

demo-rfiw-t1-verification

February 4, 2020

1 Demo for RFIW-2020 (Task 1): Kinship Verification

1.1 Overview

This basic demo shows some tricks for using [pandas](#) in the Recognizing Families In the Wild ([RFIW](#)) data challenge. Specifically, kinship verification ([Task-I](#)).

We will evaluate pairs and perform analysis on the features used for assessment. Specifically, we will - Load all features into dictionary. - Evaluate according to verification protocol. - Calculate verification accuracies for the different relationship pair-types, along with the averaged accuracy. - Generate a ROC curve. - Visualize score distributions for KIN and NON-KIN for the different relationship types.

1.2 Preparing Data

Features are assumed to be extracted, stored as [pickles](#), and saved with the same directory structure and naming scheme as the face images. Features are read in as a dictionary, with keys set as the relative file paths without file extensions (i.e., <FID>/<MID>/<faceID>). See Section [1.2.2](#)– to change the i/o scheme modify the respective cell. For this, faces were encoded using ArcFace trained on MSCeleb in Pytorch (source, [Github](#)). However, any features can be plugged in.

No fine-tuning or special tricks were applied to the features. The purpose here is to demonstrate how to complete the evaluation in a few easy steps. Also, we see how to easily generate visualizations that are both appealing and insightful.

1.2.1 Setup environment and set style for plots

```
[15]: import numpy as np
import pandas as pd
import seaborn as sns

import matplotlib.pyplot as plt
from sklearn.metrics import roc_auc_score, roc_curve
```

```
[16]: %matplotlib inline
# set styles for figures
sns.set(style="white", rc={"axes.facecolor": (0, 0, 0, 0)})
```

```
sns.set_style('whitegrid', {'font.family': 'serif',
                             'font.serif' : 'Times New Roman', 'fontsize': 18})
```

1.2.2 Prepare features

```
[28]: # here set the baths to pairs list, along with directory containing features
dir_data = '../..data/rfiw2020-data/verification/'
dir_val = dir_data + 'val-faces/'
dir_val_features = dir_val.replace('/val-faces/', '/val-features/')
```

Load pickle files and determine relationship types

```
[25]: # load pairs as DataFrame (from PKL file)
df_pairlist = pd.read_csv(dir_data + 'val-pairs.csv')
df_pairlist.ptype =df_pairlist.ptype.str.upper() # set tags to uppercase for
↳formatting later

# get all unique relationship types in DF
relationship_types = df_pairlist.ptype.unique()

print('Processing {} pairs of {} relationship types'.format(len(df_pairlist),
↳len(relationship_types)))
print(relationship_types)
df_pairlist.head()
```

Processing 143168 pairs of 11 relationship types

['BB' 'SS' 'FS' 'FD' 'SIBS' 'MD' 'MS' 'GFGS' 'GFGD' 'GMGS' 'GMGD']

```
[25]:
```

	p1	p2	ptype	fid1	\
0	F0007/MID1/P00074_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
1	F0007/MID1/P11274_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
2	F0007/MID1/P00079_face1.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
3	F0007/MID1/P11275_face2.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
4	F0007/MID1/P00078_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	

	fid2	label
0	F0007	1
1	F0007	1
2	F0007	1
3	F0007	1
4	F0007	1

1.2.3 Build a list of all images in pairs list

```
[29]: li_images = list(np.unique(df_pairlist.p1.to_list() + df_pairlist.p2.to_list()))
print(f"No. Images {len(li_images)}")
```

No. Images 5045

1.2.4 load all features in LUT (ie dictionary)

```
[30]: features = {f: pd.read_pickle(dir_val_features + f.replace('.jpg', '.pkl')) for
    ↪ f in
        li_images}
```

