

# **Asking Friendly Strangers: Non-Semantic Attribute Transfer** Nils Murrugarra-Llerena and Adriana Kovashka Department of Computer Science, University of Pittsburgh



# Introduction

- We examine how to transfer knowledge from attribute classifiers on **unrelated domains**.
- We intelligently select how to weigh the contribution of the semantically unrelated source models using an attention-guided network.
- Employing this attention network, we outperform five different baselines.

# Motivation

- Traditional attribute transfer learning aims to transfer knowledge between attributes from the same domain, e.g. using "has spots", "has stripes", "hooved" as sources for the "furry" target attribute, in the animals domain.
- However, what can we do given data scarcity, i.e. no semantically related categories?

# Key idea

Transfer knowledge from attribute classifiers on unrelated domains.





# Evaluation

#### We compare our methods:

#### • Attention – Different Domain (ours), which uses D<sub>i</sub> as target domain and $D/D_i$ as source domains.

• Attention – Any Domain (ours), which uses D<sub>i</sub> as target domain and D as source domains.

D<sub>i</sub> : domain (instances + attributes)  $D = \bigcup D_i$ 

with five different baselines using **F-measure**:

- Attention Same Domain, which uses  $D_i$  as target domain and  $D_i$  as source domain.
- *Target-only*, which performs no transfer.
- Attention-SDU, Attention-DDU, and Attention-ADU, which replace our attention weights  $(\mathbf{W}_{att})$  with uniform weights.
- Confusion Different Domain and Confusion Any Domain, which use a transfer learning approach with invariant feature representation (Tzeng et al., ICCV 2015).
- Finetune Different Domain and Finetune Any Domain, which finetune an AlexNet with source data, and then with target data (Oquab et al., CVPR 2014).

**Take away message:** Unrelated domains have valuable knowledge for learning attributes.

# Related work

- We use multi-task neural networks for attribute transfer learning.
- Prior work only considers objects and attributes from the same domain (Chen and Grauman, CVPR 2014; Liu and Kovashka, WACV 2016). Our study differs in that we study if transferability of **unrelated attributes** (from **different domains**) is more beneficial.
- Attention networks are very common in question answering (Xu and Saenko, ECCV 2016; Shih et al., CVPR 2016). Instead of an image-text attention, we perform attention-guided transfer from source to target attribute classifiers.



• We believe the success of our method is due to a common feature representation (shared layer: W<sub>shared</sub>) and parameter transfer (attention weights: W<sub>att</sub>).



### Qualitative results

0.9

0.8



- We use an attention network to select relevant source models for our target attributes.
- We find a common feature space for source and target images via W<sub>shared</sub>.
- In order to transfer knowledge between the source and target classifiers, we calculate normalized similarities  $W_{att}$  (attention weights).
  - W<sub>att</sub> employs cosine similarity and a RELU function to avoid negative transfer.
- We employ a loss composed of three terms. Our main task  $T_1$  predicts target attributes using our attention-guided transfer, and our side tasks  $T_2$  and  $T_3$  predict source and target attributes, respectively. All of them use a binary cross-entropy loss.

# Experimental setup





Source

animals objects scenes shoes textures

animals

objects

- The most relevant domain for animals, shoes, and textures is scenes, and scenes is not closely related to any of these domains.
- Similarly, the most meaningful domain objects and scenes is animals, for another semantically unrelated source domain.

#### • Shoes and textures attributes do not almost at all benefit from other attributes in the same domain.

- On the other hand, objects, scenes, animals do benefit from semantically related attributes, but the overall withindomain model similarity is lower than 50%, again reaffirming our choice to allow non-semantic transfer.
- We illustrate what visual information is being transferred across domains, for particular attribute examples. Some of them have an intuitive explanation.

Domain	Target attribute	Relevant source attributes from [domain]
textures	Aluminum	muscular [animal], made of glass [object]
shoes	long-on-the-leg	has leg [object]
object	has stem	dirty soil [scene], feed from fields [animal]