
PURDUE
UNIVERSITY
Space Management & Academic Scheduling

# UNI|Time: University Course Timetabling & Student Scheduling System

System Demonstration

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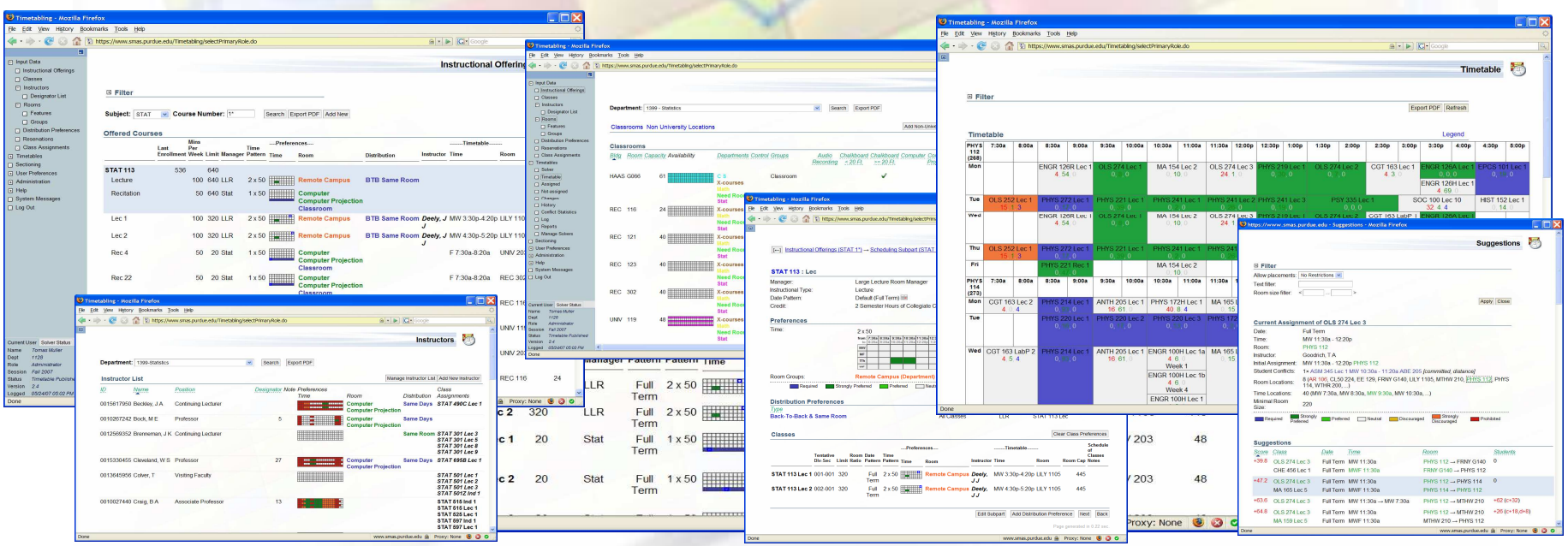
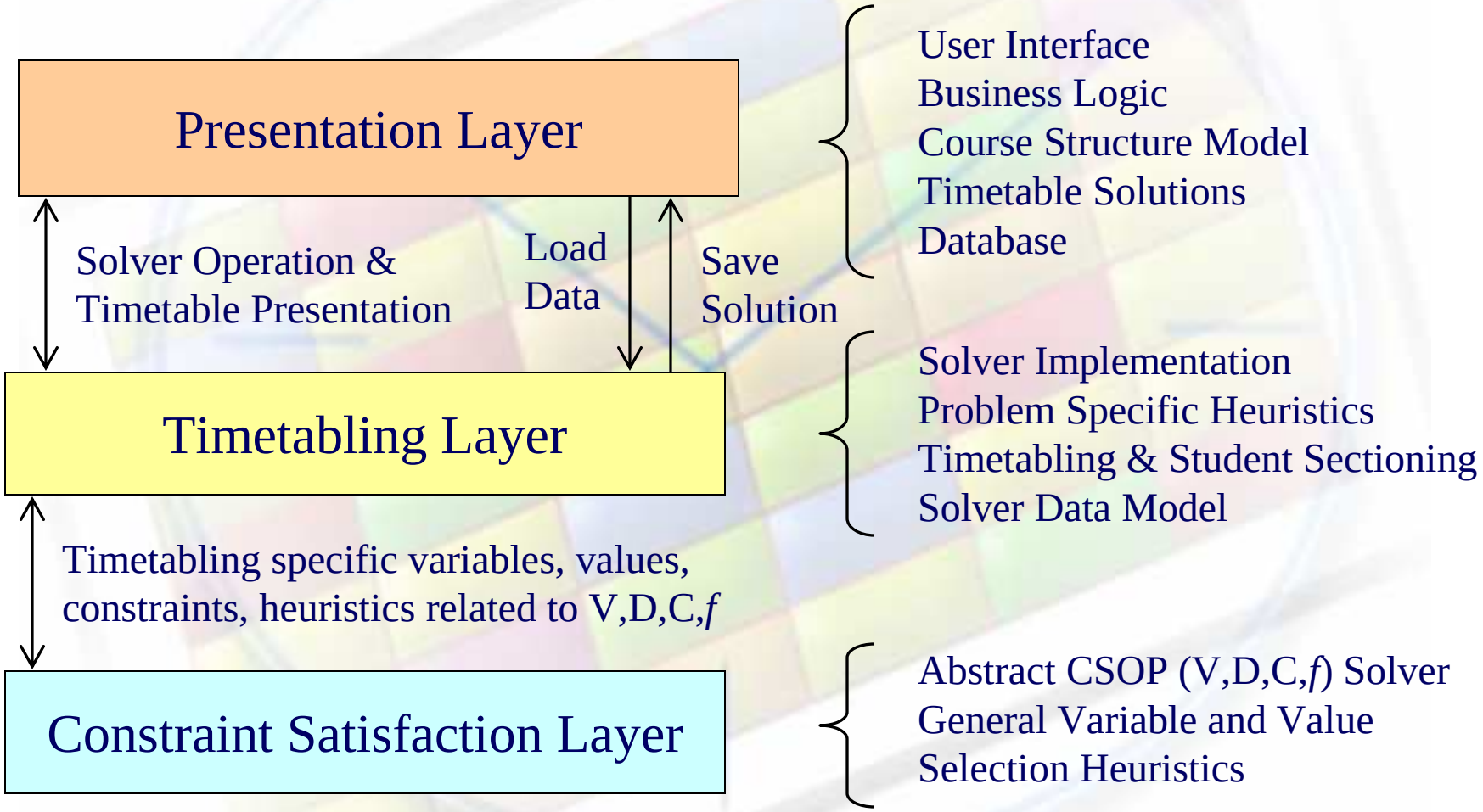
# UNI|Time: Motivation

