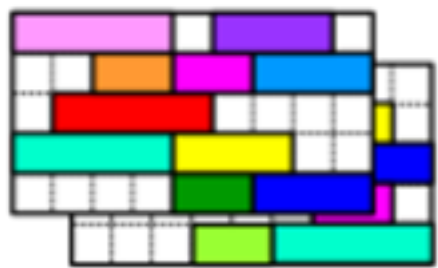


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UNI_ITIME

UniTime 101

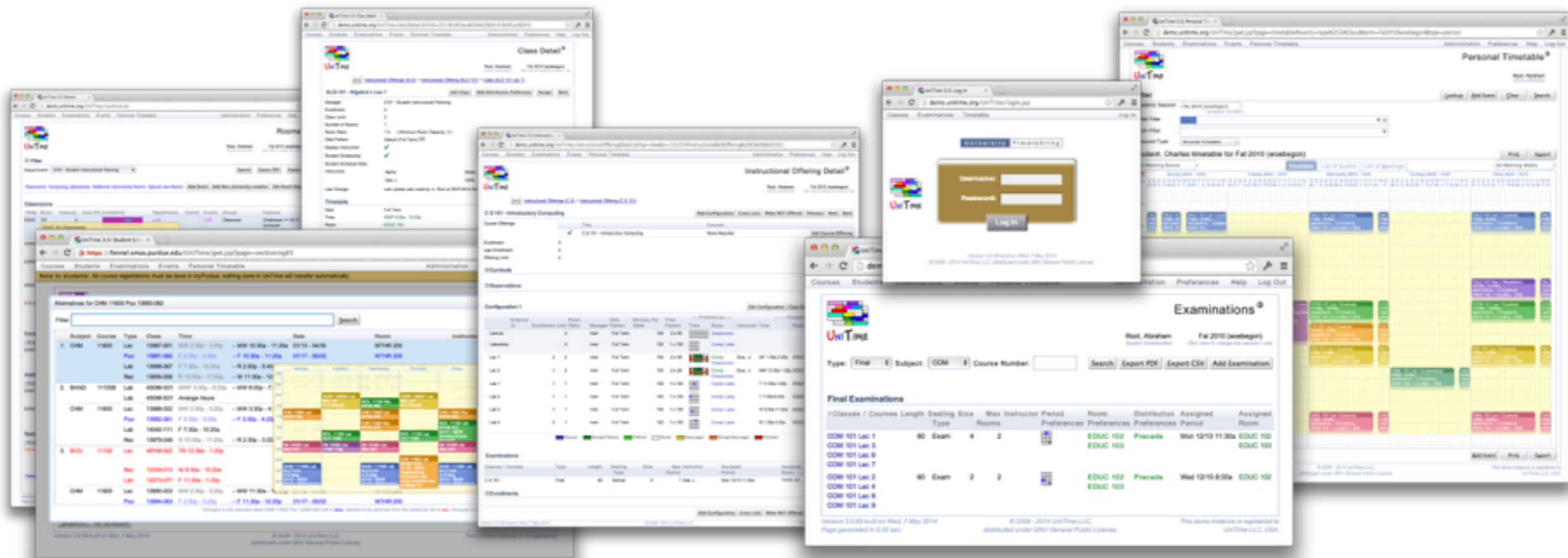
Zuzana Müllerová, Tomáš Müller





Workshop Plan

- UniTime
- Introduction of the four modules
- Administration



The UniTime 101 presentation is available at <http://goo.gl/aCINuy>





What is UniTime?

- Comprehensive academic scheduling solution
- Four components
 - Course timetabling
 - Examination timetabling
 - Student scheduling
 - 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
- First used at Purdue University in 2005
- Apereo project since 2015





UniTime

Course Timetabling





Course Timetabling

What is Course Timetabling?

- The process of assigning **times** and **rooms** to **classes**
- Creating a course timetable for **students**
- Respecting various restrictions and preferences
 - Courses: size, room equipment, structure, ...
 - Instructors: availability, preferred times, ...
 - Students: curricula, pre-registrations, ...
 - Other: number of rooms available and their sizes, ...
- It is a difficult optimization problem





Course Timetabling

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**
- **Fairness** and **satisfaction** with the timetable
- **What-if** scenarios
- Ability to **adapt to changes** (curriculum, facilities, etc.)





Course Timetabling in UniTime

1. Distributed or centralized data entry

- Rooms, instructors, courses
- Requirements and preferences

2. Distributed or centralized timetabling

- Automatically generated timetable
- Manual computer aided modifications

3. Course management

- Once a timetable is published





Administrative Tasks

- Academic session setup
- Roll-forward

Data Entry






- Courses
- Instructors
- Rooms
- Relations between courses / classes (distribution preferences)
- Curricula (plans of study)





Data Entry: Courses

Instructional Offering

		Limit	Date	Pattern	Minutes	Per Week	Time	Pattern	Time	----Preferences----		
										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





Data Entry: Courses

Instructional Offering

Course Offerings

		Limit	Date	Pattern	Minutes	Per Week	Time	Pattern	Time	----Preferences----		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










Data Entry: Courses

Instructional Offering

Course Offerings

Scheduling Subparts

		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

----Preferences----





Data Entry: Courses

Instructional Offering

Course Offerings

Scheduling Subparts

Classes

							----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





Data Entry: Dates and Times

Date Patterns

- Weeks of instructions (All weeks, Even/Odd weeks, Week 5, ...)

