

ECE472 - Deep Learning: Assignment 3

Authors

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Notes

There are two functions containing two separate neural networks to predict MNIST data. The first one, *proven_case* has an "overly-safe" convolutional neural network that has greater than a 95.5% prediction percentage on testing data. The second function, *less_parameters_case* should not be considered, as I ran out of time to properly implement anything. I would have liked to attempt the following to reduce the number of parameters: only selecting a small chunk of the image (perhaps a 3x3 square in the middle) and using that as an input. Additionally, I would have attempted to "predict" based off of 1 output, rather than 10, such that the output was a float in the range of zero to nine, and the prediction was just the closest integer to that decimal. This would prevent the need for having a 10 output system that automatically has at least 10 weights. Please note, this is just something I thought about, but not in great detail - it could be completely wrong.

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1  '''
2  Alexander Koldy
3  ECE 472 - Deep Learning
4  Assignment 3: Classify MNIST digits with a
5  (optionally convoultional) neural network.
6  Get at least 95.5% accuracy on the test test.
7  '''
8
9  import numpy as np
10 import matplotlib.pyplot as plt
11 import tensorflow as tf
12 import gzip
13
14 class Data():
15     def __init__(self):
16         '''Training, validation, and testing data parameters'''
17         self.image_shape = (28, 28)
18         self.num_training = 50000
19         self.num_validation = 10000
20         self.num_testing = 10000
21
22     def load_data(self, training_data_path, training_label_path,
23 testing_data_path, testing_label_path):
24         training_data = gzip.open(training_data_path, 'r')
25         training_labels = gzip.open(training_label_path, 'r')
26         testing_data = gzip.open(testing_data_path, 'r')
27         testing_labels = gzip.open(testing_label_path, 'r')
28         training_data.read(16)
29         training_labels.read(8)
30         testing_data.read(16)
31         testing_labels.read(8)
32
33         '''Establish training and validation data'''
34         training_data =
35 np.frombuffer(training_data.read(self.image_shape[0]*self.image_shape[1]*
36 (self.num_training + self.num_testing)), dtype=np.uint8).astype(np.float64)
37         training_data = training_data.reshape(self.num_training +
38 self.num_validation, self.image_shape[0], self.image_shape[1], 1)
39         new_order = np.random.permutation(self.num_training +
40 self.num_validation)
41         training_data = training_data[new_order, :, :, :]
42         self.validation_data = training_data[50000:, :, :, :]
43         self.training_data = training_data[:50000, :, :, :]
44
45         '''Establish training and validation labels'''
46         training_labels = np.frombuffer(training_labels.read(self.num_training +
47 self.num_validation), dtype=np.uint8).astype(np.float64)
48         training_labels = training_labels[new_order]
49         self.validation_labels = training_labels[50000:]
50         self.training_labels = training_labels[:50000]
51
52         '''Establish testing data'''
53         testing_data =
54 np.frombuffer(testing_data.read(self.image_shape[0]*self.image_shape[1]*self.
55 num_testing), dtype=np.uint8).astype(np.float64)
56         testing_data = testing_data.reshape(self.num_testing,
57 self.image_shape[0], self.image_shape[1], 1)
58         self.testing_data = testing_data
59

