Domain Adaptation for Rare Classes Augmented with Synthetic Samples

1. BACKGROUND

- rare classes can be augmented with synthetic samples to improve classification performance
- **context** camera-trap dataset of animals, with synthetically augmented rare deer class [1]
- **problem** feature distributions of synthetic deer samples and real deer samples are not similar
- **objective** reduce domain discrepancy between real and synthetic deer samples using domain adaptation

3. RESULTS

- using ImageNet-pretrained ResNet50 as F, fully connected (1024-1024-2) layers as D and fully connected (1024-12) layers as C
- comparison with Inception v3 baseline trained on original dataset and augmented dataset (10k synthetic deer):

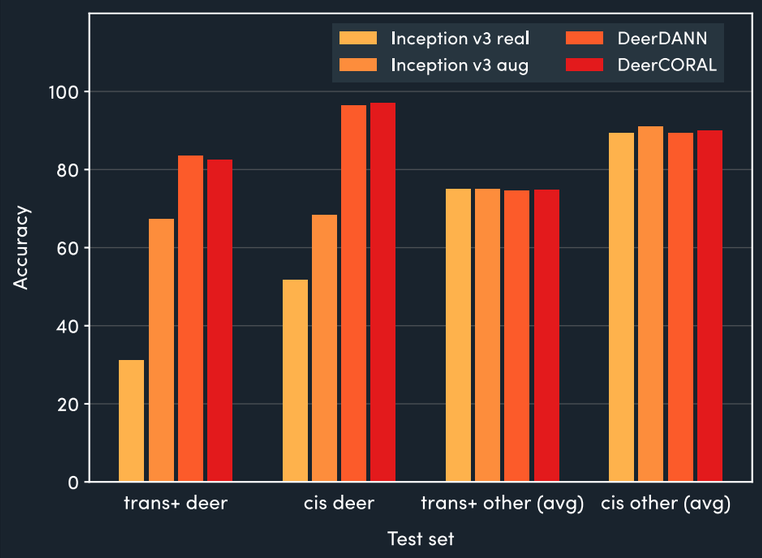

Fig 4. Comparison of DeerDANN (8k syn deer), DeerCORAL (2k syn deer) and Inception baselines (0 and 10k syn deer). Cis and trans+ respectively represent camera locations seen and unseen in the training set.

2. METHODS

- split real and synthetic data in source and target domains S and T (see Fig. 1)
- two domain adaptation variations: **DeerDANN** and **DeerCORAL**, to generate more similar features distributions of real and synthetic deer

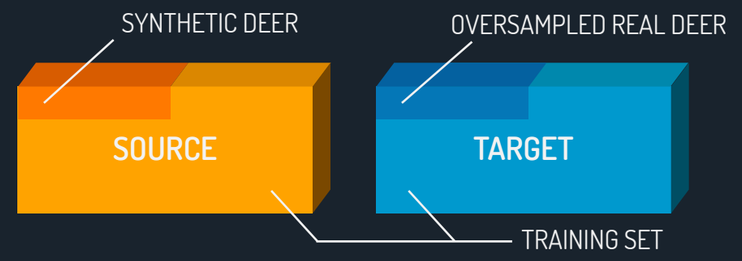

Fig 1. Organisation of training data and synthetic samples in source and target domains.

DeerDANN

- train a feature extractor F, domain discriminator D and classifier C adversarially on S and T [2]
- **modification** only deer samples enter D
- minimize classification loss of C and maximize domain confusion loss of D

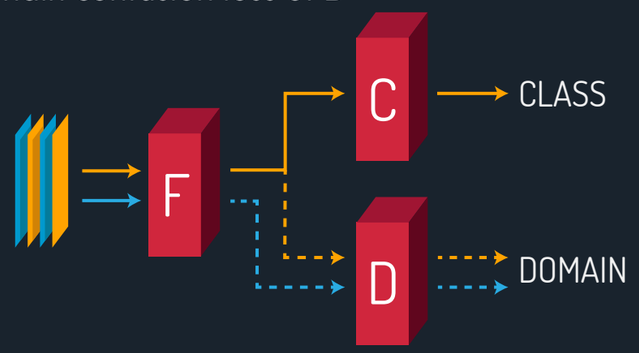

Fig 2. DeerDANN architecture. Dashed lines indicate deer.

DeerCORAL

- incorporate correlation alignment (CORAL) loss term in classifier [3]
- CORAL loss term represents distance between second order statistics of S and T
- minimize classification loss and CORAL loss

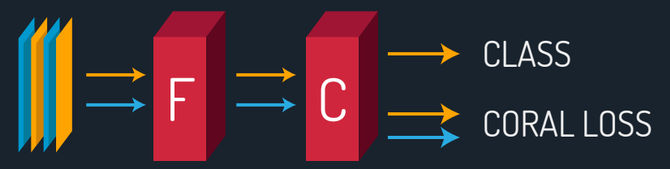

Fig 3. DeerCORAL architecture.

4. CONCLUSION

- DeerDANN and DeerCORAL have higher deer classification accuracies than the baselines
- both models have similar average accuracies for the other animal classes
- DeerDANN has the largest trans+ deer accuracy improvement, justifying sending only deer to the discriminator
- both methods require fewer synthetic samples than the baseline to achieve higher deer accuracies

5. REFERENCES

[1] S. Beery et al., "Synthetic Examples Improve Generalization for Rare Classes," in IEEE WACV, 2020, pp. 852–862.

[2] Y. Ganin and V. Lempitsky, "Unsupervised Domain Adaptation by Backpropagation," in ICML, 2015, pp. 1180–1189.

[3] B. Sun and K. Saenko, "Deep CORAL: Correlation Alignment for Deep Domain Adaptation," in ECCV Workshops, 2016, pp. 443–450.

Author Tuhin Das
Contact T.Das@student.tudelft.nl
Supervision Attila Lengyel
Robert-Jan Bruintjes
Sara Beery
Professor Jan van Gemert

TU Delft
Caltech