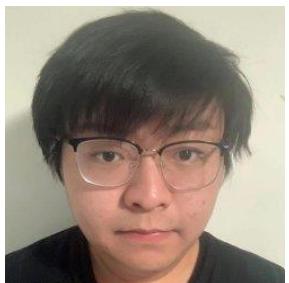


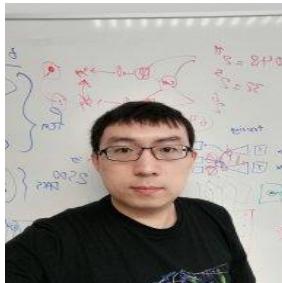
# You Only Cut Once: Boosting Data Augmentation with a Single Cut



Junlin Han



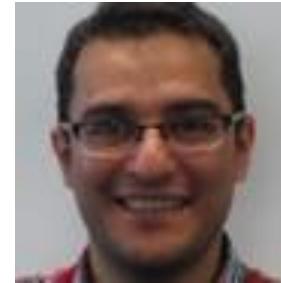
Pengfei Fang



Weihao Li



Jie Hong



Ali Armin



Ian Reid



Lars Petersson



Hongdong Li



Australian  
National  
University



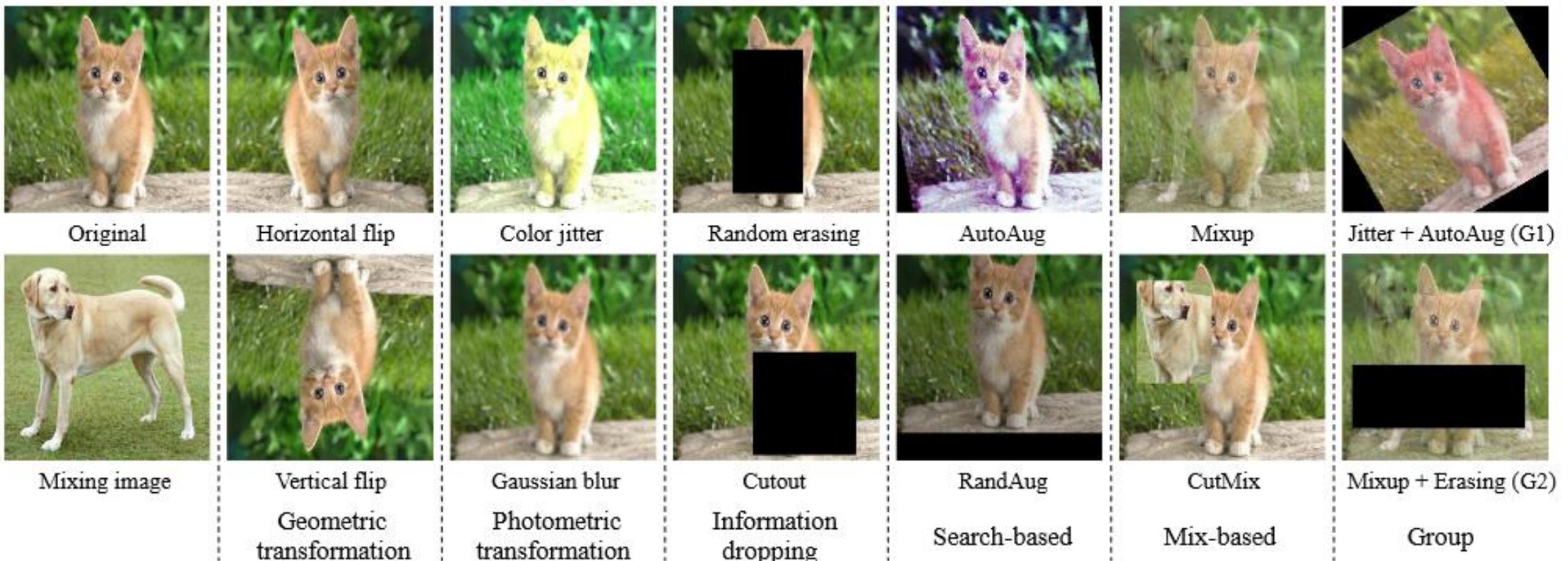
