What Does Rotation Prediction Tell Us about Classifier Accuracy under Varying Testing Environments?

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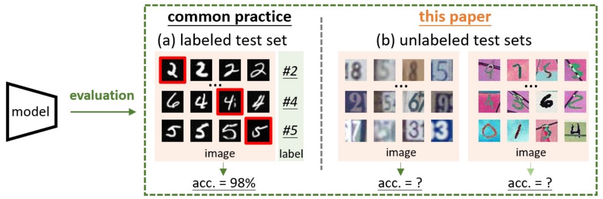
Unsupervised Accuracy Estimation

Given a trained classifier, the overall goal is to estimate its accuracy on various test datasets **without labels**

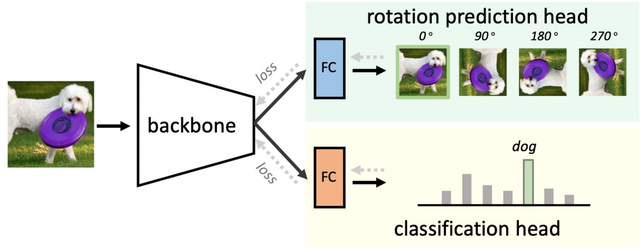


Motivation

- **Rotation prediction** is self-supervised: we can obtain its rotation labels freely and calculate its accuracy on any test set;
- Can we predict the classifier performance from the accuracy of rotation prediction?

- Multi-task framework

We train a multi-task network for both semantic classification and rotation prediction

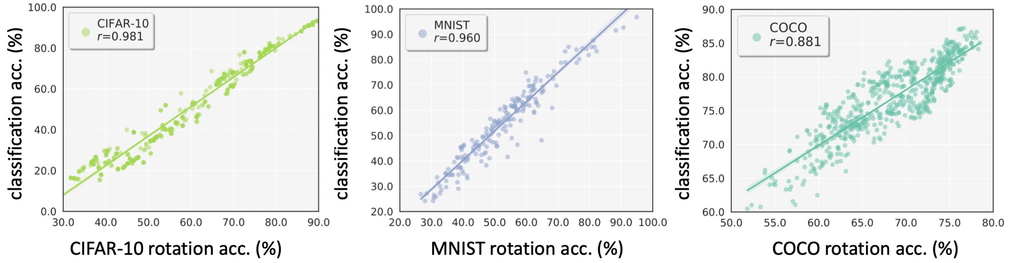


Correlation Study

- Synthetic test sets

Data synthesis: using image transforms to generate many datasets

- Correlation study
  - Test our multi-task network on them and calculate: a) sematic classification accuracy; b) rotation prediction accuracy
  - Measure the accuracy relationship between two types of tasks



- We consistently observe a strong linear relationship (*Pearson Correlation r > 0.88*) between the accuracy of two tasks;
- If the multi-task network is good at predicting rotations, it is most likely to achieve good object recognition accuracy under the same environment, and vice versa

- Correlation study across different backbones

	VGG11	VGG19	ResNet26	ResNet44	Dense40
Class. Acc.	92.53	92.51	92.84	93.73	94.75
Rot. Acc.	91.32	92.07	87.84	88.81	91.28
Cor. (r)	0.990	0.987	0.975	0.981	0.981

CIFAR-10 Setup

The strong linear correlation is maintained when using different backbones

- Correlation when the number of classes is large

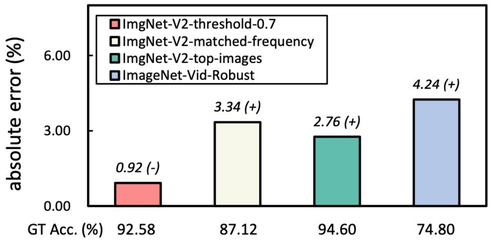
Backbone	CIFAR-10	CIFAR-100		
	Cor. (r)	Cor. (r)	Class Acc.	Rot. Acc.
ResNet26	0.975	0.918	69.31	73.18
ResNet44	0.981	0.910	71.38	75.60
Dense40	0.981	0.950	74.55	75.20

CIFAR-100 Setup

When the number of classes is huge, the correlation decreases but it still has a high value

Linear Regression for Accuracy Estimation

$a^{cls} = w_1 a^{rot} + w_0$, where $w_1, w_0 \in \mathbb{R}$ are linear regression parameters



It feasible to estimate classifier accuracy using rotation prediction performance which can be easily obtained

Reference

1. Deng, W., & Zheng, L. Are Labels Always Necessary for Classifier Accuracy Evaluation? In CVPR, 2021
2. Gidaris, S., et.al. Unsupervised representation learning by predicting image rotations. In *ICLR*, 2018.

The code is available at http://weijiandeng.xyz