Output tables for the test of Multiple comparisons.

June 12, 2025

1 Average rankings of Friedman test

Average ranks obtained by applying the Friedman procedure

Friedman statistic considering reduction performance (distributed according to chi-square with 15 degrees of freedom: 488.76777.

P-value computed by Friedman Test: 2.2276680500254997E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 15 and 525 degrees of freedom: 333.908397.

P-value computed by Iman and Daveport Test: 5.171982459451586E-257.

Algorithm	Ranking
BestCyclicAssignment	5.4444
BestNearest	4.1667
CLARA	15
CoefficientPropagation	9.9444
CyclicAssignment	4.1528
Farthest-First	13.8889
KMEANS	13
NearestByCustomer	3.7361
NearestByDepot	8.7917
PAM	16
Parallel	5.4861
RandomByElement	1.7639
Simplified	5.1528
Sweep	6.4444
ThreeCriteriaClustering	11.4167
UPGMC	11.6111

Table 1: Average Rankings of the algorithms

2 Post hoc comparisons

Results achieved on post hoc comparisons for $\alpha = 0.05$, $\alpha = 0.10$ and adjusted p-values.

2.1 P-values for $\alpha = 0.05$

Nemenyi's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000417.
Holm's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.001.
Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000417.

i	algorithms	$z = (R_0 - R_i)/SE$	p	Holm
120	PAM vs. RandomByElement	12.686265	0	0.000417
119	CLARA vs. RandomByElement	11.795133	0	0.00042
118	NearestByCustomer vs. PAM	10.928754	0	0.000424
117	Farthest-First vs. RandomByElement	10.804985	0	0.000427
116	CyclicAssignment vs. PAM	10.557448	0	0.000431
115	BestNearest vs. PAM	10.545071	0	0.000435
114	CLARA vs. NearestByCustomer	10.037621	0	0.000439
113	KMEANS vs. RandomByElement	10.012867	0	0.000442
112	PAM vs. Simplified	9.666315	0	0.000446
111	CLARA vs. CyclicAssignment	9.666315	0	0.00045
110	BestNearest vs. CLARA	9.653939	0	0.000455
109	BestCyclicAssignment vs. PAM	9.406402	0	0.000459
108	PAM vs. Parallel	9.369271	0	0.000463
107	Farthest-First vs. NearestByCustomer	9.047473	0	0.000467
106	RandomByElement vs. UPGMC	8.775183	0	0.000472
105	CLARA vs. Simplified	8.775183	0	0.000476
104	CyclicAssignment vs. Farthest-First	8.676168	0	0.000481
103	BestNearest vs. Farthest-First	8.663791	0	0.000485
102	RandomByElement vs. ThreeCriteriaClustering	8.601907	0	0.00049
101	PAM vs. Sweep	8.515269	0	0.000495
100	BestCyclicAssignment vs. CLARA	8.515269	0	0.0005
99	CLARA vs. Parallel	8.478138	0	0.000505
98	KMEANS vs. NearestByCustomer	8.255355	0	0.00051
97	CyclicAssignment vs. KMEANS	7.88405	0	0.000515
96	BestNearest vs. KMEANS	7.871673	0	0.000521
95	Farthest-First vs. Simplified	7.785035	0	0.000526
94	CLARA vs. Sweep	7.624136	0	0.000532
93	BestCyclicAssignment vs. Farthest-First	7.525121	0	0.000538
92	Farthest-First vs. Parallel	7.487991	0	0.000543
91	CoefficientPropagation vs. RandomByElement	7.289961	0	0.000549
90	NearestByCustomer vs. UPGMC	7.017671	0	0.000556
89	KMEANS vs. Simplified	6.992917	0	0.000562
88	NearestByCustomer vs. ThreeCriteriaClustering	6.844395	0	0.000568
87	BestCyclicAssignment vs. KMEANS	6.733003	0	0.000575
86	KMEANS vs. Parallel	6.695873	0	0.000581
85	CyclicAssignment vs. UPGMC	6.646365	0	0.000588
84	Farthest-First vs. Sweep	6.633989	0	0.000595
83	BestNearest vs. UPGMC	6.633989	0	0.000602
