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: 323.930526.

P-value computed by Friedman Test: 1.7245838090929055E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 17 and 408 degrees of freedom: 76.92068.

P-value computed by Iman and Daveport Test: 1.1102230246251565E-16.

Algorithm	Ranking
BestCyclicAssignment	12.2
BestNearest	6.7
CLARA	10.12
CoefficientPropagation	9.96
CyclicAssignment	14.52
Farthest-First	3.78
KMEANS	5.1
NearestByCustomer	6
NearestByDepot	10.32
PAM	17.28
Parallel	6
RandomByElement	17.68
RandomSequentialCyclic	14.44
SequentialCyclic	14.84
Simplified	5.48
Sweep	5.5
ThreeCriteriaClustering	3.64
UPGMC	7.44

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 ≤ 0.000581.
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	RandomByElement vs. ThreeCriteriaClustering	9.298217	0	0.000327
152	Farthest-First vs. RandomByElement	9.2055	0	0.000329
151	PAM vs. ThreeCriteriaClustering	9.033311	0	0.000331
150	Farthest-First vs. PAM	8.940593	0	0.000333
149	KMEANS vs. RandomByElement	8.331309	0	0.000336
148	RandomByElement vs. Simplified	8.079647	0	0.000338
147	KMEANS vs. PAM	8.066402	0	0.00034
146	RandomByElement vs. Sweep	8.066402	0	0.000342
145	PAM vs. Simplified	7.814741	0	0.000345
144	PAM vs. Sweep	7.801496	0	0.000347
143	NearestByCustomer vs. RandomByElement	7.735269	0	0.00035
142	Parallel vs. RandomByElement	7.735269	0	0.000352
141	NearestByCustomer vs. PAM	7.470362	0	0.000355
140	PAM vs. Parallel	7.470362	0	0.000357
139	SequentialCyclic vs. ThreeCriteriaClustering	7.417381	0	0.00036
138	Farthest-First vs. SequentialCyclic	7.324664	0	0.000362
137	BestNearest vs. RandomByElement	7.271683	0	0.000365
136	CyclicAssignment vs. ThreeCriteriaClustering	7.205456	0	0.000368
135	RandomSequentialCyclic vs. ThreeCriteriaClustering	7.152475	0	0.00037
134	CyclicAssignment vs. Farthest-First	7.112739	0	0.000373
133	Farthest-First vs. RandomSequentialCyclic	7.059757	0	0.000376
132	BestNearest vs. PAM	7.006776	0	0.000379
131	RandomByElement vs. UPGMC	6.781606	0	0.000382
130	PAM vs. UPGMC	6.516699	0	0.000385
129	KMEANS vs. SequentialCyclic	6.450473	0	0.000388
128	CyclicAssignment vs. KMEANS	6.238547	0	0.000391
127	SequentialCyclic vs. Simplified	6.198811	0	0.000394
126	SequentialCyclic vs. Sweep	6.185566	0	0.000397
125	KMEANS vs. RandomSequentialCyclic	6.185566	0	0.0004
124	CyclicAssignment vs. Simplified	5.986886	0	0.000403
123	CyclicAssignment vs. Sweep	5.973641	0	0.000407
122	RandomSequentialCyclic vs. Simplified	5.933905	0	0.00041
121	RandomSequentialCyclic vs. Sweep	5.92066	0	0.000413
120	NearestByCustomer vs. SequentialCyclic	5.854433	0	0.000417
119	Parallel vs. SequentialCyclic	5.854433	0	0.00042
118	BestCyclicAssignment vs. ThreeCriteriaClustering	5.668998	0	0.000424
117	CyclicAssignment vs. NearestByCustomer	5.642508	0	0.000427
116	CyclicAssignment vs. Parallel	5.642508	0	0.000431
115	NearestByCustomer vs. RandomSequentialCyclic	5.589527	0	0.000435
114	Parallel vs. RandomSequentialCyclic	5.589527	0	0.000439
113	BestCyclicAssignment vs. Farthest-First	5.576281	0	0.000442
112	BestNearest vs. SequentialCyclic	5.390847	0	0.000446
111	BestNearest vs. CyclicAssignment	5.178922	0	0.00045
110	BestNearest vs. RandomSequentialCyclic	5.12594	0	0.000455
109	CoefficientPropagation vs. RandomByElement	5.112695	0	0.000459
