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Capital Budgeting

Stocks & Bonds is considering four investments. Investment 1 will yield a net present value (NPV) of R16 000; investment 2, an NPV of R22 000; investment 3, an NPV of R12 000; and investment 4, an NPV of R8 000. Each investment requires a certain cash outflow at the present time: investment 1, R5 000; investment 2, R7 000; investment 3, R4 000; and investment 4, R3 000. Currently, R14 000 is available for investment. Formulate an IP whose solution will tell Stocks & Bonds how to maximize the NPV obtained from investments 1 – 4.

- First, we will declare the decision variables:
 - $x_i = \text{Investment } i \text{ invested (1) or not (0) where } i = \text{investments } 1 - 4$
- Next, we create the objective function:
 - $\max z = 16x_1 + 22x_2 + 12x_3 + 8x_4$
- Next, we will create the constraint:
 - $s.t. 5x_1 + 7x_2 + 4x_3 + 3x_4 \leq 14$
- Lastly, we choose the sign restrictions:
 - $x_i = 0 \text{ or } 1$

Binary constraints

Modify the Stocks & Bonds formulation to account for each of the following requirements:

1. Stocks & Bonds can invest in at most two investments.
2. If Stock & Bonds invests in investment 2, they must also invest in investment 1.
3. If Stocks & Bonds invests in investment 2, they cannot invest in investment 4.

Answers:

1. $x_1 + x_2 + x_3 + x_4 \leq 2$
2. $x_2 \leq x_1$ $x_2 - x_1 \leq 0$
3. $x_2 + x_4 \leq 1$

x_2	x_1	
1	1	TRUE
1	0	FALSE
0	1	TRUE
0	0	TRUE

x_2	x_4	
1	1	FALSE
1	0	TRUE
0	1	TRUE
0	0	TRUE

x_2	+	x_4	≤ 1	
1	+	1	=2	FALSE
1	+	0	=1	TRUE
0	+	1	=1	TRUE
0	+	0	=0	TRUE

Exercises

Coach Lombardi is trying to choose the starting line-up for his five-a-side football 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, tackling, and defensive abilities. The positions that each player is allowed to play and the player's abilities are listed in the table.

Player	Position	Ball-handling	Shooting	Tackling	Defence
1	B	3	3	1	3
2	C	2	1	3	2
3	B-F	2	3	2	2
4	F-C	1	3	3	1
5	B-F	3	3	3	3
6	F-C	3	1	2	3
7	B-F	3	2	2	1

Exercises

The five-player starting line-up must satisfy the following restrictions:

- At least four team members must be able to play backfield, at least two members must be able to play forward, and at least one member must be able to play centre.
- The average ball-handling, shooting, and tackling level of the starting line-up 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 Lombardi wants to maximize the total defensive ability of the starting team.

1. Formulate an Integer Programming Model that will solve the requirements of the Football Team.
2. Solve the formulated Integer Programming Model using Solver.
3. Solve the formulated Integer Programming Model using the Branch & Bound Simplex Algorithm.
4. Solve the formulated Integer Programming Model using the Cutting Plane Algorithm.

Exercises


Formulate the additional constraints for the team:


1. If player 4 starts, then player 2 must also start.
2. If player 1 starts, player 5 must also start and vice versa.
3. If player 4 does not start, then player 3 must also not start.
4. If player 2 starts, then players 3 and 4 must also start.
5. If player 2 starts, then player 4 cannot start.
6. Either player 2 or player 3 must start.

END




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