International Journal of Innovative
Computing, Information and Control
Volume **2**, Number **6**, December **2006**

ICIC International ©2006 ISSN 1349-4198
pp. 1399–1416

# PARALLEL MEMETIC ALGORITHM WITH SELECTIVE LOCAL SEARCH FOR LARGE SCALE QUADRATIC ASSIGNMENT PROBLEMS

Jing Tang, Meng Hiot Lim, Yew Soon Ong and Meng Joo Er

Intelligent Systems Centre
Nanyang Technological University
Research TechnoPlaza, 7th Storey, BorderX Block, Singapore 637553
{pg04159923; emhlim; asysong; emjer}@ntu.edu.sg

Received September 2005; revised January 2006

Abstract. *The extent of the application of local searches in canonical memetic algorithm is typically based on the principle of "more is better". In the same spirit, the parallel memetic algorithm (PMA) is an important extension of the canonical memetic algorithm which applies local searches to every transitional solutions being considered. For PMA which applies complete local search, we termed it as PMA-CLS. We show in this paper that instead of complete local search, the island model PMA with selective application of local search (PMA-SLS) is effective in solving complex combinatorial optimization problems, in particular large-scale quadratic assignment problems (QAPs). A distinct feature of the PMA-SLS to be noted in our study is the sampling size. We make use of a normal distribution scheme to determine the sampling ratio. Empirical study on large scale QAPs with PMA-SLS and PMA-CLS are presented. It is shown that PMA-SLS arrives at solutions that are competitive to the PMA-CLS at significantly lower computation efforts on the diverse large scale QAPs considered. This we concluded is due mainly to the ability of the PMA-SLS to manage a more desirable diversity profile as the search progresses.*

**Keywords:** Combinatorial optimization, Quadratic assignment problem, Island model parallel memetic algorithm, Selective local search

1. **Introduction.** Among the many classes of combinatorial optimization problems, the quadratic assignment problems (QAPs) are among the hardest with many interesting practical applications. It was formulated by Koopmans and Beckmann [15] for location planning of economic activities. To formulate a QAP mathematically, consider $n$ facilities to be assigned to $n$ locations with minimum cost. The QAP can be described by two $n \times n$ matrices $A = [a_{ij}]$ and $B = [b_{ij}]$. The goal is to find a permutation $\pi$ of the set $M=\{1,2,\ldots,n\}$, which minimizes the objective function $C(\pi)$ as in Eq.(1).

$$C(\pi) = \sum_{l=1}^{n} \sum_{t=1}^{n} a_{lt} b_{\pi(l)\pi(t)} \tag{1}$$

In the above equation, matrix $A$ can be interpreted as a distance matrix, i.e. $a_{ij}$ denotes the distance between location $i$ and location $j$. $B$ is referred to as the flow matrix, i.e. $b_{ij}$ represents the flow of materials from facility $i$ to facility $j$. We denote an assignment as $\pi$ with $\pi(i)$ being the location to which facility $i$ is assigned.