Domain Generalization with MixStyle

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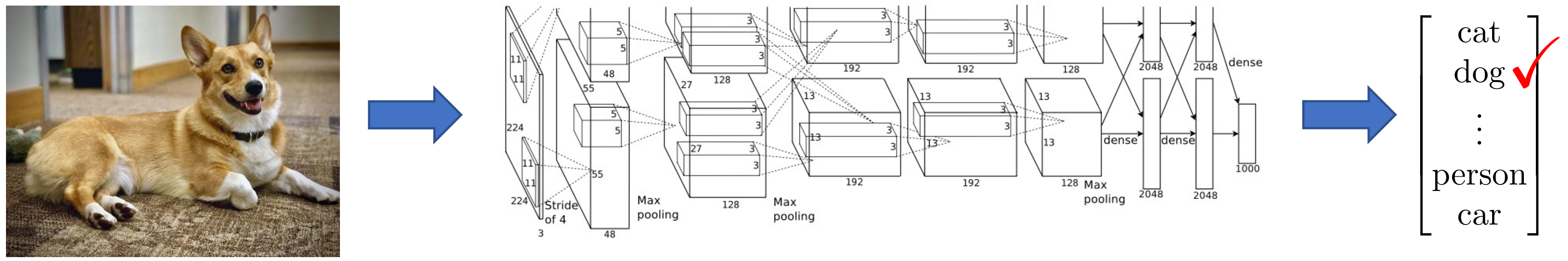
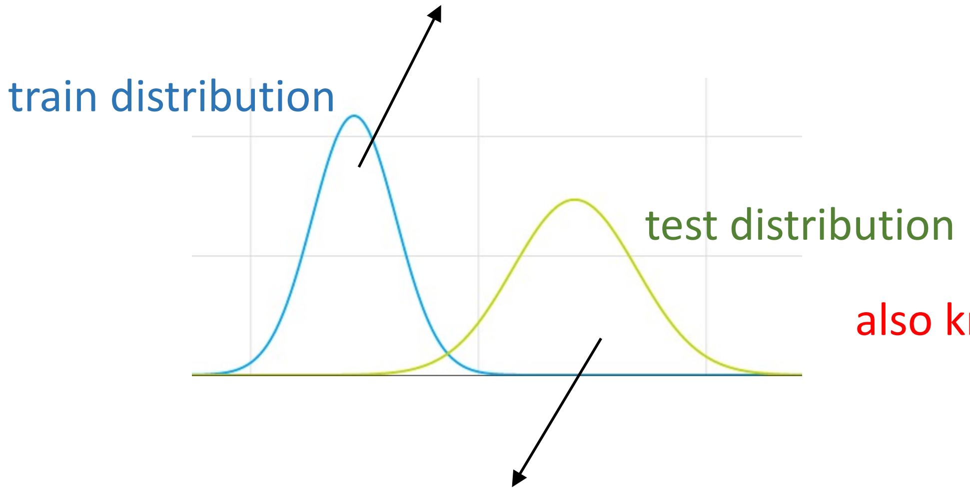
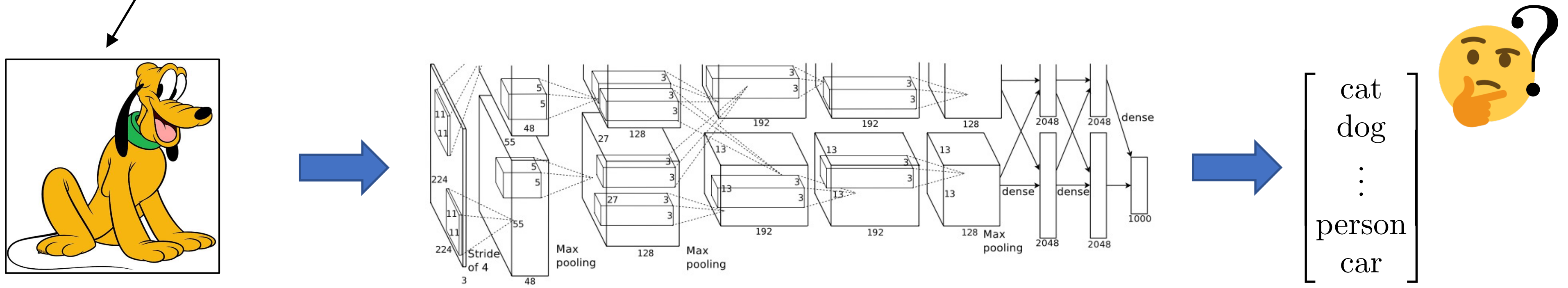
Problem: CNNs do not work well on out-of-distribution (OOD) data





