Towards Designing an Adaptive Framework for Facial Image Quality Estimation at Edge

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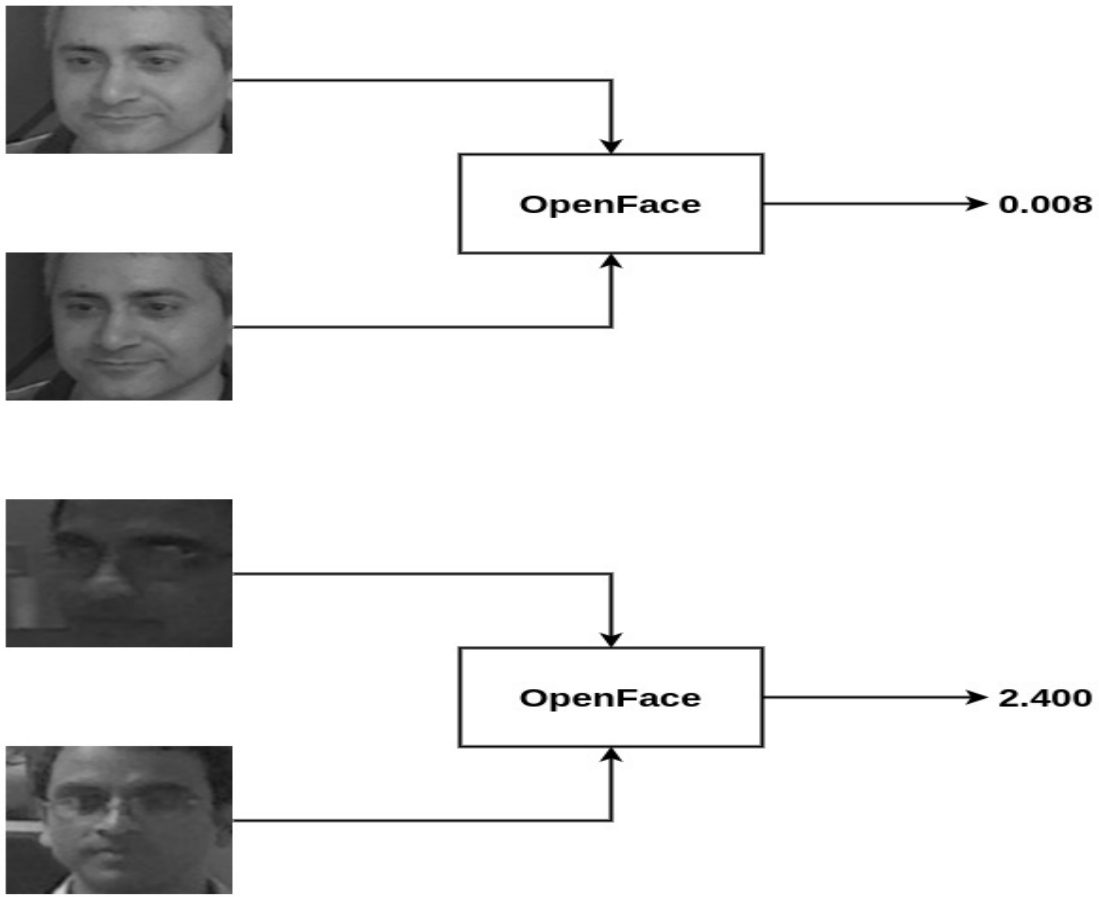
Outline

OpenFace

- A general-purpose face recognition library
- It is a Python and Torch implementation of face recognition with deep neural networks
- Compares two images to give a MatchScore in the range of 0 to 4, with 0 being the best MatchScore