1.2.5 Calculate cosine score for each pair

```
[31]: # score all feature pairs, because L2 norm applied on features dot is same as
    ↪ cosine sim
df_pairlist['score'] = df_pairlist.apply(
    lambda x: np.dot(features[x.p1], features[x.p2].T), axis=1)
```

```
[32]: df_pairlist.head()
```

```
[32]:
```

	p1	p2	ptype	fid1	\
0	F0007/MID1/P00074_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
1	F0007/MID1/P11274_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
2	F0007/MID1/P00079_face1.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
3	F0007/MID1/P11275_face2.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	
4	F0007/MID1/P00078_face3.jpg	F0007/MID9/P00079_face3.jpg	BB	F0007	

	fid2	label	score
0	F0007	1	0.161586
1	F0007	1	0.277958
2	F0007	1	0.412821
3	F0007	1	0.341715
4	F0007	1	0.251078

```
[33]: df_pairlist.tail()
```

```
[33]:
```

	p1	p2	ptype	fid1	\
143163	F1004/MID2/P13032_face0.jpg	F0705/MID2/P07378_face4.jpg	FD	F1004	
143164	F1004/MID2/P13033_face0.jpg	F0627/MID3/P06577_face2.jpg	FD	F1004	
143165	F1004/MID2/P13033_face0.jpg	F0162/MID5/P01737_face1.jpg	FD	F1004	
143166	F1004/MID2/P13033_face0.jpg	F0873/MID5/P09224_face0.jpg	FD	F1004	
143167	F1004/MID2/P13033_face0.jpg	F0490/MID2/P05158_face1.jpg	FD	F1004	

	fid2	label	score
143163	F0705	0	-0.012467
143164	F0627	0	0.164647
143165	F0162	0	0.192913
143166	F0873	0	0.210949
143167	F0490	0	0.210582

The top of the table contains the positive pairs, while the bottom is the negatives. See the differences in scores. As we would hope, the KIN pairs seem to score higher (i.e., be more similar) than that of the NON-KIN.

2 Measure Performance

In most cases, the labels get loaded from a separate file. However, here, we infer the tag as ‘KIN’ or ‘NON-KIN’ depending on whether or not the family ID (FID) of subjects 1 and 2.

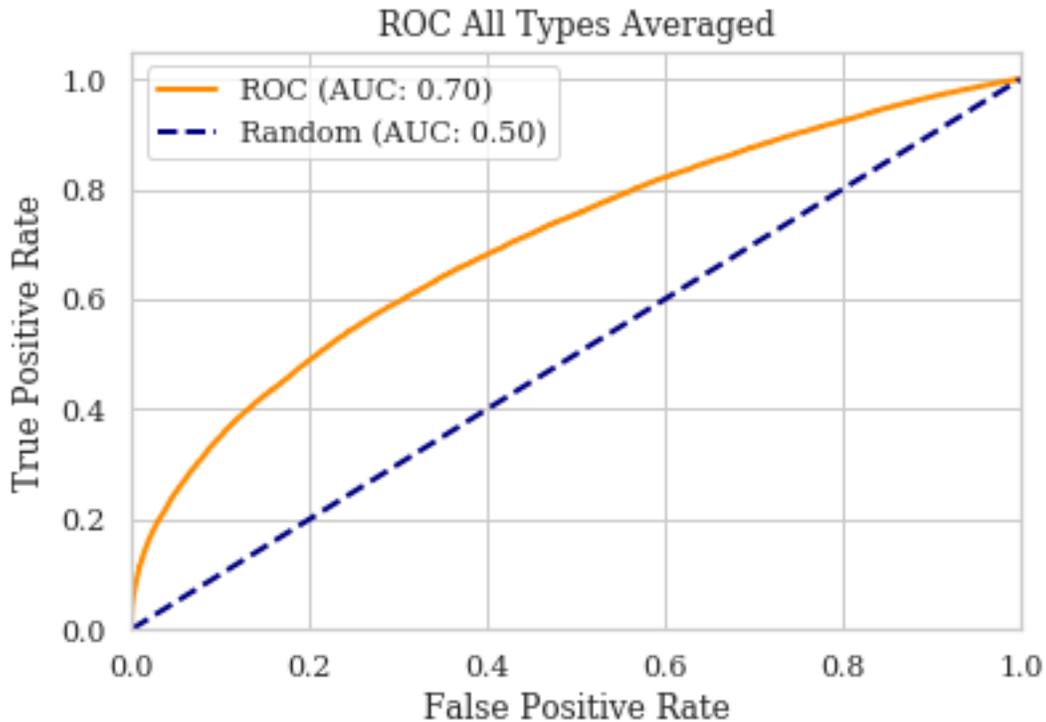
```
[34]: df_pairlist['label'] = (df_pairlist.fid1 == df_pairlist.fid2).astype(np.uint)
      # 'tags' column in for formatting legend in plots
      df_pairlist['tags'] = 'KIN'
      df_pairlist.loc[df_pairlist.label==0, 'tags'] = 'NON-KIN'
```

