Transfer Learning

Sharing knowledge between models

Transfer Learning

Sharing of knowledge between machine learning models.

Formal Definition - Domain

- Feature space $\mathcal{X}$
- Probability distribution $P(\mathcal{X})$

Formal Definition - Task

- Label space, y
- Predictive function $f_T(\cdot)$

Formal Definition - Transfer Learning

Given a source domain $\mathcal{D}_S$ and a learning task $\mathcal{T}_S$, a target domain $\mathcal{D}_T$ and a learning task $\mathcal{T}_T$, transfer learning aims to help **improve the learning of the target predictive function $f_T(\cdot)$ in $\mathcal{D}_T$ using the knowledge in $\mathcal{D}_S$ and $\mathcal{T}_S$, where $\mathcal{D}_S \neq \mathcal{D}_T$, or $\mathcal{T}_S \neq \mathcal{T}_T$.**

Transfer Learning Categories

Category	Source Labels	Target Labels
Inductive	✓ or x	✓
Transductive	✓	x
Unsupervised	x	x

Transfer Learning Approaches

- Instance-based transfer learning - re-weighting samples in the source domain based on their relevance when applied to the target domain.
- Feature representation transfer learning - finding a feature representation that reduces the difference between the source and target domains.
- Parameter transfer learning - determining shared parameters between the domains for the trained models.
- Relational knowledge transfer learning - mapping relational knowledge between source and target domains.

Approaches x Categories

	Inductive	Transductive	Unsupervised
Instance	✓	✓	
Feature Representation	✓	✓	✓
Parameters	✓		
Relational Knowledge	✓		

Why to use transfer learning

- Augmenting data
- Small amount of data available in target domain
- Prevent overfitting by generalizing

Effectiveness of transfer learning

20 Newsgroup Classification Accuracy

Source vs Target	SVM (Baseline)	TrAdaBoost (Transfer)
rec vs talk	87.3%	92.0%
rec vs sci	83.6%	90.3%
sci vs talk	82.3%	87.5%

Negative transfer learning

When the knowledge being transferred can negatively impact the model focused on the target domain and task.

Computer Vision

Dataset: ImageNet

Models:

- Xception
- VGG-16
- VGG-19
- ResNet50

Natural Language Processing

Datasets:

- Common Crawl
- Google Books
- Wikipedia

Models:

- GloVe
- ELMo
- GLoMo
- OpenAI Transformer

Questions