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Prediction of Diabetic Retinopathy and Classifiers Sensitivity Analysis

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Khaled Mohamad Almustafa

Presented By:
Dr. Khaled Almustafa
Prince Sultan University
Riyadh, KSA
kalmustafa@psu.edu.sa

Out Line

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- Preparation of the Diabetic Retinopathy Dataset
- Experimental Results
- Feature Selection
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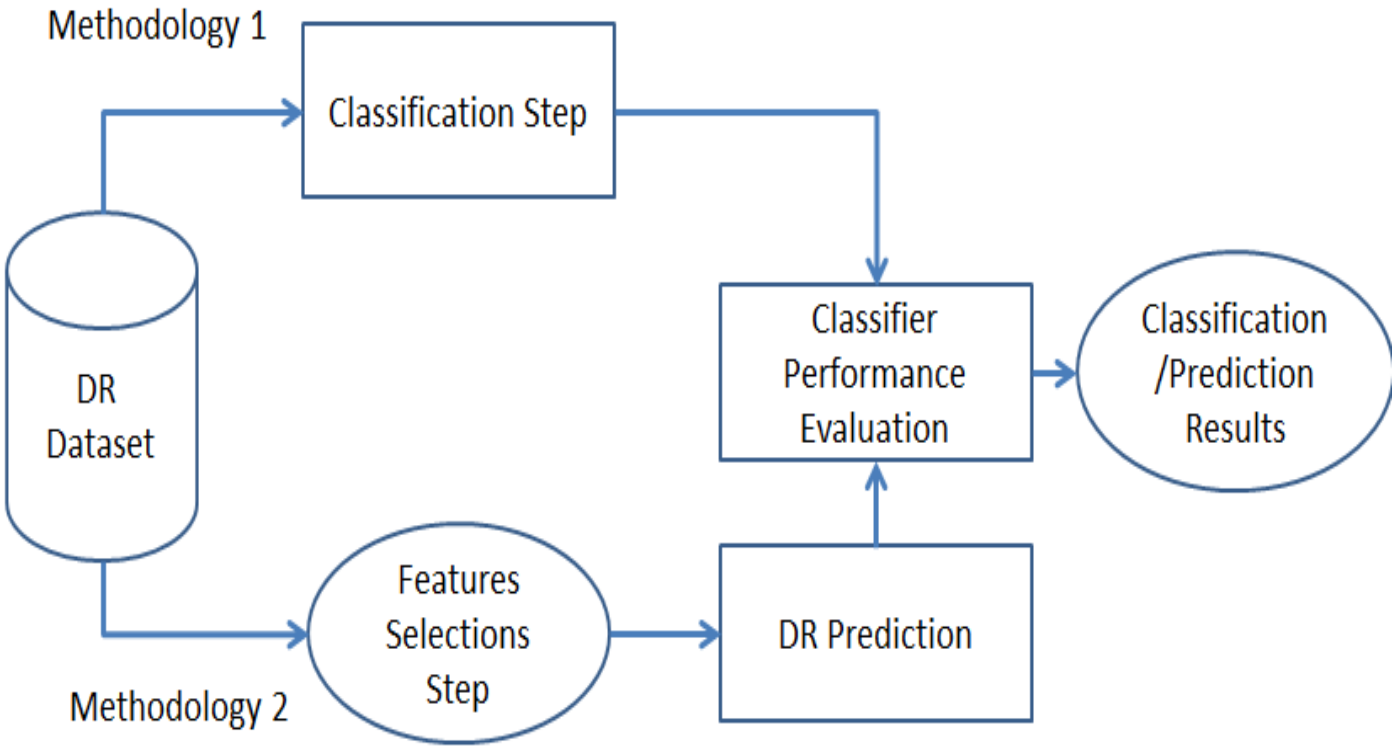
Introduction