- 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

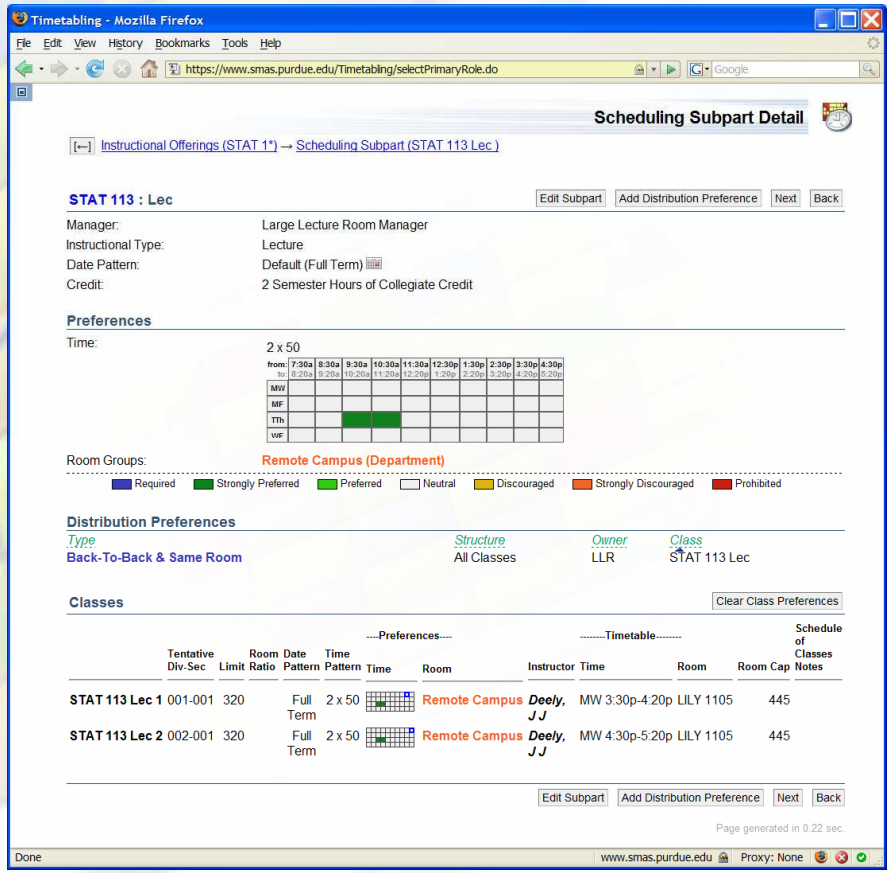


# UNI|Time: System Architecture

- 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

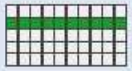
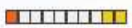
# UNI|Time: Course Timetabling

- 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, …



# 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 | ----Preferences---- Time | Room | Distribution | Instructor |
|---|---|---|---|---|---|---|---|---|
| **MA 170** STAT 170 | 62 | | 40 | | | | | |
| Lecture | | 50 | 40 | 1 x 50 |  | Classroom | | |
| Laboratory | | 150 | 40 | 3 x 50 |  | ENAD<br>Dell 2.8 machines | BTB | |
