Output tables for the test of Multiple comparisons.

June 6, 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 17 degrees of freedom: 337.558596.

P-value computed by Friedman Test: 1.379816261248834E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 17 and 408 degrees of freedom: 92.649546.

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

Algorithm	Ranking
BestCyclicAssignment	13.12
BestNearest	6.86
CLARA	13.2
CoefficientPropagation	12.32
CyclicAssignment	14.48
Farthest-First	4.9
KMEANS	5.78
NearestByCustomer	6.68
NearestByDepot	10.6
PAM	1.04
Parallel	6.68
RandomByElement	17.96
RandomSequentialCyclic	16.04
SequentialCyclic	15.6
Simplified	5.76
Sweep	6.02
ThreeCriteriaClustering	5.52
UPGMC	8.44

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 ≤ 0.000327.

Holm's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000649.

Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000327.

i	algorithms	$z = (R_0 - R_i)/SE$	p	Holm
153	PAM vs. RandomByElement	11.205544	0	0.000327
152	PAM vs. RandomSequentialCyclic	9.933993	0	0.000329
151	PAM vs. SequentialCyclic	9.642596	0	0.000331
150	CyclicAssignment vs. PAM	8.900857	0	0.000333
149	Farthest-First vs. RandomByElement	8.649196	0	0.000336
148	RandomByElement vs. ThreeCriteriaClustering	8.238591	0	0.000338
147	RandomByElement vs. Simplified	8.079647	0	0.00034
146	KMEANS vs. RandomByElement	8.066402	0	0.000342
145	CLARA vs. PAM	8.053157	0	0.000345
144	BestCyclicAssignment vs. PAM	8.000175	0	0.000347
143	RandomByElement vs. Sweep	7.907458	0	0.00035
142	NearestByCustomer vs. RandomByElement	7.470362	0	0.000352
141	Parallel vs. RandomByElement	7.470362	0	0.000355
140	CoefficientPropagation vs. PAM	7.470362	0	0.000357
139	Farthest-First vs. RandomSequentialCyclic	7.377645	0	0.00036
138	BestNearest vs. RandomByElement	7.351155	0	0.000362
137	Farthest-First vs. SequentialCyclic	7.086248	0	0.000365
136	RandomSequentialCyclic vs. ThreeCriteriaClustering	6.96704	0	0.000368
135	RandomSequentialCyclic vs. Simplified	6.808096	0	0.00037
134	KMEANS vs. RandomSequentialCyclic	6.794851	0	0.000373
133	SequentialCyclic vs. ThreeCriteriaClustering	6.675643	0	0.000376
132	RandomSequentialCyclic vs. Sweep	6.635907	0	0.000379
131	SequentialCyclic vs. Simplified	6.516699	0	0.000382
130	KMEANS vs. SequentialCyclic	6.503454	0	0.000385
129	CyclicAssignment vs. Farthest-First	6.34451	0	0.000388
128	SequentialCyclic vs. Sweep	6.34451	0	0.000391
127	NearestByDepot vs. PAM	6.331265	0	0.000394
126	RandomByElement vs. UPGMC	6.304774	0	0.000397
125	NearestByCustomer vs. RandomSequentialCyclic	6.198811	0	0.0004
124	Parallel vs. RandomSequentialCyclic	6.198811	0	0.000403
123	BestNearest vs. RandomSequentialCyclic	6.079604	0	0.000407
122	CyclicAssignment vs. ThreeCriteriaClustering	5.933905	0	0.00041
121	NearestByCustomer vs. SequentialCyclic	5.907414	0	0.000413
120	Parallel vs. SequentialCyclic	5.907414	0	0.000417
119	BestNearest vs. SequentialCyclic	5.788206	0	0.00042
118	CyclicAssignment vs. Simplified	5.774961	0	0.000424
117	CyclicAssignment vs. KMEANS	5.761716	0	0.000427
116	CyclicAssignment vs. Sweep	5.602772	0	0.000431
115	CLARA vs. Farthest-First	5.496809	0	0.000435
