

This test should take 3 hours. The candidate can optionally answer problems in the extras section if time allows.

Employee training and planning problem

The HR department of a company needs to hire enough trainees to work at different departments of the company. The goal is to hire enough trainees each month at minimum cost so that the required person-hour in each department is satisfied. Trainees are trained for 3 departments and the requirements for the next 6 months is given in Table below.

Table 1: Total person-hour needed for each department and for each month

HOURS REQUIRED	
JAN	1900
FEB	1700
MAR	1600
APR	1900
MAY	1500
JUN	1800

Each trainee starts their contract at the beginning of the month. They become a full-time employee after 2 months. Both trainees and full-time employees can work toward the required person-hours in each department. Each trainee (while they are under training) can contribute 35 hours per month, and each full-time employee can contribute 100 hours per month to the person-hour requirement.

Before planning, we need to know how many trainees are hired in the last month and how many full-time employees are available at the beginning of the planning. The number of trainees one month before planning is 2 for each department. The number of full-time employees at the beginning of planning is 25, 20 and 18 for the first, second and third department, respectively. Note that we already counted trainees that started two months before planning toward the initial number of full-time employees.

Additional information:

- The training capacity for each month is 6
- The cost of training a trainee is \$50,000
- The understaffing cost is \$60,000 per staff
- The total number of employees across all departments at the end of the planning should be equal or greater than the number of employees at the beginning of the planning
- Employee resignations happen at the beginning of the month. We assume resignations are known before the planning: 3 employees resign on April 5 resign in May, and 6 resign in June in the first, second, and third departments, respectively.
-

The objective is to hire enough trainees each month at minimum cost so that the required person-hour in each department is satisfied.

Please provide:

- 1) The mathematical formulation including decision variables, constraints, and an objective. You can use a nomenclature of sets and indices and parameters instead of the actual numbers provided above
- 2) Assuming that 30% of employees are allowed to work in different departments, describe how you will model employee exchange between departments. Would this increase the costs of training or decrease it? Why?
- 3) Implement the problem that you modeled using your desired free solver (MIP, CLP, SCIP, google OR) and programming language (ideally Python, C++, or Java)

Note: Like a real-life optimization problem, if you think the data are missing or the description is not clear please make the necessary assumptions to formulate or solve the problem.

Extras:

- 4) Provide the total cost of hiring and the total number of trainees' hire each month and describe how you ensure that the solution you provided is optimal.
- 5) Describe how you model resignations if they are not known prior to planning.