- Many eye diseases, such as Diabetic Retinopathy (DR), can lead to blindness without early clinical diagnosis
- DR has a preclinical phase that can't be observed by potential patients, and such phase would be extremely important to take the necessary measures before it is too late.
- An early diagnosis of such disease has been sought for many years,
- Many data analytics tools have been applied to help health care providers to identify some of the early signs of DR.
- Many tests can be performed on potential patients to take the extra precautions measures to reduce the effect of having such a disease
- Reliable methods to predict early stages of DR, such as Number of Machine Learning (ML) algorithms:
  - Naïve Bayes,
  - Stochastic Gradient Descents (SGD),
  - Multilayer Perceptron

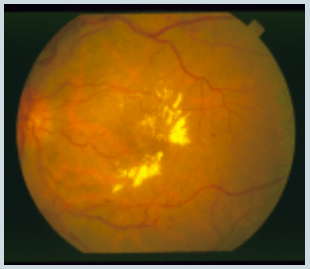
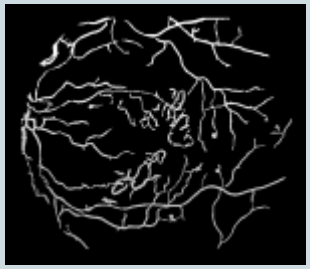
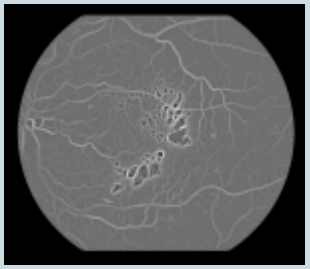
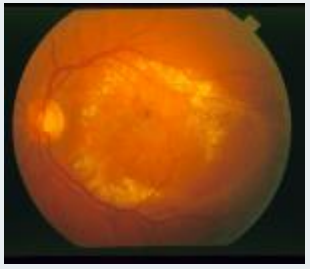
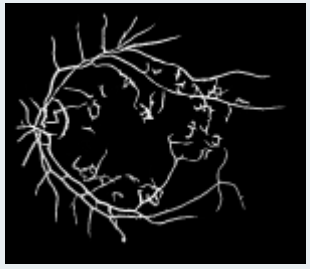
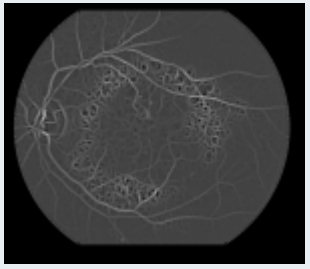
Methodology



Diabetic Retinopathy Dataset's Attributes

- The DR dataset used in this paper contains features extracted from the Messidor image set.
- The original dataset contains 1052 samples and 20 attributes (features), including the class attribute, and 611 cases with DR and 540 healthy samples.

Sample of Retina images from the STARE dataset

Sample Image	Raw Image	Vessels	MSF Vessels
1			
2			

Diabetic Retinopathy Dataset's Attributes

Number	Attribute	Value	Note	Clarification
0	quality assessment.	0,1	0 = bad quality 1=sufficient quality	Binary values
1	pre-screening, where	0,1	1 = indicates severe retinal abnormality 0 = its lack	Binary values
2-7	MA detection.	levels alpha = 0.5, . . . , 1	Each feature value stand for the number of MAs found at the confidence	Discreet values Microaneurysm detection in retinal images
8-15	Exudates detection.	levels alpha = 0.5, . . . , 1	set of points	Discreet values
16	The Euclidean distance	0.367-0.592	of the center of the macula and the center of the optic disc to provide information regarding the patient's condition.	Continuous values
17	Diameter	0-3.087	The diameter of the optic disc.	Continuous values
18	AM/FM	0,1	AM/FM-based classification.	Binary values amplitude-modulation and frequency-modulation (AM-FM) methods for discriminating between normal and pathological retinal images.
19	Class	1 = contains signs of DR 0 = no signs of DR.	Accumulative label for the Messidor classes 1, 2, 3	Binary values

Statistical Terminologies

- **Relative absolute error (RAE):**

$$RAE = \left| \frac{V_A - V_E}{V_E} \right|$$

RAE Is the value of the relative error divided by the exact value

- **Mean Absolute Error (MAE):**

$$MAE = \frac{\sum_{i=1}^{n} |V_{Ai} - V_{Ei}|}{n}$$

MAE is a value of the relative error divided by the number of instances

- **Area Under Curve (ROC):** is a classification parameter to distinguish how well a classifier is performing in term of the accuracy of identifying data point