**ICML | 2022**

Thirty-ninth International Conference on  
Machine Learning

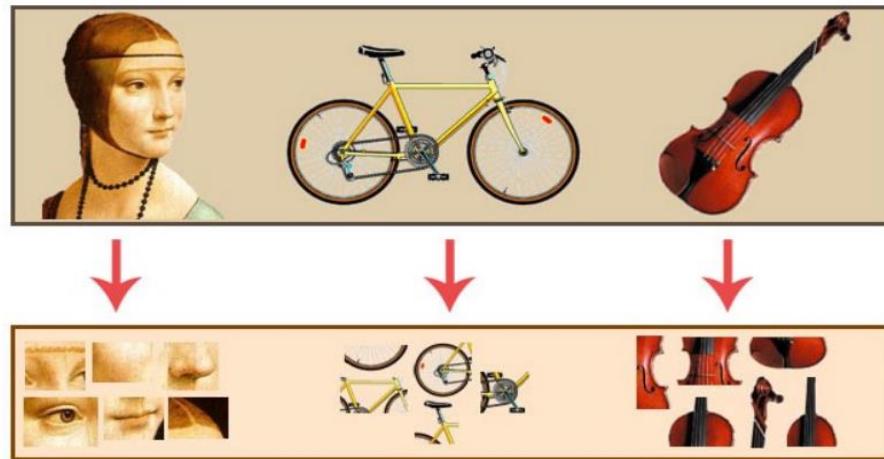
# Highlights

- A simple method for **performing** data augmentations
- ... benefits **a variety of** vision tasks, including classification, contrastive learning, and low-level vision, **for free**
- ... scales well to **almost all** augmentation operations
- ... applies to **multiple** neural network architectures

