# Final Report on CEC'09 MOEA Competition

Qingfu Zhang[1] and Ponnuthurai N. Suganthan[2]

[1] School of CS & EE, University of Essex, UK

[1] School of EEE, Nanyang Technological University, Singapore

# Test Instances

Q. Zhang, A. Zhou, S. Zhao, P. N. Suganthan, W. Liu and S.Tiwari, *Multiobjective Optimization Test Instances for the CEC 2009 Special Session and Competition*, Working Report, CES-887, School of Computer Science and Electrical Engineering, University of Essex, 2008

- 13 unconstrained instances
- 10 constrained instances (only the first 7 instances were used for ranking, since there were typos in the last 3 instances in earlier versions, which have been corrected in the current version).

# Entries

| Algorithm | Tested on Constrained MOP? | Authors |
|---|---|---|
| AMGA | No | Santosh Tiwari et al, Clemson University |
| DECMOSA-SQP | Yes | Ales Zamuda et al UM FERI |
| DMOEADD | Yes | Minzhong Liu et al, Wuhan University |
| GDE3 | Yes | Saku Kukkonen et al, Lappeenranta University of Technology |
| LiuLiAlgorithm | Yes | Hai-Lin Liu, Guangdong University of Technology |
| MOEADGM | Yes | Chih-Ming Chen et al. National Chiao Tung University, |
| MOEP | No | B Y. Qu et al. Nanyang Technological university |
| MTS | Yes | Lin-YU Tseng et al, National Chung Hsing University |
| NSGAIILS | Yes | Karthik et al, Helsinki School of Economics |
| OMOEAII | No | Song Gao et al, China University of Geosciences |
| OWMOSaDE | No | Vicky Ling Huang, Nanyang Technological University |
| MOEAD | No | Qingfu Zhang et al, University of Essex |
| ClusteringMOEA | No | Yuping Wang, et al, Xidian University |

13 for unconstrained MOP, and 7 for unconstrained MOP

# Performance Metric

- IGD value is used to measure algorithm performances
- The maximal no of the final solutions for computing the IGD
  - 100 for two objectives
  - 150 for three objectives
  - 800 for five objectives
- The maximal function evaluations: 300K
- 30 independent runs on each instance should be run.
- The mean/dev of IGD should be reported.

# Experimental Results (IGD value) on Unconstrained Test Instances

| rank | UF1 | | UF2 | | UF3 | |
|---|---|---|---|---|---|---|
| 1 | MOEAD | 0.00435 | MTS | 0.00615 | MOEAD | 0.00742 |
| 2 | GDE3 | 0.00534 | MOEADGM | 0.0064 | LiuLiAlgorithm | 0.01497 |
| 3 | MOEADGM | 0.0062 | DMOEADD | 0.00679 | DMOEADD | 0.03337 |
| 4 | MTS | 0.00646 | MOEAD | 0.00679 | MOEADGM | 0.049 |
| 5 | LiuLiAlgorithm | 0.00785 | OWMOSaDE | 0.0081 | MTS | 0.0531 |
| 6 | DMOEADD | 0.01038 | GDE3 | 0.01195 | ClusteringMOEA | 0.0549 |
| 7 | NSGAIILS | 0.01153 | LiuLiAlgorithm | 0.0123 | AMGA | 0.06998 |
| 8 | OWMOSaDE | 0.0122 | NSGAIILS | 0.01237 | DECMOSA-SQP | 0.0935 |
| 9 | ClusteringMOEA | 0.0299 | AMGA | 0.01623 | MOEP | 0.099 |
| 10 | AMGA | 0.03588 | MOEP | 0.0189 | OWMOSaDE | 0.103 |
| 11 | MOEP | 0.0596 | ClusteringMOEA | 0.0228 | NSGAIILS | 0.10603 |
| 12 | DECMOSA-SQP | 0.07702 | DECMOSA-SQP | 0.02834 | GDE3 | 0.10639 |
| 13 | OMOEAII | 0.08564 | OMOEAII | 0.03057 | OMOEAII | 0.27141 |

