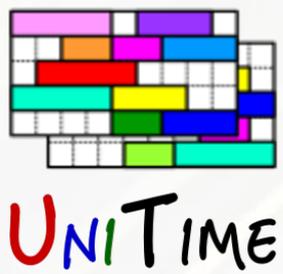


UNI TIME

# Comprehensive University Timetabling System UniTime

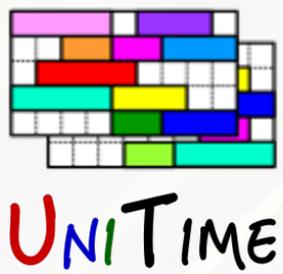
Open Apereo 2014



# Educational Timetabling

## What is Educational Timetabling?

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



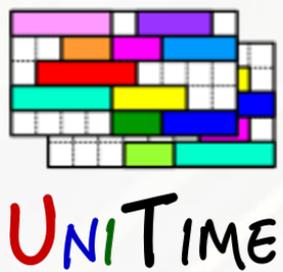
# Educational Timetabling

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## Why is it Needed?

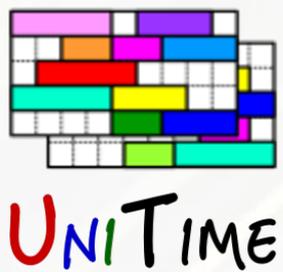
- **Minimize student conflicts** to help students receive degrees on time
- Help **use limited resources more effectively**
- Make process more transparent and sustainable (no one point of failure)
- Fairness and satisfaction with the timetable
- What-if scenarios
- Ability to adapt to changes (curriculum, facilities, etc.)



# Introducing UniTime

## Currently 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 scheduling problems*



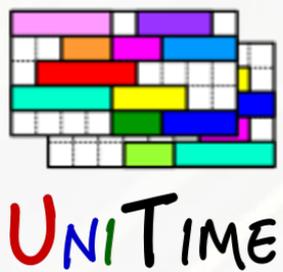
# Introducing UniTime

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## How UniTime Bridges this Gap

- Began as a research project in 2000
  - Goal of producing an automated course timetabling solution for a large university
  - Makes use of latest timetabling research
- Has become a useful enterprise system meeting university timetabling needs



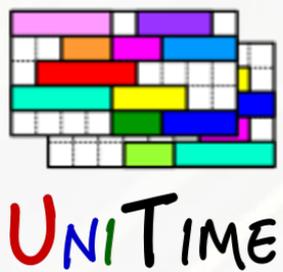
# Introducing UniTime

## Comprehensive Academic Scheduling Solution

- Course and exam timetabling, individual student schedules, and events
- System uses state-of-the-art optimization algorithms
- Open Source, web-based, written in Java using modern technologies
- Distributed data entry and timetabling in multi-user environments

The screenshots illustrate the UniTime interface across different user roles and functions:

- Rooms:** Displays a map of campus buildings with room locations and details like capacity and availability.
- Instructional Offerings:** Shows a table of course offerings with columns for External Id, Enrollment Limit, Room, Manager, Date, Minutes Per Week, Time, and Room.
- Log In:** A simple form for entering Username and Password.
- Personal Timetable:** A grid view showing a student's schedule for a specific term, with colored blocks representing different courses.
- Examinations:** A search interface for finding exam details, including subject, course number, and exam type.
- ExamList.do:** A detailed view of exam listings, showing course names, exam length, seating type, and assigned rooms.



