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: 342.880702.

P-value computed by Friedman Test: 1.5732615210595213E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 17 and 408 degrees of freedom: 100.209537.

P-value computed by Iman and Daveport Test: 2.220446049250313E-16.

Algorithm	Ranking
BestCyclicAssignment	13.48
BestNearest	7.22
CLARA	12.04
CoefficientPropagation	11.96
CyclicAssignment	15.04
Farthest-First	5.74
KMEANS	6.38
NearestByCustomer	6.84
NearestByDepot	10.68
PAM	1
Parallel	6.84
RandomByElement	17.96
RandomSequentialCyclic	16.16
SequentialCyclic	16.24
Simplified	5.52
Sweep	5.74
ThreeCriteriaClustering	6.44
UPGMC	5.72

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 ≤ 0.000667.
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	11.232034	0	0.000327
152	PAM vs. SequentialCyclic	10.092937	0	0.000329
151	PAM vs. RandomSequentialCyclic	10.039955	0	0.000331
150	CyclicAssignment vs. PAM	9.298217	0	0.000333
149	BestCyclicAssignment vs. PAM	8.265082	0	0.000336
148	RandomByElement vs. Simplified	8.238591	0	0.000338
147	RandomByElement vs. UPGMC	8.106138	0	0.00034
146	Farthest-First vs. RandomByElement	8.092893	0	0.000342
145	RandomByElement vs. Sweep	8.092893	0	0.000345
144	KMEANS vs. RandomByElement	7.669042	0	0.000347
143	RandomByElement vs. ThreeCriteriaClustering	7.629306	0	0.00035
142	NearestByCustomer vs. RandomByElement	7.3644	0	0.000352
141	Parallel vs. RandomByElement	7.3644	0	0.000355
140	CLARA vs. PAM	7.311419	0	0.000357
139	CoefficientPropagation vs. PAM	7.258437	0	0.00036
138	BestNearest vs. RandomByElement	7.112739	0	0.000362
137	SequentialCyclic vs. Simplified	7.099493	0	0.000365
136	RandomSequentialCyclic vs. Simplified	7.046512	0	0.000368
135	SequentialCyclic vs. UPGMC	6.96704	0	0.00037
134	Farthest-First vs. SequentialCyclic	6.953795	0	0.000373
133	SequentialCyclic vs. Sweep	6.953795	0	0.000376
132	RandomSequentialCyclic vs. UPGMC	6.914059	0	0.000379
131	Farthest-First vs. RandomSequentialCyclic	6.900814	0	0.000382
130	RandomSequentialCyclic vs. Sweep	6.900814	0	0.000385
129	KMEANS vs. SequentialCyclic	6.529945	0	0.000388
128	SequentialCyclic vs. ThreeCriteriaClustering	6.490209	0	0.000391
127	KMEANS vs. RandomSequentialCyclic	6.476963	0	0.000394
126	RandomSequentialCyclic vs. ThreeCriteriaClustering	6.437227	0	0.000397
125	NearestByDepot vs. PAM	6.410737	0	0.0004
124	CyclicAssignment vs. Simplified	6.304774	0	0.000403
123	NearestByCustomer vs. SequentialCyclic	6.225302	0	0.000407
122	Parallel vs. SequentialCyclic	6.225302	0	0.00041
121	NearestByCustomer vs. RandomSequentialCyclic	6.172321	0	0.000413
120	Parallel vs. RandomSequentialCyclic	6.172321	0	0.000417
119	CyclicAssignment vs. UPGMC	6.172321	0	0.00042
118	CyclicAssignment vs. Farthest-First	6.159075	0	0.000424
117	CyclicAssignment vs. Sweep	6.159075	0	0.000427
116	BestNearest vs. SequentialCyclic	5.973641	0	0.000431
115	BestNearest vs. RandomSequentialCyclic	5.92066	0	0.000435
114	CyclicAssignment vs. KMEANS	5.735225	0	0.000439
113	CyclicAssignment vs. ThreeCriteriaClustering	5.695489	0	0.000442
112	CyclicAssignment vs. NearestByCustomer	5.430583	0	0.000446
111	CyclicAssignment vs. Parallel	5.430583	0	0.00045
110	BestCyclicAssignment vs. Simplified	5.271639	0	0.000455