108	CLARA vs. RandomByElement	5.006732	0.000001	0.000463
107	SequentialCyclic vs. UPGMC	4.90077	0.000001	0.000467
106	NearestByDepot vs. RandomByElement	4.874279	0.000001	0.000472
105	CoefficientPropagation vs. PAM	4.847788	0.000001	0.000476
104	CLARA vs. PAM	4.741826	0.000002	0.000481
103	BestCyclicAssignment vs. KMEANS	4.70209	0.000003	0.000485
102	CyclicAssignment vs. UPGMC	4.688845	0.000003	0.00049
101	RandomSequentialCyclic vs. UPGMC	4.635863	0.000004	0.000495
100	NearestByDepot vs. PAM	4.609373	0.000004	0.0005
99	BestCyclicAssignment vs. Simplified	4.450429	0.000009	0.000505
98	BestCyclicAssignment vs. Sweep	4.437183	0.000009	0.00051
97	NearestByDepot vs. ThreeCriteriaClustering	4.423938	0.00001	0.000515
96	Farthest-First vs. NearestByDepot	4.331221	0.000015	0.000521
95	CLARA vs. ThreeCriteriaClustering	4.291485	0.000018	0.000526
94	CLARA vs. Farthest-First	4.198768	0.000027	0.000532
93	CoefficientPropagation vs. ThreeCriteriaClustering	4.185522	0.000028	0.000538
92	BestCyclicAssignment vs. NearestByCustomer	4.10605	0.00004	0.000543
91	BestCyclicAssignment vs. Parallel	4.10605	0.00004	0.000549
90	CoefficientPropagation vs. Farthest-First	4.092805	0.000043	0.000556
89	BestCyclicAssignment vs. BestNearest	3.642464	0.00027	0.000562
88	BestCyclicAssignment vs. RandomByElement	3.629219	0.000284	0.000568
87	KMEANS vs. NearestByDepot	3.457029	0.000546	0.000575
86	BestCyclicAssignment vs. PAM	3.364312	0.000767	0.000581
85	CLARA vs. KMEANS	3.324576	0.000886	0.000588
84	CoefficientPropagation vs. SequentialCyclic	3.231859	0.00123	0.000595
83	CoefficientPropagation vs. KMEANS	3.218614	0.001288	0.000602
82	NearestByDepot vs. Simplified	3.205368	0.001349	0.00061
81	NearestByDepot vs. Sweep	3.192123	0.001412	0.000617
80	BestCyclicAssignment vs. UPGMC	3.152387	0.001619	0.000625
79	CLARA vs. SequentialCyclic	3.125896	0.001773	0.000633
78	CLARA vs. Simplified	3.072915	0.00212	0.000641
77	CLARA vs. Sweep	3.05967	0.002216	0.000649
76	CoefficientPropagation vs. CyclicAssignment	3.019934	0.002528	0.000658
75	NearestByDepot vs. SequentialCyclic	2.993443	0.002758	0.000667
74	CoefficientPropagation vs. Simplified	2.966952	0.003008	0.000676
73	CoefficientPropagation vs. RandomSequentialCyclic	2.966952	0.003008	0.000685
72	CoefficientPropagation vs. Sweep	2.953707	0.00314	0.000694
71	CLARA vs. CyclicAssignment	2.913971	0.003569	0.000704
70	NearestByCustomer vs. NearestByDepot	2.86099	0.004223	0.000714
69	NearestByDepot vs. Parallel	2.86099	0.004223	0.000725
68	CLARA vs. RandomSequentialCyclic	2.86099	0.004223	0.000735
67	CyclicAssignment vs. NearestByDepot	2.781518	0.005411	0.000746
66	CLARA vs. NearestByCustomer	2.728537	0.006362	0.000758
65	CLARA vs. Parallel	2.728537	0.006362	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 ≤ 0.00119.

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	RandomByElement vs. ThreeCriteriaClustering	9.298217	0	0.000654
152	Farthest-First vs. RandomByElement	9.2055	0	0.000658
151	PAM vs. ThreeCriteriaClustering	9.033311	0	0.000662
150	Farthest-First vs. PAM	8.940593	0	0.000667
149	KMEANS vs. RandomByElement	8.331309	0	0.000671
148	RandomByElement vs. Simplified	8.079647	0	0.000676
147	KMEANS vs. PAM	8.066402	0	0.00068
146	RandomByElement vs. Sweep	8.066402	0	0.000685
145	PAM vs. Simplified	7.814741	0	0.00069
144	PAM vs. Sweep	7.801496	0	0.000694
