Department of Engineering/Informatics, King's College London
Pattern Recognition, Neural Networks and Deep Learning (7CCSMPNN).
Assignment: Support Vector Machines (SVMs)

This coursework is assessed. A type-written report needs to be submitted online through KEATS by the deadline specified on the module's KEATS webpage. In this coursework, we consider a classification problem of 3 classes. A multi-class SVM-based classifier formed by multiple SVMs is designed to deal with the classification problem.

Q1. Write down your 7-digit student ID denoted as $s_1s_2s_3s_4s_5s_6s_7$. (5 Marks)

Q2. Find R_1 which is the remainder of $\frac{s_1+s_2+s_3+s_4+s_5+s_6+s_7}{4}$. Table 1 shows the multi-class methods to be used corresponding to the value of R_1 obtained. (5 Marks)

R_1	Method
0	One against one
1	One against all
2	Binary decision tree
3	Binary coded

Table 1: R_1 and its corresponding multi-class method.

Q3. Create a linearly separable two-dimensional dataset of your own, which consists of 3 classes. List the dataset in the format as shown in Table 2. Each class should contain at least 10 samples and all three classes have the same number of samples. *Note: This is your own created dataset. The chance of having the same dataset in other submissions is slim. Do not share your dataset with others to avoid any plagiarism/collusion issues.* (10 Marks)

Sample of Class 1	Sample of Class 2	Sample of Class 3
⋮	⋮	⋮
⋮	⋮	⋮

Table 2: Samples of three classes.

Q4. Plot the dataset in Q3 to show that the samples are linearly separable. **Explain why your dataset is linearly separable.** *Hint: the Matlab built-in function* `plot` *can be used and show some example hyperplanes which can linearly separable the datasets. Identify which hyperplane is for which classes.* (20 Marks)

Q5. According to the method obtained in Q2, draw a block diagram at SVM level to show the structure of the multi-class classifier constructed by linear SVMs. Explain the design (e.g., number of inputs, number of outputs, number f SVMs used, class label assignment, etc.) and describe how this multi-class classifier works.

Remark: A blocking diagram is a diagram which is used to, say, show a concept or a structure, etc. Here in this question, a diagram is used to show the structure of the multi-class SVM classifier, i.e., how to put binary SVM classifiers together to work as a multi-class SVM classifier. For example, Q5 of tutorial 8 is an example of a block diagram at SVM level. Neural network diagram is a kind of diagram to show its structure at neuron level. The block diagrams in lecture 9 are to show the architecture of ensemble classifier, etc. (20 Marks)

Q6. According to your dataset in Q3 and the design of your multi-class classifier in Q5, identify the support vectors of the linear SVMs **by "inspection"** and design their hyperplanes **by hand**. Show the calculations and explain the details of your design. (20 Marks)

Q7. Produce a test dataset by averaging the samples for each row in Table 2, i.e., (sample of class 1 + sample of class 2 + sample of class 3)/3. Summarise the results in the form of Table 3, where N is the number of SVMs in your design and "Classification" is the class determined by your multi-class classifier. Explain how to get the "Classification" column using one test sample. Show the calculations for one or two samples to demonstrate how to get the contents in the table. (20 Marks)

Test Sample	Output of SVM 1	$\cdots$	Output of SVM N	Classification
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$

Table 3: Summary of classification accuracy.

Marking: The learning outcomes of this assignment are that student understands the fundamental principle and theory of support vector machine (SVM) classifier; is able to design multi-class SVM classifier for linearly separable dataset and knows how to determine the classification of test samples with the designed classifier. The assessment will look into the knowledge and understanding on the topic. When answering the questions, show/explain/describe clearly the steps/design/concepts with reference to the equations/theory/algorithms (stated in the lecture slides). When making comments (if necessary), provide statements with the support from the results obtained.

Purposes of Assignment: This assignment provides the overall classification idea from samples to design to classification. It helps you to make clear the concept, working principle, theory, classification of samples, design procedure and multiple-class classification techniques for SVM.