

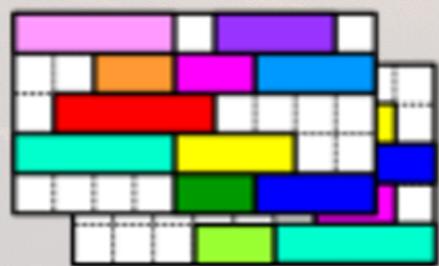
# OPEN APEREO

# 2019

The Higher Education Open-Source Conference

Los Angeles, CA June 2-6

Photo by Bart Jaillet on Unsplash

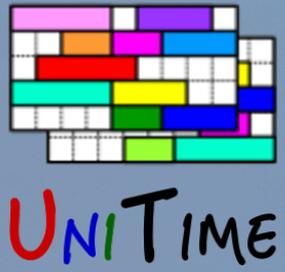


UNI<sup>T</sup>IME

## Introducing UniTime

Zuzana Müllerová, Tomáš Müller





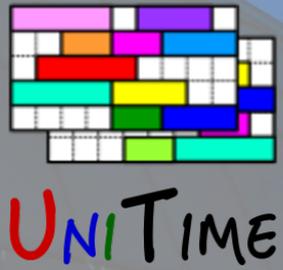
# Agenda

## Agenda

- Short introduction to UniTime
- Demo
- Discussion

This presentation is available at [www.unitime.org/present/apereo19-intro.pdf](http://www.unitime.org/present/apereo19-intro.pdf)





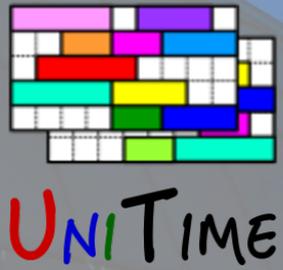
# Educational Timetabling

## What is educational timetabling?

- The process of assigning classes (or exams) in time and space
- A difficult optimization problem with many competing objectives
  - Student conflicts, faculty requirements, space constraints

## Why is it needed?

- Minimize student conflicts, thus help students receive degrees on time
- Help use resources more effectively
- Makes process easier to manage (knowledge transfer and cooperation)
- Fairness and satisfaction with the timetable
- What-if scenarios
- Ability to adapt to changes
- ...



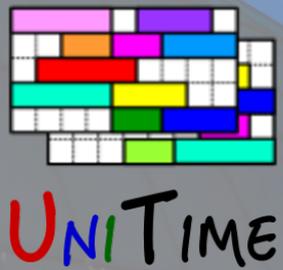
# Introducing UniTime

## There is a gap between research and practice

- Practice: timetables are created manually
  - *Often reuse prior timetable as much as possible*
- Research: the problem has been extensively studied
  - *Subject of a lot of focus over the last two decades*
  - *Numerous useful algorithms have been developed that can be applied*
  - *Computers are becoming fast enough to solve large problems*

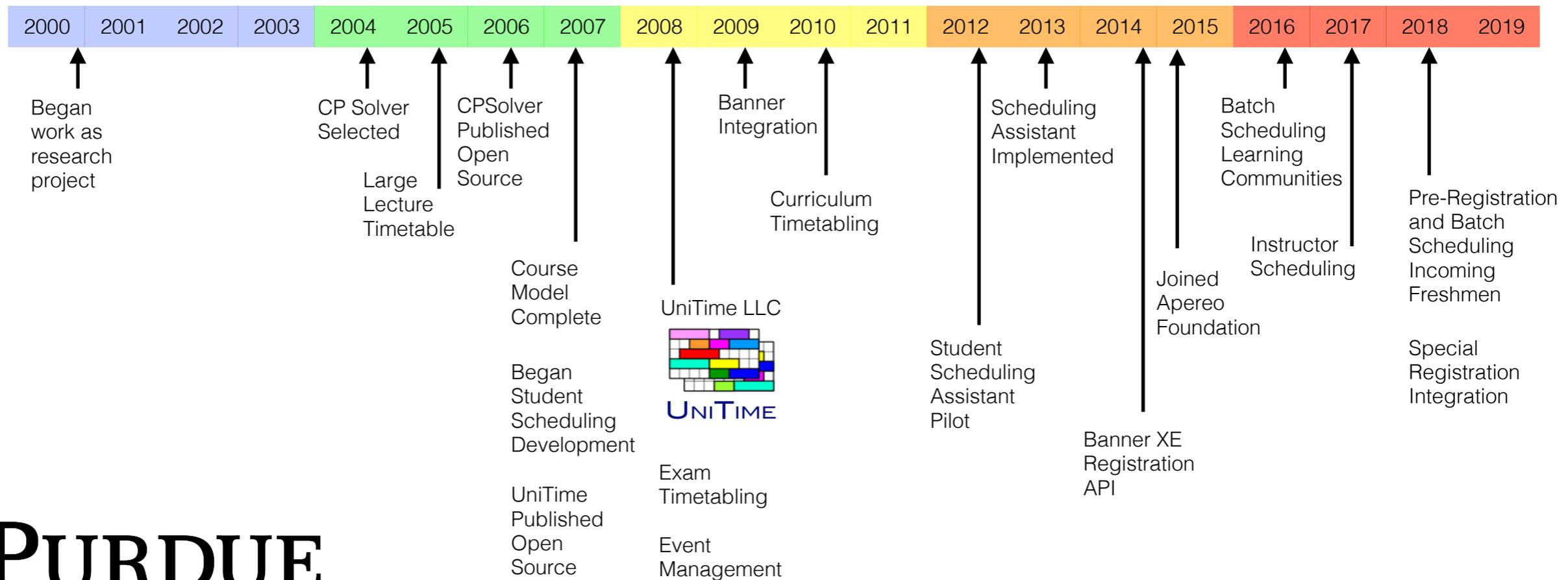
## Here is where UniTime comes in place

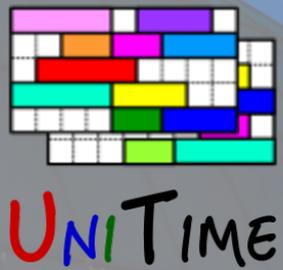
- Began as a research project in 2000
  - *Goal of producing an automated course timetabling solution for a large university*
- Became an enterprise system meeting many university timetabling needs