143	NearestByCustomer vs. RandomByElement	7.735269	0	0.000699
142	Parallel vs. RandomByElement	7.735269	0	0.000704
141	NearestByCustomer vs. PAM	7.470362	0	0.000709
140	PAM vs. Parallel	7.470362	0	0.000714
139	SequentialCyclic vs. ThreeCriteriaClustering	7.417381	0	0.000719
138	Farthest-First vs. SequentialCyclic	7.324664	0	0.000725
137	BestNearest vs. RandomByElement	7.271683	0	0.00073
136	CyclicAssignment vs. ThreeCriteriaClustering	7.205456	0	0.000735
135	RandomSequentialCyclic vs. ThreeCriteriaClustering	7.152475	0	0.000741
134	CyclicAssignment vs. Farthest-First	7.112739	0	0.000746
133	Farthest-First vs. RandomSequentialCyclic	7.059757	0	0.000752
132	BestNearest vs. PAM	7.006776	0	0.000758
131	RandomByElement vs. UPGMC	6.781606	0	0.000763
130	PAM vs. UPGMC	6.516699	0	0.000769
129	KMEANS vs. SequentialCyclic	6.450473	0	0.000775
128	CyclicAssignment vs. KMEANS	6.238547	0	0.000781
127	SequentialCyclic vs. Simplified	6.198811	0	0.000787
126	SequentialCyclic vs. Sweep	6.185566	0	0.000794
125	KMEANS vs. RandomSequentialCyclic	6.185566	0	0.0008
124	CyclicAssignment vs. Simplified	5.986886	0	0.000806
123	CyclicAssignment vs. Sweep	5.973641	0	0.000813
122	RandomSequentialCyclic vs. Simplified	5.933905	0	0.00082
121	RandomSequentialCyclic vs. Sweep	5.92066	0	0.000826
120	NearestByCustomer vs. SequentialCyclic	5.854433	0	0.000833
119	Parallel vs. SequentialCyclic	5.854433	0	0.00084
118	BestCyclicAssignment vs. ThreeCriteriaClustering	5.668998	0	0.000847
117	CyclicAssignment vs. NearestByCustomer	5.642508	0	0.000855
116	CyclicAssignment vs. Parallel	5.642508	0	0.000862
115	NearestByCustomer vs. RandomSequentialCyclic	5.589527	0	0.00087
114	Parallel vs. RandomSequentialCyclic	5.589527	0	0.000877
113	BestCyclicAssignment vs. Farthest-First	5.576281	0	0.000885
112	BestNearest vs. SequentialCyclic	5.390847	0	0.000893
111	BestNearest vs. CyclicAssignment	5.178922	0	0.000901
110	BestNearest vs. RandomSequentialCyclic	5.12594	0	0.000909
109	CoefficientPropagation vs. RandomByElement	5.112695	0	0.000917
108	CLARA vs. RandomByElement	5.006732	0.000001	0.000926
107	SequentialCyclic vs. UPGMC	4.90077	0.000001	0.000935
106	NearestByDepot vs. RandomByElement	4.874279	0.000001	0.000943
105	CoefficientPropagation vs. PAM	4.847788	0.000001	0.000952
104	CLARA vs. PAM	4.741826	0.000002	0.000962
103	BestCyclicAssignment vs. KMEANS	4.70209	0.000003	0.000971
102	CyclicAssignment vs. UPGMC	4.688845	0.000003	0.00098
101	RandomSequentialCyclic vs. UPGMC	4.635863	0.000004	0.00099
100	NearestByDepot vs. PAM	4.609373	0.000004	0.001
99	BestCyclicAssignment vs. Simplified	4.450429	0.000009	0.00101
98	BestCyclicAssignment vs. Sweep	4.437183	0.000009	0.00102
97	NearestByDepot vs. ThreeCriteriaClustering	4.423938	0.00001	0.001031
96	Farthest-First vs. NearestByDepot	4.331221	0.000015	0.001042
95	CLARA vs. ThreeCriteriaClustering	4.291485	0.000018	0.001053
94	CLARA vs. Farthest-First	4.198768	0.000027	0.001064
93	CoefficientPropagation vs. ThreeCriteriaClustering	4.185522	0.000028	0.001075
92	BestCyclicAssignment vs. NearestByCustomer	4.10605	0.00004	0.001087
91	BestCyclicAssignment vs. Parallel	4.10605	0.00004	0.001099
90	CoefficientPropagation vs. Farthest-First	4.092805	0.000043	0.001111
89	BestCyclicAssignment vs. BestNearest	3.642464	0.00027	0.001124
88	BestCyclicAssignment vs. RandomByElement	3.629219	0.000284	0.001136
