WQD7011 Numerical Optimization

Optimizing Human Resource Allocation in Organization

Group 1
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Introduction

In every organization, one of the key objectives is to achieve maximum output with minimum resources.

Linear programming has been applied extensively in various fields to optimize the use of resources.

In our study, we discussed about human resource allocation using linear programming to help in achieving optimal performance and reducing manpower wastage with a given budget.

Dataset

HR DATASET FROM KAGGLE

THIS DATASET CONSISTS OF 35 ATTRIBUTES AND 1470 INSTANCES

THE DETAILS OF 1470 EMPLOYEES INCLUDING GENDER, EDUCATION FIELD, MONTHLY SALARY, JOB ROLE, PERFORMANCE RATING, MARITAL STATUS, TOTAL WORKING YEARS AND OTHER

Framing a linear programming model

The variables for our problem, x_i will be defined as 1 if employee is selected and 0 otherwise

x_i = Variable for employee i

$$x_i = \begin{cases} 1 & if\ employee\ i\ is\ selected\ to\ form\ a\ team \\ 0 & if\ employee\ i\ is\ not\ selected\ to\ form\ a\ team \end{cases}$$

Objective Function:

Maximize the performance rating by forming a team of 30 employees.

$$Max \sum_{i=1}^{n} r_i x_i$$

r_i = Performance rating for employee i

Constraints:

A total of 9 constraints has been identified.

i. Salary constraint: By calculating the mean salary for each job role, we had limited our total monthly salary to $200,000. This means that we should form a team of 30 employees with the total salary less than or equal to $200,000.

$$\sum_{i=1}^{n} s_i x_i \leq 200000$$

s_i = Monthly salary for employee i

ii. Position constraint: A team is formed with only 5 human resources, 5 sales executive, 6 sales representative, 4 research scientist, 5 laboratory technician and 5 managers.

$\sum_{i=1}^{n} a_{1,i}x_i = 5$	set $a_{1,i}$ to 1 if employee i is human resource, and 0 otherwise
$\sum_{i=1}^{n} a_{2,i}x_i = 5$	set $a_{2,i}$ to 1 if employee i is sales executive, and 0 otherwise
$\sum_{i=1}^{n} a_{3,i}x_i = 6$	set $a_{3,i}$ to 1 if employee i is sales representative, and 0 otherwise
$\sum_{i=1}^{n} a_{4,i}x_i = 4$	set $a_{4,i}$ to 1 if employee i is research scientist, and 0 otherwise
$\sum_{i=1}^{n} a_{5,i}x_i = 5$	set $a_{5,i}$ to 1 if employee i is laboratory technician, and 0 otherwise
$\sum_{i=1}^{n} a_{6,i}x_i = 5$	set $a_{6,i}$ to 1 if employee i is manager, and 0 otherwise

iii. Job satisfaction constraint: Select employees with enough passionate towards their jobs to form this team. Thus, employees with job satisfaction scoring more than or equal to 3 will only be chosen.

$\sum_{i=1}^{n} b_i x_i = 30$ set b_i to 1 if employee i score ≥ 3 for job satisfaction, and 0 otherwise

iv. Working experience of manager constraint: Select all the managers with at least 10 years of working experiences.

$\sum_{i=1}^{n} c_i x_i = 5$ set c_i to 1 if employee i is manager and has ≥ 10 years working experience, and 0 otherwise

Finding & Justification

- 30 employees are selected with the total salary is $155,555 which is less than $200,000.
- The total number of candidates for each job role as predefined.
- Working experience of all the managers are more than 10 years.
- The job satisfaction rating for each candidate is more than or equal to 3.
- Thus, the optimal value of the objective function (performance rating) found in the feasible region is 119.

