

Appendix B

Besides providing the detailed results in Figure 9-10, to further confirm and validate our results in **Tables (2–4; 9-11;13; 16)**, we statistically consider the results of WPRkNN in contrast to its best rival kNNs across all datasets using the paired t-test and P-value test, providing statistical evidence of the robustness of WPRkNN's performance. The tests results are shown in **Tables 1-8**, indicating that WPRkNN is generally quite effective, supporting the findings presented in **Tables 2–4; 9-11;13; 16**. The findings of the statistical analysis are examined in terms of the t-score and p-value, with the widely-used value of the significance threshold being set at 0.05 (95%). The positive and negative signs (in **Tables 1-8**) demonstrate the superiority and inferiority of WPRkNN when compared to its rival kNNs, concerning each evaluation metric. The P value then confirms the fact that it is superior or inferior based on the p value being greater or less than 0.05.

Table 1. Accuracy - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals

Dataset/kNN	Test	ExNRule	CDkNN	LMkNN	WLMkNN
Banknote	T-test	26.52407820	4.28790034	7.77844570	-2.10935719
	P-Value	0.000046186	0.00159146	0.00000962	0.051108198
Glass	T-test	1.55978379	-0.38640672	1.81006732	1.953509625
	P-Value	0.00987124	0.067289822	0.00039121	0.029285502
Transfusion	T-test	3.72978861	6.985855780	-3.70223519	1.058637811
	P-Value	0.00091171	0.049567218	0.104093371	0.003666110
WPbc	T-test	1.57220875	-3.24360747	-0.46298194	1.784490623
	P-Value	0.146977108	0.037815399	0.083288789	0.014660486
Landsat	T-test	-1.38205681	4.261071770	-3.21854530	2.879145520
	P-Value	0.197043588	0.151660222	0.090197800	0.016409532
Wine	T-test	-1.25254535	1.794524621	0.582255547	-5.076712041
	P-Value	0.008870580	0.092966163	0.013287095	0.1104800893
Page Blocks	T-test	0.786889021	2.502836660	2.309609547	4.3097980980
	P-Value	0.049593352	0.031294402	0.043536333	0.0015375672
PLRX	T-test	0.476984897	2.801221582	3.627694554	3.5213013301
	P-Value	0.043625367	0.018755202	0.004630226	0.0055264202
Ecoli	T-test	1.659310430	-0.68314799	2.143629975	1.2993953542
	P-Value	0.028041900	0.010030329	0.037680865	0.0229652472
Optical digits	T-test	18.05143922	6.704777135	2.144386183	7.1597580911
	P-Value	0.000017126	0.000828197	0.057607358	0.0090395403
Robot-navigation	T-test	-11.3764404	2.463432619	-0.474979908	-1.581083041
	P-Value	0.017523465	0.033479165	0.6450047980	0.1449403301
pen_digits	T-test	5.207825128	6.626675117	-0.239257081	9.8957569600
	P-Value	0.000396785	0.005831318	0.0557385890	0.0007496515
Wdbc	T-test	1.717121850	-12.2440529	0.9720402722	0.5243518211
	P-Value	0.126711969	0.416933807	0.0339552158	0.0414584750