114	BestCyclicAssignment vs. Farthest-First	5.443828	0	0.000439
113	CyclicAssignment vs. NearestByCustomer	5.165676	0	0.000442
112	CyclicAssignment vs. Parallel	5.165676	0	0.000446
111	CLARA vs. ThreeCriteriaClustering	5.086204	0	0.00045
110	BestNearest vs. CyclicAssignment	5.046468	0	0.000455
109	RandomSequentialCyclic vs. UPGMC	5.033223	0	0.000459
108	BestCyclicAssignment vs. ThreeCriteriaClustering	5.033223	0	0.000463
107	CLARA vs. Simplified	4.92726	0.000001	0.000467
106	CLARA vs. KMEANS	4.914015	0.000001	0.000472
105	CoefficientPropagation vs. Farthest-First	4.914015	0.000001	0.000476
104	PAM vs. UPGMC	4.90077	0.000001	0.000481
103	NearestByDepot vs. RandomByElement	4.874279	0.000001	0.000485
102	BestCyclicAssignment vs. Simplified	4.874279	0.000001	0.00049
101	BestCyclicAssignment vs. KMEANS	4.861034	0.000001	0.000495
100	CLARA vs. Sweep	4.755071	0.000002	0.0005
99	SequentialCyclic vs. UPGMC	4.741826	0.000002	0.000505
98	BestCyclicAssignment vs. Sweep	4.70209	0.000003	0.00051
97	CoefficientPropagation vs. ThreeCriteriaClustering	4.50341	0.000007	0.000515
96	CoefficientPropagation vs. Simplified	4.344466	0.000014	0.000521
95	CoefficientPropagation vs. KMEANS	4.331221	0.000015	0.000526
94	CLARA vs. NearestByCustomer	4.317975	0.000016	0.000532
93	CLARA vs. Parallel	4.317975	0.000016	0.000538
92	BestCyclicAssignment vs. NearestByCustomer	4.264994	0.00002	0.000543
91	BestCyclicAssignment vs. Parallel	4.264994	0.00002	0.000549
90	BestNearest vs. CLARA	4.198768	0.000027	0.000556
89	CoefficientPropagation vs. Sweep	4.172277	0.00003	0.000562
88	BestCyclicAssignment vs. BestNearest	4.145786	0.000034	0.000568
87	CyclicAssignment vs. UPGMC	4.000088	0.000063	0.000575
86	BestNearest vs. PAM	3.854389	0.000116	0.000581
85	Farthest-First vs. NearestByDepot	3.774917	0.00016	0.000588
84	CoefficientPropagation vs. NearestByCustomer	3.735181	0.000188	0.000595
83	CoefficientPropagation vs. Parallel	3.735181	0.000188	0.000602
82	CoefficientPropagation vs. RandomByElement	3.735181	0.000188	0.00061
81	NearestByCustomer vs. PAM	3.735181	0.000188	0.000617
80	PAM vs. Parallel	3.735181	0.000188	0.000625
79	BestNearest vs. CoefficientPropagation	3.615973	0.000299	0.000633
78	NearestByDepot vs. RandomSequentialCyclic	3.602728	0.000315	0.000641
77	NearestByDepot vs. ThreeCriteriaClustering	3.364312	0.000767	0.000649
76	NearestByDepot vs. SequentialCyclic	3.311331	0.000929	0.000658
75	PAM vs. Sweep	3.298086	0.000973	0.000667
74	BestCyclicAssignment vs. RandomByElement	3.205368	0.001349	0.000676
73	NearestByDepot vs. Simplified	3.205368	0.001349	0.000685
72	KMEANS vs. NearestByDepot	3.192123	0.001412	0.000694
71	CLARA vs. UPGMC	3.152387	0.001619	0.000704
70	CLARA vs. RandomByElement	3.152387	0.001619	0.000714
69	KMEANS vs. PAM	3.139142	0.001694	0.000725
68	PAM vs. Simplified	3.125896	0.001773	0.000735
67	BestCyclicAssignment vs. UPGMC	3.099406	0.001939	0.000746
66	NearestByDepot vs. Sweep	3.033179	0.00242	0.000758
65	PAM vs. ThreeCriteriaClustering	2.966952	0.003008	0.000769

2.2 P-values for $\alpha = 0.10$

Nemenyi's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000654.