Experimental Results

- **Using Different Classifiers**
  - **Logistic Regression**

$$log_b \frac{p}{1-p} = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

  - **Naïve Bayes**

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

  - **Stochastic Gradient Descent (SGD):** In Stochastic Gradient Descent, for each iteration, samples are selected randomly using a term "batch" for number of samples, instead of the whole data set, and these batches are used to calculate the gradient for each iteration.
  - **Multilayer Perceptron (MP):** A class of feed forward artificial neural network (ANN), and it utilizes a supervised learning technique called back propagation for training for instances classification.
  - **Random Forest (RF):** Random forest classifier is a collection of multiple random trees classifiers and usually an average of all trees classification results will be combined to give the performance of the random forest classification

Experimental Results

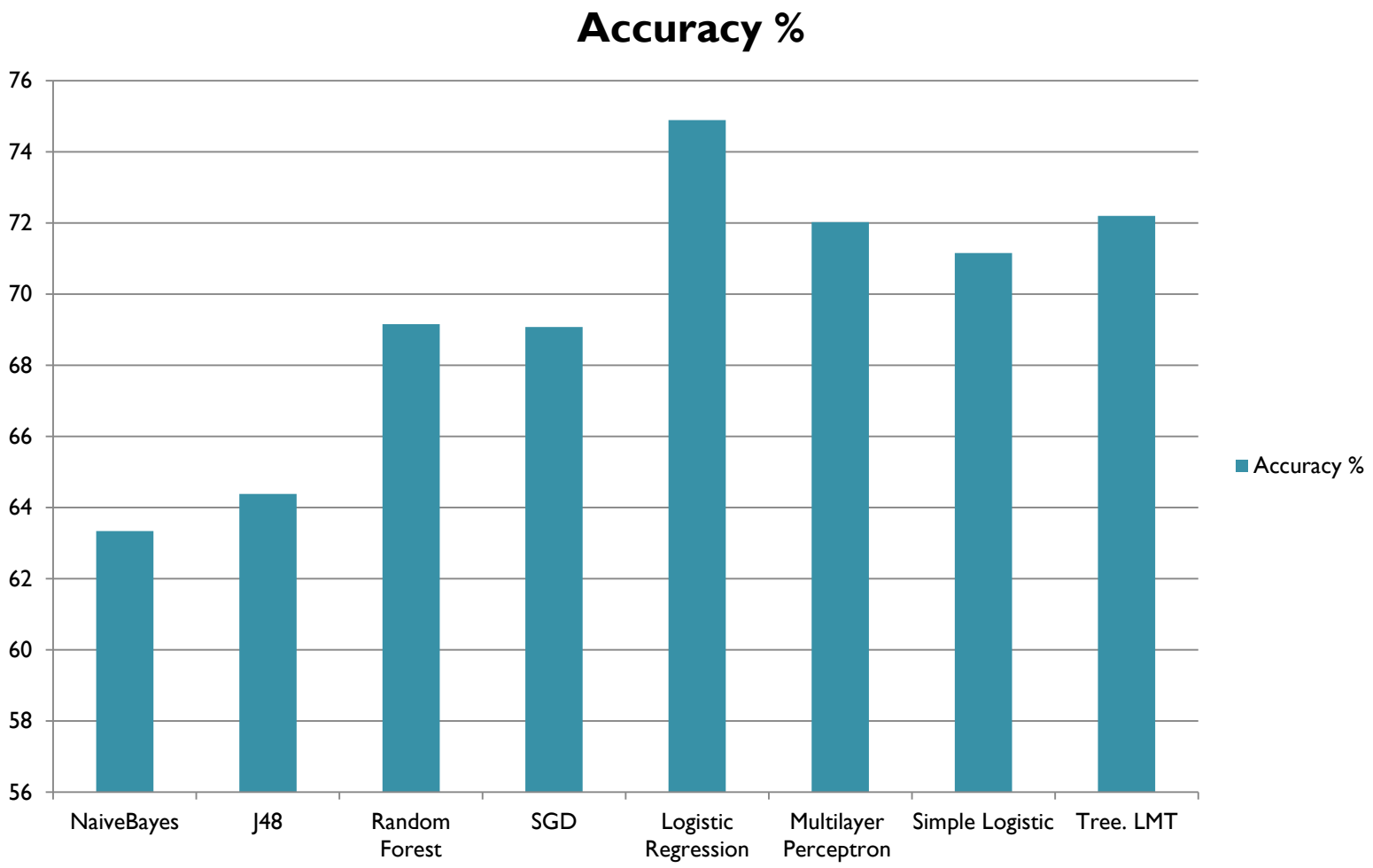
- **Parameter's Sensitivity**
  - **Multilayer Perceptron Learning Rate (LR):** Learning Rate is the rate associated with the MP classifier in term of its classification weight updates, and it is a configurable parameter that influences the convergence of the algorithm
- Feature Selection