# Timeline

## UniTime at Purdue University





# Introducing UniTime

## What is UniTime?

- Comprehensive academic scheduling solution
- Four components: course timetabling, examination timetabling, student scheduling and event management
- Open source, web-based, written in Java using modern technologies
- Using state-of-the-art optimization algorithms
- Distributed data entry and timetabling in multi-user environments
- Apereo project since March 2015

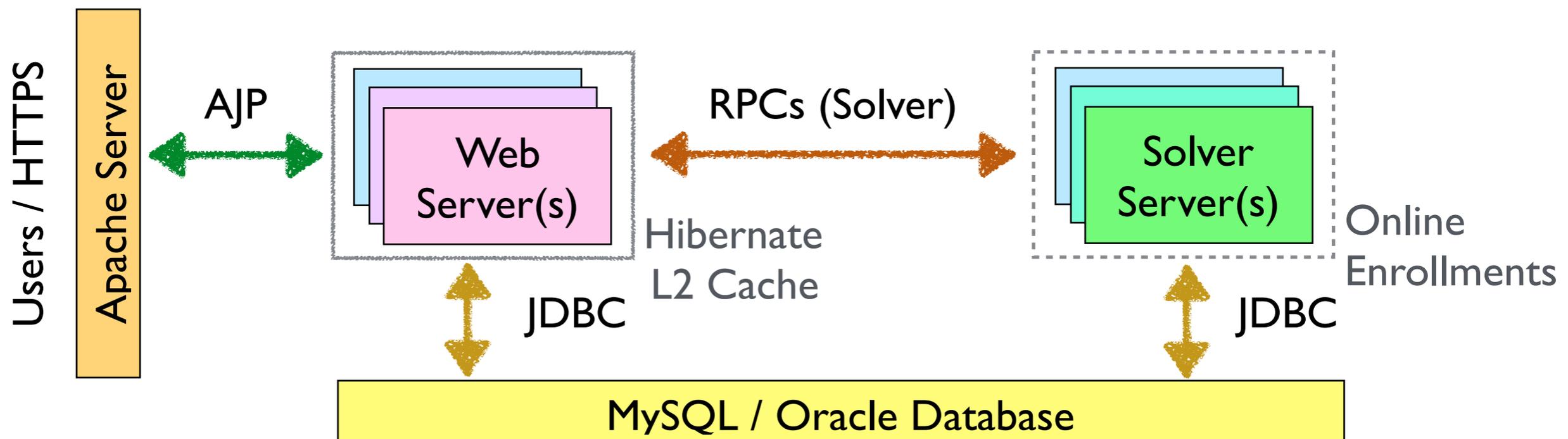
The screenshots illustrate the UniTime interface across several key areas:

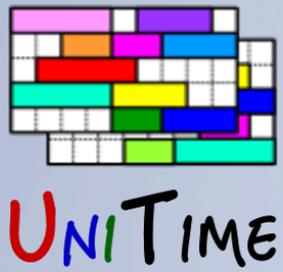
- Rooms:** A table listing room details such as room number, building, and capacity.
- Instructional Offering Details:** A page for 'C S 101 - Introductory Computing' showing enrollment statistics and configuration options.
- Log In:** A simple login form with fields for 'Username' and 'Password' and a 'Log In' button.
- Personal Timetable:** A view of a student's schedule for 'Fall 2010 (woebegon)', showing a grid of classes and exams.
- Final Examinations:** A table listing exam details including course, length, seating size, and room.



## Software Installation

- One or more web servers (Apache Tomcat / UniTime.war)
- One or more remote solver servers (Java)
- JGroups Clusters
  - Hibernate L2 Cache (web servers only)
  - Solver Cluster (RPCs)
  - Online Student Scheduling Server replications (optional)



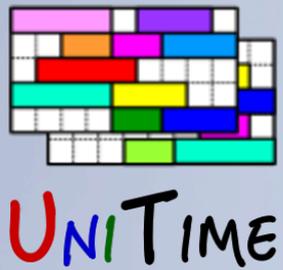


# Course Modeling

## Enables system to create timetable for entire university

- Ability to model all types of course structure and needs
- Intuitive data entry and display of classes and their requirements
- Helps to define how students can enroll into the course
- Additional relationships can be derived from the structure

	Limit	Date Pattern	Minutes Per Week	Time Pattern	Time	----Preferences----		
						Room	Distribution	Instructor
MA 170 STAT 170	40	Statistics I Introductory statistics						
Lecture	40	Full Term	50	1 x 50		Classroom		
Laboratory	40	Full Term	150	3 x 50		EDUC CompPr	Same Room	
Lec 1	40	Full Term	50	1 x 50		ThtrSeat Classroom		G. Newman
Lab 1	20	Full Term	150	3 x 50		EDUC CompPr	Same Room	J. Smith
Lab 2	20	Full Term	150	3 x 50		EDUC CompPr	Same Room	J. Smith



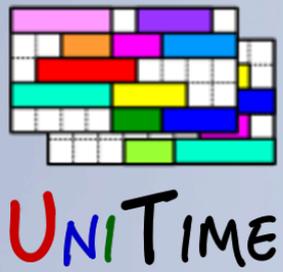
# Course Timetabling

## Constraints

- Rooms sizes, equipment, and availability
- Faculty time, room requirements and preferences
- Structures of courses that are to be offered
- Student course demands
  - Curricula, pre-registration, last-like course enrollments, etc.

