

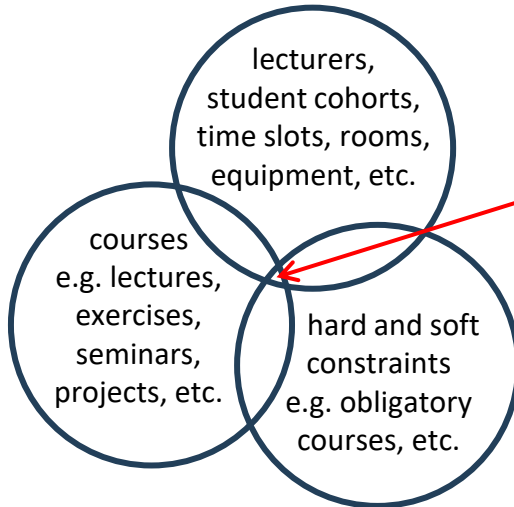
AI-Based Tool for Curriculum-Based Course Timetabling at the University of Potsdam



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Motivation

What is a Curriculum-Based Course Timetabling (CB-CTT) problem?



Goal: seeking for a conflict-free timetable for teaching from the beginning, instead of resolving conflicts on demand

Motivation

Traditional approach at UP (Faculty of Science)

- Coordinate/schedule obligatory lectures/courses for large lecture halls (on faculty level)
 - Involves a lot of human efforts, agreements and time
 - May contain/cause redundancies
 - May result in suboptimal timetables and/or conflicts
- Plan other courses after obligatory lectures/courses are set (on institutes level)
 - May ignore needs of players of other institutes/faculties
 - May run into conflicts at a later stage

AI-Based Approach

- Represent hard and soft constraints by a logic program
 - Using Answer Set Programming (ASP)
 - Human readable and elaboration tolerant
 - Get solutions by state-of-the-art solvers like *clingo*

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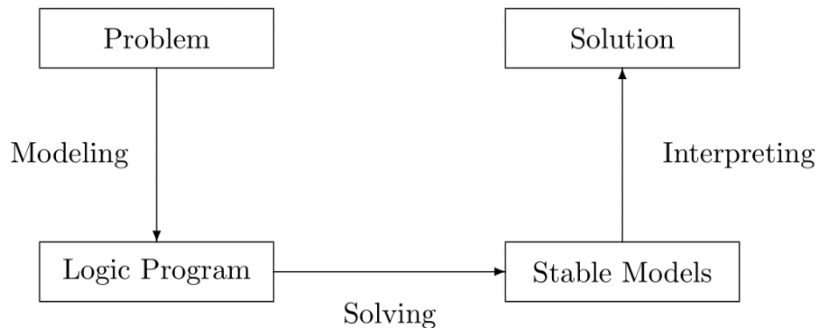


Figure 3: Schematic representation of declarative problem solving process.

AI-Based Approach

- Represent hard and soft constraints by a logic program
 - Using Answer Set Programming (ASP)
 - Human readable and elaboration tolerant
 - Get solutions by state-of-the-art solvers like *clingo*
- Develop a web interface
 - Minimizing communication among planners and lecturers
 - Reduce (some) redundancies of creating a course, linking to modules and booking a room

Prototypical Web Interface (1)

Veranstaltung erstellen

Veranstaltungsname *

Wie ist der Name der Veranstaltung (Bsp: Elementargeometrie)?

Semester *

WiSe

SoSe

In welchem Semester findet diese Veranstaltung statt?
Mehrfachauswahl möglich.

Modulkürzel

Geben Sie das Modulkürzel für die Veranstaltung ein (Bsp: MAT-LS-1) - optional

Planer/*in *

Wählen Sie hier »Schellhorn« aus, wenn Sie eine eigene Veranstaltung anlegen.

Falls Sie stellvertretend eine Veranstaltung anlegen, wählen Sie hier den/die Planer/-in

Prototypical Web Interface (2)

KURS BZW. KURSKOMPONENTE

Typ *

v
v

v = Vorlesung | v1, v2 = Verbund
 s = Seminar | s1, s2 = Verbund
 u = Übung | u1, u2 = Verbund
 p = Praktikum

Gewünschte Raum-Kapazität

100

Wie viele TN werden erwartet?

