# Results

October 11, 2018

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



Table 1: Average Rankings of the algorithms

| Algorithm | Ranking |
|---|---|
| Col09 | 3.4166666666666665 |
| Byk13 | 1.2499999999999998 |
| Ham13 | 4.666666666666666 |
| Bat17 | 2.583333333333333 |
| FastSA | 3.083333333333333 |

Friedman statistic considering reduction performance (distributed according to chi-square with 4 degrees of freedom: 29.73333333333329. P-value computed by Friedman Test: 5.545954431029898E-6.

Iman and Davenport statistic considering reduction performance (distributed according to F-distribution with 4 and 44 degrees of freedom: 17.90510948905103.

P-value computed by Iman and Daveport Test: 8.597571862878918E-9.

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

| $i$ | algorithm | $z = (R_0 - R_i)/SE$ | $p$ | Holm/Hochberg/Hommel |
|---|---|---|---|---|
| 4 | Ham13 | 5.293077239816802 | 1.2027508945921517E-7 | 0.0125 |
| 3 | Col09 | 3.356585566713095 | 7.891129890156221E-4 | 0.016666666666666666 |
| 2 | FastSA | 2.840187787218772 | 0.004508698364904261 | 0.025 |
| 1 | Bat17 | 2.065591117977289 | 0.03886710381241729 | 0.05 |

Bonferroni-Dunn's procedure rejects those hypotheses that have a p-value $\leq 0.0125$.
Hochberg's procedure rejects those hypotheses that have a p-value $\leq 0.05$.
Hommel's procedure rejects all hypotheses.

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

| $i$ | algorithm | $z = (R_0 - R_i)/SE$ | $p$ | Holm/Hochberg/Hommel |
|---|---|---|---|---|
| 4 | Ham13 | 5.293077239816802 | 1.2027508945921517E-7 | 0.025 |
| 3 | Col09 | 3.356585566713095 | 7.891129890156221E-4 | 0.03333333333333333 |
| 2 | FastSA | 2.840187787218772 | 0.004508698364904261 | 0.05 |
| 1 | Bat17 | 2.065591117977289 | 0.03886710381241729 | 0.1 |

Bonferroni-Dunn's procedure rejects those hypotheses that have a p-value $\leq 0.025$.
Hochberg's procedure rejects those hypotheses that have a p-value $\leq 0.1$.
Hommel's procedure rejects all hypotheses.

Table 4: Adjusted $p$-values

| i | algorithm | unadjusted $p$ | $p_{Bonf}$ | $p_{Holm}$ | $p_{Hoch}$ | $p_{Homm}$ |
|---|---|---|---|---|---|---|
| 1 | Ham13 | 1.2027508945921517E-7 | 4.811003578368607E-7 | 4.811003578368607E-7 | 4.811003578368607E-7 | 4.811003578368607E-7 |
| 2 | Col09 | 7.891129890156221E-4 | 0.0031564519560624885 | 0.0023673389670468663 | 0.0023673389670468663 | 0.0023673389670468663 |
| 3 | FastSA | 0.004508698364904261 | 0.018034793459617043 | 0.009017396729808521 | 0.009017396729808521 | 0.009017396729808521 |
| 4 | Bat17 | 0.03886710381241729 | 0.15546841524966917 | 0.03886710381241729 | 0.03886710381241729 | 0.03886710381241729 |

Nemenyi's procedure rejects those hypotheses that have a p-value $\leq 0.005$.
Holm's procedure rejects those hypotheses that have a p-value $\leq 0.008333333333333333$.

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

| $i$ | algorithms | $z = (R_0 - R_i)/SE$ | $p$ | Holm | Shaffer |
|---|---|---|---|---|---|
| 10 | Byk13 vs. Ham13 | 5.293077239816802 | 1.2027508945921517E-7 | 0.005 | 0.005 |
| 9 | Col09 vs. Byk13 | 3.356585566713095 | 7.891129890156221E-4 | 0.005555555555555556 | 0.008333333333333333 |
| 8 | Ham13 vs. Bat17 | 3.227486121839514 | 0.0012488309880884449 | 0.00625 | 0.008333333333333333 |
| 7 | Byk13 vs. FastSA | 2.840187787218772 | 0.004508698364904261 | 0.0071428571428571435 | 0.008333333333333333 |
| 6 | Ham13 vs. FastSA | 2.4528894525980305 | 0.014171388254012299 | 0.008333333333333333 | 0.008333333333333333 |
| 5 | Byk13 vs. Bat17 | 2.065591117977289 | 0.03886710381241729 | 0.01 | 0.01 |
| 4 | Col09 vs. Ham13 | 1.9364916731037078 | 0.05280751141611372 | 0.0125 | 0.0125 |
| 3 | Col09 vs. Bat17 | 1.2909944487358058 | 0.19670560245894683 | 0.016666666666666666 | 0.016666666666666666 |
| 2 | Bat17 vs. FastSA | 0.7745966692414834 | 0.4385780260809999 | 0.025 | 0.025 |
| 1 | Col09 vs. FastSA | 0.5163977794943225 | 0.6055766163353462 | 0.05 | 0.05 |