also known as the domain shift problem

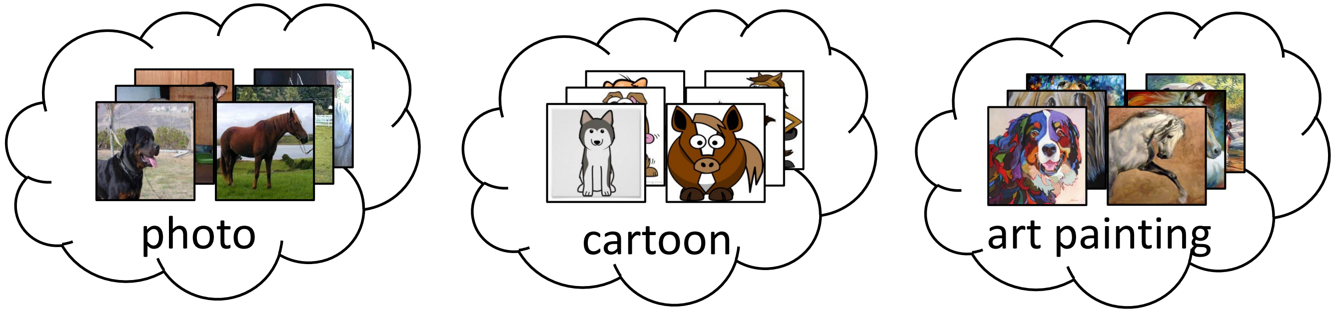


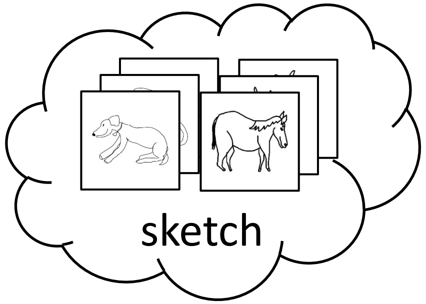
We focus on domain generalization (DG)

- setup

train a model using multiple source domains
e.g., 3 source domains: photo, cartoon & art painting

test on an unseen domain
e.g., sketch



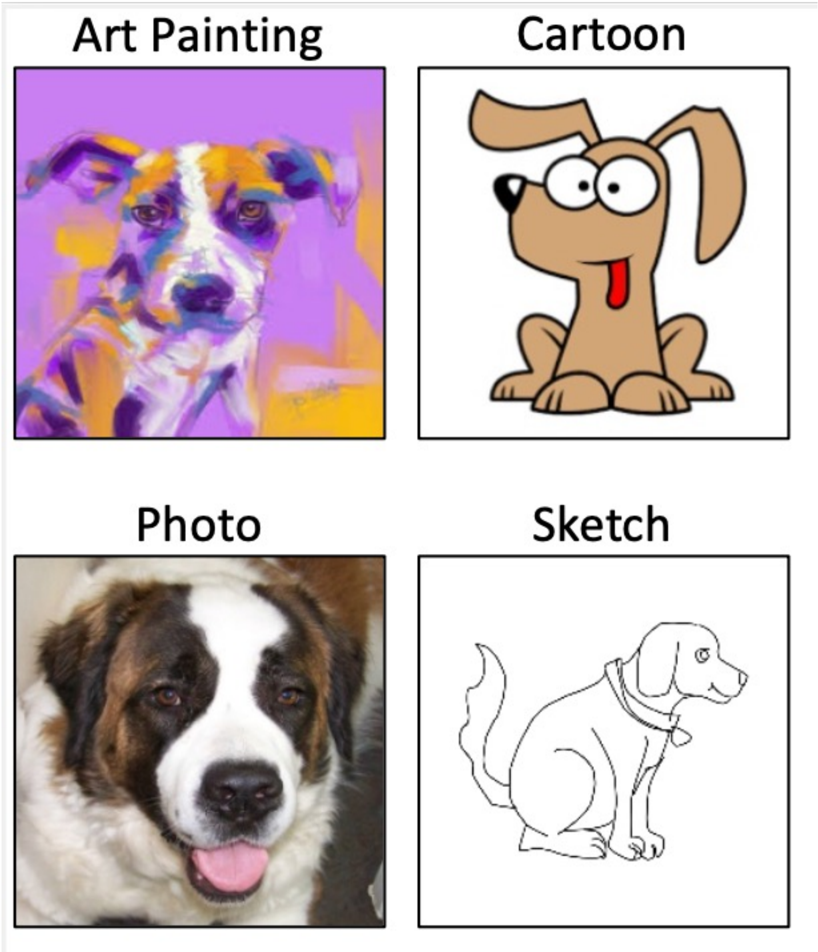


- problem

- DG is challenging (without accessing the target data)
- intuitively, more source domains -> more generalizable -> better performance
- however, collecting data of a large variety of domains is often costly or even impossible

