CSE 457: In Class Review 3

Test III (105 Walker. 12:20 – 2:10 pm, Tuesday Dec 19) can include questions from any topic covered during the semester. This review focuses only the post Test II topics.

1. Consider best first branch and bound for the optimization version of the robot-drill-site problem with the following distance matrix.

$$\begin{bmatrix} 0 & 1 & 5 & X & 1 & 3 \\ 1 & 0 & 2 & 2 & 5 & X \\ 5 & 2 & 0 & X & 1 & X \\ X & 2 & X & 0 & X & 2 \\ 1 & 5 & 1 & X & 0 & 6 \\ 3 & X & X & 2 & 6 & 0 \end{bmatrix}$$

a). In our lecture nodes we used the distance of the partial route as a trivial lower bound on the distance of the complete route (starting and ending at 1). Let d_i be the *maximum* value in a row of the matrix (excluding elements equal to X), i.e.,$d_i = \max_{j=1}^{j=6}\{D[i,j],\ D[i,j] \neq X\}$. Initialize the lower bound on the root (initial state) to the sum $L = d_1 + d_2 + d_3 \cdots d_6$. Next, if you consider site i for the next move, set the lower bound of the new node as $L - d_1 + D[1,i]$ if $D[1,i] \neq X$ and to X if $D[1,x] = X$. You can use a similar rule to generate the bound for a child node from the bound for its parent. If L is the lower bound on node x where the last drill site visited is q, then at a child node representing the move from q to drill site r, set $L = L - d_q + D[q,r]$ if $D[q,r] \neq X$ and to X otherwise. Is this a valid lower bound, i.e., does it meet all the conditions on the bound?

b) Show a path where the bound conditions are violated.

c) Explain what happens if the same rules are used to generate the bound but d_i is the *minimum value greater than zero* in a row of the matrix, i.e.,$d_i = \min_{j=1}^{j=6}\{D[i,j],\ D[i,j] \neq 0\}$. Does this bound meet all the conditions of a valid bound?

d) With the bounds defined in (c), show best first search until you reach a leaf node that could be a feasible solution.

e) Explain if the search should continue after reaching the leaf node in (d); the leaf node should represent a valid route ending at 1 (and not a dead end at an intermediate drill site). What test must this leaf node satisfy to end the search?

f) Consider parallelizing this problem using 2 processors. Assume computation starts with processor 0 which then selects a node for processor 1 to continue exploring. Show the tree generated by processor 0 until it finds a node to be assigned to processor 1.

2. Assume you are solving a decision problem in parallel using P processors and backtrack. Assume the computation is ideally parallelized. Now $T_p = T_1 + T_O$ where T_O represents the communication overhead of the DTD algorithm. You can assume that $T_1 = (n-1)^n$ (much like the robot-drill-site problem with n sites).

a) Provide an expression for T_O and T_P.

b) You are satisfied with the near ideal efficiency you observe for your parallel code for solving a problem of size $n = 10$ on 10 processors. If the problem size is increased to $n = 13$ and you solve it using 100 processors, do you expect the efficiency to increase, decrease or stay the same? Explain using the isoefficiency equation.

3. Give one example of a problem whose parallel solution is purely data-parallel. Clearly explain why there is no significant task-parallel component.

4. Give one example of a problem whose parallel solution is purely task-parallel. Clearly explain why there is no significant data parallel component.

5.Give one example of a problem whose parallel solution has significant data-parallel and task-parallel components.

6. You are given an algorithm with sequential complexity T seconds. It is known that 99% of the cost of this algorithm can be parallelized ideally using an arbitrary number of processors P. However, the remaining 1% cannot be parallelized; it is inherently sequential. Additionally, the parallel form (on any number of processors) will incur communication costs equal to $.01T$, i.e., 1% of the sequential cost.

a) Provide an expression for the speedup of the parallel algorithm using P processors.

b) What is highest speedup achievable (given an arbitrarily large number of processors)?

c) At what value of P is the highest efficiency observed?

d) How does the efficiency change when the number of processors is increased?

e) What is Amdahl's law?