Laboratory Experience 3 - Mandatory

Task The aim of this experience is to get familiar with the transfer learning techniques discussed in [2].
Specifically, you will have to replicate the results in Figure 2 (a,g) and figure 5, involving four different learning algorithms:

- the no-transfer Weighted Least-Squares SVM (WLS-SVM) baseline
- the Single Knowledge Transfer (KT) baseline
- the Average-KT baseline
- the Multi-KT algorithm

Data The experience makes use of a subset of the Caltech 256 dataset [1], which can be downloaded from:
http://www.idiap.ch/ftp/courses/EE-700/material/experience3/KTcaltech256.tar.gz

The KTcaltech256/data directory contains:

- LBP, PHOG, RECOV, SIFT: every directory includes 18 mat files, each of them containing a $n \times m$ matrix, where n is the number of samples of the object and m is the dimensionality of the image descriptor.
- prior_models_4class.mat, prior_models_6class.mat, prior_models_10class.mat: these three files contains the the prior knowledges for three different class groups:
  1. four unrelated classes
  2. six related classes
  3. ten mixed classes

  as described in the paper.

Code All the code that is necessary to run the experience is included in the KTExperience.m Matlab class, downloadable from:
http://www.idiap.ch/ftp/courses/EE-700/material/experience3/KTExperience.m

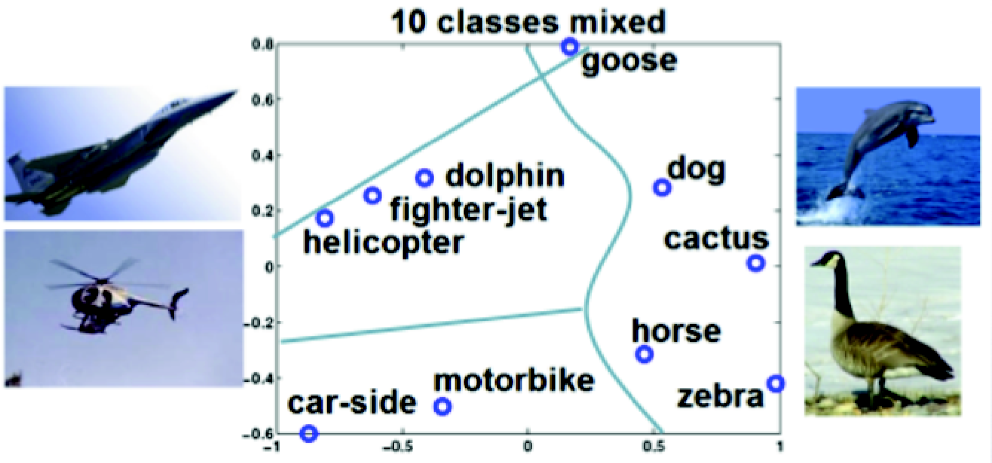
You are asked to complete the code in some relevant points, remembering that:

1. Each line of code to be completed contains a specific suggestion that will be helpful
2. The WLS-SVM problem in eq. (8) of the paper can be easily solved by inverting the matrix
$$G = \begin{bmatrix} K + \frac{1}{C}W & 1 \\ 1' & 0 \end{bmatrix} \tag{1}$$
3. The Single-KT optimization problem in eq. (10) can be solved using the matricial form:
$$\begin{bmatrix} K + \frac{1}{C}W & 1 \\ 1' & 0 \end{bmatrix} \begin{bmatrix} \alpha \\ b \end{bmatrix} = \begin{bmatrix} y - \beta w \cdot \Phi(X) \\ 0 \end{bmatrix} \tag{2}$$
where $\Phi(X)$ represents the matrix of training points in feature space
4. The solution of the Multi-KT optimization problem in eq. (11) can be found by solving the system:
$$\begin{bmatrix} K + \frac{1}{C}W & 1 \\ 1' & 0 \end{bmatrix} \begin{bmatrix} \alpha \\ b \end{bmatrix} = \begin{bmatrix} y - \sum_j \beta_j w_j \cdot \Phi(X) \\ 0 \end{bmatrix} \tag{3}$$
5. the Multi-KT optimal solution w^* is of the form:
$$w^* = \sum_i \alpha_i \phi(x_i) + \sum_j \beta_j w_j \tag{4}$$

Experiments Use the developed code to run each experiment ten times, on ten different training/testing splits. Moreover, instead of plotting the results using only up to 6 samples of the target class for training, plot the results obtained with up to 30 target training samples / class. Finally, use the method:

```
KTExperience.plotClassDistance(beta,classes)
```

to plot, for each experiment, a class similarity map, similar to this:



Comment the results w.r.t. the computational costs and the benefits w.r.t. the baselines.

References

[1] G. Griffin, A. Holub, and P. Perona. Caltech-256 object category dataset. Technical Report 7694, California Institute of Technology, 2007.

[2] T. Tommasi, F. Orabona, and B. Caputo. Safety in numbers: Learning categories from few examples with multi model knowledge transfer. In *Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on*, pages 3081–3088. IEEE, 2010.