

The dean's dilemma

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ABSTRACT

A case study that focuses on integer linear programming techniques and can be used in an operations management, management science, spreadsheet modeling, or decision modeling course for learning purposes is presented. The case includes different minimizing and maximizing objectives where an optimal solution must be found given many constraints. A case solution is also provided.

Keywords: integer linear programming, scheduling case



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CASE

The business school dean has a dilemma. He needs to put together a course schedule for the upcoming semester and has to contend with administrative, faculty, and student issues regarding the schedule. The poor dean tries to make everyone happy; however, there are always conflicts. Faculty members have a preference for the types of classes they would like to teach and want to teach additional classes in order to earn more income. The administration would like to reduce the number of adjuncts teaching classes and at the same time would like to see costs reduced. The students would like to see more course sections offered. These sections would have smaller class sizes and thus provide the opportunity for more instructor and student interaction which is often more difficult with larger classes. Finally, the dean wants his faculty to have more time for research; thus, he would like to limit the number of classes faculty members teach in a semester.

The dean wonders if perhaps a spreadsheet model could help him to determine an appropriate course schedule, the total faculty happiness level regarding course preferences, the total number of course sections that will be available, the total number of adjuncts needed, and the total costs (adjunct costs and faculty extra course costs) that he will incur for different objectives. He asks one of his spreadsheet savvy students to help him with the model and has his faculty members rate on a scale from 1 to 5 (with 1 being the lowest and 5 being the highest) the courses they would like to teach next semester. Table 1 (Appendix) lists the faculty preferences. For example, faculty member C gave financial accounting a 4 and statistics a 5.

Currently, the minimum required course load for faculty members is three classes per semester. In addition, faculty members can teach up to an additional two courses per semester for a maximum total of five classes. Faculty members can earn an additional \$5,000 per extra course they teach above the minimum three and adjuncts earn \$3,500 per course. In addition, it is estimated that roughly 100 students will need to take each course next semester, the maximum size per course section is 50 students, and the students prefer course sections with 20 or less students in them. The dean does not allow faculty to teach more than two sections of the same course and would like each faculty member's happiness level regarding course preferences to be at least a 12.

The dean would like to know the solution to the following scenarios:

- When the objective is to maximize total faculty happiness regarding course preferences.
- When the objective is to maximize the total number of course sections available for the students.
- When the objective is to minimize the number of adjuncts needed.
- When the objective is to minimize the total costs.
- When the objective is to minimize the total costs. However, faculty can only teach three classes per semester and at least three sections of each course must be offered.

SOLUTION

This case study focuses on integer linear programming techniques and can be used in an operations management, management science, spreadsheet modeling, or decision modeling course for learning purposes. Figure 1 (Appendix) shows the basic spreadsheet model that can be used to find the solution for the scenarios mentioned in the case. The decision variables are

the number of course sections that should be assigned to the faculty and adjuncts. The model constraints are the following:

- The minimum and maximum number of classes that faculty can teach each semester.
- The minimum and maximum sections available for each course.
- The decision variables must be integers.
- Each faculty member's happiness level regarding course preferences needs to be at least a 12.
- Faculty members may not teach more than two sections of the same course.

The model shows the course schedule, the total faculty happiness level regarding course preferences, the total number of course sections available for the students, the number of adjuncts needed, and the total costs (which include the costs for the adjuncts and extra courses that faculty teach). A complete spreadsheet of the decision model can be obtained by emailing the author.

Table 2 (Appendix) shows the course schedule for the scenario where the objective is to maximize the total faculty happiness level regarding course preferences. The total faculty happiness level regarding course preferences is 192 (weighted average is 4.80), the number of adjuncts needed is two, the number of course sections available for the students is 42, and the total costs are \$87,000.

Table 3 (Appendix) shows the course schedule for the scenario where the objective is to maximize the number of course sections available for the students. The total faculty happiness level regarding course preferences is 145 (weighted average is 3.63), the number of adjuncts needed is 30, the number of course sections available for the students is 70, and the total costs are \$185,000.

Table 4 (Appendix) shows the course schedule for the scenario where the objective is to minimize the number of adjuncts needed. The total faculty happiness level regarding course preferences is 123 (weighted average is 4.10), the number of adjuncts needed is zero, the number of course sections available for the students is 30, and the total costs are \$30,000.

Table 5 (Appendix) shows the course schedule for the scenario where the objective is to minimize the total costs. The total faculty happiness level regarding course preferences is 107 (weighted average is 4.46), the number of adjuncts needed is four, the number of course sections available for the students is 28, and the total costs are \$14,000.

Table 6 (Appendix) shows the course schedule for the scenario where the objective is to minimize the total costs, but at the same time only allow faculty to teach three courses per semester and offer at least three sections of each course. The total faculty happiness level regarding course preferences is 107 (weighted average is 4.46), the number of adjuncts needed is 18, the number of course sections available for the students is 42, and the total costs are \$63,000.