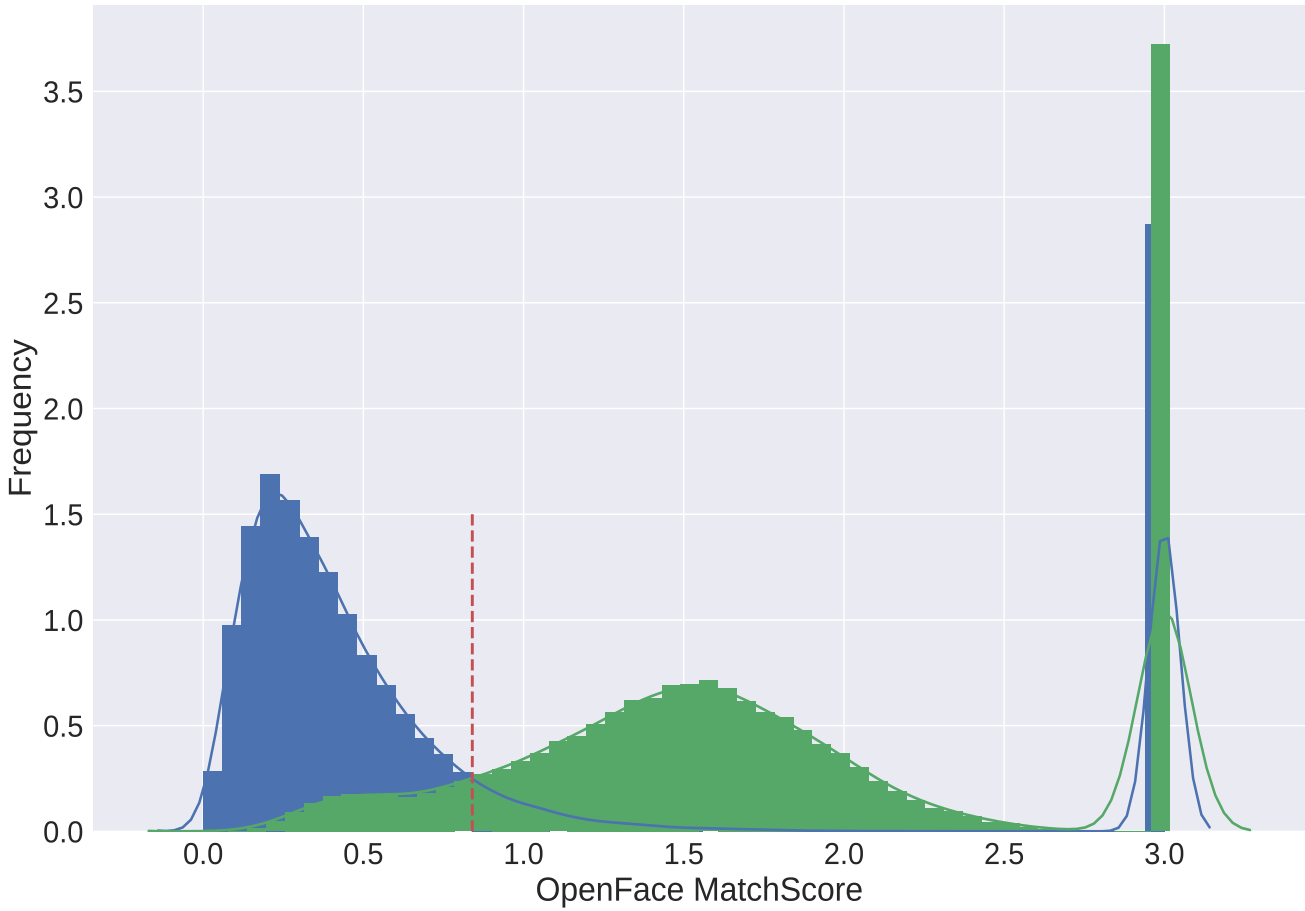
OpenFace



ChokePoint Dataset

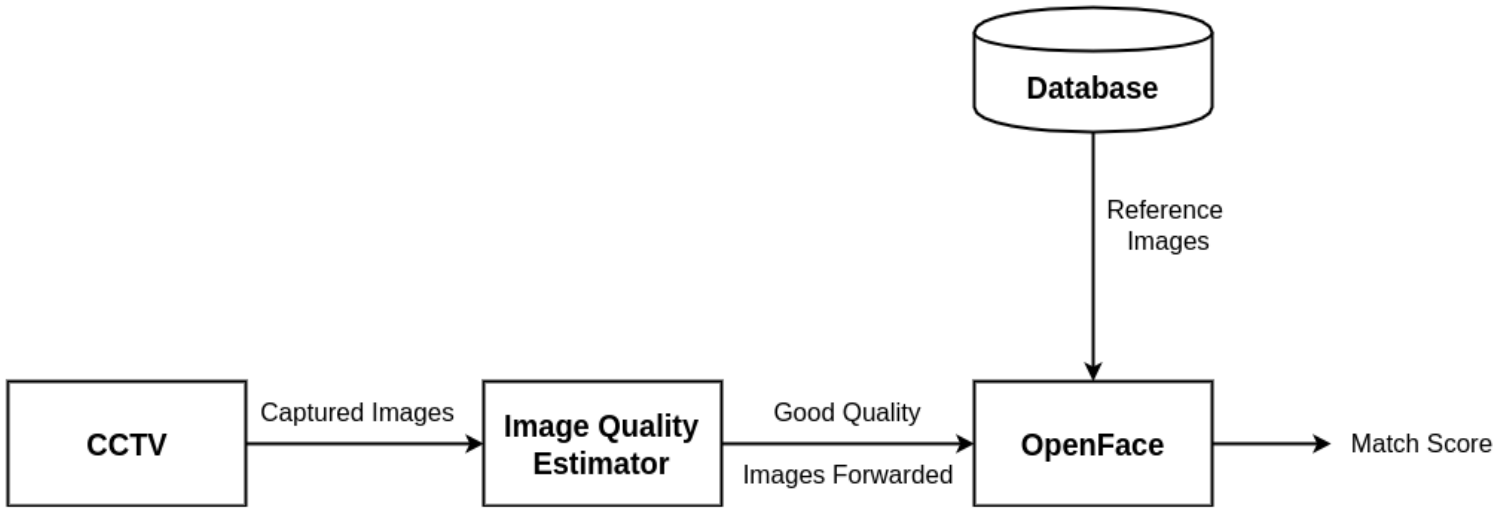
- Staged experiment
- Specially designed for security applications
- Number of Subjects: 29
- Total number of images: 64,204
- Number of images used: 29,022