| Lec 1 | | 50 | 40 | 1 x 50 |  | Classroom | | S. Bell |
| Lab 1 | | 150 | 20 | 3 x 50 |  | ENAD<br>Dell 2.8 machines | BTB | J. Beckley |
| Lab 2 | | 150 | 20 | 3 x 50 |  | ENAD<br>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**

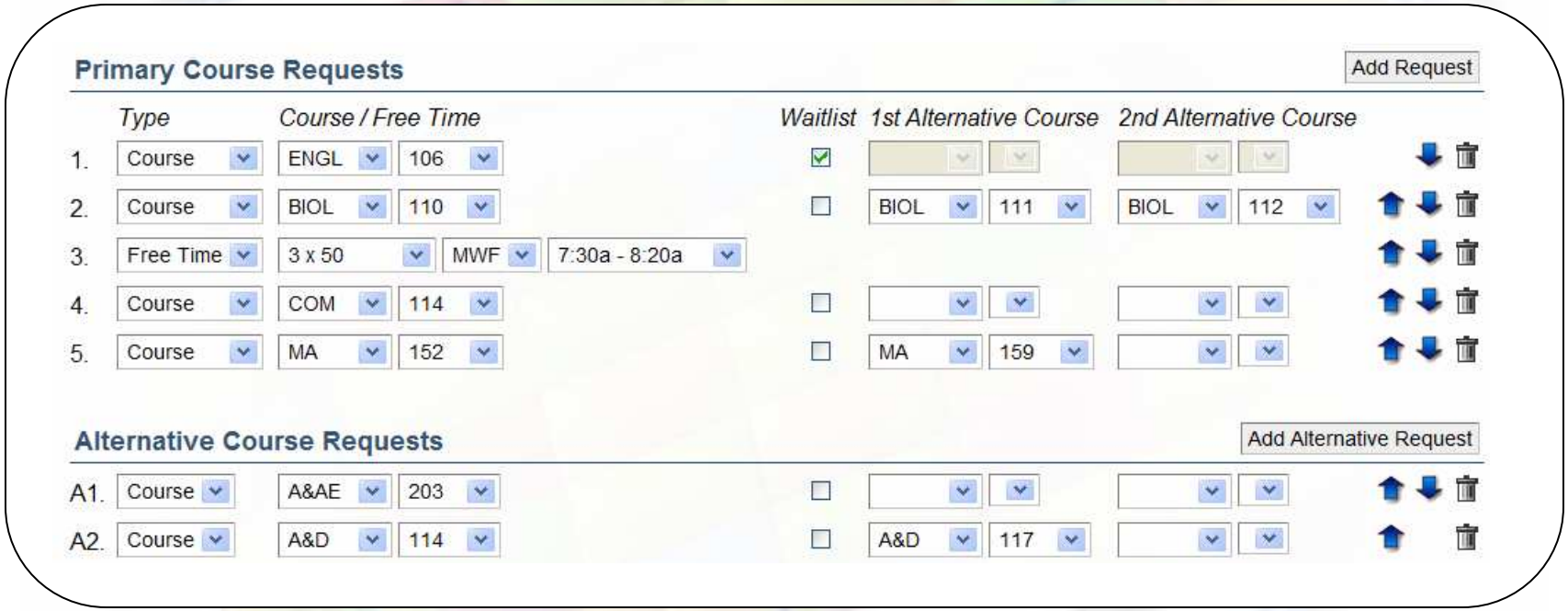
| Score | Class | Date | Time | Room | Students |
|---|---|---|---|---|---|
| +15.2 | POL 101 Lec 3 | Full Term | TTh 12:00p → TTh 7:30a | BRNG 2280 | +11 |
| +31.7 | POL 101 Lec 3 | Full Term | TTh 12:00p → TTh 10:30a | BRNG 2280 | +36 (h+3) |
| | HIST 342 Lec 1 | Full Term | TTh 10:30a → TTh 1:30p | 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

