Universidade do Minho Academic Year 2020/2021

Mestrado Integrado em Engenharia Informática / Mestrado em Informática

Algoritmos Paralelos

Work 1: The room assignment problem

Introduction The problem is to allocate n persons to $n/2$ double rooms in a way that minimizes the potential conflicts between the occupants of the same room. For this end, each person expresses with a number between 1 and 10 how much he/she dislikes to share the room with each one of the others (larger numbers express a higher level of incompatibility). This information is gathered in a square matrix, say D, of order n. So, for each i and j from 1 to n, $i \neq j$, $D(i,j)$ expresses how much person i dislikes to share a room with person j. For simplicity, we assume that D is symmetric, i.e., D(i,j)=D(j,i). In summary, we want to find the set of pairs (i_k, j_k) that minimizes

$$cost = \sum_{k=1}^{n/2} D(i_k, j_k).$$

The number of sets of pairs (i_k, j_k) with different indices grows very quickly with n and it is for this reason that alternatives to the "brute force" methods need to be considered. Monte-Carlo methods do not in general produce the optimal solution but they provide approximations in reasonable time.

In the Blackboard, folder "Trabalhos", you may find the following files which have been presented in the on-line session of march, 9:

- *rooms.m* This Matlab code implements a Monte Carlo method. It starts with an initial random distribution and then reduces the total cost through successive exchanges of occupants in adjacent rooms. Exchanges are accepted only if they reduce the value of cost.
- *roomsSA.m* This is a modification of *rooms.m* which implements the so-called "simulated annealing" (as explained, in the session of march 9).
- *roomsMAIN* This code randomly generates a symmetric matrix D. Then, it uses *rooms.m* and *roomsSA.m* to get different answers. The code roomsMAIN has two input parameters: the number n of persons and p the number of times to repeat the experience (these p processes are potentially parallel since they are completely independent).

The work to be done by the students (individually or in groups of 2)

- To develop codes implementing the different approaches to be tested in the cluster SEARCH. The tests should be carried out using large values of $n(100, 200, 300, \cdots)$, and eventually some of the heuristic parameters in the code may be changed, as well (these are the limit on the number of successive trials that do not produce a change in the distribution, i.e, counter i, the initial value of the temperature T in the code roomsSA.m, as well as the decreasing function T=0.999*T).
- (optional) To develop, code and test different ideas. In particular, a greedy algorithm may prove to be an interesting approach.
- To write a short report (maximum 10 pages plus a copy of the code) with a brief description of the problem and its complexity, the algorithms used and a comparison of the results obtained with the different approaches.

Deadline: send pdf file to r_ralha@math.uminho.pt) till march, 27.