Using Classifier Subset Evaluator to estimate the accuracy of these subsets for all used classifiers on the DR dataset in order to evaluate the classification performance after selecting the relevant attributes per classification algorithm

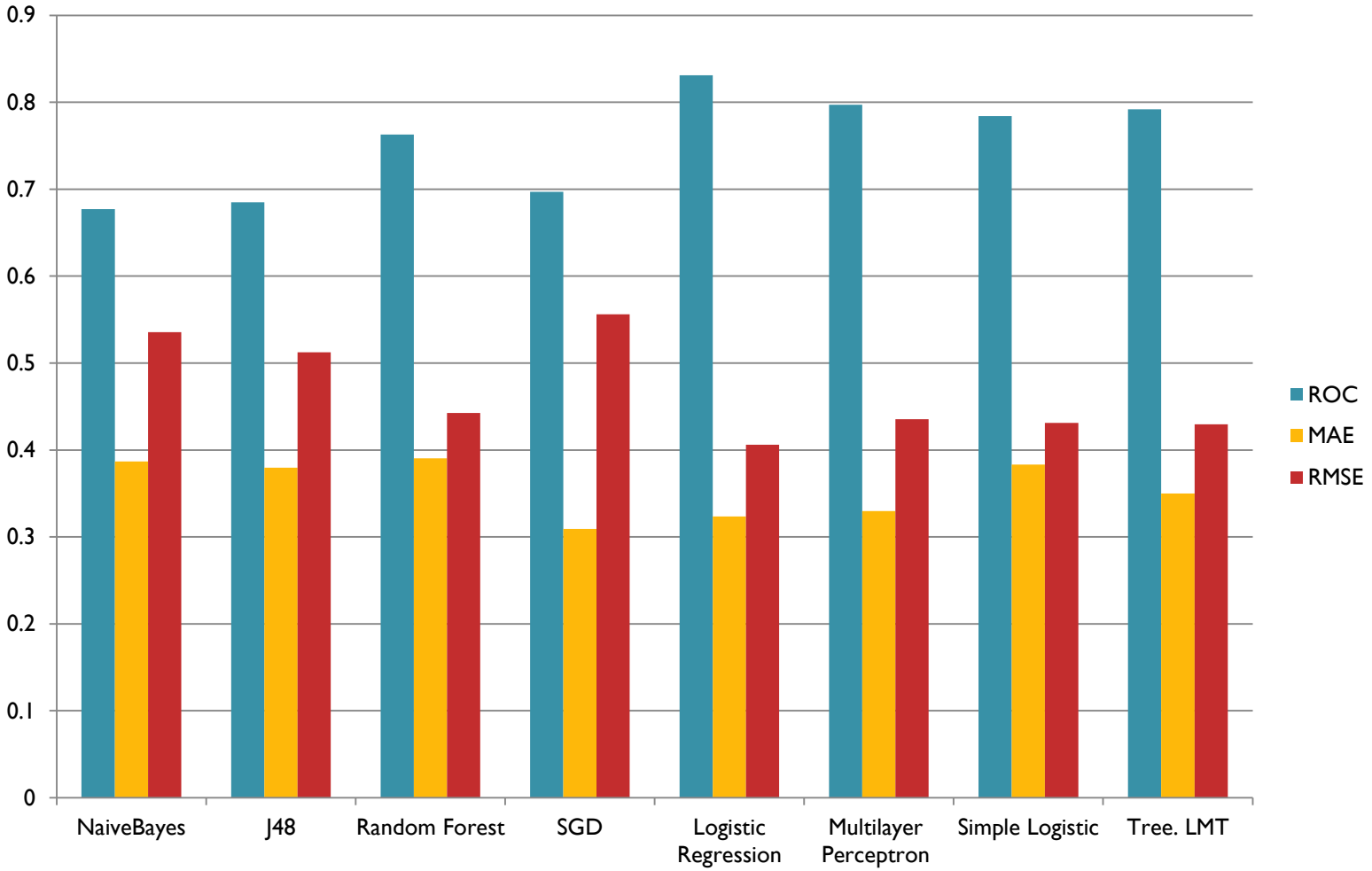
Different Classifiers Results

Classifier Used	Accuracy %	ROC	MAE	RMSE	Time (S)
NaiveBayes	63.3362	0.677	0.3867	0.5356	0.04
J48	64.3788	0.685	0.3796	0.5125	0.04