Genuine Impostor MatchScore Distribution



Edge Computing

- Framework to run before matcher

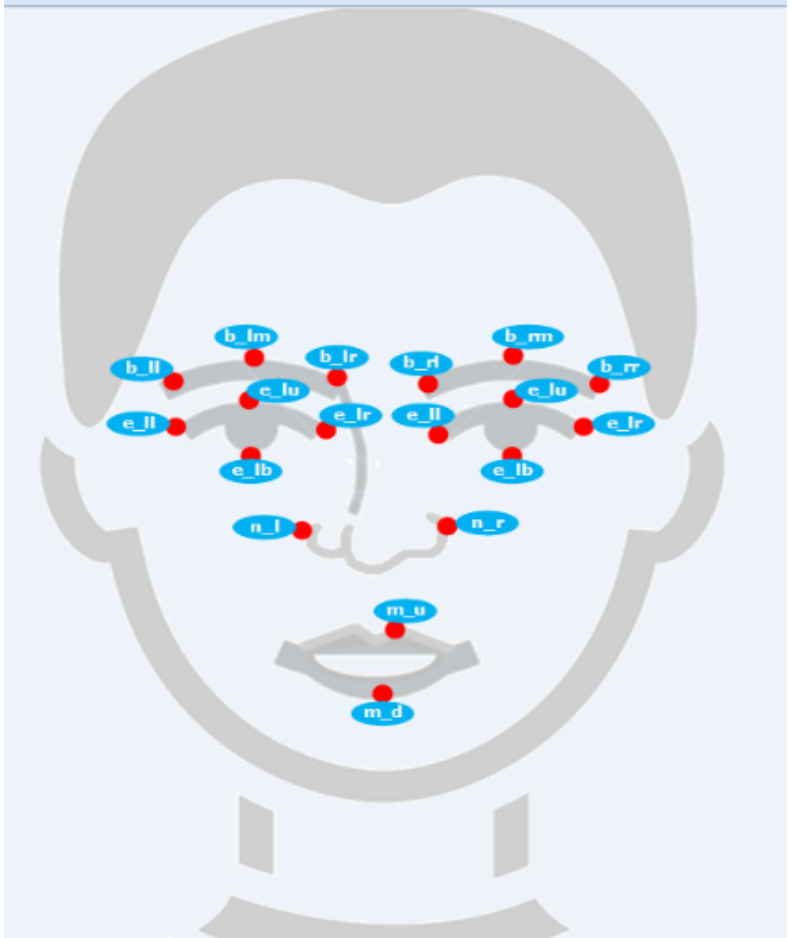


- Maximum processing at Edge
- Reduced Latency

ML Approach

- Feature Extraction using Amazon Rekognition
- Features
  1. Brightness
  2. Sharpness
  3. Face Area
  4. Eyes Distance
  5. Mouth Distance

