Technical Report

Parameter Tuning of Multi-Start Strategy Based Simulated Annealing Algorithm for the Large Scale Next Release Problem

Jifeng Xuan, He Jiang, Zhilei Ren
E-mail: xuan@mail.dlut.edu.cn
School of Software, Dalian University of Technology, China

1. Introduction

In this report, we will introduce the parameter tuning of Multi-Start strategy based Simulated Annealing algorithm (MSSA) for the large scale Next Release Problem (NRP). To illustrate the process of parameter tuning, we visualize the quality and the running time of each solutions.

The NRP is a combinatorial optimization problem in search based requirements engineering. The problem model can be found in [1]. The pseudo code of MSSA can be found in another technical report in [2], which is in the same directory of this document.

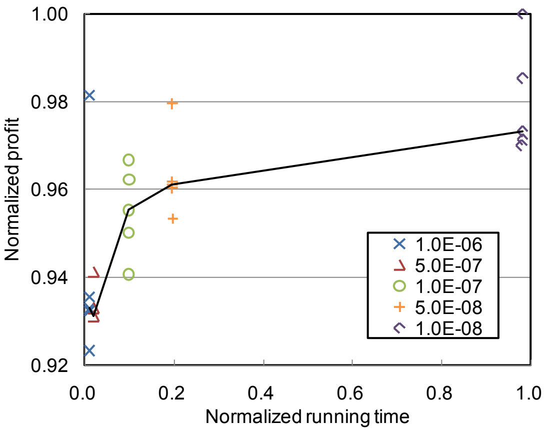
Based on the following Section 2, we choose the parameter value 1.0×10^{-7} for the non-linear ratio β of MSSA.

2. Parameter tuning for MSSA

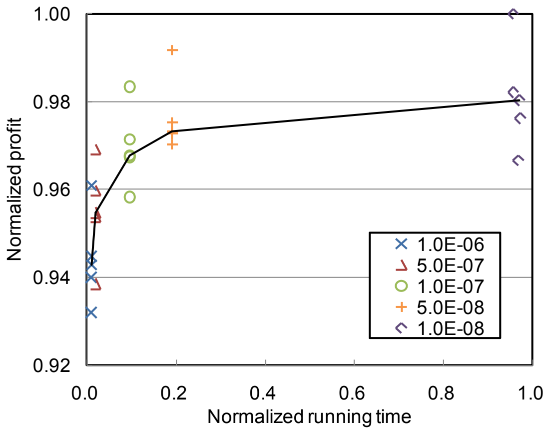
MSSA is a multi-start strategy based simulated annealing algorithm. In our work, the number of multi-starts is a given parameter. Thus, we would like to tune the parameter for the embedded algorithm, i.e., Simulated Annealing (SA). In MSSA, the SA algorithm is the same as the non-linear SA in [1]. Based on the description for this SA, only one parameter should be tuned, i.e., the non-linear ratio β. In [1], three candidate values are listed, such as 5.0×10^{-7}, 1.0×10^{-7}, and 1.0×10^{-8}. We also give two other candidate values, namely 1.0×10^{-6} and 5.0×10^{-8}. Thus, five candidate values are listed.

We use five typical instances to show the process of parameter tuning, i.e., nrp-1-0.5, nrp-2-0.5, nrp-3-0.5, nrp-4-0.5, and nrp-5-0.5. For each instance and each candidate value of β, we repeat MSSA for five times and five solutions can be obtained. In Fig. A, we show the results of parameter tuning. The x-axis is the normalized running time; the y-axis is the normalized profit. Both the x-axis and the y-axis are normalized to the range (0, 1]. Besides the quality and the running time of solutions, we show the tendency of the median solutions for five candidate parameter values (in black lines).