March 2015

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
10	1	2	3	4	5	6	7
11	8	9	10	11	12	13	14
12	15	16	17	18	19	20	21
13	22	23	24	25	26	27	28
14	29	30	31				

April 2015

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
14				1	2	3	4
15	5	6	7	8	9	10	11
16	12	13	14	15	16	17	18
17	19	20	21	22	23	24	25
18	26	27	28	29	30		

May 2015

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
18						1	2
19	3	4	5	6	7	8	9
20	10	11	12	13	14	15	16
21	17	18	19	20	21	22	23
22	24	25	26	27	28	29	30
23	31						

Time Patterns

- Possible time slots within a week

2h

	from:	7:30a	8:25a	9:20a	10:15a	11:10a	12:05p	1:00p	1:55p	2:50p	3:45p	4:40p	5:35p	6:30p
	to:	9:10a	10:05a	11:00a	11:55a	12:50p	1:45p	2:40p	3:35p	4:30p	5:25p	6:20p	7:15p	8:10p
Mon		Discouraged	Strongly Preferred	Strongly Preferred	Strongly Preferred	Preferred	Neutral	Neutral	Neutral	Discouraged	Strongly Discouraged	Strongly Discouraged	Prohibited	Prohibited
Tue		Discouraged	Strongly Preferred	Strongly Preferred	Strongly Preferred	Preferred	Neutral	Neutral	Neutral	Discouraged	Strongly Discouraged	Strongly Discouraged	Prohibited	Prohibited
Wed		Discouraged	Strongly Preferred	Strongly Preferred	Strongly Preferred	Preferred	Neutral	Neutral	Neutral	Discouraged	Strongly Discouraged	Strongly Discouraged	Prohibited	Prohibited
Thu		Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited

Required	Required
Strongly Preferred	Strongly Preferred
Preferred	Preferred
Neutral	Neutral
Discouraged	Discouraged
Strongly Discouraged	Strongly Discouraged
Prohibited	Prohibited





Data Entry: Rooms

Rooms

- Each department may have a different set of rooms
- Some times may be unavailable or given to a different department

K 73

Workdays × Daytime ⌵																						
from:	7:30a	8:00a	8:30a	9:00a	9:30a	10:00a	10:30a	11:00a	11:30a	12:00p	12:30p	1:00p	1:30p	2:00p	2:30p	3:00p	3:30p	4:00p	4:30p	5:00p	5:30p	6:00p
to:	8:00a	8:30a	9:00a	9:30a	10:00a	10:30a	11:00a	11:30a	12:00p	12:30p	1:00p	1:30p	2:00p	2:30p	3:00p	3:30p	4:00p	4:30p	5:00p	5:30p	6:00p	6:30p
Mon																						
Tue	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL	BIOL
Wed	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC													
Thu	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC	CIVC													
Fri	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- Room coordinates, travel times

	A 50	D 20	K 73	140A	JAMU		
A 50			5	5	19	22	A 50
D 20		5		0	17	20	D 20
K 73		5	0		17	22	K 73
140A		19	17	17		10	140A
JAMU		22	20	22	10		JAMU
	A 50	D 20	K 73	140A	JAMU		





Data Entry: Room Preferences

Minimal Room Size

- Calculated from class limit and room ratio

Room Preferences

- Particular room or building
- Room group
- Room feature

Room Groups:	Geology Classroom (Department) Classroom
Rooms:	B 11
Buildings:	Y - Porici 7, budova Y
Room Features:	Data Projector
Available Rooms:	34 (A 51, A 53, A 54, A 55, ...)





Data Entry: Distributions

Distribution Preferences

- Relationship between two or more classes
- Examples
 - Back-To-Back
 - Same Room
 - Same Days
 - Meet Together
 - At Most 6 Hours A Day
 - Can Share Room
- Set directly between classes / subparts or on an instructor





Data Entry: Instructors

Instructors

- Each department has a list of instructors
 - Connection between departments through external id
- Instructor availability (prohibited times)
- Instructor preferences & requirements
 - Time, room, distribution

Preferences

Time:

Workdays × Daytime

Horizontal

	from:	7:30a	8:00a	8:30a	9:00a	9:30a	10:00a	10:30a	11:00a	11:30a	12:00p	12:30p	1:00p	1:30p	2:00p	2:30p	3:00p	3:30p	4:00p	4:30p	5:00p	5:30p	6:00p	6:30p
	to:	8:00a	8:30a	9:00a	9:30a	10:00a	10:30a	11:00a	11:30a	12:00p	12:30p	1:00p	1:30p	2:00p	2:30p	3:00p	3:30p	4:00p	4:30p	5:00p	5:30p	6:00p	6:30p	
Mon																								
Tue																								
Wed																								
Thu																								
Fri																								

	Strongly Preferred
	Preferred
	Neutral
	Discouraged
	Strongly Discouraged
	Prohibited

Room Groups: **Computer Lab**

Buildings: **D - Porici 31, budova D**

K - Porici 31, budova K

Room Features: **Interactive Blackboard**

Piano

Distribution: **At Most 5 Hours A Day**

Required Strongly Preferred Preferred Neutral Discouraged Strongly Discouraged Prohibited





Data Entry: Preferences

Combination of preferences

- Preferences can be set on scheduling subpart, class, or instructor
- The end result is displayed on the class and used by the solver

							----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





Student Course Demands

Curricula

- For a group of students of the same major and classification
- Requested enrollment
- List of courses and their expected attendance
- Courses can be grouped together (same / different students)

Course Projections			
Group	Course		01
Required	ALG 101		100.0%
Required	CALC 101		100.0%
Elective	ENGL 101		60.0%
Elective	SPAN 101		40.0%
	BIOL 101		10.0%
	CHM 101		20.0%

Course Projections			
Group	Course		01
M1 and M2	M or N or O	M1	50.0%
M1 and M2		M2	50.0%
N1 and N2	M or N or O	N1	30.0%
N1 and N2		N2	30.0%
O1 and O2	M or N or O	O1	20.0%
O1 and O2		O2	20.0%

Last year's enrollments

Pre-registration

Other possible sources: historical enrolments, pre-registrations, or their combination





Data Entry: Input Data

Importance of having good input data

- The solution will only be as good as the input data
- No preferences
 - A class can end up anywhere (unpopular time, wrong room)
- Too many requirements
 - Impossible to find a complete timetable
 - Too many student conflicts
 - Difficult to make modifications





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





Timetabling: Problem

Model

- Variable: class
- Value: time and room placement
- Constraints: hard and soft





Timetabling: Problem

Model

- Variable: class
- Value: time and room placement

Hard Constraints

- Room size, sharing, availability
- No instructor / room can have two classes at the same time
- Required or prohibited preferences





Timetabling: Problem

Model

- Variable: class
- Value: time and room placement

Hard Constraints

- Room size, sharing, availability
- No instructor / room can have two classes at the same time
- Required or prohibited preferences

Soft Constraint (Objectives)

- Time, room, and distribution preferences
- Student conflicts
- Additional criteria (too big rooms, back-to-back instructors, ...)