  and so on



Dataset

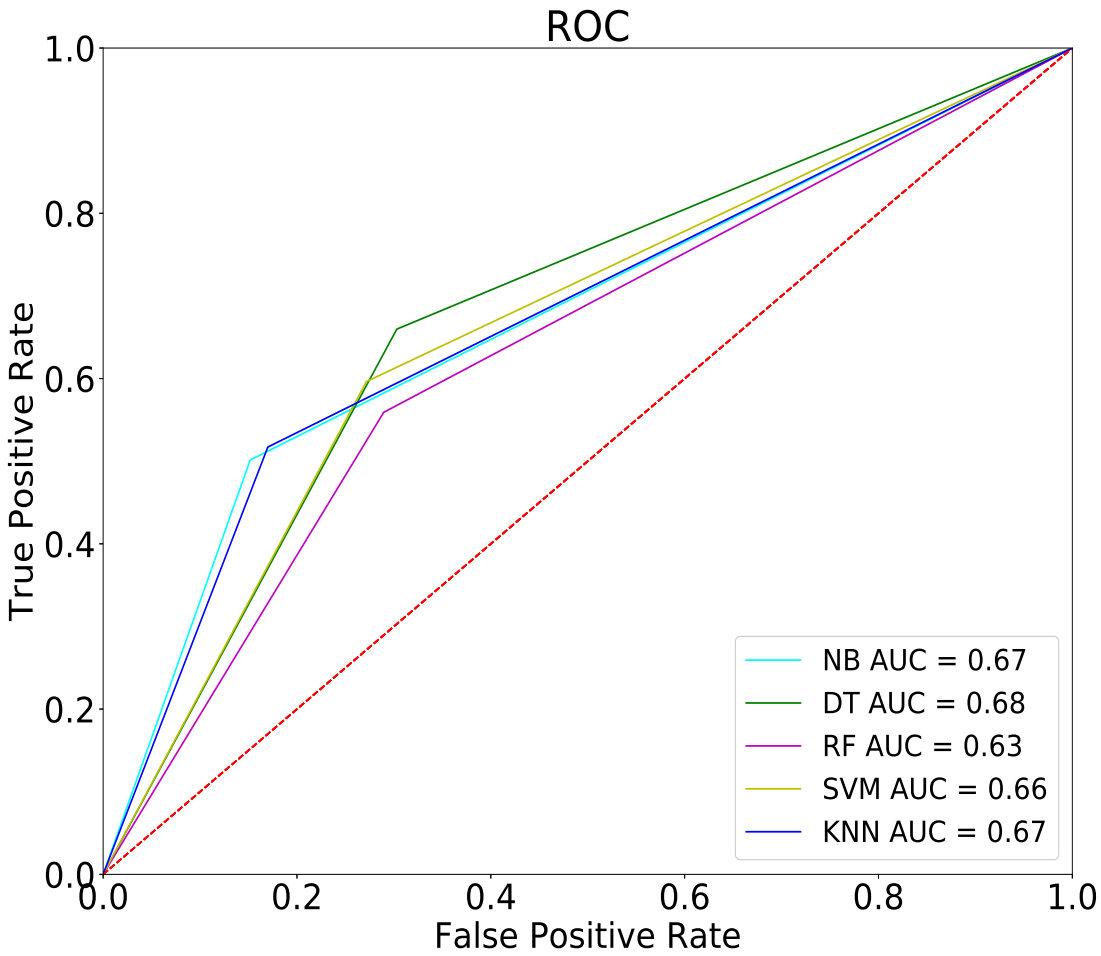
	Brightness	FaceArea	Sharpness	EyesDistance	MouthDistance	Eyeglass	EyesOpen	Gender	Moustache	Beard	MatchScore	Quality
0	28.721546	1.003208	162.066102	0.326623	0.266900	0	2	0	0	0	0.008	0
1	30.817011	0.955632	50.472411	0.329842	0.227280	0	2	0	1	0	0.009	0
2	49.386166	0.721411	58.588165	0.350090	0.283679	0	0	1	0	0	0.010	0
3	37.276478	0.748891	254.853094	0.339438	0.221756	0	1	1	0	0	0.010	0
4	33.498543	0.748891	273.242966	0.302376	0.216229	2	2	0	0	0	0.010	0
5	42.453091	0.591716	49.957179	0.314596	0.228642	0	1	1	0	0	0.010	0
6	45.174900	0.791073	64.809343	0.334807	0.267335	0	1	1	0	0	0.011	0
7	28.935623	1.187541	233.220835	0.337993	0.248478	0	1	1	0	0	0.012	0
8	29.668480	0.947799	64.632192	0.329297	0.321298	0	1	0	0	0	0.012	0
9	0.000000	0.000000	259.192189	0.000000	0.000000	2	2	0	1	1	0.012	0
10	23.603483	0.849115	37.685119	0.317771	0.267990	0	2	1	0	0	0.013	0
11	18.563124	0.791073	101.640405	0.347660	0.288419	0	1	1	0	0	0.013	0
12	48.151733	0.776884	278.662218	0.304013	0.222630	2	2	0	0	0	0.013	0
13	42.102028	0.735086	53.975158	0.327796	0.237176	0	2	0	1	0	0.013	0
14	24.985128	0.834412	274.403006	0.299895	0.219765	2	1	0	0	0	0.014	0
15	40.099644	0.748891	108.402428	0.322537	0.252055	0	2	1	0	0	0.014	0
16	26.610985	0.987221	309.142608	0.340208	0.250482	0	1	0	1	1	0.014	0
17	42.403271	0.674541	89.104172	0.324571	0.284493	0	2	1	0	0	0.014	0
18	38.684399	0.748891	253.544569	0.335448	0.272425	0	1	1	0	0	0.014	0
19	25.665012	0.762823	51.227891	0.318734	0.240523	0	1	0	1	0	0.014	0
20	41.338806	0.924556	87.074197	0.328622	0.263917	0	2	0	0	0	0.014	0
21	42.598389	0.783947	47.470539	0.336709	0.271968	0	1	1	0	0	0.015	0
22	33.043808	0.909211	283.820081	0.345020	0.281379	0	1	1	0	0	0.015	0
23	28.809786	1.205069	62.700858	0.339794	0.280091	0	1	0	0	0	0.015	0
24	54.263733	0.629276	217.894609	0.269618	0.173196	2	1	0	0	0	0.016	0
25	40.374470	1.019323	30.355622	0.326990	0.232846	0	1	0	1	1	0.016	0
26	35.820786	0.893995	264.883790	0.318421	0.257727	0	1	1	0	0	0.016	0
27	29.320204	0.819837	66.953666	0.341541	0.286928	0	1	0	0	0	0.016	0
28	38.708790	0.955632	110.281486	0.339712	0.254853	0	1	0	0	0	0.016	0
29	0.000000	0.000000	78.465355	0.000000	0.000000	2	2	0	0	0	0.016	0
...	...	...	...	...	...	...	...	...	...	...	...	...
28975	40.514614	0.748891	264.313076	0.332188	0.235584	0	1	0	0	0	3.000	1
28976	44.890583	0.735086	57.306533	0.347297	0.224702	0	2	0	0	0	3.000	1
28977	44.446518	0.776884	194.556226	0.338546	0.243247	0	2	0	0	0	3.000	1
28978	41.821259	0.849115	40.172824	0.327721	0.267921	1	2	0	0	0	3.000	1

