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HW5 — Neural Network

1 Neural Network

1. For each problem below, state which dimensions d, d_H, d_o are determined by the problem, and state the value of each of those dimensions. Similarly, state whether the activation function $g_H(\cdot)$ or $g_o(\cdot)$ is determined by the problem, and if it is determined, state what it should be.

   (a) One wants a neural network that takes a 32×32 RGB-format image and determines which alphanumeric letter (from 'a' through 'z' and '0' through '9') the image depicts.

   (b) Suppose that you are presented with a paragraph of 128 tokens given by a writer. One wants a network that determines whether the writer is happy or sad.

   (c) You want a neural network that predicts the future GPS coordinate pair of a watch given 20 past GPS coordinate pairs.

2. Design a MLP neural network to solve the house price prediction problem (using the same data set we have been using for the first half of the semester). Take all 6 X features as the input and the house price as the output. Use no more than 3 hidden layers. Each hidden layer can have no more than 30 units. Use ReLU as the activation function.

   (a) Show me your code (data loading & normalization, network structure, and training). Use the "NeuralNetwork.ipynb" as an example.

   (b) How many hidden layers does your MLP model have? How many units does each hidden layer have?

   (c) What is your learning rate? What is your batch size? How many training epochs did you have?

   (d) How many parameters does your MLP model have? Why? Show me the calculation process.

   (e) Is your trained model better than, the same with, or worse than the `Multiple Linear Regression` solution you had from your previous homework submission? Why?

3. Take the "MNIST.ipynb" as a start point:

   (a) Execute the given code using torch and `nn.Sequential` model to train a neural network. What is your testing accuracy? (Just tell me a number, no need to show the code, this is for your own convenience to make sure you can run the code)

   (b) Modify the code to train the same model with the test data, and evaluate the accuracy using the training data. What is your accuracy? Show me your modifications (i.e., only the lines of programs that are different from my given code).

   (c) Consider the following modification of the data set: for every hand written digit image, suppose the corresponding digit is $i \in \{0, \dots, 9\}$, change its label (y) to $i\%2$ (i.e., $\mod(i, 2)$).

      - Show me your code that modifies `y_train` and `y_test` to align with the data set modifications.
      - Using the same MLP provided in the "MNIST.ipynb", what minimum change should you make to have the model work with the modified data set (i.e., what is your number of outputs)?
      - What are the one hot encoded outcomes of the labels in the modified data set?

   (d) Modify your train data set such that **there are only 10 images left with the label being 3, and 10 images left with the label being 9**.

      - Show me your code that makes the above modification.

- Using the same MLP provided in the "MNIST.ipynb", and train the model with the modified data set. Evaluate your model's performance with the testing data set. Your model should be performing worse than the original model. **Describe** what changes you could make to improve the model's performance given the modified data set? Undoing your above data set modifications cannot be a solution. Do not include your code, but you are welcome to use experiments or other analyses to help deriving your answer to this question.

Submitted by Bowen Weng on .