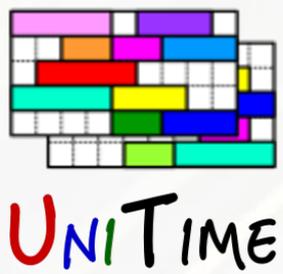
# Course Timetabling

## Constraints

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

## Goal

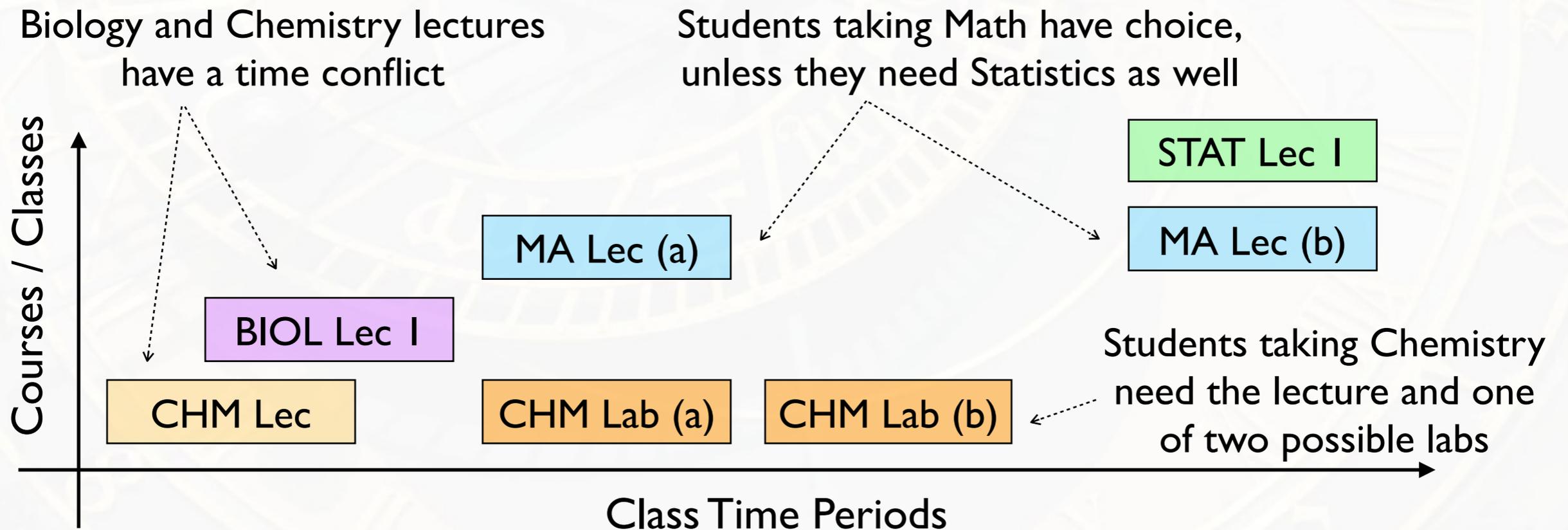
- Assign class times and locations such that
  - All required constraints are met
  - Other desirable objectives are satisfied as much as possible
    - Minimize student conflicts
    - Accommodate time and room preferences
    - Allow preferred class time distributions
    - Fairness
    - Minimize travel times

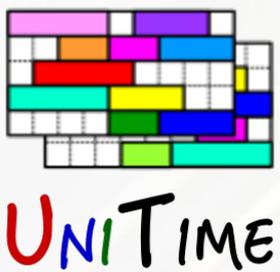


# Student Conflicts

## A student cannot take a combination of courses

1. Classes overlap in time
  - or one after the other in rooms that are too far apart
2. There is not enough space in a non-overlapping combination of classes





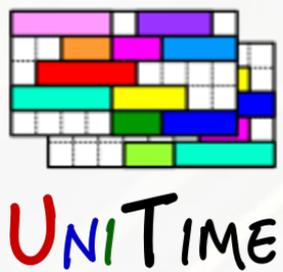
# Course Structure

## Classes are Organized by the Course Structure

- Intuitive data entry and display of classes and their requirements
- Helps to define how students can enroll into the course
- Additional relations can be derived from the structure

							----Preferences----		
	Limit	Date Pattern	Minutes Per Week	Time Pattern	Time		Room	Distribution	Instructor
MA 170	40	Statistics I							
STAT 170		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

Required
  Strongly Preferred
  Preferred
  Neutral
  Discouraged
  Strongly Discouraged
  Prohibited



# Timetabling Solver

## Constraint-based Solver

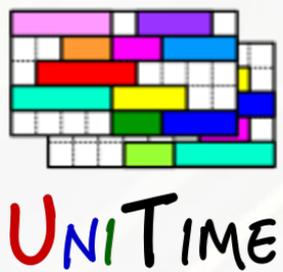
- Can be used in modes between manual and fully automated
- State of the art methods
  - Work published in refereed journals
  - Winner of the International Timetabling Competition 2007
- Easy to extend

