Chapter_12_Section_3_RankNet_Utility_Function

February 9, 2019

1 Learn ranking utility function

1.1 Practical explanation

This notebook combines the code in `Chapter_12_Section_1_RankNet.ipynb` and `Chapter_12_Section_2_Loading_VGG_Model.ipynb` to perform the following: * Extract first (start_imgs) and last (end_imgs) frames of a video demonstrating the folding of clothes. * Embedd these images using the fully connected output layer of the vgg model shown in `Chapter_12_Section_2_Loading_VGG_Model.ipynb`. * Use the nn model in `Chapter_12_Section_1_RankNet.ipynb` to learn a model to learn a utility function that ranks the last frame (folded) higher than the first frame (unfolded). * Check that the utility function has learned to score the frames in a video in increasing order as the cloth progress from unfolded to folded.

See "Jointly Learning Grounded Task Structures from Language Instruction and Visual Demonstration" at http://shukla.io/docs/2016_EMNLP.pdf

1.2 Code

Download cloth folding dataset from https://data.mendeley.com/datasets/c7y3hcrj7z/1.

Extract the zip. Keep note of where you extract it; we'll call that location `DATASET_DIR`.

```
In [1]: import tensorflow as tf
        import numpy as np
        from vgg16 import vgg16
        import glob, os
        from scipy.misc import imread, imresize
        %matplotlib inline
        from matplotlib import pyplot as plt

        DATASET_DIR = './data/cloth_folding_rgb_vids'
        NUM_VIDS = 45

        def get_img_pair(video_id):
            """Extract tuples of start and end images"""
            img_files = sorted(glob.glob(os.path.join(DATASET_DIR, video_id, '*.png')))
            start_img = img_files[0]
            end_img = img_files[-1]
```

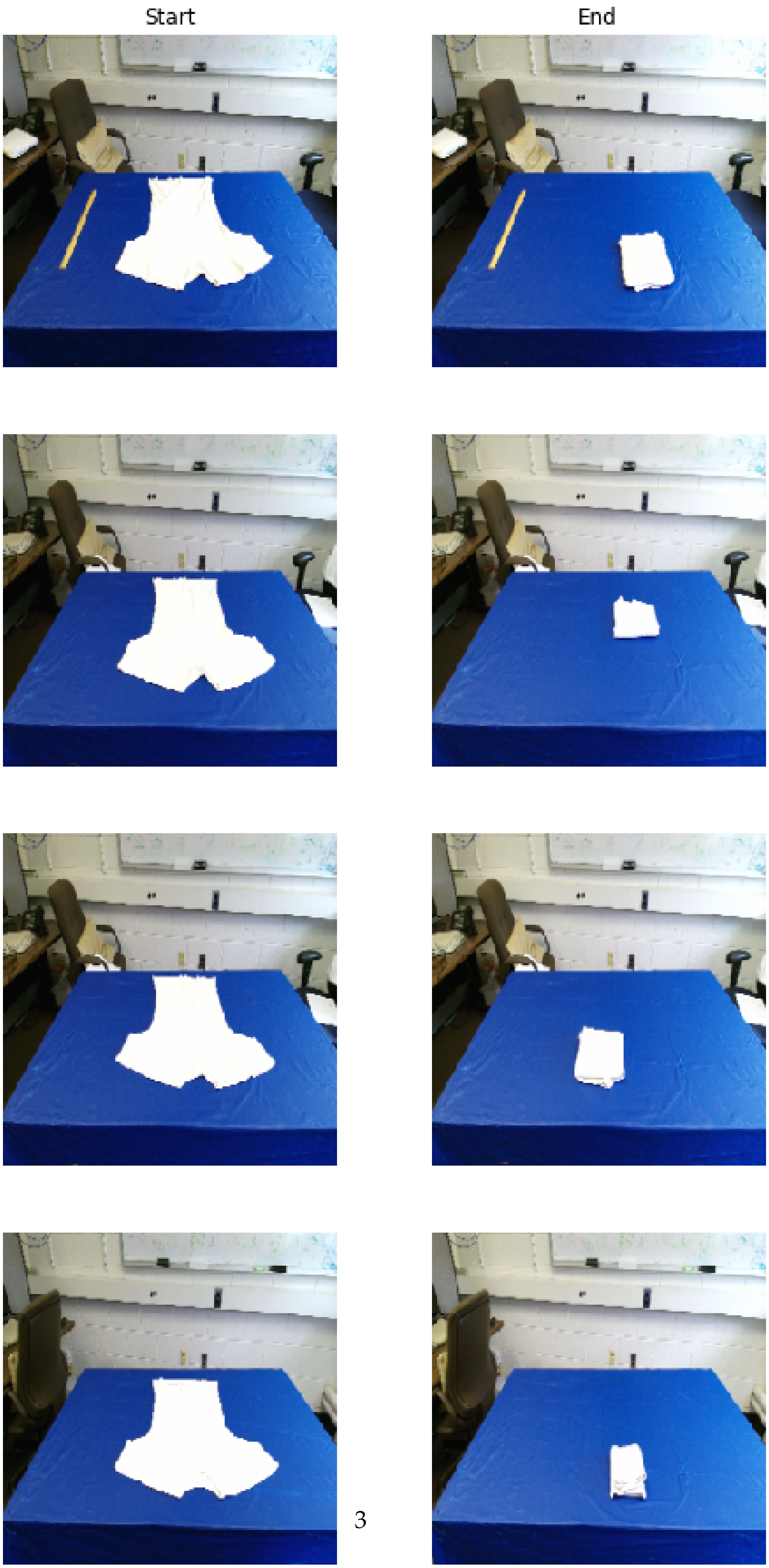
```
    pair = []
    for image_file in [start_img, end_img]:
        img_original = imread(image_file)
        img_resized = imresize(img_original, (224, 224))
        pair.append(img_resized)
    return tuple(pair)

start_imgs = []
end_imgs= []
# Extract list of start and end images of unfolded/folded shirts
for vid_id in range(1, NUM_VIDS + 1):
    start_img, end_img = get_img_pair(str(vid_id))
    start_imgs.append(start_img)
    end_imgs.append(end_img)
print('Images of starting state {}'.format(np.shape(start_imgs)))
print('Images of ending state {}'.format(np.shape(end_imgs)))
nExamples=4
fig, ax = plt.subplots(nExamples,2,figsize=(8,16))
for i in range(nExamples):
    ax[i,0].imshow(start_imgs[i])
    ax[i,0].set_axis_off()
    ax[i,1].imshow(end_imgs[i])
    ax[i,1].set_axis_off()
ax[0,0].set_title('Start')
ax[0,1].set_title('End')
```

```
/home/damianos/.conda/envs/tfCPU/lib/python3.5/site-packages/ipykernel/__main__.py:19: Depreca
`imread` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``imageio.imread`` instead.
/home/damianos/.conda/envs/tfCPU/lib/python3.5/site-packages/ipykernel/__main__.py:20: Depreca
`imresize` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``skimage.transform.resize`` instead.


Images of starting state (45, 224, 224, 3)
Images of ending state (45, 224, 224, 3)
```

```
Out[1]: Text(0.5, 1.0, 'End')
```


