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: 291.27451.

P-value computed by Friedman Test: 1.38757338952189E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 15 and 525 degrees of freedom: 40.987387.

P-value computed by Iman and Daveport Test: 4.440892098500626E-16.

Algorithm	Ranking
BestCyclicAssignment	11.8611
BestNearest	7.0417
CLARA	10.0556
CoefficientPropagation	9.3056
CyclicAssignment	14.6944
Farthest-First	4.25
KMEANS	5.1528
NearestByCustomer	6.6111
NearestByDepot	11.6667
PAM	8.1389
Parallel	6.6111
RandomByElement	16
Simplified	6.2222
Sweep	6.2083
ThreeCriteriaClustering	4.7361
UPGMC	7.4444

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 ≤ 0.000746.
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	Farthest-First vs. RandomByElement	10.47081	0	0.000417
119	RandomByElement vs. ThreeCriteriaClustering	10.037621	0	0.00042
118	KMEANS vs. RandomByElement	9.666315	0	0.000424
117	CyclicAssignment vs. Farthest-First	9.307387	0	0.000427
116	CyclicAssignment vs. ThreeCriteriaClustering	8.874197	0	0.000431
115	RandomByElement vs. Sweep	8.725675	0	0.000435
114	RandomByElement vs. Simplified	8.713298	0	0.000439
113	CyclicAssignment vs. KMEANS	8.502892	0	0.000442
112	NearestByCustomer vs. RandomByElement	8.366747	0	0.000446
111	Parallel vs. RandomByElement	8.366747	0	0.00045
110	BestNearest vs. RandomByElement	7.983065	0	0.000455
109	RandomByElement vs. UPGMC	7.624136	0	0.000459
108	CyclicAssignment vs. Sweep	7.562252	0	0.000463
107	CyclicAssignment vs. Simplified	7.549875	0	0.000467
106	CyclicAssignment vs. NearestByCustomer	7.203323	0	0.000472
105	CyclicAssignment vs. Parallel	7.203323	0	0.000476
104	PAM vs. RandomByElement	7.005294	0	0.000481
103	BestNearest vs. CyclicAssignment	6.819641	0	0.000485
102	BestCyclicAssignment vs. Farthest-First	6.782511	0	0.00049
101	Farthest-First vs. NearestByDepot	6.609235	0	0.000495
100	CyclicAssignment vs. UPGMC	6.460713	0	0.0005
99	BestCyclicAssignment vs. ThreeCriteriaClustering	6.349321	0	0.000505
98	NearestByDepot vs. ThreeCriteriaClustering	6.176045	0	0.00051
97	BestCyclicAssignment vs. KMEANS	5.978016	0	0.000515
96	CoefficientPropagation vs. RandomByElement	5.965639	0	0.000521
95	CyclicAssignment vs. PAM	5.841871	0	0.000526
94	KMEANS vs. NearestByDepot	5.80474	0	0.000532
93	CLARA vs. RandomByElement	5.297289	0	0.000538
92	CLARA vs. Farthest-First	5.173521	0	0.000543
91	BestCyclicAssignment vs. Sweep	5.037376	0	0.000549
90	BestCyclicAssignment vs. Simplified	5.024999	0.000001	0.000556
89	NearestByDepot vs. Sweep	4.8641	0.000001	0.000562
88	NearestByDepot vs. Simplified	4.851723	0.000001	0.000568
87	CoefficientPropagation vs. CyclicAssignment	4.802216	0.000002	0.000575
86	CLARA vs. ThreeCriteriaClustering	4.740331	0.000002	0.000581
85	BestCyclicAssignment vs. NearestByCustomer	4.678447	0.000003	0.000588
