Using UniTime
to improve institutional efficiency

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Using UniTime to improve institutional efficiency

• Introduction to UniTime
• Benefits of using UniTime
• Enrollment growth simulation from Purdue University
What is UniTime?

- Comprehensive **academic scheduling solution**
- Five components: course timetabling, examination timetabling, student scheduling, instructor scheduling, and event management
- Open source, web-based, written in Java using modern technologies
- Distributed data entry and timetabling in a multi-user environment
- Apereo project since March 2015
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
What is student scheduling?

**Enroll students to classes** in a way that maximizes the ability for students to get the courses they need.

1. Student fills in course requests
   - Including priorities, alternatives, and their own time availability

2. System provides a schedule that best meets student needs

3. Students have the ability to modify their schedule
Benefits

Why is it needed?

• Help use limited resources more efficiently
• Make process more transparent and sustainable
• Fairness and satisfaction with the timetable
• Minimize student conflicts to help students receive degrees on time
• Ability to adapt to changes (curriculum, facilities, etc.)
• What-if scenarios
Effective use of teaching space

- Room requirements and preferences
- Room location, travel times between classes
- Higher utilization than when the timetable is done by hand
- Minimization of excess space
  (more space for other activities, or for schedule changes)

Instructor assignments

- Easier to meet instructor needs
- Automatic checking for conflicts
- Minimize travel times
- Automated assignment of instructors (typically TAs) to classes
  - Teaching load
  - Qualifications & course preferences
  - Availability & time preferences
  - Minimizing the need for new hires
Transparent Process

Transparency & Fairness

• All preferences and requirements that have been used to build a timetable are available in the system
• The “computer” is equally fair to all the interested parties
• Additional constraints to improve fairness
  • Equal balancing of good/bad times between departments
  • Normalization of time preferences
  • …

Sustainability

• Requirements and preferences stay in the system and are reused next semester
• If there is a new scheduling person, the knowledge transfer is easier
• Degree program (and other) changes are easier to do
• Certain level of robustness can be included in the timetable
• Help with making schedule changes
Helps students get the courses they need
  • Build course schedule that minimizes conflicts between courses
  • Available space can be monitored during pre-registration
  • Conflicts can be resolved before students make adjustments

Equalize opportunities, improve fairness, reduce stress
  • Students coming in later have the same chance to get the courses
  • All students get their top priority courses / minimal credits
  • Substitutive courses, free times, section preferences

Balanced sectioning, student schedule quality, accommodations

Critical courses
  • For courses with excess demand, help prioritize students who need the course in order to make progress in their degree

Certain students may be given higher priority
  • Athletes, honor students, students near graduation, etc.
Minimizing Disruptions

Small changes

- E.g., new section and/or larger room needed
- One class/course is changed at the time
- All decisions are on the operator, UniTime provides suggestions
  - Available rooms, possible class swaps, etc.

Larger changes

- E.g., a building goes offline, reduced room capacities due to the social distancing
- Minimal Perturbation Problem mode of the solver
  - Solution to a new (modified) problem
  - As close as possible to the previous (published) solution
- Various flavors
  - Different weights on different types of changes
  - Some changes may not be allowed (e.g., times are fixed)
Many various scenarios can be considered

• Building or room should become unavailable
• Change in time patterns  
  (e.g., more evening classes, unified class start times)
• Going from semesters to trimesters
• Reducing room capacity to allow for social distancing
• Planning for future (enrollment growth, etc.)

Running simulations

• Starting from historic data, with adjustments
• The whole term (academic session) can be duplicated  
  • Or copied over to a separate (test) instance of UniTime
• There can be multiple copies of the same academic session
• XMLs exports/imports or Scripts can be used to quickly manipulate the data
Purdue University Quick Facts

Enrollment Fall 2019
- Undergraduate: 33,646
- Graduate: 9,963
- Professional: 942
- Total: 44,551

Courses Offered Annually: ~8,260

Simulation
- Enrollment growth to about 48,000 by 2025
- Projections based broken down by major
Simulation Input Data

Input Data

- Fall 2019 data (UniTime)
  - Course timetable and student course demands
  - Including course structure and existing requirements/preferences
- Recruitment targets, broken down by major (Admissions)
  - Continuing student enrollment projections
  - Predictive modeling, considering degree programs, historic data, etc.
  ⇒ Number of students in each major and classification