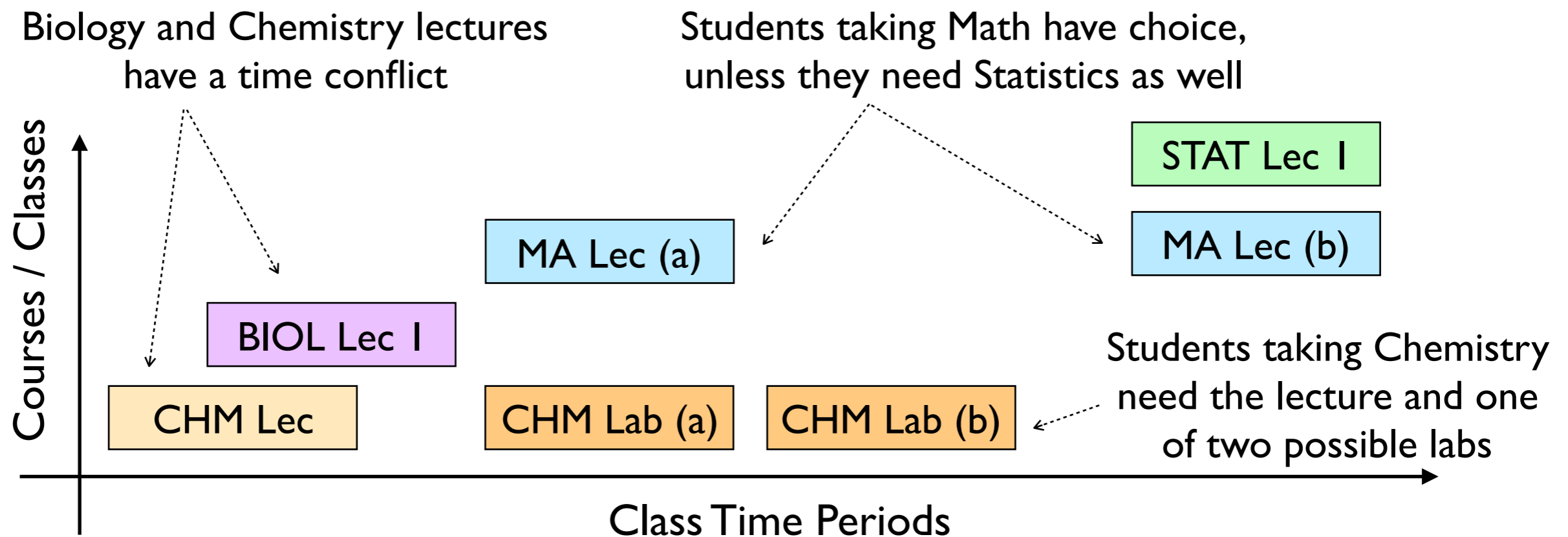




Timetabling: Student Conflicts

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





Timetabling: Solver

Using the Solver

I. Make sure the problem has a solution

- All classes are assigned
- Using check configuration
- Conflict-statistics can be used to discover issues

- [-] 15851× C S 110 Lec 1
 - [-] 6384× MW 1:30p - 2:20p Full Term EE 129 KING, ERIC J
 - [-] 6318× Instructor KING, ERIC J
 - [-] 5771× C S 110 Lec 2 ← MW 1:30p - 2:20p Full Term EE 129 KING, ERIC J
 - [-] 3541× MW 12:30p - 1:20p Full Term LILY 1105 KING, ERIC J
 - [-] 3019× Instructor KING, ERIC J
 - [-] 2931× C S 110 Lec 2 ← MW 12:30p - 1:20p Full Term LILY 1105 KING, ERIC J
 - [-] 3467× MW 12:30p - 1:20p Full Term EE 129 KING, ERIC J
 - [-] 3408× Instructor KING, ERIC J
 - [-] 2932× C S 110 Lec 2 ← MW 12:30p - 1:20p Full Term EE 129 KING, ERIC J
 - [-] 2459× MW 1:30p - 2:20p Full Term LILY 1105 KING, ERIC J
 - [-] 1268× Room LILY 1105
 - [-] 1265× BIOL 221 Lec 1 ← MWF 1:30p - 2:20p Full Term LILY 1105 SANDERS, DAVID
 - [-] 1191× Instructor KING, ERIC J
 - [-] 1191× C S 110 Lec 2 ← MW 1:30p - 2:20p Full Term LILY 1105 KING, ERIC J
- [+] 15840× C S 110 Lec 2
- [+] 2588× BIOL 221 Lec 1
- [+] 338× AGECE 217 Lec 3





Timetabling: Solver

Using the Solver

1. Make sure the problem has a solution
2. Run the solver to produce a timetable
 - Using default configuration
 - It is possible to iterate (if needed), or start the solver from the previous timetable

Type	Course Timetabling Solver
Solver	Solving problem ...
Phase	Improving found solution ...
Progress	5 of 100 (5.0%)
Owner	A. Root as ART & BIOL & CIVC & CZ & ENG & FRN &...
Host	local Change Refresh
Session	Spring 2015 (ED)
Version	4.0.16
Assigned variables	100.00% (1613/1613)
Overall solution value	-17554.24
Time preferences	91.26% (-36722.00)
Student conflicts	807 [committed:0, distance:1, hard:177]
Room preferences	93.31% (-1385)
Distribution preferences	96.37% (-525.00)
Back-to-back instructor preferences	99.98% (1)
Too big rooms	19.84% (1280)
Useless half-hours	0.63% (0 + 1316)
Same subpart balancing penalty	36.58
Room Size Penalty	17.36
Perturbation variables	9.60% (154 + 8)
Perturbations: Total penalty	330.10
Time	0.06 min
Iteration	1940
Memory usage	1791.38M
Speed	520.45 it/s
Block Constraints	100% (0)
Important student conflicts	495 [hard: 34]





