Enhancing VSIDS with domain-specific information for the MRCPSP

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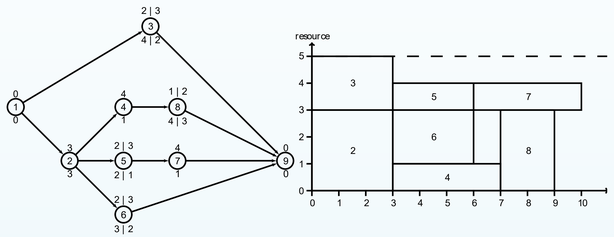
1. Background

MRCPSP is an NP-hard optimization problem
The goal is to schedule a set of activites to optimize makespan while adhering to constraints.



An example of the MRCPSP (J. Rezaeian, 2015) [1]

MRCPSP appears in fields such as construction engineering, transportation, and software development.

Two ways to solve it include:

1. Heuristic: A practical method used to solve problems efficiently, often relying on educated guesses or experience
2. Constraint Programming (CP) solver:
   A tool that explores the entire solution space while reducing it at the same time using logical inference and deduction

2. Research question

Can domain-specific heuristics be integrated into a Constraint Programming (CP) solver to improve solution times for the Multi-Mode Resource-Constrained Project Scheduling Problem (MRCPSP)?

3. Research method

Chosen heuristic: Longest Processing Time (LPT)
LPT schedules the tasks in order from largest to smallest.

An adaptation of this heuristic is used for the MRCPSP as follows:

$$LPT_i = \min(d_{i,m})\ \forall_m \in M_i$$

LPT score is used to initialize VSIDS parameters
VSIDS is a heuristic used to guide the search of CP solvers.

4 different parameter runs

Parameters	value	increment
VSIDS	0	1
LPT	LPT	1
LPT Avg	LPT	AVG_LPT
LPT Max	LPT	MAX_LPT

Runs performed using J30 dataset generated by ProGen

Each run conducted under two stop criteria:
1. 30 second timeout
2. 100 second timeout

Results will be analyzed using 3 metrics:
1. Average deviation of the optimal
2. Average computation time
3. Number of optimal solutions

4. Results

Under 30 second stop criterion VSIDS give closest to optimal solutions
But LPT shows much lower computation times

Under 100 second stop criterion LPT has closest to optimal solutions and fastest computation times
LPT Max performed the worst while LPT and LPT Avg are close to equal

Parameters	Avg deviation	Avg time	Optimal	Satisfiable
VSIDS	0.126%	3.031s	518	32
LPT	0.130%	2.837s	517	33
LPT Avg	0.127%	2.802s	517	33
LPT Max	0.138%	2.911s	514	36

Results under a 30-second stop criterion

Parameters	Avg deviation	Avg time	Optimal	Satisfiable
VSIDS	0.080%	6.687s	526	24
LPT	0.050%	6.082s	527	23
LPT Avg	0.051%	6.101s	526	24
LPT Max	0.076%	6.558s	525	25

Results under a 100-second stop criterion

5. Conclusions and limitations

LPT proved to be an effective domain-specific heuristic to initialize VSIDS values
Both the LPT and LPT Avg perform equal or better than the default VSIDS
LPT for default increment has not shown any improvements

Try different datasets to generalize results
Create a graph to see how the different runs converge to the solution
Use the LPT in other parameters such as the decay factor

1. Using a meta-heuristic algorithm for solving the multi-mode resource-constrained project scheduling problem - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/An-example-of-the-MRCPSP_fig1_282468244 [accessed 19 May, 2024]