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• **Supplementary File** •

# Zoning search using a hyper-heuristic algorithm

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## Appendix A

**Table A1** Parameter settings of all selected algorithms

| **Algorithm** | **Parameter settings** |
|---|---|
| JADE | $NP = 100, \quad p = 0.05, \quad c = 0.1$ |
| SSCPDE | $NP = 100, \quad G_s = 0.2 \times G_{\max}$ |

**Table A2** Results on 30-dimensional IEEE CEC2014 test suite

| Function | JADE | | SSCPDE | | ZS-JADE | | ZS-SSCPDE | | The proposed algorithm |
|---|---|---|---|---|---|---|---|---|---|
| $F1_{CEC2014}$ | 7.62E+02(1.12E+03) | - | 2.35E+04(1.83E+04) | + | 5.05E+01(1.34E+02) | - | 7.28E+03(2.63E+03) | + | 1.89E+03(1.45E+03) |
| $F2_{CEC2014}$ | 1.71E-14(1.42E-14) | - | 4.92E-14(1.65E-14) | + | 1.13E-14(1.41E-14) | - | 4.64E-14(1.39E-14) | + | 3.50E-14(1.22E-14) |
| $F3_{CEC2014}$ | 3.29E-06(1.01E-05) | + | 1.06E-13(3.57E-14) | ≈ | 9.48E-10(4.91E-09) | + | 1.06E-13(2.46E-14) | ≈ | 1.13E-13(7.75E-14) |
| $F4_{CEC2014}$ | 9.09E-14(4.62E-14) | - | 3.39E-03(1.76E-02) | + | 5.68E-14(2.11E-14) | - | 1.32E-04(6.77E-04) | + | 2.75E-03(1.51E-02) |
| $F5_{CEC2014}$ | 2.03E+01(3.62E-02) | + | 2.04E+01(2.92E-02) | + | 2.01E+01(1.86E-14) | + | 2.02E+01(2.65E-02) | + | 2.01E+01(2.77E-02) |
| $F6_{CEC2014}$ | 9.11E+00(3.06E+00) | + | 1.36E+00(1.18E+00) | + | 0.00E+00(0.00E+00) | - | 8.77E-03(7.18E-03) | + | 1.63E-04(6.92E-04) |
| $F7_{CEC2014}$ | 2.46E-04(1.35E-03) | + | 2.46E-04(1.35E-03) | + | 3.78E-15(2.07E-14) | - | 3.48E-13(1.19E-13) | + | 1.85E-13(2.74E-13) |
| $F8_{CEC2014}$ | 0.00E+00(0.00E+00) | ≈ | 0.00E+00(0.00E+00) | ≈ | 0.00E+00(0.00E+00) | ≈ | 0.00E+00(0.00E+00) | ≈ | 0.00E+00(0.00E+00) |
| $F9_{CEC2014}$ | 2.66E+01(4.37E+00) | + | 2.97E+01(5.45 E+00) | + | 2.27E+01(2.91E+00) | ≈ | 2.35E+01(4.09E+00) | ≈ | 2.39E+01(3.14E+00) |
| $F10_{CEC2014}$ | 6.93E-03(1.37E-02) | - | 1.00E+00(1.16E+00) | + | 2.08E-03(6.35E-03) | - | 3.85E-01(2.03E-01) | + | 3.61E-02(2.56E-02) |
| $F11_{CEC2014}$ | 1.65E+03(2.37E+02) | + | 2.15E+03(3.82E+02) | + | 9.17E+02(9.41E+01) | + | 9.14E+02(1.19E+02) | + | 8.58E+02(1.18E+02) |
| $F12_{CEC2014}$ | 2.58E-01(3.37E-02) | + | 4.47E-01(7.06E-02) | + | 1.35E-01(1.23E-02) | + | 1.99E-01(3.74E-02) | + | 9.16E-02(2.34E-02) |
| $F13_{CEC2014}$ | 2.20E-01(2.81E-02) | + | 1.85E-01(2.42E-02) | + | 1.60E-01(1.35E-02) | + | 1.35E-01(2.24E-02) | - | 1.49E-01(1.90E-02) |
| $F14_{CEC2014}$ | 2.31E-01(3.44E-02) | + | 2.08E-01(2.76E-02) | + | 1.57E-01(1.24E-02) | ≈ | 1.48E-01(1.50E-02) | - | 1.57E-01(1.42E-02) |
| $F15_{CEC2014}$ | 3.11E+00(2.96E-01) | + | 2.76E+00(5.73E-01) | + | 2.68E+00(2.51E-01) | + | 2.02E+00(3.02E-01) | - | 2.29E+00(3.69E-01) |
