University of Burgundy

MsCV

MEDICAL IMAGE ANALYSIS

Lab 1 Algorithm Evaluation

by

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1. Introduction

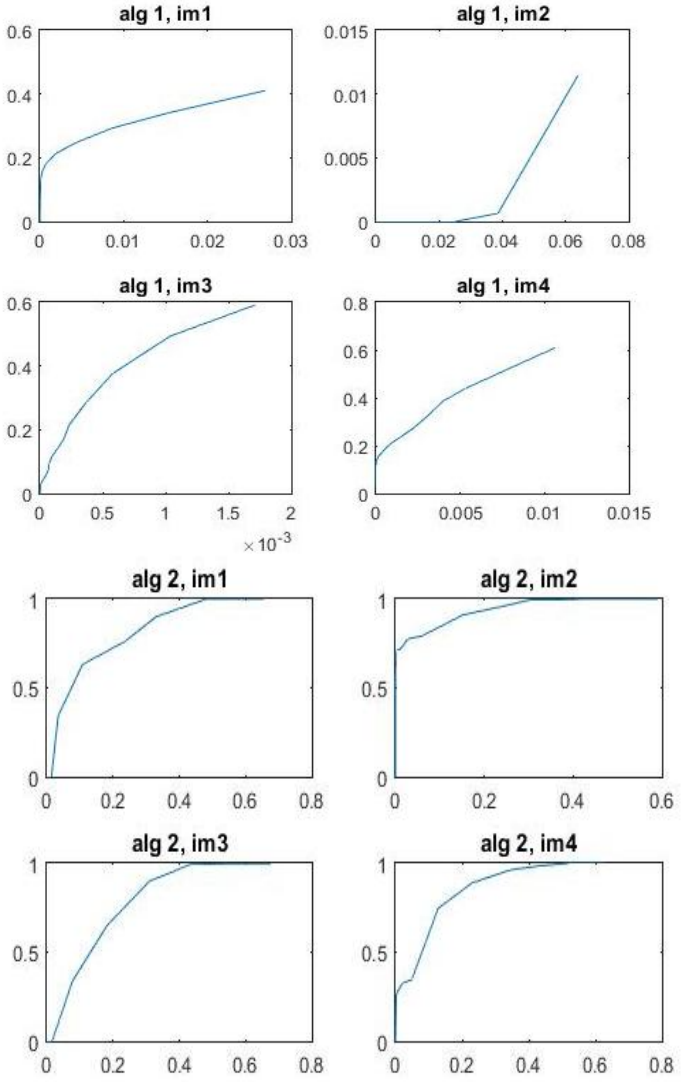
In Computer Aided Diagnosis (CAD), the role of classifier is to properly classify each object instance to a particular class. So, this is the step of decision making and it leads to very significant effects on diagnosis. So, evaluation of these decision making algorithms becomes vital in the process. The performance of a classifier is analyzed by ROC analysis or by measuring the cluster distances.

2. ROC Curves

Receiver Operating Characteristics (ROC) play a significant role in algorithm evaluation. ROC curves also proved useful for the evaluation of machine learning techniques, in comparing and evaluating different classification algorithms.

A ROC graph is a technique for visualizing, organizing and selecting classifiers based on their performance.

The results of ROC curves plotted for different algorithms are as in Fig.1.