84	BestCyclicAssignment vs. Parallel	4.678447	0.000003	0.000595
83	NearestByCustomer vs. NearestByDepot	4.505171	0.000007	0.000602
82	NearestByDepot vs. Parallel	4.505171	0.000007	0.00061
81	CoefficientPropagation vs. Farthest-First	4.505171	0.000007	0.000617
80	CLARA vs. KMEANS	4.369026	0.000012	0.000625
79	BestCyclicAssignment vs. BestNearest	4.294765	0.000017	0.000633
78	CLARA vs. CyclicAssignment	4.133866	0.000036	0.000641
77	BestNearest vs. NearestByDepot	4.121489	0.000038	0.000649
76	CoefficientPropagation vs. ThreeCriteriaClustering	4.071982	0.000047	0.000658
75	BestCyclicAssignment vs. UPGMC	3.935836	0.000083	0.000667
74	NearestByDepot vs. RandomByElement	3.861575	0.000113	0.000676
73	NearestByDepot vs. UPGMC	3.762561	0.000168	0.000685
72	CoefficientPropagation vs. KMEANS	3.700676	0.000215	0.000694
71	BestCyclicAssignment vs. RandomByElement	3.6883	0.000226	0.000704
70	Farthest-First vs. PAM	3.465516	0.000529	0.000714
69	CLARA vs. Sweep	3.428386	0.000607	0.000725
68	CLARA vs. Simplified	3.416009	0.000635	0.000735
67	BestCyclicAssignment vs. PAM	3.316994	0.00091	0.000746
66	NearestByDepot vs. PAM	3.143718	0.001668	0.000758
65	CLARA vs. NearestByCustomer	3.069457	0.002144	0.000769
64	CLARA vs. Parallel	3.069457	0.002144	0.000781
63	PAM vs. ThreeCriteriaClustering	3.032327	0.002427	0.000794
62	Farthest-First vs. UPGMC	2.846674	0.004418	0.000806
61	CoefficientPropagation vs. Sweep	2.760036	0.005779	0.00082
60	CoefficientPropagation vs. Simplified	2.747659	0.006002	0.000833
59	CyclicAssignment vs. NearestByDepot	2.698152	0.006973	0.000847
58	BestNearest vs. CLARA	2.685775	0.007236	0.000862
57	KMEANS vs. PAM	2.661022	0.00779	0.000877
56	BestCyclicAssignment vs. CyclicAssignment	2.524876	0.011574	0.000893
55	BestNearest vs. Farthest-First	2.487746	0.012856	0.000909
54	ThreeCriteriaClustering vs. UPGMC	2.413485	0.015801	0.000926
53	CoefficientPropagation vs. NearestByCustomer	2.401108	0.016346	0.000943
52	CoefficientPropagation vs. Parallel	2.401108	0.016346	0.000962
51	CLARA vs. UPGMC	2.326847	0.019973	0.00098
50	BestCyclicAssignment vs. CoefficientPropagation	2.277339	0.022766	0.001
49	CoefficientPropagation vs. NearestByDepot	2.104064	0.035373	0.00102
48	Farthest-First vs. NearestByCustomer	2.104064	0.035373	0.001042
47	Farthest-First vs. Parallel	2.104064	0.035373	0.001064
46	BestNearest vs. ThreeCriteriaClustering	2.054556	0.039922	0.001087
45	KMEANS vs. UPGMC	2.042179	0.041134	0.001111
44	BestNearest vs. CoefficientPropagation	2.017426	0.043651	0.001136
43	Farthest-First vs. Simplified	1.757512	0.078831	0.001163
42	Farthest-First vs. Sweep	1.745135	0.080961	0.00119
41	PAM vs. Sweep	1.720381	0.085363	0.00122
40	PAM vs. Simplified	1.708005	0.087636	0.00125
39	CLARA vs. PAM	1.708005	0.087636	0.001282
38	BestNearest vs. KMEANS	1.683251	0.092327	0.001316
