

Results

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1 Tables of Friedman, Bonferroni-Dunn, Holm, Hochberg and Hommel Tests

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Table 1: Average Rankings of the algorithms

Algorithm	Ranking
DE	3.473684210526314
CHC	1.4736842105263157
G-CMA-ES	1.973684210526316
VXQR1	3.0789473684210527

Friedman statistic considering reduction performance (distributed according to chi-square with 3 degrees of freedom: 29.794736842105117).
Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 3 and 54 degrees of freedom: 19.713290771909257).

Bonferroni-Dunn's procedure rejects those hypotheses that have a p-value $\leq 0.016666666666666666$.

Holm's procedure rejects those hypotheses that have a p-value ≤ 0.05 .

Hochberg's procedure rejects those hypotheses that have a p-value ≤ 0.025 .

Hommel's procedure rejects those hypotheses that have a p-value ≤ 0.05 .

Table 2: Holm / Hochberg Table for $\alpha = 0.05$

i	algorithm	$z = (R_0 - R_i) / SE$	p	Holm/Hochberg/Hommel
3	DE	4.77493454525325	1.7976570566878026E-6	0.016666666666666666
2	VXQR1	3.832513260869014	1.2684075974808194E-4	0.025
1	G-CMA-ES	1.1937336386313329	0.232582177582135	0.05

Table 3: Holm / Hochberg Table for $\alpha = 0.10$

i	algorithm	$z = (R_0 - R_i) / SE$	p	Holm/Hochberg/Hommel
3	DE	4.77493454525325	1.7976570566878026E-6	0.033333333333333333
2	VXQR1	3.832513260869014	1.2684075974808194E-4	0.05
1	G-CMA-ES	1.1937336386313329	0.232582177582135	0.1

Bonferroni-Dunn's procedure rejects those hypotheses that have a p-value $\leq 0.033333333333333333$.
 Holm's procedure rejects those hypotheses that have a p-value ≤ 0.1 .
 Hochberg's procedure rejects those hypotheses that have a p-value ≤ 0.05 .
 Hommel's procedure rejects those hypotheses that have a p-value ≤ 0.05 .

Table 4: Adjusted p-values

i	algorithm	unadjusted p	p^{Bonf}	p^{Holm}	p^{Hoch}	p^{Hommel}
1	DE	1.7976570566878026E-6	5.392971170063408E-6	5.392971170063408E-6	5.392971170063408E-6	5.392971170063408E-6
2	VXQR1	1.2684075974808194E-4	3.805222792442458E-4	2.5368151949616387E-4	2.5368151949616387E-4	2.5368151949616387E-4
3	G-CMA-ES	0.232582177582135	0.697746532746405	0.232582177582135	0.232582177582135	0.232582177582135

Table 5: Holm / Shaffer Table for $\alpha = 0.05$

i	algorithms	$z = (R_0 - R_i) / SE$	p	Holm	Shaffer
6	DE vs. CHC	4.77493454525325	1.7976570566878026E-6	0.008333333333333333	0.008333333333333333
5	CHC vs. VXQR1	3.832513260869014	1.2684075974808194E-4	0.01	0.016666666666666666
4	DE vs. G-CMA-ES	3.5812009158939926	3.420185079493796E-4	0.0125	0.016666666666666666
3	G-CMA-ES vs. VXQR1	2.638779622376814	0.008320505023884388	0.016666666666666666	0.016666666666666666
2	CHC vs. G-CMA-ES	1.1937336386313329	0.232582177582135	0.025	0.025
1	DE vs. VXQR1	0.942421293656311	0.345976989569084	0.05	0.05

Nemenyi's procedure rejects those hypotheses that have a p-value $\leq 0.008333333333333333$.

Holm's procedure rejects those hypotheses that have a p-value ≤ 0.025 .
 Shaffer's procedure rejects those hypotheses that have a p-value $\leq 0.008333333333333333$.
 Bergmann's procedure rejects these hypotheses:

- DE vs. CHC
- DE vs. G-CMA-ES
- CHC vs. VXQR1
- G-CMA-ES vs. VXQR1

Table 6: Holm / Shaffer Table for $\alpha = 0.10$

i	algorithms	$z = (R_0 - R_i) / SE$	p	Holm	Shaffer
6	DE vs. CHC	4.77493454525325	1.7976570566878026E-6	0.016666666666666666	0.016666666666666666
5	CHC vs. VXQR1	3.832513260869014	1.2684075974808194E-4	0.02	0.033333333333333333
4	DE vs. G-CMA-ES	3.5812009158939926	3.420185079493796E-4	0.025	0.033333333333333333
3	G-CMA-ES vs. VXQR1	2.6387796222376814	0.008320505023884388	0.033333333333333333	0.033333333333333333
2	CHC vs. G-CMA-ES	1.1937336386313329	0.232582177582135	0.05	0.05
1	DE vs. VXQR1	0.942421293656311	0.345976989569084	0.1	0.1

Nemenyi's procedure rejects those hypotheses that have a p-value $\leq 0.008333333333333333$.
 Holm's procedure rejects those hypotheses that have a p-value ≤ 0.05 .
 Shaffer's procedure rejects those hypotheses that have a p-value $\leq 0.016666666666666666$.
 Bergmann's procedure rejects these hypotheses:

- DE vs. CHC
- DE vs. G-CMA-ES
- CHC vs. VXQR1
- G-CMA-ES vs. VXQR1

Table 7: Adjusted p -values

i	hypothesis	unadjusted p	p_{Nernst}	p_{Holm}	p_{Shaf}	p_{Berg}
1	DE vs .CHC	1.7976570566878026E-6	1.0785942340126816E-5	1.0785942340126816E-5	1.0785942340126816E-5	1.0785942340126816E-5
2	CHC vs .VXQR1	1.2684075974808194E-4	7.6104455848484916E-4	6.342037987404097E-4	3.805222792442458E-4	3.805222792442458E-4
3	DE vs .G-CMA-ES	3.420185079493796E-4	0.0020521110476962776	0.0013680740317975183	0.0010260555238481388	0.0010260555238481388
4	G-CMA-ES vs .VXQR1	0.008320505023884388	0.04992303014530633	0.024961515071653166	0.024961515071653166	0.008320505023884388
5	CHC vs .G-CMA-ES	0.232582177582135	1.39549306549281	0.46516435516427	0.46516435516427	0.46516435516427
6	DE vs .VXQR1	0.345976989569084	2.075861937414504	0.46516435516427	0.46516435516427	0.46516435516427