



UNI|Time: University Course Timetabling & Student Scheduling System

System Demonstration

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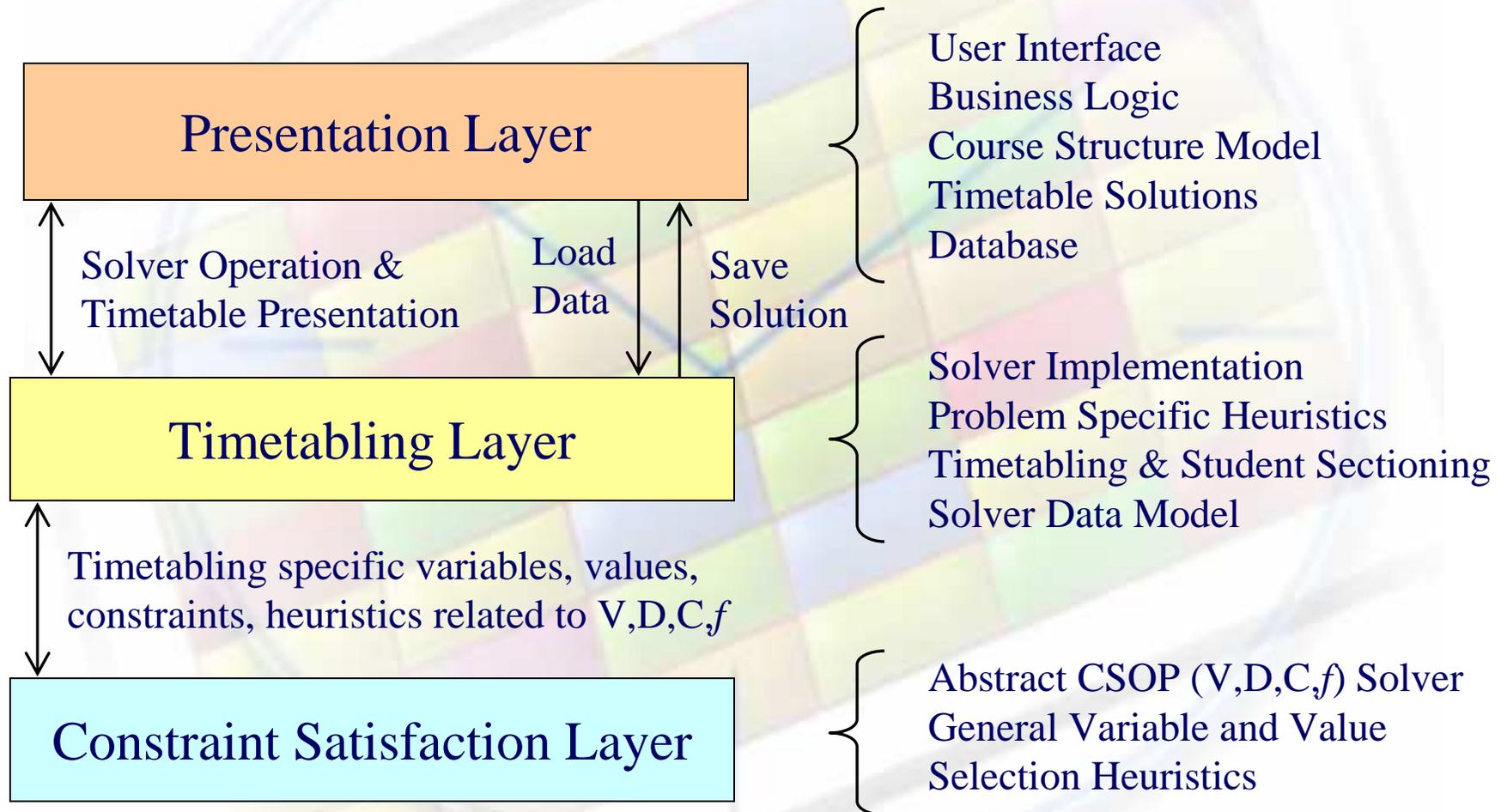
Keith Murray

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UNI|Time: Motivation

- Course Timetabling & Student Sectioning Problem at Purdue University
 - Create and modify course timetables that better meet student course demands
 - And allow students to be assigned to the courses in a way that minimizes conflicts
 - Large scale university-wide problem
 - 9 000 classes, 570 rooms, 39 000 students with 259 000 class requests
 - Allow decomposition to several problems (large lectures, departmental timetables)
 - Departmental schedule managers responsible for their own solutions

