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: 350.077895.

P-value computed by Friedman Test: 1.9115653504542252E-10.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 17 and 408 degrees of freedom: 112.141396.

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

Algorithm	Ranking
BestCyclicAssignment	12.56
BestNearest	6.46
CLARA	10.76
CoefficientPropagation	11.52
CyclicAssignment	14.28
Farthest-First	4.3
KMEANS	4.78
NearestByCustomer	6.16
NearestByDepot	10.2
PAM	16.92
Parallel	6.16
RandomByElement	18
RandomSequentialCyclic	15.04
SequentialCyclic	14.92
Simplified	4.96
Sweep	5.06
ThreeCriteriaClustering	3.64
UPGMC	5.28

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 ≤ 0.000685.
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	9.510142	0	0.000327
152	Farthest-First vs. RandomByElement	9.073047	0	0.000329
151	PAM vs. ThreeCriteriaClustering	8.794895	0	0.000331
150	KMEANS vs. RandomByElement	8.755159	0	0.000333
149	RandomByElement vs. Simplified	8.635951	0	0.000336
148	RandomByElement vs. Sweep	8.569724	0	0.000338
147	RandomByElement vs. UPGMC	8.424026	0	0.00034
146	Farthest-First vs. PAM	8.357799	0	0.000342
145	KMEANS vs. PAM	8.039911	0	0.000345
144	PAM vs. Simplified	7.920703	0	0.000347
143	PAM vs. Sweep	7.854477	0	0.00035
142	NearestByCustomer vs. RandomByElement	7.841232	0	0.000352
141	Parallel vs. RandomByElement	7.841232	0	0.000355
140	PAM vs. UPGMC	7.708778	0	0.000357
139	BestNearest vs. RandomByElement	7.642552	0	0.00036
138	RandomSequentialCyclic vs. ThreeCriteriaClustering	7.549834	0	0.000362
137	SequentialCyclic vs. ThreeCriteriaClustering	7.470362	0	0.000365
136	NearestByCustomer vs. PAM	7.125984	0	0.000368
135	PAM vs. Parallel	7.125984	0	0.00037
134	Farthest-First vs. RandomSequentialCyclic	7.112739	0	0.000373
133	CyclicAssignment vs. ThreeCriteriaClustering	7.046512	0	0.000376
132	Farthest-First vs. SequentialCyclic	7.033267	0	0.000379
131	BestNearest vs. PAM	6.927304	0	0.000382
130	KMEANS vs. RandomSequentialCyclic	6.794851	0	0.000385
129	KMEANS vs. SequentialCyclic	6.715379	0	0.000388
128	RandomSequentialCyclic vs. Simplified	6.675643	0	0.000391
127	CyclicAssignment vs. Farthest-First	6.609416	0	0.000394
126	RandomSequentialCyclic vs. Sweep	6.609416	0	0.000397
125	SequentialCyclic vs. Simplified	6.596171	0	0.0004
124	SequentialCyclic vs. Sweep	6.529945	0	0.000403
123	RandomSequentialCyclic vs. UPGMC	6.463718	0	0.000407
122	SequentialCyclic vs. UPGMC	6.384246	0	0.00041
121	CyclicAssignment vs. KMEANS	6.291529	0	0.000413
120	CyclicAssignment vs. Simplified	6.172321	0	0.000417
119	CyclicAssignment vs. Sweep	6.106094	0	0.00042
118	CyclicAssignment vs. UPGMC	5.960396	0	0.000424
117	BestCyclicAssignment vs. ThreeCriteriaClustering	5.907414	0	0.000427
116	NearestByCustomer vs. RandomSequentialCyclic	5.880924	0	0.000431
115	Parallel vs. RandomSequentialCyclic	5.880924	0	0.000435
114	NearestByCustomer vs. SequentialCyclic	5.801452	0	0.000439
113	Parallel vs. SequentialCyclic	5.801452	0	0.000442
112	BestNearest vs. RandomSequentialCyclic	5.682244	0	0.000446
111	BestNearest vs. SequentialCyclic	5.602772	0	0.00045
110	BestCyclicAssignment vs. Farthest-First	5.470319	0	0.000455
109	CyclicAssignment vs. NearestByCustomer	5.377601	0	0.000459