## Goal

- Assign class times and locations such that
  - All hard constraints and other requirements are met
  - Desirable objectives are satisfied as much as possible
    - Minimize student conflicts
    - Accommodate time and room preferences
    - Allow preferred class time distributions
    - Fairness, minimize travel times



# Timetabling Solver

## Constraint-based solver

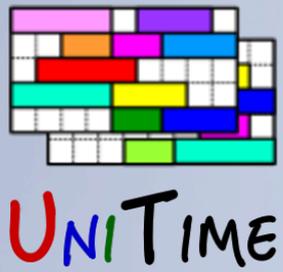
- Can be used anywhere between fully automated to manual
- State of the art
  - We have published a number of research papers over the years
  - Winner of the International Timetabling Competition 2007
- Easy to extend

### Suggestions

<u>Score</u>	<u>Class</u>	<u>Date</u>	<u>Time</u>	<u>Room</u>	<u>Students</u>
+15.2	POL 101 Lec 3	Full Term	TTh 12:00p → TTh 7:30a	BRNG 2280	+11
+31.7	POL 101 Lec 3	Full Term	TTh 12:00p → TTh 10:30a	BRNG 2280	+36 (h+3)
	HIST 342 Lec 1	Full Term	TTh 10:30a → TTh 1:30p	BRNG 2280 → BRNG 2290	
+36.6	POL 101 Lec 3	Full Term	TTh 12:00p → TTh 10:30a	BRNG 2280	+36 (h+4)
	HIST 342 Lec 1	Full Term	TTh 10:30a → TTh 7:30a	BRNG 2280	
+44.1	POL 101 Lec 3	Full Term	TTh 12:00p → TTh 10:30a	BRNG 2280	+34 (h+2)
	HIST 342 Lec 1	Full Term	TTh 10:30a → TTh 3:00p	BRNG 2280 → BRNG 2290	
	OBHR 330 Lec 4	Full Term	TTh 3:00p	BRNG 2290 → LWSN B155	

(all 1571 possibilities up to 3 changes were considered, top 4 of 17 suggestions displayed)

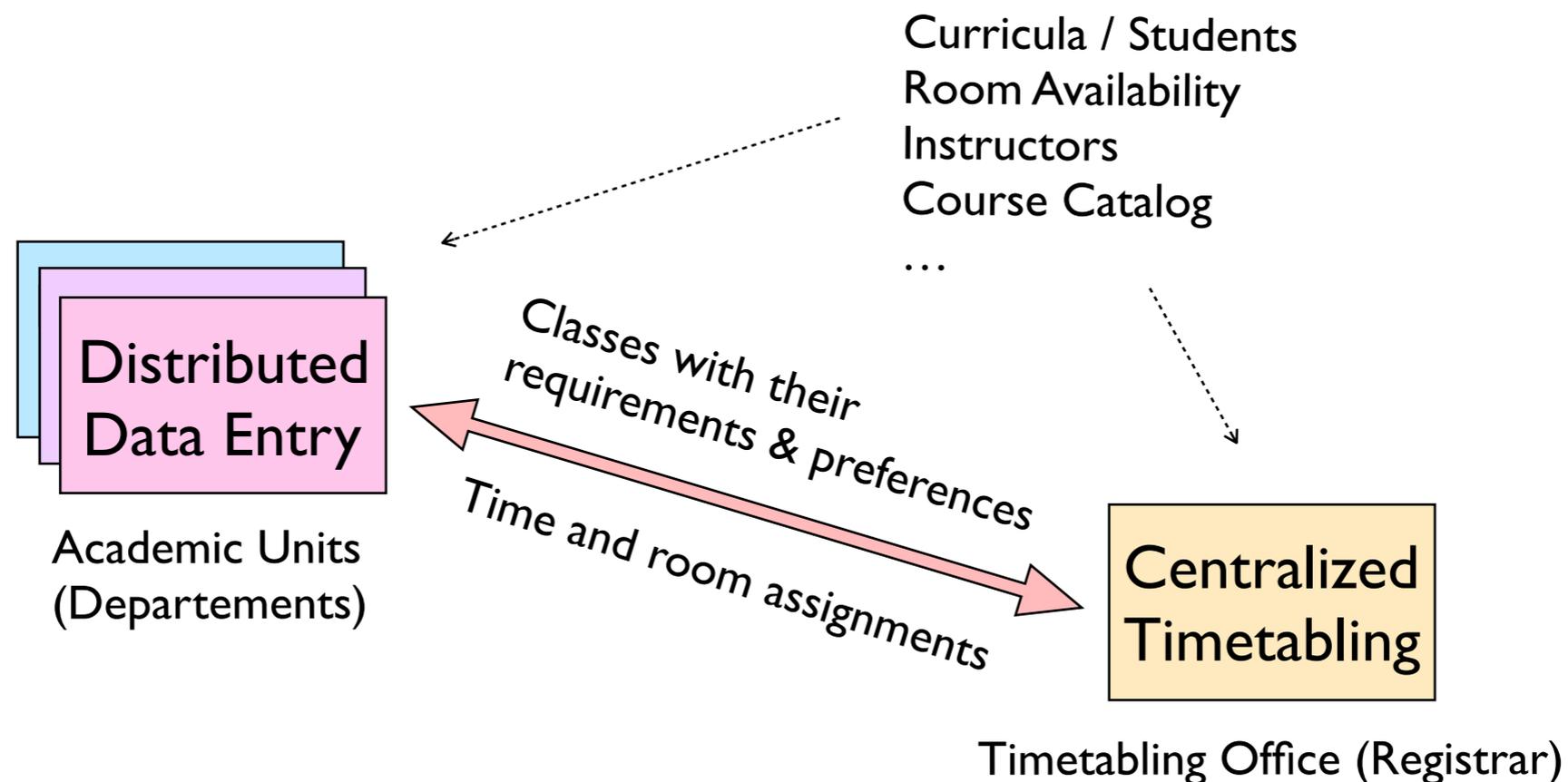
[Search Deeper](#)