| $F16_{CEC2014}$ | 9.45E+00(4.23E-01) | + | 1.07E+01(3.22E-01) | + | 7.95E+00(2.81E-01) | ≈ | 9.17E+00(2.58E-01) | + | 8.16E+00(3.03E-01) |
| $F17_{CEC2014}$ | 3.20E+04(1.68E+05) | + | 9.00E+02(5.14E+02) | + | 4.76E+02(1.48E+02) | - | 3.37E+02(9.95E+01) | - | 5.93E+02(1.54E+02) |
| $F18_{CEC2014}$ | 2.34E+02(6.08E+02) | + | 3.66E+01(1.52E+01) | + | 2.79E+01(7.48E+00) | + | 1.70E+01(5.57E+00) | - | 2.23E+01(4.94E+00) |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $F19_{CEC2014}$ | 4.62E+00(9.63E-01) | + | 3.68E+00(6.91E-01) | + | 3.07E+00(3.96E-01) | + | 2.49E+00(4.64E-01) | - | 2.82E+00(4.82E-01) |
| $F20_{CEC2014}$ | 3.75E+03(2.97E+03) | + | 8.58E+00(2.76E+00) | - | 1.23E+01(3.47E+00) | ≈ | 6.67E+00(1.46E+00) | - | 1.30E+01(2.27E+00) |
| $F21_{CEC2014}$ | 6.06E+03(3.14E+04) | + | 2.08E+02(9.54E+01) | - | 1.05E+02(7.61E+01) | - | 8.96E+01(6.60E+01) | - | 2.74E+02(1.15E+02) |
| $F22_{CEC2014}$ | 1.29E+02(6.47E+01) | + | 2.39E+01(1.88 E+00) | + | 2.74E+01(2.42E+00) | + | 1.69E+01(7.56E+00) | + | 1.28E+01(9.19E+00) |
| $F23_{CEC2014}$ | 3.15E+02(5.78E-14) | ≈ | 3.15E+02(4.25E-13) | + | 3.15E+02(5.78E-14) | ≈ | 3.15E+02(4.06E-13) | ≈ | 3.15E+02(5.78E-14) |
| $F24_{CEC2014}$ | 2.24E+02(1.07E+00) | + | 2.23E+02(9.13E-01) | + | 2.00E+02(1.16E-02) | ≈ | 2.00E+02(6.30E-03) | ≈ | 2.00E+02(1.57E-02) |
| $F25_{CEC2014}$ | 2.04E+02(1.77E+00) | + | 2.04E+02(6.94E-01) | + | 2.03E+02(2.64E-01) | ≈ | 2.03E+02(2.09E-01) | ≈ | 2.03E+02(2.21E-01) |
| $F26_{CEC2014}$ | 1.00E+02(4.17E-02) | + | 1.00E+02(3.21E-02) | ≈ | 1.00E+02(2.06E-02) | ≈ | 1.00E+02(2.36E-02) | ≈ | 1.00E+02(2.80E-02) |
| $F27_{CEC2014}$ | 3.37E+02(4.95E+01) | ≈ | 3.06E+02(2.16E+01) | + | 3.05E+02(1.29E+01) | - | 3.00E+02(3.11E-01) | + | 3.00E+02(7.59E-01) |
| $F28_{CEC2014}$ | 8.01E+02(3.63E+01) | + | 7.94E+02(1.67E+01) | + | 6.61E+02(1.86E+01) | ≈ | 6.74E+02(1.79E+01) | - | 6.85E+02(2.02E+01) |
| $F29_{CEC2014}$ | 7.29E+02(1.43E+02) | + | 8.15E+02(7.29E+01) | + | 3.96E+02(5.21E+01) | ≈ | 4.77E+02(5.10E+01) | + | 3.93E+02(8.17E+01) |
| $F30_{CEC2014}$ | 1.54E+03(7.04E+02) | + | 7.77E+02(1.88E+02) | + | 5.52E+02(7.47E+01) | + | 4.67E+02(6.63E+01) | - | 5.23E+02(6.12E+01) |
| + | | 23 | | 25 | | 10 | | 13 | |
| ≈ | | 3 | | 3 | | 11 | | 7 | |
| − | | 4 | | 2 | | 9 | | 10 | |

**Table A3** $p$-values obtained by Bonferroni-Dunn's, Holm's, and Hochberg's procedures on 30-dimensional IEEE CEC2014 functions

| | $z$ | Unadjusted $p$ | Bonferroni-Dunn $p$ | Holm $p$ | Hochberg $p$ |
|---|---|---|---|---|---|
| ZS-ASM-JADE-SSCPDE **V.S.** JADE | 4.28 | 1.81E-05 | 7.25E-05 | 7.25E-05 | 7.25E-05 |
| ZS-ASM-JADE-SSCPDE **V.S.** SSCPDE | 3.96 | 7.49E-05 | 2.25E-04 | 2.25E-04 | 2.25E-04 |
| ZS-ASM-JADE-SSCPDE **V.S.** ZS-JADE | -0.61 | 5.40E-01 | 1.00 | 1.00 | 6.24E-01 |
| ZS-ASM-JADE-SSCPDE **V.S.** ZS-SSCPDE | -0.48 | 6.24E-01 | 1.00 | 1.00 | 6.24E-01 |