Große Tafel

Nein
v

Wird eine große Kreidetafel benötigt?

RÄUME UND ZEITEN *

RAUM

+	<input checked="" type="checkbox"/> 2.25.F0.01 150 Hörsaal gr. Tafel: Ja
+	<input checked="" type="checkbox"/> 2.25.F1.01 100 Hörsaal gr. Tafel: Ja
+	<input checked="" type="checkbox"/> 2.28.0.108 99 Hörsaal gr. Tafel: Ja

Eintrag hinzufügen

ZEITEN UND PRIORITÄT

<p>Tag</p> <p><input type="checkbox"/> Montag</p> <p><input type="checkbox"/> Dienstag</p> <p><input type="checkbox"/> Mittwoch</p> <p><input type="checkbox"/> Donnerstag</p> <p><input checked="" type="checkbox"/> Freitag</p>	<p>Zeit</p> <p><input type="checkbox"/> 08:00 - 10:00</p> <p><input type="checkbox"/> 10:00 - 12:00</p> <p><input checked="" type="checkbox"/> 12:00 - 14:00</p> <p><input checked="" type="checkbox"/> 14:00 - 16:00</p> <p><input type="checkbox"/> 16:00 - 18:00</p> <p><input type="checkbox"/> 18:00 - 20:00</p>	<p>Priorität</p> <p><input type="radio"/> n. v.</p> <p><input checked="" type="radio"/> 1</p> <p><input type="radio"/> 2</p> <p><input type="radio"/> 3</p> <p><input type="radio"/> 4</p>	<div style="border: 1px solid #ccc; border-radius: 10px; padding: 2px 10px; background-color: #eee; display: inline-block;">Dieses Zeitfenster entfernen</div>
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<p>Tag</p> <p><input type="checkbox"/> Montag</p> <p><input type="checkbox"/> Dienstag</p> <p><input type="checkbox"/> Mittwoch</p> <p><input type="checkbox"/> Donnerstag</p> <p><input checked="" type="checkbox"/> Freitag</p>	<p>Zeit</p> <p><input type="checkbox"/> 08:00 - 10:00</p> <p><input type="checkbox"/> 10:00 - 12:00</p> <p><input type="checkbox"/> 12:00 - 14:00</p> <p><input type="checkbox"/> 14:00 - 16:00</p> <p><input checked="" type="checkbox"/> 16:00 - 18:00</p> <p><input type="checkbox"/> 18:00 - 20:00</p>	<p>Priorität</p> <p><input type="radio"/> n. v.</p> <p><input type="radio"/> 1</p> <p><input checked="" type="radio"/> 2</p> <p><input type="radio"/> 3</p> <p><input type="radio"/> 4</p>	<div style="border: 1px solid #ccc; border-radius: 10px; padding: 2px 10px; background-color: #eee; display: inline-block;">Dieses Zeitfenster entfernen</div>
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Prototypical Web Interface (3)

Relating courses

- Not parallel
- Parallel
- Simultaneous
- Consecutive

NICHT PARALLELE VERANSTALTUNGSPLANUNG

PARALLELE VERANSTALTUNGSPLANUNG AUSSCHLIESSEN

Distributed Systems-546-Schellhorn

Typ

V

Modeled Hard Constraints

- H0. No course component can take place in parallel to its lecture.
- H1. Each course must be scheduled.
- H2. Obligatory lectures of a cohort must be scheduled in different time slots.
- H3. Two courses cannot take place in the same room and time slot.
- H4. A lecturer cannot be scheduled in parallel.
- H5-8. Respect relations parallel, not parallel, simultaneous and consecutive.

Logic representation of H1.

$1 \{ \text{book}(\text{ID}, \text{Course}) : \text{availability_course}(\text{ID}, \text{Course}) \} 1 \text{ :- course}(\text{Course}).$

Modeled Soft Constraints

- S0. Try to serve prioritized availability.
- S1. Try to fit students that are expected to attend into a selected room.
- S2. Courses of a cohort should be scheduled in different time slots.
- S3. Reduce gaps of courses regarding cohorts and lecturers.
- S4. Try to schedule consecutive courses into the same room.
- S5. Cohorts and lecturers should not exceed 4 courses per day.
- S6. Reduce travel time for cohorts and lecturers.
- S7-13. Try to satisfy particular equipment (e.g. large board, etc.).