Random Forest	69.1573	0.763	0.3905	0.4427	0.42
SGD	69.0704	0.697	0.3093	0.5561	0.06
Logistic Regression	74.8914	0.831	0.3236	0.4061	0.14
Multilayer Perceptron	72.0243	0.797	0.3298	0.4353	2.43
Simple Logistic	71.1555	0.784	0.3834	0.4313	0.64
Tree. LMT	72.1981	0.792	0.35	0.4295	3.35

Classification Results in term of the Accuracy



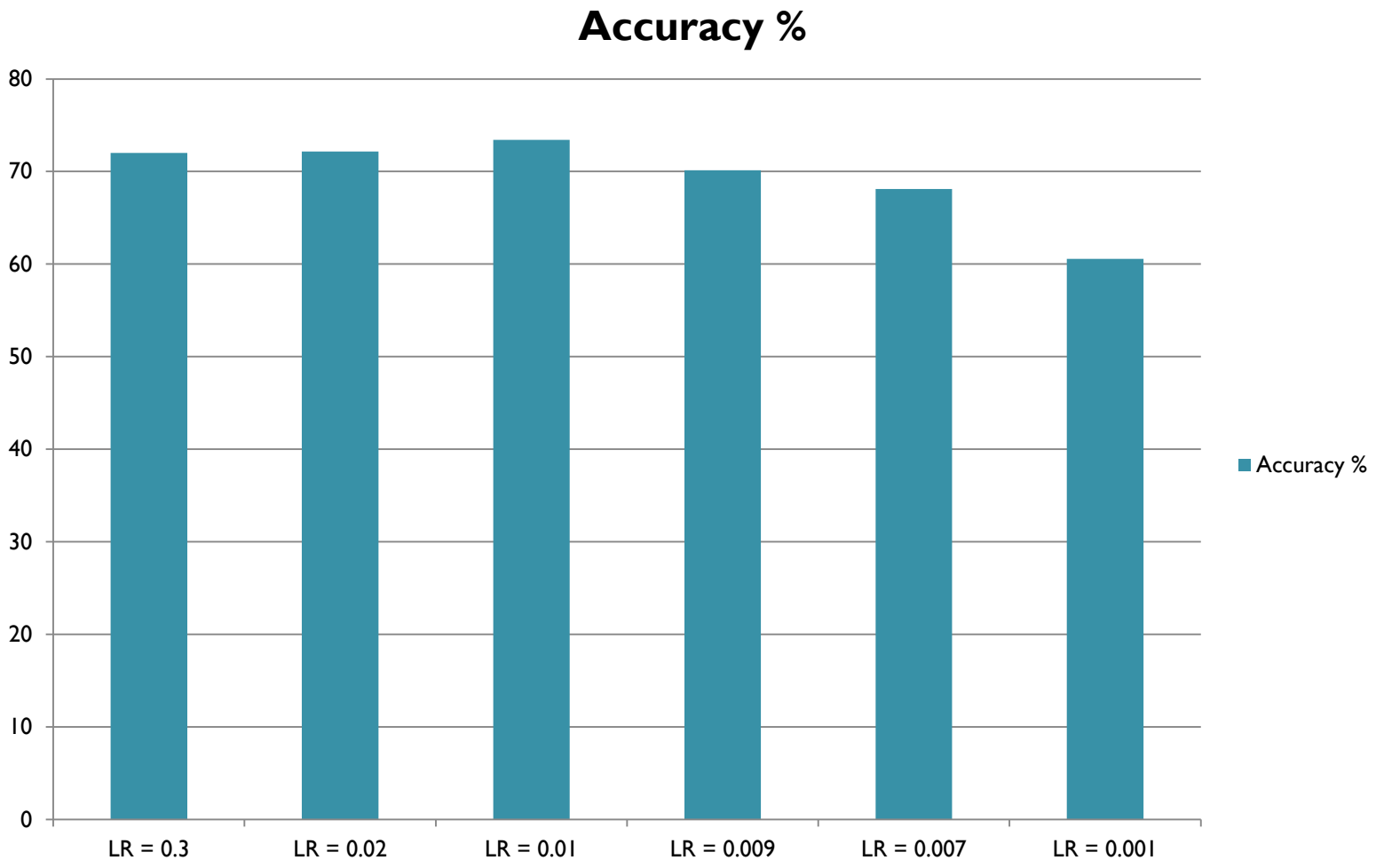
Classification Results in term of the ROC, MAE and RMSE



