

UNI^{TIME}

Comprehensive University Timetabling System UniTime

ESUP-Days #19 & Apereo Europe 2015



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



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- 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
- Make 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*



Introducing UniTime

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- 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*
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How UniTime Bridges this Gap

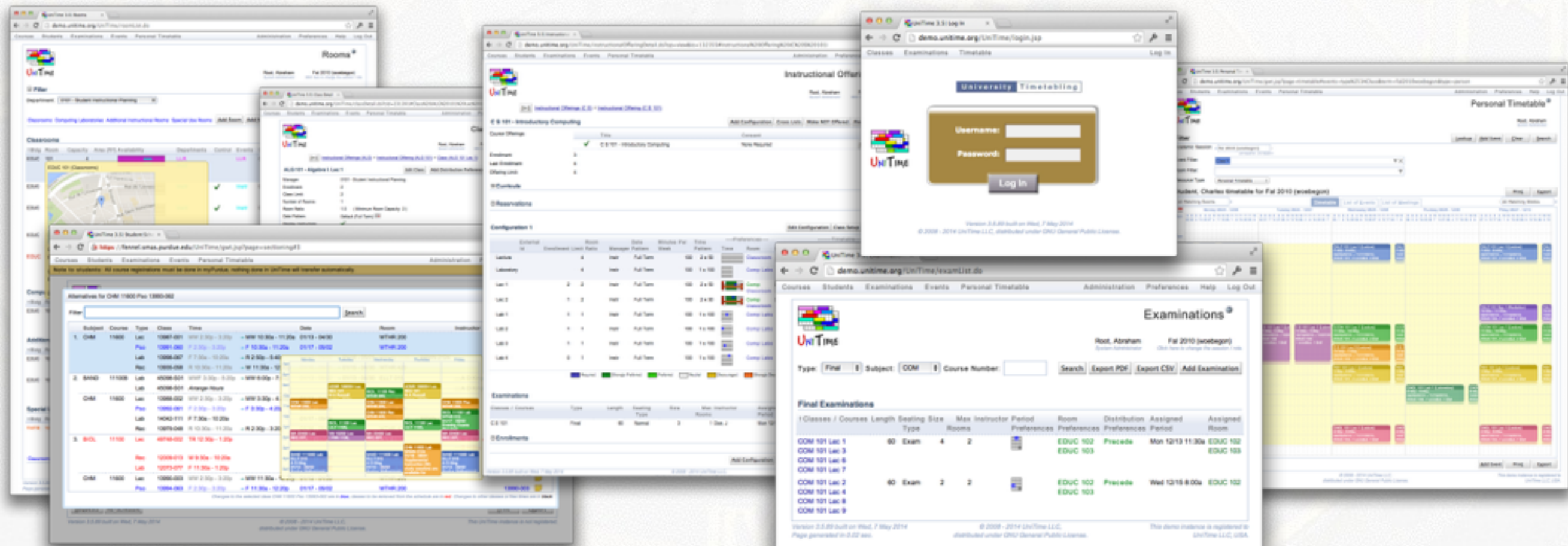
- Began as a research project in 2000
 - *Goal of producing an automated course timetabling solution for a large university*
 - *Makes use of latest timetabling research*
- Became an enterprise system meeting many university timetabling needs



Introducing UniTime

Comprehensive Academic Scheduling Solution

- Course timetabling, examination timetabling, student scheduling and events
- Based on the state of the art optimization algorithms
- Open Source, web-based, written in Java using modern technologies
- Distributed data entry and timetabling in a multi-user environment