Output

```
Optimization: 34 1 292
Answer: 92
```

```
Optimization: 34 0 291
OPTIMUM FOUND
```

```
Models      : 92
  Optimum   : yes
Optimization : 34 0 291
Calls       : 1
Time        : 170.129s (Solving: 169.69s 1st Model: 0.02s Unsat: 154.04s)
CPU Time    : 0.000s
```

snapshot 166 Veranstaltungen geplant

y-scaling

	Montag	Dienstag	Mittwoch	Donnerstag	Freitag
08:00 Uhr	(v1) Aufbauomodul Stochastik... 2.14.0.47 (Dohrmann)	(v1) Allgemeine und Anorgan... 2.27.1.01 (Eidner)	(v2) Aufbauomodul Stochastik... 2.12.0.01 (Dohrmann)	(u) Bioinformatik 2.70.0.01 (Meyer)	(v) Bioinformatik 2.27.0.01 (Meyer)
2.05.F.06	(v) Bioanorganische Chemie... 2.25.F1.01 (Eidner)	(v) Aufbauomodul Computerma... 2.14.0.47 (Dohrmann)	(v2) ExpPhys III 2.27.0.01 (Cherstvy)	(v1) BM LAAG I 2.27.0.01 (Braunss)	(v2) BM LAAG I 2.25.F1.01 (Braunss)
2.12.0.01	(v1) Lineare Algebra und An... 2.27.0.01 (Dohrmann)	(v) Bioinformatik biologis... 2.70.0.10 (Meyer)	(v) Mikrobiologie 2.27.1.01 (Meyer)	(v) Kolloidchemie I Teil 2... 2.25.F0.01 (Eidner)	(v) Chemie für Biologie-Le... 2.27.1.01 (Eidner)
2.14.0.47	(v1) Maschinenmodelle 2.27.1.01 (Schellhorn)	(v) Festkörperchemie und A... 2.25.F1.01 (Eidner)	(v1) Molecular Biotechnolog... 2.25.F0.01 (Meyer)	(v1) Math Meth 2.25.F1.01 (Cherstvy)	(v) Introduction to databa... 2.70.0.01 (Meyer)
2.25.F0.01	(v1) Mathe III Phys 2.28.0.108 (Cherstvy)	(v2) Mathe III Phys 2.28.0.108 (Cherstvy)	(v1) Praktikum chemische Sc... 2.25.F1.01 (Eidner)	(v2) Ökologie I 2.12.0.01 (Meyer)	(v) Mathematik für Informa... 2.25.F0.01 (Schellhorn)
2.25.F1.01		(v) Moderne Themen 2.27.0.01 (Cherstvy)	(v2) Statistical Data Analy... 2.28.0.108 (Braunss)	(v1) Vorlesung Anorganische... 2.27.1.01 (Eidner)	(v) Mathe 1 für BIWERN 2.12.0.01 (Braunss)
2.27.0.01		(v2) Organische Chemie 2.25.F0.01 (Eidner)			(v2) TheoPhys QM II 2.28.0.108 (Cherstvy)
2.27.1.01		(v) Versorgungsforschung 2.12.0.01 (Kühne)			
2.28.0.108					
2.70.0.01					

Results and Future Work

- Optimal and conflict-free timetable in a couple of seconds
- Fair, transparent and elaboration tolerant approach
- Reduces involved time, human efforts and communication overhead

- Involve more data
 - Implement interfaces to access data
 - Reuse previous course catalogues and availabilities
 - Previous linked modules
- Implement conflict handling
- Automated integration of resulting timetable to course catalogue

Questions?

- Is this idea new?
 - No
- Why not using existing approaches then?
 - Elaboration tolerance and flexible
 - Human readable modeling language
 - Easy to handle
 - Addresses particular needs (of UP)
 - (free) state-of-the-art solver

More questions?

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