

Parental Consultation Scheduling

Course 42133

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Presentation

- Industrial PhD students at DTU Management and MaCom A/S
- MaCom is a small Danish company based in Copenhagen. Primary product is Lectio:
 - A cloud-based high school administration software system
 - Mainly provides daily schedule for students and teachers, as well as handling assignment hand-ins, messaging system, and a big number of administrative tasks.
 - Used by approx. 75% of all Danish high schools
 - A total of around 100.000 users
 - About 25 million page views every week
- Both PhDs aim at developing scheduling-algorithms for Lectio. Timetabling, elective course planning, consultation planning, etc.

Parental Consultation Scheduling

Introduction

Once or twice a year the high schools invite students and their parents to participate in consultations between them and the teachers of the given student.

The goal of these meetings is to allow the teachers to inform the parents of the students educational progression. Each student (in collaboration with his parents) makes prioritized requests for teachers he would like to meet for a consultation.

The problem from a operational point of view is to allocate the requests to a schedule such that as many requests as possible are granted, and such that the schedule for each individual is acceptable.

Motivation

From the high schools point of view the PCSP is important because:

- Make best use of resources
- Contentment of the students and teachers
- Address issues between the student and the teacher, which leads to a better teaching environment

Theoretical point of view:

- Not a well-researched problem
- The problem is \mathcal{NP} -hard and contains a lot of symmetry
- The problem is multi-objective
- The proposed IP-model is non-linear.

Description

- Prioritized consultation requests of the students are given

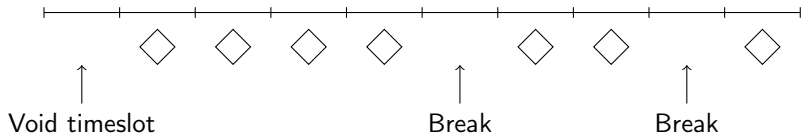
The problem is multi objective.

- Maximize the number of consultation requests granted
- Minimize the number of undesirable breaks for students and teachers

Limitations:

- A student cannot have two contiguous consultations
- A student or teacher can only attend a consultation if he/she is not occupied by other activities, e.g. meetings

Timeslots teacher



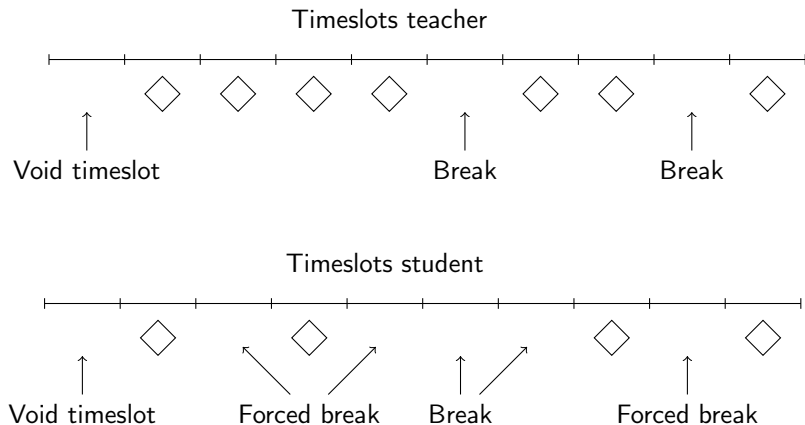


Figure: Example of a feasible consultation schedule, for a high school

The screenshot shows a Windows Internet Explorer browser window. The title bar reads "Beregning konsultation - Lectio - [redacted] - Windows Internet Explorer". The address bar shows the URL "https://[redacted].lectio.dk/lectio/[redacted]". The browser's Favorites bar contains "Beregning konsultation - Lectio - Birkerød Gymnasiu...". The page content includes a navigation menu with "Hovedmenu", "Stamdata", "Bogdepot", "Log ud", "Kontakt", and "Hjælp". The main heading is "Beregning konsultation". Below it is a form titled "Parametre for beregning" with the following options:

- Beregn
- Eftertilmeld

Tidsfordeling:

- Start
- Midt
- Slut

Optimeret efter:

Lærer Elev

At the bottom of the form, there are two buttons: "Beregning" (highlighted with a red box) and "Annuller".

Elev	18:30	18:40	18:50	19:00	19:10	19:20	19:30	19:40	19:50	20:00	20:10	20:20	20:30	20:40	20:50	21:00	21:10	21:20	1.	2.	3.
[REDACTED]																					
[REDACTED]							MJ		CE		ES		BT						MJ	ES	BT
[REDACTED]																					
[REDACTED]									OJ		AJ		LF		EN		MB		LF	OJ	AJ
[REDACTED]																					
[REDACTED]													TP		LF		TU	MS	TP	TU	LF
[REDACTED]					LP		MB		HF		TI		MK						MB	TI	MK
[REDACTED]											BK		HL		AJ		GM		HL	MK	GM
[REDACTED]								SS		HM		KB							SS	HM	KB
[REDACTED]																					