2.0.1 Generate ROC curve

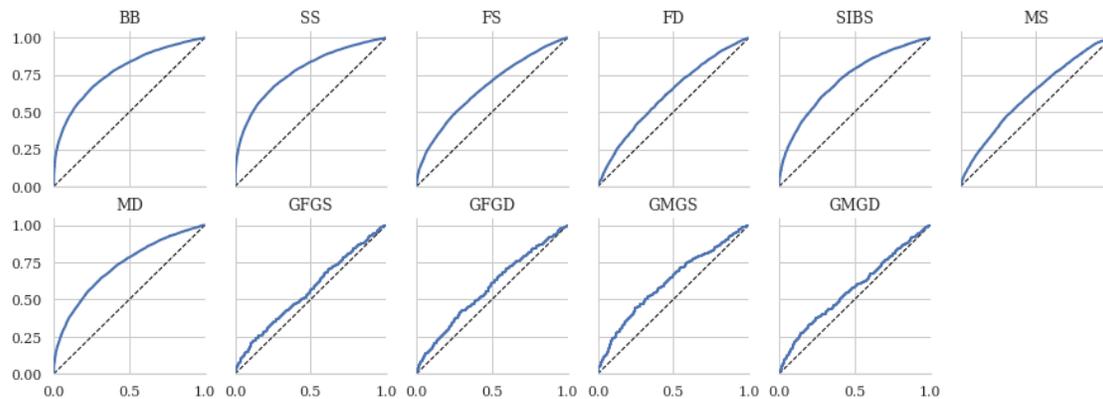
```
[35]: fpr, tpr, threshold = roc_curve(df_pairlist.label.values,
                                     df_pairlist.score.values)
      auc = roc_auc_score(df_pairlist.label.values, df_pairlist.score.values)
```

```
[37]: plt.figure()
      plt.plot(fpr, tpr, color='darkorange', lw=2, label='ROC (AUC: %0.2f)' % auc)
      plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--', label='Random (AUC:
      → 0.50)')
      plt.xlim([0.0, 1.0])
      plt.ylim([0.0, 1.05])
      plt.xlabel('False Positive Rate')
      plt.ylabel('True Positive Rate')
      plt.title('ROC All Types Averaged')
      plt.legend(loc="best")
```

```
[37]: <matplotlib.legend.Legend at 0x7ff16797eb80>
```



```
[38]: f, axs = plt.subplots(2, int(np.ceil(len(relationship_types)/
    ↪2)), figsize=(15,5), sharex=True, sharey=True)
sns.despine(left=True)
i = [[0,0],[0,1],[0,2],[0,3],[0,4],[1,0],[0,5],[1,1],[1,2],[1,3],[1,4],[1,5]]
for j, att in enumerate(relationship_types):
    df_cur = df_pairlist.loc[df_pairlist.ptype == att,['score', 'label']]
    fpr, tpr, threshold = roc_curve(df_cur.label.values, df_cur.score.values)
    auc = roc_auc_score(df_cur.label.values, df_cur.score.values)
    axs[i[j][0],i[j][1]].plot([0, 1], [0, 1], color='black', lw=1,
    ↪linestyle='--')
    axs[i[j][0],i[j][1]].plot(fpr, tpr, lw=2, label='(AUC: {:.2})'.format(auc))
    axs[i[j][0],i[j][1]].set_xlim([0.0, 1.0])
    axs[i[j][0],i[j][1]].set_ylim([0.0, 1.05])
    axs[i[j][0],i[j][1]].set_title(f"{att}")
axs[-1,-1].set_axis_off()
```