Holm's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.001389.

Shaffer's procedure rejects those hypotheses that have an unadjusted p-value ≤ 0.000654.

i	algorithms	$z = (R_0 - R_i)/SE$	p	Holm
153	PAM vs. RandomByElement	11.205544	0	0.000654
152	PAM vs. RandomSequentialCyclic	9.933993	0	0.000658
151	PAM vs. SequentialCyclic	9.642596	0	0.000662
150	CyclicAssignment vs. PAM	8.900857	0	0.000667
149	Farthest-First vs. RandomByElement	8.649196	0	0.000671
148	RandomByElement vs. ThreeCriteriaClustering	8.238591	0	0.000676
147	RandomByElement vs. Simplified	8.079647	0	0.00068
146	KMEANS vs. RandomByElement	8.066402	0	0.000685
145	CLARA vs. PAM	8.053157	0	0.00069
144	BestCyclicAssignment vs. PAM	8.000175	0	0.000694
143	RandomByElement vs. Sweep	7.907458	0	0.000699
142	NearestByCustomer vs. RandomByElement	7.470362	0	0.000704
141	Parallel vs. RandomByElement	7.470362	0	0.000709
140	CoefficientPropagation vs. PAM	7.470362	0	0.000714
139	Farthest-First vs. RandomSequentialCyclic	7.377645	0	0.000719
138	BestNearest vs. RandomByElement	7.351155	0	0.000725
137	Farthest-First vs. SequentialCyclic	7.086248	0	0.00073
136	RandomSequentialCyclic vs. ThreeCriteriaClustering	6.96704	0	0.000735
135	RandomSequentialCyclic vs. Simplified	6.808096	0	0.000741
134	KMEANS vs. RandomSequentialCyclic	6.794851	0	0.000746
133	SequentialCyclic vs. ThreeCriteriaClustering	6.675643	0	0.000752
132	RandomSequentialCyclic vs. Sweep	6.635907	0	0.000758
131	SequentialCyclic vs. Simplified	6.516699	0	0.000763
130	KMEANS vs. SequentialCyclic	6.503454	0	0.000769
129	CyclicAssignment vs. Farthest-First	6.34451	0	0.000775
128	SequentialCyclic vs. Sweep	6.34451	0	0.000781
127	NearestByDepot vs. PAM	6.331265	0	0.000787
126	RandomByElement vs. UPGMC	6.304774	0	0.000794
125	NearestByCustomer vs. RandomSequentialCyclic	6.198811	0	0.0008
124	Parallel vs. RandomSequentialCyclic	6.198811	0	0.000806
123	BestNearest vs. RandomSequentialCyclic	6.079604	0	0.000813
122	CyclicAssignment vs. ThreeCriteriaClustering	5.933905	0	0.00082
121	NearestByCustomer vs. SequentialCyclic	5.907414	0	0.000826
120	Parallel vs. SequentialCyclic	5.907414	0	0.000833
119	BestNearest vs. SequentialCyclic	5.788206	0	0.00084
118	CyclicAssignment vs. Simplified	5.774961	0	0.000847
117	CyclicAssignment vs. KMEANS	5.761716	0	0.000855
116	CyclicAssignment vs. Sweep	5.602772	0	0.000862
115	CLARA vs. Farthest-First	5.496809	0	0.00087
114	BestCyclicAssignment vs. Farthest-First	5.443828	0	0.000877
113	CyclicAssignment vs. NearestByCustomer	5.165676	0	0.000885
112	CyclicAssignment vs. Parallel	5.165676	0	0.000893
111	CLARA vs. ThreeCriteriaClustering	5.086204	0	0.000901
110	BestNearest vs. CyclicAssignment	5.046468	0	0.000909
