Problem Set 1

Assigned: Sept. 8  
Due: Sept. 22

Problem 1

Consider the following scheduling problem. There are $N$ tasks and $K$ processors. Each task $T$ has a length $T.length$. Each processor $P$ has a speed $P.speed$. If $T$ is assigned to $P$, it will take time $T.length/P.speed$ to complete. There is an overall deadline $D$. A processor can only work on one task at a time, and a task cannot be split between processors. The problem is to find an assignment of tasks to processors in which the all the tasks complete before time $D$.

For example, suppose that $N = 4$, $K = 2$, $D = 33$ and you have the following parameters

<table>
<thead>
<tr>
<th>Task</th>
<th>$T1$</th>
<th>$T2$</th>
<th>$T3$</th>
<th>$T4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>12</td>
<td>42</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Processor</td>
<td>$P1$</td>
<td>$P2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Then one correct strategy is to assign $T1$ and $T3$ to $P1$, where they will take a total of 30 time units, and $T2$ and $T4$ to $P2$, where they will take a total of 32 time units.

A. Characterize this as a tree-structured state space search problem. In particular:
- What are the states?
- What are the operators?
- What is the branching factor?
- Is the depth of the goal node known initially?

B. Show the portion of the state space generated in solving the example in Problem 1 using depth-first search.

C. Show the portion of the state space generated in solving the example using breadth-first search.

Problem 2

Suppose we modify problem 1 as follows. Assume that each task has a value which is equal to its length; and assume that the problem specifies a target total value $S$. The problem then is to find an assignment of tasks to processors such that the tasks all complete within time $D$ and have a value of at least $S$. (Problem 1 is just the special case where $S$ is the total value of all the tasks.)

For example, using the same set of tasks as in problem 1, if the target value $S = 110$ and the deadline $D = 25$, then the solution is to assign $T3$ to $P1$, taking time 24, and $T1$ and $T4$ to $P2$, taking time 22, for a total value of 114.

A. Characterize this as a tree-structured search space problem, answering the same questions as in problem 1.

B. Show the portion of the state space generated in solving the example in Problem 1 using depth-first search.

C. Show the portion of the state space generated in solving the example using breadth-first search.