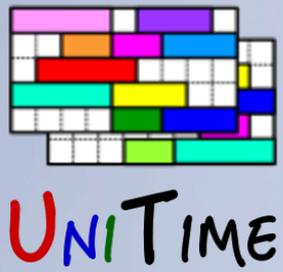


# Course Management

## Multi-user environment

- Allows for distributed timetabling with sharing of resources
  - Rooms, instructors, and students
- Typical use: distributed data entry + centralized timetabling
  - Data are entered by schedule deputies at each academic unit
  - Course timetable is produced at a central timetabling office

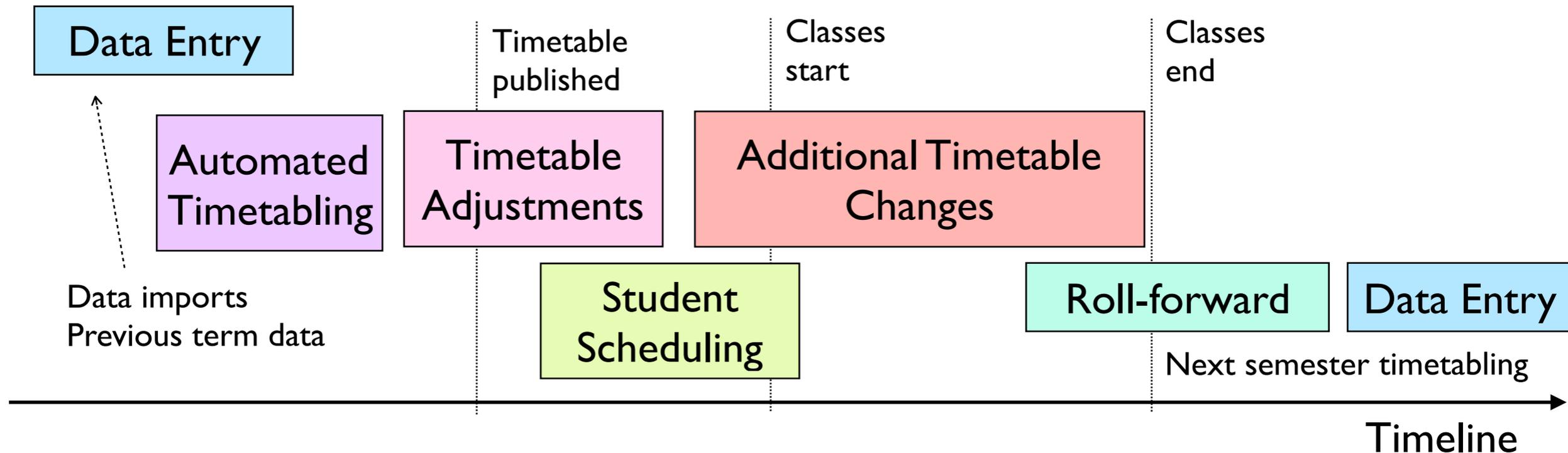


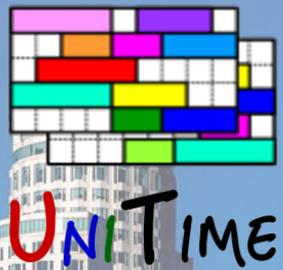


# Course Management

## Lifecycle of a Course Timetable

1. Data entry
2. Automated timetabling (solver is used to compute a timetable)
3. Timetabling adjustments (interactive changes)
4. Student scheduling, classes start
5. Additional, ad-hoc (mostly room) changes made throughout the term
6. Roll-forward of selected data into the next like term