Start
End

```
In [2]: imgs_plc = tf.placeholder(tf.float32, [None, 224, 224, 3])
```

```
In [3]: # nn model to learn to rank two image embeddings
        # See Concept01_ranknet_DC.ipynb


        # this is the size of the embedding
        n_features = 4096
        n_hidden = 10 # n_features * 2

        with tf.name_scope("input"):
            # The input to the ranking nn is the embedding NOT the image
            x1 = tf.placeholder(tf.float32, [None, n_features], name="x1")
            x2 = tf.placeholder(tf.float32, [None, n_features], name="x2")
            dropout_keep_prob = tf.placeholder(tf.float32, name='dropout_prob')


        # Two hidden layers with a relu activation
        # Each hidden layer will take an x1 and x2 inputs
        with tf.name_scope("hidden_layer"):
            with tf.name_scope("weights"):
                w1 = tf.Variable(tf.random_normal([n_features, n_hidden]), name="w1")
                tf.summary.histogram("w1", w1)
                b1 = tf.Variable(tf.random_normal([n_hidden]), name="b1")
                tf.summary.histogram("b1", b1)

            with tf.name_scope("output"):
                h1 = tf.nn.dropout(tf.nn.relu(tf.matmul(x1,w1) + b1), keep_prob=dropout_keep_pr
                tf.summary.histogram("h1", h1)
                h2 = tf.nn.dropout(tf.nn.relu(tf.matmul(x2, w1) + b1), keep_prob=dropout_keep_p
                tf.summary.histogram("h2", h2)

        # Two output layers without an activation function
        # corresponding to each input image embedding
        with tf.name_scope("output_layer"):
            with tf.name_scope("weights"):
                w2 = tf.Variable(tf.random_normal([n_hidden, 1]), name="w2")
                tf.summary.histogram("w2", w2)
                b2 = tf.Variable(tf.random_normal([1]), name="b2")
                tf.summary.histogram("b2", b2)

            with tf.name_scope("output"):
                s1 = tf.matmul(h1, w2) + b2
                s2 = tf.matmul(h2, w2) + b2
        with tf.name_scope("loss"):
            s12 = s1 - s2
            s12_flat = tf.reshape(s12, [-1])

            cross_entropy = tf.nn.softmax_cross_entropy_with_logits(labels=tf.zeros_like(s12_fl
                                                                    logits=s12_flat + 1)

            loss = tf.reduce_mean(cross_entropy)
            tf.summary.scalar("loss", loss)

        with tf.name_scope("train_op"):
            train_op = tf.train.AdamOptimizer(0.001).minimize(loss)
```

```
WARNING:tensorflow:From <ipython-input-3-6d4668ce4d69>:50: softmax_cross_entropy_with_logits (
Instructions for updating:

Future major versions of TensorFlow will allow gradients to flow
into the labels input on backprop by default.

See @{tf.nn.softmax_cross_entropy_with_logits_v2}.
```

```
In [4]: sess = tf.InteractiveSession()
        sess.run(tf.global_variables_initializer())
```

```
In [5]: print('Loading model...')
        vgg = vgg16(imgs_plc, './vggWeights/vgg16_weights.npz', sess)