Shaffer's procedure rejects those hypotheses that have a p-value $\leq 0.005$.
Bergmann's procedure rejects these hypotheses:

- Col09 vs. Byk13
- Byk13 vs. Ham13
- Byk13 vs. FastSA
- Ham13 vs. Bat17



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

| $i$ | algorithms | $z = (R_0 - R_i)/SE$ | $p$ | Holm | Shaffer |
|---|---|---|---|---|---|
| 10 | Byk13 vs. Ham13 | 5.293077239816802 | 1.2027508945921517E-7 | 0.01 | 0.01 |
| 9 | Col09 vs. Byk13 | 3.356585566713095 | 7.891129890156221E-4 | 0.011111111111111112 | 0.016666666666666666 |
| 8 | Ham13 vs. Bat17 | 3.227486121839514 | 0.0012488309880884449 | 0.0125 | 0.016666666666666666 |
| 7 | Byk13 vs. FastSA | 2.840187787218772 | 0.004508698364904261 | 0.014285714285714287 | 0.016666666666666666 |
| 6 | Ham13 vs. FastSA | 2.4528894525980305 | 0.014171388254012299 | 0.016666666666666666 | 0.016666666666666666 |
| 5 | Byk13 vs. Bat17 | 2.065591117977289 | 0.03886710381241729 | 0.02 | 0.025 |
| 4 | Col09 vs. Ham13 | 1.9364916731037078 | 0.05280751141611372 | 0.025 | 0.025 |
| 3 | Col09 vs. Bat17 | 1.2909944487358058 | 0.19670560245894683 | 0.03333333333333333 | 0.03333333333333333 |
| 2 | Bat17 vs. FastSA | 0.7745966692414834 | 0.4385780260809999 | 0.05 | 0.05 |
| 1 | Col09 vs. FastSA | 0.5163977794943225 | 0.6055766163353462 | 0.1 | 0.1 |

Nemenyi's procedure rejects those hypotheses that have a p-value $\leq 0.01$.

Holm's procedure rejects those hypotheses that have a p-value $\leq 0.02$.
Shaffer's procedure rejects those hypotheses that have a p-value $\leq 0.01$.
Bergmann's procedure rejects these hypotheses:

- Col09 vs. Byk13
- Byk13 vs. Ham13
- Byk13 vs. Bat17
- Byk13 vs. FastSA
- Ham13 vs. Bat17
- Ham13 vs. FastSA



Table 7: Adjusted $p$-values

| i | hypothesis | unadjusted $p$ | $p_{Neme}$ | $p_{Holm}$ | $p_{Shaf}$ | $p_{Berg}$ |
|---|---|---|---|---|---|---|
| 1 | Byk13 vs .Ham13 | 1.2027508945921517E-7 | 1.202750894592151 7E-6 | 1.202750894592151 7E-6 | 1.202750894592151 7E-6 | 1.202750894592151 7E-6 |
| 2 | Col09 vs .Byk13 | 7.891129890156221E-4 | 0.007891129890156222 | 0.007102016901140599 | 0.004734677934093732 6 | 0.004734677934093732 6 |
| 3 | Ham13 vs .Bat17 | 0.0012488309880884449 | 0.012488309880884448 | 0.009990647904707559 | 0.007492985928530 67 | 0.007492985928530 67 |
| 4 | Byk13 vs .FastSA | 0.004508698364904261 | 0.04508698364904261 | 0.03156088855432983 | 0.027052190189425562 | 0.018034793459617043 |
| 5 | Ham13 vs .FastSA | 0.014171388254012299 | 0.141713882540123 | 0.0850283295240738 | 0.085028329524073 8 | 0.056685553016049196 |
| 6 | Byk13 vs .Bat17 | 0.03886710381241729 | 0.3886710381241729 | 0.19433551906208646 | 0.15546841524966917 | 0.07773420762483459 |
| 7 | Col09 vs .Ham13 | 0.05280751141611372 | 0.5280751141611372 | 0.21123004566445489 | 0.211230045664454 89 | 0.10561502283222744 |
| 8 | Col09 vs .Bat17 | 0.19670560245894683 | 1.9670560245894684 | 0.5901168073768405 | 0.590116807376840 5 | 0.5901168073768405 |
| 9 | Bat17 vs .FastSA | 0.4385780260809999 | 4.385780260809999 | 0.8771560521619998 | 0.877156052161999 8 | 0.5901168073768405 |
| 10 | Col09 vs .FastSA | 0.6055766163353462 | 6.055766163353462 5 | 0.8771560521619998 | 0.877156052161999 8 | 0.6055766163353462 |