

Introduction to Machine Learning
Lab Assignment 4: Classification Using Hand-Crafted
Features and Neural Networks

Due March 20, 2018 at 11:59pm

1. **Classification Using Hand-Crafted Features [70 points]:** You will compete with the members in your class on a challenge to predict whether a visual question is answerable. For this task, you are required to create a multi-modal (computer vision + natural language processing) classification system. In this case, this means you must use a combination of image-based and language-based features.
 - (a) You must use the VizWiz dataset with its pre-defined train/validation/test split. You can find the dataset at the following [link](#) and the paper describing the dataset at the following [link](#).
 - (b) Define a feature representation for each visual question that uses at least:
 - i. Image-based features extracted using the Microsoft Azure API
 - ii. Question-based features extracted using the Microsoft Azure API
 - (c) You can use any transformations (e.g., feature dimension reduction techniques) and classification models (e.g., SVM, ensemble) of your choice to train your system to predict whether a visual question is answerable using the input features. For full credit, you need to train using at least 100 training visual questions. (Code)
 - (d) You must submit the test prediction results from your classification system for the first 30 examples in the test split: i.e.,
VizWiz_test_000000020000.jpg – VizWiz_test_000000020029.jpg. (Code)
 - (e) Write 2-4 paragraphs describing you proposed prediction method and why you chose your design (e.g., initial analysis on the training set). Describe the implementation of your proposed approach in such a way that a 1) reader could reproduce your set-up and 2) understand why you made your design decisions.
 - (f) Extra credit 1: the first place winner of this challenge will receive 10 extra points and the second place of this challenge will receive 5 extra points.
 - (g) Extra credit 2: receive 5 extra credit points if you use additional feature extraction methods tools not taught in class and discuss the motivation for using those additional language-based or image-based features in your write-up (e.g., features extracted using scikit-image, OpenCV, NLTK, etc).
2. **Classification Using Neural Networks [30 points]:**
 - (a) Load MNIST and create a 70/30 train/test split. (Code)
 - (b) Optimize hyperparameters: find the optimal number of hidden layers (at least 10 different values) and number of neurons per layer (at least 10 different values) when training a multilayer perceptron (MLP). Set all other parameters constant when training; e.g., activation function, number of iterations for training, batch size, and gradient descent approach. (Code)
 - (c) Report the optimal hyperparameters you found and the number of weights that are in this optimal model. (Write-up)
 - (d) Write a discussion about the performance of the neural network when using different hyperparameters. For example, what number of hidden layers and neurons per layer did better/worse and why do you think so? Your discussion should consist of two to four paragraphs. (Write-up)

How to Submit Lab Assignment 4: Please submit a pdf that provides hyperlinks to your code or answers to the questions, as deemed appropriate for the task. The pdf file should be named using your first and last name; i.e., `firstname.lastname.pdf`. The material you submit must be your own.