Let’s write down the formulation

- Decision Variables
  - For each course (A, B, C, …, J), should you enroll or not enroll.
- Objectives
  - Maximize the utility of the courses that you do enroll in
- Constraints
  - Bids
  - Credits
  - Schedules

Formulating the Course Selection Problem

The Decision Variables

- Define *binary decision variables* for whether or not you bid/enroll in a course

$$y_A, y_B, \ldots, y_J$$

- For example:
  - $y_A = 1$ means you enroll in course A.
  - $y_A = 0$ means you do not enroll in course A.

- Note: In this simplified model, we assume that enrolling in a course is your core decision. You will simply bid the minimum number of points required to get a spot and assume you will get a spot for sure.

Formulating the Course Selection Problem

Objective Function

- **Variables:** whether or not you enroll in a course

$$y_A, y_B, \ldots, y_J \qquad = 0 \text{ or } 1$$

- **Objective:** Our goal is to maximize the utility of the courses we enroll in.

	A	B	C	D	E	F	G	H	I	J
Utility	10	2	4	2	5	4	8	7	6	6

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

- Is the objective function linear?

Formulating the Course Selection Problem

Objective Function

- **Variables:** whether or not you bid/enroll in a course

$$y_A, y_B, \ldots, y_J \qquad = 0 \text{ or } 1$$

- **Objective:** Our goal is to maximize the utility of the courses we bid/enroll in.

	A	B	C	D	E	F	G	H	I	J
Utility	10	2	4	2	5	4	8	7	6	6

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

- Is the objective function linear? Yes, it is a weighted sum of the binary variables.

Suppose you have a Solver that can optimize integer variables. How can you “force” it to solve for binary variables?

Integer variables + Constraints = Binary variables

$y_A , y_B , \dots , y_J$ integral

$y_A , y_B , \dots , y_J \geq 0$

$y_A , y_B , \dots , y_J \leq 1$

$y_A , y_B , \dots , y_J$ binary

Formulating the Course Bidding Problem

Constraints

Variables	(binary)	$y_A, y_B, \ldots, y_J \geq 0, \leq 1$ and integral
Bidding	(1000 points budget)	???
Credits	(54 max credits)	???
	(36 min credits)	???
Schedule	(MW H3 load)	???
	(MW H4 load)	???
	(TR H3 load)	???
	(TR H4 load)	???

In-class EXERCISE!

Dos and Donts when writing constraints

- You can use $\leq$, $\geq$ and =

$y_C + y_D + y_I \leq 3$ ✅

$y_C + y_D + y_I \geq 3$ ✅

$y_C + y_D + y_I = 3$ ✅

- You cannot use <, > or $\neq$

$y_C + y_D + y_I < 3$ ❌

$y_C + y_D + y_I > 3$ ❌

$y_C + y_D + y_I \neq 3$ ❌

Write down the constraints for the budget, credits and MW H3 load

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

Bidding (1000 points budget)

	A	B	C	D	E	F	G	H	I	J
Required Bid	200	50	150	400	50	0	150	50	180	100

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										