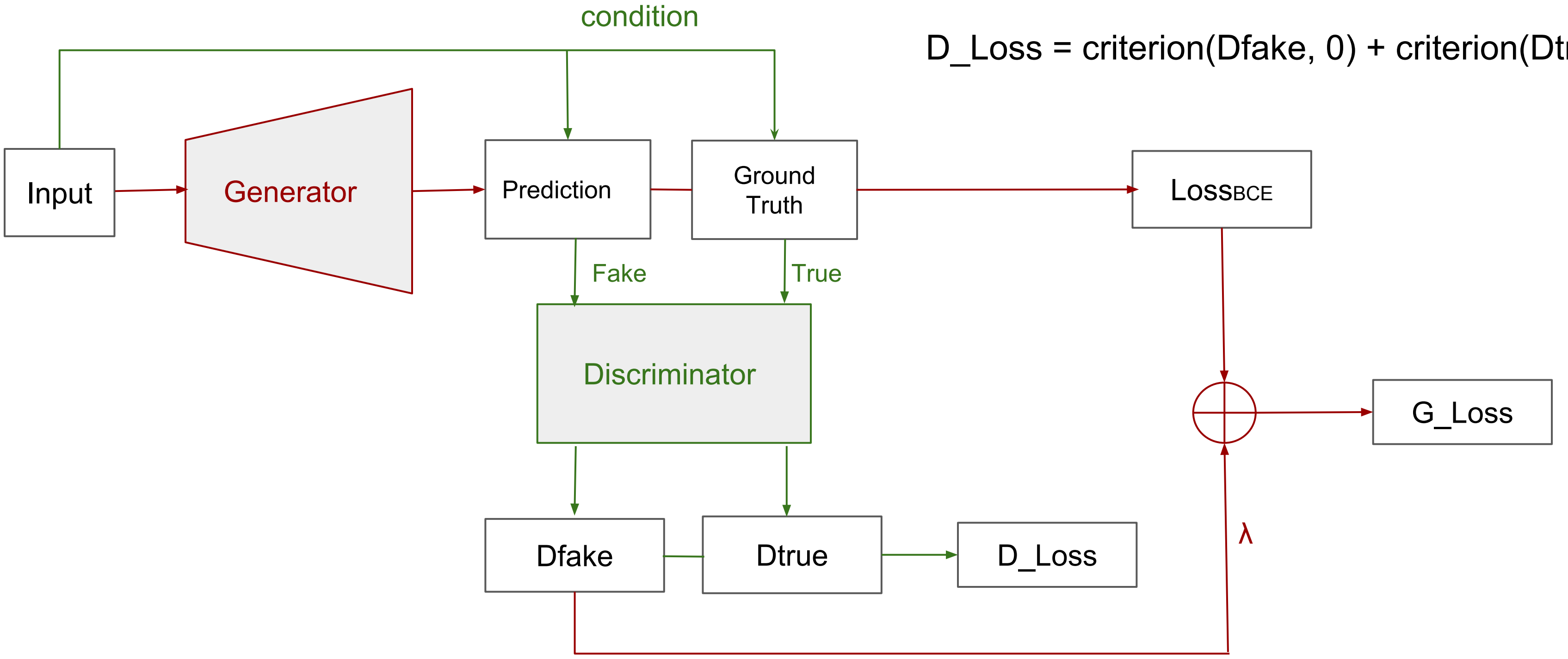
- [Indian Diabetic Retinopathy Image Dataset (IDRiD)]

	TRAINING SET	TESTING SET
microaneurysms (MA)	54	27
soft exudates (SE)	26	14
hard exudates (EX)	54	27
hemorrhages (HE)	53	27

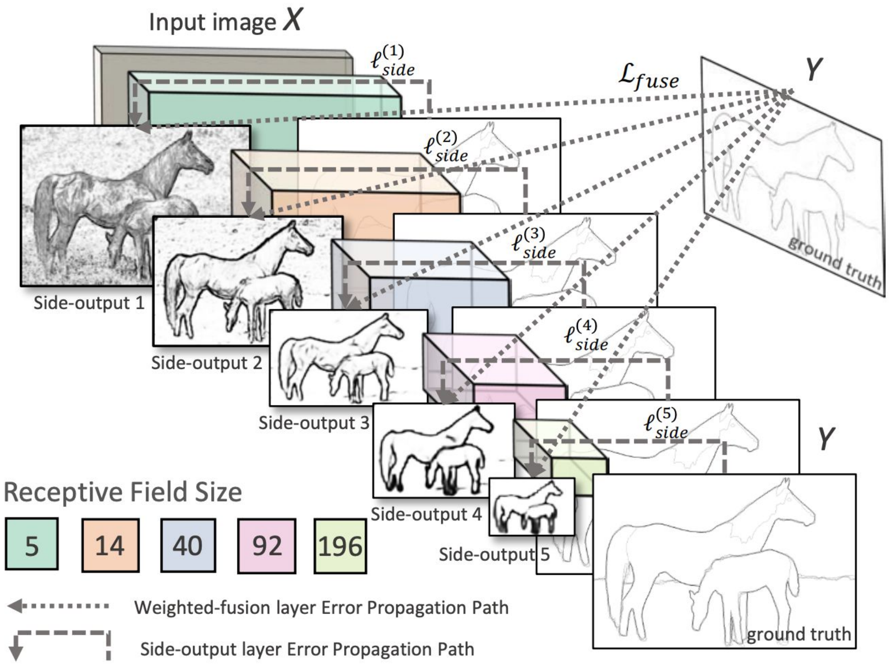
Framework

$$G\_Loss = Loss_{BCE} + \lambda \cdot criterion(Dfake, 1)$$

$$D\_Loss = criterion(Dfake, 0) + criterion(Dtrue, 1)$$



Generator: HedNet Based



- **Loss function:**
  Pixel-wise binary cross-entropy loss
- **Loss weights:**
  Positive:Negative = 10:1

- Xie, Saining, and Zhuowen Tu. "Holistically-nested edge detection." *Proceedings of the IEEE international conference on computer vision*. 2015.

Performance Evaluation

Computing area under Precision (Positive Predictive Value) and Sensitivity (Recall) curve obtained by thresholding the results at 11 equally spaced instances. i.e. [0,0.1,…,1].

The area under precision-recall (AUPR) is used to obtain a single score.

Average Precision

Quantitative Results(Average Precision)

Our Results

	EX	HE	MA	SE
Hednet	0.7935	0.4302	0.4270	0.5291
λ = 0.01	0.8183	0.4330	0.4468	-

LeaderBoard Results

Team Name	MA Score	RANK	HE Score	RANK	SE Score	RANK	EX Score	RANK
VRT	0.4951	2	0.6804	1	0.6995	1	0.7127	11
PATech	0.474	3	0.649	2	-		0.885	1
iFLYTEK-MIG	0.5017	1	0.5588	3	0.6588	3	0.8741	2
SOONER	0.4003	5	0.5395	4	0.5369	7	0.739	10
SAIHST	-		-		-		0.8582	3
lzyuncc_fusion	-		-		0.6259	4	0.8202	4
SDNU	0.4111	4	0.4572	7	0.5374	6	0.5018	17
CIL	0.392	6	0.4886	5	0.5024	8	0.7554	8
MedLabs	0.3397	8	0.3705	8	0.2637	10	0.7863	5
AIMIA	0.3792	7	0.3283	10	0.2733	9	0.7662	6

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FUTURE: Milestones