# Coding Test (RA/JRF) - Cross-dataset Applications

**Image Analysis & Computer Vision Lab, EE, IISc Bangalore**

[1]May, 2021

Please include appropriate comments in the script and share your implementation (PyTorch / Keras) through a GitHub repository.

## Question

Let's consider the problem of cross-domain adaptation of a classification model, which consists of a feature-extractor $\mathcal{F}$ (ResNet-18, pre-trained with ImageNet data) and a classifier $\mathcal{C}$ (Linear layer with relevant number of output nodes, initialized randomly), which can classify $C$-number of object categories.
You may consider the PACS-dataset for this experiment. It contains samples of 7-object classes ($C = 7$) from 4-different domains (Image, Art-painting, Sketch and Carton). This dataset can be accessed here. Consider the RGB images as the *Source*-domain samples $\mathcal{S} = \{\mathbf{x}, y\}$ for this problem and the *Target*-domain consists of the unlabeled samples from Sketch-domain, $\mathcal{T} = \{\mathbf{x}\}$.

1. $10\%$ of the Source samples are to be used as the validation set to decide on the best set of model-parameters during training. The test set should contain all the samples from the Target-domain. Both the labeled Source data and unlabeled Target data can be used during training. Please implement the dataloader with transformations required for the input samples during training and evaluation.
2. Please incorporate the following loss functions:
   (a) standard cross-entropy loss computed on the Labeled Source dataset as $\mathcal{L}_{CE}(\mathbf{x}, y)$, for $\mathbf{x} \in \mathcal{S}$.
   (b) weighted cross-entropy loss function computed on the unlabeled Target data, satisfying the condition mentioned here. Let's say the soft-max output for class-$c$ of an input sample $\mathbf{x} \in \mathcal{T}$ is $\sigma_c(\mathbf{x})$. Then, compute:

$$\begin{aligned}
\sigma_{max}(\mathbf{x}) &= \underset{c \in C}{max}\ \sigma_c(\mathbf{x}) \\
y_{pred}(\mathbf{x}) &= \underset{c \in C}{arg\ max}\ \sigma_c(\mathbf{x}) \\
\mathcal{L}_{weighted-CE}(\mathbf{x}) &= \sigma_{max}(\mathbf{x}).\mathcal{L}_{CE}(\mathbf{x}, y_{pred}(\mathbf{x})), \text{if } \sigma_{max}(\mathbf{x}) \geq 0.95 \\
&= 0, \text{ otherwise}
\end{aligned}$$

   (c) entropy loss computed on the unlabeled Target data as $\mathcal{H}(\mathbf{x})$, for $\mathbf{x} \in \mathcal{T}$.
3. The model should be optimized by jointly minimizing the total loss $\mathcal{L} = \lambda_1\mathcal{L}_{CE} + \lambda_2\mathcal{L}_{weighted-CE} + \lambda_3\mathcal{H}$, where $\lambda_j$'s, $j = 1, 2, 3$ are the hyper-parameters, and can be obtained according to the classification accuracy on validation set.
4. Please generate a graph tracking the status of individual loss components as the training progresses.
5. Please report the classification accuracy on the test set.