Classification

Algorithm	f1-score
Gaussian NB	0.66
Decision Tree	0.68
Random Forest	0.62
SVM	0.66
KNN	0.66

Classification Algorithms and f1-score

Classification Result



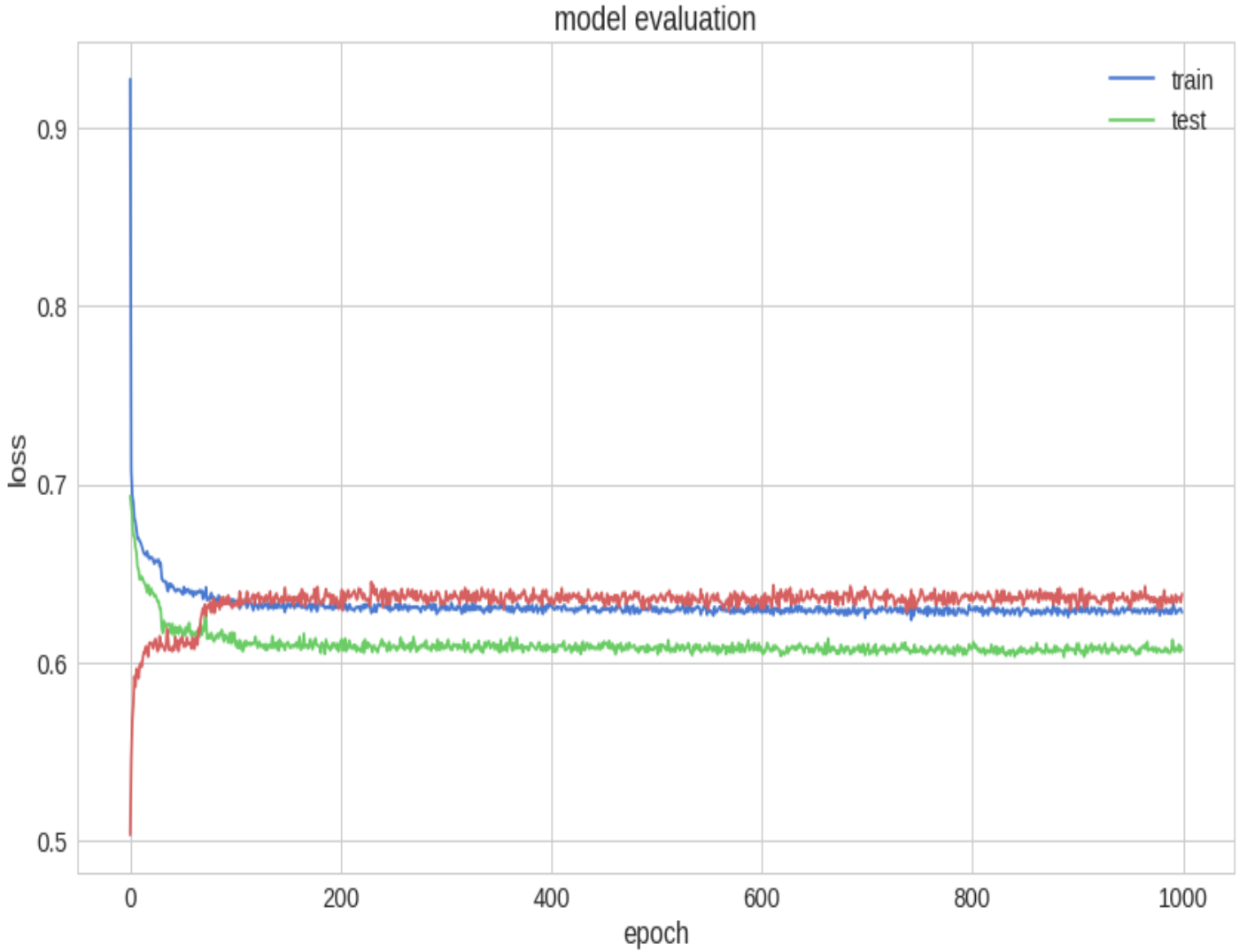
Neural Network

Model Summary

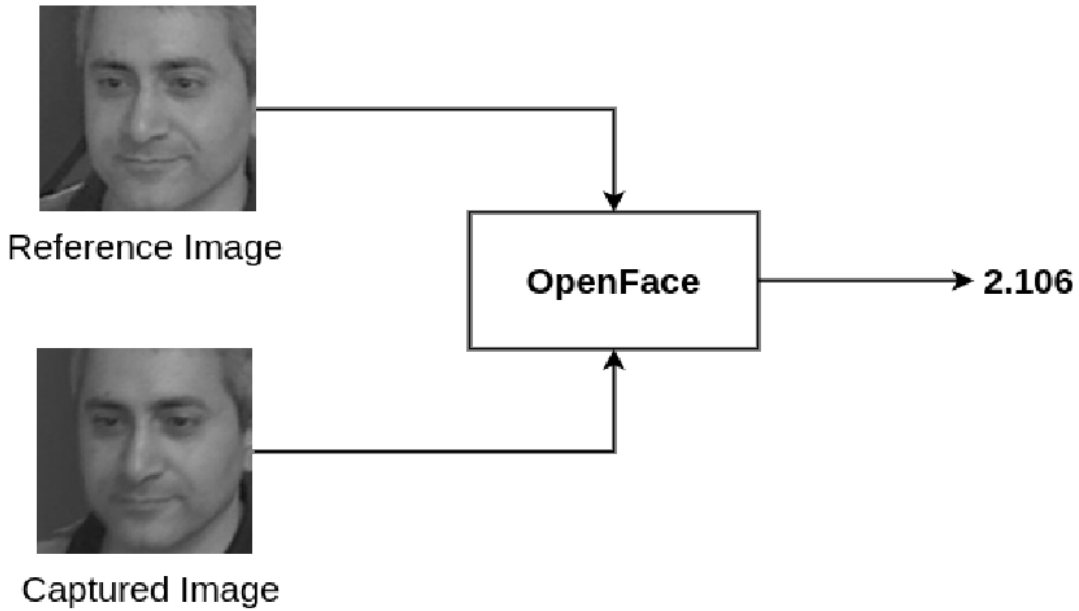
Layer	Output Shape	Param
dense_1(Dense)	(None, 10)	110
dropout_1(Dropout)	(None, 10)	0
dense_2(Dense)	(None, 5)	55
dropout_2(Dropout)	(None, 5)	0
dense_3(Dense)	(None, 2)	12
dropout_3(Dropout)	(None, 2)	0
dense_4(Dense)	(None, 1)	3

Total params: 180
Trainable params: 180
Non-trainable params: 0

NN Result


model evaluation
train
test
loss
epoch
0.9
0.8
0.7
0.6
0.5
0
200
400
600
800
1000