82	CyclicAssignment vs. ThreeCriteriaClustering	6.47309	0	0.00061
81	BestNearest vs. ThreeCriteriaClustering	6.460713	0	0.000617
80	NearestByDepot vs. PAM	6.423582	0	0.000625
79	NearestByDepot vs. RandomByElement	6.262683	0	0.000633
78	KMEANS vs. Sweep	5.841871	0	0.000641
77	Simplified vs. UPGMC	5.755233	0	0.000649
76	Simplified vs. ThreeCriteriaClustering	5.581957	0	0.000658
75	CoefficientPropagation vs. NearestByCustomer	5.532449	0	0.000667
74	CLARA vs. NearestByDepot	5.532449	0	0.000676
73	BestCyclicAssignment vs. UPGMC	5.495319	0	0.000685
72	Parallel vs. UPGMC	5.458188	0	0.000694
71	CoefficientPropagation vs. PAM	5.396304	0	0.000704
70	BestCyclicAssignment vs. ThreeCriteriaClustering	5.322043	0	0.000714
69	Parallel vs. ThreeCriteriaClustering	5.284913	0	0.000725
68	CoefficientPropagation vs. CyclicAssignment	5.161144	0	0.000735
67	BestNearest vs. CoefficientPropagation	5.148767	0	0.000746
66	Sweep vs. UPGMC	4.604186	0.000004	0.000758
65	Farthest-First vs. NearestByDepot	4.542302	0.000006	0.000769
64	NearestByCustomer vs. NearestByDepot	4.505171	0.000007	0.000781
63	CLARA vs. CoefficientPropagation	4.505171	0.000007	0.000794
62	Sweep vs. ThreeCriteriaClustering	4.43091	0.000009	0.000806
61	CoefficientPropagation vs. Simplified	4.270011	0.00002	0.00082
60	RandomByElement vs. Sweep	4.170997	0.00003	0.000833
59	CyclicAssignment vs. NearestByDepot	4.133866	0.000036	0.000847
58	BestNearest vs. NearestByDepot	4.121489	0.000038	0.000862
57	PAM vs. ThreeCriteriaClustering	4.084359	0.000044	0.000877
56	BestCyclicAssignment vs. CoefficientPropagation	4.010098	0.000061	0.000893
55	CoefficientPropagation vs. Parallel	3.972967	0.000071	0.000909
54	PAM vs. UPGMC	3.911083	0.000092	0.000926
53	KMEANS vs. NearestByDepot	3.750184	0.000177	0.000943
52	CoefficientPropagation vs. Farthest-First	3.515024	0.00044	0.000962
51	Parallel vs. RandomByElement	3.316994	0.00091	0.00098
50	BestCyclicAssignment vs. RandomByElement	3.279864	0.001039	0.001
49	NearestByDepot vs. Simplified	3.242733	0.001184	0.00102
48	CLARA vs. ThreeCriteriaClustering	3.193226	0.001407	0.001042
47	CoefficientPropagation vs. Sweep	3.118965	0.001815	0.001064
46	RandomByElement vs. Simplified	3.01995	0.002528	0.001087
45	CLARA vs. UPGMC	3.01995	0.002528	0.001111
44	BestCyclicAssignment vs. NearestByDepot	2.982819	0.002856	0.001136
43	NearestByDepot vs. Parallel	2.945689	0.003222	0.001163
42	CoefficientPropagation vs. KMEANS	2.722906	0.006471	0.00119
41	KMEANS vs. PAM	2.673398	0.007509	0.00122
40	NearestByDepot vs. UPGMC	2.512499	0.011988	0.00125
39	NearestByCustomer vs. Sweep	2.413485	0.015801	0.001282
38	NearestByDepot vs. ThreeCriteriaClustering	2.339224	0.019324	0.001316
37	Farthest-First vs. ThreeCriteriaClustering	2.203078	0.027589	0.001351
36	BestNearest vs. RandomByElement	2.141194	0.032258	0.001389
35	CyclicAssignment vs. RandomByElement	2.128817	0.033269	0.001429
34	NearestByDepot vs. Sweep	2.091687	0.036467	0.001471
33	CyclicAssignment vs. Sweep	2.042179	0.041134	0.001515
32	Farthest-First vs. UPGMC	2.029802	0.042377	0.001563

2.2 P-values for $\alpha = 0.10$

Nemenyi's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000833.

Holm's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.002174.

Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000833.

i	algorithms	$z = (R_0 - R_i)/SE$	p	Holm
120	PAM vs. RandomByElement	12.686265	0	0.000833
119	CLARA vs. RandomByElement	11.795133	0	0.00084
118	NearestByCustomer vs. PAM	10.928754	0	0.000847
117	Farthest-First vs. RandomByElement	10.804985	0	0.000855
116	CyclicAssignment vs. PAM	10.557448	0	0.000862
115	BestNearest vs. PAM	10.545071	0	0.00087
114	CLARA vs. NearestByCustomer	10.037621	0	0.000877
113	KMEANS vs. RandomByElement	10.012867	0	0.000885
112	PAM vs. Simplified	9.666315	0	0.000893
111	CLARA vs. CyclicAssignment	9.666315	0	0.000901
110	BestNearest vs. CLARA	9.653939	0	0.000909
109	BestCyclicAssignment vs. PAM	9.406402	0	0.000917
108	PAM vs. Parallel	9.369271	0	0.000926
107	Farthest-First vs. NearestByCustomer	9.047473	0	0.000935
106	RandomByElement vs. UPGMC	8.775183	0	0.000943
105	CLARA vs. Simplified	8.775183	0	0.000952
104	CyclicAssignment vs. Farthest-First	8.676168	0	0.000962
103	BestNearest vs. Farthest-First	8.663791	0	0.000971
102	RandomByElement vs. ThreeCriteriaClustering	8.601907	0	0.00098
101	PAM vs. Sweep	8.515269	0	0.00099
100	BestCyclicAssignment vs. CLARA	8.515269	0	0.001
99	CLARA vs. Parallel	8.478138	0	0.00101
98	KMEANS vs. NearestByCustomer	8.255355	0	0.00102
97	CyclicAssignment vs. KMEANS	7.88405	0	0.001031
96	BestNearest vs. KMEANS	7.871673	0	0.001042
95	Farthest-First vs. Simplified	7.785035	0	0.001053
94	CLARA vs. Sweep	7.624136	0	0.001064
93	BestCyclicAssignment vs. Farthest-First	7.525121	0	0.001075
92	Farthest-First vs. Parallel	7.487991	0	0.001087
91	CoefficientPropagation vs. RandomByElement	7.289961	0	0.001099
90	NearestByCustomer vs. UPGMC	7.017671	0	0.001111
89	KMEANS vs. Simplified	6.992917	0	0.001124
88	NearestByCustomer vs. ThreeCriteriaClustering	6.844395	0	0.001136
87	BestCyclicAssignment vs. KMEANS	6.733003	0	0.001149
86	KMEANS vs. Parallel	6.695873	0	0.001163
85	CyclicAssignment vs. UPGMC	6.646365	0	0.001176
84	Farthest-First vs. Sweep	6.633989	0	0.00119
83	BestNearest vs. UPGMC	6.633989	0	0.001205
82	CyclicAssignment vs. ThreeCriteriaClustering	6.47309	0	0.00122
81	BestNearest vs. ThreeCriteriaClustering	6.460713	0	0.001235
80	NearestByDepot vs. PAM	6.423582	0	0.00125
79	NearestByDepot vs. RandomByElement	6.262683	0	0.001266
78	KMEANS vs. Sweep	5.841871	0	0.001282
77	Simplified vs. UPGMC	5.755233	0	0.001299
76	Simplified vs. ThreeCriteriaClustering	5.581957	0	0.001316
75	CoefficientPropagation vs. NearestByCustomer	5.532449	0	0.001333
74	CLARA vs. NearestByDepot	5.532449	0	0.001351
73	BestCyclicAssignment vs. UPGMC	5.495319	0	0.00137
72	Parallel vs. UPGMC	5.458188	0	0.001389
71	CoefficientPropagation vs. PAM	5.396304	0	0.001408
70	BestCyclicAssignment vs. ThreeCriteriaClustering	5.322043	0	0.001429
69	Parallel vs. ThreeCriteriaClustering	5.284913	0	0.001449
68	CoefficientPropagation vs. CyclicAssignment	5.161144	0	0.001471
67	BestNearest vs. CoefficientPropagation	5.148767	0	0.001493
66	Sweep vs. UPGMC	4.604186	0.000004	0.001515
65	Farthest-First vs. NearestByDepot	4.542302	0.000006	0.001538
64	NearestByCustomer vs. NearestByDepot	4.505171	0.000007	0.001563
63	CLARA vs. CoefficientPropagation	4.505171	0.000007	0.001587
62	Sweep vs. ThreeCriteriaClustering	4.43091	0.000009	0.001613
61	CoefficientPropagation vs. Simplified	4.270011	0.00002	0.001639
60	RandomByElement vs. Sweep	4.170997	0.00003	0.001667
59	CyclicAssignment vs. NearestByDepot	4.133866	0.000036	0.001695
58	BestNearest vs. NearestByDepot	4.121489	0.000038	0.001724
57	PAM vs. ThreeCriteriaClustering	4.084359	0.000044	0.001754
56	BestCyclicAssignment vs. CoefficientPropagation	4.010098	0.000061	0.001786
55	CoefficientPropagation vs. Parallel	3.972967	0.000071	0.001818
54	PAM vs. UPGMC	3.911083	0.000092	0.001852
53	KMEANS vs. NearestByDepot	3.750184	0.000177	0.001887
52	CoefficientPropagation vs. Farthest-First	3.515024	0.00044	0.001923
51	Parallel vs. RandomByElement	3.316994	0.00091	0.001961
50	BestCyclicAssignment vs. RandomByElement	3.279864	0.001039	0.002
49	NearestByDepot vs. Simplified	3.242733	0.001184	0.002041
48	CLARA vs. ThreeCriteriaClustering	3.193226	0.001407	0.002083
47	CoefficientPropagation vs. Sweep	3.118965	0.001815	0.002128
46	RandomByElement vs. Simplified	3.01995	0.002528	0.002174
45	CLARA vs. UPGMC	3.01995	0.002528	0.002222
44	BestCyclicAssignment vs. NearestByDepot	2.982819	0.002856	0.002273
43	NearestByDepot vs. Parallel	2.945689	0.003222	0.002326
42	CoefficientPropagation vs. KMEANS	2.722906	0.006471	0.002381
41	KMEANS vs. PAM	2.673398	0.007509	0.002439
40	NearestByDepot vs. UPGMC	2.512499	0.011988	0.0025
39	NearestByCustomer vs. Sweep	2.413485	0.015801	0.002564
38	NearestByDepot vs. ThreeCriteriaClustering	2.339224	0.019324	0.002632
37	Farthest-First vs. ThreeCriteriaClustering	2.203078	0.027589	0.002703
36	BestNearest vs. RandomByElement	2.141194	0.032258	0.002778
35	CyclicAssignment vs. RandomByElement	2.128817	0.033269	0.002857
34	NearestByDepot vs. Sweep	2.091687	0.036467	0.002941
33	CyclicAssignment vs. Sweep	2.042179	0.041134	0.00303
32	Farthest-First vs. UPGMC	2.029802	0.042377	0.003125