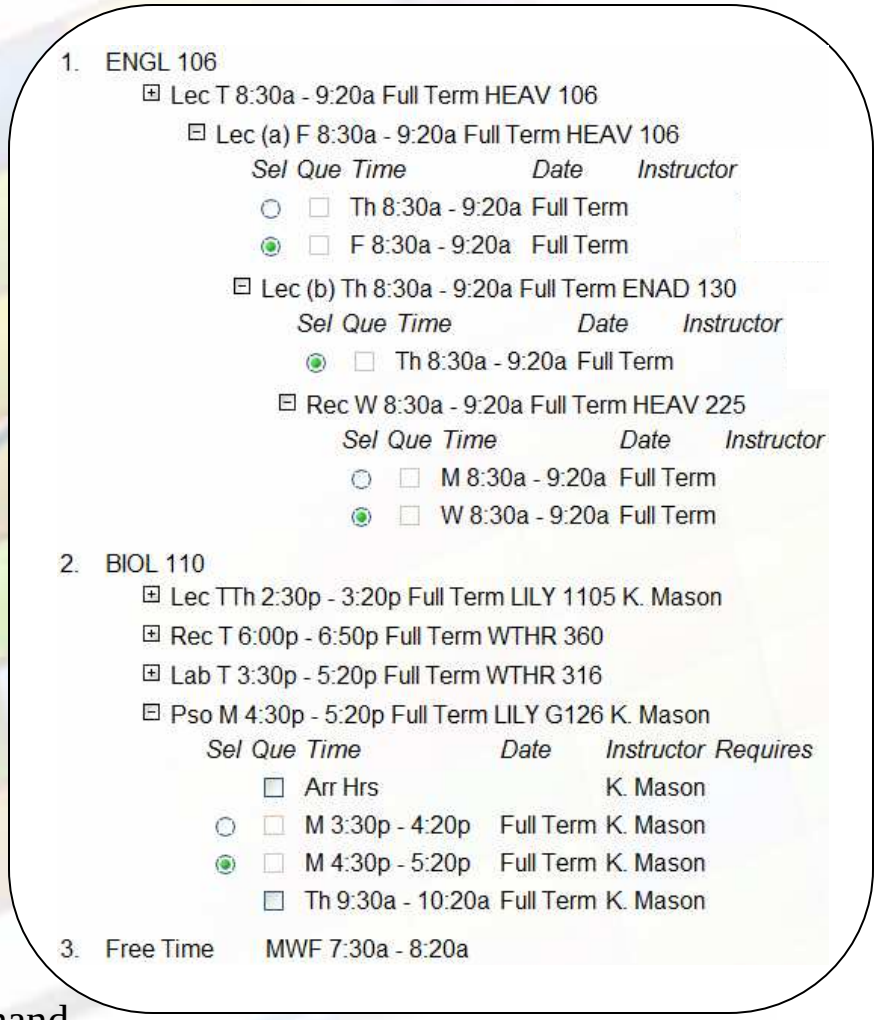
# UNI|Time: Student Sectioning

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



# 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



# 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