87	KMEANS vs. NearestByDepot	3.457029	0.000546	0.001149
86	BestCyclicAssignment vs. PAM	3.364312	0.000767	0.001163
85	CLARA vs. KMEANS	3.324576	0.000886	0.001176
84	CoefficientPropagation vs. SequentialCyclic	3.231859	0.00123	0.00119
83	CoefficientPropagation vs. KMEANS	3.218614	0.001288	0.001205
82	NearestByDepot vs. Simplified	3.205368	0.001349	0.00122
81	NearestByDepot vs. Sweep	3.192123	0.001412	0.001235
80	BestCyclicAssignment vs. UPGMC	3.152387	0.001619	0.00125
79	CLARA vs. SequentialCyclic	3.125896	0.001773	0.001266
78	CLARA vs. Simplified	3.072915	0.00212	0.001282
77	CLARA vs. Sweep	3.05967	0.002216	0.001299
76	CoefficientPropagation vs. CyclicAssignment	3.019934	0.002528	0.001316
75	NearestByDepot vs. SequentialCyclic	2.993443	0.002758	0.001333
74	CoefficientPropagation vs. Simplified	2.966952	0.003008	0.001351
73	CoefficientPropagation vs. RandomSequentialCyclic	2.966952	0.003008	0.00137
72	CoefficientPropagation vs. Sweep	2.953707	0.00314	0.001389
71	CLARA vs. CyclicAssignment	2.913971	0.003569	0.001408
70	NearestByCustomer vs. NearestByDepot	2.86099	0.004223	0.001429
69	NearestByDepot vs. Parallel	2.86099	0.004223	0.001449
68	CLARA vs. RandomSequentialCyclic	2.86099	0.004223	0.001471
67	CyclicAssignment vs. NearestByDepot	2.781518	0.005411	0.001493
66	CLARA vs. NearestByCustomer	2.728537	0.006362	0.001515
65	CLARA vs. Parallel	2.728537	0.006362	0.001538

2.3 Adjusted p-values

i	hypothesis	unadjusted p	p_{Neme}	p_{Holm}	p_{Sh}
1	RandomByElement vs .ThreeCriteriaClustering	0	0	0	0
2	Farthest-First vs .RandomByElement	0	0	0	0
3	PAM vs .ThreeCriteriaClustering	0	0	0	0
4	Farthest-First vs .PAM	0	0	0	0
5	KMEANS vs .RandomByElement	0	0	0	0
6	RandomByElement vs .Simplified	0	0	0	0
7	KMEANS vs .PAM	0	0	0	0
8	RandomByElement vs .Sweep	0	0	0	0
9	PAM vs .Simplified	0	0	0	0
10	PAM vs .Sweep	0	0	0	0
11	NearestByCustomer vs .RandomByElement	0	0	0	0
12	Parallel vs .RandomByElement	0	0	0	0
13	NearestByCustomer vs .PAM	0	0	0	0
14	PAM vs .Parallel	0	0	0	0
15	SequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
16	Farthest-First vs .SequentialCyclic	0	0	0	0
17	BestNearest vs .RandomByElement	0	0	0	0
18	CyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
19	RandomSequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
20	CyclicAssignment vs .Farthest-First	0	0	0	0
21	Farthest-First vs .RandomSequentialCyclic	0	0	0	0
22	BestNearest vs .PAM	0	0	0	0
23	RandomByElement vs .UPGMC	0	0	0	0
24	PAM vs .UPGMC	0	0	0	0
25	KMEANS vs .SequentialCyclic	0	0	0	0
26	CyclicAssignment vs .KMEANS	0	0	0	0
27	SequentialCyclic vs .Simplified	0	0	0	0
28	SequentialCyclic vs .Sweep	0	0	0	0
29	KMEANS vs .RandomSequentialCyclic	0	0	0	0
30	CyclicAssignment vs .Simplified	0	0	0	0
31	CyclicAssignment vs .Sweep	0	0	0	0
32	RandomSequentialCyclic vs .Simplified	0	0	0	0
33	RandomSequentialCyclic vs .Sweep	0	0	0	0
34	NearestByCustomer vs .SequentialCyclic	0	0.000001	0.000001	0.000
35	Parallel vs .SequentialCyclic	0	0.000001	0.000001	0.000
36	BestCyclicAssignment vs .ThreeCriteriaClustering	0	0.000002	0.000002	0.000
37	CyclicAssignment vs .NearestByCustomer	0	0.000003	0.000002	0.000
38	CyclicAssignment vs .Parallel	0	0.000003	0.000002	0.000
39	NearestByCustomer vs .RandomSequentialCyclic	0	0.000003	0.000003	0.000
40	Parallel vs .RandomSequentialCyclic	0	0.000003	0.000003	0.000
