1. (2 points) State three possible project topics (give the title for each of three research papers) for this class.

2. (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 \( w_1, w_2, \ldots, w_n. \)

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

Where \( E_{\text{total}} \) is the sum squared error.

\[
E_{\text{total}} = \sum (1/2) \text{(target - output)}^2
\]
3. (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. \((W \times H \times D)\)
- 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?) __________
4. (2 points) In the figure above (for the question that is two above), 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?

5. (2 points) a) what is the derivative of the sigmoid function? b) describe One-Hot encoding?

6. (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.

7. (4 points) State the calculations needed to get the complete 2-d optical flow \((u,v)\) by using measurements at three or more points.

8. (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