

Heuristic SAT solver for project scheduling with task preemption

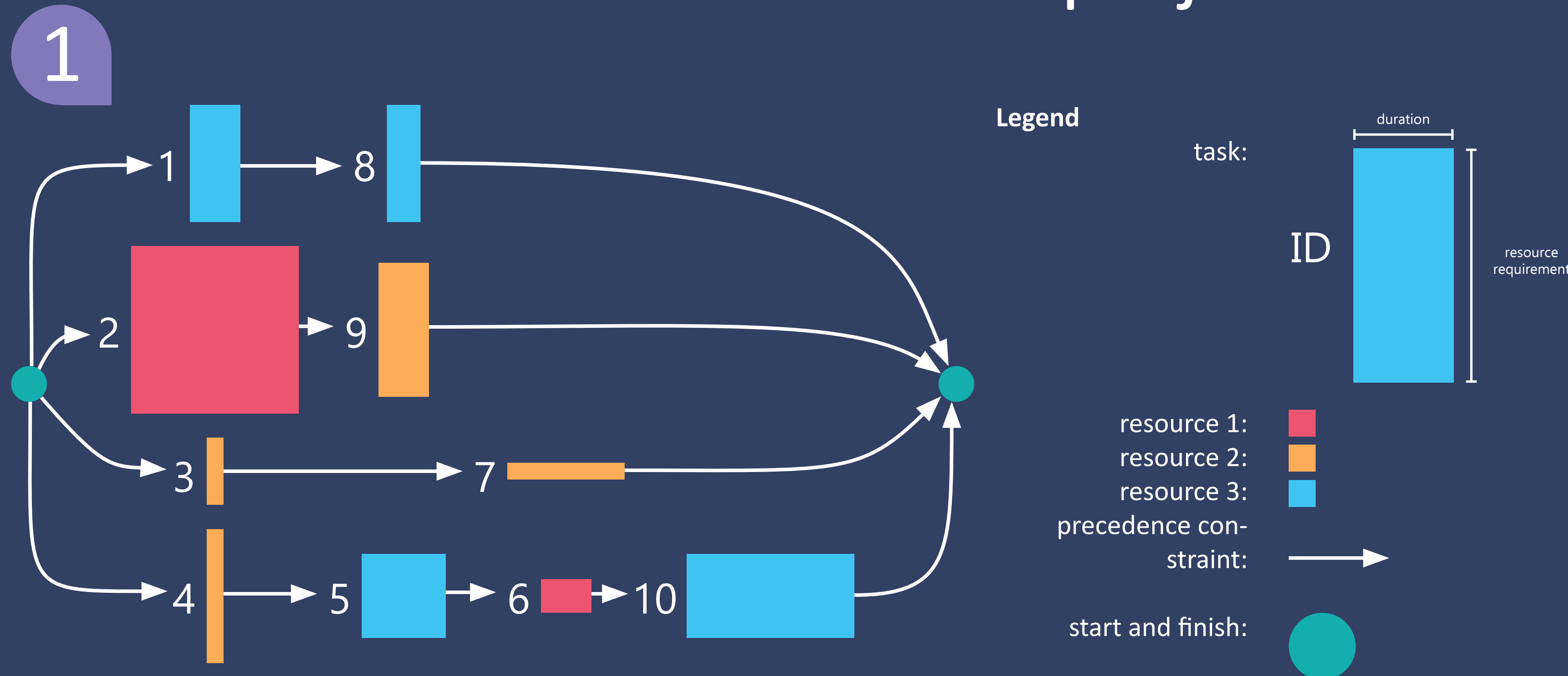


Figure 1: Example project task network
Source: Adapted from [1]

Motivation and research question

If production and logistics companies allocate their resources efficiently they can make more profit. Algorithms can be made for a general version of the problem and take a long time return a result. Alternatively a specialized algorithm can be used that is faster but very limited in application to custom requirements and constraints. If the problem can be encoded for a very general problem solver (called SAT solvers) and then the solver can be taught a trick about the specific problem the best of both worlds might be combined. So, the research question is:

“Can the addition of a simple heuristic to a SAT solver algorithm used to solve to PRCPSPST models reduce the average makespan of the resulting schedule in an equal amount time?”

To answer the question three different algorithms are being made and compared on their result:

1. A heuristic algorithm
2. PRCPSP-ST encoding directly solved by a SAT solver
3. Same encoding as in 2 but SAT solver is augmented with a heuristic

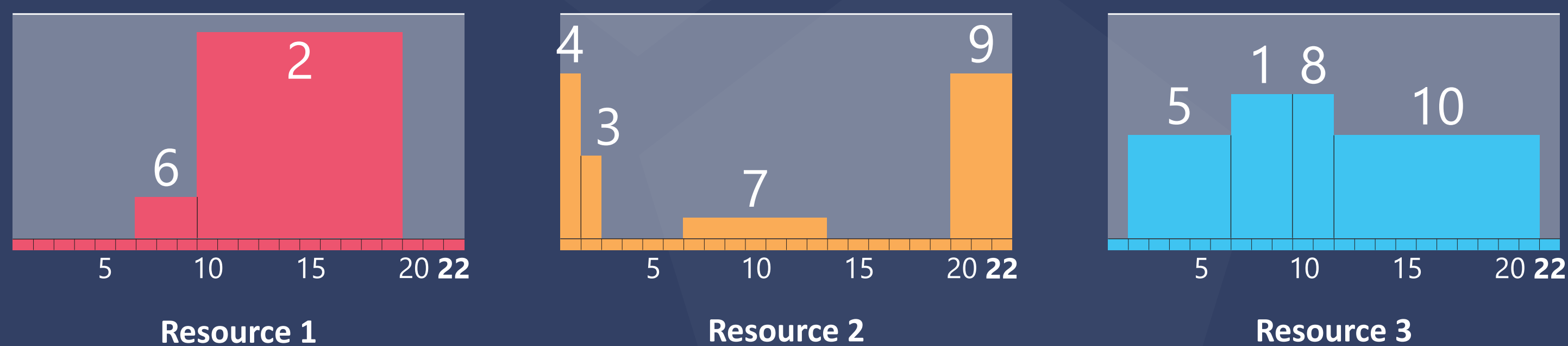


Figure 2: Shortest possible schedule of duration 22 without preemption
Source: Adapted from [1]

Work done by now

Done

- An adaption of the iterated greedy algorithm is implemented
- It solves simple instances (30 tasks) in a few seconds and can find the proven optimal solutions
- Most of the time no improvements to the schedule are found when preemption is allowed
- Hard to verify if the optimizations do not exist or are just not found

Work in progress

- Started work on the SAT encoding
- This encoding has to be done constraint per constraint
- For the second algorithm a MAX-SAT solver will be used
- It tries to make a feasible schedule while reducing an objective (eg. schedule time)

References

[1] Mario Vanhoucke and José Coelho. Resource-constrained project scheduling with activity splitting and setup times. *Computers Operations Research*, 109:230249, 2019.



Figure 3: A shorter possible schedule of duration 21 with preemption of task 2
Source: Adapted from [1]

Background

Resource constraint project scheduling problem (RCPSP)

- a project has multiple tasks
- each task needs an amount of specific resource
- each task has a duration
- tasks have precedence constraints
- all tasks must be scheduled
- objective is to try and find the shortest makespan (makespan = total schedule time)

Preemption and setup times (PRCPSP-ST)

- a task can be put on hold before it finishes
- each preemption is penalized (setup time)
- preemption must result in a shorter schedule

Figure 2 and 3 show a reduction of the schedule time by allowing preemption