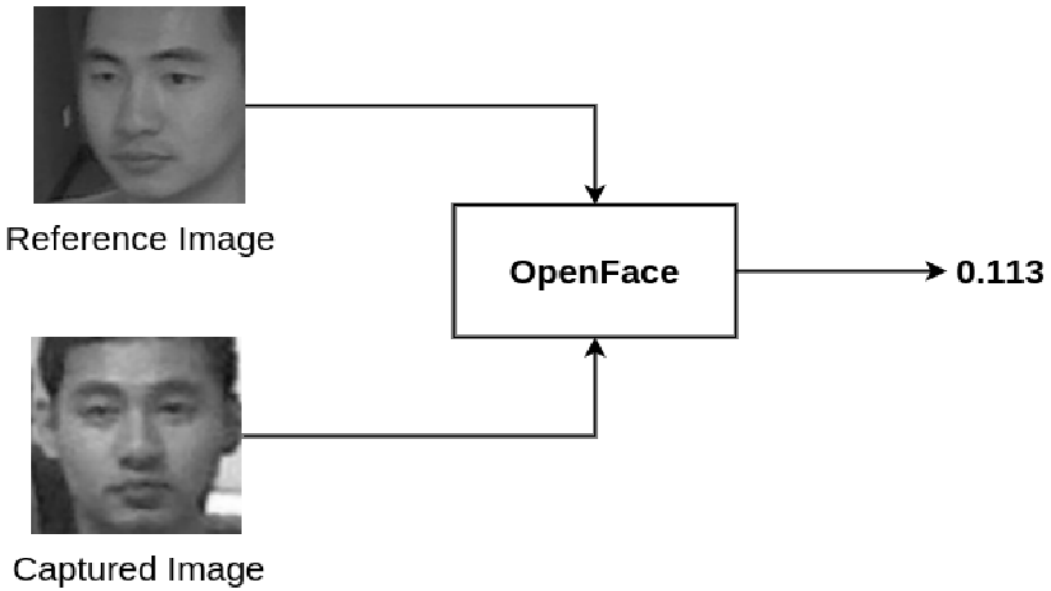
Need for Deep Learning



Feature Vector

Brightness	Face Area	Focus Measure	Eyes Distance	Mouth Distance
33.79	1.09	26.45	0.32	0.27

