KI DELTA LEARNING
Scalable AI for Automated Driving

Visual Transfer Learning using Knowledge Graphs

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WP 2.4

Environment

Use-Case in Delta Learning

Our research focuses on investigating techniques for mitigating the challenge of data distribution and developing robust networks w.r.t. distribution shifts. The main objective is to exploit and reuse prior knowledge which is represented in form of a Knowledge Graph (i.e. Figure 1 – RoadSigns KG) and infuse it into a learning pipeline.

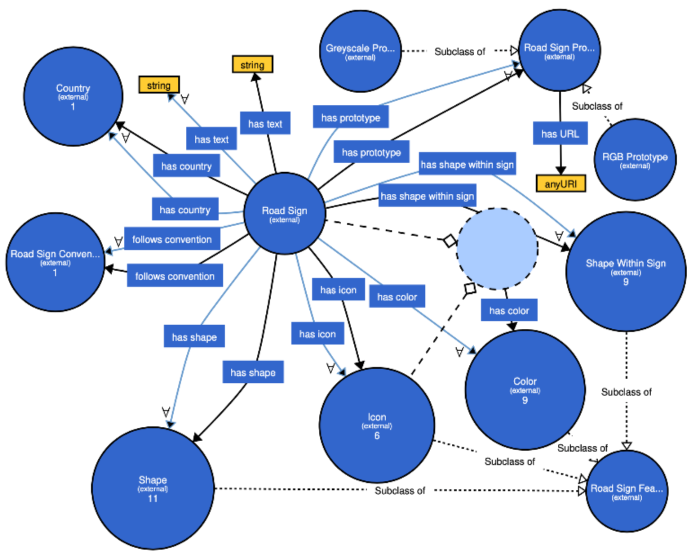

Figure 1: The Road Signs Knowledge Graph

Technical Problem

Transfer learning tasks consist of a source dataset and a target dataset, which differ in terms of their underlying distribution, e.g sensors, environments, countries. A domain generalization task has only access to labeled source data, whereas the domain adaptation task contains a small amount of additional labeled target data.

Our research direction is to focus on reducing the high dependency on the training domain by generating pre-training methods that generate rich embedding spaces using the domain-invariant knowledge.

Technical Solution

Our main goal is incorporating prior knowledge into the deep learning pipeline using a knowledge graph as a trainer. As depicted in Figure 2, the class labels of a given dataset are infused to the NN in form of a high-dimensional vector of the knowledge graph embedding space h_{KG}, instead of using the standard one-hot encoded vectors. This h_{KG} shown in Figure 2 is generated from a KG using a knowledge graph embedding method KGE(·). It incorporates domain-invariant relations to other classes inside or outside the dataset and therefore enriches the NN with auxiliary knowledge in an indirect manner. To guide the adaption of the NN to the h_{KG} space, we use the *contrastive knowledge graph embedding loss*. It compares the respective outputs from the visual feature extractor with the class label vectors of the h_{KG} forming a visual-sematic embedding space $h_{v(KG)}$. As a result, the learned NN projects respective images close to their representations given by the h_{KG}.

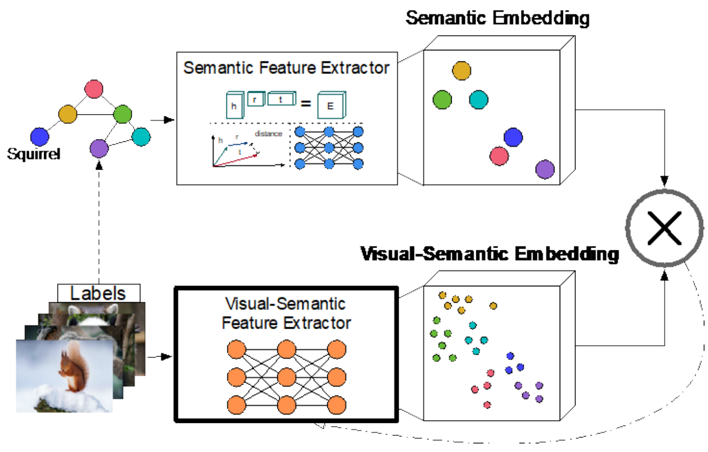

Figure 2: Our KG-NN approach - the main building blocks for learning a visual embedding space in a supervised fashion by a knowledge graph.

Evaluation

We consider two scenarios in our evaluation: the domain generalization scenario - training in a source domain, e.g. GTSRB – German Traffic Road Signs Benchmark and testing in a target domain, e.g. CTSD – Chinese Traffic Sign Dataset ; and the domain adaptation scenario – using only few labeled data. In both scenarios we achieve significant improvements.

	CE	SupCon	KG-NN
GTSRB	96.1 +0.8%	41.9 +55.0%	**96.9**
CTSD	63.0 +7.1%	34.4 +35.7%	**70.1**

BOSCH

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Partners

External partners

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KI FAMILIE

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