109	BestNearest vs. CyclicAssignment	5.178922	0	0.000459
108	BestCyclicAssignment vs. UPGMC	5.139186	0	0.000463
107	BestCyclicAssignment vs. Sweep	5.12594	0	0.000467
106	BestCyclicAssignment vs. Farthest-First	5.12594	0	0.000472
105	NearestByDepot vs. RandomByElement	4.821298	0.000001	0.000476
104	BestCyclicAssignment vs. KMEANS	4.70209	0.000003	0.000481
103	BestCyclicAssignment vs. ThreeCriteriaClustering	4.662354	0.000003	0.000485
102	BestCyclicAssignment vs. NearestByCustomer	4.397447	0.000011	0.00049
101	BestCyclicAssignment vs. Parallel	4.397447	0.000011	0.000495
100	CLARA vs. Simplified	4.317975	0.000016	0.0005
99	CoefficientPropagation vs. Simplified	4.264994	0.00002	0.000505
98	CLARA vs. UPGMC	4.185522	0.000028	0.00051
97	CLARA vs. Sweep	4.172277	0.00003	0.000515
96	CLARA vs. Farthest-First	4.172277	0.00003	0.000521
95	BestCyclicAssignment vs. BestNearest	4.145786	0.000034	0.000526
94	CoefficientPropagation vs. UPGMC	4.132541	0.000036	0.000532
93	BestNearest vs. PAM	4.119296	0.000038	0.000538
92	CoefficientPropagation vs. Sweep	4.119296	0.000038	0.000543
91	CoefficientPropagation vs. Farthest-First	4.119296	0.000038	0.000549
90	CoefficientPropagation vs. RandomByElement	3.973597	0.000071	0.000556
89	CLARA vs. RandomByElement	3.920616	0.000088	0.000562
88	NearestByCustomer vs. PAM	3.867634	0.00011	0.000568
87	PAM vs. Parallel	3.867634	0.00011	0.000575
86	CLARA vs. KMEANS	3.748427	0.000178	0.000581
85	CLARA vs. ThreeCriteriaClustering	3.708691	0.000208	0.000588
84	CoefficientPropagation vs. KMEANS	3.695445	0.00022	0.000595
83	NearestByDepot vs. SequentialCyclic	3.6822	0.000231	0.000602
82	CoefficientPropagation vs. ThreeCriteriaClustering	3.655709	0.000256	0.00061
81	NearestByDepot vs. RandomSequentialCyclic	3.629219	0.000284	0.000617
80	PAM vs. ThreeCriteriaClustering	3.602728	0.000315	0.000625
79	KMEANS vs. PAM	3.562992	0.000367	0.000633
78	CLARA vs. NearestByCustomer	3.443784	0.000574	0.000641
77	CLARA vs. Parallel	3.443784	0.000574	0.000649
76	NearestByDepot vs. Simplified	3.417293	0.000632	0.000658
75	CoefficientPropagation vs. NearestByCustomer	3.390803	0.000697	0.000667
74	CoefficientPropagation vs. Parallel	3.390803	0.000697	0.000676
73	NearestByDepot vs. UPGMC	3.28484	0.00102	0.000685
72	NearestByDepot vs. Sweep	3.271595	0.001069	0.000694
71	Farthest-First vs. NearestByDepot	3.271595	0.001069	0.000704
70	BestNearest vs. CLARA	3.192123	0.001412	0.000714
69	Farthest-First vs. PAM	3.139142	0.001694	0.000725
68	PAM vs. Sweep	3.139142	0.001694	0.000735
67	BestNearest vs. CoefficientPropagation	3.139142	0.001694	0.000746
66	PAM vs. UPGMC	3.125896	0.001773	0.000758
65	PAM vs. Simplified	2.993443	0.002758	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 ≤ 0.001449.

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	11.232034	0	0.000654
152	PAM vs. SequentialCyclic	10.092937	0	0.000658
151	PAM vs. RandomSequentialCyclic	10.039955	0	0.000662
150	CyclicAssignment vs. PAM	9.298217	0	0.000667
149	BestCyclicAssignment vs. PAM	8.265082	0	0.000671
148	RandomByElement vs. Simplified	8.238591	0	0.000676
147	RandomByElement vs. UPGMC	8.106138	0	0.00068
146	Farthest-First vs. RandomByElement	8.092893	0	0.000685
145	RandomByElement vs. Sweep	8.092893	0	0.00069
