# Results

June 18, 2010

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



Table 1: Average Rankings of the algorithms

| Algorithm | Ranking |
|---|---|
| DE | 3.473684210526314 |
| CHC | 1.5263157894736836 |
| G-CMA-ES | 1.7631578947368416 |
| VXQR1 | 3.2368421052631575 |

Friedman statistic considering reduction performance (distributed according to chi-square with 3 degrees of freedom: 33.99473684210508.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 3 and 54 degrees of freedom: 26.598490048043562.

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 $\leq 0.05$.

Hochberg's procedure rejects those hypotheses that have a p-value $\leq 0.025$.

Hommel's procedure rejects those hypotheses that have a p-value $\leq 0.05$.

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

| $i$ | algorithm | $z = (R_0 - R_i)/SE$ | $p$ | Holm/Hochberg/Hommel |
|---|---|---|---|---|
| 3 | DE | 4.649278382037818 | 3.330983777894627E-6 | 0.016666666666666666 |
| 2 | VXQR1 | 4.083825605844032 | 4.430028241597432E-5 | 0.025 |
| 1 | G-CMA-ES | 0.5654527761937891 | 0.5717658361284772 | 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 | 4.649278382037818 | 3.330983777894627E-6 | 0.03333333333333333 |
| 2 | VXQR1 | 4.083825605844032 | 4.430028241597432E-5 | 0.05 |
| 1 | G-CMA-ES | 0.5654527761937891 | 0.5717658361284772 | 0.1 |

Bonferroni-Dunn's procedure rejects those hypotheses that have a p-value $\leq 0.03333333333333333$.
Holm's procedure rejects those hypotheses that have a p-value $\leq 0.1$.
Hochberg's procedure rejects those hypotheses that have a p-value $\leq 0.05$.
Hommel's procedure rejects those hypotheses that have a p-value $\leq 0.05$.



Table 4: Adjusted $p$-values

| i | algorithm | unadjusted $p$ | $p_{Bonf}$ | $p_{Holm}$ | $p_{Hoch}$ | $p_{Homm}$ |
|---|---|---|---|---|---|---|
| 1 | DE | 3.330983777894627E-6 | 9.992951333683881E-6 | 9.992951333683881E-6 | 9.992951333683881E-6 | 9.992951333683881E-6 |
| 2 | VXQR1 | 4.430028241597432E-5 | 1.3290084724792295E-4 | 8.860056483194864E-5 | 8.860056483194864E-5 | 8.860056483194864E-5 |
| 3 | G-CMA-ES | 0.5717658361284772 | 1.7152975083854316 | 0.5717658361284772 | 0.5717658361284772 | 0.5717658361284772 |

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

| $i$ | algorithms | $z = (R_0 - R_i)/SE$ | $p$ | Holm | Shaffer |
|---|---|---|---|---|---|
| 6 | DE vs. CHC | 4.649278382037818 | 3.330983777894627E-6 | 0.008333333333333333 | 0.008333333333333333 |
| 5 | CHC vs. VXQR1 | 4.083825605844032 | 4.430028241597432E-5 | 0.01 | 0.016666666666666666 |
| 4 | DE vs. G-CMA-ES | 4.083825605844028 | 4.430028241597499E-5 | 0.0125 | 0.016666666666666666 |
| 3 | G-CMA-ES vs. VXQR1 | 3.5183728296502426 | 4.342018690566085E-4 | 0.016666666666666666 | 0.016666666666666666 |
| 2 | CHC vs. G-CMA-ES | 0.5654527761937891 | 0.5717658361284772 | 0.025 | 0.025 |
| 1 | DE vs. VXQR1 | 0.565452776193786 | 0.5717658361284794 | 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 $\leq 0.025$.
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 | 4.649278382037818 | 3.330983777894627E-6 | 0.016666666666666666 | 0.016666666666666666 |
| 5 | CHC vs. VXQR1 | 4.083825605844032 | 4.430028241597432E-5 | 0.02 | 0.03333333333333333 |
| 4 | DE vs. G-CMA-ES | 4.083825605844028 | 4.430028241597499E-5 | 0.025 | 0.03333333333333333 |
| 3 | G-CMA-ES vs. VXQR1 | 3.5183728296502426 | 4.342018690566085E-4 | 0.03333333333333333 | 0.03333333333333333 |
| 2 | CHC vs. G-CMA-ES | 0.5654527761937891 | 0.5717658361284772 | 0.05 | 0.05 |
| 1 | DE vs. VXQR1 | 0.565452776193786 | 0.5717658361284794 | 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 $\leq 0.05$.
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 $p$ | $p_{Neme}$ | $p_{Holm}$ | $p_{Shaf}$ | $p_{Berg}$ |
|---|---|---|---|---|---|---|
| 1 | DE vs .CHC | 3.330983777894627E-6 | 1.9985902667367762E-5 | 1.9985902667367762E-5 | 1.9985902667367762E-5 | 1.9985902667367762E-5 |
| 2 | CHC vs .VXQR1 | 4.430028241597432E-5 | 2.658016944958459E-4 | 2.2150141207987161E-4 | 1.3290084724792295E-4 | 1.3290084724792295E-4 |
| 3 | DE vs .G-CMA-ES | 4.430028241597499E-5 | 2.6580169449584996E-4 | 2.2150141207987161E-4 | 1.3290084724792498E-4 | 1.3290084724792498E-4 |
| 4 | G-CMA-ES vs .VXQR1 | 4.342018690566085E-4 | 0.002605211214339651 | 0.0013026056071698256 | 0.0013026056071698256 | 4.342018690566085E-4 |
| 5 | CHC vs .G-CMA-ES | 0.5717658361284772 | 3.430595016770863 | 1.1435316722569544 | 1.1435316722569544 | 1.1435316722569544 |
| 6 | DE vs .VXQR1 | 0.5717658361284794 | 3.4305950167708765 | 1.1435316722569544 | 1.1435316722569544 | 1.1435316722569544 |