Timetabling: Solver

Using the Solver

1. Make sure the problem has a solution
2. Run the solver to produce a timetable
3. Once there is a decent timetable
 - Make manual changes, using interactive configuration

<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)
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+36.6	POL 101 Lec 3	Full Term	TTh 12:00p → TTh 10:30a	BRNG 2280	+36 (h+4)
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	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)

Solver Configuration: it is possible to tweak solver parameters if needed

(there is a tradeoff between times, rooms, distributions, and student conflicts)





Timetabling: Making Changes

Making changes

1. Minimal Perturbation Mode (MPP)
 - When many changes are needed
 - Fully automated (default configuration with the mode set to MPP)
 - Additional criterion: changes from the initial solution
 - Different weights, e.g., time changes are usually more penalized
2. Once there is a timetable saved, use the interactive configuration
 - Can break some constraints
 - Solver provides suggestions, but does not make any decisions
3. When the timetable is published
 - Changes can be made without loading the data into the solver





Timetabling: Cooperation

Decentralized Timetabling

- Defined by solver groups
 - One or more departments that are to be solved together
- Committed solutions of other problems are used as basis
- Multiple problems can be solved together, manual changes can be made separately

Externally Managed Classes

- For instance, distance learning classes are solved separately
- Different set of rooms
- Timetabled before or after the departmental problems
- Other examples: large lecture rooms, computing labs, need room





Timetabling: Publication

Publication

- A committed timetable can be published by changing the status on the academic session
- Instructors and students can see the timetable
- Next steps
 - Export to an external system
 - Student scheduling
 - Examination timetabling
 - Event management

The screenshot displays the 'Personal Timetable' interface for Blair Nichols in Spring 2014. The interface includes a filter section for the academic session, a title for the user's timetable, and navigation options like 'Print' and 'Export'. The main area is a grid showing a weekly schedule from Monday to Friday. Each cell in the grid contains a colored box representing a class, with details such as course number, instructor name, and room. The schedule is color-coded by day: Monday (yellow), Tuesday (green), Wednesday (purple), Thursday (pink), and Friday (blue). The interface also shows a list of matching works on the right side of the grid.

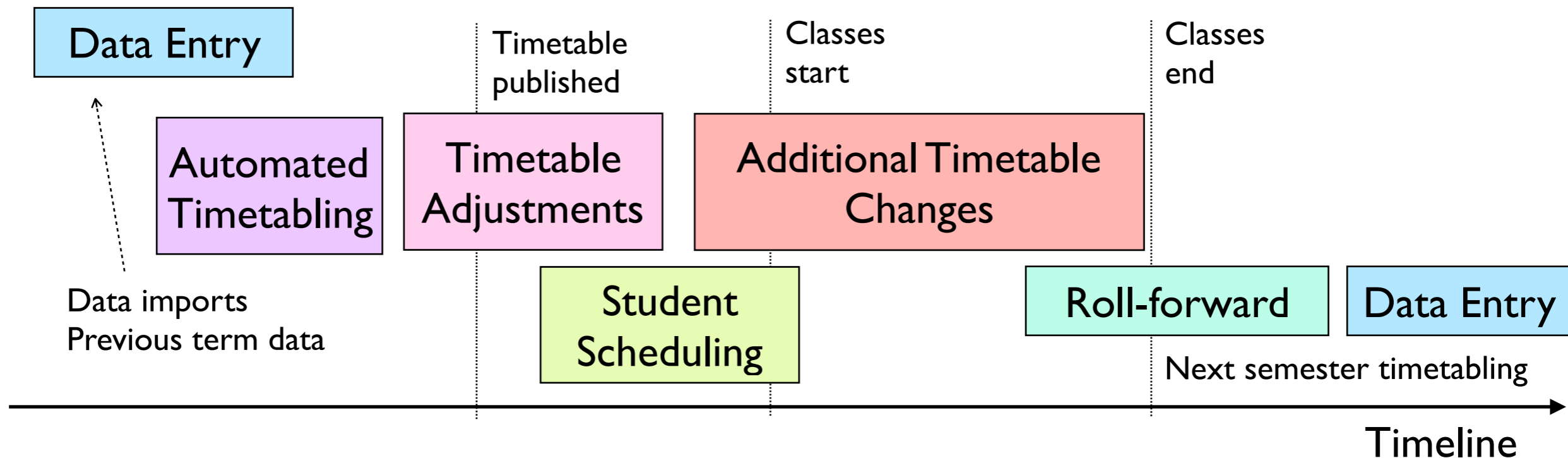




Course Management

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





Demonstration

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
- 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





Examination Timetabling





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





Example Data Entry

Final Examinations

↑ Classes / Courses	Length	Seating Type	Size	Max Rooms	Instructor	Period Preferences	Room Preferences	Distribution Preferences	Assigned Period	Assigned Room
MGMT 20000	120	Exam	881	4					Thu 12/12 7:00p	LAMB F101
MGMT 20010 50874-T01	120	Exam	205	4			PHYS 114 PHYS		Mon 12/09 8:00a	WTHR 200
MGMT 20100	120	Exam	437	4					Thu 12/12 3:30p	STEW 183
MGMT 29000B 23766-002	120	Exam	36	4			KRAN		Fri 12/13 10:30a	KRAN G016
MGMT 30400	120	Exam	115	4					Tue 12/10 1:00p	LILY 1105
MGMT 30500 23769-001 MGMT 30500 23771-003 MGMT 30500 23772-004 MGMT 30500 23770-002	120	Exam	280	4			RAWL 1086 RAWL	Same Per	Wed 12/11 1:00p	WTHR 200 WTHR 104
MGMT 30500 23773-005	120	Exam	70	4			RAWL 1062 RAWL	Same Per	Wed 12/11 1:00p	WTHR 172
MGMT 30600	120	Exam	236	4					Mon 12/09 8:00a	STEW 183