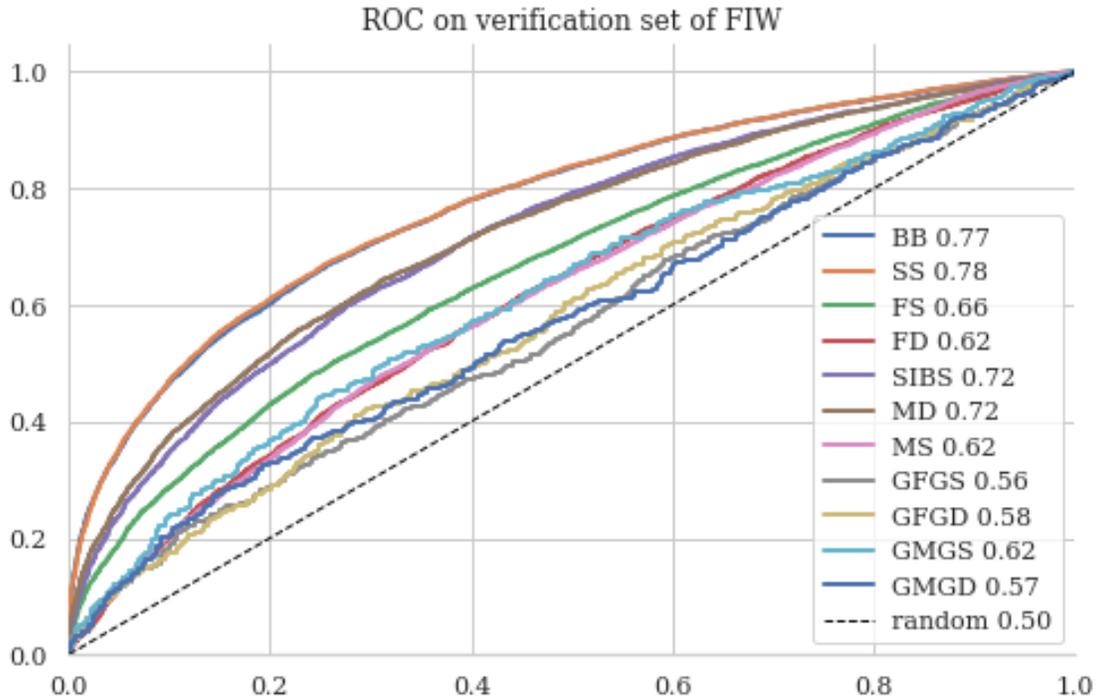


The grandparent-grandchildren do not separate well provided the current settings. Let us do some analysis.

```
[48]: fig, ax = plt.subplots(figsize=(8,5))
sns.despine(left=True)
i = [[0,0],[0,1],[0,2],[0,3],[0,4],[1,0],[0,5],[1,1],[1,2],[1,3],[1,4],[1,5]]
for j, att in enumerate(relationship_types):
    df_cur = df_pairlist.loc[df_pairlist.ptype == att,['score', 'label']]
    fpr, tpr, threshold = roc_curve(df_cur.label.values, df_cur.score.values)
    auc = roc_auc_score(df_cur.label.values, df_cur.score.values)
    ax.plot(fpr, tpr, lw=2, label='{} {:.2}'.format(att, auc))

ax.set_xlim([0.0, 1.0])
ax.plot([0, 1], [0, 1], label='random 0.50', color='black', lw=1,
        ↪linestyle='--')
ax.set_title(f"ROC on verification set of FIW")
ax.set_ylim([0.0, 1.05])
plt.legend(loc='best')
```

```
[48]: <matplotlib.legend.Legend at 0x7ff164501a90>
```