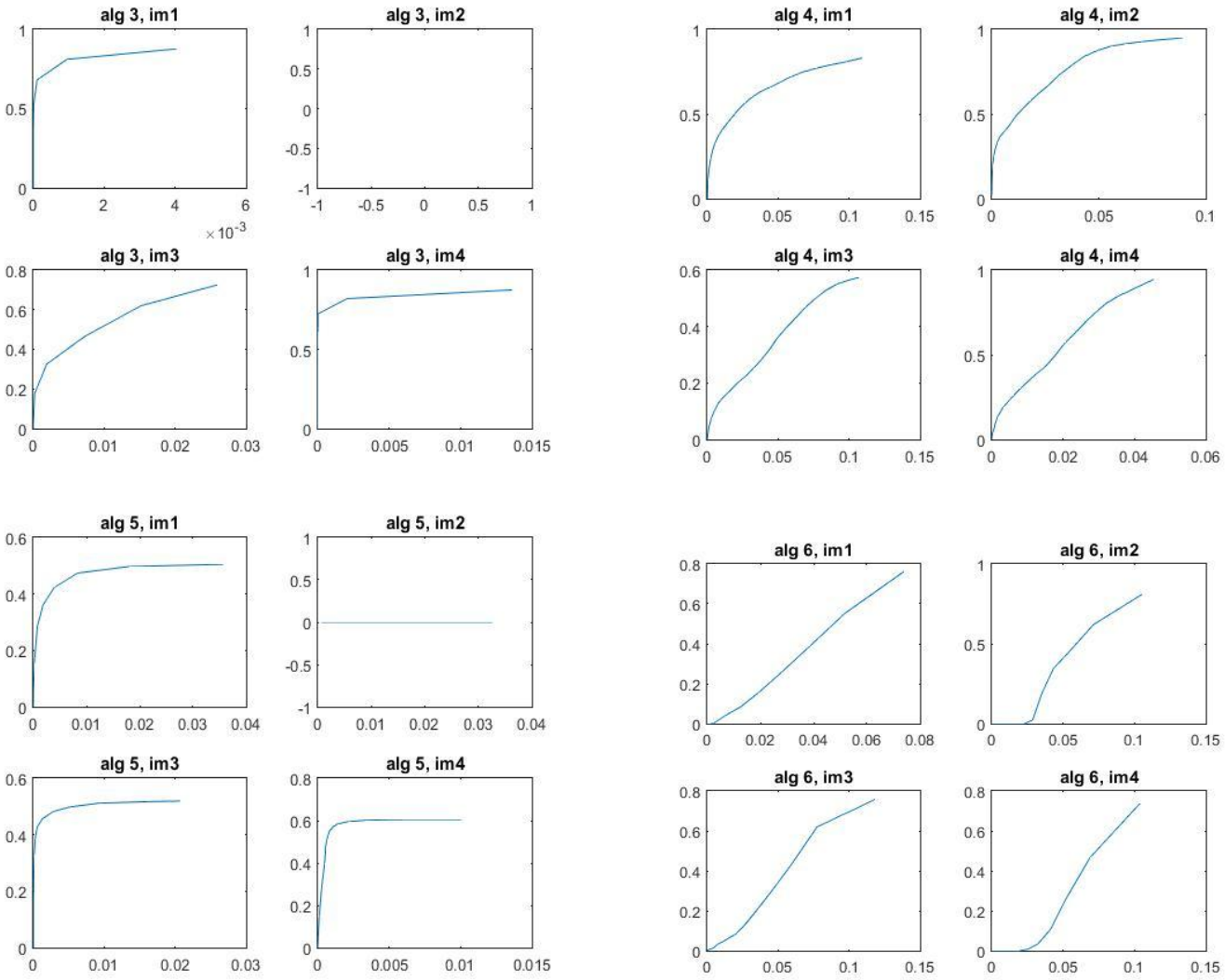


Figure1 ROC plots of all algorithms with all images, the false positive rate is along the horizontal axis and sensitivity along the vertical

From the above ROC curves shown in Fig. 1 **Algorithm 2** has good performance because we can observe that **Area Under Curve (AUC) [1]** for algorithm 2 is far more (the range of false positive rate is high for all images, as is the range of specificity) than other algorithms.