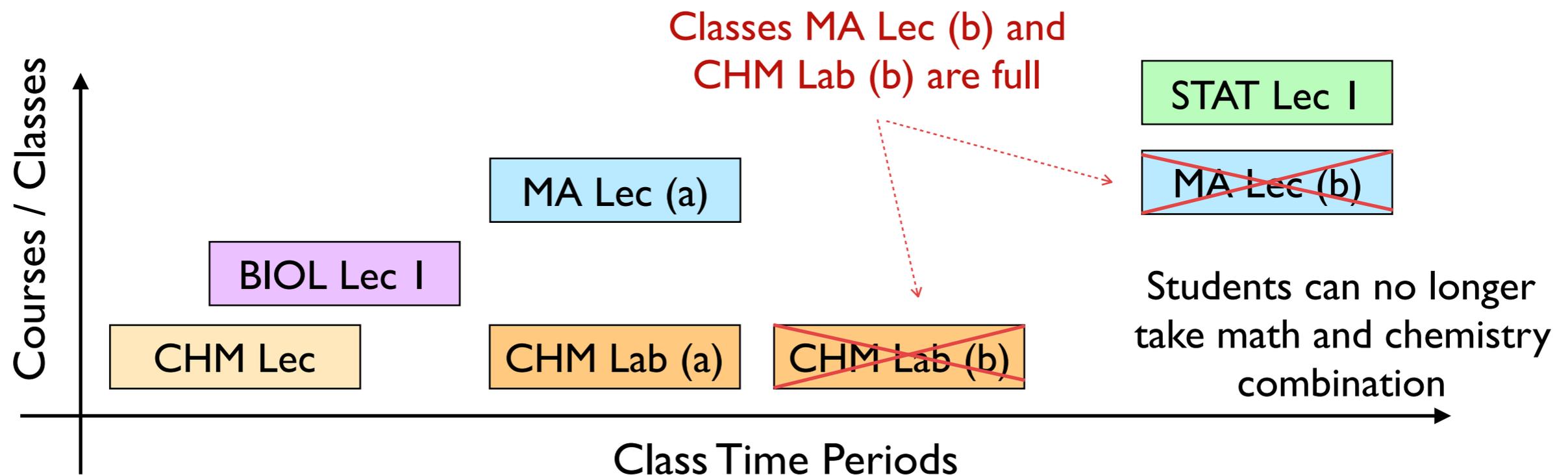


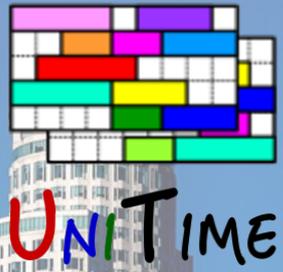


# Student Scheduling

## Why is scheduling needed?

- To ensure that students will be able to get the courses they need in a multi-section environment
  - *Students who come early may block later students from being able to get the courses they need*





# Student Scheduling

## Goal

Enroll students to classes in a way that maximizes the ability for students to get the courses they need

- Student fills in course requests
  - Including priorities, alternatives, and their availabilities
- System suggests a schedule that best meets student needs
- Students have the ability to modify their schedule

**Student Scheduling Assistant**

User: Student, Imogene Eugenia (A) Click here to log out. Session: Fall 2019 (PWL) Click here to change the session.

**UNITIME**

### Course Requests

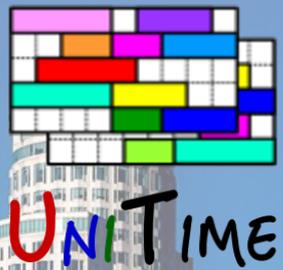
1. Priority	ENGR 13100	12664-004 x	14811-005 x					
1. Alternative	Alternative to ENGR 13100							
2. Priority	MA 16500							
1. Alternative	MA 16100							
3. Priority	CHM 11500	Traditional x						
1. Alternative	PHYS 17200							
4. Priority	ENGL 10600							
1. Alternative	SCLA 10100							
2. Alternative	ENGL 10800							
5. Priority	PSY 12000	Hybrid x						
1. Alternative	SOC 10000	Hybrid x						
6. Priority	Free MWF 7:30a - 8:30a							
7. Priority								
8. Priority								
9. Priority								
10. Priority								
11. Priority								
12. Priority	Course with the lowest priority.							

Tip: Use Esc to hide suggestions, Ctrl+L (or Ctrl+Alt+L in some browsers) to show suggestions.

### Substitute Course Requests (used only if a course requested above is not available)

1. Substitute	FR 10100					
2. Substitute						
3. Substitute						

You are not registered for any classes yet. Please click the Build Schedule button in order to complete your registration.



# Student Scheduling

## Option 1: Batch (one time)

- All students are scheduled at one time after the timetable is produced based on student pre-registrations
- An optimization process, using the (student scheduling) solver

## Option 2: Online (real-time)

- Students without pre-registrations (e.g., incoming freshmen) can enroll online
- All students can make adjustments to their schedules
- Automatically hold space in sections based on expected student demand
- Reservations, automated wait-list, processing, instructor consents, advisor roles, etc.

## Option 3: Both

- Any combination of various batches and online scheduling

Student Scheduling Assistant

User: Student, Imogene Eugenia (A) Session: Fall 2019 (PWL)  
[Click here to log out.](#) [Click here to change the session.](#)

[Add/Drop Courses](#) [Rearrange Schedule](#) [Current Registration](#) [Submit Schedule](#) [Print](#)

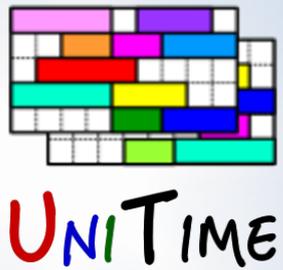
[List of Classes](#) [Time Grid](#) **Class Schedule**

Lock	Subject	Course	Type	Class	Avail	Days	Start	End	Date	Room	Instructor	Requires	Note	Credit
	ENGR	13100	Stdo	14811-005	116 / 116	T	3:30p	5:20p	08/20 - 12/03	ARMS B061				2
			Stdo	14811-005	116 / 116	R	3:30p	5:20p	08/22 - 12/05	ARMS B098		14811-005		
	MA	16500	Lec	23122-100	468 / 468	MWF	12:30p	1:20p	08/19 - 12/06	CL50 224	K Matsuki		Evening Exams Required. Prere...	4
			Rec	42955-111	39 / 39	R	12:30p	1:20p	08/22 - 12/05	EE 236		23122-100	Evening Exams Required. Prere...	
	CHM	11500	Lec	51542-001	44 / 50	MF	11:30a	12:20p	08/19 - 12/06	WTHR 200	G Schmidt		Supplemental Instruction (SI) st...	4
			Lab	51531-396	3 / 3	T	11:30a	2:20p	08/20 - 12/03	BRWN 1175			Supplemental Instruction (SI) st...	
			Rec	15631-492	3 / 3	M	4:30p	5:20p	08/19 - 12/02	BRWN 3102		51531-396	Supplemental Instruction (SI) st...	
	ENGL	10600	Lec	59218-831	1 / 3	MR	2:30p	3:20p	08/19 - 12/05	REC 108			Traditional	4
			Lec	59218-831	1 / 3	W	2:30p	3:20p	08/21 - 12/04	BRNG B274		59218-831	Traditional	
			Rec	59219-832	1 / 1	F	2:30p	3:20p	08/23 - 12/06	HEAV 223		59218-831	Traditional	
	PSY	12000	Rec (Hybrid)	10045-029	15 / 15	W	3:30p	4:20p	08/21 - 12/04	BCHM 105			Evening Exams Required on all ... Students registering for this sect...	3
			Dist (Hybrid)	10062-038	168 / 225	Arrange Hours			08/19 - 12/07				Evening Exams Required on all ... Students registering for this sect...	
	Free	Time				MWF	7:30a	8:30a						