144	KMEANS vs. RandomByElement	7.669042	0	0.000694
143	RandomByElement vs. ThreeCriteriaClustering	7.629306	0	0.000699
142	NearestByCustomer vs. RandomByElement	7.3644	0	0.000704
141	Parallel vs. RandomByElement	7.3644	0	0.000709
140	CLARA vs. PAM	7.311419	0	0.000714
139	CoefficientPropagation vs. PAM	7.258437	0	0.000719
138	BestNearest vs. RandomByElement	7.112739	0	0.000725
137	SequentialCyclic vs. Simplified	7.099493	0	0.00073
136	RandomSequentialCyclic vs. Simplified	7.046512	0	0.000735
135	SequentialCyclic vs. UPGMC	6.96704	0	0.000741
134	Farthest-First vs. SequentialCyclic	6.953795	0	0.000746
133	SequentialCyclic vs. Sweep	6.953795	0	0.000752
132	RandomSequentialCyclic vs. UPGMC	6.914059	0	0.000758
131	Farthest-First vs. RandomSequentialCyclic	6.900814	0	0.000763
130	RandomSequentialCyclic vs. Sweep	6.900814	0	0.000769
129	KMEANS vs. SequentialCyclic	6.529945	0	0.000775
128	SequentialCyclic vs. ThreeCriteriaClustering	6.490209	0	0.000781
127	KMEANS vs. RandomSequentialCyclic	6.476963	0	0.000787
126	RandomSequentialCyclic vs. ThreeCriteriaClustering	6.437227	0	0.000794
125	NearestByDepot vs. PAM	6.410737	0	0.0008
124	CyclicAssignment vs. Simplified	6.304774	0	0.000806
123	NearestByCustomer vs. SequentialCyclic	6.225302	0	0.000813
122	Parallel vs. SequentialCyclic	6.225302	0	0.00082
121	NearestByCustomer vs. RandomSequentialCyclic	6.172321	0	0.000826
120	Parallel vs. RandomSequentialCyclic	6.172321	0	0.000833
119	CyclicAssignment vs. UPGMC	6.172321	0	0.00084
118	CyclicAssignment vs. Farthest-First	6.159075	0	0.000847
117	CyclicAssignment vs. Sweep	6.159075	0	0.000855
116	BestNearest vs. SequentialCyclic	5.973641	0	0.000862
115	BestNearest vs. RandomSequentialCyclic	5.92066	0	0.00087
114	CyclicAssignment vs. KMEANS	5.735225	0	0.000877
113	CyclicAssignment vs. ThreeCriteriaClustering	5.695489	0	0.000885
112	CyclicAssignment vs. NearestByCustomer	5.430583	0	0.000893
111	CyclicAssignment vs. Parallel	5.430583	0	0.000901
110	BestCyclicAssignment vs. Simplified	5.271639	0	0.000909
109	BestNearest vs. CyclicAssignment	5.178922	0	0.000917
108	BestCyclicAssignment vs. UPGMC	5.139186	0	0.000926
107	BestCyclicAssignment vs. Sweep	5.12594	0	0.000935
106	BestCyclicAssignment vs. Farthest-First	5.12594	0	0.000943
105	NearestByDepot vs. RandomByElement	4.821298	0.000001	0.000952
104	BestCyclicAssignment vs. KMEANS	4.70209	0.000003	0.000962
103	BestCyclicAssignment vs. ThreeCriteriaClustering	4.662354	0.000003	0.000971
102	BestCyclicAssignment vs. NearestByCustomer	4.397447	0.000011	0.00098
101	BestCyclicAssignment vs. Parallel	4.397447	0.000011	0.00099
100	CLARA vs. Simplified	4.317975	0.000016	0.001
99	CoefficientPropagation vs. Simplified	4.264994	0.00002	0.00101
98	CLARA vs. UPGMC	4.185522	0.000028	0.00102
97	CLARA vs. Sweep	4.172277	0.00003	0.001031
96	CLARA vs. Farthest-First	4.172277	0.00003	0.001042
95	BestCyclicAssignment vs. BestNearest	4.145786	0.000034	0.001053
94	CoefficientPropagation vs. UPGMC	4.132541	0.000036	0.001064
93	BestNearest vs. PAM	4.119296	0.000038	0.001075
92	CoefficientPropagation vs. Sweep	4.119296	0.000038	0.001087
91	CoefficientPropagation vs. Farthest-First	4.119296	0.000038	0.001099
