IE4210 Operations Research II
AY2019/2020 Semester 2
Group Assignment

This group assignment is an adaptation of Case 6, pages 1359-1362 of the textbook, *Operations Research: Applications and Algorithms* by Wayne L. Winston:

Selecting Corporate Training Programs

For a corporation, the primary purpose of training is to ensure that employees have the key skills needed to effectively manage and operate the business. There are many options for providing training. For example, to train staff members in computer skills, a corporation may use any of the following strategies:

- hiring an outside consultant to develop and present an on-site training course,
- using corporate personnel to develop and present an on-site training course,
- purchasing a training course and having employees use it for self-study,
- contracting with a local education institute to provide training, or
- sending employees to an off-site training seminar.

The above possibilities are for a single skill. The purpose of many training programs, however, is to give employees a broad set of skills. Often the skill sets of two or more programs partially overlap. When this happens, the corporation must choose the set of programs that give employees the required skills for their jobs and the appropriate employees for each training program. In any case, training decisions made in an ad-hoc "pay-as-you-go" manner will be inefficient and generally result in additional expense.

It is appropriate to make the following assumptions:

- There is a known study period, for example the next 3 or the next 5 years, over which there is a need to plan training. The study period should fit with the overall business strategy and enable accurate estimates for training needs and available resources.
- There is a known set of skills that employees need. Among others, these may include technical, interpersonal, communication and management skills.
- Employees are divided into classes. In each class, there are estimates for (1) the number of employees, (2) the employee hourly wage, (3) the number of employees that require each particular skill, and (4) the maximum time available for training employees in each class during the study period.
- There is a list of training programs. For each program, there is usually information on (1) the set of skills taught, (2) the cost, (3) the completion time for an employee, and (4) the maximum number of employees who can participate per decision cycle.
- Training is equally effective for all people, and so the concern is with which programs to offer and which employees in each class to assign to each program. If the quality of the training for individual skills for individual classes is known, this assumption can be relaxed.

Your job is to develop models to aid businesses and corporations in determining the appropriate training programs to use. The type of model and issues often depend on the size of the corporation and the potential uses of the models. For large corporations, there are many employees in each class, so it is not necessary to model and schedule down to the individual employee. Concentrate instead on the assignment of employee classifications to programs and ignore the assignment of specific individuals to programs. Also, sufficient resources exist to develop internal training programs, hence you should consider program development costs as well as employee costs (lost work time, travel, meals, course materials) in the objective. A large corporation can use the model to plan the development of courses. This will help determine (1) program-development costs so that in-house programs are cost-effective and (2) appropriate programs for each employee classification so that, on average, there is sufficient time to complete the assigned programs within the available time.

Note that for small businesses, the focus is often different. Typically, these companies do not develop in-house programs because they do not train enough employees to justify development costs. Because the number of employees is small, it is important to model down to the employee level and schedule employees so that both training and job tasks can be completed.

Your OR consulting firm has been hired to design the training program for a company. There are no in-house classes and vendors provide all training. The company has determined 41 skills that are important for its employees; these are listed in Table 1. There are six employee classes and you can first assume that there is only one person in each employee class; the annual salary level and skills required for each employee class are given in Tables 2a and 2b. In general, there are 250 working days per year. There are 15 programs available for use. Tables 3a and 3b contain the cost per person and the skills covered for each program. In Tables 3a and 3b, a 1 in the row for program p and the column for skill s implies that program p contains skill s. Table 4 lists the duration of each program and the programs that conflict in time with other programs (for example, programs 3, 5, and 8 conflict with program 1). An employee cannot take two programs simultaneously. It is company policy that each employee has at least 5 days of training per year but the training cannot exceed 15 days per year. Also, the company does not allow any employee to go for more than 5 programs per year.

Your job is to develop a recommendation for the company for addressing its training needs. In particular, you should address the following key questions in your report:

- Which training programs should be used? What is the assignment of personnel to those programs?
- Identify programs with heavy use that may justify the development of an in-house course. How much would the company be willing to pay for that development if the program could be used for the next three years?
- There is opportunity to negotiate prices for programs. Which programs would you suggest are candidates for negotiation?
- What skills are especially expensive for the company to cover? If the company were to develop its own programs, what skills should be covered?
- Would your recommendation change if more days of training or more number of programs per year were allowed?

