Examination Timetabling Problem

Course of Discrete Optimization

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Definition of the Problem

Problem

- Exams, E = {e1, e2, …, en}
- Students, S = {s1, s2, …, sm}
- Time slots, Tj = {t1 <= t2 <= … <= tT} (ordered)
- Ne1,e2 = number of common student between two exams

Problem

- each exam is scheduled exactly once during the examination period;
- two conflicting exams are not scheduled in the same time-slot;
- the total penalty resulting from the created timetable is minimized

Problem

A penalty is assigned for each pair of conflicting exams scheduled up to a distance of 5 time-slots.

Given two exams e1,e2 scheduled at distance i of time-slots, with $1 \leq i \leq 5$, the relative penalty is $2(5-i) \cdot \frac{n_{e_1,e_2}}{|S|}$.

Definition of the Basic Model

Data

- exams=[] , list of exams
- Time_slots, list of time slots from 1 to T (ordered)
- enrollment=dict(), dict where students are keys and the list of the exams they belong is the value
- Conflicting exams={} dict where for each pair of conflicting exams we store the number of conflicts (n(e1,e2))

Variables and Constraints

$x_{t,e} \in \{0, 1\}$, binary variable declaring if exam e is scheduled in time slot t

$$x = \begin{cases} 1, & \text{if exam e is scheduled in t} \\ 0, & \text{otherwise} \end{cases}$$

Variables and Constraints

1. Each exam is scheduled exactly once during the examination period.

$$\sum_{j=1}^{T} x_{t_j,e} = 1, \forall e \in E$$

2. Two conflicting exams are not scheduled in the same time-slot

$$x_{t,e_1} + x_{t,e_2} \leq 1, \forall t \in T_j, \forall (e_1, e_2) \in \text{conflicting\_exams}$$

Variables and Constraints

1. $a[distance, time\_slot, exam_1, exam_2] \in \{0, 1\}$, binary variable for scheduling $exam_1$ before $exam_2$
2. $b[distance, time\_slot, exam_1, exam_2] \in \{0, 1\}$, binary variable for scheduling $exam_2$ before $exam_1$

1. $a[i, t, exam_1, exam_2] >= x[t, exam_1] + x[t+i, exam_2] - 1$ exam 2 is scheduled after exam 1
2. $b[i, t, exam_1, exam_2] >= x[t+i, exam_1] + x[t, exam2] - 1$ exam 1 is scheduled after exam 2

Variables and Constraints

$p[i, t, exam_1, exam_2] = sum(a[i, t, e1, e2] + b[i, t, e1, e2])$ for t in range(1, $len(time_slots)$ - i + 1 exam 2 is scheduled after exam 1

Finally, the objective function:

$$\min \sum_{e_1, e_2 \in \text{conflicting\_exams}} p_{e_1, e_2}$$

Results

Results

instance	penalty value
Test	3.375
instance 01	162.585
instance 02	53.359