| rank | UF4 | | UF5 | | UF6 | |
|---|---|---|---|---|---|---|
| 1 | MTS | 0.02356 | MTS | 0.01489 | MOEAD | 0.00587 |
| 2 | GDE3 | 0.0265 | GDE3 | 0.03928 | MTS | 0.05917 |
| 3 | DECMOSA-SQP | 0.03392 | AMGA | 0.09405 | DMOEADD | 0.06673 |
| 4 | AMGA | 0.04062 | LiuLiAlgorithm | 0.16186 | OMOEAII | 0.07338 |
| 5 | DMOEADD | 0.04268 | DECMOSA-SQP | 0.16713 | ClusteringMOEA | 0.0871 |
| 6 | MOEP | 0.0427 | OMOEAII | 0.1692 | MOEP | 0.1031 |
| 7 | LiuLiAlgorithm | 0.0435 | MOEAD | 0.18071 | DECMOSA-SQP | 0.12604 |
| 8 | OMOEAII | 0.04624 | MOEP | 0.2245 | AMGA | 0.12942 |
| 9 | MOEADGM | 0.0476 | ClusteringMOEA | 0.2473 | LiuLiAlgorithm | 0.17555 |
| 10 | OWMOSaDE | 0.0513 | DMOEADD | 0.31454 | OWMOSaDE | 0.1918 |
| 11 | NSGAIILS | 0.0584 | OWMOSaDE | 0.4303 | GDE3 | 0.25091 |
| 12 | ClusteringMOEA | 0.0585 | NSGAIILS | 0.5657 | NSGAIILS | 0.31032 |
| 13 | MOEAD | 0.06385 | MOEADGM | 1.7919 | MOEADGM | 0.5563 |

| rank | UF7 | | UF8 | | UF9 | |
|---|---|---|---|---|---|---|
| 1 | MOEAD | 0.00444 | MOEAD | 0.0584 | DMOEADD | 0.04896 |
| 2 | LiuLiAlgorithm | 0.0073 | DMOEADD | 0.06841 | NSGAIILS | 0.0719 |
| 3 | MOEADGM | 0.0076 | LiuLiAlgorithm | 0.08235 | MOEAD | 0.07896 |
| 4 | DMOEADD | 0.01032 | NSGAIILS | 0.0863 | GDE3 | 0.08248 |
| 5 | MOEP | 0.0197 | OWMOSaDE | 0.0945 | LiuLiAlgorithm | 0.09391 |
| 6 | NSGAIILS | 0.02132 | MTS | 0.11251 | OWMOSaDE | 0.0983 |
| 7 | ClusteringMOEA | 0.0223 | AMGA | 0.17125 | MTS | 0.11442 |
| 8 | DECMOSA-SQP | 0.02416 | OMOEAII | 0.192 | DECMOSA-SQP | 0.14111 |
| 9 | GDE3 | 0.02522 | DECMOSA-SQP | 0.21583 | MOEADGM | 0.1878 |
| 10 | OMOEAII | 0.03354 | ClusteringMOEA | 0.2383 | AMGA | 0.18861 |
| 11 | MTS | 0.04079 | MOEADGM | 0.2446 | OMOEAII | 0.23179 |
| 12 | AMGA | 0.05707 | GDE3 | 0.24855 | ClusteringMOEA | 0.2934 |
| 13 | OWMOSaDE | 0.0585 | MOEP | 0.423 | MOEP | 0.342 |