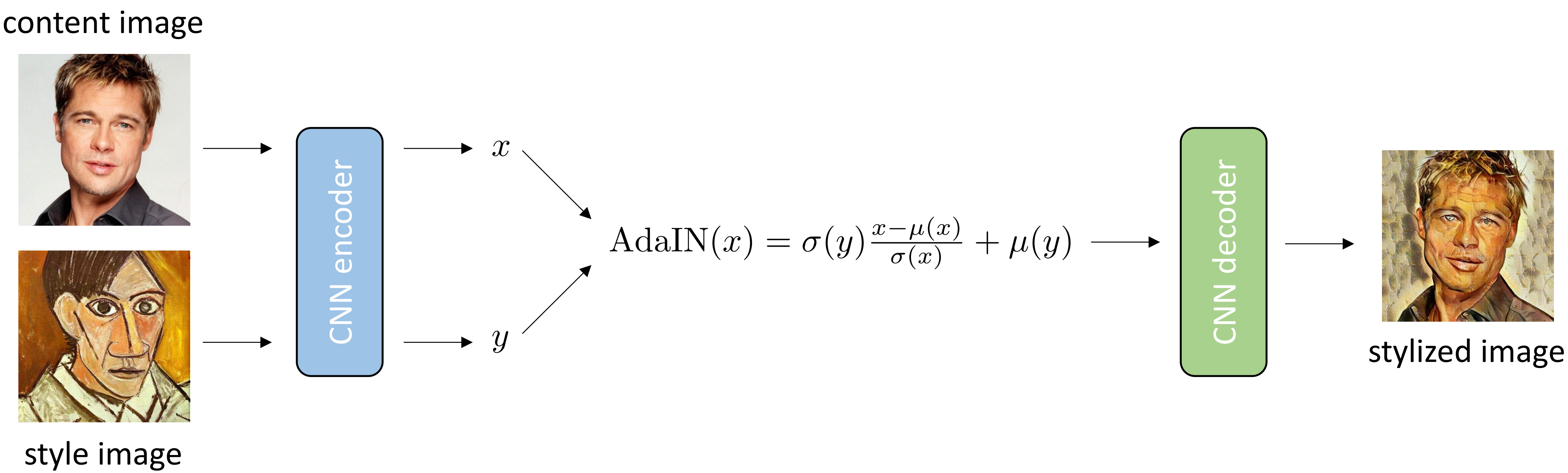
Motivation: to increase the diversity of source domains in the feature space

- Visual domain is closely related to image style



Motivation: to increase the diversity of source domains in the feature space

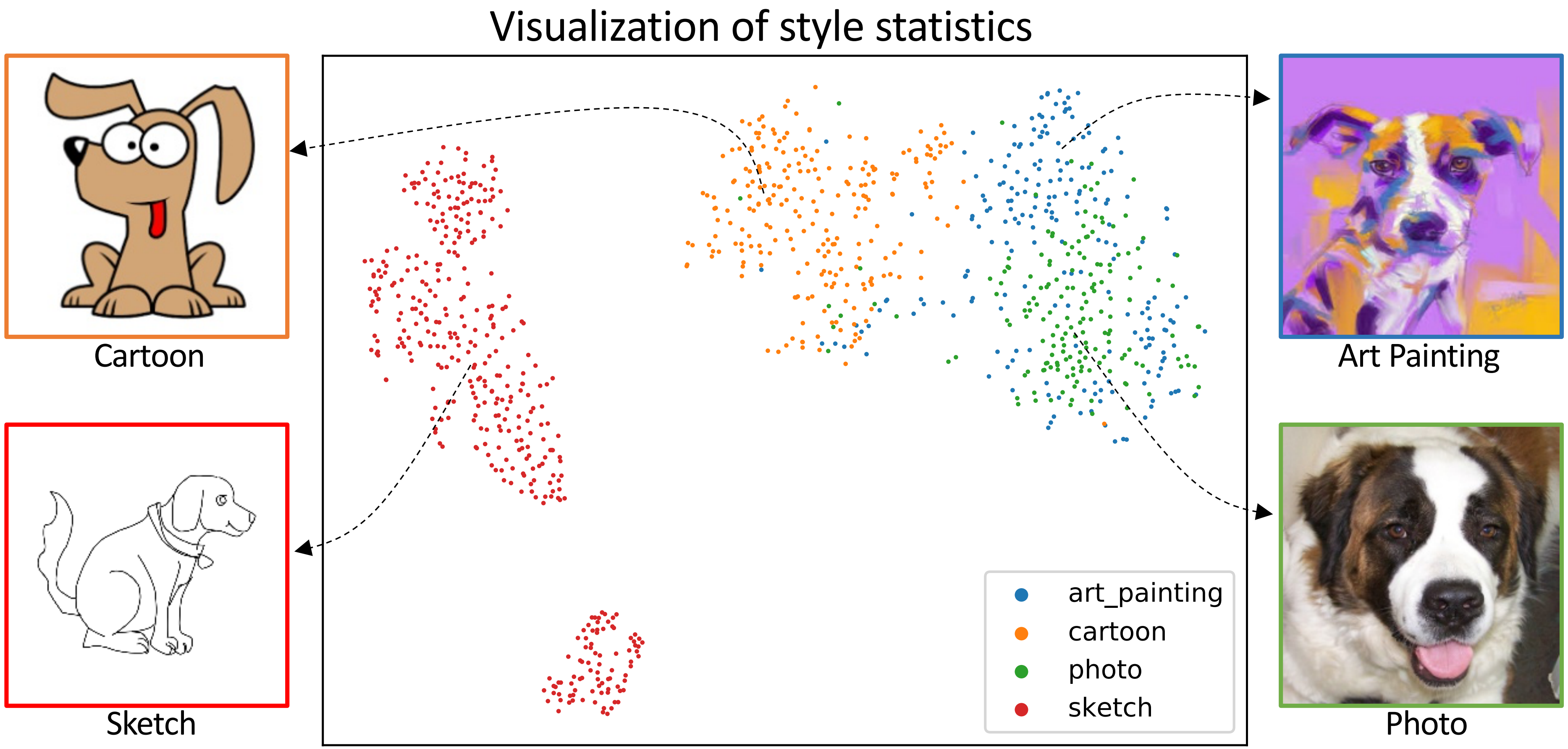
- CNN feature statistics (i.e., mean & std) can be used to manipulate image style (inspired by neural style transfer)