37	NearestByCustomer vs. ThreeCriteriaClustering	1.670874	0.094747	0.001351
36	Parallel vs. ThreeCriteriaClustering	1.670874	0.094747	0.001389
35	CoefficientPropagation vs. UPGMC	1.658497	0.097217	0.001429
34	BestCyclicAssignment vs. CLARA	1.60899	0.107619	0.001471
33	CLARA vs. NearestByDepot	1.435714	0.151084	0.001515
32	NearestByCustomer vs. PAM	1.361453	0.173371	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 ≤ 0.001515.

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	Farthest-First vs. RandomByElement	10.47081	0	0.000833
119	RandomByElement vs. ThreeCriteriaClustering	10.037621	0	0.00084
118	KMEANS vs. RandomByElement	9.666315	0	0.000847
117	CyclicAssignment vs. Farthest-First	9.307387	0	0.000855
116	CyclicAssignment vs. ThreeCriteriaClustering	8.874197	0	0.000862
115	RandomByElement vs. Sweep	8.725675	0	0.00087
114	RandomByElement vs. Simplified	8.713298	0	0.000877
113	CyclicAssignment vs. KMEANS	8.502892	0	0.000885
112	NearestByCustomer vs. RandomByElement	8.366747	0	0.000893
111	Parallel vs. RandomByElement	8.366747	0	0.000901
110	BestNearest vs. RandomByElement	7.983065	0	0.000909
109	RandomByElement vs. UPGMC	7.624136	0	0.000917
108	CyclicAssignment vs. Sweep	7.562252	0	0.000926
107	CyclicAssignment vs. Simplified	7.549875	0	0.000935
106	CyclicAssignment vs. NearestByCustomer	7.203323	0	0.000943
105	CyclicAssignment vs. Parallel	7.203323	0	0.000952
104	PAM vs. RandomByElement	7.005294	0	0.000962
103	BestNearest vs. CyclicAssignment	6.819641	0	0.000971
102	BestCyclicAssignment vs. Farthest-First	6.782511	0	0.00098
101	Farthest-First vs. NearestByDepot	6.609235	0	0.00099
100	CyclicAssignment vs. UPGMC	6.460713	0	0.001
99	BestCyclicAssignment vs. ThreeCriteriaClustering	6.349321	0	0.00101
98	NearestByDepot vs. ThreeCriteriaClustering	6.176045	0	0.00102
97	BestCyclicAssignment vs. KMEANS	5.978016	0	0.001031
96	CoefficientPropagation vs. RandomByElement	5.965639	0	0.001042
95	CyclicAssignment vs. PAM	5.841871	0	0.001053
94	KMEANS vs. NearestByDepot	5.80474	0	0.001064
93	CLARA vs. RandomByElement	5.297289	0	0.001075
92	CLARA vs. Farthest-First	5.173521	0	0.001087
91	BestCyclicAssignment vs. Sweep	5.037376	0	0.001099
90	BestCyclicAssignment vs. Simplified	5.024999	0.000001	0.001111
89	NearestByDepot vs. Sweep	4.8641	0.000001	0.001124
88	NearestByDepot vs. Simplified	4.851723	0.000001	0.001136
87	CoefficientPropagation vs. CyclicAssignment	4.802216	0.000002	0.001149
86	CLARA vs. ThreeCriteriaClustering	4.740331	0.000002	0.001163
85	BestCyclicAssignment vs. NearestByCustomer	4.678447	0.000003	0.001176
84	BestCyclicAssignment vs. Parallel	4.678447	0.000003	0.00119
83	NearestByCustomer vs. NearestByDepot	4.505171	0.000007	0.001205
82	NearestByDepot vs. Parallel	4.505171	0.000007	0.00122
81	CoefficientPropagation vs. Farthest-First	4.505171	0.000007	0.001235
