

Homework requirement

- For problems that require a mathematical formulation, please clearly state the definition of decision variables and the indexes of them. Write a sentence to explain each constraint and objective function. Also include an explanation of the optimal solution when you are required to solve the problem in AMPL.
 - Submit your homework (typed, scanned or photographed) and AMPL code in a single pdf file. You can choose to merge the pdf files together or include screenshots of your AMPL code and solutions in your homework pdf.
1. Dorian Auto is considering manufacturing three types of autos: compact, midsize and large. The resource required for, and the profits yielded by, each type of car are shown below:

Resource	Compact	Midsize	Large
Steel required (ton)	1.5	3	5
Labor required (hour)	30	25	40
Profit yielded (\$)	2,000	3,000	4,000

Currently 6,000 tons of steel and 60,000 hours of labor are available. For production of a type of car to be economically feasible, at least 1,000 cars of that type must be produced. Formulate an IP to maximize Dorian's profit. Notice that for this problem you will need to find a number M to bound the maximum amount of cars of a given type that can be built.

2. Coach Night is trying to choose the starting lineup for the basketball team. The team consists of seven players who have been rated (on a scale of 1 = poor to 3 = excellent) according to their ball handling, shooting, rebounding, and defensive abilities. The positions that each player is allowed to play, along with the players' abilities, are listed below:

Player	Position	Ball-handling	Shooting	Rebounding	Defense
1	G	3	3	1	3
2	C	2	1	3	2
3	G,F	2	3	2	2
4	F,C	1	3	3	3
5	G,F	3	3	3	3
6	F,C	3	1	2	3
7	G,F	3	2	2	1

The five-player starting lineup must satisfy the following restrictions:

- At least 4 members must be able to play guard, at least 2 members must be able to play forward, and at least 1 member must be able to play center
- The average ball-handling, shooting, and rebounding level of the starting lineup must be at least 2
- If player 3 starts, then player 6 cannot start
- If player 1 starts, then players 4 and 5 must both start
- Either player 2 or player 3 must start

Given these constraints, Coach Night wants to maximize the total defensive ability of the starting team. Formulate an IP that will help him choose his starting team.

3. A investment management company currently has several projects to invest on: P1, P2, P3, P4, P5 and P6. Each project has an initial cost, an expected annual profit rate expressed as a percentage of the initial cost, and an associated risk of failure. These numbers are given in the table below:

	P1	P2	P3	P4	P5	P6
Initial cost (in M)	1.3	0.8	0.6	1.8	1.2	2.4
Profit rate	10%	20%	20%	10%	10%	10%
Failure risk	6%	4%	6%	5%	5%	4%

- a) Provide a formulation to choose the projects that maximize total expected profit, such that the company does not invest more than 4M dollars and its average failure risk is not over 5%. For example, if the company invests only into P1 and P2, it invests only 2.1M dollars and its average failure risk is $(6\% + 4\%)/2 = 5\%$.
 - b) Suppose that if P1 is chosen, P2 must be chosen. Modify your formulation.
 - c) Suppose that if P3 and P4 are chosen, P5 must be chosen. Modify your formulation.
4. Suppose that Li Hua (a MBA student) in our class is considering choosing courses in the next spring semester. He plans to study 40 hours in a week. He is interested in 8 courses. They are listed below with the number of hours (per week) required to successfully complete each course.

Optimization	Accout.	Info. Tech.	Finance	Market.	O. Behav.	Psyc.	Chinese
9	7	5	8	5	3	7	10

Completing each of these courses increases Li Hua's chances of finding a job at a consulting firm. But the contributions of courses towards this dream are different as given below:

Optimization	Accout.	Info. Tech.	Finance	Market.	O. Behav.	Psyc.	Chinese
0.10	0.04	0.06	0.12	0.08	0.03	0.04	0.05

Li Hua wants to choose his spring courses so that he maximizes his chances of getting this job. Assuming courses can be chosen independently, formulate this situation as an IP. Solve this problem using AMPL.