Deep Learning Practical Work 2-c

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Contents

Section 1 - Domain Adaptation

1. If you keep the network with the three parts (green, blue, pink) but didn't use the GRL, what would happen ?

When the GRL (Gradient Reversal Layer) is not used, the feature extractor will receive a regular gradient from both the label predictor and the domain classifier. Thus:

(a) The domain classifier would learn to distinguish between source and target images.

(b) Since there's no negative sign, the gradients from the domain classifier flowing back to the feature extractor will push the feature extractor to produce features that are easier to discriminate between domains.

(c) In other words, instead of forcing the network to become domain-invariant, the training would push the feature extractor to emphasize domain-specific differences, so that the domain classifier can do a better job. This is the opposite of what we want.

Effectively, without the GRL, we'd end up with a domain-aware feature extractor rather than a domain-invariant one, defeating the purpose of domain adaptation.

2. Why does the performance on the source dataset may degrade a bit ?

The goal of domain adaptation is to learn a domain-invariant representation that works well across domains. By forcing the model to produce features that are less discriminative of the domain, we might lose some fine-grained information that helps classify the source data perfectly.

Before domain adaptation, the feature extractor can overfit to the source domain's particular textures, colors, etc. But once we introduce the GRL and the domain classifier, the model is forced to "forget" these domain-specific cues in favor of more generic features that could represent both source and target domains in a similar way.

Because of this constraint toward generality, the performance on the source might degrade slightly compared to a purely source-trained model. However, the model gains the ability to work better on the target domain, which is the ultimate goal of domain adaptation.

3. Discuss the influence of the value of the negative number used to reverse the gradient in the GRL

- **If the factor is too small:**
  - The penalty for being domain-discriminative is weak.
  - The domain classifier cannot effectively push the feature extractor to become invariant.
  - As a result, the model remains too domain-specific.
- **If the factor is too large:**
  - You might strongly force the feature extractor to become domain-invariant.

- However, there is a risk of overcompensation, which can lead to instability in training.
- You may see a big drop in source performance or even degraded performance on both source and target.

4. Another common method in domain adaptation is pseudo-labeling. Investigate what it is and describe it in your own words.

Pseudo-labeling is a semi-supervised learning technique that is often used in domain adaptation. The idea is to use the model's predictions on the target domain to generate pseudo-labels for the unlabeled target data. These pseudo-labels are then combined with the labeled source data to train the model.

You first train a model on the source domain and use it to make predictions on the unlabeled target domain data. The model's predictions on target data (where the ground truth is unknown) are taken as "pseudo-labels." You then retrain or fine-tune the model (or a part of it) using these pseudo-labeled target samples, essentially pretending that these predicted labels are correct.

However, pseudo-labeling can be risky if the model's predictions are not reliable.