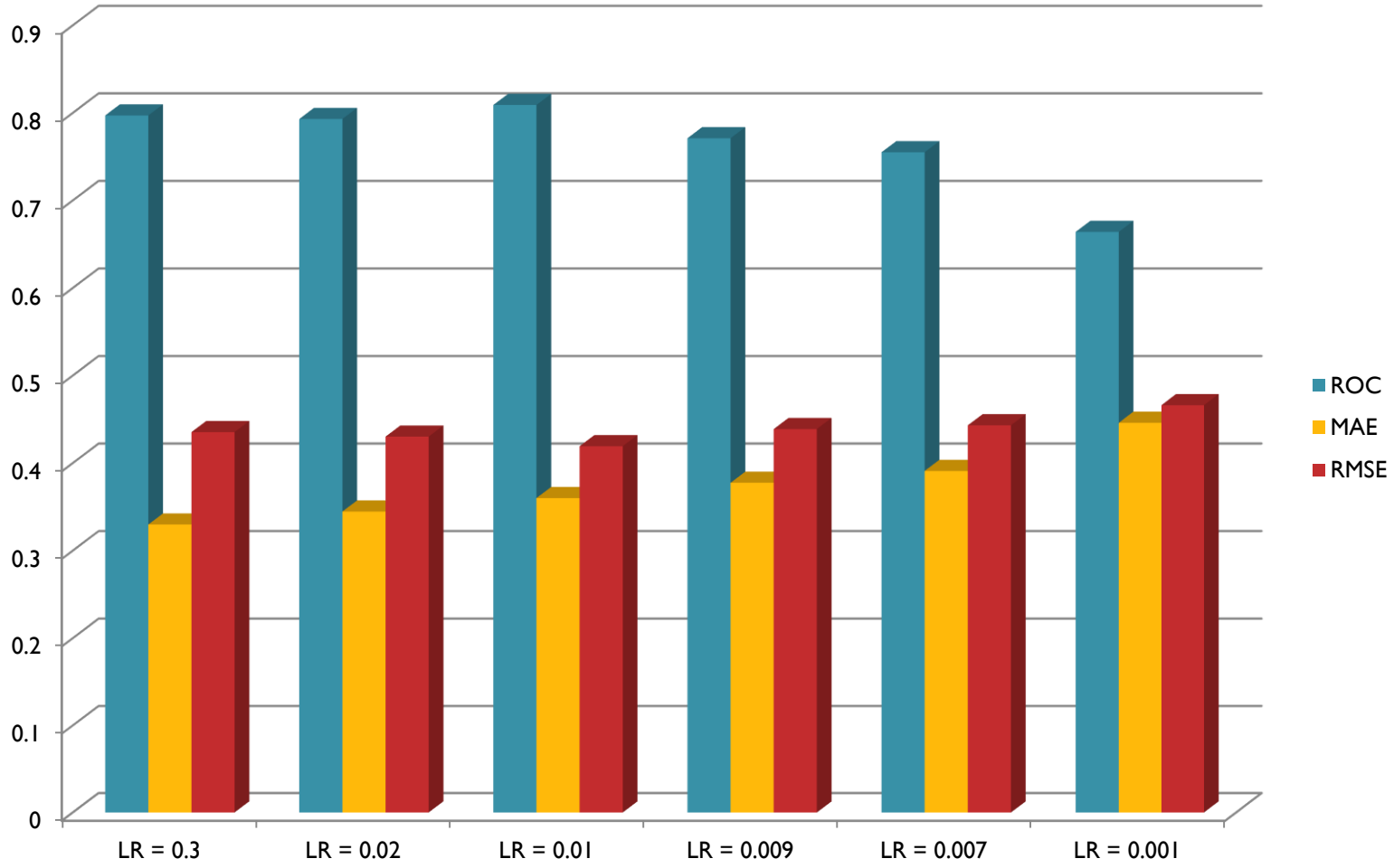
Sensitivity Analysis of the Multilayer Perceptron Learning Rate (LR)