[New Course](#) Total Credit: 17  Show unassignments

[Add/Drop Courses](#) [Rearrange Schedule](#) [Current Registration](#) [Submit Schedule](#) [Print](#)

You are not registered for any classes yet. Please click the Submit Schedule button in order to complete your registration.



# Examination Timetabling

## What is Examination Timetabling?

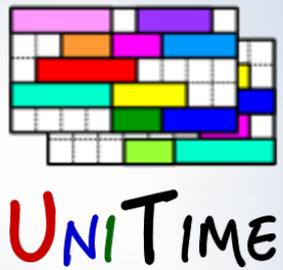
- The process of assigning examinations to time periods and locations
- A difficult optimization problem with many competing objectives
  - Student conflicts, faculty requirements, space constraints

## Why is it needed?

- The traditional process of mapping lecture times to examination periods does not really work
- More choices for courses mean more potential scheduling conflicts
- Make process easier to manage, fairness and satisfaction, what-ifs

## Many flavors

- Final examinations, evening examinations, mid-terms, ...
- Additional objectives

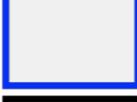


# Examination Data

## Input Data

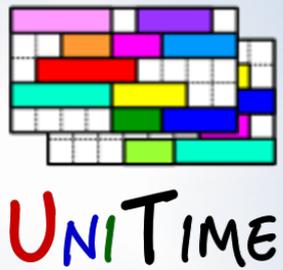
- Examinations (*with students enrolled in them*)
- Periods (*not overlapping, can have various durations*)
- Rooms (*with capacities, availabilities, and period preferences*)
- Individual examination requirements and preferences
- Distribution constraints (*same/different room, same/different period, precedence*)

	from: 8:00a	10:30a	1:00p	3:30p	7:00p
	to: 10:00a	12:30p	3:00p	5:30p	9:00p
Mon 12/09					
Tue 12/10					
Wed 12/11					
Thu 12/12					
Fri 12/13					
Sat 12/14					

	Required
	Strongly Preferred
	Preferred
	Neutral
	Discouraged
	Strongly Discouraged
	Prohibited

## Evening Examinations

- Mondays - Thursdays
- 6:30p - 7:30p or 8p - 10p
- 3 days & early / late
- 2-3 exams for a course
- Student availability



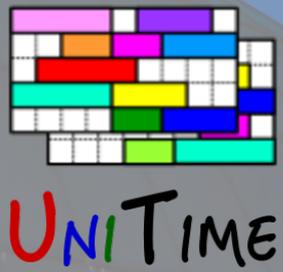
# Examination Problem

## Hard Constraints

- No two exams in the same period and room
- Examination must fit the period and room (or rooms)
- Room must be available
- An exam cannot be placed in a period or a room that is prohibited
- Required (*hard*) distribution constraints must be satisfied

## Soft Constraints / Objectives

- Student conflicts: direct, more than two on a day, back-to-backs
  - Period, room, and distribution penalties
- ... and a few others
- Minimize room splits (*and the distance between these rooms, if an exam is split*)
  - Distance to original room (*i.e., the room where the class took place*)
  - Large exams first
  - Rotation (*average period*)



# Event Management

## Event management

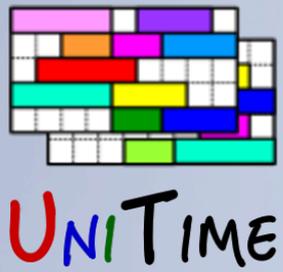
- Management of the remaining classroom space
- Fully distributed, including an (optional) approval process
- Authenticated users can request events
- Faculty can request course-related events

The screenshot shows the 'Events' management page for Muller, Tomas, Administrator. It includes a filter section for Academic Session (Spring 2014 (PWL)), Event Filter (6:00 pm), and Room Filter (Classrooms >=100, Central Campus). Below the filters, it displays 'CL50 224 events for weeks 03/31 - 05/18'. A table lists various events with columns for Name, Section Type, Title, Date, Published Time, Location, Capacity, Instructor / Sponsor, Main Contact, and Approved status. The table includes entries for courses like AGEC 21700, ANTH 20500, CLCS 23300, and special events like Speech and Debate Competition.

