Domain Adaptation with Asymmetrically Relaxed Distribution Alignment

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Unsupervised Domain Adaptation:

- Labeled data from **source** domain: \( \{(x_i, y_i)\}_{i=1,...,n} \sim p_S \cdot p_{y|x} \).
- Unlabeled data from **target** domain: \( \{x_i\}_{i=1,...,m} \sim p_T \).
- **Goal**: learn a good **target** domain classifier \( \hat{y}_x = \arg\max_y p_{y|x}(y|x) \) for \( x \sim p_T \).
Domain Adversarial Training (Ganin et al., 2016):

Learn a predictor $\hat{y}_x = h(\phi(x))$ by optimizing:

$$\min_{\phi, h} E_S(\phi, h) + \lambda D(p_S^\phi, p_T^\phi) + \Omega(\phi, h).$$

- **Source domain prediction error**
- **Distance between feature distributions in the latent space**
Problems with domain adversarial training:

- **Fails under label distribution shift.**
  - **We propose to use relaxed distribution alignment.**
- **Not clear how to prevent cross-label matching.**
  - **We drive a general error bound which explains under what assumptions this CANNOT happen.**
Our approach: replace the standard distance between distributions with a relaxed distance:

\[
\min_{\phi, h} \mathcal{E}_S(\phi, h) + \lambda D_\beta(p^\phi_S, p^\phi_T) + \Omega(\phi, h).
\]

- Relaxed Jensen-Shannon Divergence:

\[
D_{f_\beta}(p, q) = \sup_{g: \mathbb{Z} \to [0,1]} \mathbb{E}_{z \sim q} \left[ \log \frac{g(z)}{2 + \beta} \right] + \mathbb{E}_{z \sim p} \left[ \log \left( 1 - \frac{g(z)}{2 + \beta} \right) \right].
\]

- Relaxation for any \( f \)-divergence, Wasserstein distance, etc.
### Experiments - Handwritten Digits

#### Table: MNIST → USPS

<table>
<thead>
<tr>
<th>target labels</th>
<th>[0-4]</th>
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<td>59.5±3.0</td>
<td>66.7±2.1</td>
<td>Source</td>
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#### Table: USPS → MNIST

The number 6 appears on page 8.
Thank You

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