	EmployeeNumber	JobRole	TotalWorkingYears	MonthlyIncome	PerformanceRating	Gender	JobSatisfaction	include
1	205	Sales Representative	13	2306	4	Male	3	1
2	484	Sales Representative	3	2610	4	Male	4	1
3	1541	Sales Representative	12	2308	4	Male	3	1
4	1554	Sales Representative	6	2430	4	Female	3	1
5	1556	Sales Representative	7	2644	4	Male	4	1
6	1702	Sales Representative	3	2275	4	Male	4	1
7	60	Sales Executive	10	4568	4	Male	3	1
8	62	Sales Executive	14	5772	4	Male	4	1
9	120	Sales Executive	11	5441	4	Male	4	1
10	128	Sales Executive	4	4999	4	Female	3	1
11	709	Sales Executive	8	4028	4	Female	4	1
12	377	Research Scientist	5	2070	4	Male	4	1
13	1270	Research Scientist	1	1223	4	Male	3	1
14	1374	Research Scientist	5	2029	4	Female	3	1
15	1581	Research Scientist	1	2061	4	Female	4	1
16	327	Manager	22	16064	4	Female	4	1
17	473	Manager	15	12504	4	Female	3	1
18	1520	Manager	26	16032	4	Female	4	1
19	1550	Manager	21	16437	4	Male	4	1
20	1644	Manager	23	15202	4	Male	4	1
21	525	Laboratory Technician	8	2258	4	Male	4	1
22	958	Laboratory Technician	16	2519	4	Male	3	1
23	1107	Laboratory Technician	1	2377	4	Male	3	1
24	1279	Laboratory Technician	2	2625	4	Female	3	1
25	1693	Laboratory Technician	7	2570	4	Male	4	1
26	177	Human Resources	8	2942	4	Female	3	1
27	1499	Human Resources	6	2064	4	Male	3	1
28	1714	Human Resources	1	1555	3	Male	3	1
29	1744	Human Resources	9	9756	4	Female	3	1
30	1890	Human Resources	10	3886	4	Male	4	1

Conclusion

A simple linear programming model that could help in optimal human resource allocation based on job position, salary, performance rating, job satisfaction score and total years of working experiences.

R coding

```r
library(dplyr)
library(lpSolve)

options(stringsAsFactors = FALSE)

#load dataset
df <- read.csv('hr.csv')

#dataset preparation
df <- df %>%
  filter(JobRole %in% c('Human Resources','Sales Executive','Sales Representative',
                        'Research Scientist','Laboratory Technician','Manager'))

#linear programming setup
#maximization of objective function
direction <- 'max'
objective.in <- df$PerformanceRating

#matrix of constraints coefficient
const.mat <- rbind(
  1 * (df$MonthlyIncome),
  1 * (df$JobRole == 'Human Resources'),
  1 * (df$JobRole == 'Sales Executive'),
  1 * (df$JobRole == 'Sales Representative'),
  1 * (df$JobRole == 'Research Scientist'),
  1 * (df$JobRole == 'Laboratory Technician'),
  1 * (df$JobRole == 'Manager'),
  1 * (df$JobSatisfaction >= 3),
  1 * (df$JobRole == 'Manager' & df$TotalWorkingYears >= 10))
```

```r
#type of constraint (inequality, equality)
const.dir <- c(
  '<=',
  '==',
  '==',
  '==',
  '==',
  '==',
  '==',
  '==',
  '==')

#numeric values for the RHS of the constraints
const.rhs <- c(
  200000,
  5,
  5,
  6,
  4,
  5,
  5,
  30,
  5)

# solve linear programming
lp_solution <- lp(
  direction = direction,
  objective.in = objective.in,
  const.mat = const.mat,
  const.dir = const.dir,
  const.rhs = const.rhs,
  all.bin = TRUE,
  num.bin.solns = 1)
```

```r
# attach solution to HR dataset
team <- mutate(df, include = lp_solution$solution)

#identify the employees included in the team
t <- team %>%
  select(EmployeeNumber,JobRole,TotalWorkingYears,MonthlyIncome,
         PerformanceRating,Gender,JobSatisfaction,include) %>%
  filter(include == 1) %>%
  arrange(desc(JobRole))

#the maximize value of ofjective function
lp_solution$objval
```