### 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)

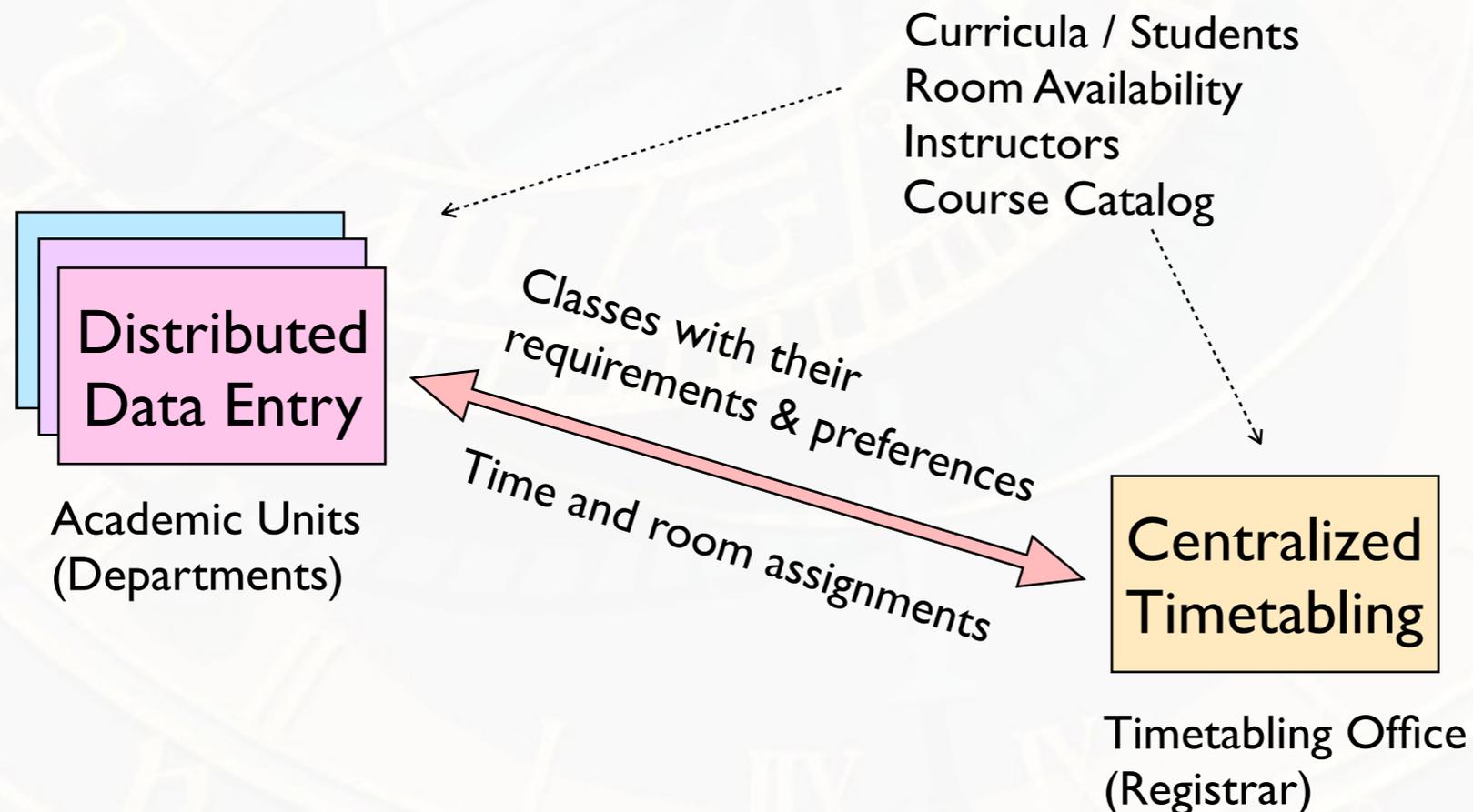
Search Deeper

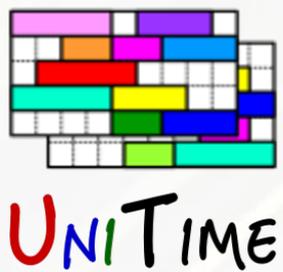


# Course Timetabling Application

## 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 managers in each academic unit
  - Course timetable is produced by a central timetabling office