90	CoefficientPropagation vs. RandomByElement	3.973597	0.000071	0.001111
89	CLARA vs. RandomByElement	3.920616	0.000088	0.001124
88	NearestByCustomer vs. PAM	3.867634	0.00011	0.001136
87	PAM vs. Parallel	3.867634	0.00011	0.001149
86	CLARA vs. KMEANS	3.748427	0.000178	0.001163
85	CLARA vs. ThreeCriteriaClustering	3.708691	0.000208	0.001176
84	CoefficientPropagation vs. KMEANS	3.695445	0.00022	0.00119
83	NearestByDepot vs. SequentialCyclic	3.6822	0.000231	0.001205
82	CoefficientPropagation vs. ThreeCriteriaClustering	3.655709	0.000256	0.00122
81	NearestByDepot vs. RandomSequentialCyclic	3.629219	0.000284	0.001235
80	PAM vs. ThreeCriteriaClustering	3.602728	0.000315	0.00125
79	KMEANS vs. PAM	3.562992	0.000367	0.001266
78	CLARA vs. NearestByCustomer	3.443784	0.000574	0.001282
77	CLARA vs. Parallel	3.443784	0.000574	0.001299
76	NearestByDepot vs. Simplified	3.417293	0.000632	0.001316
75	CoefficientPropagation vs. NearestByCustomer	3.390803	0.000697	0.001333
74	CoefficientPropagation vs. Parallel	3.390803	0.000697	0.001351
73	NearestByDepot vs. UPGMC	3.28484	0.00102	0.00137
72	NearestByDepot vs. Sweep	3.271595	0.001069	0.001389
71	Farthest-First vs. NearestByDepot	3.271595	0.001069	0.001408
70	BestNearest vs. CLARA	3.192123	0.001412	0.001429
69	Farthest-First vs. PAM	3.139142	0.001694	0.001449
68	PAM vs. Sweep	3.139142	0.001694	0.001471
67	BestNearest vs. CoefficientPropagation	3.139142	0.001694	0.001493
66	PAM vs. UPGMC	3.125896	0.001773	0.001515
65	PAM vs. Simplified	2.993443	0.002758	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 .SequentialCyclic	0	0	0	0
3	PAM vs .RandomSequentialCyclic	0	0	0	0
4	CyclicAssignment vs .PAM	0	0	0	0
5	BestCyclicAssignment vs .PAM	0	0	0	0
6	RandomByElement vs .Simplified	0	0	0	0
7	RandomByElement vs .UPGMC	0	0	0	0
8	Farthest-First vs .RandomByElement	0	0	0	0
9	RandomByElement vs .Sweep	0	0	0	0
10	KMEANS vs .RandomByElement	0	0	0	0
11	RandomByElement vs .ThreeCriteriaClustering	0	0	0	0
12	NearestByCustomer vs .RandomByElement	0	0	0	0
13	Parallel vs .RandomByElement	0	0	0	0
14	CLARA vs .PAM	0	0	0	0
15	CoefficientPropagation vs .PAM	0	0	0	0
16	BestNearest vs .RandomByElement	0	0	0	0
17	SequentialCyclic vs .Simplified	0	0	0	0
18	RandomSequentialCyclic vs .Simplified	0	0	0	0
19	SequentialCyclic vs .UPGMC	0	0	0	0
20	Farthest-First vs .SequentialCyclic	0	0	0	0
21	SequentialCyclic vs .Sweep	0	0	0	0
22	RandomSequentialCyclic vs .UPGMC	0	0	0	0
23	Farthest-First vs .RandomSequentialCyclic	0	0	0	0
24	RandomSequentialCyclic vs .Sweep	0	0	0	0
25	KMEANS vs .SequentialCyclic	0	0	0	0
26	SequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
27	KMEANS vs .RandomSequentialCyclic	0	0	0	0
28	RandomSequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
29	NearestByDepot vs .PAM	0	0	0	0
30	CyclicAssignment vs .Simplified	0	0	0	0
31	NearestByCustomer vs .SequentialCyclic	0	0	0	0
32	Parallel vs .SequentialCyclic	0	0	0	0
33	NearestByCustomer vs .RandomSequentialCyclic	0	0	0	0
34	Parallel vs .RandomSequentialCyclic	0	0	0	0
35	CyclicAssignment vs .UPGMC	0	0	0	0
36	CyclicAssignment vs .Farthest-First	0	0	0	0
37	CyclicAssignment vs .Sweep	0	0	0	0
38	BestNearest vs .SequentialCyclic	0	0	0	0
39	BestNearest vs .RandomSequentialCyclic	0	0	0	0
40	CyclicAssignment vs .KMEANS	0	0.000001	0.000001	0.000