Required
 Strongly Preferred
 Preferred
 Neutral
 Discouraged
 Strongly Discouraged
 Prohibited





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





Examination Problem

Soft Constraints / Objectives

- Direct conflicts
 - More than two exams 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*)

} student conflicts





Examination Solver

Solver

- Same solver as in course timetabling, different model (variable: exam, value: period and room placement)
- Can handle large problems (e.g., *Purdue has around 1900 exams with 120k enrollments and 29 periods*)
- Easy to extend and customize
- It is possible to use just the solver (without UniTime user interface)
 - See http://www.unitime.org/cpsolver_examples.php
- It is possible to use UniTime just for exams
- However, because exams take student data from courses and/or classes
 - A course structure with classes is needed (but can be simplified)
 - Students and their class enrollments





UniTime

Student Scheduling





Student Scheduling

What is Student Scheduling?

- Enrollment of student into classes in a way that maximizes the ability for students to get the courses they need

Why is it 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
- Getting a workable schedule can be a tedious process for a student

Goal

- Student fills in course requests, including alternatives, free times, etc.
- System provides a schedule that meets student needs
- Students have the ability to modify their schedule

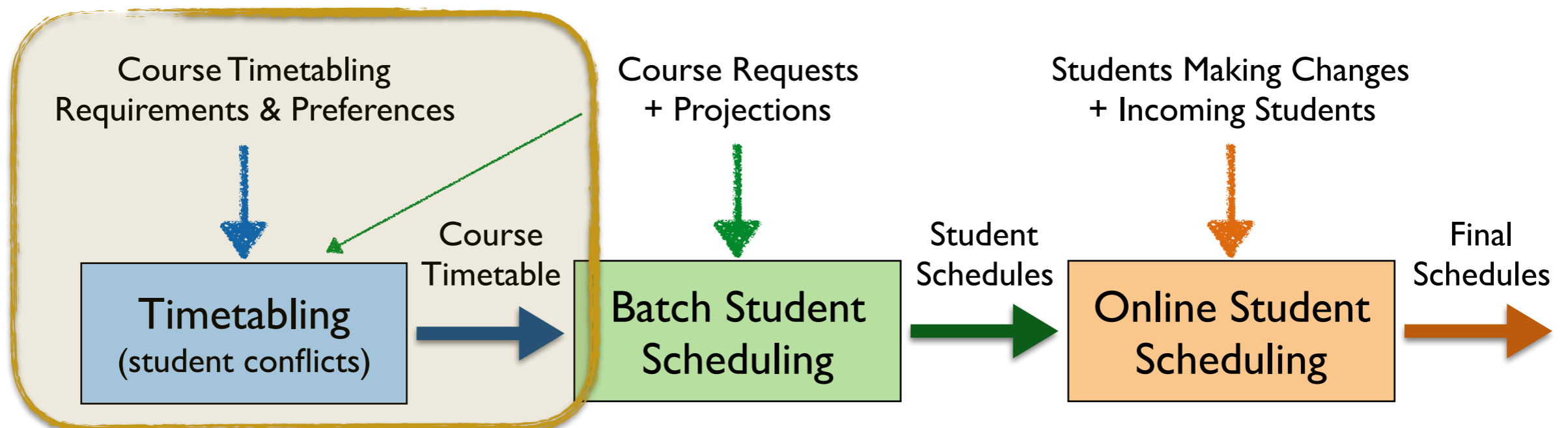




Student Scheduling Process

Step I: Course Timetabling

- Minimizing student conflicts together with faculty preferences
 - Last-like student course enrollments
 - Curricula (e.g., *list of courses for each program and year*)
 - Courses Requests (pre-registration)
 - A combination of these

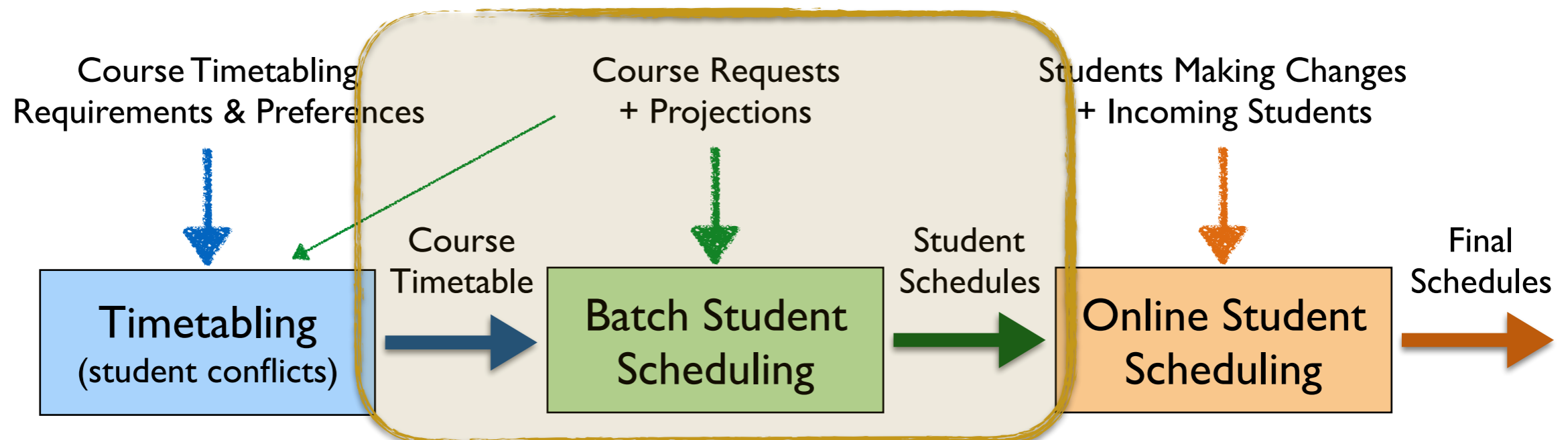




Student Scheduling Process

Step 2: Batch Student Scheduling

- After a timetable is produced
- Using pre-registrations and student course demand projections
- To provide students with initial schedules
- An optimization process, using the (student scheduling) solver
- It is possible to iterate
 - With the ability to keep already enrolled students unchanged or to minimize changes