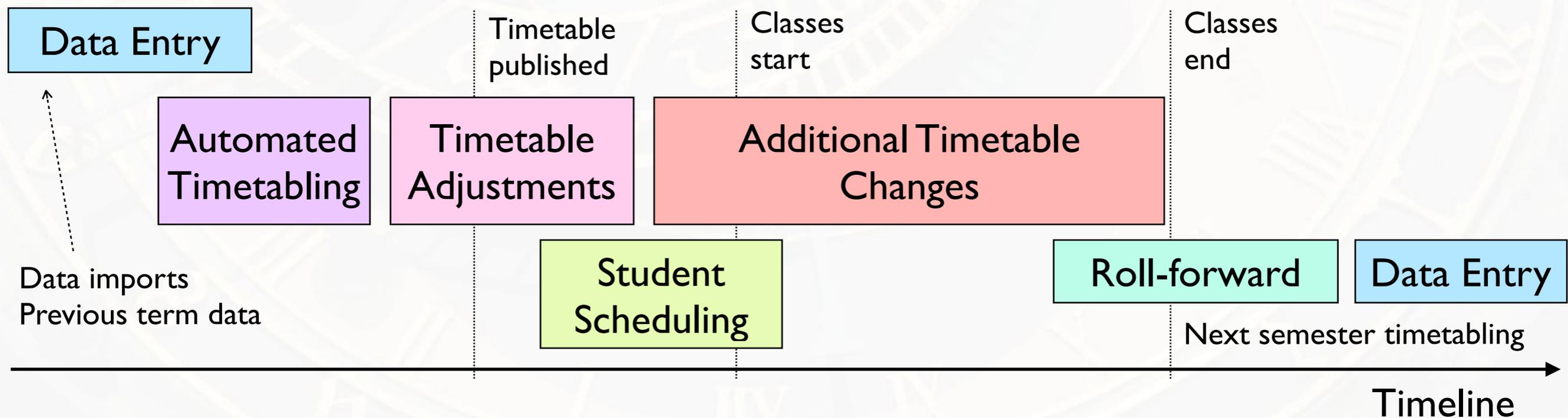


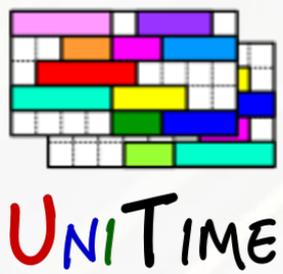


# Course Management

## 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

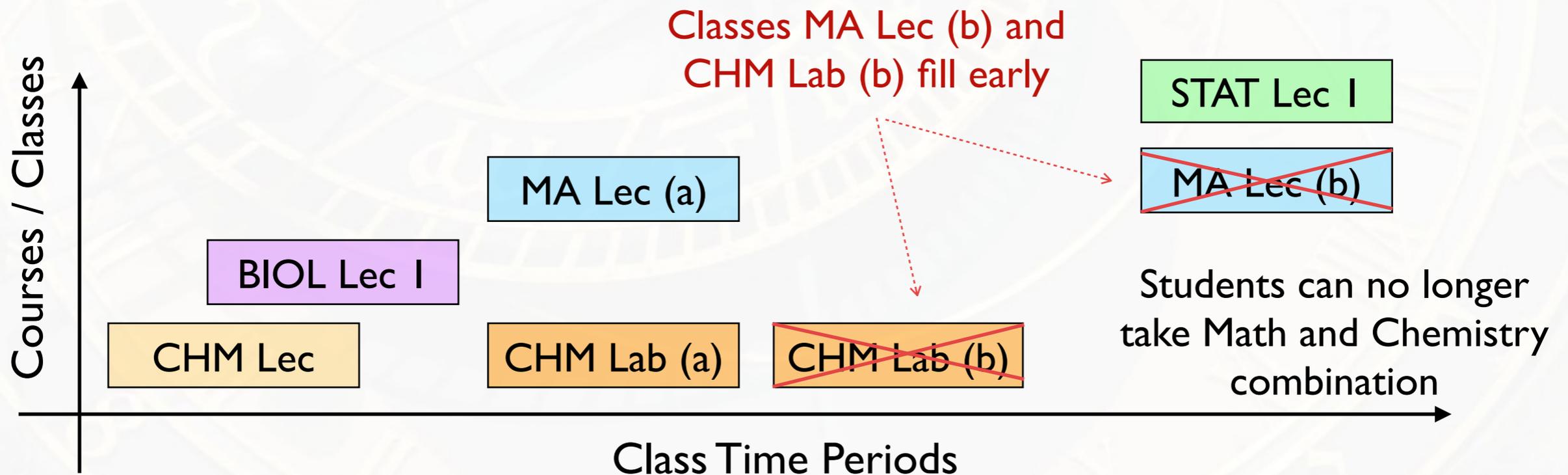


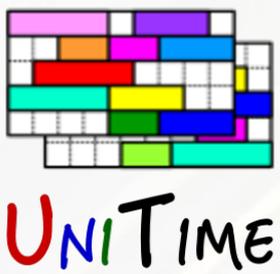


# Student Scheduling

## Why is Scheduling Needed?

- To ensure that students will be able to get the courses they need when multiple sections are offered
  - *Earlier enrolling students may block later students from being able to get needed courses*





# Student Scheduling

## Goal

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

- Student fills in course requests
  - Including priorities, alternatives, and their own time availability
- System suggests a schedule that best meets student needs
- Students can make later modifications to schedule



### Student Scheduling Assistant <sup>?</sup>

User: Hooser, Blair Nichols    Session: Spring 2014 (PWL)  
[Click here to log out.](#)    [Click here to change the session.](#)

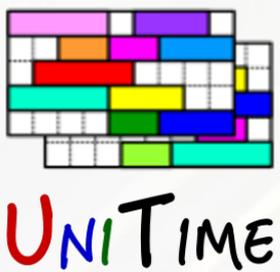
#### Course Requests

1. Priority	BAND 11100B	Alternative to BAND 11100B		↓
2. Priority	BIOL 11100	BIOL 11200	Alt. to BIOL 11100 & BIOL 11200	↑ ↓