80	CLARA vs. KMEANS	4.369026	0.000012	0.00125
79	BestCyclicAssignment vs. BestNearest	4.294765	0.000017	0.001266
78	CLARA vs. CyclicAssignment	4.133866	0.000036	0.001282
77	BestNearest vs. NearestByDepot	4.121489	0.000038	0.001299
76	CoefficientPropagation vs. ThreeCriteriaClustering	4.071982	0.000047	0.001316
75	BestCyclicAssignment vs. UPGMC	3.935836	0.000083	0.001333
74	NearestByDepot vs. RandomByElement	3.861575	0.000113	0.001351
73	NearestByDepot vs. UPGMC	3.762561	0.000168	0.00137
72	CoefficientPropagation vs. KMEANS	3.700676	0.000215	0.001389
71	BestCyclicAssignment vs. RandomByElement	3.6883	0.000226	0.001408
70	Farthest-First vs. PAM	3.465516	0.000529	0.001429
69	CLARA vs. Sweep	3.428386	0.000607	0.001449
68	CLARA vs. Simplified	3.416009	0.000635	0.001471
67	BestCyclicAssignment vs. PAM	3.316994	0.00091	0.001493
66	NearestByDepot vs. PAM	3.143718	0.001668	0.001515
65	CLARA vs. NearestByCustomer	3.069457	0.002144	0.001538
64	CLARA vs. Parallel	3.069457	0.002144	0.001563
63	PAM vs. ThreeCriteriaClustering	3.032327	0.002427	0.001587
62	Farthest-First vs. UPGMC	2.846674	0.004418	0.001613
61	CoefficientPropagation vs. Sweep	2.760036	0.005779	0.001639
60	CoefficientPropagation vs. Simplified	2.747659	0.006002	0.001667
59	CyclicAssignment vs. NearestByDepot	2.698152	0.006973	0.001695
58	BestNearest vs. CLARA	2.685775	0.007236	0.001724
57	KMEANS vs. PAM	2.661022	0.00779	0.001754
56	BestCyclicAssignment vs. CyclicAssignment	2.524876	0.011574	0.001786
55	BestNearest vs. Farthest-First	2.487746	0.012856	0.001818
54	ThreeCriteriaClustering vs. UPGMC	2.413485	0.015801	0.001852
53	CoefficientPropagation vs. NearestByCustomer	2.401108	0.016346	0.001887
52	CoefficientPropagation vs. Parallel	2.401108	0.016346	0.001923
51	CLARA vs. UPGMC	2.326847	0.019973	0.001961
50	BestCyclicAssignment vs. CoefficientPropagation	2.277339	0.022766	0.002
49	CoefficientPropagation vs. NearestByDepot	2.104064	0.035373	0.002041
48	Farthest-First vs. NearestByCustomer	2.104064	0.035373	0.002083
47	Farthest-First vs. Parallel	2.104064	0.035373	0.002128
46	BestNearest vs. ThreeCriteriaClustering	2.054556	0.039922	0.002174
45	KMEANS vs. UPGMC	2.042179	0.041134	0.002222
44	BestNearest vs. CoefficientPropagation	2.017426	0.043651	0.002273
43	Farthest-First vs. Simplified	1.757512	0.078831	0.002326
42	Farthest-First vs. Sweep	1.745135	0.080961	0.002381
41	PAM vs. Sweep	1.720381	0.085363	0.002439
40	PAM vs. Simplified	1.708005	0.087636	0.0025
39	CLARA vs. PAM	1.708005	0.087636	0.002564
38	BestNearest vs. KMEANS	1.683251	0.092327	0.002632
37	NearestByCustomer vs. ThreeCriteriaClustering	1.670874	0.094747	0.002703
36	Parallel vs. ThreeCriteriaClustering	1.670874	0.094747	0.002778
35	CoefficientPropagation vs. UPGMC	1.658497	0.097217	0.002857
34	BestCyclicAssignment vs. CLARA	1.60899	0.107619	0.002941