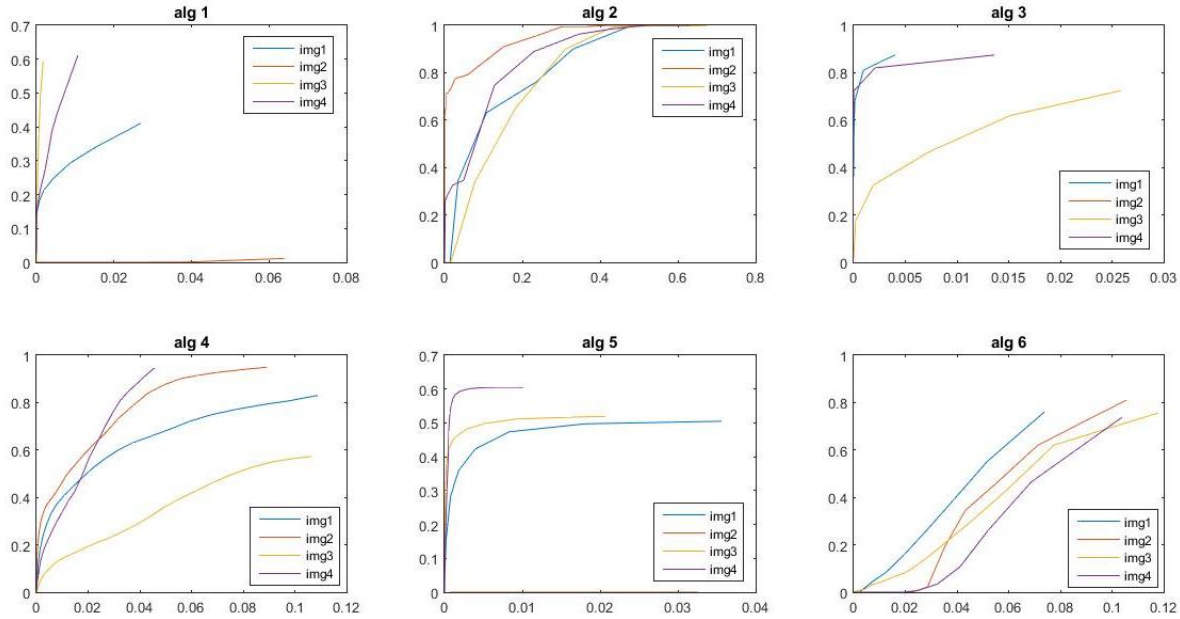


Figure 2 ROC curves of all algorithms for comparison

The code for all the modules can be found in Lab1_AlgorithmEvaluation folder and you can find README.txt file which explains about execution of code.

3. Coefficients and Distances Measures

The Jaccard, Dice coefficients and Hausdorff distance [2] is calculated for each algorithm and for each image for a best possible threshold of each algorithm as given in Tab. 1,2 and 3. We selected the best thresholds by visually checking the ROC curves, for which threshold the false positive rate is low and true positive rate is high.

The files are : jaccardindex.m, diceindex.m and hausdrofdist.m. The hausdorfdist.m file takes time to execute because of computation (~90 sec for each image).

Table 1: Jaccard indices of segmentations and corresponding ground truths for algorithm-image pairs using a certain optimum threshold for each algorithm.

Jaccard Index	**Image1**	**Image2**	**Image3**	**Image4**	**Threshold**
Algo 1	0.172	0	0.211	0.26	50
Algo 2	0.044	0.014	0.042	0.0426	80
Algo 3	0.526	0	0.29	0.6	40
Algo 4	0.123	0.09	0.097	0.23	100
Algo 5	0.284	0	0.428	0.46	70
Algo 6	0	0	0.006	0	120

Table 2: Dice indices of segmentations and corresponding ground truths for algorithm-image pairs using a certain optimum threshold for each algorithm.

Dice index	Image1	Image2	Image3	Image4	Threshold
Algo 1	0.29	0	0.34	0.42	50
Algo 2	0.08	0.02	0.08	0.08	80
Algo 3	0.68	0	0.45	0.75	40
Algo 4	0.21	0.17	0.18	0.37	100
Algo 5	0.44	0	0.59	0.63	70
Algo 6	0	0	0.012	0	120

Table 3: Haussdorf distances between segmentations and corresponding ground truths for algorithm-image pairs using a certain optimum threshold for each algorithm.

Hausdorff Dist	Image1	Image2	Image3	Image4	Threshold
Algo 1	460.39	612.3	257.43	148.83	50
Algo 2	807.2	681.32	559.07	708.84	80
Algo 3	36.67	1e7	501.4	30.08	40
Algo 4	757.54	536.27	475.76	587.03	100
Algo 5	845.23	707.67	564.64	677.26	70
Algo 6	712.45	627.45	564.9	664.46	120

We also tried to select threshold by giving weights to threshold, maximizing the jaccard index of each image at a given threshold and this approach also leads us to similar results as in Tab. 1.

We can say that, comparison of algorithm using a few images and different metrics is not reliable but Area under Curve (AUC) can be considered as one of the good evaluation measure but care should be taken because of different ranges of false positive rates and sensitivities we got for different algorithm-image pairs.

References :

[1] Class slides on Algorithm Evaluation by Dr. Joan Marti.

[2] Daniel P. Hottenlocher et al., "Comparing Images Using the Hausdorff Distance", IEEE trans. on Pattern Analysis and Machine Intelligence, Vol. 15, No. 9, Sept 1993.