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Fall 2019 Census

Fall 2025 Projection
Estimate course enrollments, adjust section limits / counts

• Automatically computed in UniTime, using the enrollment projections
  • For each course, Fall 2019 enrollments counts are scaled by the new enrollment counts (individually for each major and classification)
  • Determine how increased demand would be accommodated by the planned course offerings
    ⇒ Larger sections, more sections, a mix of both

<table>
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<tr>
<th>Course</th>
<th>Enrollment Census 2019</th>
<th>Projected Demand 2020</th>
<th>Projected Demand 2023</th>
<th>Projected Demand 2025</th>
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<td>558</td>
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<td>CHM 115</td>
<td>2,561</td>
<td>2,526</td>
<td>2,643</td>
<td>2,675</td>
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Running the course timetabling solver

- Build a timetable to determine where teaching space and faculty shortages may occur
  - Various scenarios can be run to determine impact of future plans
  - E.g., extending teaching days (more evening classes), building new room(s)
- The simulated timetable validated using student scheduling
  - Using Fall 2019 course requests scaled to match projected data

<table>
<thead>
<tr>
<th></th>
<th>Fall 2019 - actual</th>
<th>Fall 2020 - base simulation</th>
<th>Fall 2020 with extended day</th>
<th>Fall 2023 simulation with 1-180 LALR</th>
<th>Fall 2023 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs</th>
<th>Fall 2025 with 1-180 LALR</th>
<th>Fall 2025 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs</th>
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<tr>
<td>Assigned sections</td>
<td>100.00% (8,527)</td>
<td>100.00% (8,693)</td>
<td>100.00% (8,693)</td>
<td>100.00% (8,807)</td>
<td>100.00% (8,807)</td>
<td>100.00% (8,917)</td>
<td>100.00% (8,917)</td>
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<tr>
<td>Time preferences</td>
<td>90.55% (20,883)</td>
<td>89.82% (22,920)</td>
<td>90.09% (22,374)</td>
<td>89.63% (23,491)</td>
<td>89.61% (23,555)</td>
<td>89.35% (24,281)</td>
<td>89.38% (24,219)</td>
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<tr>
<td>Room preferences</td>
<td>86.36% (1,632)</td>
<td>86.95% (1,598)</td>
<td>86.99% (1,557)</td>
<td>86.00% (1,761)</td>
<td>86.24% (1,691)</td>
<td>85.68% (1,842)</td>
<td>85.82% (1,779)</td>
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Various reports can be generated from the results

- Example: room utilization report for the 4 largest lecture halls

<table>
<thead>
<tr>
<th>Room</th>
<th>Capacity</th>
<th>Fall 2019 - actual frequency</th>
<th>Fall 2020 - base simulation frequency</th>
<th>Fall 2020 with extended day frequency</th>
<th>Fall 2023 simulation with 1-180 LALR frequency</th>
<th>Fall 2023 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs frequency</th>
<th>Fall 2025 with 1-180 LALR frequency</th>
<th>Fall 2025 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs frequency</th>
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<td>NEW ROOM</td>
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<td>96.7%</td>
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<td>94.7%</td>
<td>83.7%</td>
<td>95.7%</td>
<td>89.7%</td>
<td>94.7%</td>
<td>92.7%</td>
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<tr>
<td>EE 129</td>
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<td>94.7%</td>
<td>88.8%</td>
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<td>LILY 1105</td>
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<td>82.1%</td>
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<td>83.9%</td>
<td>85.9%</td>
<td>74.0%</td>
<td>86.8%</td>
<td>84.1%</td>
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Outcomes

• Identification of areas where resources need to be adjusted
• Ensure there are enough spaces of correct type and size
• Evaluation of utilization rates
• During what timeframe is more space going to be needed?
• Faculty needs
• Curriculum changes
• Budgets requests, capital planning, policy recommendations, etc.
• Balancing demand between Fall and Spring
• Contingency plans are made for when not enough seats can be offered (e.g., increase space in substitute courses)
Thank you!

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For more details about UniTime, see https://www.unitime.org