Appendix D. Comparison of classification algorithms using data preprocessing techniques in binary class models from the perspective of evaluation metrics for the Nemenyi test.

In general, the XBGBoost (eXtreme Gradient-Boosting) algorithm was the one that presented the best results in all analyzed metrics. XBGBoost showed a statistically significant difference from the perspective of all metrics. XBGBoost maintained the first and second most significant distances compared to other algorithms. The LightGBM (Light Gradient-Boosting Model) obtained the third most considerable distance, ranking second as the best algorithm from the perspective of all metrics. RF (Random Forest) and kNN (k-Nearest Neighbors) were always within the margin of the critical distance limit and did not show significant statistical differences. RF had a slight advantage over kNN when compared. Next, the classification algorithms' detailed results are presented from each analyzed metric's perspective.

Precision (Table D.1): the XGBoost algorithm presented a significant statistical difference compared to the kNN and RF algorithms, with the first and second largest distances, with 54% and 29% above the critical margin limit, respectively. LightGBM, with the third most significant distance, also showed a difference compared to kNN, with 17% above the critical distance value. The comparison between LightGBM and RF showed a distance within the critical limit margin, with 92% of the critical distance value. In the other comparisons, all values were within the critical limit margin, varying between 17% and 37% of the critical distance value.

Critical Distance: 1.35						
Group 1	**Ranking**	**Group 2**	**Ranking**	**Distance**	**(%)**	**Hypothesis**
XGB	1.42	LGBM	1.92	0.50	37%	Equal
XGB	1.42	RF	3.17	1.75	129%	Different
XGB	1.42	KNN	3.50	2.08	154%	Different
LGBM	1.92	RF	3.17	1.25	92%	Equal
LGBM	1.92	KNN	3.50	1.58	117%	Different
RF	3.17	KNN	3.50	0.33	24%	Equal

Table D.1: Comparison of classification algorithms using data preprocessing techniques in binary class models from the perspective of **Precision metric** for the Nemenyi test.

Recall (Table D.2): the XGBoost algorithm showed a significant statistical difference compared to the kNN and RF algorithms, with the first and second most significant distances, with 57% and 38% above the critical limit margin, respectively. LightGBM, with the third largest distance, also showed a difference compared to kNN, with 20% above the critical distance value. The comparison between LightGBM and RF showed a slightly significant difference, with 1% above the critical distance value. In the other comparisons, all values were within the critical limit margin, varying between 18% and 37% of the critical distance value.

Critical Distance: 1.35						
Group 1	**Ranking**	**Group 2**	**Ranking**	**Distance**	**(%)**	**Hypothesis**
XGB	1.38	LGBM	1.88	0.50	37%	Equal
XGB	1.38	RF	3.25	1.87	138%	Different
XGB	1.38	KNN	3.50	2.12	157%	Different
LGBM	1.88	RF	3.25	1.37	101%	Different
LGBM	1.88	KNN	3.50	1.62	120%	Different
RF	3.25	KNN	3.50	0.25	18%	Equal

Table D.2: Comparison of classification algorithms using data preprocessing techniques in binary class models from the perspective of **Recall metric** for the Nemenyi test.

F1-Score (Table D.3): the XGBoost algorithm showed a significant statistical difference compared to the RF and kNN algorithms, with the first and second highest distances, with 72% and 29% above the critical limit margin, respectively. The LightGBM, with the third most significant distance, showed a difference when compared to the RF, with 54% above the critical distance value. The comparison between LightGBM and kNN showed a considerable difference, with 11% above the critical distance value. In the other comparisons, all values were within the critical limit margin, varying between 18% and 43% of the critical distance value.

Critical Distance: 1.35						
Group 1	**Ranking**	**Group 2**	**Ranking**	**Distance**	**(%)**	**Hypothesis**
XGB	1.42	LGBM	1.67	0.25	18%	Equal
XGB	1.42	KNN	3.17	1.75	129%	Different
XGB	1.42	RF	3.75	2.33	172%	Different
LGBM	1.67	KNN	3.17	1.50	111%	Different
LGBM	1.67	RF	3.75	2.08	154%	Different
KNN	3.17	RF	3.75	0.58	43%	Equal

Table D.3: Comparison of classification algorithms using data preprocessing techniques in binary class models from the perspective of **F1-Score metric** for the Nemenyi test.

FAR (Table D.4): the XGBoost algorithm showed a significant statistical difference compared to the kNN and RF algorithms, with the first and second largest distances, with 42% and 17% above the critical limit margin, respectively. LightGBM, with the third most significant distance, showed a difference when compared to kNN, with only 5% above the critical distance value. The comparison between LightGBM and RF showed a distance within the critical limit margin, with 80% of the critical distance value. In the other comparisons, all values were within the critical limit margin, varying between 25% and 37% of the critical distance value.

Critical Distance: 1.35						
Group 1	**Ranking**	**Group 2**	**Ranking**	**Distance**	**(%)**	**Hypothesis**
XGB	1.50	LGBM	2.00	0.50	37%	Equal
XGB	1.50	RF	3.08	1.58	117%	Different
XGB	1.50	KNN	3.42	1.92	142%	Different
LGBM	2.00	RF	3.08	1.08	80%	Equal
LGBM	2.00	KNN	3.42	1.42	105%	Different
RF	3.08	KNN	3.42	0.34	25%	Equal

Table D.4: Comparison of classification algorithms using data preprocessing techniques in binary class models from the perspective of **FAR metric** for the Nemenyi test.