Name	Section Type	Title	Date	Published Time	Location	Capacity	Instructor / Sponsor	Main Contact	Approved
AGEC 21700	10552-002	Lecture Economics	MWF 03/31 - 05/02, 2014	12:30p - 1:20p	CL50 224	470	Perkis, D F	Horan, C J	09/18/2013
AGEC 33100	10562-001	Lecture Selling Agri Business	TTh 04/01 - 05/01, 2014	10:30a - 11:45a	CL50 224	470	Cochran, A L Downey, W	Horan, C J	09/18/2013
ANTH 20500	11041-001	Lecture Human Cultural Diversity	MW 03/31 - 04/30, 2014	3:30p - 4:20p	CL50 224	470	Ricke, A C	Horan, C J	09/18/2013
CLCS 23300	69057-001	Lecture Comparative Mythology	MWF 03/31 - 05/02, 2014	11:30a - 12:20p	CL50 224	470	Dickson, K M	Horan, C J	09/18/2013
COM 31800	16596-001	Lecture Prin Of Persuasion	TTh 04/01 - 05/01, 2014	3:00p - 4:15p	CL50 224	470	Morgan, S E	Horan, C J	09/18/2013
ECON 25200	17628-002	Lecture Macroeconomics	TTh 04/01 - 05/01, 2014	9:00a - 10:15a	CL50 224	470	Thompson, J S	Horan, C J	09/18/2013
ECON 25200	63299-001	Lecture Macroeconomics	TTh 04/01 - 05/01, 2014	7:30a - 8:45a	CL50 224	470	Thompson, J S	Horan, C J	09/18/2013
FNR 10300	19837-001	Lecture Intro Envir Conservatn	MWF 03/31 - 05/02, 2014	1:30p - 2:20p	CL50 224	470	Dunning, J B	Horan, C J	09/18/2013
IE 37000	20984-001	Lecture Mfg Processes I	MWF 03/31 - 05/02, 2014	2:30p - 3:20p	CL50 224	470	Cheng, G J	Horan, C J	09/18/2013
MA 16200	57850-200	Lecture PI Anly Geo Calc II	MWF 03/31 - 05/02, 2014	9:30a - 10:20a	CL50 224	470	Banuelos, R	Horan, C J	09/18/2013
MGMT 20000	22494-002	Lecture Intro Accounting	TTh 04/01 - 05/01, 2014	4:30p - 5:45p	CL50 224	470	Trax, R	Horan, C J	09/18/2013
MGMT 20000	22501-001	Lecture Intro Accounting	TTh 04/01 - 05/01, 2014	noon - 1:15p	CL50 224	470	Trax, R	Horan, C J	09/18/2013
PSY 12000	26377-004	Lecture Elementary Psychology	MWF 03/31 - 05/02, 2014	8:30a - 9:20a	CL50 224	470	Ward, E S	Horan, C J	09/18/2013
SOC 10000	27351-006	Lecture Intro Sociology	MWF 03/31 - 05/02, 2014	10:30a - 11:20a	CL50 224	470	Hillis, R S	Horan, C J	09/18/2013
SOC 10000	52406-032	Lecture Intro Sociology	TTh 04/01 - 05/01, 2014	1:30p - 2:45p	CL50 224	470	Weiss, D M	Horan, C J	09/18/2013
Speech and Debate Competition 1	Special		Fri 04/11, 2014	5:30p - 10:30p	CL50 224	470		Scharf, B C	10/08/2013
Speech and Debate Competition 2	Special		Sat 04/12, 2014	7:00a - 10:30p	CL50 224	470			10/08/2013
USU Nationals Debate Tournament	Special		Fri 04/25, 2014	5:30p - 10:30p	CL50 224	470		Scharf, B C	10/08/2013

The screenshot shows the 'Personal Timetable' for Blair Nichols, Hooser, for Spring 2014 (PWL). It features a grid view of the week from Monday 01/13 to Friday 01/17. The grid shows various events scheduled in different rooms (CL50 224, WTHR 200, etc.) with their respective times and instructors. The interface includes filters for Academic Session and Matching Rooms, and options to print or export the timetable.





# Instructor Scheduling

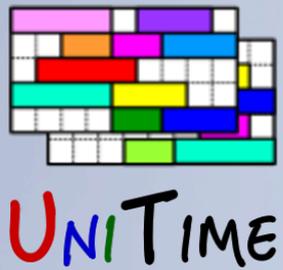
## Instructors

- Attributes: *skills, qualifications, seniority, certifications, etc.*
- Maximal teaching load
- Availability and preferences (*on time and courses*)
- Other: *hiring cost, back-to-back / same day / same room preferences, ...*

## Courses

- Teaching requests (*classes that need an instructor*)
- Teaching load
- Number of instructors needed
- Requirements and preferences (*instructor and attributes*)
- Other: *same course, same lecture preferences*

**Goal:** assign instructors to classes in a way that maximizes satisfaction while all the constraints are met



# Instructor Scheduling

## 1. Teaching Request

[Remove Request](#)

Teaching Load:

Scheduling Subpart:

Classes:

	Class	External Id	Enrollment	Limit	Time	Date	Room
<input type="checkbox"/>	CHM 11100 Lab 1	13765-009	22	24	W 11:30a - 2:20p	Full Term	BRWN 1164
<input type="checkbox"/>	CHM 11100 Lab 2	13767-011	21	24	W 11:30a - 2:20p	Full Term	BRWN 1135
<input type="checkbox"/>	CHM 11100 Lab 3	13757-017	20	24	W 11:30a - 2:20p	Full Term	BRWN 1134
<input type="checkbox"/>	CHM 11100 Lab 4	13764-008	23	24	W 2:50p - 5:40p	Full Term	BRWN 1124
<input type="checkbox"/>	CHM 11100 Lab 5	13758-002	22	24	W 2:50p - 5:40p	Full Term	BRWN 1125
<input type="checkbox"/>	CHM 11100 Lab 6	13762-006	22	24	W 11:30a - 2:20p	Full Term	BRWN 1124
<input type="checkbox"/>	CHM 11100 Lab 7	13760-004	23	24	W 2:50p - 5:40p	Full Term	BRWN 1134
<input type="checkbox"/>	CHM 11100 Lab 8	13766-010	21	24	W 11:30a - 2:20p	Full Term	BRWN 1125
<input type="checkbox"/>	CHM 11100 Lab 9	13761-005	24	24	W 2:50p - 5:40p	Full Term	BRWN 1164
<input type="checkbox"/>	CHM 11100 Lab 10	13759-003	20	24	W 2:50p - 5:40p	Full Term	BRWN 1135