APPENDIX

Table 1: Faculty Preferences

Course	Faculty							
	A	B	C	D	E	F	G	H
Financial Accounting	5	3	4	4	2	1	1	2
Managerial Accounting	5	1	4	5	3	1	1	2
Microeconomics	3	2	3	4	4	2	3	3
Macroeconomics	2	2	3	4	3	2	3	3
Introduction to Business	4	5	5	4	5	4	5	5
Statistics	3	5	5	1	4	2	2	1
Operations Management	2	5	3	1	4	2	2	2
Organizational Behavior	1	1	2	1	2	5	5	4
Marketing	3	2	1	3	1	3	4	5
Strategy	3	3	4	2	4	3	3	5
Human Resources	2	1	1	1	1	5	5	4
Management Information Systems	2	5	3	3	4	2	1	2
Financial Management	5	3	3	4	2	1	1	1
Entrepreneurship	2	4	5	2	3	3	4	4

Table 2: Course Schedule When Maximizing Total Faculty Happiness Regarding Course Preferences

Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	1	0	0	2	0	0	0	0	0	3
Managerial Accounting	2	0	1	2	0	0	0	0	0	5
Microeconomics	0	0	0	1	1	0	0	0	0	2
Macroeconomics	0	0	0	0	0	0	0	0	2	2
Introduction to Business	0	0	0	0	2	1	1	1	0	5
Statistics	0	2	2	0	0	0	0	0	0	4
Operations Management	0	1	0	0	2	0	0	0	0	3
Organizational Behavior	0	0	0	0	0	2	2	0	0	4
Marketing	0	0	0	0	0	0	0	2	0	2
Strategy	0	0	0	0	0	0	0	2	0	2
Human Resources	0	0	0	0	0	2	2	0	0	4
Management Information Systems	0	2	0	0	0	0	0	0	0	2
Financial Management	2	0	0	0	0	0	0	0	0	2
Entrepreneurship	0	0	2	0	0	0	0	0	0	2

Table 3: Course Schedule When Maximizing the Number of Course Sections Available

Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	2	0	0	0	0	0	0	0	3	5.00
Managerial Accounting	0	2	0	2	0	0	0	0	1	5.00
Microeconomics	0	0	0	0	2	0	0	0	3	5.00
Macroeconomics	0	0	0	0	0	0	0	0	5	5.00
Introduction to Business	0	2	0	0	0	0	0	0	3	5.00
Statistics	1	0	2	0	0	0	0	0	2	5.00
Operations Management	0	0	0	0	2	0	0	0	3	5.00
Organizational Behavior	0	0	0	0	0	2	0	0	3	5.00
Marketing	0	0	0	1	0	0	0	2	2	5.00
Strategy	0	0	0	2	0	0	1	2	0	5.00
Human Resources	0	1	0	0	0	0	2	1	1	5.00
Management Information Systems	2	0	2	0	0	0	0	0	1	5.00
Financial Management	0	0	1	0	0	2	0	0	2	5.00
Entrepreneurship	0	0	0	0	1	1	2	0	1	5.00

Table 4: Course Schedule When Minimizing the Number of Adjuncts Needed

Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	2	0	0	0	0	0	0	0	0	2.00
Managerial Accounting	0	0	0	2	0	0	0	0	0	2.00
Microeconomics	0	1	0	1	2	0	0	0	0	4.00
Macroeconomics	0	0	2	0	0	0	0	0	0	2.00
Introduction to Business	0	2	0	0	0	0	0	0	0	2.00
Statistics	0	0	2	0	0	0	0	0	0	2.00
Operations Management	0	0	0	0	2	0	0	0	0	2.00
Organizational Behavior	0	0	0	0	0	2	0	0	0	2.00
Marketing	0	0	0	0	0	0	0	2	0	2.00
Strategy	0	0	0	0	0	0	0	2	0	2.00
Human Resources	0	0	0	0	0	0	2	0	0	2.00
Management Information Systems	1	0	1	0	0	0	0	0	0	2.00
Financial Management	0	0	0	0	0	2	0	0	0	2.00
Entrepreneurship	0	0	0	0	0	0	2	0	0	2.00

