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Weeks 12 and 13

Recall Exam Study Scheduling

- You have to devise an exam study schedule.
  - There are D study days of H (even) hours each before the exam; each day split into equal AM & PM halves
  - There are n topics to study, each with a required number of hours
  - Some topics must be finished before others can start
  - On days in HALF, the last H div 2 hours are not available (topic must be finished before)
  - Some topics must be started first thing in the morning (when you are freshest)
  - Devise a schedule that starts as late as possible

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Exam Study Scheduling Data

```
int: n;
set of int: TOPIC = 1..n;
array[TOPIC] of int: hours;
int: m;                  % number of precedence pairs
set of int: PREC = 1..m;
array[PREC] of TOPIC: before;
array[PREC] of TOPIC: after;
set of TOPIC: morning;
int: D;
int: H;
set of int: DAY = 1..D;
set of DAY: HALF;
```

Exam Study Scheduling Data

- Example data

```
n = 10;
hours = [2,5,4,3,6,4,5,4,3,4];
m = 4;
before = [1,1,4,7];
after  = [2,3,5,9];
morning = {4,6,8};
D = 10;
H = 8;
HALF = {3,4,7,9};
```

Find the Best Search Strategy

- Only using start times
  - can you beat the default search!?
- Use Gist and the small data file: examsmall.dzn
  - On details on how to use Gist, read “Modeling and Programming with Gecode”, which is available online

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Let's look at Survey 11

Simplex Form

- A linear optimization problem *(C, f)* is in *simplex form*:
  - *C* is the conjunction of *CE* and *CI*
  - *CE* is a conjunction of linear equations
  - *CI* constrains all variables in *C* to be non-negative
  - *f* is a linear expression over variables in *C*

Transforming to Simplex Form

- An arbitrary problem can be put in simplex form by replacing
  - unconstrained var X by new vars and $X^+ - X^-$
  - inequality $e \leq r$ by new slack vars and $e + s = r$

Simplex Form Exercise

- Turn the following problem into Simplex Form

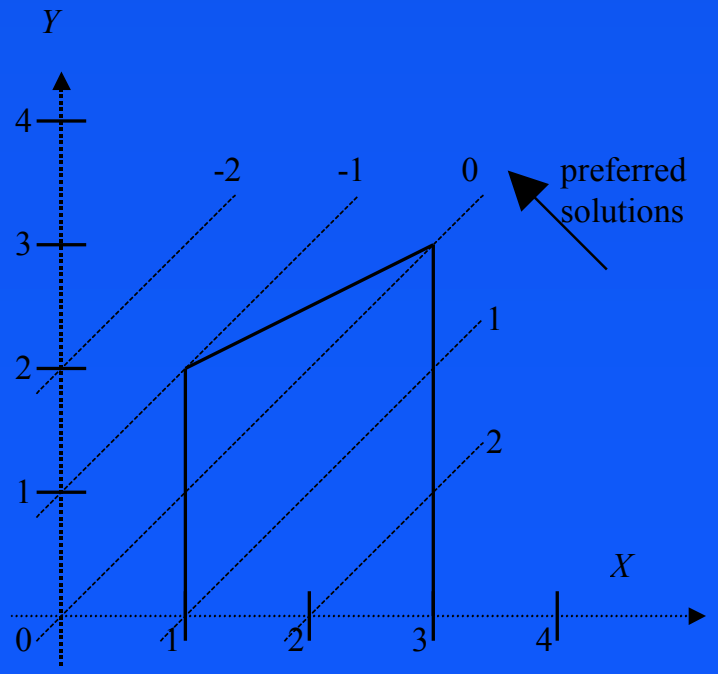
$$\min X - Y \text{ subj to}$$

$$Y \geq 0$$

$$X \geq 1$$

$$X \leq 3$$

$$2Y \leq X + 3$$



Equivalent Simplex Form

$$\max\ Y - X \text{ subj to}$$

$$\begin{aligned} X \qquad\qquad - S_2 \qquad\quad &= 1 \\ X \qquad\qquad\quad + S_3 \quad &= 3 \\ -X + 2Y + S_1 \qquad\quad &= 3 \end{aligned}$$

$$X \geq 0,\ Y \geq 0,\ S_1 \geq 0,\ S_2 \geq 0,\ S_3 \geq 0$$

Equivalent Simplex Form

$$\max\ Y - X \text{ subj to}$$

$$\begin{aligned} X \qquad\qquad - S_2 \qquad\quad &= 1 \\ X \qquad\qquad\qquad + S_3 \ &= 3 \\ -X + 2Y + S_1 \qquad\quad &= 3 \end{aligned}$$

$$X \geq 0,\ Y \geq 0,\ S_1 \geq 0,\ S_2 \geq 0,\ S_3 \geq 0$$

- Find the initial basic feasible solved form!

Simplex in Action

- Initial BFSF: circle

  max $0–0.5S_1+0.5S_3$ subj to

  $Y = 3 - 0.5S_1 - 0.5S_3$

  $S_2 = 2 - S_3$

  $X = 3 - S_3$

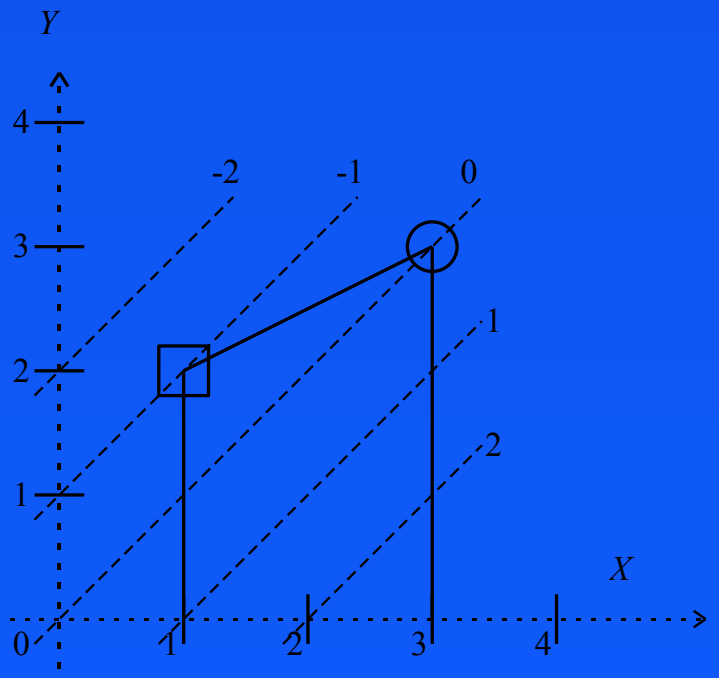
- Choose S_3, pivot using 2nd eqt

  max $1–0.5S_1–0.5S_2$ subj to

  $Y = 2 - 0.5S_1 + 0.5S_2$

  $S_3 = 2 - S_2$

  $X = 1 + S_2$



Optimal solution: box

Gomory Cut

- Compute the Gomory Cut of the following equations
  - 3 X1 + 1 1/4 X2 + 1/3 X3 = 2 2/3
  - 3 X1 – 1 1/4 X2 + 1/3 X3 = 8/3
  - X1 – 1.25 X2 + 0.25 X3 = -3.75

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Let's look at Survey 12

Local Search

- Neighbourhood and moves
- Gradient/Steepest Descent
- Escaping/Avoiding Local Minima
- Representing constraints as penalty functions
- Large Neighbourhood Search
  - Remember to couple with Restart
- Can be problem specific!