SCHEDULING EMPLOYEES AT AN ORGANISATION: A MATHEMATICAL PROGRAMMING APPROACH

CL643-COMPUTER AIDED APPLIED OPTIMISATION PROJECT PRESENTATION

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INTRODUCTION

- Staff scheduling poses a universal challenge across service-oriented sectors such as healthcare, aviation, hospitality, and law enforcement.
- Scheduling personnel requires a delicate balance between employee/customer needs and operational demands.
- This is a multiobjective optimization problem, where we aim to achieve a balance between minimizing organizational costs and enhancing employee satisfaction.
- The primary objective is to streamline the scheduling process to reduce overall organizational costs. Beyond cost considerations, our approach places a strong emphasis on employee satisfaction.
- The optimization model tackles various constraints inherent in employee scheduling, including the one-shift-per-day rule and the implementation of a rotating shift schedule every week.

PROBLEM STATEMENT

Shift Types:
- Morning Shift (M): 06:00–14:00
- Evening Shift (E): 14:00–22:00
- Overtime Shift (O): 12:00-20:00

OBJECTIVE:
To minimize the employing cost and overtime shifts required to be done by an employee.

Department Rules and Constraints:
- Working 7 days a week necessitates a consistent workforce. A day must include two operators and 4 supervisors.
- Each employee is obligated to work an average of 40 hours per week.
- Employees commit to a consistent shift (morning or evening) for an entire week.
- Employees are assigned to morning, evening, or overtime schedules.
- Mandatory shift rotation after each week to ensure equitable distribution.
- Overtime shifts are capped at two per employee per week.

NOTATIONS

i : particular day varies, from i to n, n = no. of days

j: particular employee, varies from i to m(j), m(j) = no. of employees of category j

l: level of employee, varies from i to m(j), m(j) = no. of employees of category j

cost_regular(l): cost required for particular category of employee working at Morning or Evening Shift

cost_overtime(l): cost required for a particular category of employee working at Overtime shift. An overtime cost is more than regular shift cost.

Beta1: weightage of first objective i.e. minimize cost

Beta2: weightage of first objective i.e. minimize overtime

DECISION VARIABLES

varM(i,j,l): Binary variable indicating whether an employee j of level l is assigned a morning shift on ith day.

var_E(i,j,l): Binary variable indicating whether an employee j of level l is assigned an evening shift on ith day.

var_O(i,j,l):Binary variable indicating whether an employee j of level l is assigned an overtime shift on ith day.

CONSTRAINTS

$$var_M(i,j,l) + var_E(i,j,l) + var_O(i,j,l) \leq 1$$

For Level 1 employees

$$\sum_{j=1}^{P} var_M(i,j,l) + var_E(i,j,l) + var_O(i,j,l) \geq 2$$

For level 2 employees

$$\sum_{j=1}^{P} var_M(i,j,l) + var_E(i,j,l) + var_O(i,j,l) \geq 4$$

$$\left| \sum_{j,l} var_M(i,j,l) - \sum_{j,l} var_E(i,j,l) \right| \leq 1$$

$$\sum_{i \in S_w} var_M(i,j,l) + var_E(i,j,l) = 5$$

$$var_M(i,j,l) + var_E(i+1,j,l) \leq 1$$

$$var_M(i+1,j,l) + var_E(i,j,l) \leq 1$$

$$\sum_{i \in S_w} var_O(i,j,l) \leq 2$$

$$var_M(i,j,l) + var_M(i+7,j,l) \leq 1$$

$$var_E(i,j,l) + var_E(i+7,j,l) \leq 1$$

1) An employee works only one shift per day
2)Minimum employees of each level must be present each day.
3) The absolute difference in the number of employees for the morning and evening shifts should not exceed 1.
4)An employee works for fixed 5 days a week in a regular shift.
5)An employee cannot work in the evening shift the next day if he works in the morning shift the previous day or vice versa
6)An employee can work in overtime shift for atmost 2 days in a week
7)There must be shift rotation after each week.

OBJECTIVE FUNCTION

$$Z = \beta 1 * \sum_{i,j,l}(var_M(i,j,l) + var_E(i,j,l)) * cost(l) + var_O(i,j,l) * costOvertime(l)) + \beta 2 * \sum_{i,j,l} var_O(i,j,l))$$

The multiobjective model minimizes the total costs associated with regular shifts and overtime hours as well as overtime shifts of employees, achieving an optimal allocation of shifts among employees.

RESULT

		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	E1		E	E	E	E		E
	E2	M		E	E	E		E
Supervisor	E3	E		M	M		E	E
	E4		M		M	M	M	M
	E5	M	M	M	M		E	
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	E1	E	E	E	E		M	
	E2	E			M	M	M	M
Operator	E3	M	M	M		M	O	M
	E4	M	M	M	M	M	O	O
	E5		E	E	E	E		M

The optimization model developed for employee scheduling effectively balances various constraints while minimizing costs. The results offer valuable insights and solutions for creating feasible and cost-effective schedules, promoting workforce efficiency and minimizing overtime expenses.

CONCLUSION AND FUTURE WORK

Future Considerations:

Refinement of Cost Parameters: Fine-tuning the cost parameters could further optimize the cost-effectiveness of the schedules.

Real-Time Implementation: Considerations for implementing this model in a real-time scheduling system could enhance operational efficiency by continually adapting to changing workforce demands.

Additional Constraints: Incorporation of further constraints or preferences, such as employee preferences, skill sets, or specific shift rotations, could refine the model to better suit specific organizational requirements.

Overall, the optimization model developed for employee scheduling presents a powerful tool for enhancing operational efficiency, reducing costs, and ensuring an optimal allocation of workforce resources.

THANK YOU