108	CyclicAssignment vs. Parallel	5.377601	0	0.000463
107	CoefficientPropagation vs. ThreeCriteriaClustering	5.218657	0	0.000467
106	BestNearest vs. CyclicAssignment	5.178922	0	0.000472
105	NearestByDepot vs. RandomByElement	5.165676	0	0.000476
104	BestCyclicAssignment vs. KMEANS	5.152431	0	0.000481
103	BestCyclicAssignment vs. Simplified	5.033223	0	0.000485
102	BestCyclicAssignment vs. Sweep	4.966996	0.000001	0.00049
101	BestCyclicAssignment vs. UPGMC	4.821298	0.000001	0.000495
100	CLARA vs. RandomByElement	4.794807	0.000002	0.0005
99	CoefficientPropagation vs. Farthest-First	4.781562	0.000002	0.000505
98	CLARA vs. ThreeCriteriaClustering	4.715335	0.000002	0.00051
97	CoefficientPropagation vs. KMEANS	4.463674	0.000008	0.000515
96	NearestByDepot vs. PAM	4.450429	0.000009	0.000521
95	CoefficientPropagation vs. Simplified	4.344466	0.000014	0.000526
94	NearestByDepot vs. ThreeCriteriaClustering	4.344466	0.000014	0.000532
93	CoefficientPropagation vs. RandomByElement	4.291485	0.000018	0.000538
92	CLARA vs. Farthest-First	4.27824	0.000019	0.000543
91	CoefficientPropagation vs. Sweep	4.27824	0.000019	0.000549
90	BestCyclicAssignment vs. NearestByCustomer	4.238504	0.000023	0.000556
89	BestCyclicAssignment vs. Parallel	4.238504	0.000023	0.000562
88	CoefficientPropagation vs. UPGMC	4.132541	0.000036	0.000568
87	CLARA vs. PAM	4.07956	0.000045	0.000575
86	BestCyclicAssignment vs. BestNearest	4.039824	0.000053	0.000581
85	CLARA vs. KMEANS	3.960352	0.000075	0.000588
84	Farthest-First vs. NearestByDepot	3.90737	0.000093	0.000595
83	CLARA vs. Simplified	3.841144	0.000122	0.000602
82	CLARA vs. Sweep	3.774917	0.00016	0.00061
81	CLARA vs. UPGMC	3.629219	0.000284	0.000617
80	BestCyclicAssignment vs. RandomByElement	3.602728	0.000315	0.000625
79	KMEANS vs. NearestByDepot	3.589483	0.000331	0.000633
78	CoefficientPropagation vs. PAM	3.576237	0.000349	0.000641
77	CoefficientPropagation vs. NearestByCustomer	3.549747	0.000386	0.000649
76	CoefficientPropagation vs. Parallel	3.549747	0.000386	0.000658
75	NearestByDepot vs. Simplified	3.470275	0.00052	0.000667
74	NearestByDepot vs. Sweep	3.404048	0.000664	0.000676
73	BestNearest vs. CoefficientPropagation	3.351067	0.000805	0.000685
72	NearestByDepot vs. UPGMC	3.25835	0.001121	0.000694
71	NearestByDepot vs. RandomSequentialCyclic	3.205368	0.001349	0.000704
70	NearestByDepot vs. SequentialCyclic	3.125896	0.001773	0.000714
69	CLARA vs. NearestByCustomer	3.046424	0.002316	0.000725
68	CLARA vs. Parallel	3.046424	0.002316	0.000735
67	BestCyclicAssignment vs. PAM	2.887481	0.003883	0.000746
66	BestNearest vs. CLARA	2.847745	0.004403	0.000758
65	CLARA vs. RandomSequentialCyclic	2.834499	0.00459	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 ≤ 0.001429.

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	9.510142	0	0.000654
152	Farthest-First vs. RandomByElement	9.073047	0	0.000658
151	PAM vs. ThreeCriteriaClustering	8.794895	0	0.000662
150	KMEANS vs. RandomByElement	8.755159	0	0.000667
149	RandomByElement vs. Simplified	8.635951	0	0.000671
148	RandomByElement vs. Sweep	8.569724	0	0.000676
147	RandomByElement vs. UPGMC	8.424026	0	0.00068
146	Farthest-First vs. PAM	8.357799	0	0.000685