Include Subparts:

Instructional Type	Assign	Share	Lead	Can Overlap	Common
<input checked="" type="checkbox"/> CHM 11100 Lec (1 parent class)	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> CHM 11100 Pso (1 parent class)	<input checked="" type="checkbox"/>	<input type="text" value="100"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> CHM 11100 Lab	<input checked="" type="checkbox"/>	<input type="text" value="100"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Same Course Preference:

Same Common Part:

Qualification Preferences:

<input type="text" value="CHM 11100"/>	<input type="text" value="Strongly Preferred"/>	<input checked="" type="checkbox"/>
<input type="text" value="Select..."/>	<input type="text" value="Neutral"/>	<input checked="" type="checkbox"/>

Role Preferences:

<input type="text" value="TA"/>	<input type="text" value="Required"/>	<input checked="" type="checkbox"/>
<input type="text" value="Select..."/>	<input type="text" value="Neutral"/>	<input checked="" type="checkbox"/>

Skill Preferences:

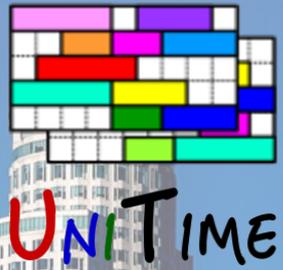
<input type="text" value="Select..."/>	<input type="text" value="Neutral"/>	<input checked="" type="checkbox"/>
--	--------------------------------------	-------------------------------------

Instructor Preferences:

<input type="text" value="Select..."/>	<input type="text" value="Neutral"/>	<input checked="" type="checkbox"/>
--	--------------------------------------	-------------------------------------



# Other Features

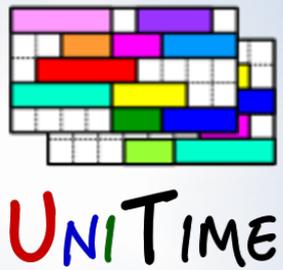


## Customization

- Many configuration properties, custom CSS, etc.
- Localization
- User roles & permissions
- Authentication (CAS, LDAP, Spring Security)
- Custom reports
- JavaScript / Python scripts
- Automation

## Data Exchange

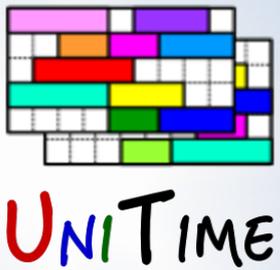
- XML imports and exports
- RESTful APIs (JSON)
- CSV/PDF/iCal exports



# UniTime Demo Instance

## Workshop Demo Instance

- A college with about 6,000 students
- 24 departments entering the data
- Distributed data entry, centralized timetabling
  - Distance learning timetabled separately
  - For this workshop, the timetabling has been decentralized
- Shared resources (especially rooms)
- Student demands based on curricula
- Loosely based on the College of Education, Masaryk University
- Web: [demo.unitime.org/workshop](http://demo.unitime.org/workshop)
- Accounts: user00 | /pwd00 | ... user05 | /pwd05 |



# demo.unitime.org/workshop

User	Department	Courses	Classes	Instructors
20, 26, 48	Art	57	154	43
38, 40	Biology	33	111	41
14, 49	Civics	58	95	21
17, 18, 28, 42	Czech	114	225	32
15, 30, 36	English	157	250	50
1, 22	French	56	81	18
24, 33	Geography	25	43	19
8, 12, 34	German	78	133	20
27, 47	Health Ed	21	39	17
6, 32	History	39	93	49
4, 45	IT	49	95	20
9, 10	Language	23	89	14
23, 25, 29	Mathematics	53	104	27
41, 51	Music	59	196	17
37, 46	Pedagogy	17	76	28
2, 7, 31, 35, 43	Physics	170	416	84
5, 19	Prime Ped	34	99	16
16	Psychology	40	109	14
21, 39	Physical Ed	24	64	16
11, 50	Russian	83	156	18
13	Social Ed	89	136	75
3, 44	Special Ed	135	231	74

**Username:**  
user001

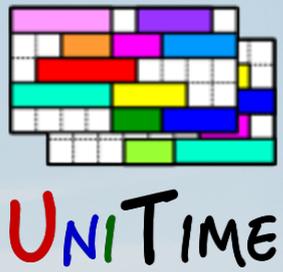
**Password:**  
pwd001



**Username:**  
user051

**Password:**  
pwd051





# Conclusion

## Introducing UniTime

- More resources at <http://bit.ly/unitime43docs>

## For more details, please see us at the conference

- **Introducing UniTime** (Sunday, 1:30pm - 4:30pm in Crocker)
- **UniTime: State of the Project** (Monday, 11:15am - 12:00pm in Watercourt A)
- **UniTime at Faculty of Medicine** (Monday, 1:30pm - 2:15 pm in Watercourt A)
- **Student Scheduling at Purdue** (Tuesday, 11:15am - 12:00pm in Watercourt A)
- **Event Management in UniTime** (Wed, 11:00am - 11:45am in Watercourt A)
- Or visit [www.unitime.org](http://www.unitime.org)

An online demo is available at <https://demo.unitime.org>