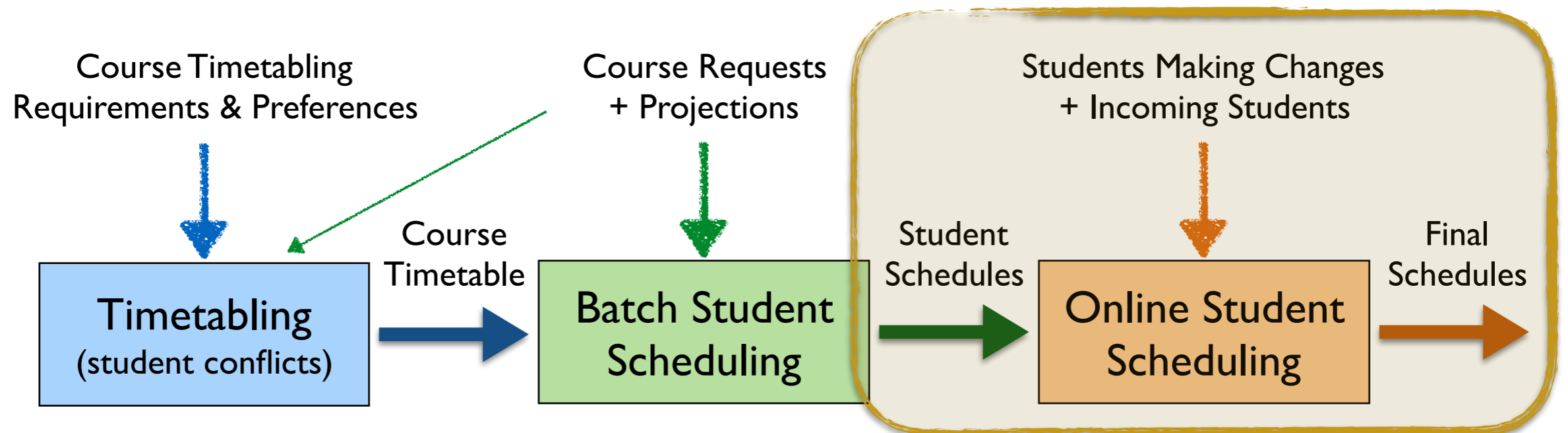




Student Scheduling Process

Step 3: Online Student Scheduling

- Students without pre-registration can enroll online (*incoming freshmen and students that did not register*)
- All students can make adjustments to their schedules
- Automatically reserve space in sections based on historical data
- Solver provides suggestions
 - Ordered by their quality, with the ability to filter through





Course Requests

Course Requests

- Each requested course can have up to two alternatives (or it can be wait-listed)
- There can also be additional alternate course requests to get the desired number of courses
- There can be free time requests in the list

+ Course Structure
+ Reservations
+ Other Constraints

The screenshot displays the 'Student Scheduling Assistant' interface. At the top right, it shows the user 'Student, Imogene Alice' and the session 'Fall 2016 (PWL)'. The main section is titled 'Course Requests' and contains a table with 12 rows. Each row represents a course request with columns for priority, course ID, alternative course, and a 'Wait-List' checkbox. The first row is '1. Priority ENGL 10600' with an alternative of 'ENGL 10600' and the 'Wait-List' checkbox checked. The second row is '2. Priority COM 11400' with an alternative of 'COM 11400'. The third row is '3. Priority Free M 7:00a - 12:00p'. The fourth row is '4. Priority CHM 11500' with an alternative of 'CHM 11100' and the note 'Alt. to CHM 11500 & CHM 11100'. The fifth row is '5. Priority BIOL 11000' with an alternative of 'BIOL 11000'. The sixth row is '6. Priority HIST 37100' with an alternative of 'HIST 37100'. The seventh row is '7. Priority' with an empty alternative. The eighth row is '8. Priority' with an empty alternative. The ninth row is '9. Priority' with an empty alternative. The tenth row is '10. Priority' with an empty alternative. The eleventh row is '11. Priority' with an empty alternative. The twelfth row is '12. Priority Course with the lowest priority.' with an empty alternative. Below the 'Course Requests' table is the 'Alternate Course Requests' section, which is used only if a course requested above is not available. It contains three rows: '1. Alternate AD 11300' with an alternative of 'AD 11300', '2. Alternate' with an empty alternative, and '3. Alternate' with an empty alternative. At the bottom of the interface, there are buttons for 'Degree Plan', 'Current Registration', and 'Build Schedule'.