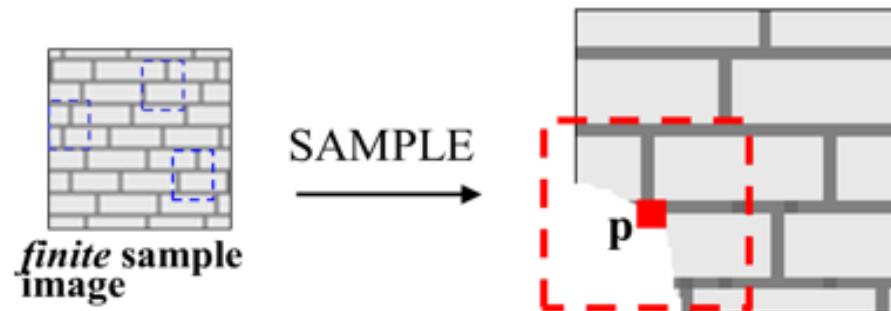
# Data augmentation



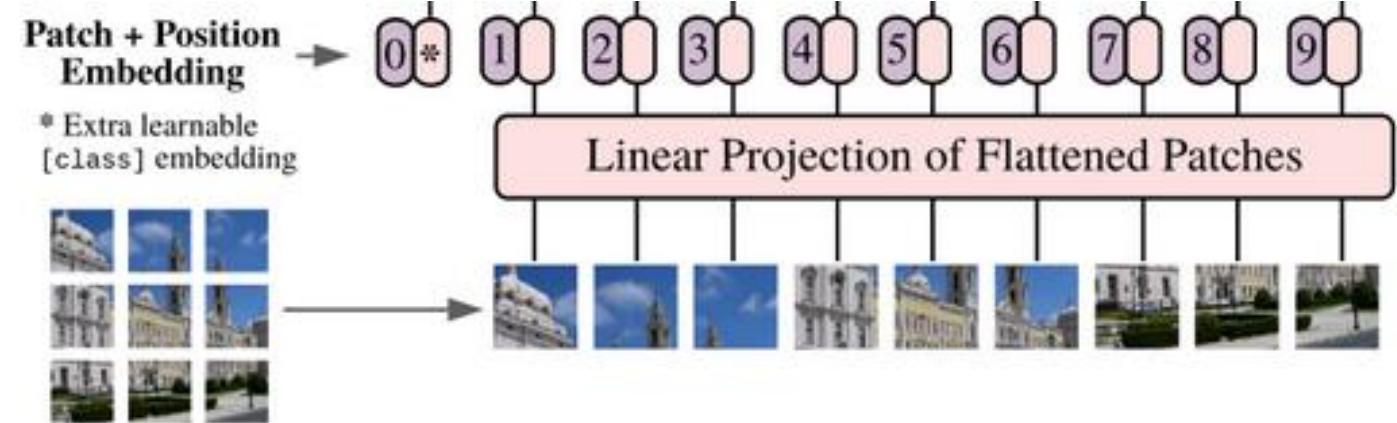
# Motivation and Intuition



Bag of features



Texture synthesis

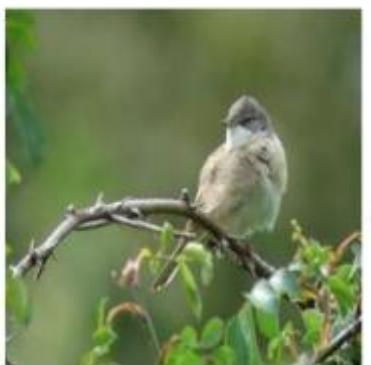


ViT



Human cognition

# Our method: You Only Cut Once (YOCO)

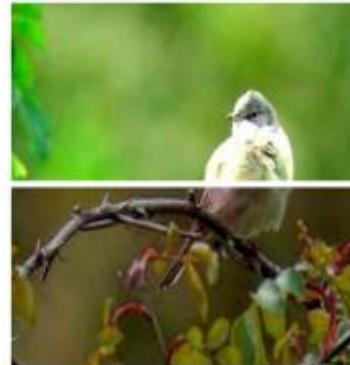


Cut

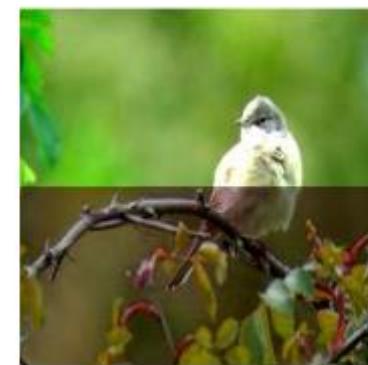


Aug

