Comparison with State-of-the-Art: Traps and Pitfalls

Rafał Biedrzycki

Warsaw University of Technology
Institute of Computer Science
riedrzy@elka.pw.edu.pl
Popular road to publication

- Create some algorithm
- Compare to state-of-the-art
- If the algorithm is better for some problems, then write an article
Popular road to publication

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What is state-of-the-art? – known algorithms with source code available in researchers favorite programming language

Cite the first paper that introduced algorithm used in comparison
Usual road to publication

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Article-implementation gap

- Usually articles skip some details that are needed by the implementation
- These details can be filled in different ways by the developers
- Different implementations can give different results
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Use trusted implementation

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- CMA-ES will serve as an example of a good method, with high-quality implementations
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Experimental setup

- For all implementations, the same population size, initial $\sigma$, and maximal number of objective function evaluations were set.
- The comparison and analysis of the results were performed by COCO using 24 noiseless single-objective functions formerly used in 2009 in Workshop on Real-Parameter Black-Box Optimization Benchmarking.
- Bounds of the area of interest were used as bounds for constrained search, which better reflects a real-world application.
- Python version comes with two constraint handling techniques – transformation (default) and weighted quadratic penalty.
- A simple implementation in Python which was meant for reading, was also included in the experiments as it is used in direct translations into other languages.
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Results on selected functions in 5D

Comparison with State-of-the-Art: Traps and Pitfalls
Results on selected functions in 5D

16 Weierstrass

bbob f16, 5-D
51 targets: 100..1e-08
15 instances

Comparison with State-of-the-Art: Traps and Pitfalls
Results on selected functions in 5D

19 Griewank-Rosenbrock F8F2

Comparison with State-of-the-Art: Traps and Pitfalls
Results on selected functions in 5D

22 Gallagher 21 peaks

Comparison with State-of-the-Art: Traps and Pitfalls
Results on selected functions in 5D

23 Katsuuras

Fraction of function, target pairs

log10(# f-evals / dimension)

Comparison with State-of-the-Art: Traps and Pitfalls
The numbers in tables show average runtime divided by the best value measured during BBOB-2009 competition.

- The target error level was set to $10^{-5}$.
- The half difference between 10 and 90%-tile of bootstrapped run lengths was put in braces as dispersion measure.
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Bound constraint handling

- Internal stopping conditions (sanity checks) – 8 in C, 11 in Python; stopTolFun, stopTolFunHist, stopTolX are different
- After setting Python like C, Python was interrupted on function 19
- Implementing different versions of the method – Python implements ActiveCMA version
- Different heuristics used to detect and escape from flat areas of the fitness
- Different values used in initialization of internal recombination weights
Tracing the differences

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Authors of the CMA-ES cited sequence of four articles when referring to CMA-ES.

Article-implementation relation is not clear:
- there are no references in the C code
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- there are five references in Matlab and five in Java, four of them are common for both implementations.
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- Authors should reveal how all parameters were set up, not only in the proposed method but also in methods used for comparison.
- The code used for running experiments should be available.
- Authors should use the most up-to-date trusted implementation of the state-of-the-art and reveal its origin, name, and version.
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- Publishers should require the availability of the source code for all new optimization methods.
- Authors should reveal how all parameters were set up, not only in the proposed method but also in methods used for comparison.
- The code used for running experiments should be available.
- Authors should use the most up-to-date trusted implementation of the state-of-the-art and reveal its origin, name, and version.
- Authors of implementations should define article-implementation relation.
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Conclusions

- The choice of a particular implementation of even a popular and standard algorithm may have a substantial impact on the results obtained in research studies or applications.
- Many articles do not provide information about implementations used in experiments, which puts in question the utility of their findings.
- The sources of discrepancies are frequently hidden in the auxiliary code.
- The difference in the outcome of implementations also stems from implementing different versions of the algorithm.
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Thank you for watching!