ECEN 649-Pattern Recognition

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The Viola Jones Ada Boost algorithm has been run on 1, 3, 5 and 10 rounds. Separate Jupyter notebooks have been submitted since it took considerable computing power and had to be run on multiple machines to get the results on time. Python 3.6 has been used.

Packages used:

```
%matplotlib inline
import os
import tarfile
import shutil
import hashlib
import glob
import random
from datetime import datetime
from typing import *

import requests
from joblib import Parallel, delayed
from pathlib import Path
from PIL import Image, ImageOps # install the pillow package
import numpy as np
from sklearn.metrics import *
import seaborn as sns
import matplotlib.pyplot as plt
```

2.1) Extract Haar Features

```
Number of type 2 (2 horizontal) features: 17100
Number of type 1 (2 vertical) features: 17100
Number of type 3 (3 horizontal) features: 10830
Number of type 4 (3 vertical): 10830
Number of type 5 (4)features:  8100
Total number of features:     63960
```

The images are 19x19, hence a WINDOW_SIZE of 19 has been used for extracting the Haar Features. The total number of features is 63,960.

On limiting the max filter size to 8, I obtained 2056 features which is considerably lower than 63,960.

2.2) Ada Boost

1) Round 1

Results:

```
[WeakClassifier(threshold=-2.403821110725403, classifier=Feature2h(x=8,
y=1, width=2, height=10))]
```

Feature 2 horizontal (type 2) was chosen as the best feature.
Accuracy obtained was 0.79.

```
False Positives: 181
False Negatives: 332
```

2) Rounds 3

Results:

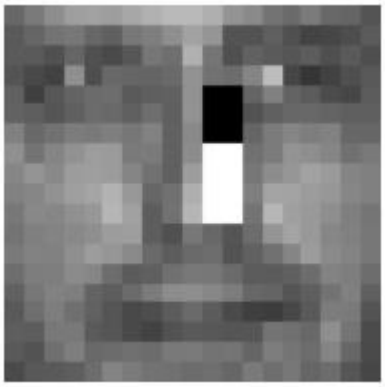
```
[WeakClassifier(threshold=-2.859752744436264, classifier=Feature3h(x=1,
y=7, width=9, height=3)),

 WeakClassifier(threshold=0.7901344299316406, classifier=Feature2v(x=11,
y=3, width=8, height=2)),

 WeakClassifier(threshold=0.26337987184524536, classifier=Feature2h(x=10,
y=4, width=2, height=7))]
```

Features chosen:

- 3 horizontal (type 3)
- 2 vertical (type 1)
- 2 horizontal (type 2)

The accuracy obtained was 0.83.

```
False Positives: 57
False Negatives: 347
```



3) Rounds 5

Results:

```
[WeakClassifier(threshold=-2.414795756340027, classifier=Feature2h(x=8,
y=1, width=2, height=10)),

 WeakClassifier(threshold=1.1981849670410156, classifier=Feature2v(x=14,
y=4, width=4, height=2)),

 WeakClassifier(threshold=0.23963642120361328, classifier=Feature2v(x=12,
y=15, width=3, height=2)),

 WeakClassifier(threshold=-4.424053192138672, classifier=Feature4(x=4, y=0,
width=4, height=12)),

 WeakClassifier(threshold=1.585296630859375, classifier=Feature4(x=4, y=10,
width=8, height=6))]
```

Features chosen:

- 2 horizontal (type 2)
- 2 vertical (type 1)
- 2 vertical (type 1)
- 4 (type 5)
- 4 (type 5)

Accuracy obtained was 0.84.

```
False Positives: 61
False Negatives: 337
```

4) Rounds 10

Results:

```
[WeakClassifier(threshold=-1.0794528722763062 classifier=Feature3h(x=1,
y=8, width=9, height=1)),

 WeakClassifier(threshold=-1.4321107864379883, classifier=Feature2v(x=3,
y=6, width=16, height=6)),

 WeakClassifier(threshold=0.46091461181640625, classifier=Feature2h(x=10,
y=3, width=2, height=8)),

 WeakClassifier(threshold=0.4938373565673828, classifier=Feature2v(x=11,
y=3, width=7, height=2)),

 WeakClassifier(threshold=-18.68893814086914, classifier=Feature3h(x=8,
y=1, width=9, height=11)),

 WeakClassifier(threshold=-0.14815521240234375, classifier=Feature4(x=10,
y=11, width=4, height=4)),

 WeakClassifier(threshold=1.2345921993255615, classifier=Feature2v(x=1,
y=3, width=5, height=4)),

 WeakClassifier(threshold=0.03292274475097656 classifier=Feature2v(x=8,
y=13, width=3, height=2)),

 WeakClassifier(threshold=-17.948191046714783, classifier=Feature3h(x=8,
y=1, width=9, height=11)),

 WeakClassifier(threshold=-0.5267586708068848, classifier=Feature2h(x=2,
y=1, width=8, height=2))]
```

Features chosen:

- 3 horizontal (type 3)
- 2 vertical (type 1)
- 2 horizontal (type 2)

- 2 vertical (type 1)
- 3 horizontal (type 3)
- 4 (type 5)
- 2 vertical (type 1)
- 2 vertical (type 1)
- 3 horizontal (type 3)
- 2 horizontal (type 2)

Accuracy obtained was 0.91.

```
Precision 0.71,
recall 0.92,
false positive rate 0.09,
false negative rate 0.08.
```

2.3) Adjusting Threshold

```
for y, w in zip(ys, ws):
        if y < .6:
            s_minus += w
            t_minus += w
        else:
            s_plus += w
            t_plus += w
        s_minuses.append(s_minus)
        s_pluses.append(s_plus)
```

5 rounds of Ada Boost were run.
First, I adjusted the threshold value to 0.6 (from 0.5) for separating the positive and negative samples. This means only samples above the threshold of 0.6 will be classified as positive. This aims to reduce the false positives in the prediction.

```
T+ : total sum of positive sample weights
T- : total sum of negative sample weights
S+ : sum of positive sample weights below the threshold
S- : sum of negative sample weights below the threshold
```

```
Error e = Min{(S+) + (T-) - (S-), (S-) + (T+) - (S-)}
```

The results obtained were:

```
Precision 0.83
Accuracy 0.60
Recall 0.25
False positive rate 0.05
False negative rate 0.75
```

On setting a threshold of 0.4, the algorithm classifies samples as positive if they have a value above 0.4. This aims to reduce the false negatives in the prediction.

The results obtained were:

```
Precision 0.85
Accuracy 0.59
Recall 0.26
False positive rate 0.07
False negative rate 0.72
```

Criterion	Accuracy	False Positive	False Negative
Empirical Error	0.84	0.03	0.41
False Positive	0.60	0.05	0.75
False Negative	0.59	0.07	0.72

2.4) Cascading

I tried the cascading algorithm for 5 and 10 rounds. Due to computational limitations, I wasn't able to train for 20 and 40 rounds.

Cascading was attempted on the "groupe2.jpg" image. On cascading with half window size (window size = 19) and 5 rounds, 17164 candidates were obtained.

Further rounds could not be tried due to time limitations.