Aug



Concat



Cut



Aug

Aug



Concat



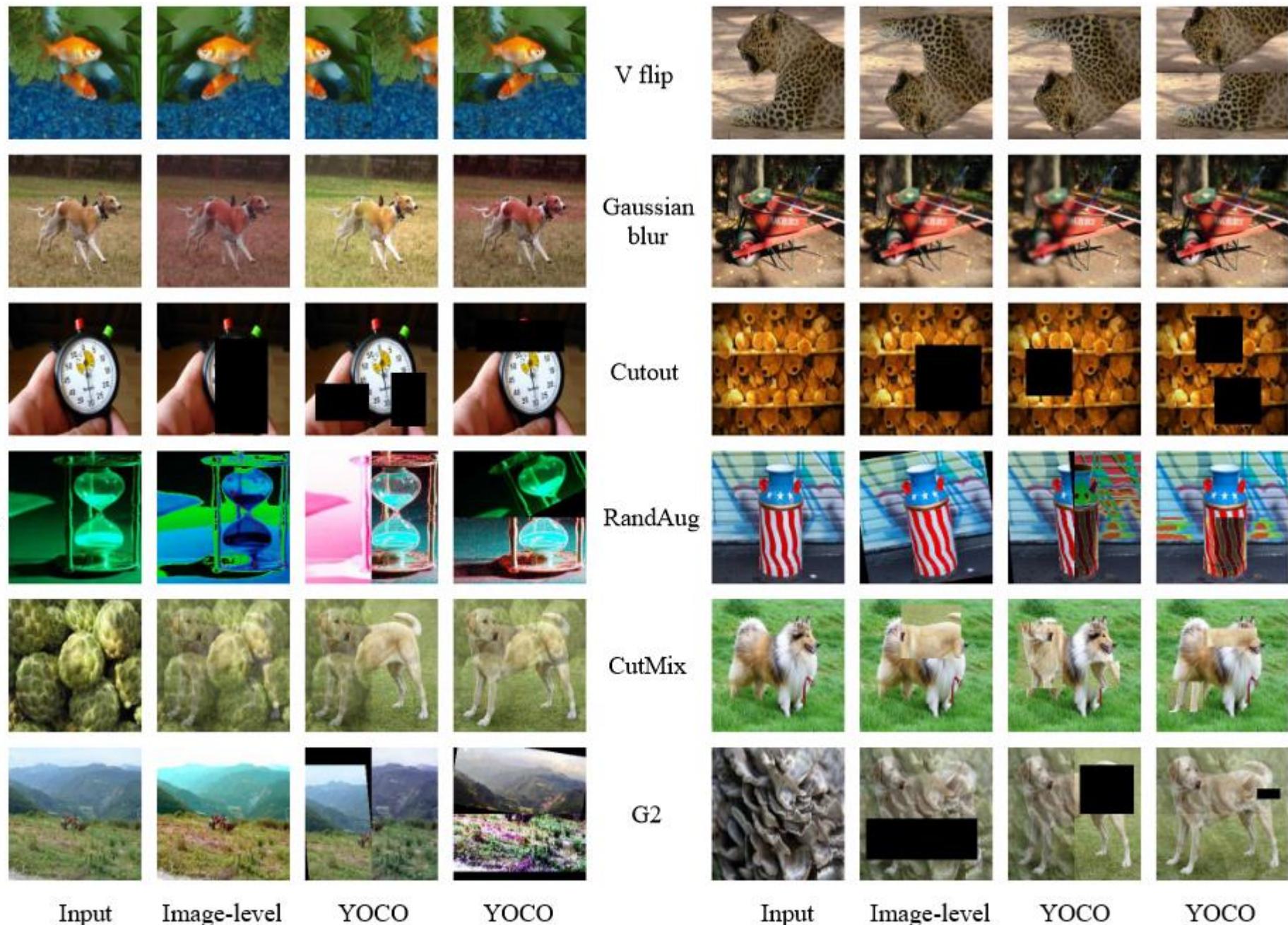
Aug

Color jitter

Aug

Random horizontal flip

# Augmented images



# Experiments

- Image Classification

CIFAR-10, CIFAR-100, and ImageNet

- Contrastive Learning

Transfer to classification, segmentation, and detection

- Low-level vision

Image deraining and image super-resolution.