2.0.2 Feature Analysis

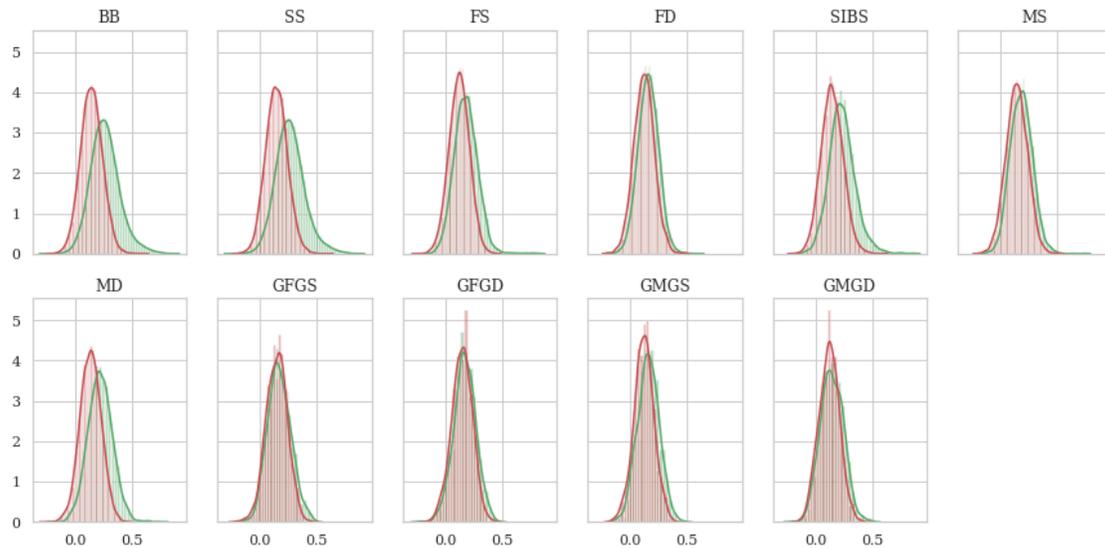
Next, plot signal detection models (SDM) for each relationship type. From this, we view the distribution of scores as a function of the label (i.e., KIN vs. NON-KIN).

```
[49]: df_pairlist.label=df_pairlist.label.astype(int)

sns.despine(left=True)

f, axs = plt.subplots(2, int(np.ceil(len(relationship_types)/
→2)),figsize=(15,7), sharex=True, sharey=True)
i = [[0,0],[0,1],[0,2],[0,3],[0,4],[1,0],[0,5],[1,1],[1,2],[1,3],[1,4],[1,5]]
for j, att in enumerate(relationship_types):
    df_cur = df_pairlist.loc[df_pairlist.ptype == att,['score', 'label']]
    sns.distplot(df_cur.loc[df_cur.label==1,'score'],hist=True,
→label='True',ax=axs[i[j][0],i[j][1]],color='g')
    sns.distplot(df_cur.loc[df_cur.label==0,'score'],
→hist=True,label='False',ax=axs[i[j][0],i[j][1]],color='r')
    axs[i[j][0],i[j][1]].set_title(att)
    axs[i[j][0],i[j][1]].set_xlabel('')
axs[-1,-1].set_axis_off()
```

<Figure size 432x288 with 0 Axes>



Similar to SDM, but let's look at violin plots as means of another visualization of two-class separability.

```
[55]: plt.close('all')
fig = plt.figure(figsize=(12,9))
ax = fig.gca()
sns.despine(left=True)

sns.violinplot(x='ptype',y='score',data=df_pairlist,hue='tags', ax=ax,
↳linewidth=2.5, width=0.75, palette="Pastel1",
order=[ "BB", "SS", "SIBS", 'FD', 'FS', "MD",
↳"MS",'GFGD', 'GFGS', 'GMGD', 'GMGS'])
ax.spines['right'].set_visible(False)
ax.spines['top'].set_visible(False)
ax.set_xlabel('Relationship Type', fontsize=18)

ax.set_ylabel('Similarity Score', fontsize=18)
# Calculate number of obs per group & median to position labels
medians = df_pairlist.groupby(['ptype'])['score'].min().values
nobs = df_pairlist['ptype'].value_counts().values
nobs = [str(f'{x:,}') for x in nobs.tolist()]
nobs = ["n: " + i for i in nobs]

# Add it to the plot
pos = range(len(nobs))
for tick,label in zip(pos,ax.get_xticklabels()):
value = pos[tick]
```

```

ax.text(value, -0.35, nobs[tick], horizontalalignment='center',
        ↪fontsize=18, size='small', color='k', weight='semibold')
        # ax.text(value, medians[tick] - medians[tick]*0.15, nobs[tick],
        ↪horizontalalignment='center', size='x-small', color='k', weight='semibold')

plt.legend(loc="best", fontsize=18)
plt.tight_layout()

```