(Huang & Belongie, ICCV'17)

Motivation: to increase the diversity of source domains in the feature space

- t-SNE visualization of feature statistics (a.k.a. style statistics)



Our method: MixStyle

$$\lambda \sim Beta(\alpha, \alpha)$$
$$\gamma_{mix} = \lambda\sigma(x) + (1 - \lambda)\sigma(\tilde{x})$$
$$\beta_{mix} = \lambda\mu(x) + (1 - \lambda)\mu(\tilde{x})$$
$$\text{MixStyle}(x) = \gamma_{mix} \frac{x - \mu(x)}{\sigma(x)} + \beta_{mix}$$

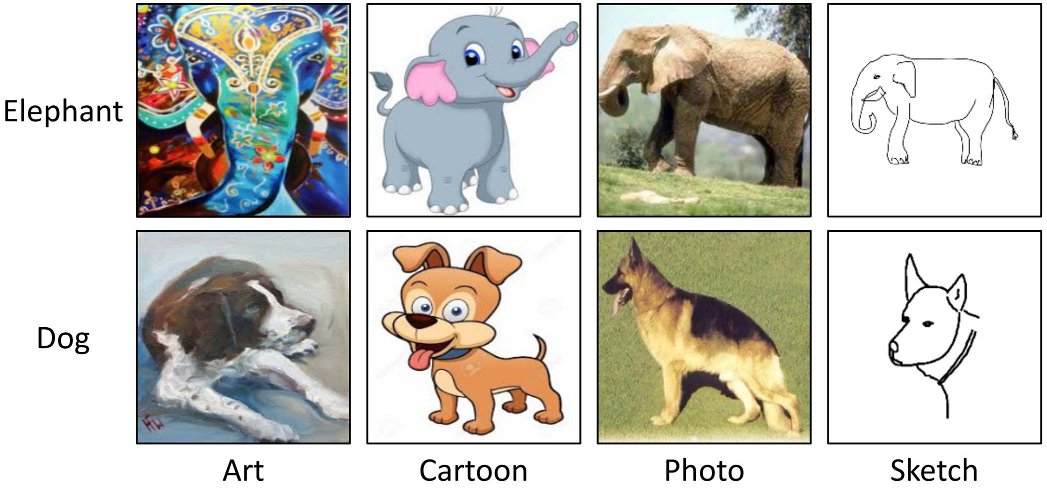
a random instance from the same mini-batch; or an instance from a different domain (if domain labels are provided)

MixStyle is inserted to multiple shallow layers in a CNN

```
def forward(self, x):
    x = self.conv1(x) # 1st convolution layer
    x = self.res1(x) # 1st residual block
    x = self.mixstyle(x)
    x = self.res2(x) # 2nd residual block
    x = self.mixstyle(x)
    x = self.res3(x) # 3rd residual block
    x = self.res4(x) # 4th residual block
    ...
```

MixStyle improves OOD generalization on these tasks

1. category classification



2. instance retrieval

Market1501 Duke

3. reinforcement learning

more details about the results can be found in the paper:
https://openreview.net/forum?id=6xHJ37MVxxp

Thanks for your attention

interested in knowing more about the topic of domain generalization?
check out our latest survey paper at
https://arxiv.org/abs/2103.02503 (Domain Generalization: A Survey)