**Problem 4: Questions and Answers (25%)**

1. (5%) Given a trained classifier for 4 object classes (C1, C2, C3, C4), an input data belongs to C2 generates (0.15, 0.7, 0.1, 0.05) output likelihood, what are the corresponding loss values (L1 loss, L2 loss and cross-entropy loss.) associated with this data?

Y\_pred = {0.15, 0.7, 0.1, 0.05}

Y\_true = {0, 1, 0, 0}

L1 = sum\_{i:1~N}|y\_true - y\_pred| = |0.15 - 0| + |0.7-1| + |0 - 0.1| + |0-0.05| = ?

Ans:

2. (5%) Given the **confusion matrix** of this 4-class classifier

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Predicted Classes** | | | | |
| **Actual Classes** |  | *C1* | *C2* | *C3* | *C4* |
| *C1* | 68 | 12 | 9 | 11 |
| *C2* | 14 | 74 | 5 | 7 |
| *C3* | 12 | 3 | 82 | 3 |
| *C4* | 6 | 10 | 12 | 72 |

Please compute the overall average accuracy. Followed by per class precision and recall, F1 score of C4, and the micro-average precision of all 4 classes.

Ans:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *C1* | *C2* | *C3* | *C4* |
| TP |  |  |  |  |
| TN |  |  |  |  |
| FP |  |  |  |  |
| FN |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *C1* | *C2* | *C3* | *C4* |
| Precision, |  |  |  |  |
| Recall, |  |  |  |  |
| F1-score, |  |  |  |  |

3. (5%) Multiple Linear Regression: Given the following dataset with one response variable and two predictor variables and :

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 140 | 60 | 22 |
| 155 | 62 | 25 |
| 159 | 67 | 24 |
| 179 | 70 | 20 |
| 192 | 71 | 15 |
| 200 | 72 | 14 |
| 212 | 75 | 14 |
| 215 | 78 | 11 |

Please find the linear regression model, i.e., determine the linear regression coefficients, , and based on least squares solution.

4. (5%) Explain what is Support Vector Machine (SVM) (3%), and when and how do we use nonlinear SVM (Hint: Kernel Trick) (2%)?

Ans:

1. Support vector machine is a model that finding a separating hyperplane so that the distances of support vectors of the classes-to-separate to the hyperplane, i.e., margin, satisfy the requirement.
2. Nonlinear SVM is used when the input space can be mapped to some “implicitly” higher-dimensional feature space via nonlinear mapping, making the training set is more separable. To use the nonlinear SVM, we can define a kernel function which is nonlinear and corresponds to the dot product of two feature vectors in some expanded feature space.

5. (5%) Explain what are discriminative and generative classifiers?

Discriminative classifiers are the models that requires all the training examples of different classes to be jointly used to build the model up. General classifiers are the models that have to be trained independently on only the examples of the same label.