Advanced Machine Learning
MASTER 2 MLDM

TRANSFER LEARNING AND OPTIMAL TRANSPORT

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In this practical session, two domain adaptation methods namely subspace alignment and Sinkhorn- Knopp method is implemented to classify an image composing of 4 domains Amazon (A), Caltech (C),Webcam (W) and DSLR (D), belonging each to one of 10 different classes respectively.

1 Subspace alignment

Subspace alignment is a domain adaptation method where it learns a linear mapping on both source and target domain which aligns the source subspace with the target subspace minimizing the divergence between the two domains. Thus, enabling direct comparison of source domain with target domain.Later classifiers build on source data can be applied to target data. Webcam and amazon data have been used to perform the analysis.

1.1 Methodology

At first, d principal components of source X_s and target X_t is extracted keeping the maximum variance. After alignment matrix M and X_a are calculated. Afterwards, source and projected data S_a and T_a are calculated from initial matrices. Finally, 1-NN classifier is fitted and prediction is made. Here,

S = initial source data
T = initial target data
X_s = d principle components of source features having highest variance
X_t = d principle components of target features having highest variance
M = alignment matrix
S_a = source projected data
S_t = target projected data

1.2 Result analysis

At first, webcam was considered as source data and dslr was considered as target data. Using subspace alignment method, 92.36% accuracy was achieved considering webcam as source and dslr as target data. While 69.15 % accuracy was achieved using dslr as base and webcam as target data.

2 Entropic regularized optimal transport

Adding more entropy makes the matrix sparse to obtain the most evenly spread out representation that incorporates the idea of Maximum Mean Discrepancy (MMD). Sinkhorn-Knopp algorithm can be used When approximating Optimal Transport distance. The accuracy of the approximation is parameterized by a regularization parameter.For large values of regularization parameter (lambda), the computation bounds become computationally expensive where small lambda gives better results. In this experiment, a fixed value of lambda (0.01) is used.

But to get a better result, best value of lambda can be obtained by cross validating.

2.1 Methodology

At first, two unit vectors a and b is initialized having the same size of source and target data respectively. Then, the loss matrix M is calculated, which is the distance between source and target data points. After normalizing the matrix, the Sinkhorn- Knopp algorithm is fitted to obtain the coupling matrix. To make things simple, the value of the regularization was kept fixed at 0.01. Lastly, 1-NN classifier is used to make prediction on T. Here,

a = uniform vector of same size as source feature
b = uniform vector of same size as target feature
M = loss matrix of the data point between source and target
G = Coupling matrix

2.2 Result analysis

Using webcam and dslr as source and target data respectively, 82.17% accuracy was achieved. On the other hand, considering dslr as source and webcam as target, 73.90% accuracy was achieved. When comparing with the results of subspace alignment method, it can be seen that in the first case, subspace alignment had a better result. For the other case, Sinkhorn-knopp had a better result than subspace alignment.