

Second Progress Report

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A) Current Goals

Currently, we are trying to further study CNNs, or convolutional neural networks, and test the full extent of their use in classification problems. However, instead of going down the standard road of image classification, we are trying to do something different. Our matrices have an extra dimension, time, as we are now working on classification of videos. The TensorFlow library is still being used extensively, but as CNNs for 4-D classification have not been used much in the past, several key functions have to be written by ourselves. Another problem we encountered with this is that for videos to be classified to specific categories/labels, they all have to be, to a certain degree, uniform. With that in mind, we chose to use fMRI clips. We wish to be able to diagnose a patient as autistic or not autistic based solely off of the software's analysis on the fMRI clips.

B) Current Work

Each fMRI clip is a $64 \times 64 \times 40 \times 300$ clip. The first three dimensions are spatial, and the last is temporal. An immediate challenge that is presented here is that in a classic image classification problem, although the images **are** three dimensional, the third dimension was color channels and not depth. This would mean that we would have to reshape all of our clips into matrices of dimension $64 \times 64 \times 1 \times 40 \times 300$ instead for better results. There are several problems with this however. First of all, reshaping a matrix with near 50,000,000 entries is not a task that a computer can do in a fast amount of time. Even with clever manipulations of list slicing and redeclarations of portions of the matrix in Python, this is still a lengthy process. Second, TensorFlow does not support convolution and pooling operations over input data that is 5 - D. This problem is not as troublesome though, as we can write custom functions as the work progresses. Another problem we encountered is the order of the dimensions of the data. In NIFTI format, the first three dimensions are spatial and the last is temporal. However, for a convolutional network, filters extend through the depth of the input (the last dimension) and are through a small spatial size. This means that we need our input to actually be in the form $300 \times 64 \times 64 \times 40$. Here again we encounter the problem of reshaping a matrix with 50,000,000 entries, which is no easy problem.

C) Code/Network Layout

The entire script for the classification is over 250 lines long, so it is hard to go through all the details in a succinct matter, but we can focus on the main convolution and pooling methods, as well as the overall layer of the network.

```
def conv3d(x, W):  
    return tf.nn.conv3d(x, W, strides=[1, 1, 1, 1, 1], padding='SAME')  
  
def max_pool_2x2(x):  
    return tf.nn.max_pool3d(x, ksize=[1, 2, 2, 1, 1],  
                             strides=[1, 2, 2, 1, 1], padding='SAME')
```

Our convolution function is having a stride of 1 among every single dimension (the first dimension being the index of the input clip). Our pooling is doing 2×2 pooling over the x and y dimensions of the clip and retaining information in all other dimensions.

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5 W_conv1 = weight_variable([5, 5, 40, 300, 64])
6 b_conv1 = bias_variable([64])
7 x_image = tf.reshape(x, [-1, 64, 64, 40, 300])
8 h_conv1 = tf.nn.relu(conv3d(x_image, W_conv1) + b_conv1)
9 h_pool1 = max_pool_2x2(h_conv1)
10
11
12 W_conv2 = weight_variable([5, 5, 1, 64, 128])
13 b_conv2 = bias_variable([128])
14
15 h_conv2 = tf.nn.relu(conv3d(h_pool1, W_conv2) + b_conv2)
16 h_pool2 = max_pool_2x2(h_conv2)
17
18 W_fc1 = weight_variable([13 * 13 * 128, 4096])
19 b_fc1 = bias_variable([4096])
20
21 h_pool2_flat = tf.reshape(h_pool2, [-1, 13 * 13 * 128])
22 h_fc1 = tf.nn.relu(tf.matmul(h_pool2_flat, W_fc1) + b_fc1)
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