2.3 Adjusted p-values

i	hypothesis	unadjusted p	p_{Neme}	p_{Holm}	p_{Sha}
1	PAM vs .RandomByElement	0	0	0	0
2	CLARA vs .RandomByElement	0	0	0	0
3	NearestByCustomer vs .PAM	0	0	0	0
4	Farthest-First vs .RandomByElement	0	0	0	0
5	CyclicAssignment vs .PAM	0	0	0	0
6	BestNearest vs .PAM	0	0	0	0
7	CLARA vs .NearestByCustomer	0	0	0	0
8	KMEANS vs .RandomByElement	0	0	0	0
9	PAM vs .Simplified	0	0	0	0
10	CLARA vs .CyclicAssignment	0	0	0	0
11	BestNearest vs .CLARA	0	0	0	0
12	BestCyclicAssignment vs .PAM	0	0	0	0
13	PAM vs .Parallel	0	0	0	0
14	Farthest-First vs .NearestByCustomer	0	0	0	0
15	RandomByElement vs .UPGMC	0	0	0	0
16	CLARA vs .Simplified	0	0	0	0
17	CyclicAssignment vs .Farthest-First	0	0	0	0
18	BestNearest vs .Farthest-First	0	0	0	0
19	RandomByElement vs .ThreeCriteriaClustering	0	0	0	0
20	PAM vs .Sweep	0	0	0	0
21	BestCyclicAssignment vs .CLARA	0	0	0	0
22	CLARA vs .Parallel	0	0	0	0
23	KMEANS vs .NearestByCustomer	0	0	0	0
24	CyclicAssignment vs .KMEANS	0	0	0	0
25	BestNearest vs .KMEANS	0	0	0	0
26	Farthest-First vs .Simplified	0	0	0	0
27	CLARA vs .Sweep	0	0	0	0
28	BestCyclicAssignment vs .Farthest-First	0	0	0	0
29	Farthest-First vs .Parallel	0	0	0	0
30	CoefficientPropagation vs .RandomByElement	0	0	0	0
31	NearestByCustomer vs .UPGMC	0	0	0	0
32	KMEANS vs .Simplified	0	0	0	0
33	NearestByCustomer vs .ThreeCriteriaClustering	0	0	0	0
34	BestCyclicAssignment vs .KMEANS	0	0	0	0
35	KMEANS vs .Parallel	0	0	0	0
36	CyclicAssignment vs .UPGMC	0	0	0	0
37	Farthest-First vs .Sweep	0	0	0	0
38	BestNearest vs .UPGMC	0	0	0	0
39	CyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
40	BestNearest vs .ThreeCriteriaClustering	0	0	0	0
41	NearestByDepot vs .PAM	0	0	0	0
42	NearestByDepot vs .RandomByElement	0	0	0	0
43	KMEANS vs .Sweep	0	0.000001	0	0
44	Simplified vs .UPGMC	0	0.000001	0.000001	0.00000
45	Simplified vs .ThreeCriteriaClustering	0	0.000003	0.000002	0.00000
46	CoefficientPropagation vs .NearestByCustomer	0	0.000004	0.000002	0.00000
47	CLARA vs .NearestByDepot	0	0.000004	0.000002	0.00000
48	BestCyclicAssignment vs .UPGMC	0	0.000005	0.000003	0.00000
49	Parallel vs .UPGMC	0	0.000006	0.000003	0.00000
50	CoefficientPropagation vs .PAM	0	0.000008	0.000005	0.00000
51	BestCyclicAssignment vs .ThreeCriteriaClustering	0	0.000012	0.000007	0.00000
52	Parallel vs .ThreeCriteriaClustering	0	0.000015	0.000009	0.00000
53	CoefficientPropagation vs .CyclicAssignment	0	0.000029	0.000017	0.0000