3. Priority	CHM 11600	Alternative to CHM 11600		↑ ↓
4. Priority	Free M 7:00a - 12:00p			↑ ↓
5. Priority	HONR 19900H	Alternative to HONR 19900H		↑ ↓
6. Priority	MA 22400	Alternative to MA 22400		↑ ↓
7. Priority	VM 10200	Alternative to VM 10200		↑ ↓
8. Priority				↑ ↓
9. Priority				↑ ↓
10. Priority				↑ ↓
11. Priority				↑ ↓
12. Priority	Course with the lowest priority.			↑ ↓

Tip: The Alternate Course Requests below can be used to ensure that the desired number of courses are scheduled even when a Course Request (and its alternatives) are not available.

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

1. Alternate	PES 11600C	Alternative to PES 11600C		↑ ↓
2. Alternate				↑ ↓
3. Alternate				↑



# Student Scheduling

## Option I: 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 II: 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.

Student Scheduling Assistant<sup>®</sup>

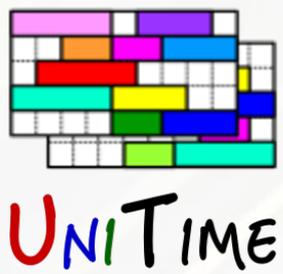
User: Hooser, Blair Nichols    Session: Spring 2014 (PWL)  
[Click here to log out.](#)    [Click here to change the session.](#)

[List of Classes](#)    [Timetable](#)

