

BBM 416 – Fundamentals of Computer Vision - 2020
Midterm Exam
May 6, 2020

Problem	Points	Grade
1	25	
2	25	
3	25	
4	25	
Total	100	

Name: _____

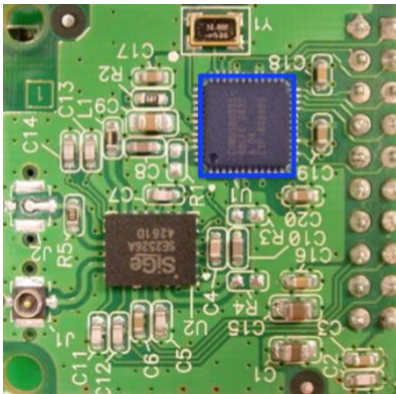
Student ID: _____

INSTRUCTIONS

- **Collaboration of any kind is strictly forbidden.**
- **Sharing exam questions/answers during and after the exam is not allowed.**
- You are only allowed to use your own notes and lecture slides during the exam.
- The exam includes 4 multi-part questions on 4 pages. You have **60** minutes.
- Show all work, as partial credit will be given. You will be graded not only on the correctness and efficiency of your answers, but also on your clarity which you express it. Be neat.
- Write the algorithms in bulleted form.
- **GOOD LUCK!**

1. Line fitting [25 pts]

Suppose we want to locate the largest rectangular component in a given electronic circuit. Example images are given below. Write the algorithm for such a region detection task.



2. Logo Matching [25pts]



Given Example Logo:

Example images to search:



You are asked to develop a vision algorithm to detect the given logos in a set of existing images. For example, given a logo image like the "Carrefour logo", your algorithm is expected to find the location of the logos on the images like the examples above. Note that the logos in the images can be in different orientations, scales and can be partially occluded. Your algorithm should be robust to such cases.

Describe the steps of such a logo finding algorithm.

3. Recognition – Bag-of-words [25pts]

Suppose you have two recognition tasks, with two different datasets, such that

Task 1: There are two classes. There are 50 images from each class, a total of 100 images. The task is to assign a new image to any of these two classes.

Task 2: There are 100 classes, 1000 images in each class, with a total of 100000 images. The task is to assign a new image to any of the 100 classes.

You are asked to construct **bag-of-words** models for each of these tasks. Note that your boss demands you to use **k-NN classifier** as the recognition model.

- a) List the hyperparameters (*the parameters that you set before training*) that will be used for these tasks and briefly describe them. [6pts]
- b) How would you choose these hyperparameters in different tasks? What are the important points to consider? Discuss about their effects on the expressivity, robustness and the accuracy of the final recognition model. [14 pts]
- c) How can these two tasks benefit from each other while forming the recognition models? Explain. [5pts]

4. CNN [25 pts]

Design a Convolutional Neural Network (CNN), according to the following criteria:

Input Image Size: 28x28x3

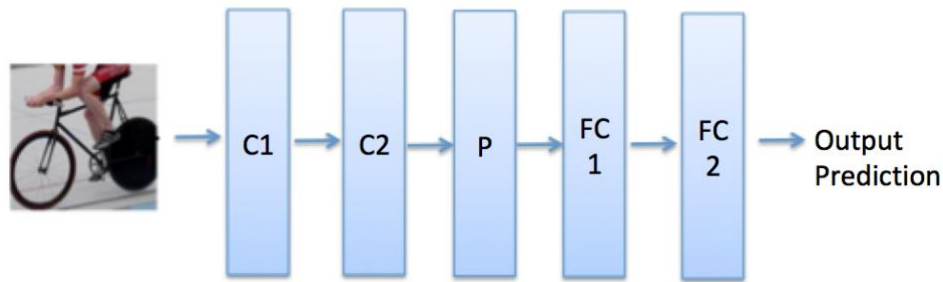
Number of convolution layers: 2 (Layer names: C1, C2)

Number of fully connected layers: 2 (Layer names: FC1, FC2)

Pooling Layer P: MAXPOOL with 3x3 filters and stride =2

Number of output classes: 5

Here is the overall architecture, indicating the ordering of the layers.



You are free to choose the hyperparameters (like size of the filters, number of filters, etc.) given that they are compatible (*Türkçesi: uyumlu*) with the given values. Draw and fill the following tables, based on your own decisions on hyperparameters. Make sure that all the dimensions are compatible with each other in your architecture. Note that C2's output size is given and pooling layer's (P's) hyperparameters are given. Make sure you set the other dimensions accordingly.

Layer	Filter Dimensions (WxHxD)	Output Size (WxHxD)	Number of Filters	Stride	Amount of Zero-padding	Number of parameters that will be estimated (exclude bias)
C1						
C2		5x5x20				

Layer	Input Size (Nx1)	Output Size	Number of Neurons	Stride	Amount of Zero-padding	Number of parameters that will be estimated (exclude bias)
FC1						
FC2						

Note: In this question, there is not a unique correct answer. There are a lot of possible hyperparameter combinations that will be compatible. You are asked to choose one suitable set of hyperparameters.