54	BestNearest vs .CoefficientPropagation	0	0.000031	0.000018	0.0000
55	Sweep vs .UPGMC	0.000004	0.000497	0.000273	0.0002
56	Farthest-First vs .NearestByDepot	0.000006	0.000668	0.000362	0.0003
57	NearestByCustomer vs .NearestByDepot	0.000007	0.000796	0.000424	0.0004
58	CLARA vs .CoefficientPropagation	0.000007	0.000796	0.000424	0.0004
59	Sweep vs .ThreeCriteriaClustering	0.000009	0.001126	0.000582	0.0005
60	CoefficientPropagation vs .Simplified	0.00002	0.002346	0.001192	0.0011
61	RandomByElement vs .Sweep	0.00003	0.003639	0.00182	0.0018
62	CyclicAssignment vs .NearestByDepot	0.000036	0.004281	0.002105	0.0021
63	BestNearest vs .NearestByDepot	0.000038	0.004517	0.002183	0.0021
64	PAM vs .ThreeCriteriaClustering	0.000044	0.005304	0.002519	0.0025
65	BestCyclicAssignment vs .CoefficientPropagation	0.000061	0.007283	0.003399	0.0033
66	CoefficientPropagation vs .Parallel	0.000071	0.008518	0.003904	0.0039
67	PAM vs .UPGMC	0.000092	0.011026	0.004962	0.0047
68	KMEANS vs .NearestByDepot	0.000177	0.021205	0.009365	0.0091
69	CoefficientPropagation vs .Farthest-First	0.00044	0.052766	0.022865	0.0228
70	Parallel vs .RandomByElement	0.00091	0.10919	0.046406	0.0464
71	BestCyclicAssignment vs .RandomByElement	0.001039	0.124629	0.051929	0.0508
72	NearestByDepot vs .Simplified	0.001184	0.142067	0.058011	0.0580
73	CLARA vs .ThreeCriteriaClustering	0.001407	0.168831	0.067533	0.0675
74	CoefficientPropagation vs .Sweep	0.001815	0.217785	0.085299	0.0852
75	RandomByElement vs .Simplified	0.002528	0.30338	0.116296	0.1162
76	CLARA vs .UPGMC	0.002528	0.30338	0.116296	0.1162
77	BestCyclicAssignment vs .NearestByDepot	0.002856	0.342728	0.125667	0.1256
78	NearestByDepot vs .Parallel	0.003222	0.386684	0.138562	0.1385
79	CoefficientPropagation vs .KMEANS	0.006471	0.776526	0.271784	0.2717
80	KMEANS vs .PAM	0.007509	0.901044	0.307857	0.3078
81	NearestByDepot vs .UPGMC	0.011988	1.438552	0.479517	0.4795
82	NearestByCustomer vs .Sweep	0.015801	1.896095	0.616231	0.6162
83	NearestByDepot vs .ThreeCriteriaClustering	0.019324	2.318864	0.734307	0.7343
84	Farthest-First vs .ThreeCriteriaClustering	0.027589	3.310708	1.020802	1.0208
85	BestNearest vs .RandomByElement	0.032258	3.871007	1.161302	1.1613
86	CyclicAssignment vs .RandomByElement	0.033269	3.992326	1.164429	1.1644
87	NearestByDepot vs .Sweep	0.036467	4.375986	1.239863	1.2398
88	CyclicAssignment vs .Sweep	0.041134	4.93605	1.357414	1.3574
89	Farthest-First vs .UPGMC	0.042377	5.085195	1.357414	1.3574