Lock	Subject	Course	Type	Class	Avail	Days	Start	End	Date	Room	Instructor	Requires	Note	Credit
<input type="checkbox"/>	BAND	11100B	Lab	11797-P01	33 / 100	MWF	3:30p	5:20p	01/13 - 05/02	ELLT 015	A D King		Purdue Philharmonic	2
<input type="checkbox"/>	BIOL	11100	Lec	49748-002	0 / 425	TR	12:30p	1:20p	01/14 - 05/01	LILY 1105	M E Browning, D H Bos		Evening Exams Required. Supp...	4
<input type="checkbox"/>			Rec	12009-013	0 / 24	W	9:30a	10:20a	01/15 - 04/30	WTHR 360			Evening Exams Required. Supp...	
<input type="checkbox"/>			Lab	12073-077	0 / 23	F	11:30a	1:20p	01/17 - 05/02	WTHR 313			Evening Exams Required. Supp...	
<input type="checkbox"/>	CHM	11600	Lec	13989-004	40 / 312	MW	2:30p	3:20p	01/13 - 04/30	WTHR 200			Supplemental Instruction (SI) st...	4
<input type="checkbox"/>			Pso	13993-062	40 / 312	F	2:30p	3:20p	01/17 - 05/02	WTHR 200		13989-004	Supplemental Instruction (SI) st...	
<input type="checkbox"/>			Lab	14035-104	8 / 24	F	7:30a	10:20a	01/17 - 05/02	BRWN 1135		13993-062	Supplemental Instruction (SI) st...	
<input type="checkbox"/>			Rec	13972-041	8 / 24	R	10:30a	11:20a	01/16 - 05/01	WTHR 420		14035-104	Supplemental Instruction (SI) st...	
<input type="checkbox"/>	Free	Time				M	7:00a	12:00p						
<input type="checkbox"/>	HONR	19900H	Lec	12186-006	13 / 20	TR	9:00a	10:15a	01/14 - 05/01	REC 121	M A Russell			3
<input type="checkbox"/>	MA	22400	Lec	63718-001	0 / 38	MWF	1:30p	2:20p	01/13 - 05/02	REC 227			Evening Exams Required	3
<input type="checkbox"/>	VM	10200	Lec	28066-001	40 / 196	T	1:30p	2:20p	01/14 - 04/29	LYNN 1136	S A McLaughlin			1

Show unassignments

[Requests](#)    [Re-schedule](#)    [Print](#)    [Export](#)



# Other Features

## Examination Timetabling

- An exam can be offered for a class, a course, or a combination of these
- Multiple examination problems (final exams, mid-term exams, etc.)
- Each exam is assigned to an examination period and one (or more) rooms
- Student conflicts are minimized
  - *Direct conflicts, more than two exams on a day, back-to-back exams*

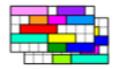


**Examinations**  
Muller, Tomas Administrator Fall 2013 (PWL) [Click here to change the session / role.](#)

Type: Final Subject: AAE Course Number: 3\* Search Export PDF Export CSV Add Examination

**Final Examinations**

Classes / Courses	Length	Seating	Size	Max	Instructor	Period	Room	Distribution	Assigned	Assigned
	Type	Rooms	Preferences	Preferences	Preferences	Period	Room	Period	Room	
AAE 30100 10010-001	120 Exam	141	4 Frazho, A E	ARMS 1010 ARMS	Wed 12/11 8:00a	STEW 130				
AAE 33300 10011-001	120 Exam	147	4 Alexeenko, A	MATH 175 MATH	Thu 12/12 10:30a	LILY 1105				
AAE 33400 10023-001	120 Exam	59	4 Sullivan, J P	WTHR 160 WTHR	Thu 12/12 3:30p	WTHR 104				
AAE 34000 10031-001	120 Exam	77	4 Howell, K	EE 170 EE	Tue 12/10 1:00p	EE 170				
AAE 35200 52120-002	120 Exam	60	4 Sangid, M D	ARMS B071 ARMS	Fri 12/13 8:00a	PHYS 223				
AAE 35200 62157-003	120 Exam	59	4 Chen, W W	ARMS 1109 ARMS	Mon 12/09 7:00p	ARMS B061				
AAE 36400 10036-001	120 Exam	50	4 Hwang, I	FRNY B124 FRNY	Wed 12/11 8:00a	FRNY G140				



