Handout

Discrete Optimization II

15.060: Data, Models, and Decisions

2007

Sloan Course Schedule

- You would like to determine your optimal course schedule for your first two terms at MIT.
- You have created a list of the 20 courses that most interest you, with interest levels from 3 to 5, and you want to maximize your total interest level.

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Considerations

- You can only take a class if you have completed or are currently taking all the courses that are pre-requisite for a particular course.
- In the Fall Semester, you must take at least 3 of the following courses: DMD, Micro-Economics, Finance Theory, Accounting, Business Communication.
- If you take Financial Engineering you can't take Options and Futures because the two courses overlap.
- You want to take at least one course in Marketing and at least one in Operations Management.
- You can't take the same class twice.

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The Data

Course Number	Course Title	Semester Offered	Course Prerequistes	Interest Level
1	DMD	Fall		5
2	Micro-Economics	Fall		5
3	Finance Theory	Fall and Spring		4
4	Strategy I	Fall		4
5	Strategy II	Spring	4	4
6	Accounting I	Fall		3
7	Accounting II	Spring	2, 6	3
8	Finacial Engineering	Spring	1, 3	5
9	Statistics	Spring	1	4
10	Operations Management I	Fall		4
11	Operations Management II	Spring	1, 10	4
12	Marketing I	Fall		3
13	Marketing II	Spring	9, 12	3
14	Options and Futures	Spring	3	5
15	Information Technology I	Fall		4
16	Information Technology II	Spring	15	4
17	Entrepreneurship	Spring	4	4
18	New Product Development	Spring	10,12,17	3
19	Organizational Processes	Fall	4	3
20	Business Communications	Fall		5

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Formulating the problem

- Let $F_1, \ldots, F_{20}$ be binary variables indicating whether or not you take any of the 20 courses during the fall term.
- Similarly, let $S_1, \ldots, S_{20}$ be binary variables indicating whether or not you take any of the 20 courses during the spring term
- Let $OF_1, \ldots, OF_{20}$ and $OS_1, .., OS_{20}$ be binary constants indicating whether each of the classes is offered in the fall and spring terms, respectively
- Finally, let $I_1, .., I_{20}$ be the interest level you assigned to each of the 20 courses

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- Objective: maximize total interest

  Max $I_1(F_1 + S_1) + \ldots + I_{20}(F_{20} + S_{20})$
- Constraints:
  - Cannot take a course twice: $F_1 + S_1 \leq 1, \ldots, F_{20} + S_{20} \leq 1$
  - Fall course offering: $F_1 \leq OF_1, \ldots, F_{20} \leq OF_{20}$
  - Spring course offering: $S_1 \leq OS_1, \ldots, S_{20} \leq OS_{20}$
  - Fall term maximum: $F_1 + \ldots + F_{20} \leq 5$
  - Spring term maximum: $S_1 + \ldots + S_{20} \leq 5$

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Constraints (cont.)

- Fall term requirement: $F1 + F2 + F3 + F6 + F20 \geq 3$
- Financial or Options: $S14 + S8 \leq 1$
- Marketing: $F12 + S13 \geq 1$
- O.M.: $F10 + S11 \geq 1$
- Binary: $F1, \ldots, F20, S1, \ldots, S20 = 0 \text{ or } 1$

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Constraints (cont.)

- Prerequisites course 5: $S_5 \leq F_4$
- Prerequisites course 7: $S_7 \leq F_2$, $S_7 \leq F_6$
- Prerequisites course 8: $S_8 \leq F_1$, $S_8 \leq F_3 + S_3$
- Prerequisites course 9: $S_9 \leq F_1$
- Prerequisites course 11: $S_{11} \leq F_1$, $S_{11} \leq F_{10}$
- Prerequisites course 13: $S_{13} \leq S_9$, $S_{13} \leq F_{12}$
- Prerequisites course 14: $S_{14} \leq F_3 + S_3$
- Prerequisites course 16: $S_{16} \leq F_{15}$
- Prerequisites course 17: $S_{17} \leq F_4$
- Prerequisites course 18: $S_{18} \leq F_{10}$, $S_{18} \leq F_{12}$, $S_{18} \leq S_{17}$
- Prerequisites course 19: $F_{19} \leq F_4$

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The Solution

- The optimal courses to take are DMD, MicroEco, OM I, Marketing I, and Business Comm in the fall and Finance Theory, Stats, OM II, Marketing II, and Options and Futures during the spring

Course	Value		Course	Value
F1	1		S1	0
F2	1		S2	0
F3	0		S3	1
F4	0		S4	0
F5	0		S5	0
F6	0		S6	0
F7	0		S7	0
F8	0		S8	1
F9	0		S9	1
F10	1		S10	0
F11	0		S11	1
F12	1		S12	0
F13	0		S13	1
F14	0		S14	0
F15	0		S15	0
F16	0		S16	0
F17	0		S17	0
F18	0		S18	0
F19	0		S19	0
F20	1		S20	0

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