41	CyclicAssignment vs .ThreeCriteriaClustering	0	0.000002	0.000001	0.000
42	CyclicAssignment vs .NearestByCustomer	0	0.000009	0.000006	0.000
43	CyclicAssignment vs .Parallel	0	0.000009	0.000006	0.000
44	BestCyclicAssignment vs .Simplified	0	0.000021	0.000015	0.000
45	BestNearest vs .CyclicAssignment	0	0.000034	0.000024	0.000
46	BestCyclicAssignment vs .UPGMC	0	0.000042	0.00003	0.000
47	BestCyclicAssignment vs .Sweep	0	0.000045	0.000032	0.000
48	BestCyclicAssignment vs .Farthest-First	0	0.000045	0.000032	0.000
49	NearestByDepot vs .RandomByElement	0.000001	0.000218	0.00015	0.000
50	BestCyclicAssignment vs .KMEANS	0.000003	0.000394	0.000268	0.000
51	BestCyclicAssignment vs .ThreeCriteriaClustering	0.000003	0.000478	0.000322	0.000
52	BestCyclicAssignment vs .NearestByCustomer	0.000011	0.001676	0.001117	0.001
53	BestCyclicAssignment vs .Parallel	0.000011	0.001676	0.001117	0.001
54	CLARA vs .Simplified	0.000016	0.002409	0.001575	0.001
55	CoefficientPropagation vs .Simplified	0.00002	0.003059	0.001979	0.001
56	CLARA vs .UPGMC	0.000028	0.004353	0.002788	0.002
57	CLARA vs .Sweep	0.00003	0.004614	0.002925	0.002
58	CLARA vs .Farthest-First	0.00003	0.004614	0.002925	0.002
59	BestCyclicAssignment vs .BestNearest	0.000034	0.005181	0.003217	0.003
60	CoefficientPropagation vs .UPGMC	0.000036	0.005489	0.003372	0.003
61	BestNearest vs .PAM	0.000038	0.005814	0.003534	0.003
62	CoefficientPropagation vs .Sweep	0.000038	0.005814	0.003534	0.003
63	CoefficientPropagation vs .Farthest-First	0.000038	0.005814	0.003534	0.003
64	CoefficientPropagation vs .RandomByElement	0.000071	0.010832	0.006372	0.006
65	CLARA vs .RandomByElement	0.000088	0.013513	0.007861	0.007
66	NearestByCustomer vs .PAM	0.00011	0.016814	0.009671	0.009
67	PAM vs .Parallel	0.00011	0.016814	0.009671	0.009
68	CLARA vs .KMEANS	0.000178	0.027226	0.015303	0.014
69	CLARA vs .ThreeCriteriaClustering	0.000208	0.031875	0.017708	0.01
70	CoefficientPropagation vs .KMEANS	0.00022	0.033584	0.018438	0.018
71	NearestByDepot vs .SequentialCyclic	0.000231	0.035378	0.019192	0.018
72	CoefficientPropagation vs .ThreeCriteriaClustering	0.000256	0.03924	0.021031	0.021
73	NearestByDepot vs .RandomSequentialCyclic	0.000284	0.043495	0.023027	0.023
74	PAM vs .ThreeCriteriaClustering	0.000315	0.048179	0.025192	0.025
75	KMEANS vs .PAM	0.000367	0.056098	0.028965	0.028
76	CLARA vs .NearestByCustomer	0.000574	0.087766	0.044743	0.044
77	CLARA vs .Parallel	0.000574	0.087766	0.044743	0.044
78	NearestByDepot vs .Simplified	0.000632	0.096768	0.048068	0.048
79	CoefficientPropagation vs .NearestByCustomer	0.000697	0.106623	0.052266	0.050
80	CoefficientPropagation vs .Parallel	0.000697	0.106623	0.052266	0.050
81	NearestByDepot vs .UPGMC	0.00102	0.156122	0.074489	0.074
82	NearestByDepot vs .Sweep	0.001069	0.163622	0.076999	0.076
83	Farthest-First vs .NearestByDepot	0.001069	0.163622	0.076999	0.076
84	BestNearest vs .CLARA	0.001412	0.216084	0.098862	0.098
85	Farthest-First vs .PAM	0.001694	0.259249	0.116916	0.116
86	PAM vs .Sweep	0.001694	0.259249	0.116916	0.116
87	BestNearest vs .CoefficientPropagation	0.001694	0.259249	0.116916	0.116
88	PAM vs .UPGMC	0.001773	0.271214	0.116994	0.116
89	PAM vs .Simplified	0.002758	0.422049	0.179302	0.179