Priority	Course	Alternative	Wait-List
1. Priority	ENGL 10600	Alternative to ENGL 10600	<input checked="" type="checkbox"/>
2. Priority	COM 11400	Alternative to COM 11400	<input type="checkbox"/>
3. Priority	Free M 7:00a - 12:00p		<input type="checkbox"/>
4. Priority	CHM 11500	CHM 11100 Alt. to CHM 11500 & CHM 11100	<input type="checkbox"/>
5. Priority	BIOL 11000	Alternative to BIOL 11000	<input type="checkbox"/>
6. Priority	HIST 37100	Alternative to HIST 37100	<input type="checkbox"/>
7. Priority			<input type="checkbox"/>
8. Priority			<input type="checkbox"/>
9. Priority			<input type="checkbox"/>
10. Priority			<input type="checkbox"/>
11. Priority			<input type="checkbox"/>
12. Priority	Course with the lowest priority.		<input type="checkbox"/>

Alternate	Course	Alternative
1. Alternate	AD 11300	Alternative to AD 11300
2. Alternate		
3. Alternate		





Student Schedule

Student Schedule

- As complete as possible (alternatives are used when a course is not available)
- Priorities are used to resolve conflicts
- The amount of overlapping time is minimized (where allowed)
- Distance conflicts are minimized (consequent classes too far)

Additional Criteria

- Avoid over-expected classes
- Keep previous schedule
- Section balancing
- Avoid arrange hour classes
- Keep students of the same group together (batch)

Student Scheduling Assistant
User: Student, Imagine Alice Session: Fall 2016 (PWL)

Lock	Subject	Course	Type	CRN	Avail	Days	Start	End	Date	Room	Instructor	Requires	Note	Credit
	ENGL	10600	Lec	65648-859	0 / 3	T	7:30a	8:20a	08/23 - 12/08	HEAV 105				4
			Lec	65648-859	0 / 3	F	7:30a	8:20a	08/26 - 12/08	HEAV 104		65648-859		
			Lec	65648-859	0 / 3	R	7:30a	8:20a	08/25 - 12/08	BRNG B275		65648-859		
			Rec	45178-630	0 / 2	W	7:30a	8:20a	08/24 - 12/07	HEAV 223		65648-859		
	COM	11400	Lec	69540-736	23 / 25	T	8:30a	9:20a	08/23 - 12/08	BRNG B230				3
			Lec	69540-736	23 / 25	R	8:30a	9:20a	08/25 - 12/08	BRNG B230		69540-736		
			Lec	69540-736	23 / 25	F	8:30a	9:20a	08/26 - 12/09	BRNG B232		69540-736		
	Free	Time				M	7:00a	12:00p						
	CHM	11500	Lec	14183-002	68 / 95	MF	3:30p	4:20p	08/22 - 12/09	WTHR 200	C Das		Supplemental Instruction (SI) stu...	4
			Lab	42365-183	4 / 5	R	11:30a	2:20p	08/25 - 12/08	BRWN 2124		14183-002	Supplemental Instruction (SI) stu...	
			Rec	42498-236	4 / 5	W	12:30p	1:20p	08/24 - 12/07	WTHR 362		42365-183	Supplemental Instruction (SI) stu...	
	BIOL	11000	Lec	12061-001	360 / 445	TR	2:30p	3:20p	08/23 - 12/08	LILY 1105	A R Anderson		Supplemental Instruction (SI) stu...	4
			Rec	12088-027	35 / 40	R	4:30p	5:20p	08/25 - 12/08	WTHR 420			Supplemental Instruction (SI) stu...	
			Lab	12131-071	23 / 29	T	6:00p	7:50p	08/23 - 12/08	WTHR 316			Supplemental Instruction (SI) stu...	
	HIST	37100			Not available (course is full)									
	AD	11300	Stds	10191-006	3 / 14	MWF	1:30p	3:20p	08/22 - 12/09	PAD 3108			\$100 course fee.	3
Total Credit: 18														

Buttons: Add/Drop Courses, Rearrange Schedule, Current Registration, Submit Schedule, Print





Other Features

Other Features

- Expectations (avoid over-expected classes, if possible)
- Automated wait-listing
- Consent of instructor, department
- Linked classes
- Reservations (individual, student group, course, curriculum)
- Allow time conflicts (for a course, for a request, between classes)
- Course management (locking)
- Enrollment deadlines
- Email notifications
- Dashboard, student change logs
- Reports
- User roles, student statuses, mass cancel, customizations, ...





UniTime

Event Management





Event Management

What is Event Management?

- Booking rooms for events
- Process
 - Anybody can enter a request for reservation
 - Event manager approves / rejects / inquires further

The screenshot displays the UNITIME Event Management interface. At the top, there is a 'Filter' section with 'Academic Session: Spring 2015 (ED)' and buttons for 'Add Event', 'Clear', and 'Search'. Below this is a 'Dates' section showing a calendar grid for February, March, April, May, June, and July 2015. A legend on the right indicates: Selected (yellow), Not Selected (white), Not in Session (grey), Classes Start/End (blue), and Holiday (red). The 'Times' section shows 'From: 9:00 am' and 'To: 9:00 am'. The 'Locations' section shows 'A 50'. Below the calendar, there is a 'Print' button and a 'Sort by' dropdown. The main content area shows a list of events for room 'A 50 (234)'. The events are:

Room	Event	Time	Enrollment	Instructor
7am	PED 201 Rec 2 (Recitation)	7:30a - 8:15a	0 enrolled, 267 limit	Jones, Jonathan, Robinson, Sophie
8am	PED 201 Rec 3 (Recitation)	8:30a - 9:15a	0 enrolled, 267 limit	Jones, Jonathan, Robinson, Sophie
9am	PED 404 Rec 7 (Recitation)	8:30a - 10:00a	0 enrolled, 30 limit	Webb, Lucas





Event Management

Why is it needed?

- Accurate information about room availability
- Searchable information about scheduled student's or instructor's activities in one place
 - Course timetable
 - Course related events
 - Examinations
 - Student's room reservations

