IEOR Course Scheduling

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Introduction

- Personal difficulties scheduling required courses and technical electives effectively
  - See if we can provide a better schedule
- Formulated 3 integer programs, each with increasing complexity
  - Deterministic Model
  - Stochastic Model
  - Stochastic Model with Professor Preferences

Deterministic Model

Find a feasible schedule as a baseline with fixed class sizes

No 2 classes can be in same room at the same time

No professor can teach 2 classes at same time

No class can be held in a room with capacity less than class size

minimize

$$\sum_i \sum_j \sum_k \sum_l x_{ijkl}$$

subject to

$$\sum_j \sum_k \sum_l x_{ijkl} = 1, \qquad \forall i$$

$$\sum_i \sum_j x_{ijkl} \leq 1, \qquad \forall k, l$$

$$\sum_i \sum_l x_{ijkl} \leq 1, \qquad \forall j, k$$

$$C_i x_{ijkl} \leq C_j x_{ijkl}$$

Stochastic Model

Since class size can be unpredictable, we decided to make class enrollment a Random Variable distributed as a Normal ~ (previous enrollment, 0.1previous enrollment) given past data

Since rescheduling affects students attempting to fulfill certain requirements which may now conflict, our first cost metric is class rescheduling

Objective is to minimize the expected cost (unit cost to reschedule a class), i.e. minimize sum(P(class *i* is going to be larger than assigned room capacity))

minimize

$$\sum_i \mathbf{E}[U_i]$$

subject to

$$\sum_j \sum_k \sum_l x_{ijkl} = 1, \qquad \forall i$$

$$\sum_i \sum_j x_{ijkl} \leq 1, \qquad \forall k, l$$

$$\sum_i \sum_l x_{ijkl} \leq 1, \qquad \forall j, k$$

$$E_i * x_{ijkl} \leq C_j x_{ijkl}$$

Stochastic Model with Professor Preferences

Wanted to see how taking into account professor preferences would impact the schedule we created

Now we are trying to minimize unit cost of rescheduling while maximizing professor preferences (Pikl)

minimize

$$\sum_i \mathbf{E}[U_i] - \sum_i \sum_k \sum_l P_{ikl} * x_{ijkl}$$

subject to

$$\sum_j \sum_k \sum_l x_{ijkl} = 1, \qquad \forall i$$

$$\sum_i \sum_j x_{ijkl} \leq 1, \qquad \forall k, l$$

$$\sum_i \sum_l x_{ijkl} \leq 1, \qquad \forall j, k$$

$$E_i * x_{ijkl} \leq C_j x_{ijkl}$$

Data

Grand total:	19 timeslots	79 classes	55 instructors		36 rooms	
	MW 8;40	ACCOUNTING & FINANCE	Agrawal, Shipra	BAR	304	
	MW 10;10	ALGORITHMIC TRADING	Avgar, Yair	FAY	310	313
	MW 11;40	APPLICATIONS PROGRAMMING FOR FE	Bienstock, Daniel	GDH	363	
	MW 1;10	APPLIED CONSULTING	Blanchet, Jose	HAM	303	517
	MW 225	APPLIED INTEGER PROGRAMMING	Blank, Steven	HAV	209	309
	MW 3;40	APPLIED SYSTEMS ENGINEERING	Bulkley-Logston, Pau	IAB	403	404
	TTR 8;40	ASSET ALLOCATION	Byrd, Julia	KNT	413	
	TTR10;10	BUSINESS ANALYTICS	Capponi, Agostino	MAT	203	207
	TR11;40	CLOUD COMPUTING	Choromanski, Krzys	MUD	227	233
	....	COMPUTATIONAL DISCRETE OPTIMIZATION	Dehnad, Khosrow	NWC	501	
		COMPUTATIONAL METHODS IN DERIVATIVES PRICIN	Derman, Emanuel	PUP	214	420
		CONTEMPORARY FINANCIAL SYSTEMS	DeRosa, David	SCEP	415	750
		CORPORATE FINANCE FOR ENGINEERS	Dieker, Antonius	SCH	501	614
		DATA ANALYTICS FOR OR	Effik, Anthony			
		DATA MINING	Elmachtoub, Adam			

Observations

Heuristics: More urgent classes implies larger class size

Constraints:

Two required classes at same time
Packing preferences (sparse vs dense) - classes not packed into sequential times
Teacher constraint -
"free time” / Outside constraints

Problems/ stuff:

Urgency Heuristic

- Schedule largest class first (most students means more inconvenience if rescheduled)
- Take professor's preferences into account
  - If Largest room unavailable at time, go to second preference of time, and so on until out of time slots that do not break other constraints
  - If largest room is booked fully, start scheduling in second largest room, etc
  - Do so until all classes are scheduled

Heuristic solution (Professor time preference)

ROOM			TIME							
	M840	T840	M1010	T1010	M1140	T1140	M110	T110	M240	T240
309 Havemeyer	IEORE4150	IEORE4500	IEORE4404	IEOR4525	IEORE3608	-	IEORE3658	IEORE4004		IEORE4106s1
	M410	T410	M540	T540	M7	T7	W7	TH7	F 1010	
		IEORE4570		IEORE3404	IEORE4726	IEORE4510 S1	IEORE4106 S2	IEORE470	IEORE2261	
501 NorthwestCorner Building	M840	T840	M1010	T1010	M1140	T1140	M110	T110	M240	T240
	-	IEORE4403	IEORE3402			IEORE4102	IEORE4578	IEORE4700		IEORE4701
	M410	T410	M540	T540	M7	T7	W7	TH7	F 1010	
	IEORE4003		IEORE4709	IEORE4703	IEORE4706		IEORE4735 S1	IEORE400	IEORE3106	

Heuristic solution (time preference/blocked classes)

ROOM	TIME									
	M840	T840	M1010	T1010	M1140	T1140	M110	T110	M240	T240
309 Havemeyer	IEORE4150	IEORE4500	X	X	IEORE3608	X	IEORE3658	IEORE4004	X	X
	M410	T410	M540	T540	M7	T7	W7	TH7	F 1010	
		IEORE4570		IEORE3404	IEORE4726	IEORE4510 S1	X	IEORE4707	IEORE2261	
501 NorthwestCorner Building	M840	T840	M1010	T1010	M1140	T1140	M110	T110	M240	T240
	-	IEORE4403	IEORE4404	IEOR4525	X	IEORE4102	IEORE4578	IEORE4700		IEORE4106s1
	M410	T410	M540	T540	M7	T7	W7	TH7	F 1010	
	IEORE4003		IEORE4709	IEORE4703	IEORE4706		IEORE4106 S2	IEORE4007	IEORE3106	
207 Mathematics	M840	T840	M1010	T1010	M1140	T1140	M110	T110	M240	T240
	X	-	IEORE3402	-	IEORE4706 S2	IEORE4102	X	-	-	IEORE4701
	M410	T410	M540	T540	M7	T7	W7	TH7	F 1010	
	X			X			IEORE4735 S1	X	X	

Further Suggestions

Implement further quality criteria in addition to professor preferences, such as:

Event hours - Maximize total number of events assigned to every room

Seated student hours - Maximize total hours spent by students in a classroom, i.e. weigh events by number of students

Seat utilization - Maximize the ratio of the number of students to the number of available seats

Room preferences - Maximize total course-to-room preference (similar to professor preferences)

Equipment preferences - Maximize classes to rooms with desired equipment (ex. projectors, white board)

Course room stability - Minimize total number of different rooms

Spare seat robustness - Maximizing robustness in the case for extra enrollment than expected