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










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	

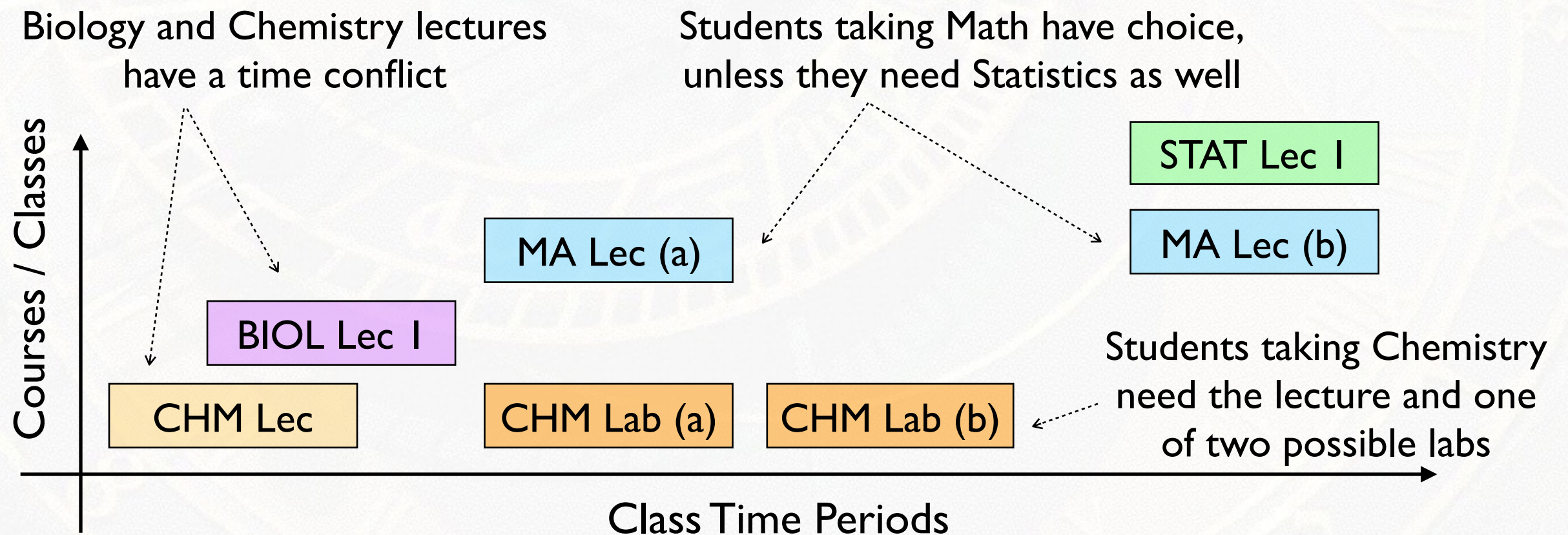
 Required
  Strongly Preferred
  Preferred
  Neutral
  Discouraged
  Strongly Discouraged
  Prohibited



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 Timetabling Solver

Constraint-based Solver

- Can be used in modes between manual and fully automated
- State of the art
 - Work published a number of research papers
 - 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)

