Team 8

University Of Auckland SoftEng 370

Innov8 data solutions

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# Algorithm

### Algorithms Used (What algorithm(s), give pseudo-code)

Two prominent branch-and-bound algorithms, Depth-First Search and A\*, could have been chosen to solve this NP-hard scheduling problem. The algorithm chosen by Team 8 was A\*, as it is known for being faster than Depth-First Search. However, Depth-First Search was still implemented to aid in testing.

A\*:

// Initialise

GRAPH: JGraphT graph of all vertices

UNEXPLORED: Priority Queue of unexplored partial solutions

EXPLORED: HashSet of explored partial solutions

For all starting vertices v in the GRAPH

Create a partial solution for v

Add to UNEXPLORED

Loop:

Pop best partial solution ps from UNEXPLORED

If ps is complete (contains all vertices in GRAPH)

Found optimal solution, Return ps

Else

//Calculate new possible partial solutions based on ps

Get all child vertices cv with all parent vertices in ps

Create new partial solution with cv that expands on ps

Add to UNEXPLORED

Add ps to EXPLORED

Depth-First Search branch-and-bound:

global unsigned best-bound = ∞

global Node best-solution = null

% Branch and bound

Node branch-and-bound():

Node root = make-root-node(init())

depth-first-branch-and-bound(root)

**return** best-solution

% Depth-first visit for branch and bound

**void** depth-first-branch-and-bound(Node n):

% base cases

f = n.g + h(n.state)

if f > best-bound **return**

if n.state.is-goal()

best-bound = n.g

best-solution = n

**return**

% depth-first recursion

**foreach** <s,a> in n.state.successors()

depth-first-branch-and-bound(n.make-node(s,a))

### Bound and Heuristic Function

A crude upper bound was calculated along with the two heuristic functions discussed in lectures. The crude upper bound was a summation of the weight of each vertex, representing the time taken if all tasks were running sequentially on the same processor.

The first heuristic function used the next vertex to be added into the current partial solution. It retrieved the earliest time the vertex could start on any processor and added this to its bottom level. The second heuristic function added the time of the crude upper bound to the total idle time for the new partial solution and divided the value by the number of processors that were present. The maximum of these two values would result in the minimum finish time for the new partial solution and it was then used to sort the partial solution in the priority queue.

### Important Data structures

The important data structures used in this project was the DefaultDirectedWeightedGraph from JGraphT, PriorityQueue, HashSets and HashMaps.

The DefaultDirectedWeightedGraph was essential for storing the input as a directed graph as it also had supporting methods which allowed easy access to the required information of each vertex and edge. The PriorityQueue allowed unexplored partial solutions to be stored in a specific order while the HashSets were used to store vertices that had and had not been allocated to a processor.

The HashMaps stored a vertex and its information pair, with the information held in a class called AllocatorInfo. AllocatorInfo which holds its start time and allocated processor for a vertex is then accessed during output file creation.

### Pruning Techniques

To remove unpromising subtrees during the search, two pruning techniques were used. The first technique detected duplicate partial solutions through accessing the closed set of explored partial solutions. Before adding a new partial solution to the priority queue, it would check if exactly the same solution had previous been examined. If so, it would not be added, otherwise it would.

The second technique pruned equivalent partial solutions when there was more than one empty processor. For example, if adding one task to the first empty processor was equivalent to adding it to the second empty processor, only a new partial solution would be created for the first case and added to the priority queue. Therefore, eliminating a large number of partial solutions at the start of the process.

### Libraries Used

The libraries used in this project were JGraphT, GraphStream and JFreeChart. JGraphT provided a way to store the directed graph as an object while GraphSteam and JfreeChart aided in visualisation of the process. Using GraphStream meant that the graph could be easily displayed and JFreeChart assisted in the creation of a Gantt chart that showed the processor each task was added to and the order they would be run.

# Parallelisation

### Parallelisation approach

### How is work split? How is work synchronised? ∗ Change in data structures/additional data structures ∗ Pseudo-code –

### Parallelisation technology

### ∗ Threads, ExecutorService, Pyjama, Parallel Task, ....? – How was it implemented?

# Visualisation

### Concept

### Components Displayed (What is displayed? Why)

### Implementation (How was that implemented?)

### Sequential and Parallel visualization (differences)

# Testing

### 

### Components tested

### Method of Testing (How was it tested?)

# Development Process

### Describe your development process

### Communication and decision making

### Conflict resolution

### Used tools and technologies

### Comment on team cohesion and spirit

# Task Contribution