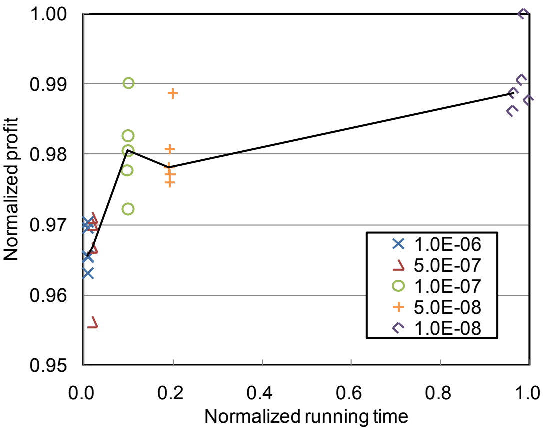
In Fig. A, we can find that solutions based on 1.0×10^{-6} or 5.0×10^{-7} are not stable. Moreover, most of the slopes of tendency lines from 5.0×10^{-7} to 1.0×10^{-7} are larger than the other tendency lines. In other words, the parameter 1.0×10^{-7} can provide more solution profits when increasing the same running time. Thus, based on these tendency lines, we choose the value 1.0×10^{-7} for the parameter β of MSSA.



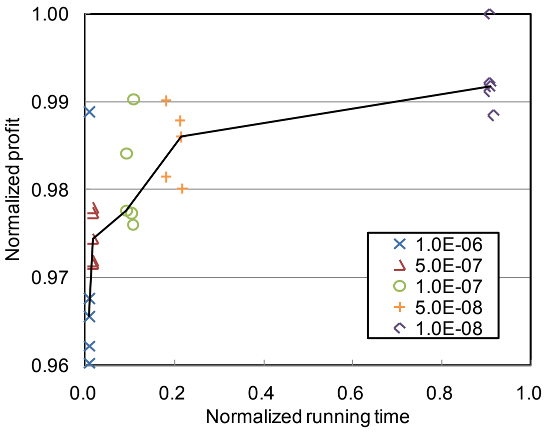
(a) Parameter tuning for nrp-1-0.5. The maximum time for normalization is 1000 seconds.



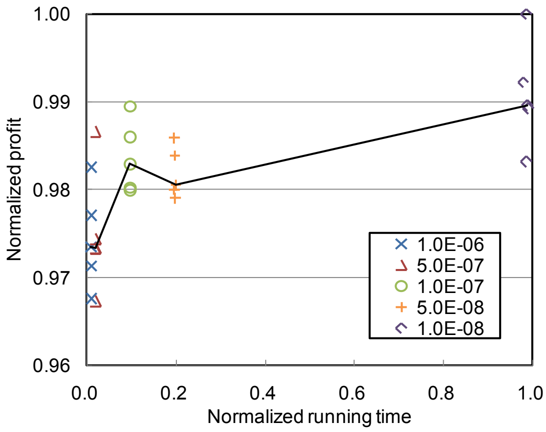
(b) Parameter tuning for nrp-2-0.5. The maximum time for normalization is 3000 seconds.



(c) Parameter tuning for nrp-3-0.5. The maximum time for normalization is 4300 seconds.



(d) Parameter tuning for nrp-4-0.5. The maximum time for normalization is 11000 seconds.



(e) Parameter tuning for nrp-5-0.5. The maximum time for normalization is 4700 seconds.

Fig. A. Parameter tuning for β in MSSA. The candidate values are 1.0×10^{-6}, 5.0×10^{-7}, 1.0×10^{-7}, 5.0×10^{-8}, and 1.0×10^{-8}. In each sub-figure, each parameter is tried for five times. The x-axis is the normalized running time (the running time divided by the maximum time); the y-axis is the normalized profit (the profit divided by the maximum profit). To compare the running time, we give the maximum time in the caption of each sub-figure. The black line in each sub-figure shows the tendency of the median solutions for five parameter values.

References

[1] A. Bagnall, V. Rayward-Smith, and I. Whittley, "The Next Release Problem," *Information and Software Technology*, vol. 43, no. 14, pp. 883-890, Dec. 2001, doi:10.1016/S0950-5849(01)00194-X.

[2] J. Xuan, H. Jiang, and Z. Ren, "Pseudo Code of Genetic Algorithm and Multi-Start Strategy Based Simulated Annealing Algorithm for Large Scale Next Release Problem," technical report, 2011.