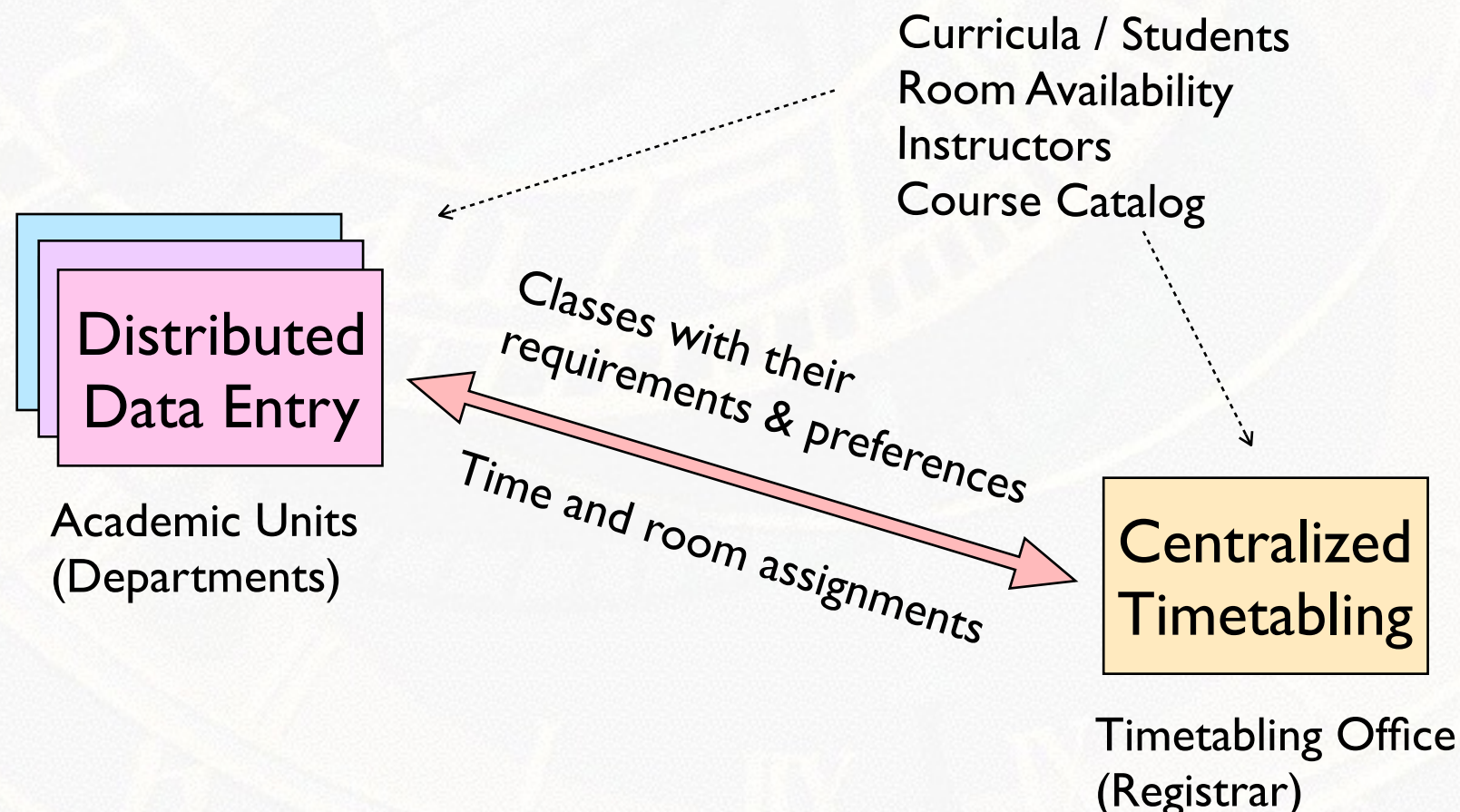
Search Deeper



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 managers in each department (academic unit)
 - Course timetable is produced by a central (timetabling) office

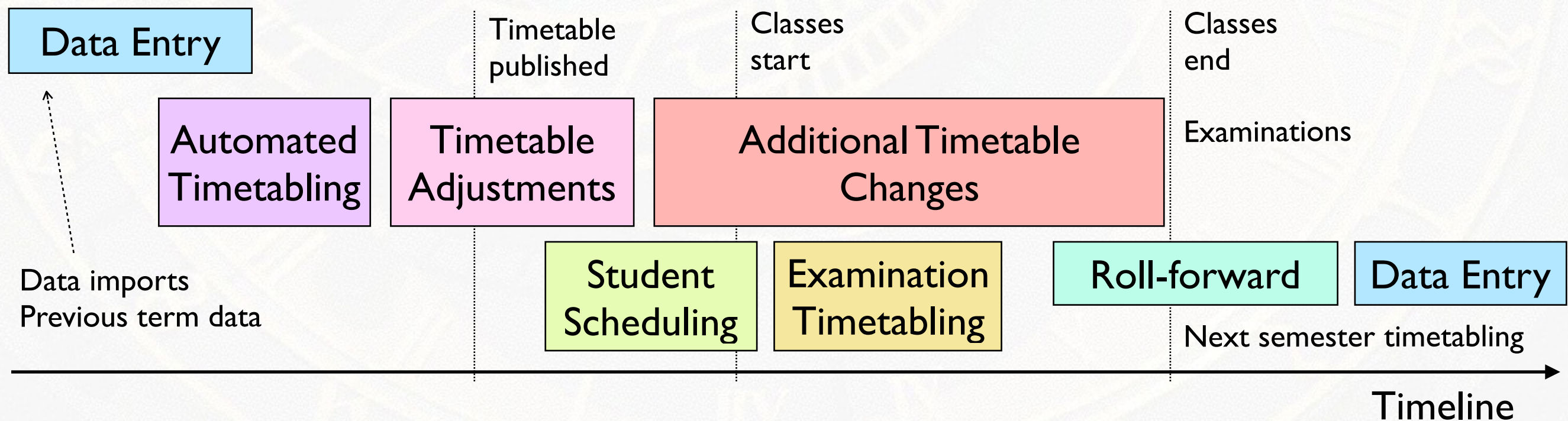




Course Management

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. Examination timetabling
7. Roll-forward of selected data into the next like term

