



AIPlan4EU

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Problem

The problem involves the efficient assignment of qualified technicians to machines requiring different maintenance types. Given a set of machines, maintenance types, technician qualifications, technician working hour shifts, and skip cost data, the objective is to determine the optimal technician assignments and identify any skipped maintenance, while minimizing the overall cost and maximizing the number of tasks assigned.

Mathematical Representation

Inputs	<ul style="list-style-type: none">◦ Machine set◦ Technician set◦ Maintenance types◦ Technician qualifications◦ Technician shifts◦ Tasks (backlog)◦ Skip costs
Objectives	<ul style="list-style-type: none">◦ Minimize total skipping cost◦ Maximize number of tasks assigned◦ Maximize number of assigned tasks that has high skipping cost
Constraints	<ul style="list-style-type: none">◦ Each task can be assigned to only one technician◦ Each technician can be allocated to only one machine at a time◦ A Technician can only be assigned to tasks that he is able to do the maintenance type◦ A Technician can only be assigned to task if task duration \leq shift end time left
Decision Variables	<ul style="list-style-type: none">◦ Tx_My_MTz : Technician X assigned to Machine Y to perform Maintenance type Z
Outputs	<ul style="list-style-type: none">◦ Total Cost Occured◦ Total Makespan◦ Sequences of tasks to be held◦ Remaining tasks

Problem Inputs and Dummy Data

Machine Set	<ul style="list-style-type: none"> ◦ M1, M2, M3, M4, M5
Technician Set	<ul style="list-style-type: none"> ◦ T1, T2, T3
Maintenance Matrix	<ul style="list-style-type: none"> ◦ MT1: {Skipcost: \$100, Duration: 4} ◦ MT2: {Skipcost: \$150, Duration: 6} ◦ MT3: {Skipcost: \$200, Duration: 5} ◦ MT4: {Skipcost: \$120, Duration: 4}
Technician Matrix	<ul style="list-style-type: none"> ◦ T1: {Qualified for: [MT1, MT4], Shift_start: 08.00, Shift_end:16.00} ◦ T2: {Qualified for: [MT2, MT3], Shift_start: 09.00, Shift_end:17.00} ◦ T3: {Qualified for: [MT1, MT3], Shift_start: 08.00, Shift_end:15.00}
Task Matrix(Backlog)	<ul style="list-style-type: none"> ◦ Machine 1: MT1 ◦ Machine 2: MT1 ◦ Machine 3: MT4 ◦ Machine 4: MT3 ◦ Machine 5: MT3

Sample Solution

Technician	Machine	Maintenance Type	Start Time	End Time	Cost Occured	Time(h) Left For Technician
T1	M1	MT1	08:00	12:00	0	4
T1	M3	MT4	12:00	16:00	0	0
T2	M4	MT3	09:00	13:00	0	4
T3	M2	MT1	08:00	13:00	0	2
-	M5	MT3	-	-	200	-

Total Cost: \$200

Earliest start time: 08:00 (T1 on M1 for MT1)
Latest end time: 16:00 (T1 on M3 for MT4)

Makespan : 8 hours

Total Technician Time Left : 6

Optimum Solution by ENHSP Model

Technician	Machine	Maintenance Type	Start Time	End Time	Cost Occured	Time(h) Left For Technician
T3	M4	MT3	08:00	13:00	0	2
T1	M3	MT4	08:00	12:00	0	4
T1	M2	MT1	12:00	16:00	0	0
T2	M5	MT3	08:00	13:00	0	3
-	M1	MT1	-	-	100	-

Total Cost: \$100

Earliest start time: 08:00 (T1 on M3 for MT4)

Latest end time: 16:00 (T1 on M2 for MT1)

Makespan : 8 hours

Total Technician Time Left : 5

Modelling the Problem in Unifiedplanning Library

Fluents	<ul style="list-style-type: none">◦ boolean task ex : m1_mt1◦ int duration of task ex : m1_mt1_duration◦ int technician time left : t1_time_left◦ int assign_counter to calculate number of assignments made◦ int target_n_task_assigned : targeted number of tasks to be assigned
Actions	<ul style="list-style-type: none">◦ InstantaneousAction of technician 1 assigned to machine 1 to do the maintenance type 1 : t1_m1_mt1
Precondition	<ul style="list-style-type: none">◦ for action t1_m1_mt1<ul style="list-style-type: none">• m1_mt1 = false (unassigned)• m1_mt1_duration < t1_time_left
Effect	<ul style="list-style-type: none">◦ for action t1_m1_mt1<ul style="list-style-type: none">• m1_mt1 = true (assigned)• t1_time_left = t1_time_left - m1_mt1_duration
Goal	<ul style="list-style-type: none">◦ initial goal<ul style="list-style-type: none">• assign_counter > target_n_task_assigned
Operation Modes	<ul style="list-style-type: none">◦ OneshotPlanner◦ Replanner◦ SequentialSimulator
Quality Metric	<ul style="list-style-type: none">◦ MinimizeActionCosts(action_costs)
Engines	<ul style="list-style-type: none">◦ enhsp-opt◦ replanner[enhsp-opt]

MODEL ARCHITECTURE