33	CLARA vs. NearestByDepot	1.435714	0.151084	0.00303
32	NearestByCustomer vs. PAM	1.361453	0.173371	0.003125

2.3 Adjusted p-values

i	hypothesis	unadjusted p	p_{Neme}	p_{Holm}	p_{Shaj}
1	Farthest-First vs .RandomByElement	0	0	0	0
2	RandomByElement vs .ThreeCriteriaClustering	0	0	0	0
3	KMEANS vs .RandomByElement	0	0	0	0
4	CyclicAssignment vs .Farthest-First	0	0	0	0
5	CyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
6	RandomByElement vs .Sweep	0	0	0	0
7	RandomByElement vs .Simplified	0	0	0	0
8	CyclicAssignment vs .KMEANS	0	0	0	0
9	NearestByCustomer vs .RandomByElement	0	0	0	0
10	Parallel vs .RandomByElement	0	0	0	0
11	BestNearest vs .RandomByElement	0	0	0	0
12	RandomByElement vs .UPGMC	0	0	0	0
13	CyclicAssignment vs .Sweep	0	0	0	0
14	CyclicAssignment vs .Simplified	0	0	0	0
15	CyclicAssignment vs .NearestByCustomer	0	0	0	0
16	CyclicAssignment vs .Parallel	0	0	0	0
17	PAM vs .RandomByElement	0	0	0	0
18	BestNearest vs .CyclicAssignment	0	0	0	0
19	BestCyclicAssignment vs .Farthest-First	0	0	0	0
20	Farthest-First vs .NearestByDepot	0	0	0	0
21	CyclicAssignment vs .UPGMC	0	0	0	0
22	BestCyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
23	NearestByDepot vs .ThreeCriteriaClustering	0	0	0	0
24	BestCyclicAssignment vs .KMEANS	0	0	0	0
25	CoefficientPropagation vs .RandomByElement	0	0	0	0
26	CyclicAssignment vs .PAM	0	0.000001	0	0
27	KMEANS vs .NearestByDepot	0	0.000001	0.000001	0.00000
28	CLARA vs .RandomByElement	0	0.000014	0.000011	0.0000
29	CLARA vs .Farthest-First	0	0.000028	0.000021	0.00003
30	BestCyclicAssignment vs .Sweep	0	0.000057	0.000043	0.00004
31	BestCyclicAssignment vs .Simplified	0.000001	0.00006	0.000045	0.00004
32	NearestByDepot vs .Sweep	0.000001	0.000138	0.000102	0.00009
33	NearestByDepot vs .Simplified	0.000001	0.000147	0.000108	0.00009
34	CoefficientPropagation vs .CyclicAssignment	0.000002	0.000188	0.000137	0.00011
35	CLARA vs .ThreeCriteriaClustering	0.000002	0.000256	0.000183	0.00017
36	BestCyclicAssignment vs .NearestByCustomer	0.000003	0.000347	0.000246	0.00023
37	BestCyclicAssignment vs .Parallel	0.000003	0.000347	0.000246	0.00023
38	NearestByCustomer vs .NearestByDepot	0.000007	0.000796	0.00055	0.00053
39	NearestByDepot vs .Parallel	0.000007	0.000796	0.00055	0.00053
40	CoefficientPropagation vs .Farthest-First	0.000007	0.000796	0.00055	0.00053
41	CLARA vs .KMEANS	0.000012	0.001498	0.000998	0.00098
42	BestCyclicAssignment vs .BestNearest	0.000017	0.002099	0.001382	0.00138
43	CLARA vs .CyclicAssignment	0.000036	0.004281	0.002782	0.00278
44	BestNearest vs .NearestByDepot	0.000038	0.004517	0.002899	0.00278
45	CoefficientPropagation vs .ThreeCriteriaClustering	0.000047	0.005594	0.003543	0.00338
46	BestCyclicAssignment vs .UPGMC	0.000083	0.009949	0.006218	0.00590
47	NearestByDepot vs .RandomByElement	0.000113	0.013519	0.008337	0.0081