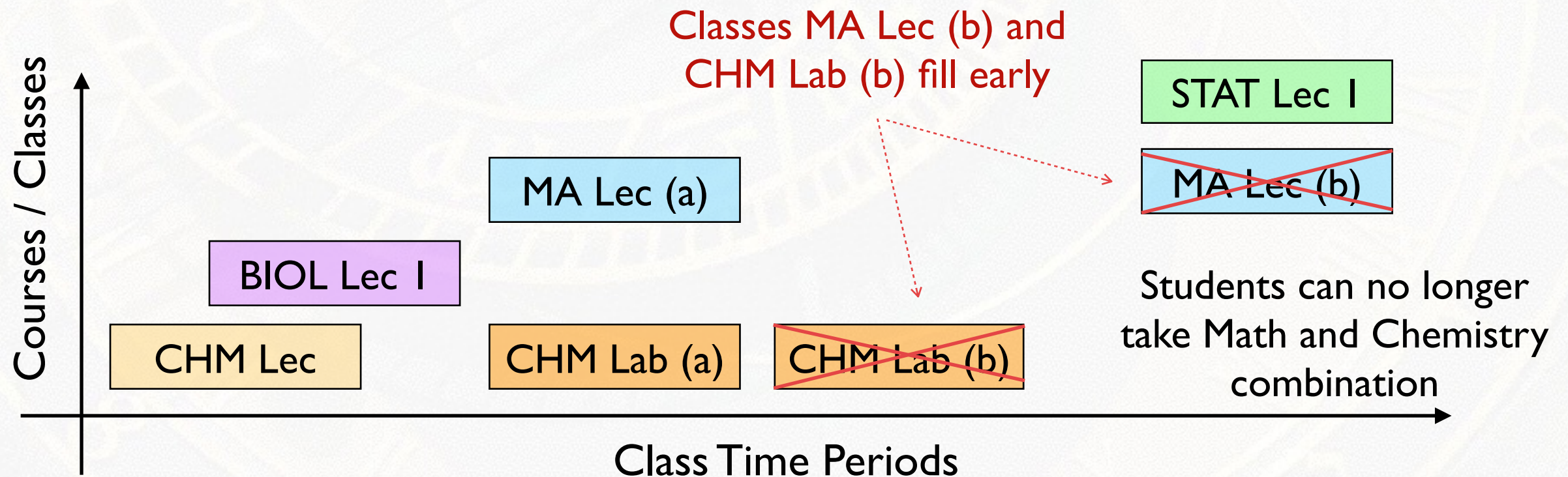




Student Scheduling

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[®]

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								

Schedule




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 historical student demand
- Reservations, automated wait-list processing, instructor consents, advisor roles, etc.

 **Student Scheduling Assistant®**

User: Hooser, Blair Nichols Session: Spring 2014 (PWL)
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[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	48748-002	0 / 425	TR	12:30p	1:20p	01/14 - 05/01	LULY 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	On weeks when all three lecture...	
<input type="checkbox"/>			Lab	14035-104	8 / 24	F	7:30a	10:20a	01/17 - 05/02	BRVN 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	12185-006	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*

UNITIME

Examinations[®]

Muller, Tomas

Administrator

Fall 2013 (PWL)

[Click here to change the session / role](#)

Type: Subject: Course Number:

Final Examinations

Classes / Courses	Length	Seating	Size	Max Instructor	Period	Room	Distribution	Assigned	Assigned
Type				Rooms	Preferences	Preferences	Preferences	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 Fail 2013 (PWL) [Click here to change the session / role.](#)

Filter Export PDF Refresh

Examination Timetable

	8:00a	10:30a	1:00p	3:30p	7:00p
Mon 12/09	ECE 36800 17766-001 0, 0, 0	AGR 20100 10674-001 0, 1, 20	AAE 43900 10058-001 0, 0, 0	CE 20300 12822-001 0, 0, 11	PHYS 34400 27130-001 0, 0, 5
Tue 12/10	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
Wed 12/11	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
Thu 12/12	HK 23300 0, 1, 4	ECE 30200 0, 0, 11	PHYS 21500 26987-001 0, 1, 3	PHYS 21900 27009-001 0, 0, 8	
Fri 12/13	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
Sat 12/14	ECON 37000 2, 1, 13	CE 38300 12876-001 0, 1, 20			

Legend

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, ...