LR	Accuracy %	ROC	MAE	RMSE
0.3	72.0243	0.797	0.3298	0.4353
0.02	72.1739	0.793	0.3446	0.4302
0.01	73.4144	0.809	0.36	0.4192
0.009	70.1449	0.771	0.3775	0.4388
0.007	68.1159	0.755	0.391	0.4431
0.001	60.556	0.664	0.446	0.4661

Classification Accuracy Performance with Changes of LR for MP



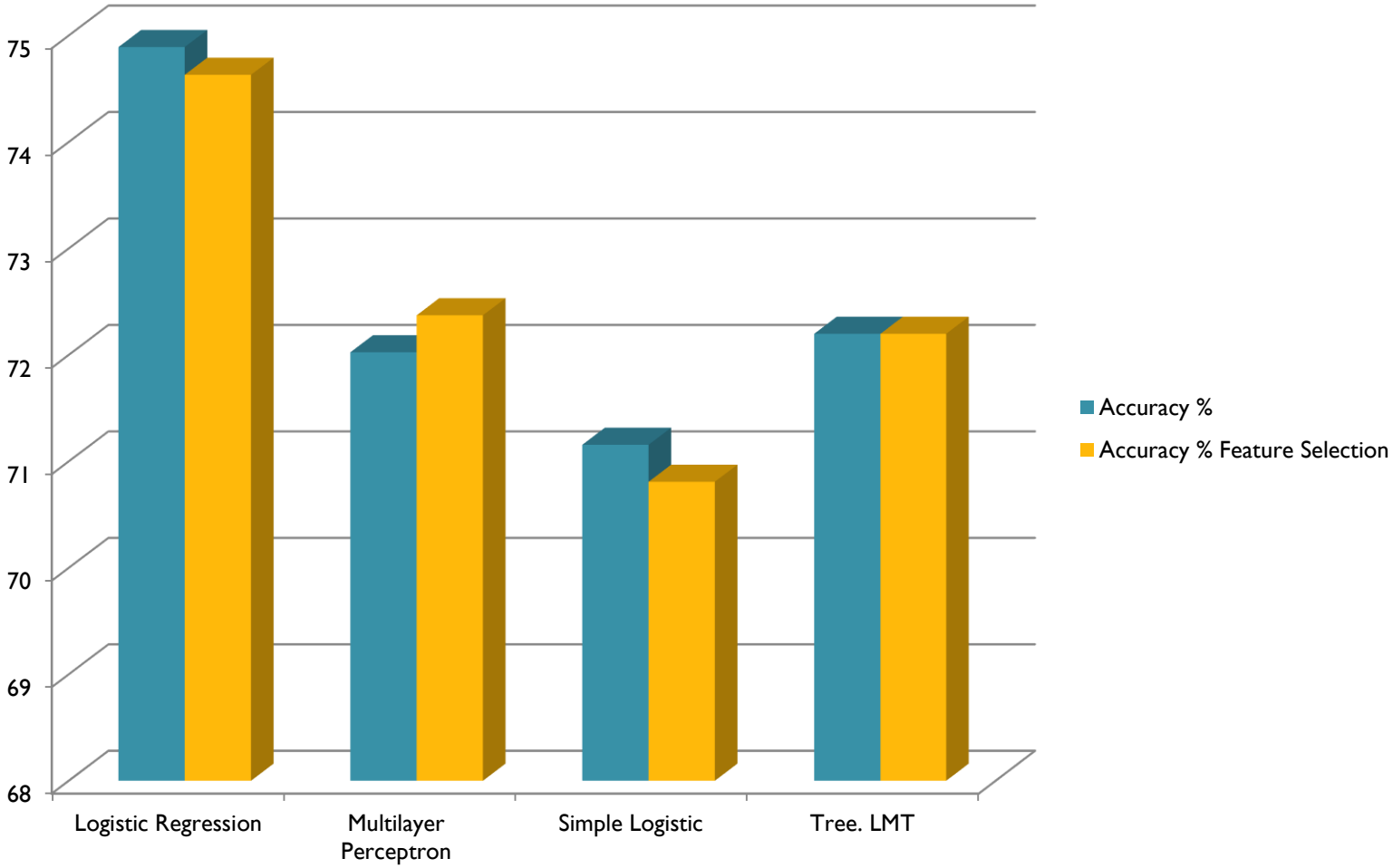
MAE, RAE and ROC Performance with Changes of LR for MP Classifier



Accuracy Results with Feature Selection

Features Selected	Accuracy %	Accuracy % Feature Selection	Selected Features (#)
Logistic Regression	74.8914	74.6308	1,2,3,4,5,6,7,8,9,10,12,13,16,18 (14)
Multilayer Perceptron	72.0243	72.3719	2,3,5,8,9,11,15,18 (8)
Simple Logistic	71.1555	70.808	1,3,5,8,9,10,14,15,17 (9)
Tree. LMT	72.1981	72.1981	1,3,4,6,7,9,10,11,12,13,14,17 (12)

Visual Representation of the Results of Feature Selection



Conclusion

- A comparative analysis of different classifiers was done for the classification of the Diabetic Retinopathy dataset for positive and negative diagnosed participants using different algorithms.
  - It was shown that using different classification algorithms for the classification of the DR dataset produced very promising results in term of the classification accuracy for the Logistic Regression with accuracy of classification of 74.8914%,
- Sensitivity analysis for the MP classifier was applied to study its performance to classify DR dataset with respect to some changes in its LR parameter, and results shows a classification accuracy of 73.4144%,

Conclusion

- A feature extraction method was performed using Classifier Subset Evaluator on the DR dataset to evaluate the classification performance after selecting the relevant attributes per classification algorithm.
  - LR, MP, SL and LMT classifiers were used and a reasonable accuracy of 72.3719% can be obtain to predict a DR case using Multilayer Perceptron by only applying a combination of up to 8 attributes instead of 20 attributes of the full dataset attributes

- We can clearly see the advantages of this analysis in term of comparing different classifiers to classify the DR dataset, and the benefit of having a reliable feature selection method for DR prediction with using minimal number of attributes instead of having to consider all available ones.

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Thank You

Dr. Khaled Mohamad Almustafa
kalmustafa@psu.edu.sa