UNI|Time: System Architecture



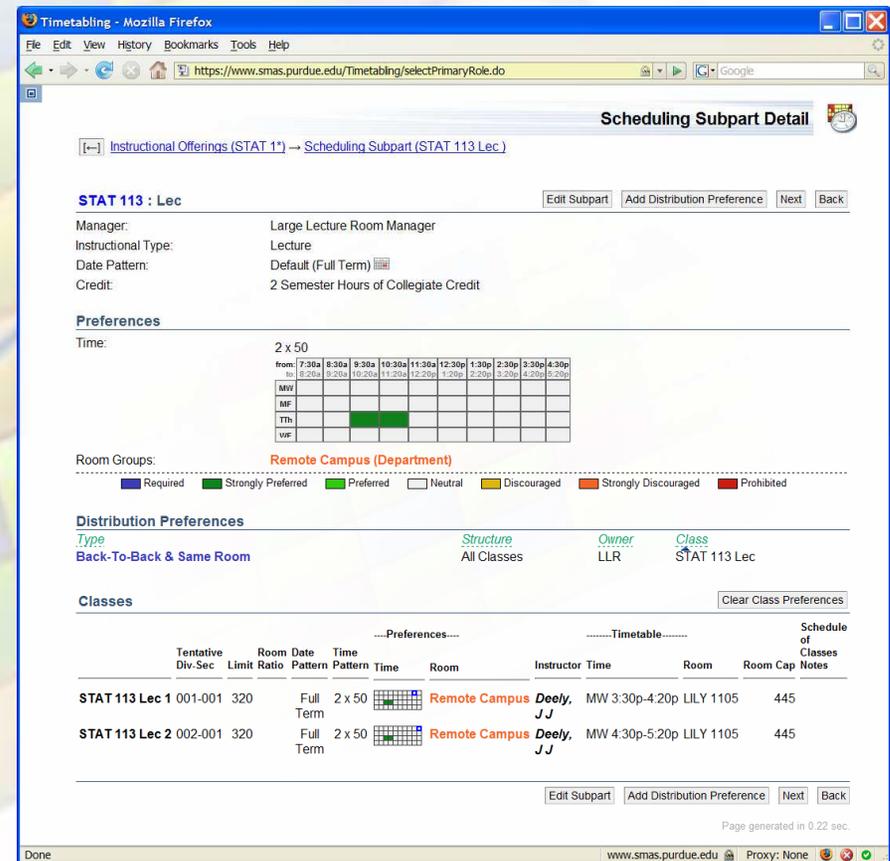
UNI|Time: System Architecture

- Web Server
 - Server-client application with web-based interface
 - Written in Java, using J2EE, Hibernate, and SQL-enabled database
 - Supports coordinated work on timetable in a multi-user environment

- Solver
 - Based on Iterative Forward Search (IFS) algorithm
 - A mixture of local search and backtracking
 - Gradually extends (partial) feasible assignment
 - Applicable to various problems and scenarios
 - Easily extensible
 - Problem model and constraints consider complexity of all university courses
 - Interaction between problems
 - Competitive behavior (fairness of the solutions among departments)
 - Data consistency
 - Ability to identify and present to the user any inconsistencies and potential problems in the input data

UNI|Time: Course Timetabling

- For each class
 - Student requirements
 - Time requirements & preferences
 - Meeting patterns
e.g., 3 x 50 min, 2 x 75 min
 - Room requirements & preferences
 - Capacity
 - Required equipment
 - Room / building preference
 - Building distances
- Instructor
- Additional (distribution) constraints
 - Between several classes
e.g., back-to-back, precedence
- Other
 - Departmental balancing,
efficient utilization of time and rooms, ...



STAT 113 : Lec [Edit Subpart] [Add Distribution Preference] [Next] [Back]

Manager: Large Lecture Room Manager
 Instructional Type: Lecture
 Date Pattern: Default (Full Term) [v]
 Credit: 2 Semester Hours of Collegiate Credit

Preferences

Time: 2 x 50

from:	7:30a	8:30a	9:30a	10:30a	11:30a	12:30p	1:30p	2:30p	3:30p	4:30p
to:	8:20a	9:20a	10:20a	11:20a	12:20p	1:20p	2:20p	3:20p	4:20p	5:20p
MW										
MF										
TTh										
WFr										

Room Groups: Remote Campus (Department)

Legend: Required Strongly Preferred Preferred Neutral Discouraged Strongly Discouraged Prohibited

Distribution Preferences

Type: Back-To-Back & Same Room
 Structure: All Classes
 Owner: LLR
 Class: STAT 113 Lec

Classes [Clear Class Preferences]

Tentative Div.-Sec	Room Limit Ratio	Date Pattern	Time Pattern	Time	Room	Instructor	Time	Room	Room Cap	Schedule of Classes Notes
STAT 113 Lec 1 001-001	320	Full Term	2 x 50		Remote Campus	Deely, J J	MW 3:30p-4:20p	LILY 1105	445	
STAT 113 Lec 2 002-001	320	Full Term	2 x 50		Remote Campus	Deely, J J	MW 4:30p-5:20p	LILY 1105	445	

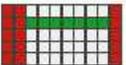
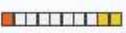
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Done www.smas.purdue.edu Proxy: None

UNI|Time: Data Management

- Data Management (instructional offering structure)
 - Classes are organized in a visual representation of the course structure
 - GUI allows intuitive entry and display of class and constraint data
 - Preferences and requirements can be set at multiple levels
 - Some constraints are automatically deduced from course structure