# Results: CIFAR-10 Classification

Models	Geometric trans		Photometric trans		Information dropping		Search-based		Mix-based		Group	
	H flip	V flip	Jitter	Blur	Erasing	Cutout	AutoAug	RandAug	Mixup	CutMix	G1	G2
PreResNet18 + YOCO	4.64 5.05 +0.41	5.90 5.52 -0.38	4.79 4.70 -0.09	5.29 5.00 -0.29	4.32 4.28 -0.04	4.66 4.36 -0.30	3.71 3.38 -0.33	4.18 4.08 -0.10	3.23 3.11 -0.12	3.45 3.38 -0.07	3.69 3.56 -0.13	3.63 3.25 -0.38
Xception + YOCO	4.62 4.91 +0.29	5.20 5.11 -0.09	4.52 4.51 -0.01	5.31 4.65 -0.66	4.07 4.07 0.00	4.15 3.94 -0.21	3.56 3.31 -0.25	4.01 3.95 -0.06	3.70 3.17 -0.53	3.66 3.22 -0.44	4.04 3.32 -0.72	3.41 3.20 -0.21
DenseNet121 + YOCO	4.58 5.09 +0.51	5.21 5.18 -0.03	4.72 4.70 -0.02	5.09 4.76 -0.33	4.17 4.13 -0.04	4.55 4.25 -0.30	3.83 3.67 -0.16	4.22 3.91 -0.31	3.71 3.28 -0.43	3.53 3.50 -0.03	3.98 3.50 -0.48	3.57 3.36 -0.21
ResNeXt50 + YOCO	4.69 5.10 +0.41	5.12 5.03 -0.09	4.74 4.60 -0.14	5.66 5.27 -0.39	4.18 3.96 -0.22	4.93 4.64 -0.29	3.65 3.26 -0.39	4.09 3.91 -0.18	3.69 3.45 -0.24	3.52 3.44 -0.08	3.79 3.26 -0.53	3.66 3.41 -0.25
WRN-28-10 + YOCO	3.51 3.53 +0.02	4.10 4.09 -0.01	3.63 3.44 -0.19	3.99 3.97 -0.02	2.92 2.89 -0.03	3.26 2.96 -0.30	2.72 2.62 -0.10	3.23 3.05 -0.18	2.60 2.46 -0.14	2.86 2.82 -0.04	2.75 2.65 -0.10	2.79 2.35 -0.44
ViT + YOCO	4.69 4.92 +0.23	5.51 5.34 -0.17	4.74 4.70 -0.04	5.49 4.95 -0.54	4.32 4.18 -0.14	4.44 4.42 -0.02	3.76 3.54 -0.22	4.13 3.96 -0.17	3.67 3.17 -0.50	3.49 3.21 -0.28	3.82 3.51 -0.31	3.27 3.14 -0.13
Swin + YOCO	4.83 4.85 +0.02	5.27 5.25 -0.02	4.90 4.40 -0.50	5.15 5.12 -0.03	4.26 4.23 -0.03	4.55 4.03 -0.52	3.63 3.54 -0.09	4.15 4.13 -0.02	3.56 3.16 -0.40	3.64 3.22 -0.42	3.74 3.44 -0.30	3.58 3.46 -0.12
Average $\Delta$	+0.27	-0.11	-0.14	-0.32	-0.07	-0.28	-0.22	-0.15	-0.34	-0.19	-0.37	-0.25

