

LP/MIP Modeling Exercises (4/3)

Exercise 1

Amazin.com is an online bookstore that is expanding its business by launching a physical store in West LA. As the manager, you need to select which bestsellers to carry at the store's grand opening. The following table provides the list of Top 10 Bestsellers in Literature & Fiction, along with their genres. Note that some bestsellers belong to more than one genre.

Rank \ Genre	Literary	Sci-Fi	Romance	Thriller
1	✓			
2		✓		✓
3			✓	✓
4	✓		✓	
5	✓			
6			✓	
7		✓		
8				✓
9	✓	✓		
10			✓	

You wish to carry the minimum number of bestsellers, while ensuring that there are at least two bestsellers in each genre. Formulate this as an optimization problem.

Exercise 2

Tom Burke, owner of Burke Construction, has promised to complete five projects this winter. Burke Construction has 10 workers that will work 40 hours a week for 12 weeks this winter. Since this is a limited workforce, Tom knows that he will not be able to complete all of his construction projects without subcontracting some of them. In the table below, he has estimated the amount of labor hours required by each project, and the profit to his company.

Project	1	2	3	4	5
Labor hours required	1300	950	1000	1400	1600
Profit (if done by own company)	\$30,000	\$10,000	\$26,000	\$18,000	\$20,000
Profit (if subcontracted)	\$6,000	\$2,000	\$8,000	\$9,000	\$4,500

To maximize profit, which jobs should Tom schedule for his company, and which should be subcontracted? Formulate an optimization problem. Assume that projects cannot be partially subcontracted; that is, a project will be completed entirely by either Burke Construction or the subcontractor.

Exercise 3

The city of Metropolis is divided into nine districts and is considering seven possible sites to place emergency vehicles. The table below shows the time (minutes) it takes for an emergency vehicle to travel from each district to each site. (The column labels are sites and row labels are districts.)

District \ Row	1	2	3	4	5	6	7
1	5	3	4	3	8	9	0
2	3	6	5	4	8	0	3
3	4	3	6	8	10	3	2
4	6	0	2	7	3	2	5
5	2	8	2	5	0	6	8
6	2	6	4	0	7	3	5
7	0	12	5	5	5	7	2
8	10	9	0	2	3	5	7
9	2	4	5	7	3	4	5

Formulate an optimization problem to find the minimum number of sites so that all districts are within three minutes of an emergency vehicle.

Exercise 4

Finco Investment Corporation wishes to determine an investment strategy for the firm for the next 3 years. At present (Year 0), 100,000 is available for investment. The goal is to maximize the cash on hand at the end of Year 3.

There are five investment options, labeled *A*, *B*, *C*, *D*, and *E*. The cash flow associated with investing \$1 in each investment is given in the table below.

Investment option	Now (Year 0)	Year 1	Year 2	Year 3
A	-\$1.00	\$0.50	\$1.00	0
B	\$0.00	-\$1.00	\$0.50	\$1.00
C	-\$1.00	\$1.20	0	0
D	-\$1.00	0	0	\$1.90
E	0	0	-\$1.00	\$1.50

For example, Option A must be invested this year, and each dollar of cash outflow now returns \$0.50 in Year 1 and one dollar in Year 2. Option E must be invested in Year 2 and each dollar returns \$1.50 the next year.

To ensure that the company's portfolio is diversified, Finco required that at most \$75,000 be placed in any single investment option. Returns from investments can be reinvested in the same year. For example, the positive cash flow received from Option C in Year 1 can be reinvested immediately in Option B. However, Finco cannot borrow funds, so net cash on hand must be non-negative in all years. Formulate this as an optimization problem.