Binary Programming

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1. The City Council in Monroe, Michigan is considering four proposed new recreational facilities: a swimming pool, a tennis center, athletic fields (football/soccer, baseball/softball, and track), and a gymnasium. The Council wants to construct the facilities that will maximize the expected daily use, but there are budgetary and land restrictions. The expected daily use, cost, and land requirements for each of the proposed facilities are given in Table 6.4.1.

|  |  |  |  |
| --- | --- | --- | --- |
| Facility | Expected Use  (people/day) | Cost  ($ million) | Land Required  (acres) |
| Swimming pool and fitness center | 550 | 5.2 | 1.2 |
| Tennis center | 150 | 1.2 | 1.5 |
| Athletic fields | 325 | 1.7 | 2.5 |
| Gymnasium | 400 | 4.3 | 1 |

The Council has planned on offering a capital funding bond for up to $10 million to construct new recreational facilities. There are 4.7 acres of land available. But, the section available for the indoor pool or gymnasium is not large enough to build both. So, only one of these can be built.

1. Use solver to obtain the optimal solution. Which of the proposed facilities should the Council build? What is the average daily usage?
2. There is a one acre swamp next to the 4.7 acres. If the council buys this property for $1 million how would this change the optimal solution?
3. The Research Triangle Electronics Company is considering eight new research and development projects. The company cannot conduct all eight projects due to limitations on their R & D budget and the number of research scientists available. Table 6.4.2 contains the resource requirements and estimated profit for each of the projects. In addition, of projects 4, 5, and 6, only two can be undertaken, because they require many of the same research scientists. The budget for the research is $3.5 million. There are 20 scientists in the research group.
   1. Which projects should be selected in order to maximize estimated profit? Be sure to indicate the profit.

|  |  |  |  |
| --- | --- | --- | --- |
| Project | Cost  (Millions of $) | Scientists Required | Estimated Profit (Millions of $) |
| 1 | .65 | 7 | 8.2 |
| 2 | 1.2 | 6 | 9.5 |
| 3 | .35 | 8 | 3.7 |
| 4 | .45 | 9 | 4.1 |
| 5 | .8 | 10 | 5.3 |
| 6 | .85 | 8 | 5.2 |
| 7 | .75 | 7 | 8.2 |
| 8 | .7 | 4 | 5.8 |

* 1. The company is considering hiring an additional 7 scientists. What projects would they select with this larger workforce? What would the maximum profit become?

**Assignment Problems**

1. Triangle Airlines is assigning six new flight attendants to fly on the six types of aircraft flown by the airline. Each of the new attendants has been trained on each type of aircraft, but the number of training hours the new attendants have on the different aircraft varies. The airline wants to assign the attendants based on their number of hours of training on each aircraft type. The table below provides the number of training hours on each aircraft type for each attendant. How should the airline assign the attendants if it wants to assign them based on their training experiences? (Hint: Is this a maximization or minimization problem?)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| (hours of training) | | Aircraft | | | | | |
| CRJ | DC-9 | A320 | 747 | 757 | 767 |
| Attendant | Albert | 4 | 4 | 2 | 4 | 2 | 8 |
| Jack | 4 | 4 | 4 | 4 | 4 | 4 |
| Mary | 4 | 2 | 2 | 4 | 8 | 4 |
| Katie | 2 | 2 | 4 | 4 | 4 | 8 |
| Dave | 2 | 2 | 4 | 6 | 6 | 4 |
| Matthew | 4 | 2 | 2 | 6 | 6 | 4 |

1. Industrial Training. Industrial Training Consultants is offering four types of courses in August. There are five instructors who have experience teaching all of the subjects. The assignment will be based on past student evaluations of the five instructors. The student evaluation scores appear in the table below.
   1. How should instructors be assigned to courses so that the total of the student evaluation scores is maximized?
   2. Which instructor is assigned no course?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| (% positive) | | Course | | | |
| Lean Manufacturing | Six Sigma | Logistic Management | Simulation |
| Student | Randolph | 93 | 96 | 86 | 87 |
| Angela | 90 | 94 | 92 | 89 |
| Anthony | 91 | 87 | 84 | 88 |
| Deborah | 92 | 88 | 90 | 85 |
| Myles | 95 | 97 | 94 | 88 |

1. Renovaçión Home Improvement Store. The Renovaçión Home Improvement Store will assign an employee to each of the five departments: Appliances, Flooring, Outdoor Living, Kitchen, and Tools. There are seven employees available who have past experience in all of these five departments. The company collected sales performance information for each worker on each day he or she was assigned to a department. The average daily sales of each employee are shown in the table below. Assign employees to departments so that the average daily sales of the five employees assigned are as large as possible.
   1. What would the daily average sales be in an optimal assignment?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ($) | | Department | | | | |
| Appliances | Flooring | Plumbing | Doors | Lighting |
| Employee | Joshua | 1,555 | 525 | 370 | 275 | 560 |
| Adan | 1,250 | 450 | 285 | 250 | 540 |
| Ha | 850 | 500 | 320 | 330 | 550 |
| Tyson | 1,675 | 490 | 375 | 350 | 580 |
| Valley | 1,125 | 510 | 365 | 345 | 190 |
| Lacole | 950 | 500 | 195 | 335 | 350 |
| Haemon | 1,050 | 300 | 345 | 200 | 545 |

* 1. Which employees would not be assigned to a department?