. Student Name:..... PID or NID:.....

CAP 4453 (face-to-face) ROBOT VISION PracticeTest 75 points

1. (17 points) In the ADABoost procedure (not the cascade procedure), suppose there are 2 positive and 2 negative training images, and there are 3 features (experts). The table below shows how the experts do on the examples (V means correct, X means wrong). For the questions below, if you wish, you can leave all answers in fractions, not wasting time trying to get real numbered answers.

	Expert 1	Expert 2	Expert 3
Face 1	V	X	X
Face 2	X	V	V
Non-Face 1	X	V	V
Non-Face 2	V	X	V

a) At the beginning of $t = 1$, what will the weights attached to the training images be (please write down four answers)?

b) During $t = 1$, the error for each expert is computed. Write down these three numbers (first Expert 1, then Expert 2, then Expert 3).

c) Which expert will be chosen at $t = 1$?

d) At the end of $t = 1$, the weights of the training images are updated. First calculate and write *Beta*, and then write down the four new weights (first Face 1, then Face 2, ... till Non-Face 2). You can keep them as fractions.

e) At the beginning of $t = 2$, the training images' weights are normalised. You can write each of these four new normalised weights as a fraction quantity. It is OK to write out denominator as a whole sum, (with plus-symbols, etc).

f) Write (possibly long) expressions for the error for each expert computed at $t = 2$.

g) Get a final number for each expression above; then, based on these final numbers, state which one of Experts 1, 2, or 3 will be selected at $t = 2$.

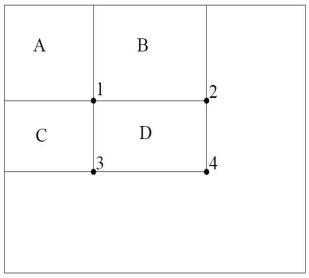
2. (2 points) State three possible project topics (give the title for each of three research papers) for this class.

3. (4 points) In words and with small figures, describe how to construct an "expert" that will say 'yes' or 'no'; the expert must be based on performing convolution. (Hint: one figure shows how to separate the resulting histogram numbers from the two types of training).

4. (2 points) Using the following figure and the concept of the integral image (I.I.), write down what is the simplified computation (in terms of letters) for

$$2 + (4 - 3 - 2 + 1) - (2 + 3).$$

(ASSUME that a number means the I.I. at that number's location)



5. (3 points) Suppose a cascade system is training with 2000 faces and 2000 non-faces. Suppose the requirements for each Team are a False Positive Rate of 30 percent, and a Missed Detection Rate of 0.1 percent. Supposing our teams are titled Team 1, Team 2, Team 3, etc. After the system is fully trained, and is being tested with the Training data, how many faces and non-faces will make it to be tested by Team 3?

6. (2 points) What are the two formulas used to compute Canny's X-mask and Y-mask?

7. (4 points) Sketch the Sobel edge detection method, but also include the actual numbers used in the final convolution masks.

8. (5 points) Suppose the Canny Direction (of gradient) and Magnitude (of gradient) images are as in the array below; indicate all pixels that will be selected as peaks.

0	0	0	0	0	0
0	|, 13	\, 3	-, 23	|, 3	0
0	|, 13	/, 23	\, 23	|, 23	0
0	-, 13	\, 35	\, 23	\, 13	0
0	\, 15	|, 23	|, 23	-, 23	0
0	0	0	0	0	0

9. (5 points) Suppose the Canny Magnitude of gradient is:

5	0	0	0	0	0
9	13	3	23	3	7
9	13	23	23	23	7
9	13	35	23	13	7
9	15	23	23	23	7
0	0	0	0	0	0

Suppose the Peaks array is as below, and HI is 30, and LO is 20. Mark the positions in Peaks that will be in FINAL.

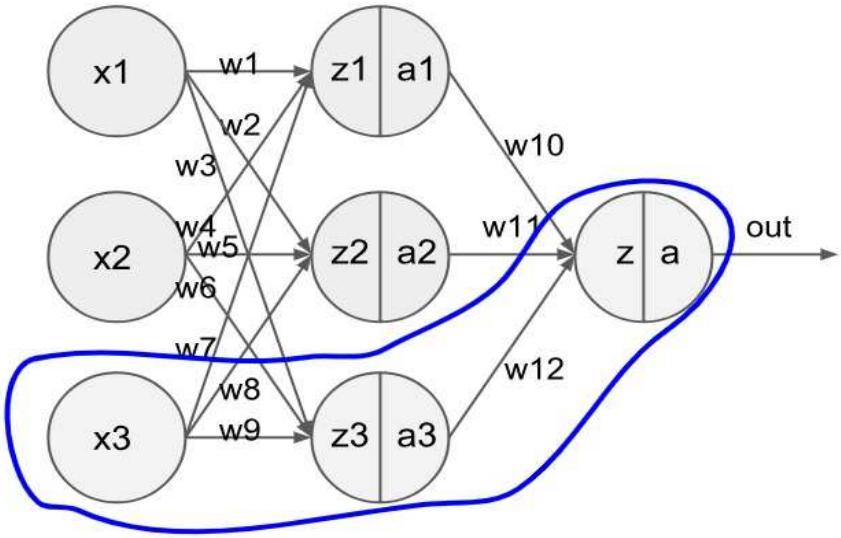
0	0	0	0	1	0
0	1	0	1	0	0
0	1	0	0	0	0
0	1	1	1	1	0
0	0	0	0	1	0
0	0	0	0	0	0

10. (4 points) Consider the following neural network with 3 inputs x_1, x_2, and x_3, 1 hidden layer with 3 neurons and a single neuron in the output layer. Weight parameters in the network are denoted as w_1, w_2, ..., w_n.

