Motivation & Contribution
1) We study domain adaptation from multiple sources. All data share the same labels (i.e. diagnosis), but the underlying reason for the decision (i.e. cause) may be different in each domain.
2) The training corpus is constructed from only a multiple sources within a large population.
3) We hypothesize that each domain should be similar to a few other domains and share statistical strength, while many other domains are irrelevant (i.e different reasons for outcomes).
4) We propose the Multiple Domain Matching Network (MDMN) to perform unsupervised domain adaptation as well as extract these domain relationships.
5) Theoretical results (in paper) bound the target error using source error and the discrepancy between domains.

Model Framework

Measure the Difference between Domains
- All domains, including sources and target, are denoted as $D_s$, for $s = 1, \ldots, S$.
- We have feature encoder $E(\cdot; \theta_E)$, and a domain discriminator $f_s(\cdot)$ for each domain $s = 1, \ldots, S$.
- Distance between two domains $D_s$ and $D_{s'}$: $d(D_s, D_{s'}) = \max_{f_s(\cdot)} \|f_s(E(x)) - f_s(E(x))\|
- Distance between domain $D_s$ and all other domains $\bar{D}_s$: $d(D_s, \bar{D}_s) = \max_{f_s(\cdot)} |w_s|_2$ with $|w_s|_2 = 1$ and $w_s = 0$.
- The total domain loss function minimizes this pair-wise domain distance with $\lambda_s$ as domain weights (target domain is upweighted) $L_D = -\sum_{s=1}^{S} \lambda_s d(D_s, \bar{D}_s)$

Calculating Domain Weights
- Domain weights $w_s = [w_{s1}, w_{s2}, \ldots, w_{sS}]$ denotes the similarity between domain $D_s$ and all other domains.
- First, calculate $d(D_s, \bar{D}_s')$ for every two domains in the set, including the target. Note that $d_{s1} = d(D_s, D_{s1}) = 0$.
- Second, compute $w_s = \text{softmax}(|d_{s1}, \ldots, d_{sS}|)$.
- Can set a temperature variable in the softmax if desired.
- $w_s$ and parameters of the networks are updated iteratively.

Learned Graph from Domain Weights

Experiments on Digit Dataset
- We use MNIST, MNIST-M, SVHN and USPS datasets.

Experiments on EEG Dataset
- Classification Accuracy

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