

Formulating the Course Selection Problem

Constraints

Variables (binary) $y_A, y_B, \dots, y_J \geq 0, \leq 1$ and integral

Bidding (1000 points budget) $200 y_A + 50 y_B + \dots + 100 y_J \leq 1000$

Credits (54 max credits)
(36 min credits)

	A	B	C	D	E	F	G	H	I	J
Credit Hours	12	9	9	12	6	6	9	6	9	6

Schedule	(MW H3 load)
	(MW H4 load)
	(TR H3 load)
	(TR H4 load)

[illegible]

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Schedule (MW H3 load) $y_A + y_B + y_E + y_G \leq 3$

(MW H4 load)

(TR H3 load)

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Variables	(binary)	$y_A, y_B, \dots, y_J \geq 0, \leq 1$ and <u>integral</u>
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Credits	(54 max credits)	$12 y_A + 9 y_B + \dots + 6 y_J \leq 54$
	(36 min credits)	$12 y_A + 9 y_B + \dots + 6 y_J \geq 36$
Schedule	(MW H3 load)	$y_A + y_B + y_E + y_G \leq 3$
	(MW H4 load)	$y_A + y_B + y_G + y_J \leq 3$
	(TR H3 load)	$y_C + y_D + y_I \leq 3$
	(TR H4 load)	$y_C + y_D + y_F + y_H + y_I \leq 3$

The Complete Formulation

Maximize: $10 y_A + 2 y_B + 4 y_C + 2 y_D + 5 y_E + 4 y_F + 8 y_G + 7 y_H + 6 y_I + 6 y_J$

over variables: y_A, y_B, \dots, y_J

Subject To:

(binary)

$y_A, y_B, \dots, y_J \geq 0, \leq 1$ and integral ←

(points budget)

$200 y_A + 50 y_B + \dots + 100 y_J \leq 1000$

(54 max credits)

$12 y_A + 9 y_B + \dots + 6 y_J \leq 54$

(36 min credits)

$12 y_A + 9 y_B + \dots + 6 y_J \geq 36$

(MW H3 load)

$y_A + y_B + y_E + y_G \leq 3$

(MW H4 load)

$y_A + y_B + y_G + y_J \leq 3$

(TR H3 load)

$y_C + y_D + y_I \leq 3$

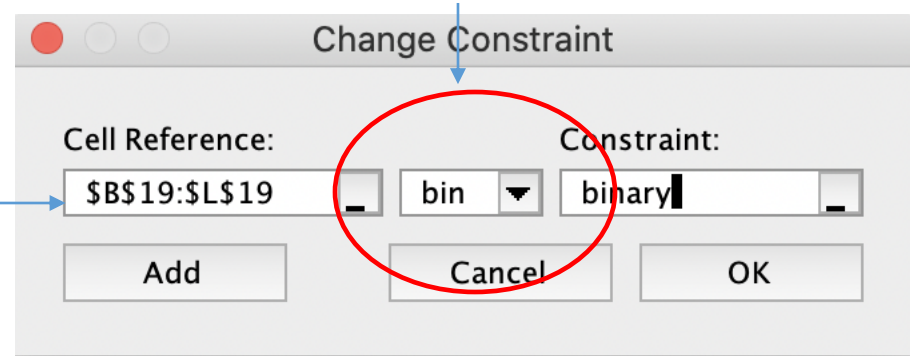
(TR H4 load)

$y_C + y_D + y_F + y_H + y_I \leq 3$

The only new piece here is we need to tell Solver that these decision variables are binary.

Excel's Solver makes it easy to create integer or binary variables

Choose the binary decision variables here

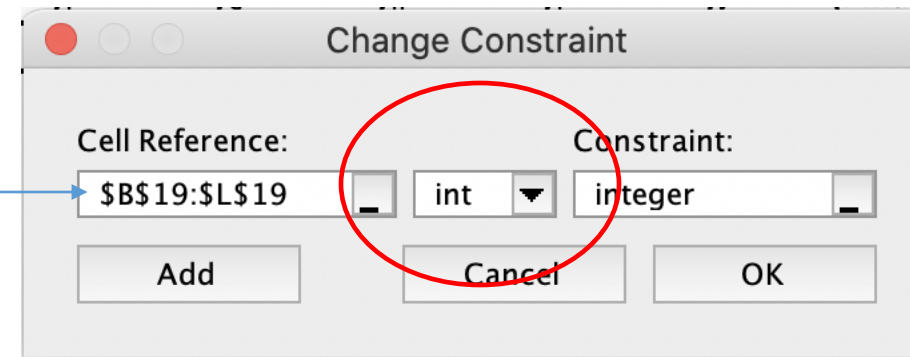


The 'Change Constraint' dialog box in Excel Solver. The 'Cell Reference' field contains '\$B\$19:\$L\$19'. The 'Constraint' field has a dropdown menu set to 'bin' and a text box containing 'binary'. A red circle highlights the 'bin' dropdown and the 'binary' text box. A blue arrow points from the text 'Choose the binary decision variables here' to the 'Cell Reference' field. Another blue arrow points from the top of the dialog box to the 'bin' dropdown.

This is a shortcut for

- Integer
- ≥ 0
- ≤ 1

Choose the integer decision variables here



The 'Change Constraint' dialog box in Excel Solver. The 'Cell Reference' field contains '\$B\$19:\$L\$19'. The 'Constraint' field has a dropdown menu set to 'int' and a text box containing 'integer'. A red circle highlights the 'int' dropdown and the 'integer' text box. A blue arrow points from the text 'Choose the integer decision variables here' to the 'Cell Reference' field.

Solving the basic formulation in Excel

DECISIONS	A	B	C	D	E	F	G	H	I	J
Course	1.0	0.0	0.0	0.0	1.0	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	1	<=	3
Mon, Wed H4 classes	3	<=	3
Tue, Thr H4 classes	3	<=	3
Binary constraints			

Summary

Model	Optimal Utility	Optimal Course Selection
Basic	46	Bid on A, E, F, G, H, I, J

Many realistic constraints are easily represented using binary variables

- A and B cannot be taken together (overlapping material)
- Must take at least one of B or C (graduation requirement)

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Can you write down linear constraints to capture these relationships?