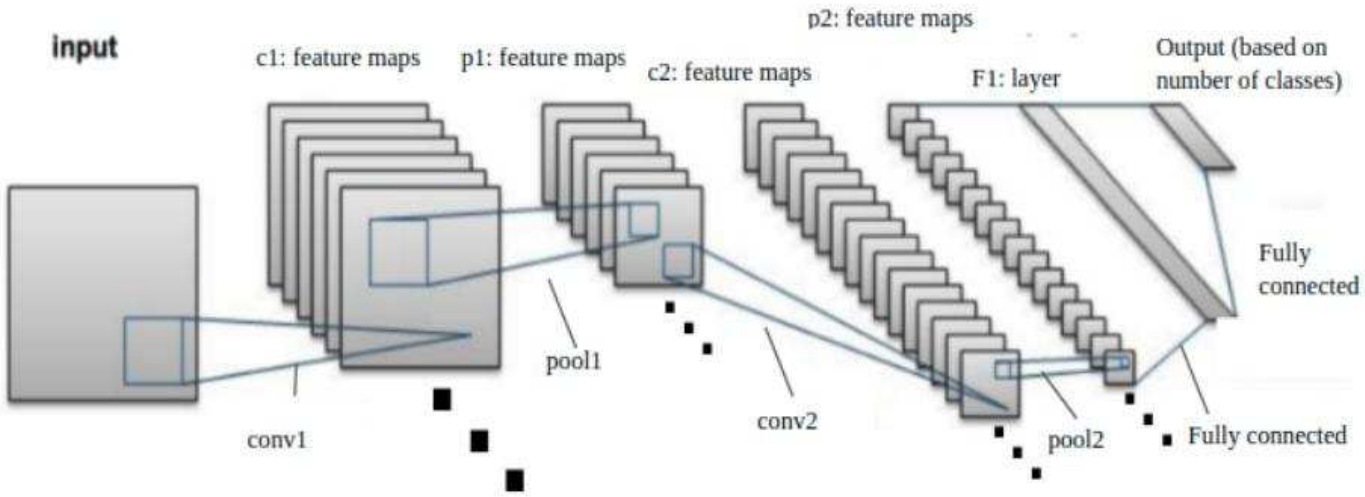
    Write down the partial derivatives (using chain rule) for nodes in the highlighted subgraph, i.e., $\partial \mathrm{E}/\partial w_{12}$ and $\partial \mathrm{E}/\partial w_9$.

    Where E_{total} is the sum squared error.

$$E_{total} = \sum (1/2)\ (target - output)^2$$



11. (6 points) Note: In the figure below, 3 dots means the number of maps will be specified in the sentences.



Given:

- Size of input image to the network is 48x32x1. (**W** x **H** x **D**)
- Conv1 - Number of filters = 10, filter size = (5,5,1), stride = 1, padding = 2
- Pool1 - filter size (2,2), stride = 2, padding = 0
- Conv2 - Number of filters = 24, filter size = (3,3,**X1**), stride = 1, padding = 0
- Pool2 - filter size (2,2), stride = 2, padding = 0
- F1 layer - 120 Neurons

Helpful formulas: **In formulas below, W is width of array, H is height of array, F is filter size (assumed to be same as its width and height), P is padding, S is stride.**

- After conv layer operation, the width of feature maps is given as **(W-F+2P)/S + 1**.
- After conv layer operation, the height of feature maps is given as **(H-F+2P)/S + 1**.
- After pooling layer operation, the width of feature maps is given as **(W-F)/S + 1**.
- After pooling layer operation, the height of feature maps is given as **(H-F)/S + 1**.

Answer the following questions:

- What would be the dimensions of feature maps after conv1 operation? _____
- What would be the dimensions of feature maps after pool1 operation? _____
- Determine the value of **X1** in conv2 filter? _____
- What would be the dimensions of feature maps after pool2 operation? _____
- What would be the size of feature vector after **flattening** operation? _____
- Calculate number of weight parameters between flattened layer and hidden layer? (How many?) _____

12. (2 points) In the figure (for the previous question), if x1, x2, x3, w1, w4, w7 has values 1, 2, 3, 1, 1, 1, respectively ; and the activation function that takes Z1 and produces a1 is the reLU function, what is the value of a1?

13. (2 points) a) what is the derivative of the sigmoid function? b) describe One-Hot encoding?

14. (4 points) State the detailed steps that show that the equation $-I_t = uI_x + vI_y$ is merely encoding the velocity component that is perpendicular to the edge.

15. (4 points) State the calculations needed to get the complete 2-d optical flow (u, v) by using measurements at three or more points.

16. (2 points) Give eight cases where the optical flow calculations will fail (i.e., optical flow will either be computed incorrectly or will not be computed).

The End