

Excluding a Solution

- The (previous) optimal solution was **A, C, E, G, I, J** :

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

Excluding a Solution

- The optimal solution was **A, C, E, G, I, J** :
 $y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1$ and $y_B^* = y_D^* = y_F^* = y_H^* = 0$
- We want to exclude just this one solution but none other. **We will add a constraint that will make just this solution infeasible.**

Excluding Solutions

- The optimal solution was **A, C, E, G, I, J :**

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$



For the solution **A, C, E, G, I, J :**

Value of this expression = 6

For the solution **A, C, E, G, I, J :**

Value of this expression = 4

= 10 (total)

Excluding Solutions

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- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$



For the solution **A, C, E, G, I, J :**

Value of this expression = 6

For the solution **A, C, E, G, I, J :**

Value of this expression = 4

= 10 (total)

For any other solution:

Value of this expression

For any other solution:

Value of this expression

= ? (total)

Excluding Solutions

- The optimal solution was **A, C, E, G, I, J :**

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$



For the solution **A, C, E, G, I, J :**

Value of this expression = 6

For the solution **A, C, E, G, I, J :**

Value of this expression = 4

= 10 (total)

For any other solution:

Value of this expression

For any other solution:

Value of this expression

= 9 or less (total)

Excluding Solutions

- The optimal solution was **A, C, E, G, I, J** :

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$

- This expression is equal to 10 for the solution **A, C, E, G, I, J**
- For every other solution, the expression is guaranteed to be less than or equal to 9

Excluding Solutions

- The optimal solution was **A, C, E, G, I, J** :

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$

- This expression is equal to 10 for the solution **A, C, E, G, I, J**
- For every other solution, the expression is guaranteed to be less than or equal to 9

So, we add the constraint:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H) \leq 9$$

This constraint eliminates **A, C, E, G, I, J** but no other solutions!

Excluding Solutions

- The optimal solution was **A, C, E, G, I, J** :

$$y_A^* = y_C^* = y_E^* = y_G^* = y_I^* = y_J^* = 1 \text{ and } y_B^* = y_D^* = y_F^* = y_H^* = 0$$

- Consider the following expression:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H)$$

- This expression is equal to 10 for the solution A, C, E, G, I, J
- For every other solution, the expression is guaranteed to be less than or equal to 9

So, we add the constraint:

$$y_A + y_C + y_E + y_G + y_I + y_J + (1 - y_B) + (1 - y_D) + (1 - y_F) + (1 - y_H) \leq 9$$

This constraint eliminates **A, C, E, G, I, J** but no other solutions!

IN GENERAL, THE RHS WILL BE THE NUMBER OF VARIABLES - 1

Formulation with All Constraints, Synergy Effect, and Excluding Previous Optimal

$$\text{maximize} \quad 10 y_A + 2 y_B + 4 y_C + 2 y_D + 5 y_E + 4 y_F + 8 y_G + 7 y_H + 6 y_I + 6 y_J + 8 z$$

subject to

(binary) z, y_A, y_B, \dots, y_J

$$(\text{points budget}) \quad 200 y_A + 50 y_B + \dots + 100 y_I \leq 1000$$

$$(\text{max credits}) \quad 12 y_A + 9 y_B + \dots + 6 y_I \leq 54$$

$$(\text{min credits}) \quad 12 \textcolor{red}{y_A} + 9 \textcolor{red}{y_B} + \dots + 6 \textcolor{red}{y_I} \geq 36$$

$$(\text{MW, H3 load}) \quad Y_A + Y_B + Y_E + Y_G \leq 3$$

(MW H4 load) $\gamma_A + \gamma_B + \gamma_G + 6 \gamma_I \leq 3$

(TR H3 load) $\gamma_C + \gamma_D + \gamma_I \leq 3$

(TR H4 load) $V_C + V_D + V_E + V_H \leq 3$

(A B conflict) $v_A + v_B \leq 1$

(B or C required) $y_B + y_C \geq 1$

(E pre-req to H) $y_H \leq y_E$

(Analytics Certificate Synergy)

- $z \leq y_i$
 - $z \leq y_j$
 - $z \geq y_i + y_j - 1$

(Exclude Previous Optimal Solution)

Updated Excel Solution

Bid on B, C, E, G, H, I, J

DECISIONS	A	B	C	D	E	F	G	H	I	J	Z
Course	0.0	1.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0

OBJECTIVE

Total utility	46
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CONSTRAINTS

	LHS		RHS
Points budget	730	<=	1,000
Course credit maximum	54	<=	54
Course credit minimum	54	>=	36
Mon, Wed H3 classes	3	<=	3
Tue, Thr H3 classes	2	<=	3
Mon, Wed H4 classes	3	<=	3
Tue, Thr H4 classes	3	<=	3
Do not take A <u>and</u> B	1.0	<=	1
Take either B or C	2.0	>=	1
H requires E	1.0	<=	1
If I not chosen, Z is 0	1.0	<=	1
If J not chosen, Z is 0	1.0	<=	1
If either I or J is chosen, Z is 1	1.0	>=	1
Exclude previous optimal solution	3.0	<=	5
Binary constraints			