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MATH

Concepts and Algorithms of Optimization – Series 9

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The car tuning service *Super Rally Cars (SRC)* is about to schedule eight pending jobs for the next day. The mechanics are working at two different, but concurrently used work areas, which are regarded as parallel machines $m = 1$ and $m = 2$. The tasks involved in one car tuning are divers and individual. Therefore, the processing time t_{jm} of a job j on a machine m is specifically defined and differs as given for different jobs and machines.

t_{jm} in min	$j = 1$	$j = 2$	$j = 3$	$j = 4$	$j = 5$	$j = 6$	$j = 7$	$j = 8$
$m = 1$	30	100	50	40	90	120	50	60
$m = 2$	40	80	80	40	50	150	40	90

Before a car tuning can be done, the work area has to be converted and prepared for the upcoming tasks. Thus, so-called set-up times arise and vary dependent on the sequence of the jobs on a machine. Between jobs with odd numbers, there are 20 minutes of set-up time needed. Job 8 is very complicated and should not be followed by another task. Furthermore, job 6 is very specific. It should be done at first on one of the machines and should not be followed by the jobs $1, \ldots, 5$. Additionally, the jobs 2 and 3 as well as the jobs 7 and 8 are not allowed to be processed directly after another. The set-up time of job 4 to be processed is constantly equal to 70 minutes and the set-up time of every of its successors is 50 minutes. Between the jobs 1 and 2 as well as the jobs 2 and 7, there are 30 minutes of converting and preparing time needed. Job 2 will require a set-up time of 40 minutes, if it is processed after job 5. All remaining orderings can be realized with a set-up time of 60 minutes.

The SRC service station closes, when all jobs are finished. Therefore, the goal of the manager is to find an assignment of the tuning jobs to the work areas and the sequences of jobs for both workplaces, so that the completion time of the last job is as early as possible.

(a) Give a graphical representation of the scheduling problem and state the theoretic structure corresponding to a feasible schedule in the graph.

(b) Give an integer programming formulation for the given problem.

(c) Solve the scheduling problem of *Super Rally Cars* by using AMPL.

(d) Indicate other real-world problems with a similar structure.