145	KMEANS vs. PAM	8.039911	0	0.00069
144	PAM vs. Simplified	7.920703	0	0.000694
143	PAM vs. Sweep	7.854477	0	0.000699
142	NearestByCustomer vs. RandomByElement	7.841232	0	0.000704
141	Parallel vs. RandomByElement	7.841232	0	0.000709
140	PAM vs. UPGMC	7.708778	0	0.000714
139	BestNearest vs. RandomByElement	7.642552	0	0.000719
138	RandomSequentialCyclic vs. ThreeCriteriaClustering	7.549834	0	0.000725
137	SequentialCyclic vs. ThreeCriteriaClustering	7.470362	0	0.00073
136	NearestByCustomer vs. PAM	7.125984	0	0.000735
135	PAM vs. Parallel	7.125984	0	0.000741
134	Farthest-First vs. RandomSequentialCyclic	7.112739	0	0.000746
133	CyclicAssignment vs. ThreeCriteriaClustering	7.046512	0	0.000752
132	Farthest-First vs. SequentialCyclic	7.033267	0	0.000758
131	BestNearest vs. PAM	6.927304	0	0.000763
130	KMEANS vs. RandomSequentialCyclic	6.794851	0	0.000769
129	KMEANS vs. SequentialCyclic	6.715379	0	0.000775
128	RandomSequentialCyclic vs. Simplified	6.675643	0	0.000781
127	CyclicAssignment vs. Farthest-First	6.609416	0	0.000787
126	RandomSequentialCyclic vs. Sweep	6.609416	0	0.000794
125	SequentialCyclic vs. Simplified	6.596171	0	0.0008
124	SequentialCyclic vs. Sweep	6.529945	0	0.000806
123	RandomSequentialCyclic vs. UPGMC	6.463718	0	0.000813
122	SequentialCyclic vs. UPGMC	6.384246	0	0.00082
121	CyclicAssignment vs. KMEANS	6.291529	0	0.000826
120	CyclicAssignment vs. Simplified	6.172321	0	0.000833
119	CyclicAssignment vs. Sweep	6.106094	0	0.00084
118	CyclicAssignment vs. UPGMC	5.960396	0	0.000847
117	BestCyclicAssignment vs. ThreeCriteriaClustering	5.907414	0	0.000855
116	NearestByCustomer vs. RandomSequentialCyclic	5.880924	0	0.000862
115	Parallel vs. RandomSequentialCyclic	5.880924	0	0.00087
114	NearestByCustomer vs. SequentialCyclic	5.801452	0	0.000877
113	Parallel vs. SequentialCyclic	5.801452	0	0.000885
112	BestNearest vs. RandomSequentialCyclic	5.682244	0	0.000893
111	BestNearest vs. SequentialCyclic	5.602772	0	0.000901
110	BestCyclicAssignment vs. Farthest-First	5.470319	0	0.000909
109	CyclicAssignment vs. NearestByCustomer	5.377601	0	0.000917
108	CyclicAssignment vs. Parallel	5.377601	0	0.000926
107	CoefficientPropagation vs. ThreeCriteriaClustering	5.218657	0	0.000935
106	BestNearest vs. CyclicAssignment	5.178922	0	0.000943
105	NearestByDepot vs. RandomByElement	5.165676	0	0.000952
104	BestCyclicAssignment vs. KMEANS	5.152431	0	0.000962
103	BestCyclicAssignment vs. Simplified	5.033223	0	0.000971
102	BestCyclicAssignment vs. Sweep	4.966996	0.000001	0.00098
101	BestCyclicAssignment vs. UPGMC	4.821298	0.000001	0.00099
100	CLARA vs. RandomByElement	4.794807	0.000002	0.001
99	CoefficientPropagation vs. Farthest-First	4.781562	0.000002	0.00101
98	CLARA vs. ThreeCriteriaClustering	4.715335	0.000002	0.00102
97	CoefficientPropagation vs. KMEANS	4.463674	0.000008	0.001031
96	NearestByDepot vs. PAM	4.450429	0.000009	0.001042
95	CoefficientPropagation vs. Simplified	4.344466	0.000014	0.001053
94	NearestByDepot vs. ThreeCriteriaClustering	4.344466	0.000014	0.001064
93	CoefficientPropagation vs. RandomByElement	4.291485	0.000018	0.001075
92	CLARA vs. Farthest-First	4.27824	0.000019	0.001087
91	CoefficientPropagation vs. Sweep	4.27824	0.000019	0.001099