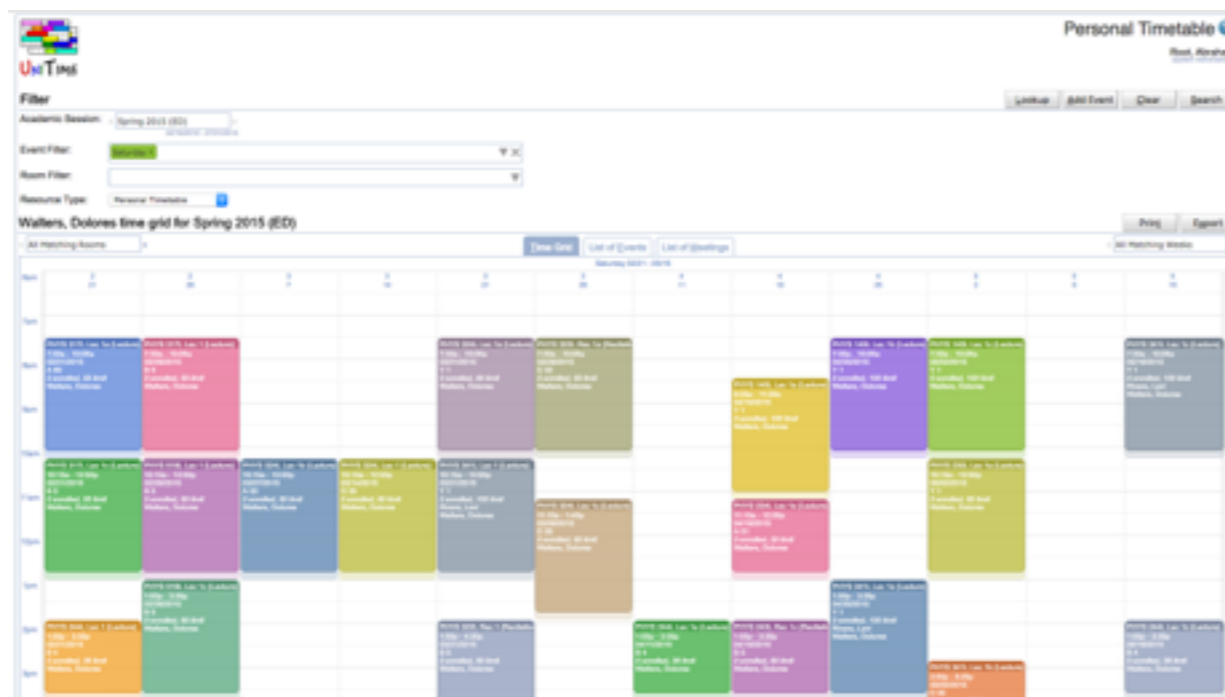




Event Management

Features

- Committed timetables are displayed here
- Lookup of available rooms by certain criteria
- Extensive filtering capabilities
- Personal timetables (students, instructors)
- Export to ical or other formats





UniTime

Administration



Installation

- Java



- Tomcat



- MySQL or Oracle



ORACLE®

- UniTime



- Instructions at http://help.unitime.org/Timetabling_Installation

Authentication

- LDAP, CAS, ...



Initial setup of the system

- Instructional types
 - Lecture, Recitation, ...
- Status types
 - Possible statuses of the academic session
- Room types
 - Rooms are sorted by their types in Rooms pages
- Position types
 - Positions of instructors; not essential for timetabling
- There are some defaults in the woebegon database





Academic session setup - new session

- Add a new academic session with important dates

Academic session setup - XML

- Departments
- Subject areas
- Buildings and rooms
- Staff
- Courses
- (Academic areas, classifications, majors, curricula)

Information available at http://www.unitime.org/uct_interfaces.php





Administration

Academic session setup - manual

- Solver groups
- Managers
- Date patterns
- Time patterns

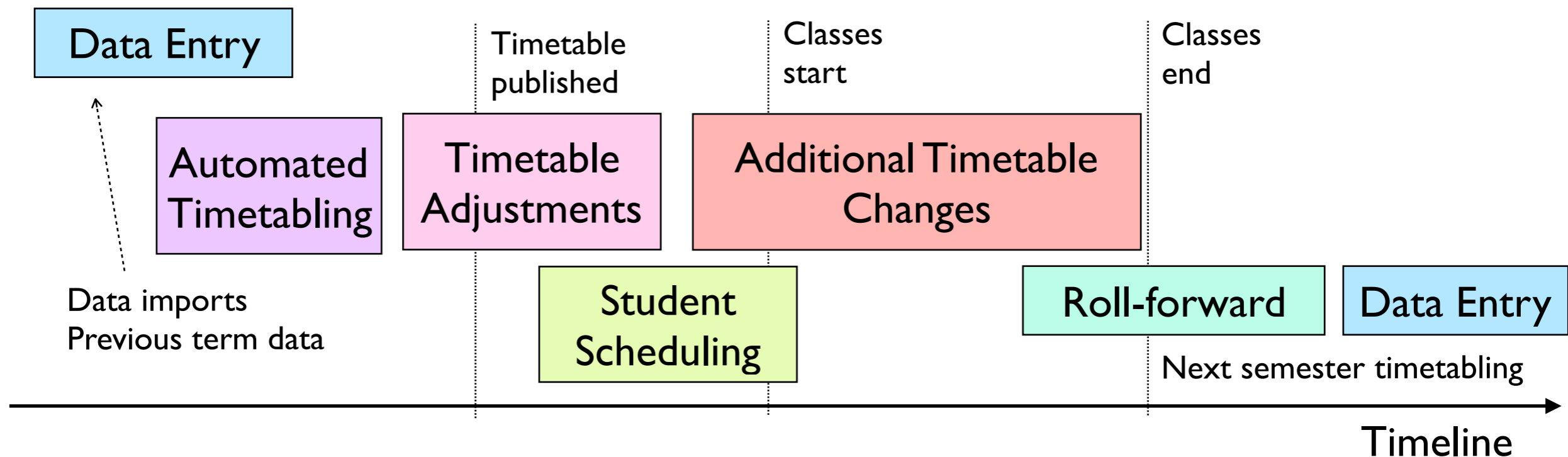
And you can start!





Academic session roll-forward

- When there already are academic sessions in UniTime
- Roll-forward most of a session's data
- Possible to combine data from different sessions
- After roll-forward, it is possible to still use XMLs to update the data





Conclusion

UniTime

- Comprehensive system
- We have covered only the basics

For more details, please see us at the conference

- UniTime: State of the Project (Tuesday, 3pm - 3:45pm in KC 912)
- Student Scheduling in UniTime (Wednesday, 11:45am - 12:30pm in KC 912)
- Or visit www.unitime.org

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