Lærer	18:30	18:40	18:50	19:00	19:10	19:20	19:30	19:40	19:50	20:00	20:10	20:20	20:30	20:40	20:50	21:00	21:10	21:20
TM																		
TP				1m 20	1m 08	1m 27	1m 18	1m 04	1m 30	1m 03	1m 14	1t 11	1m 02	1m 11	1m 05	1m 19		1m 12
TS			2u 62	1x 05	2u 72	2u 08						2u 01		2u 17				
TU								1m 20								1t 11		
VE				1x 22	1x 20	1x 16		1x 13	1x 09	1x 06	1d 02	1x 31	1x 01		1x 07	1x 04		
VI																		
ØZ													1a 16	1k 22				
AA				2u 62	2u 07			2u 09	2u 66			2u 08	2u 90					
MS	1m 27	1m 13		1m 16	1m 18	1m 20	1m 30	1m 03	1m 02	1m 12	1m 05	1m 04		1m 19	1m 14	1m 11	1t 11	

Modeling the PCSP

B	Blocks
S	Students
T	Teachers
$R_t^s \in \{0, 1\}$	Takes value 1 if student s has requested teacher t
$E_b^s \in \{0, 1\}$	Takes value 1 if student s is available in block b
$D_{t,b} \in \{0, 1\}$	Takes value 1 if teacher t is available in block b
$\alpha_t^s \in \mathbb{R}_+$	The profit of granting a request of student s for teacher t
$\beta_t \in \mathbb{R}_+$	The cost of a undesirable break for teacher t
$\gamma^s \in \mathbb{R}_+$	The cost of a undesirable break for student s
$x_{t,b}^s \in \{0, 1\}$	Takes value 1 if student s is given a consultation with teacher t in block b

Modeling the PCSP

The following nonlinear function defines the number of undesirable breaks for a teacher t . $n_t = \sum_{b,s} x_{t,b}^s$.

$$W^t = \begin{cases} 0 & n_t < 2 \\ \Delta(\mathfrak{B}_t^{\text{first}}, \mathfrak{B}_t^{\text{last}}) + 1 - n_t & n_t \geq 2 \end{cases} \quad (1)$$

where $\Delta(\mathfrak{B}_t^{\text{first}}, \mathfrak{B}_t^{\text{last}})$ is the absolute distance between the teachers first and last consultation. E.g. $\Delta(b_2, b_5) = 3$. The decision whether a student has an undesirable break is somewhat analogue.

$$Z^s = \begin{cases} 0 & n_s < 2 \\ \Delta(\mathfrak{B}_s^{\text{first}}, \mathfrak{B}_s^{\text{last}}) + 2 - 2 \cdot n_s & n_s \geq 2 \end{cases} \quad (2)$$

IP Model for Parental Consultation Scheduling

Parental Consultation Scheduling IP Model (3)

$$\begin{aligned}
 \max \quad & \sum_{t,b,s} \alpha_t^s \cdot x_{t,b}^s - \sum_t \beta_t \cdot \mathcal{W}_t - \sum_s \gamma^s \cdot \mathcal{Z}^s \\
 \text{s.t.} \quad & \sum_b x_{t,b}^s \leq R_t^s \quad \forall t, s \\
 & \sum_t x_{t,b}^s \leq E_b^s \quad \forall b, s \\
 & \sum_t x_{t,b}^s \leq D_{t,b} \quad \forall t, b \\
 & \sum_s (x_{t,b}^s + x_{t,b+1}^s) \leq 1 \quad \forall s, b \in B \setminus \{b_{|B|}\} \\
 & x_{t,b}^s \in \{0, 1\}
 \end{aligned}$$

Input

10 datasets are given, each representing a real-life instance taken directly from the Lectio-database. A dataset consists of several .csv files.

Filename	Symbol	Line-format	Example
basic.csv	$ S , T , B $	Students: S	Teachers:156
requests.csv	R_t^s, α_t^s	[Student];[Teacher];[Weight: α_t^s]	s17;t2;2.4
teachbreaks.csv	β_t	[Teacher];[Weight: β_t]	t0;0.8
studbreaks.csv	γ^s	[Student];[Weight: γ^s]	s328;0.6
teachavail.csv	$D_{t,b}$	[Teacher];[Block]	t6;b15
studavail.csv	E_b^s	[Student];[Block]	s17;b2

Table: Files in a dataset

Output

We provide `pcsp.exe` which is able to determine feasibility and objective value. The solution format is a textfile representation of $x_{t,b}^s$, specified by the line-format `[Student];[Teacher];[Block]`. E.g.:

```
s4;t55;b2  
s18;t14;b15  
...
```

`pcsp.exe` takes the solution textfile and dataset location as input:

```
pcsp [SolutionFile] [DatasetDirectory]
```

You are the first users of this program, so please be gentle...

PCSP

```
-Parental Consultation Solution Verification-
```

```
Simon Kristian <sikr@man.dtu.dk> and Matias Sorensen <msso@man.dtu.dk>  
DTU Management
```

```
For use in course 42133 Optimization Using Metaheuristics
```

```
v1.0 7/3-2011 - initial release
```

```
Solution is feasible!
```

```
Objective: 663,6999999999999
```

```
-
```

The Competition

For this project you have the opportunity to compete with your fellow students. In the final phase of the project you can submit your code and a winner will be determined based entirely on performance.

- It is completely voluntarily if you want to participate in the competition!
- Your performance in the competition will not affect your grade!

Requirements:

- Your code is written in C#.

Final test layout:

- All entries for the competition are run on the same computer.
- Winner is determined based on a number of new datasets.

Thomas has a special price for the winner!

Why should you choose this project?

- You will be among the first in the world to research on this problem!
- The mathematical model is given
- A tool for solution verification is given
- The opportunity to work with real-life data from a Danish company
- Thomas' price...