**Examination Timetable**  
Muller, Tomas Administrator Fall 2013 (PWL) [Click here to change the session / role.](#)

Filter Export PDF Refresh

**Examination Timetable** Legend

	8:00a	10:30a	1:00p	3:30p	7:00p
<b>Mon 12/09</b>	ECE 36800 17766-001 0, 0, 0	AGR 20100 10674-001 0, 1, 26	AAE 43900 10058-001 0, 0, 0	CE 20300 12822-001 0, 0, 11	PHYS 34400 27130-001 0, 0, 5
<b>Tue 12/10</b>	MGMT 41100 23824-001, 23825-002 1, 1, 10	MET 21300 34498-001 0, 1, 2	ECE 30862 56185-001 0, 0, 14	MA 37300 42982-001 0, 4, 20	CHE 45600 13886-001 0, 0, 1
<b>Wed 12/11</b>	ME 45200 0, 2, 3	PHRM 82600 56391-001 0, 1, 1	FR 10200 0, 3, 18	ME 30000 0, 6, 18	CS 35400 13241-LE1 0, 1, 7
<b>Thu 12/12</b>	HK 23300 0, 1, 4	ECE 30200 0, 0, 11	PHYS 21500 26987-001 0, 1, 3	PHYS 21900 27009-001 0, 0, 8	
<b>Fri 12/13</b>	IE 34300 50722-002 1, 0, 3	CHM 26505 36107-001 0, 1, 8	AAE 42100 10057-001 0, 0, 2	IE 54500 50788-001 0, 0, 8	TECH 32000 0, 0, 0
<b>Sat 12/14</b>	ECON 37000 2, 1, 13	CE 38300 12876-001 0, 1, 29			

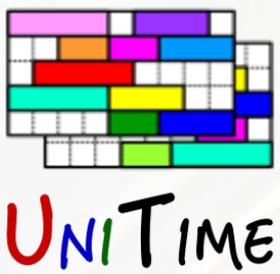
**Legend** Examination Timetable

Assigned examinations:

- 0 student direct conflicts
- 1 student direct conflicts
- 2 student direct conflicts
- 3 student direct conflicts
- 4 student direct conflicts
- 5 student direct conflicts
- 6 or more student direct conflicts

Free times:

- Period not available
- No period preference



# Other Features

## Event Management

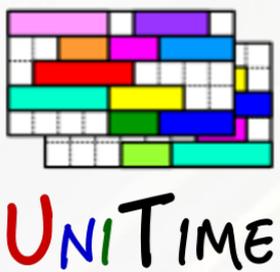
- Management of the remaining classroom space
- Fully distributed, including an (optional) approval process

## And more

- Data exchange, room distances (travel times), date patterns, ...

The screenshot shows the 'Events' management page for Muller, Tomas, Administrator. It includes a filter section with 'Academic Session' set to 'Spring 2014 (PWL)' and 'Room Filter' set to 'Classrooms >=>100 > Central Campus'. Below the filters, there is a table of 'CL50 224 events for weeks 03/31 - 05/18'. The table has columns for Name, Section Type, Title, Date, Published Time, Location, Capacity, Instructor / Sponsor, Main Contact, and Approved. The table lists various lecture and seminar events, including 'AGEC 21700 Lecture Economics', 'ANTH 20500 Lecture Human Cultural Diversity', and 'SPEECH AND DEBATE COMPETITION 1'.

The screenshot shows the 'Personal Timetable' for Blair Nichols for Spring 2014 (PWL). It features a grid view of the timetable from 8am to 5pm across five days (Monday to Friday). The grid is color-coded by event, showing various lecture and seminar slots. For example, on Monday, there are slots for 'HONR 19900H 12188-008 (Lecture)' at 9:00a-10:15a and 'BIOL 11100 12009-013 (Recitation)' at 10:30a-11:20a. The interface also includes a 'Filter' section and 'Print' and 'Export' buttons.



# Conclusion

## UniTime Provides a State-of-the-Art Timetabling Solution

- Can be used for course timetabling, examination timetabling, student scheduling, and event management
- Is very general and can be used on many higher education institutions
- Is easy to extend and/or customize
- Has been applied at large institutions (up to 40,000 students)
- Is gaining interest from institutions around the world
- Has recently entered the Apereo incubation process

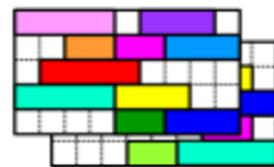
## For more details, please see us at the conference

- Tech Demo Reception Tuesday at 5:30p
- Or visit [www.unitime.org](http://www.unitime.org)

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

# Questions

# Thank You



UNITIME