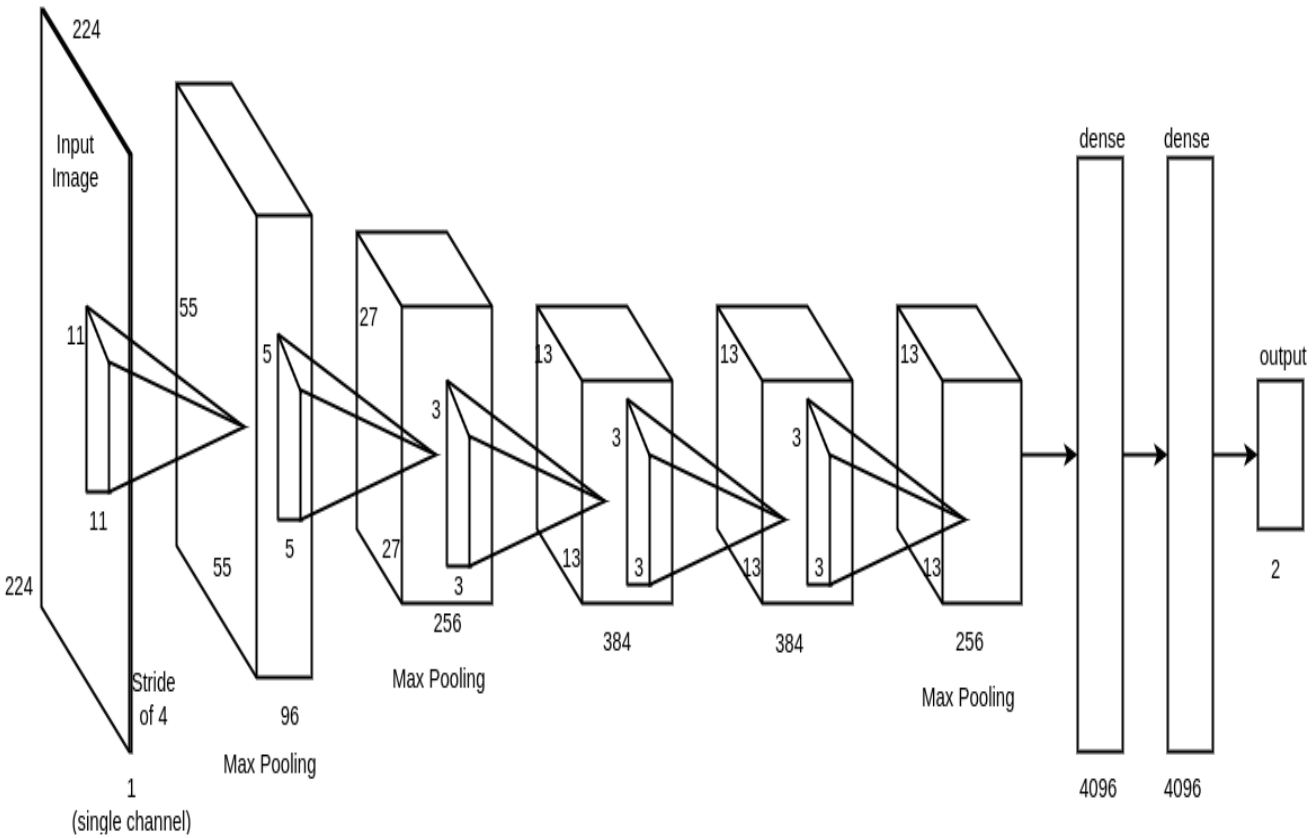
Need for Deep Learning



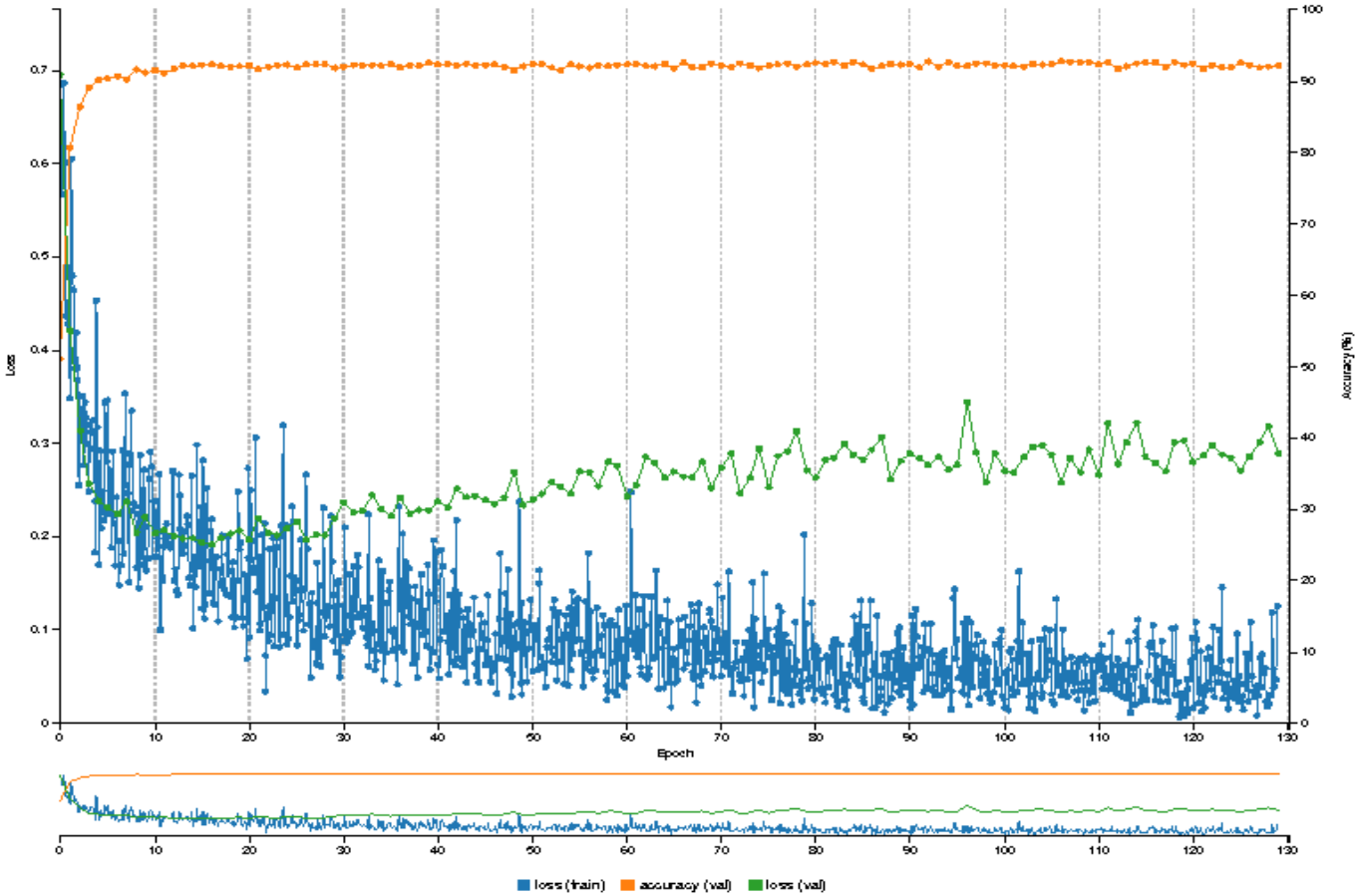
Feature Vector

Brightness	Face Area	Focus Measure	Eyes Distance	Mouth Distance
24.28	1.03	201.78	0.34	0.255

CNN Architecture



CNN Result



Conclusion

- Matcher specific image quality estimation
- Processing at logical extremes of a network
- Applications in security domain
- Future Scope

Thank You!