	Demand	Mins Per Week	Limit	Time Pattern	Time	Room	Distribution	Instructor
MA 170	62		40					
STAT 170								
Lecture		50	40	1 x 50		Classroom		
Laboratory		150	40	3 x 50		ENAD Dell 2.8 machines	BTB	
Lec 1		50	40	1 x 50		Classroom		S. Bell
Lab 1		150	20	3 x 50		ENAD Dell 2.8 machines	BTB	J. Beckley
Lab 2		150	20	3 x 50		ENAD Dell 2.8 machines	BTB	J. Beckley

UNI|Time: Modifying Solutions

- Using Automated Solver: Minimal Perturbation Problem
 - Solution to a modified problem is as close as possible to the initial solution
- Manually: Interactive Mode
 - Solver is guided by the user, providing an evaluated list of choices
 - Backtracking with limited depth is used

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](#)

Ability to incorporate changes into an existing solution is critical in real-life problems

UNI|Time: Student Sectioning

- Student requests courses, system determines classes (sections)
 - Respects course structure, reservations, and student preferences

Primary Course Requests

Add Request

	Type	Course / Free Time		Waitlist	1st Alternative Course	2nd Alternative Course	
1.	Course	ENGL	106	<input checked="" type="checkbox"/>			↓
2.	Course	BIOL	110	<input type="checkbox"/>	BIOL 111	BIOL 112	↑ ↓
3.	Free Time	3 x 50	MWF		7:30a - 8:20a		↑ ↓
4.	Course	COM	114	<input type="checkbox"/>			↑ ↓
5.	Course	MA	152	<input type="checkbox"/>	MA 159		↑ ↓

Alternative Course Requests

Add Alternative Request

A1.	Course	A&AE	203	<input type="checkbox"/>			↑ ↓
A2.	Course	A&D	114	<input type="checkbox"/>	A&D 117		↑

UNI|Time: Student Sectioning

- Initial Sectioning (during timetabling)
 - Pre-registration, last like data for first year students, projected changes
 - Timetabling solver minimizes potential student conflicts
- Final Sectioning
 - Once the timetable for the whole university is created
 - Registration of classes for students, reservations, wait lists
- Online Sectioning
 - Registration of first year students and other late registrants
 - Changes in existing enrollments
 - Expected students demands are used to direct students from sections with excess demand
 - Computed in final sectioning, updated with each new student

1. ENGL 106
 - ☑ Lec T 8:30a - 9:20a Full Term HEAV 106
 - ☑ Lec (a) F 8:30a - 9:20a Full Term HEAV 106

Sel	Que	Time	Date	Instructor
<input type="radio"/>	<input type="checkbox"/>	Th 8:30a - 9:20a	Full Term	
<input checked="" type="radio"/>	<input type="checkbox"/>	F 8:30a - 9:20a	Full Term	
 - ☑ Lec (b) Th 8:30a - 9:20a Full Term ENAD 130

Sel	Que	Time	Date	Instructor
<input checked="" type="radio"/>	<input type="checkbox"/>	Th 8:30a - 9:20a	Full Term	
 - ☑ Rec W 8:30a - 9:20a Full Term HEAV 225

Sel	Que	Time	Date	Instructor
<input type="radio"/>	<input type="checkbox"/>	M 8:30a - 9:20a	Full Term	
<input checked="" type="radio"/>	<input type="checkbox"/>	W 8:30a - 9:20a	Full Term	
2. BIOL 110
 - ☑ Lec TTh 2:30p - 3:20p Full Term LILY 1105 K. Mason
 - ☑ Rec T 6:00p - 6:50p Full Term WTHR 360
 - ☑ Lab T 3:30p - 5:20p Full Term WTHR 316
 - ☑ Pso M 4:30p - 5:20p Full Term LILY G126 K. Mason

Sel	Que	Time	Date	Instructor	Requires
<input type="checkbox"/>	<input type="checkbox"/>	Arr Hrs		K. Mason	
<input type="radio"/>	<input type="checkbox"/>	M 3:30p - 4:20p	Full Term	K. Mason	
<input checked="" type="radio"/>	<input type="checkbox"/>	M 4:30p - 5:20p	Full Term	K. Mason	
<input type="checkbox"/>	<input type="checkbox"/>	Th 9:30a - 10:20a	Full Term	K. Mason	
3. Free Time MWF 7:30a - 8:20a

UNI|Time: Web Site

- URL: <http://www.unitime.org>
 - Available for download:
 - Course Timetabling & Student Sectioning application described here
 - Open Source (GNU GPL)
 - Constraint Solver library
 - Including Course Timetabling and Student Sectioning extensions
 - Open Source (GNU LGPL)
 - Online documentation
 - Ongoing research
 - Publications & presentations
 - Benchmark data sets
 - Real-life data for course timetabling and student sectioning problems
- Contact: research@unitime.org