90	BestCyclicAssignment vs. NearestByCustomer	4.238504	0.000023	0.001111
89	BestCyclicAssignment vs. Parallel	4.238504	0.000023	0.001124
88	CoefficientPropagation vs. UPGMC	4.132541	0.000036	0.001136
87	CLARA vs. PAM	4.07956	0.000045	0.001149
86	BestCyclicAssignment vs. BestNearest	4.039824	0.000053	0.001163
85	CLARA vs. KMEANS	3.960352	0.000075	0.001176
84	Farthest-First vs. NearestByDepot	3.90737	0.000093	0.00119
83	CLARA vs. Simplified	3.841144	0.000122	0.001205
82	CLARA vs. Sweep	3.774917	0.00016	0.00122
81	CLARA vs. UPGMC	3.629219	0.000284	0.001235
80	BestCyclicAssignment vs. RandomByElement	3.602728	0.000315	0.00125
79	KMEANS vs. NearestByDepot	3.589483	0.000331	0.001266
78	CoefficientPropagation vs. PAM	3.576237	0.000349	0.001282
77	CoefficientPropagation vs. NearestByCustomer	3.549747	0.000386	0.001299
76	CoefficientPropagation vs. Parallel	3.549747	0.000386	0.001316
75	NearestByDepot vs. Simplified	3.470275	0.00052	0.001333
74	NearestByDepot vs. Sweep	3.404048	0.000664	0.001351
73	BestNearest vs. CoefficientPropagation	3.351067	0.000805	0.00137
72	NearestByDepot vs. UPGMC	3.25835	0.001121	0.001389
71	NearestByDepot vs. RandomSequentialCyclic	3.205368	0.001349	0.001408
70	NearestByDepot vs. SequentialCyclic	3.125896	0.001773	0.001429
69	CLARA vs. NearestByCustomer	3.046424	0.002316	0.001449
68	CLARA vs. Parallel	3.046424	0.002316	0.001471
67	BestCyclicAssignment vs. PAM	2.887481	0.003883	0.001493
66	BestNearest vs. CLARA	2.847745	0.004403	0.001515
65	CLARA vs. RandomSequentialCyclic	2.834499	0.00459	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	KMEANS vs .RandomByElement	0	0	0	0
5	RandomByElement vs .Simplified	0	0	0	0
6	RandomByElement vs .Sweep	0	0	0	0
7	RandomByElement vs .UPGMC	0	0	0	0
8	Farthest-First vs .PAM	0	0	0	0
9	KMEANS vs .PAM	0	0	0	0
10	PAM vs .Simplified	0	0	0	0
11	PAM vs .Sweep	0	0	0	0
12	NearestByCustomer vs .RandomByElement	0	0	0	0
13	Parallel vs .RandomByElement	0	0	0	0
14	PAM vs .UPGMC	0	0	0	0
15	BestNearest vs .RandomByElement	0	0	0	0
16	RandomSequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
17	SequentialCyclic vs .ThreeCriteriaClustering	0	0	0	0
18	NearestByCustomer vs .PAM	0	0	0	0
19	PAM vs .Parallel	0	0	0	0
20	Farthest-First vs .RandomSequentialCyclic	0	0	0	0
21	CyclicAssignment vs .ThreeCriteriaClustering	0	0	0	0
22	Farthest-First vs .SequentialCyclic	0	0	0	0
23	BestNearest vs .PAM	0	0	0	0
24	KMEANS vs .RandomSequentialCyclic	0	0	0	0
25	KMEANS vs .SequentialCyclic	0	0	0	0
26	RandomSequentialCyclic vs .Simplified	0	0	0	0
27	CyclicAssignment vs .Farthest-First	0	0	0	0
28	RandomSequentialCyclic vs .Sweep	0	0	0	0
29	SequentialCyclic vs .Simplified	0	0	0	0
30	SequentialCyclic vs .Sweep	0	0	0	0
31	RandomSequentialCyclic vs .UPGMC	0	0	0	0
32	SequentialCyclic vs .UPGMC	0	0	0	0
33	CyclicAssignment vs .KMEANS	0	0	0	0
34	CyclicAssignment vs .Simplified	0	0	0	0
35	CyclicAssignment vs .Sweep	0	0	0	0
36	CyclicAssignment vs .UPGMC	0	0	0	0
37	BestCyclicAssignment vs .ThreeCriteriaClustering	0	0.000001	0	0
38	NearestByCustomer vs .RandomSequentialCyclic	0	0.000001	0	0
39	Parallel vs .RandomSequentialCyclic	0	0.000001	0	0
40	NearestByCustomer vs .SequentialCyclic	0	0.000001	0.000001	0.000
41	Parallel vs .SequentialCyclic	0	0.000001	0.000001	0.000
