Formulating the Course Selection Problem
Constraints

Variables (binary) $y_A , y_B , \ldots , y_J \geq 0, \leq 1$ and <u>integral</u>

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

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)

	A	B	C	D	E	F	G	H	I	J
H3	✓	✓	✓	✓	✓		✓		✓	
H4	✓	✓	✓	✓		✓	✓	✓	✓	✓
Monday	✓	✓			✓		✓			✓
Tuesday			✓	✓		✓		✓	✓	
Wednesday	✓	✓			✓		✓			✓
Thursday			✓	✓		✓		✓	✓	
Friday										

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Credits (54 max credits) $12\ y_A + 9\ y_B + \ldots + 6\ y_J \leq 54$

(36 min credits) $12\ y_A + 9\ y_B + \ldots + 6\ y_J \geq 36$

Schedule

(MW H3 load)

(MW H4 load)

(TR H3 load)

(TR H4 load)

	A	B	C	D	E	F	G	H	I	J
H3	✓	✓	✓	✓	✓		✓		✓	
H4	✓	✓	✓	✓		✓	✓	✓	✓	✓
Monday	✓	✓			✓		✓			✓
Tuesday			✓	✓		✓		✓	✓	
Wednesday	✓	✓			✓		✓			✓
Thursday			✓	✓		✓		✓	✓	
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	(36 min credits)	$12\, y_A + 9\, y_B + \ldots + 6\, y_J \geq 36$
Schedule	(MW H3 load)	$y_A + y_B + y_E + y_G \leq 3$
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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: $y_A, y_B, \ldots, y_J$

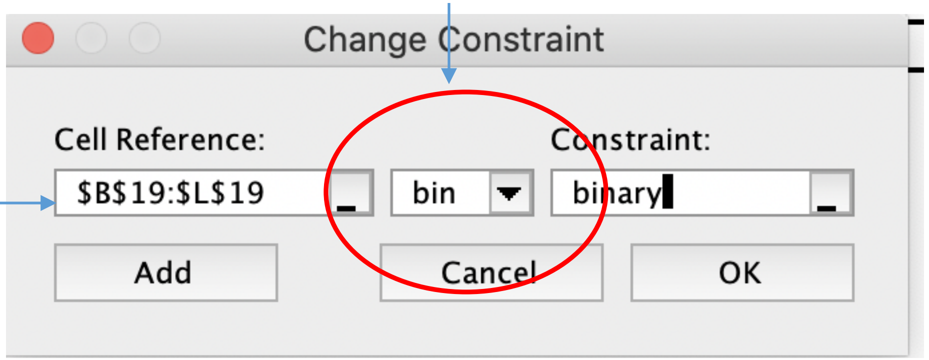
Subject To:

(binary)	$y_A, y_B, \ldots, y_J \geq 0, \leq 1$ and <u>integral</u>
(points budget)	$200\ y_A + 50\ y_B + \ldots + 100\ y_J \leq 1000$
(54 max credits)	$12\ y_A + 9\ y_B + \ldots + 6\ y_J \leq 54$
(36 min credits)	$12\ y_A + 9\ y_B + \ldots + 6\ y_J \geq 36$
(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 <u>binary</u>.

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

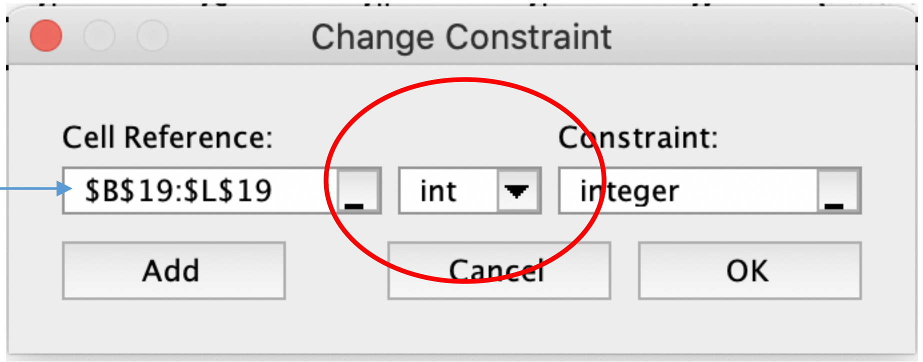
Choose the <u>binary</u> decision variables here



This is a shortcut for

- Integer
- >= 0
- <= 1

Choose the <u>integer</u> decision variables here



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

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?