Metric: Top-1 error rate

76/84 results are improved

# Results: CIFAR-100 Classification

Models	Geometric trans		Photometric trans		Information dropping		Search-based		Mix-based		Group	
	H flip	V flip	Jitter	Blur	Erasing	Cutout	AutoAug	RandAug	Mixup	CutMix	G1	G2
PreResNet18 + YOCO Δ	23.36 24.66 +1.30	25.16 24.73 -0.43	23.95 23.62 -0.33	25.96 25.11 -0.85	24.03 23.94 -0.09	25.01 23.41 -1.60	21.94 20.55 -1.39	22.70 22.70 0.00	21.32 19.62 -1.70	20.05 19.30 -0.75	22.97 21.06 -1.91	21.23 20.92 -0.31
Xception + YOCO Δ	23.34 24.46 +1.12	25.16 24.65 -0.51	23.39 23.42 +0.03	26.17 25.51 -0.66	25.01 23.74 -1.27	25.44 23.56 -1.88	22.50 20.29 -2.21	22.87 22.45 -0.42	21.41 19.96 -1.45	20.17 19.25 -0.92	23.02 20.75 -2.27	21.79 20.68 -1.11
DenseNet121 + YOCO Δ	23.14 24.21 +1.07	23.71 24.62 +0.91	24.25 23.14 -1.11	26.21 24.68 -1.53	23.97 23.34 -0.63	24.71 23.83 -0.88	22.43 20.63 -1.80	22.66 23.11 +0.45	21.17 19.87 -1.30	19.50 19.26 -0.24	22.80 21.13 -1.67	21.23 20.95 -0.28
ResNeXt50 + YOCO Δ	24.60 25.11 +0.51	24.61 24.22 -0.39	23.58 23.76 +0.18	25.86 25.66 -0.20	24.50 23.51 -0.99	24.84 23.77 -1.07	22.32 21.01 -1.31	22.77 22.47 -0.30	20.78 19.74 -1.04	19.72 19.68 -0.04	22.69 20.58 -2.11	21.69 20.55 -1.14
WRN-28-10 + YOCO Δ	19.90 20.44 +0.54	21.70 21.34 -0.36	19.54 19.59 +0.05	21.95 21.17 -0.78	19.79 19.65 -0.14	19.73 19.68 -0.05	18.07 17.17 -0.90	19.25 19.29 +0.04	18.93 17.64 -1.29	17.03 17.29 +0.26	18.39 18.89 -0.50	17.74 17.72 -0.02
ViT + YOCO Δ	23.67 24.52 +0.85	24.01 24.74 +0.73	24.53 23.49 -1.04	26.06 25.04 -1.02	24.09 23.20 -0.89	25.10 23.38 -1.72	22.14 20.61 -1.53	22.79 22.34 -0.45	21.15 19.26 -1.89	20.27 19.17 -1.10	22.75 20.85 -1.90	21.64 21.20 -0.44
Swin + YOCO Δ	23.57 24.66 +1.09	24.51 24.37 -0.14	24.04 23.96 -0.08	25.49 25.39 -0.10	24.81 23.22 -1.59	25.11 23.86 -1.25	22.30 20.70 -1.60	23.14 22.62 -0.52	21.42 19.43 -1.99	19.78 19.74 -0.04	22.92 20.75 -2.17	21.26 20.88 -0.38
Average Δ	+0.93	-0.03	-0.33	-0.73	-0.80	-1.21	-1.53	-0.17	-1.52	-0.40	-1.79	-0.53