41	BestCyclicAssignment vs .Farthest-First	0	0.000004	0.000003	0.000
42	BestNearest vs .SequentialCyclic	0	0.000011	0.000008	0.000
43	BestNearest vs .CyclicAssignment	0	0.000034	0.000025	0.000
44	BestNearest vs .RandomSequentialCyclic	0	0.000045	0.000033	0.000
45	CoefficientPropagation vs .RandomByElement	0	0.000049	0.000035	0.000
46	CLARA vs .RandomByElement	0.000001	0.000085	0.00006	0.000
47	SequentialCyclic vs .UPGMC	0.000001	0.000146	0.000102	0.000
48	NearestByDepot vs .RandomByElement	0.000001	0.000167	0.000116	0.000
49	CoefficientPropagation vs .PAM	0.000001	0.000191	0.000131	0.000
50	CLARA vs .PAM	0.000002	0.000324	0.00022	0.000
51	BestCyclicAssignment vs .KMEANS	0.000003	0.000394	0.000265	0.000
52	CyclicAssignment vs .UPGMC	0.000003	0.00042	0.00028	0.000
53	RandomSequentialCyclic vs .UPGMC	0.000004	0.000544	0.000359	0.000
54	NearestByDepot vs .PAM	0.000004	0.000618	0.000404	0.000
55	BestCyclicAssignment vs .Simplified	0.000009	0.001311	0.000848	0.000
56	BestCyclicAssignment vs .Sweep	0.000009	0.001394	0.000893	0.000
57	NearestByDepot vs .ThreeCriteriaClustering	0.00001	0.001483	0.00094	0.000
58	Farthest-First vs .NearestByDepot	0.000015	0.002269	0.001424	0.001
59	CLARA vs .ThreeCriteriaClustering	0.000018	0.002715	0.001686	0.001
60	CLARA vs .Farthest-First	0.000027	0.004106	0.002523	0.002
61	CoefficientPropagation vs .ThreeCriteriaClustering	0.000028	0.004353	0.002646	0.002
62	BestCyclicAssignment vs .NearestByCustomer	0.00004	0.006158	0.003703	0.003
63	BestCyclicAssignment vs .Parallel	0.00004	0.006158	0.003703	0.003
64	CoefficientPropagation vs .Farthest-First	0.000043	0.006521	0.003836	0.003
65	BestCyclicAssignment vs .BestNearest	0.00027	0.041316	0.024034	0.023
66	BestCyclicAssignment vs .RandomByElement	0.000284	0.043495	0.025017	0.025
67	KMEANS vs .NearestByDepot	0.000546	0.083563	0.047516	0.045
68	BestCyclicAssignment vs .PAM	0.000767	0.117404	0.065992	0.064
69	CLARA vs .KMEANS	0.000886	0.135486	0.07527	0.074
70	CoefficientPropagation vs .SequentialCyclic	0.00123	0.188171	0.10331	0.103
71	CoefficientPropagation vs .KMEANS	0.001288	0.197082	0.106914	0.105
72	NearestByDepot vs .Simplified	0.001349	0.206381	0.11061	0.110
73	NearestByDepot vs .Sweep	0.001412	0.216084	0.114397	0.114
74	BestCyclicAssignment vs .UPGMC	0.001619	0.24777	0.129553	0.129
75	CLARA vs .SequentialCyclic	0.001773	0.271214	0.140039	0.140
76	CLARA vs .Simplified	0.00212	0.324328	0.165343	0.165
77	CLARA vs .Sweep	0.002216	0.339019	0.170618	0.168
78	CoefficientPropagation vs .CyclicAssignment	0.002528	0.38683	0.192151	0.192
79	NearestByDepot vs .SequentialCyclic	0.002758	0.422049	0.206887	0.201
80	CoefficientPropagation vs .Simplified	0.003008	0.460174	0.222568	0.219
81	CoefficientPropagation vs .RandomSequentialCyclic	0.003008	0.460174	0.222568	0.219
82	CoefficientPropagation vs .Sweep	0.00314	0.480392	0.226067	0.226
83	CLARA vs .CyclicAssignment	0.003569	0.546	0.253373	0.249
84	NearestByCustomer vs .NearestByDepot	0.004223	0.64615	0.295624	0.295
85	NearestByDepot vs .Parallel	0.004223	0.64615	0.295624	0.295
86	CLARA vs .RandomSequentialCyclic	0.004223	0.64615	0.295624	0.295
87	CyclicAssignment vs .NearestByDepot	0.005411	0.827812	0.362506	0.362
88	CLARA vs .NearestByCustomer	0.006362	0.973325	0.419866	0.419
89	CLARA vs .Parallel	0.006362	0.973325	0.419866	0.419