        print('Done loading!')
```

```
Loading model...
0 conv1_1_W (3, 3, 3, 64)
1 conv1_1_b (64,)
2 conv1_2_W (3, 3, 64, 64)
3 conv1_2_b (64,)
4 conv2_1_W (3, 3, 64, 128)
5 conv2_1_b (128,)
6 conv2_2_W (3, 3, 128, 128)
7 conv2_2_b (128,)
8 conv3_1_W (3, 3, 128, 256)
9 conv3_1_b (256,)
10 conv3_2_W (3, 3, 256, 256)
11 conv3_2_b (256,)
12 conv3_3_W (3, 3, 256, 256)
13 conv3_3_b (256,)
14 conv4_1_W (3, 3, 256, 512)
15 conv4_1_b (512,)
16 conv4_2_W (3, 3, 512, 512)
```

```
17 conv4_2_b (512,)
18 conv4_3_W (3, 3, 512, 512)
19 conv4_3_b (512,)
20 conv5_1_W (3, 3, 512, 512)
21 conv5_1_b (512,)
22 conv5_2_W (3, 3, 512, 512)
23 conv5_2_b (512,)
24 conv5_3_W (3, 3, 512, 512)
25 conv5_3_b (512,)
26 fc6_W (25088, 4096)
27 fc6_b (4096,)
28 fc7_W (4096, 4096)
29 fc7_b (4096,)
30 fc8_W (4096, 1000)
31 fc8_b (1000,)
Done loading!
```

```
In [6]: # get embeddings for images
        start_imgs_embedded = sess.run(vgg.fc1, feed_dict={vgg.imgs: start_imgs})
        end_imgs_embedded = sess.run(vgg.fc1, feed_dict={vgg.imgs: end_imgs})

        idxs = np.random.choice(NUM_VIDS, NUM_VIDS, replace=False)
        train_idxs = idxs[0:int(NUM_VIDS * 0.75)]
        test_idxs = idxs[int(NUM_VIDS * 0.75):]

        train_start_imgs = start_imgs_embedded[train_idxs]
        train_end_imgs = end_imgs_embedded[train_idxs]
        test_start_imgs = start_imgs_embedded[test_idxs]
        test_end_imgs = end_imgs_embedded[test_idxs]

        print('Train start imgs {}'.format(np.shape(train_start_imgs)))
        print('Train end imgs {}'.format(np.shape(train_end_imgs)))
        print('Test start imgs {}'.format(np.shape(test_start_imgs)))
        print('Test end imgs {}'.format(np.shape(test_end_imgs)))
```

```
Train start imgs (33, 4096)
Train end imgs (33, 4096)
Test start imgs (12, 4096)
Test end imgs (12, 4096)
```

```
In [7]: # run nn model that learn to rank start and end images
        train_y1 = np.expand_dims(np.zeros(np.shape(train_start_imgs)[0]), axis=1)
        train_y2 = np.expand_dims(np.ones(np.shape(train_end_imgs)[0]), axis=1)
        for epoch in range(100):
            for i in range(np.shape(train_start_imgs)[0]):
                _, cost_val = sess.run([train_op, loss],
                                       feed_dict={x1: train_start_imgs[i:i+1,:],
                                                  x2: train_end_imgs[i:i+1,:],
                                                  dropout_keep_prob: 0.5})
            print('{}. {}'.format(epoch, cost_val))
            s1_val, s2_val = sess.run([s1, s2], feed_dict={x1: test_start_imgs,
                                                            x2: test_end_imgs,
                                                            dropout_keep_prob: 1})
            print('Accuracy: {}%'.format(100 * np.mean(s1_val < s2_val)))
```

```
0. 0.0
Accuracy: 100.0%
1. 0.0
Accuracy: 100.0%
2. 0.0
Accuracy: 100.0%
3. 0.0
Accuracy: 100.0%
4. 0.0
Accuracy: 100.0%
5. 0.0
Accuracy: 100.0%
6. 0.0