Table 2. F1 Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals

Dataset/kNN	Test	ExNRule	CDkNN	WLMkNN
Banknote	T-test	38.93570382	6.171280756	-3.05138541
	P-Value	0.000008312	0.017368334	0.056064436
Glass	T-test	2.019352629	-1.23100409	2.749076789
	P-Value	0.046396107	0.231930941	0.002023604
Transfusion	T-test	3.110741771	4.562062012	-0.332319822
	P-Value	0.000290411	0.005169552	0.142942070
WPbc	T-test	5.612629815	0.698426088	2.151855201
	P-Value	1.432925442	0.492573340	0.043196590
Landsat	T-test	6.619061812	-0.48719532	4.323464452
	P-Value	0.017892173	0.631166751	0.009299791
Wine	T-test	-1.123733041	3.868544817	-2.643478929
	P-Value	0.273808617	0.082892041	1.715193766
Page Blocks	T-test	-0.548211212	2.777479573	3.393401131
	P-Value	0.5893277289	0.011284648	0.002740172
PLRX	T-test	0.3128150876	2.582279075	3.389951580
	P-Value	0.7575065076	0.017376710	0.002762442
Ecoli	T-test	1.8060535733	-1.36007498	-0.259999749
	P-Value	0.0452648502	0.188229309	0.7973961251
Optical digits	T-test	26.562060870	9.747414826	10.464755664
	P-Value	0.0020650447	0.000309356	0.0067249519
Robot-navigation	T-test	-14.80174185	3.029136346	-2.624543790
	P-Value	0.0302402767	0.006381855	0.0158399090
pen_digits	T-test	7.5828312550	4.489388980	9.8958144307
	P-Value	0.0092515472	0.066201664	0.0000783202
Wdbc	T-test	-0.405278278	1.159707791	1.4053243211
	P-Value	0.0004721101	0.259184067	0.3009812255

Table 3. ROC Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals

Dataset/kNN	Test	ExNRule	CDkNN	WLMkNN
Banknote	T-test	28.47507495	4.076241756	-2.05362779
	P-Value	0.000000205	0.002227753	0.067099522901
Glass	T-test	1.558836133	-0.38826880	1.9539298080
	P-Value	0.0400940237	0.705954682739	0.049230261
Transfusion	T-test	0.914318981	2.736795914	2.267284720
	P-Value	0.032066291	0.02094763302	0.0467859438
WPbc	T-test	-4.72293113	-1.67490373	2.3014348331
	P-Value	0.0008128252	0.024892311	0.04414638249
Landsat	T-test	-1.384494279	4.276179870	2.907757702
	P-Value	0.0063194555	0.00162112393	0.0156246109
Wine	T-test	-1.2490096385	1.798590920	-5.0368252664
	P-Value	0.0001076389	0.10228672533	0.210508994
Page Blocks	T-test	0.7878385971	2.5465546676	4.339267682
	P-Value	0.04906251	0.0290349890	0.0014680586
PLRX	T-test	0.09730252	2.175865797	2.076254667
	P-Value	0.9244087399	0.05462586072	0.03460250
Ecoli	T-test	1.658107170	-0.67803251	1.29927413
	P-Value	0.008287978	0.513133682	0.003005243
Optical digits	T-test	18.25325778	6.573554054	6.9513064884
	P-Value	0.000006596	0.000613545e-05	0.0009019015e-05
Robot-navigation	T-test	-11.37051945	2.491201195	-1.557860207
	P-Value	0.0000013742	0.03192444	0.0103237573
pen_digits	T-test	5.19978606	6.67771629	10.042998723
	P-Value	0.00040142060	0.00431630	0.0003371750
Wdbc	T-test	-13.621649130	0.97216087483	-0.50352545952
	P-Value	0.0000073554	0.0508980979312	0.0255007119

Table 4. F1 - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals – Imbalanced Datasets

Dataset/kNN	Test	ExNRule	CDkNN
Car-good	T-test	4.819600	2.05639026
	P-Value	7.300331925347459e-05	0.041263423742613896
Cleveland	T-test	1.61271987	3.65738179
	P-Value	0.0404437655	0.0013117783516544725
Dermatology	T-test	2.94053956	2.647897301
	P-Value	0.007344599850	0.014376929476067835
Ecoli-0-1-4-6_vs_5	T-test	3.66130244	0.857959654
	P-Value	0.0012992059680738983	0.039976735423301357
Ecoli-0-6-7_vs_5	T-test	6.3095439996	-1.1501256977282
	P-Value	1.9423739667544692e-06	0.26191063841420814
Winequality-red-3_vs_5	T-test	1.3764036800	2.024396655
	P-Value	0.18195008107979638	0.05469342921699774
Yeast-2_vs_8	T-test	5.18168852	-2.805103512
	P-Value	2.9757020481556745e-05	0.010051454281772147
Yeast4	T-test	4.57327312	-1.5473820039
	P-Value	0.00013483523123571117	0.13542174046379932