Events

Muller, Tomas

Filter

Academic Session: Spring 2014 (PWL)

Event Filter: 0:00 hrs

Room Filter: CL50 224

CL50 224 events for weeks 03/31 - 05/18

Name	Section Type	Title	Date	Published Time	Location	Capacity	Instructor / Sponsor	Main Contact	Approved
AGEC 21700	10562-002	Lecture Economics	MWF 03/31 - 05/02, 2014	12:30p - 1:20p	CL50 224	470	Parkia, 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	Horan, C J	09/18/2013
ANTH 20900	11541-001	Lecture Human Cultural Diversity	MW 03/31 - 04/03, 2014	3:30p - 4:20p	CL50 224	470	Ricks, 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 26200	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
ENR 10300	19637-001	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	Chang, G J	Horan, C J	09/18/2013
MA 16200	57850-200	Lecture Pl Anly Geo Calc II	MWF 03/31 - 05/02, 2014	9:30a - 10:20a	CL50 224	470	Beruelove, R	Horan, C J	09/18/2013
MGMT 20000	23494-002	Lecture Intro Accounting	TTh 04/01 - 05/01, 2014	4:30p - 5:45p	CL50 224	470	Tiss, R	Horan, C J	09/18/2013
MGMT 20000	22501-001	Lecture Intro Accounting	TTh 04/01 - 05/01, 2014	noon - 1:10p	CL50 224	470	Tiss, 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	Hills, 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		Sun 04/13, 2014	7:00a - 6:00p	CL50 224	470			10/08/2013
			Fri 04/25, 2014	5:30p - 10:30p	CL50 224	470			10/08/2013
			Sat 04/26, 2014	7:00a - 10:30p	CL50 224	470			10/08/2013
			Sun 04/27, 2014	7:00a - 6:00p	CL50 224	470			10/08/2013
			Fri 04/11, 2014	3:30p - 5:30p	CL50 224	470	C Richard Pettigrew Forum Schultz, J P		11/14/2013

Personal Timetable

Muller, Tomas

Filter

Academic Session: Spring 2014 (PWL)

Hooser, Blair Nichols timetable for Spring 2014 (PWL)

Timetable

Weeks 03/31 - 05/18

Day	Time	Event
Mon 03/31	12:30p - 1:20p	AGEC 21700 (Lecture Economics)
Tue 04/01	10:30a - 11:45a	AGEC 33100 (Lecture Selling Agri Business)
Wed 04/02	3:30p - 4:20p	ANTH 20900 (Lecture Human Cultural Diversity)
Thu 04/03	11:30a - 12:20p	CLCS 23300 (Lecture Comparative Mythology)
Fri 04/04	3:00p - 4:15p	COM 31800 (Lecture Prin Of Persuasion)
Sat 04/05	9:00a - 10:15a	ECON 25200 (Lecture Macroeconomics)
Sun 04/06	7:30a - 8:45a	ECON 26200 (Lecture Macroeconomics)
Mon 04/07	1:30p - 2:20p	ENR 10300 (Lecture Intro Envir Conservatn)
Tue 04/08	2:30p - 3:20p	IE 37000 (Lecture Mfg Processes I)
Wed 04/09	9:30a - 10:20a	MA 16200 (Lecture Pl Anly Geo Calc II)
Thu 04/10	4:30p - 5:45p	MGMT 20000 (Lecture Intro Accounting)
Fri 04/11	noon - 1:10p	MGMT 20000 (Lecture Intro Accounting)
Sat 04/12	8:30a - 9:20a	PSY 12000 (Lecture Elementary Psychology)
Sun 04/13	10:30a - 11:20a	SOC 10000 (Lecture Intro Sociology)
Mon 04/14	1:30p - 2:45p	SOC 10000 (Lecture Intro Sociology)



Conclusion

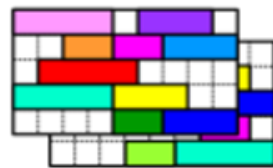
UniTime provides a state of the art timetabling solution

- 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
- Currently in the Apereo incubation process

For more details or to use our online demo visit
www.unitime.org

Questions

Thank You



UNITIME