

Screening the Parameters Affecting Heuristic Performance

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ABSTRACT

This research screens the tuning parameters of a combinatorial optimization heuristic. Specifically, it presents a Design of Experiments (DOE) approach that uses a Fractional Factorial Design to screen the tuning parameters of Ant Colony System (ACS) for the Travelling Salesperson problem. Screening is a preliminary step towards building a full Response Surface Model (RSM) [2]. It identifies parameters that have little influence on performance and can be omitted from the RSM design. This reduces the complexity and expense of the RSM design. 10 algorithm parameters and 2 problem characteristics are considered. Open questions on the effect of 3 parameters on performance are answered. A further parameter, sometimes assumed important, was shown to have no effect on performance. A new problem characteristic that effects performance was identified. A full version of this paper is available [3]

Categories and Subject Descriptors

C.4 [PERFORMANCE OF SYSTEMS]: Design studies

General Terms

Performance

Keywords

Design of Experiments, parameter screening, Ant Colony Optimization, Travelling Salesperson Problem

1. CONTRIBUTIONS & CONCLUSIONS

This paper answers several important open questions from the ACO literature.

- **It is worthwhile to distinguish between rho and rho local.** Rho local seems to have a stronger influence on performance than rho.
- **Solution Construction has a significant effect on performance.** This answers an open question in the literature [1, p. 78]
- **Pheromone update mechanism only has a significant effect on Time.**

- **Ant placement only has a significant effect on Time.**

We make the following recommendations on the parameters that actually affect ACS performance.

- **Alpha is not important for ACS.** Alpha is usually set to 1 for ACS. This paper supports that choice.
- **Beta is important for ACS.** Beta must be restricted to integer values to avoid expensive exponentiation calculations.

Furthermore, this paper poses and answers several new questions regarding the ACS algorithm.

- **The effect of cost matrix standard deviation on problem difficulty.** The paper demonstrates that cost matrix standard deviation has a strong effect on ACS performance.
- **Relative Error or Adjusted Differential Approximation (ADA)?** For the purposes of screening and tuning it does not matter which response we use.
- **Second Order Interactions are important.** It is insufficient to analyse the affects of ACS tuning parameters with a One-Factor-At-A-Time (OFAT) approach.
- **Importance of Time measurement.** Uncovered the prohibitive computational cost of non-integer values of alpha and beta.

2. FUTURE WORK

We have built a Response Surface Model for ACS [2] and will extend this to other ACO algorithms.

3. REFERENCES

- [1] M. Dorigo and T. Stützle. *Ant Colony Optimization*. The MIT Press, Massachusetts, USA, 2004.
- [2] E. Ridge and D. Kudenko. Analyzing Heuristic Performance with Response Surface Models: Prediction, Optimization and Robustness. In *Proceedings of the Genetic and Evolutionary Computation Conference*. ACM, 2007.
- [3] E. Ridge and D. Kudenko. Screening the parameters affecting heuristic performance. Technical Report YCS 415 (www.cs.york.ac.uk/ftpdir/reports/index.php), The Department of Computer Science, The University of York, April 2007.