Accuracy: 100.0%
7. 0.0
Accuracy: 100.0%
8. 0.0
Accuracy: 100.0%
9. 0.0
Accuracy: 100.0%
10. 0.0
Accuracy: 100.0%
11. 0.0
Accuracy: 100.0%
12. 0.0
Accuracy: 100.0%
13. 0.0
Accuracy: 100.0%
14. 0.0
Accuracy: 100.0%
15. 0.0
Accuracy: 100.0%
16. 0.0
Accuracy: 100.0%
17. 0.0
Accuracy: 100.0%
18. 0.0
Accuracy: 100.0%
19. 0.0
```

```
Accuracy: 100.0%
20. 0.0
Accuracy: 100.0%
21. 0.0
Accuracy: 100.0%
22. 0.0
Accuracy: 100.0%
23. 0.0
Accuracy: 100.0%
24. 0.0
Accuracy: 100.0%
25. 0.0
Accuracy: 100.0%
26. 0.0
Accuracy: 100.0%
27. 0.0
Accuracy: 100.0%
28. 0.0
Accuracy: 100.0%
29. 0.0
Accuracy: 100.0%
30. 0.0
Accuracy: 100.0%
31. 0.0
Accuracy: 100.0%
32. 0.0
Accuracy: 100.0%
33. 0.0
Accuracy: 100.0%
34. 0.0
Accuracy: 100.0%
35. 0.0
Accuracy: 100.0%
36. 0.0
Accuracy: 100.0%
37. 0.0
Accuracy: 100.0%
38. 0.0
Accuracy: 100.0%
39. 0.0
Accuracy: 100.0%
40. 0.0
Accuracy: 100.0%
41. 0.0
Accuracy: 100.0%
42. 0.0
Accuracy: 100.0%
43. 0.0
```

```
Accuracy: 100.0%
44. 0.0
Accuracy: 100.0%
45. 0.0
Accuracy: 100.0%
46. 0.0
Accuracy: 100.0%
47. 0.0
Accuracy: 100.0%
48. 0.0
Accuracy: 100.0%
49. 0.0
Accuracy: 100.0%
50. 0.0
Accuracy: 100.0%
51. 0.0
Accuracy: 100.0%
52. 0.0
Accuracy: 100.0%
53. 0.0
Accuracy: 100.0%
54. 0.0
Accuracy: 100.0%
55. 0.0
Accuracy: 100.0%
56. 0.0
Accuracy: 100.0%
57. 0.0
Accuracy: 100.0%
58. 0.0
Accuracy: 100.0%
59. 0.0
Accuracy: 100.0%
60. 0.0
Accuracy: 100.0%
61. 0.0
Accuracy: 100.0%
62. 0.0
Accuracy: 100.0%
63. 0.0
Accuracy: 100.0%
64. 0.0
Accuracy: 100.0%
65. 0.0
Accuracy: 100.0%
66. 0.0
Accuracy: 100.0%
67. 0.0
```

```
Accuracy: 100.0%
68. 0.0
Accuracy: 100.0%
69. 0.0
Accuracy: 100.0%
70. 0.0
Accuracy: 100.0%
71. 0.0
Accuracy: 100.0%
72. 0.0
Accuracy: 100.0%
73. 0.0
Accuracy: 100.0%
74. 0.0
Accuracy: 100.0%
75. 0.0
Accuracy: 100.0%
76. 0.0
Accuracy: 100.0%
77. 0.0
Accuracy: 100.0%
78. 0.0
Accuracy: 100.0%
79. 0.0
Accuracy: 100.0%
80. 0.0
Accuracy: 100.0%
81. 0.0
Accuracy: 100.0%
82. 0.0
Accuracy: 100.0%
83. 0.0
Accuracy: 100.0%
84. 0.0
Accuracy: 100.0%
85. 0.0
Accuracy: 100.0%
86. 0.0
Accuracy: 100.0%
87. 0.0
Accuracy: 100.0%
88. 0.0
Accuracy: 100.0%
89. 0.0
Accuracy: 100.0%
90. 0.0
Accuracy: 100.0%
91. 0.0
```

```
Accuracy: 100.0%
92. 0.0
Accuracy: 100.0%
93. 0.0
Accuracy: 100.0%
94. 0.0
Accuracy: 100.0%
95. 0.0
Accuracy: 100.0%
96. 0.0
Accuracy: 100.0%
97. 0.0
Accuracy: 100.0%
98. 0.0
Accuracy: 100.0%
99. 0.0
Accuracy: 100.0%
```

```
In [8]: # See how well our nn model has learned to rank sequential images of a video
        # NOT just start and end frames as it was trained on
        def get_img_seq(video_id):
            img_files = sorted(glob.glob(os.path.join(DATASET_DIR, video_id, '*.png')))
            imgs = []
            for image_file in img_files:
                img_original = imread(image_file)
                img_resized = imresize(img_original, (224, 224))
                imgs.append(img_resized)
            return imgs

        imgs = get_img_seq('2')
        print(np.shape(imgs))
```

```
(37, 224, 224, 3)
```