109	RandomSequentialCyclic vs. UPGMC	5.033223	0	0.000917
108	BestCyclicAssignment vs. ThreeCriteriaClustering	5.033223	0	0.000926
107	CLARA vs. Simplified	4.92726	0.000001	0.000935
106	CLARA vs. KMEANS	4.914015	0.000001	0.000943
105	CoefficientPropagation vs. Farthest-First	4.914015	0.000001	0.000952
104	PAM vs. UPGMC	4.90077	0.000001	0.000962
103	NearestByDepot vs. RandomByElement	4.874279	0.000001	0.000971
102	BestCyclicAssignment vs. Simplified	4.874279	0.000001	0.00098
101	BestCyclicAssignment vs. KMEANS	4.861034	0.000001	0.00099
100	CLARA vs. Sweep	4.755071	0.000002	0.001
99	SequentialCyclic vs. UPGMC	4.741826	0.000002	0.00101
98	BestCyclicAssignment vs. Sweep	4.70209	0.000003	0.00102
97	CoefficientPropagation vs. ThreeCriteriaClustering	4.50341	0.000007	0.001031
96	CoefficientPropagation vs. Simplified	4.344466	0.000014	0.001042
95	CoefficientPropagation vs. KMEANS	4.331221	0.000015	0.001053
94	CLARA vs. NearestByCustomer	4.317975	0.000016	0.001064
93	CLARA vs. Parallel	4.317975	0.000016	0.001075
92	BestCyclicAssignment vs. NearestByCustomer	4.264994	0.00002	0.001087
91	BestCyclicAssignment vs. Parallel	4.264994	0.00002	0.001099
90	BestNearest vs. CLARA	4.198768	0.000027	0.001111
89	CoefficientPropagation vs. Sweep	4.172277	0.00003	0.001124
88	BestCyclicAssignment vs. BestNearest	4.145786	0.000034	0.001136
87	CyclicAssignment vs. UPGMC	4.000088	0.000063	0.001149
86	BestNearest vs. PAM	3.854389	0.000116	0.001163
85	Farthest-First vs. NearestByDepot	3.774917	0.00016	0.001176
84	CoefficientPropagation vs. NearestByCustomer	3.735181	0.000188	0.00119
83	CoefficientPropagation vs. Parallel	3.735181	0.000188	0.001205
82	CoefficientPropagation vs. RandomByElement	3.735181	0.000188	0.00122
81	NearestByCustomer vs. PAM	3.735181	0.000188	0.001235
80	PAM vs. Parallel	3.735181	0.000188	0.00125
79	BestNearest vs. CoefficientPropagation	3.615973	0.000299	0.001266
78	NearestByDepot vs. RandomSequentialCyclic	3.602728	0.000315	0.001282
77	NearestByDepot vs. ThreeCriteriaClustering	3.364312	0.000767	0.001299
76	NearestByDepot vs. SequentialCyclic	3.311331	0.000929	0.001316
75	PAM vs. Sweep	3.298086	0.000973	0.001333
74	BestCyclicAssignment vs. RandomByElement	3.205368	0.001349	0.001351
73	NearestByDepot vs. Simplified	3.205368	0.001349	0.00137
72	KMEANS vs. NearestByDepot	3.192123	0.001412	0.001389
71	CLARA vs. UPGMC	3.152387	0.001619	0.001408
70	CLARA vs. RandomByElement	3.152387	0.001619	0.001429
69	KMEANS vs. PAM	3.139142	0.001694	0.001449
68	PAM vs. Simplified	3.125896	0.001773	0.001471
67	BestCyclicAssignment vs. UPGMC	3.099406	0.001939	0.001493
66	NearestByDepot vs. Sweep	3.033179	0.00242	0.001515
65	PAM vs. ThreeCriteriaClustering	2.966952	0.003008	0.001538