Table 5: Course Schedule When Minimizing the Total Costs

Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	2	0	0	0	0	0	0	0	0	2.00
Managerial Accounting	0	0	0	2	0	0	0	0	0	2.00
Microeconomics	0	0	0	0	0	1	0	0	1	2.00
Macroeconomics	0	1	0	1	0	0	0	0	0	2.00
Introduction to Business	0	0	0	0	1	0	0	0	1	2.00
Statistics	0	0	2	0	0	0	0	0	0	2.00
Operations Management	0	0	0	0	2	0	0	0	0	2.00
Organizational Behavior	0	0	0	0	0	2	0	0	0	2.00
Marketing	0	0	0	0	0	0	0	0	2	2.00
Strategy	0	0	0	0	0	0	0	2	0	2.00
Human Resources	0	0	0	0	0	0	2	0	0	2.00
Management Information Systems	0	2	0	0	0	0	0	0	0	2.00
Financial Management	1	0	1	0	0	0	0	0	0	2.00
Entrepreneurship	0	0	0	0	0	0	1	1	0	2.00

Table 6: Course Schedule When Minimizing the Total Costs and Limiting the Number of Faculty Classes to Three and Offering at Least Three Sections of a Course

Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	1	0	0	0	0	0	0	0	2	3.00
Managerial Accounting	0	0	0	2	0	0	0	0	1	3.00
Microeconomics	0	0	0	0	1	0	0	0	2	3.00
Macroeconomics	0	0	0	1	0	0	0	0	2	3.00
Introduction to Business	0	1	0	0	0	0	1	1	0	3.00
Statistics	0	0	1	0	0	1	1	0	0	3.00
Operations Management	0	0	0	0	0	0	0	0	3	3.00
Organizational Behavior	0	0	0	0	0	2	1	0	0	3.00
Marketing	0	0	0	0	0	0	0	2	1	3.00
Strategy	0	0	0	0	0	0	0	0	3	3.00
Human Resources	0	0	0	0	0	0	0	0	3	3.00
Management Information Systems	0	0	0	0	2	0	0	0	1	3.00
Financial Management	2	1	0	0	0	0	0	0	0	3.00
Entrepreneurship	0	1	2	0	0	0	0	0	0	3.00

Figure 1: Spreadsheet Decision Model

Adjunct salary per course	\$3,500	Objectives								
Faculty salary per extra course	\$5,000	Total faculty happiness level regarding course preferences	192.00							
Minimum classes for faculty to teach each semester	3	Total number of course sections available	42							
Maximum classes for faculty to teach each semester	5	Total number of adjuncts	2.00							
Student class size preference	20									
Maximum number of students in a section	50									
Total students needing to take each course	100	Adjunct costs	\$7,000							
Maximum sections of a course that can be taught by a faculty member	2	Faculty extra course costs	\$80,000							
Minimum sections of a course	2	Total costs	\$87,000.00							
Maximum sections of a course	5									
Minimum faculty happiness level regarding course preferences	12									
		Faculty Preferences								
Course	A	B	C	D	E	F	G	H		
Financial Accounting	5	3		4	4	2	1	1	2	
Managerial Accounting	5	1		4	5	3	1	1	2	
Microeconomics	3	2		3	4	4	2	3	3	
Macroeconomics	2	2		3	4	3	2	3	3	
Introduction to Business	4	5		5	4	5	4	5	5	
Statistics	3	5		5	1	4	2	2	1	
Operations Management	2	5		3	1	4	2	2	2	
Organizational Behavior	1	1		2	1	2	5	5	4	
Marketing	3	2		1	3	1	3	4	5	
Strategy	3	3		4	2	4	3	3	5	
Human Resources	2	1		1	1	1	5	5	4	
Management Information Systems	2	5		3	3	4	2	1	2	
Financial Management	5	3		3	4	2	1	1	1	
Entrepreneurship	2	4		5	2	3	3	4	4	
Course	A	B	C	D	E	F	G	H	Adjuncts	Number of Sections
Financial Accounting	1	0		0	2	0	0	0	0	3.00
Managerial Accounting	2	0		1	2	0	0	0	0	5.00
Microeconomics	0	0		0	1	1	0	0	0	2.00
Macroeconomics	0	0		0	0	0	0	0	2	2.00
Introduction to Business	0	0		0	0	2	1	1	1	5.00
Statistics	0	2		2	0	0	0	0	0	4.00
Operations Management	0	1		0	0	2	0	0	0	3.00
Organizational Behavior	0	0		0	0	0	2	2	0	4.00
Marketing	0	0		0	0	0	0	0	2	2.00
Strategy	0	0		0	0	0	0	0	2	2.00
Human Resources	0	0		0	0	0	2	2	0	4.00
Management Information Systems	0	2		0	0	0	0	0	0	2.00
Financial Management	2	0		0	0	0	0	0	0	2.00
Entrepreneurship	0	0		2	0	0	0	0	0	2.00
The number of classes that the faculty member is teaching	5	5		5	5	5	5	5	5	
The number of extra classes the faculty member is teaching	2	2		2	2	2	2	2	2	
Total extra classes faculty are teaching	16									
Faculty happiness level regarding course preferences	25.0	25.0		24.0	22.0	22.0	24.0	25.0	25.0	