Table 5. ROC - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals – Imbalanced Datasets

Dataset/kNN	Test	ExNRule	CDkNN
Car-good	T-test	10.82905260	1.7342434
	P-Value	3.317192762405903e-07	0.04077123286915141
Cleveland	T-test	3.001121705	4.44866570
	P-Value	0.012055645917129248	0.0009808567434660476
Dermatology	T-test	7.52418081	2.02789432
	P-Value	1.1644721817581732e-05	0.05749469037342358
Ecoli-0-1-4-6_vs_5	T-test	3.424063202	1.075405022
	P-Value	0.005682311081933931	0.03521549344068766
Ecoli-0-6-7_vs_5	T-test	24.085913843	-0.17847248
	P-Value	7.214934660354465e-11	0.8615964268964942
Winequality-red-3_vs_5	T-test	1.720630805	2.000000000
	P-Value	0.11328653632077512	0.07080395506797942
Yeast-2_vs_8	T-test	12.63838096	-2.73839174
	P-Value	6.816278240328172e-08	0.01928681974221267
Yeast4	T-test	14.406909983	-1.353280199
	P-Value	1.741310454965492e-08	0.20312234850456917

Table 6. GM - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals – Imbalanced Datasets

Dataset/kNN	Test	ExNRule	CDkNN
Car-good	T-test	12.2376872713	2.4160124046
	P-Value	9.506456541500606e-08	0.034247905521892615
Cleveland	T-test	4.33162404	4.377559302
	P-Value	0.001191327743	0.0011035791658886578
Dermatology	T-test	6.5058727	1.98908672
	P-Value	4.3922659453524533e-05	0.05213944604153992
Ecoli-0-1-4-6_vs_5	T-test	3.689421825	1.341901355
	P-Value	0.0035667486975526773	0.00667068193365304
Ecoli-0-6-7_vs_5_F Measure	T-test	14.3775749	0.0594117055
	P-Value	1.778934488656484e-08	0.9536898064430317
Winequality-red-3_vs_5	T-test	1.81659021	nan
	P-Value	0.09660089692053743	nan
Yeast-2_vs_8	T-test	23.0985443	-2.7317167713
	P-Value	1.1340067162545112e-10	0.019518349188324666
Yeast4	T-test	13.371326177	-2.0456605914
	P-Value	3.797022776805832e-08	0.06546309584107013

Table 7. Accuracy - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals – Noisy Datasets

Dataset/kNN	Test	ExNRule	CDkNN
heart h-an-nn	T-test	0.283493703	-0.2309094484
	P-Value	0.0120629277136418	0.8216237560604485
page-blocks-an-nn	T-test	0.736790453	1.56526950970
	P-Value	0.4766706011100137	0.04581521537937528
Segment-an-nn	T-test	-3.0046418414	0.6146813146
	P-Value	0.011980038108887658	0.0512680017956189
wdbc-an-nn_Accuracy	T-test	3.2609854666	3.1671568178
	P-Value	0.007585689792842773	0.008963903579666935
Wine-an-nn	T-test	-9.92151892765	1.586327679
	P-Value	7.998138496188458e-07	0.04097210123869874

Table 8. Accuracy - Statistical Significance with Paired T-test for WPRkNN vs. Best Rivals – Imbalanced Datasets

Dataset/kNN	Test	ExNRule	CDkNN
Haptics	T-test	30.2782371	7.796866519
	P-Value	3.191264858729269e-21	.7432794140253054e-08
Strawberry	T-test	35.47226170	22.856240333
	P-Value	6.649788881428509e-23	2.840376311684064e-18
GunPoint	T-test	-9.078799640	8.4947073002
	P-Value	2.171932006388704e-09	7.734995885269311e-09
Fish	T-test	8.5748861277	59.459082041
	P-Value	6.480068267580953e-09	1.9080365942372042e-28
Herring	T-test	12.2125609463	20.4457438501
	P-Value	4.925286887352079e-12	4.0191947541367003e-17
Meat	T-test	29.3651001026	29.3651001026
	P-Value	6.72484752239233e-21	6.72484752239233e-21