Metric: Top-1 error rate

68/84 results are improved

# Results: ImageNet Classification

Augs	Generalization Clean	Partial Clean	Calibration Clean, RMS↓	Adversarial attacks		Corruptions	Distribution shift	
				FGSM attack	PGD attack	Random replace	Gaussian noise	ImageNet-A
H flip + YOCO △	77.10/76.59	55.21/56.14	6.42/8.81	17.28/21.01	9.37/14.98	58.90/58.77	73.58/72.92	3.39/4.29
	77.28/77.01	56.27/56.44	7.87/8.19	20.59/21.88	14.21/15.21	59.11/58.91	73.63/72.96	3.80/4.32
	+0.18/+0.42	+1.06/+0.30	+1.45/-0.62	+3.31/+0.87	+4.84/+0.23	+0.21/+0.14	+0.05/+0.04	+0.41/+0.03
Jitter + YOCO △	77.15/76.87	56.04/56.34	8.06/8.19	18.31/18.80	11.07/11.89	59.11/58.82	73.74/73.38	3.98/4.13
	77.35/77.12	56.41/56.60	7.50/8.07	16.32/17.77	5.96/6.90	59.40/59.32	74.46/74.14	4.29/4.56
	+0.20/+0.25	+0.37/+0.26	-0.56/-0.12	-1.99/-1.03	-5.11/-4.99	+0.29/+0.50	+0.72/+0.76	+0.31/+0.43
Erasing + YOCO △	77.40/77.09	56.75/56.82	7.67/7.88	22.01/22.67	12.74/13.31	58.75/58.44	73.81/73.48	4.11/4.32
	77.29/77.20	56.66/56.76	7.57/8.00	22.34/22.82	12.93/14.00	58.80/58.85	73.95/73.59	4.12/4.28
	-0.11/+0.11	-0.09/-0.06	-0.10/+0.12	+0.33/+0.15	+0.19/+0.69	+0.05/+0.41	+0.14/+0.11	+0.01/-0.04
AutoAug + YOCO △	77.55/76.93	55.61/55.05	6.17/6.73	11.51/11.62	2.05/2.18	58.36/58.12	74.45/73.85	4.54/4.69
	77.88/77.65	56.48/56.52	6.04/6.25	12.09/11.73	1.11/0.86	58.90/58.29	76.03/75.70	5.01/4.80
	+0.33/+0.72	+0.87/+1.47	-0.13/-0.48	+0.58/+0.11	-0.94/-1.32	+0.54/+0.17	+1.58/+1.85	+0.47/+0.11
Mixup + YOCO △	77.72/77.67	55.27/55.40	8.23/9.03	35.92/35.41	7.90/7.44	61.46/61.07	75.47/75.12	8.37/8.59
	77.81/77.74	56.00/55.97	4.04/4.42	39.63/39.67	13.02/13.63	61.14/60.85	75.10/74.88	8.27/8.55
	+0.09/+0.07	+0.73/+0.57	-4.19/-4.61	+3.71/+4.26	+5.12/+6.19	-0.32/-0.22	-0.37/-0.24	-0.10/-0.04
G1 + YOCO △	77.61/77.19	55.57/55.24	6.29/6.19	13.11/13.22	2.34/2.87	58.94/58.99	75.22/74.94	5.01/5.22
	77.76/77.64	56.00/55.97	6.17/6.02	13.62/13.61	1.82/2.61	59.15/59.03	75.73/75.59	5.41/5.47
	+0.15/+0.45	+0.43/+0.73	-0.12/-0.17	+0.51/+0.39	-0.52/-0.26	+0.21/+0.04	+0.51/+0.65	+0.40/+0.25

Metric: Top-1 accuracy  
best/last results

YOCO outperforms image-level augmentation

# Results: Contrastive Learning

Method	ImageNet classification			VOC detection			COCO detection			COCO instance seg		
	linear protocol	1% label	10% label	AP <sub>50</sub>	AP	AP <sub>75</sub>	AP <sub>50</sub>	AP	AP <sub>75</sub>	AP <sub>50</sub> <sup>mask</sup>	AP <sub>mask</sub>	AP <sub>75</sub> <sup>mask</sup>
MoCo v2 + YOCO	67.5 67.6	34.5 34.9	61.1 61.5	81.9 82.4	56.8 56.6	62.9 63.6	57.3 57.4	38.0 38.1	40.8 41.6	54.1 54.1	33.3 33.4	35.5 35.5
SimSiam +YOCO	68.1 68.3	17.1 17.3	57.3 57.7	80.2 80.2	54.5 54.5	60.0 60.1	51.4 53.1	33.5 34.6	36.1 37.3	48.7 50.1	29.9 30.8	32.0 32.9

YOCO results in more **powerful representation**

# Results: Low-level Vision

Methods	Test100	Rain100H	Rain100L	Test2800	Test1200	Average
MPRNet	30.27	30.41	36.40	33.64	32.91	32.73
+ YOCO	30.33	30.53	37.13	33.64	32.84	32.89

## Deraining

Aug	Synthetic				Realistic RealSR
	DIV2K	Set14	Urban100	Manga109	
No aug	28.83	28.49	25.82	30.11	28.78
+ Image-level	28.83	28.48	25.82	30.08	28.99
+ YOCO	28.84	28.50	25.83	30.11	28.99

## Super-resolution

Metric: PSNR

YOCO generalizes well to low-level vision tasks

# Conclusion

- YOCO boosts multiple augmentations for free
- How to perform data augmentations can be further explored
- Code available: <https://github.com/JunlinHan/YOCO>