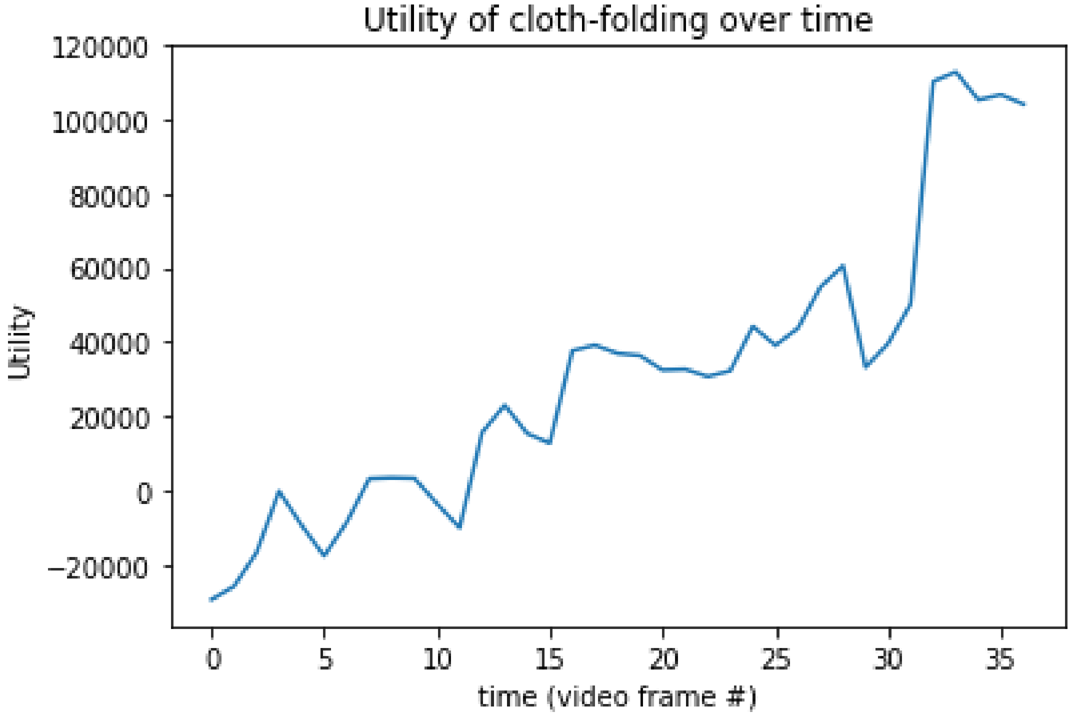
```
/home/damianos/.conda/envs/tfCPU/lib/python3.5/site-packages/ipykernel/__main__.py:7: Deprecati
`imread` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``imageio.imread`` instead.
/home/damianos/.conda/envs/tfCPU/lib/python3.5/site-packages/ipykernel/__main__.py:8: Deprecati
`imresize` is deprecated in SciPy 1.0.0, and will be removed in 1.2.0.
Use ``skimage.transform.resize`` instead.
```

```
In [9]: # Get embeddings
        imgs_embedded = sess.run(vgg.fc1, feed_dict={vgg.imgs: imgs})
        scores = sess.run([s1], feed_dict={x1: imgs_embedded, dropout_keep_prob: 1})
```

```
In [10]: plt.figure()
         plt.title('Utility of cloth-folding over time')
```

```
        plt.xlabel('time (video frame #)')
        plt.ylabel('Utility')
        plt.plot(scores[-1])
```

```
Out[10]: [<matplotlib.lines.Line2D at 0x7f25b4371cc0>]
```



sess.close()