2.3 Adjusted p-values

i	hypothesis	unadjusted p	p_{Neme}	p_{Holm}	p_{Sh}
1	PAM vs .RandomByElement	0	0	0	0
2	PAM vs .RandomSequentialCyclic	0	0	0	0
3	PAM vs .SequentialCyclic	0	0	0	0
4	CyclicAssignment vs .PAM	0	0	0	0
5	Farthest-First vs .RandomByElement	0	0	0	0
6	RandomByElement vs .ThreeCriteriaClustering	0	0	0	0
7	RandomByElement vs .Simplified	0	0	0	0
8	KMEANS vs .RandomByElement	0	0	0	0
9	CLARA vs .PAM	0	0	0	0
10	BestCyclicAssignment vs .PAM	0	0	0	0
11	RandomByElement vs .Sweep	0	0	0	0
12	NearestByCustomer vs .RandomByElement	0	0	0	0
13	Parallel vs .RandomByElement	0	0	0	0
14	CoefficientPropagation vs .PAM	0	0	0	0
15	Farthest-First vs .RandomSequentialCyclic	0	0	0	0
16	BestNearest vs .RandomByElement	0	0	0	0
17	Farthest-First vs .SequentialCyclic	0	0	0	0
18	RandomSequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
19	RandomSequentialCyclic vs .Simplified	0	0	0	0
20	KMEANS vs .RandomSequentialCyclic	0	0	0	0
21	SequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
22	RandomSequentialCyclic vs .Sweep	0	0	0	0
23	SequentialCyclic vs .Simplified	0	0	0	0
24	KMEANS vs .SequentialCyclic	0	0	0	0
25	CyclicAssignment vs .Farthest-First	0	0	0	0
26	SequentialCyclic vs .Sweep	0	0	0	0
27	NearestByDepot vs .PAM	0	0	0	0
28	RandomByElement vs .UPGMC	0	0	0	0
29	NearestByCustomer vs .RandomSequentialCyclic	0	0	0	0
30	Parallel vs .RandomSequentialCyclic	0	0	0	0
31	BestNearest vs .RandomSequentialCyclic	0	0	0	0
32	CyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
33	NearestByCustomer vs .SequentialCyclic	0	0.000001	0	0
34	Parallel vs .SequentialCyclic	0	0.000001	0	0
35	BestNearest vs .SequentialCyclic	0	0.000001	0.000001	0.000
36	CyclicAssignment vs .Simplified	0	0.000001	0.000001	0.000
37	CyclicAssignment vs .KMEANS	0	0.000001	0.000001	0.000
38	CyclicAssignment vs .Sweep	0	0.000003	0.000002	0.000
39	CLARA vs .Farthest-First	0	0.000006	0.000004	0.000
40	BestCyclicAssignment vs .Farthest-First	0	0.000008	0.000006	0.000
41	CyclicAssignment vs .NearestByCustomer	0	0.000037	0.000027	0.000
42	CyclicAssignment vs .Parallel	0	0.000037	0.000027	0.000
43	CLARA vs .ThreeCriteriaClustering	0	0.000056	0.000041	0.000
44	BestNearest vs .CyclicAssignment	0	0.000069	0.00005	0.000
45	RandomSequentialCyclic vs .UPGMC	0	0.000074	0.000053	0.000
46	BestCyclicAssignment vs .ThreeCriteriaClustering	0	0.000074	0.000053	0.000
47	CLARA vs .Simplified	0.000001	0.000128	0.000089	0.000
48	CLARA vs .KMEANS	0.000001	0.000137	0.000095	0.000
49	CoefficientPropagation vs .Farthest-First	0.000001	0.000137	0.000095	0.000
50	PAM vs .UPGMC	0.000001	0.000146	0.000099	0.000