48	NearestByDepot vs .UPGMC	0.000168	0.020182	0.012277	0.01210
49	CoefficientPropagation vs .KMEANS	0.000215	0.025803	0.015482	0.01548
50	BestCyclicAssignment vs .RandomByElement	0.000226	0.027091	0.016029	0.01557
51	Farthest-First vs .PAM	0.000529	0.063506	0.037045	0.0365
52	CLARA vs .Sweep	0.000607	0.072862	0.041896	0.04189
53	CLARA vs .Simplified	0.000635	0.076255	0.043211	0.0432
54	BestCyclicAssignment vs .PAM	0.00091	0.10919	0.060964	0.06090
55	NearestByDepot vs .PAM	0.001668	0.200179	0.110098	0.11009
56	CLARA vs .NearestByCustomer	0.002144	0.257338	0.139391	0.13939
57	CLARA vs .Parallel	0.002144	0.257338	0.139391	0.13939
58	PAM vs .ThreeCriteriaClustering	0.002427	0.291212	0.152886	0.14803
59	Farthest-First vs .UPGMC	0.004418	0.530143	0.273907	0.26948
60	CoefficientPropagation vs .Sweep	0.005779	0.693539	0.352549	0.35254
61	CoefficientPropagation vs .Simplified	0.006002	0.720268	0.360134	0.36013
62	CyclicAssignment vs .NearestByDepot	0.006973	0.836707	0.411381	0.41138
63	BestNearest vs .CLARA	0.007236	0.868341	0.419698	0.41969
64	KMEANS vs .PAM	0.00779	0.934848	0.444053	0.44403
65	BestCyclicAssignment vs .CyclicAssignment	0.011574	1.388869	0.648139	0.64813
66	BestNearest vs .Farthest-First	0.012856	1.542667	0.707056	0.70703
67	ThreeCriteriaClustering vs .UPGMC	0.015801	1.896095	0.853243	0.82164
68	CoefficientPropagation vs .NearestByCustomer	0.016346	1.961462	0.866313	0.84990
69	CoefficientPropagation vs .Parallel	0.016346	1.961462	0.866313	0.84990
70	CLARA vs .UPGMC	0.019973	2.396811	1.018645	1.01864
71	BestCyclicAssignment vs .CoefficientPropagation	0.022766	2.731916	1.138298	1.11553
72	CoefficientPropagation vs .NearestByDepot	0.035373	4.244749	1.733272	1.73327
73	Farthest-First vs .NearestByCustomer	0.035373	4.244749	1.733272	1.73327
74	Farthest-First vs .Parallel	0.035373	4.244749	1.733272	1.73327
75	BestNearest vs .ThreeCriteriaClustering	0.039922	4.790627	1.836407	1.83640
76	KMEANS vs .UPGMC	0.041134	4.93605	1.851019	1.8510
77	BestNearest vs .CoefficientPropagation	0.043651	5.238134	1.920649	1.92064
78	Farthest-First vs .Simplified	0.078831	9.459672	3.389716	3.3897
79	Farthest-First vs .Sweep	0.080961	9.715364	3.400377	3.40037
80	PAM vs .Sweep	0.085363	10.243577	3.499889	3.49988
81	PAM vs .Simplified	0.087636	10.516261	3.50542	3.5054
82	CLARA vs .PAM	0.087636	10.516261	3.50542	3.5054
83	BestNearest vs .KMEANS	0.092327	11.079186	3.508409	3.50840
84	NearestByCustomer vs .ThreeCriteriaClustering	0.094747	11.369589	3.508409	3.50840
85	Parallel vs .ThreeCriteriaClustering	0.094747	11.369589	3.508409	3.50840
86	CoefficientPropagation vs .UPGMC	0.097217	11.66606	3.508409	3.50840
87	BestCyclicAssignment vs .CLARA	0.107619	12.91423	3.659032	3.65903
88	CLARA vs .NearestByDepot	0.151084	18.130051	4.985764	4.98576
89	NearestByCustomer vs .PAM	0.173371	20.804474	5.54786	5.5478