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52     '''Establish testing labels'''
53     testing_labels = np.frombuffer(testing_labels.read(self.num_testing),
dtype=np.uint8).astype(np.float64)
54     self.testing_labels = testing_labels
55
56     #print(self.training_labels[107])
57     #image = np.asarray(self.training_data[107]).squeeze()
58     #plt.imshow(image)
59     #plt.show()
60
61     '''
62 Network that gets >= 95.5% accuracy not test case
63     '''
64 def proven_case():
65     '''Create data'''
66     training_data_path = 'data/train-images-idx3-ubyte.gz'
67     training_label_path = 'data/train-labels-idx1-ubyte.gz'
68     testing_data_path = 'data/t10k-images-idx3-ubyte.gz'
69     testing_label_path = 'data/t10k-labels-idx1-ubyte.gz'
70
71     data = Data()
72     data.load_data(training_data_path, training_label_path, testing_data_path,
testing_label_path)
73
74     '''Establish Convolutional Neural Network'''
75     model = tf.keras.models.Sequential()
76     model.add(tf.keras.layers.Conv2D(filters=28, kernel_size=(3, 3),
activation='relu', input_shape=(28, 28, 1),
kernel_regularizer=tf.keras.regularizers.l2(0.01)))
77     model.add(tf.keras.layers.MaxPooling2D((2, 2)))
78     model.add(tf.keras.layers.Conv2D(filters=56, kernel_size=(3, 3),
activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01)))
79     model.add(tf.keras.layers.MaxPooling2D((2, 2)))
80     model.add(tf.keras.layers.Conv2D(filters=56, kernel_size=(3, 3),
activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01)))
81     model.add(tf.keras.layers.Dropout(0.2))
82     model.add(tf.keras.layers.Flatten())
83     model.add(tf.keras.layers.Dense(56, activation='relu'))
84     model.add(tf.keras.layers.Dense(10, activation='softmax'))
85
86     '''Training/Validation'''
87     model.compile(optimizer='Adam', loss='sparse_categorical_crossentropy',
metrics=['accuracy'])
88
89     print("Training/Validation Data!")
90     history = model.fit(data.training_data, data.training_labels, epochs=3,
validation_data=(data.validation_data, data.validation_labels))
91
92     '''Testing'''
93     print("Testing Data!")
94     history = model.evaluate(data.testing_data, data.testing_labels)
95
96     '''Check summary'''
97     model.summary()
98
99     '''
100 Attempt at using less parameters. NOT WORKING right now, since its not
technically part
101 of the assignment (just a bonus), there is no reason to look at this
102     '''

```

```
103 def less_parameters_case():
104     '''Create data'''
105     training_data_path = 'data/train-images-idx3-ubyte.gz'
106     training_label_path = 'data/train-labels-idx1-ubyte.gz'
107     testing_data_path = 'data/t10k-images-idx3-ubyte.gz'
108     testing_label_path = 'data/t10k-labels-idx1-ubyte.gz'
109
110     data = Data()
111     data.load_data(training_data_path, training_label_path, testing_data_path,
112                   testing_label_path)
113
114     '''Establish Convolutional Neural Network'''
115     model = tf.keras.models.Sequential()
116     model.add(tf.keras.layers.Dense(1, activation='softmax'))
117
118     '''Training/Validation'''
119     model.compile(optimizer='Adam', loss='sparse_categorical_crossentropy',
120                  metrics=['accuracy'])
121
122     history = model.fit(np.reshape(data.training_data, (data.num_training,
123                                                         28*28)).mean(1), data.training_labels, epochs=1, validation_data=
124                        (np.reshape(data.validation_data, (data.num_validation, 28*28)).mean(1),
125                          data.validation_labels))
126
127     '''Testing'''
128     history = model.evaluate(np.reshape(data.testing_data, (data.num_testing,
129                                                             28*28)).mean(1), data.testing_labels)
130
131     '''Check summary'''
132     model.summary()
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134 proven_case()
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Epoch 1/3
1563/1563 [=====] - 16s 10ms/step - loss: 0.9506 - accuracy: 0.9060 - val_loss: 0.3912 - val_accuracy: 0.9796
Epoch 2/3
1563/1563 [=====] - 15s 10ms/step - loss: 0.2997 - accuracy: 0.9705 - val_loss: 0.2013 - val_accuracy: 0.9773
Epoch 3/3
1563/1563 [=====] - 15s 10ms/step - loss: 0.1747 - accuracy: 0.9764 - val_loss: 0.1325 - val_accuracy: 0.9822
Testing Data!
313/313 [=====] - 1s 3ms/step - loss: 0.1260 - accuracy: 0.9829
```