51	NearestByDepot vs .RandomByElement	0.000001	0.000167	0.000112	0.000
52	BestCyclicAssignment vs .Simplified	0.000001	0.000167	0.000112	0.000
53	BestCyclicAssignment vs .KMEANS	0.000001	0.000179	0.000118	0.000
54	CLARA vs .Sweep	0.000002	0.000304	0.000198	0.000
55	SequentialCyclic vs .UPGMC	0.000002	0.000324	0.00021	0.000
56	BestCyclicAssignment vs .Sweep	0.000003	0.000394	0.000252	0.000
57	CoefficientPropagation vs .ThreeCriteriaClustering	0.000007	0.001023	0.000649	0.000
58	CoefficientPropagation vs .Simplified	0.000014	0.002136	0.00134	0.001
59	CoefficientPropagation vs .KMEANS	0.000015	0.002269	0.001409	0.001
60	CLARA vs .NearestByCustomer	0.000016	0.002409	0.00148	0.001
61	CLARA vs .Parallel	0.000016	0.002409	0.00148	0.001
62	BestCyclicAssignment vs .NearestByCustomer	0.00002	0.003059	0.001839	0.001
63	BestCyclicAssignment vs .Parallel	0.00002	0.003059	0.001839	0.001
64	BestNearest vs .CLARA	0.000027	0.004106	0.002415	0.002
65	CoefficientPropagation vs .Sweep	0.00003	0.004614	0.002684	0.002
66	BestCyclicAssignment vs .BestNearest	0.000034	0.005181	0.00298	0.003
67	CyclicAssignment vs .UPGMC	0.000063	0.009688	0.005509	0.005
68	BestNearest vs .PAM	0.000116	0.017751	0.009978	0.009
69	Farthest-First vs .NearestByDepot	0.00016	0.024489	0.013605	0.013
70	CoefficientPropagation vs .NearestByCustomer	0.000188	0.0287	0.015757	0.015
71	CoefficientPropagation vs .Parallel	0.000188	0.0287	0.015757	0.015
72	CoefficientPropagation vs .RandomByElement	0.000188	0.0287	0.015757	0.015
73	NearestByCustomer vs .PAM	0.000188	0.0287	0.015757	0.015
74	PAM vs .Parallel	0.000188	0.0287	0.015757	0.015
75	BestNearest vs .CoefficientPropagation	0.000299	0.045781	0.023638	0.023
76	NearestByDepot vs .RandomSequentialCyclic	0.000315	0.048179	0.024562	0.024
77	NearestByDepot vs .ThreeCriteriaClustering	0.000767	0.117404	0.059086	0.058
78	NearestByDepot vs .SequentialCyclic	0.000929	0.142066	0.070569	0.070
79	PAM vs .Sweep	0.000973	0.14894	0.07301	0.071
80	BestCyclicAssignment vs .RandomByElement	0.001349	0.206381	0.099818	0.098
81	NearestByDepot vs .Simplified	0.001349	0.206381	0.099818	0.098
82	KMEANS vs .NearestByDepot	0.001412	0.216084	0.101686	0.101
83	CLARA vs .UPGMC	0.001619	0.24777	0.114978	0.113
84	CLARA vs .RandomByElement	0.001619	0.24777	0.114978	0.113
85	KMEANS vs .PAM	0.001694	0.259249	0.116916	0.116
86	PAM vs .Simplified	0.001773	0.271214	0.12054	0.120
87	BestCyclicAssignment vs .UPGMC	0.001939	0.296681	0.129919	0.129
88	NearestByDepot vs .Sweep	0.00242	0.370248	0.159715	0.159
89	PAM vs .ThreeCriteriaClustering	0.003008	0.460174	0.195499	0.195