Table 1: List of skills

Number	Skill	Number	Skill
1	New employee orientation	22	Stress management
2	Performance appraisals	23	Computer programming
3	Personal computer apps	24	Diversity
4	Leadership	25	Data processing/MIS
5	Sexual harassment	26	Planning
6	Team building	27	Public speaking and presentation
7	Safety	28	Strategic planning
8	Hiring and selection process	29	Writing skills
9	New equipment operation	30	Negotiating skills
10	Training the trainer	31	Finance
11	Product knowledge	32	Marketing
12	Decision making	33	Substance abuse
13	Listening skills	34	Ethics
14	Time management	35	Outplacement and retirement
15	Conducting meetings	36	Creativity
16	Quality improvements	37	Purchasing
17	Delegation skills	38	Smoking cessation
18	Problem solving	39	Financial and business literacy
19	Goal setting	40	Re-engineering
20	Managing change	41	Foreign language
21	Motivation		

Table 2a: Annual salary and skills (1-20) required for each job classification

Job Classification	Salary ($)	Skills 1-20
Senior Manager	250,000	0 1 0 1 0 0 0 0 0 0 0 1 1 1 0 1 0 1 1 0
Project Manager	200,000	0 1 0 0 1 0 0 0 0 0 1 1 1 1 1 0 0 1 0 0
Professional	150,000	1 1 0 0 1 1 1 0 1 0 0 0 1 0 1 0 0 0 0 1
Sales	150,000	1 1 0 0 0 0 0 0 1 1 0 0 1 0 0 0 1 0 0 1
Technician	100,000	1 1 1 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1
Administrative Assistant	80,000	1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Table 2b: Annual salary and skills (21-41) required for each job classification

Job Classification	Salary ($)	Skills 21-41
Senior Manager	250,000	1 1 1 1 0 1 1 0 1 0 1 1 0 1 0 1 1 1 0 0 0
Project Manager	200,000	0 1 1 1 0 1 1 1 1 0 1 0 1 0 0 1 1 1 1 0 1
Professional	150,000	0 0 0 0 1 1 0 0 0 1 0 0 1 0 1 0 0 1 1 0 1
Sales	150,000	0 0 0 0 1 1 0 0 0 1 0 0 1 0 1 0 0 1 1 1 1
Technician	100,000	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1
Administrative Assistant	80,000	0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 1 1 0

Table 3a: Enrollment cost and skills (1-20) of each program

Program	Enrollment Cost ($)	Skills 1-20
Program 1	500	1 1 0 1 0 0 0 0 0 0 1 1 1 1 1 0 1 0 0 0
Program 2	300	0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0
Program 3	500	0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 1
Program 4	575	0 1 0 1 0 0 0 0 1 1 0 0 1 0 0 0 1 0 0 0
Program 5	800	0 1 1 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0
Program 6	400	0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 1
Program 7	200	0 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1
Program 8	1,000	0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 0 0 1 0
Program 9	200	1 1 1 1 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0
Program 10	500	0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
Program 11	700	0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
Program 12	600	0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0
Program 13	400	0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 1 1 1 0
Program 14	900	1 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0
Program 15	700	1 0 1 0 1 0 1 1 1 0 0 0 0 0 0 0 0 0 0 1 0

Table 3b: Enrollment cost and skills (21-41) of each program

Program	Enrollment Cost ($)	Skills 21-41
Program 1	500	1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
Program 2	300	0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0
Program 3	500	1 1 1 1 1 1 1 0 1 0 1 0 0 0 0 1 0 0 0 0 0
Program 4	575	0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1
Program 5	800	0 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 1 0
Program 6	400	0 0 0 0 0 0 0 0 1 0 0 1 1 0 0 1 1 0 0 0 0
Program 7	200	0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0
Program 8	1,000	1 1 1 1 0 0 1 0 1 1 0 0 0 0 0 0 1 0 0 0 0
Program 9	200	0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0
Program 10	500	0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 1 0 0 0
Program 11	700	0 1 1 0 0 0 1 0 1 1 0 1 0 0 1 1 0 0 0 0 0
Program 12	600	0 0 0 0 0 0 0 1 0 1 1 0 0 0 0 0 0 1 1 1 0
Program 13	400	1 0 1 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0
Program 14	900	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1
Program 15	700	0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 1

Table 4: Interfering programs

Program Number	Duration (days)	Programs that interfere
1	2	3 5 8
2	2	3 7 10
3	4	1 2 12
4	3	6 7 14
5	2	1 9 12
6	3	4 7 11 14
7	5	2 4 6
8	2	1 10 13
9	3	5 15
10	3	2 8
11	2	6 12 15
12	4	3 5 11
13	3	8 14
14	4	4 6 13
15	3	9 11

In addition, you could also make further analyses and recommendations to take into account some or all of the following considerations:

- There could be more than one person in each employee class.
- There is a maximum number of employees who can participate in each program.
- There is a vendor-imposed fee for each program should there be at least an employee enrolling in the program. The fee is estimated to be five times the enrollment cost of the program.
- The company is capable of developing an in-house course for all the programs. Thus, for each program, the company has the option of developing an in-house course or letting vendors provide the training. The development cost for each program is estimated to be three times the enrollment cost of the program.

These considerations may not be exhaustive and you could provide more realistic considerations that are not listed above.

Your report should include a description of your models and any additional assumptions made in model formulation. You may have to make such assumptions because this problem has incomplete information or details that may be difficult to model. Different modeling approaches or different objectives to address the problem could be used. You may use Excel, AIMMS or any other relevant software, or you may propose heuristics to obtain solutions to this problem, depending on your modeling approaches.