| rank | UF10 | | UF11 | | UF12 | | UF13 | |
|---|---|---|---|---|---|---|---|---|
| 1 | MTS | 0.15306 | MOEAD | 0.11032 | MOEAD | 146.78 | MOEAD | 1.8489 |
| 2 | DMOEADD | 0.32211 | LiuLiAlgorithm | 0.13254 | NSGAIILS | 158.05 | MTS | 1.9079 |
| 3 | AMGA | 0.32418 | NSGAIILS | 0.1752 | GDE3 | 202.12 | DECMOSA | 1.9178 |
| 4 | MOEP | 0.3621 | GDE3 | 0.23425 | MTS | 305.2 | DMOEADD | 1.9971 |
| 5 | DECMOSA-SQP | 0.36985 | DECMOSA-SQP | 0.38304 | LiuLiAlgorithm | 444.82 | MOEP | 2.0145 |
| 6 | ClusteringMOEA | 0.4111 | OWMOSaDE | 0.3951 | DMOEADD | 477.65 | LiuLiAlgori | 2.2884 |
| 7 | GDE3 | 0.43326 | MOEP | 0.4337 | OWMOSaDE | 734.56 | GDE3 | 3.2057 |
| 8 | LiuLiAlgorithm | 0.44691 | MTS | 0.45505 | MOEP | 885.89 | NSGAIILS | 3.2323 |
| 9 | MOEAD | 0.47415 | DMOEADD | 1.20328 | DECMOSA-SQP | 943.35 | OWMOSaI | 3.2573 |
| 10 | MOEADGM | 0.5646 | ClusteringMOEA | 1.2401 | ClusteringMOEA | 1039.36 | ClusteringI | 3.4043 |
| 11 | OMOEAII | 0.62754 | | | | | | |
| 12 | OWMOSaDE | 0.743 | | | | | | |
| 13 | NSGAIILS | 0.84468 | | | | | | |

# Experimental Results on Constrained Instances

| rank | CF1 | | CF2 | | CF3 | | CF4 | |
|---|---|---|---|---|---|---|---|---|
| 1 | LiuLiAlgorithm | 0.00085 | DMOEADD | 0.0021 | DMOEADD | 0.056305 | DMOEADD | 0.00699 |
| 2 | NSGAIILS | 0.00692 | LiuLiAlgorithm | 0.0042 | MTS | 0.10446 | GDE3 | 0.00799 |
| 3 | MOEADGM | 0.0108 | MOEADGM | 0.008 | GDE3 | 0.127506 | MTS | 0.01109 |
| 4 | DMOEADD | 0.01131 | NSGAIILS | 0.01183 | LiuLiAlgorithm | 0.182905 | LiuLiAlgorithm | 0.01423 |
| 5 | MTS | 0.01918 | GDE3 | 0.01597 | NSGAIILS | 0.23994 | NSGAIILS | 0.01576 |
| 6 | GDE3 | 0.0294 | MTS | 0.02677 | MOEADGM | 0.5134 | MOEADGM | 0.0707 |
| 7 | DECMOSA-SQP | 0.10773 | DECMOSA-SQP | 0.0946 | DECMOSA-SQP | 1000000 | DECMOSA-SQP | 0.15265 |

| rank | CF5 | | CF6 | | CF7 | |
|---|---|---|---|---|---|---|
| 1 | DMOEADD | 0.01577 | LiuLiAlgorithm | 0.013948 | DMOEADD | 0.01905 |
| 2 | MTS | 0.02077 | DMOEADD | 0.01502 | MTS | 0.02469 |
| 3 | GDE3 | 0.06799 | MTS | 0.01616 | GDE3 | 0.04169 |
| 4 | LiuLiAlgorithm | 0.10973 | NSGAIILS | 0.02013 | LiuLiAlgorithm | 0.10446 |
| 5 | NSGAIILS | 0.1842 | GDE3 | 0.06199 | NSGAIILS | 0.23345 |
| 6 | DECMOSA-SQP | 0.41275 | DECMOSA-SQP | 0.14782 | DECMOSA-SQP | 0.26049 |
| 7 | MOEADGM | 0.5446 | MOEADGM | 0.2071 | MOEADGM | 0.5356 |

# Final Rank

- Each team ranked others.
- Based on these individual ranking,  lexicographic order was used to generate the final ranks.

Unconstrained MOP

| Final Ranking | Algorithm |
|---|---|
| 1 | MOEA/D |
| 2 | MTS |
| 3 | DMOEADD |
| 4 | LiuLi |
| 5 | GDE3 |

Constrained MOP

| Final Ranking | Algorithm |
|---|---|
| 1 | DMOEADD |
| 2 | LiuLi |
| 3 | MTS |