42	BestNearest vs .RandomSequentialCyclic	0	0.000002	0.000001	0.000
43	BestNearest vs .SequentialCyclic	0	0.000003	0.000002	0.000
44	BestCyclicAssignment vs .Farthest-First	0	0.000007	0.000005	0.000
45	CyclicAssignment vs .NearestByCustomer	0	0.000012	0.000008	0.000
46	CyclicAssignment vs .Parallel	0	0.000012	0.000008	0.000
47	CoefficientPropagation vs .ThreeCriteriaClustering	0	0.000028	0.000019	0.000
48	BestNearest vs .CyclicAssignment	0	0.000034	0.000024	0.000
49	NearestByDepot vs .RandomByElement	0	0.000037	0.000025	0.000
50	BestCyclicAssignment vs .KMEANS	0	0.000039	0.000027	0.000
51	BestCyclicAssignment vs .Simplified	0	0.000074	0.00005	0.000
52	BestCyclicAssignment vs .Sweep	0.000001	0.000104	0.000069	0.000
53	BestCyclicAssignment vs .UPGMC	0.000001	0.000218	0.000144	0.000
54	CLARA vs .RandomByElement	0.000002	0.000249	0.000163	0.000
55	CoefficientPropagation vs .Farthest-First	0.000002	0.000266	0.000172	0.000
56	CLARA vs .ThreeCriteriaClustering	0.000002	0.000369	0.000236	0.000
57	CoefficientPropagation vs .KMEANS	0.000008	0.001233	0.000781	0.000
58	NearestByDepot vs .PAM	0.000009	0.001311	0.000823	0.000
59	CoefficientPropagation vs .Simplified	0.000014	0.002136	0.001326	0.001
60	NearestByDepot vs .ThreeCriteriaClustering	0.000014	0.002136	0.001326	0.001
61	CoefficientPropagation vs .RandomByElement	0.000018	0.002715	0.001651	0.001
62	CLARA vs .Farthest-First	0.000019	0.002882	0.001733	0.001
63	CoefficientPropagation vs .Sweep	0.000019	0.002882	0.001733	0.001
64	BestCyclicAssignment vs .NearestByCustomer	0.000023	0.003443	0.002025	0.00
65	BestCyclicAssignment vs .Parallel	0.000023	0.003443	0.002025	0.00
66	CoefficientPropagation vs .UPGMC	0.000036	0.005489	0.003157	0.003
67	CLARA vs .PAM	0.000045	0.006904	0.003926	0.00
68	BestCyclicAssignment vs .BestNearest	0.000053	0.008184	0.0046	0.004
69	CLARA vs .KMEANS	0.000075	0.01145	0.006361	0.006
70	Farthest-First vs .NearestByDepot	0.000093	0.014276	0.007838	0.007
71	CLARA vs .Simplified	0.000122	0.018737	0.010164	0.010
72	CLARA vs .Sweep	0.00016	0.024489	0.013125	0.013
73	CLARA vs .UPGMC	0.000284	0.043495	0.023027	0.023
74	BestCyclicAssignment vs .RandomByElement	0.000315	0.048179	0.025192	0.025
75	KMEANS vs .NearestByDepot	0.000331	0.050694	0.026175	0.026
76	CoefficientPropagation vs .PAM	0.000349	0.053332	0.027189	0.027
77	CoefficientPropagation vs .NearestByCustomer	0.000386	0.058997	0.029691	0.029
78	CoefficientPropagation vs .Parallel	0.000386	0.058997	0.029691	0.029
79	NearestByDepot vs .Simplified	0.00052	0.079549	0.038994	0.037
80	NearestByDepot vs .Sweep	0.000664	0.101584	0.049132	0.048
81	BestNearest vs .CoefficientPropagation	0.000805	0.123166	0.058766	0.058
82	NearestByDepot vs .UPGMC	0.001121	0.171455	0.080685	0.080
83	NearestByDepot vs .RandomSequentialCyclic	0.001349	0.206381	0.095772	0.094
84	NearestByDepot vs .SequentialCyclic	0.001773	0.271214	0.124085	0.124
85	CLARA vs .NearestByCustomer	0.002316	0.354318	0.159791	0.159
86	CLARA vs .Parallel	0.002316	0.354318	0.159791	0.159
87	BestCyclicAssignment vs .PAM	0.003883	0.594161	0.260188	0.260
88	BestNearest vs .CLARA	0.004403	0.673663	0.2906	0.29
89	CLARA vs .RandomSequentialCyclic	0.00459	0.702233	0.298334	0.298