

# OPEN APEREO

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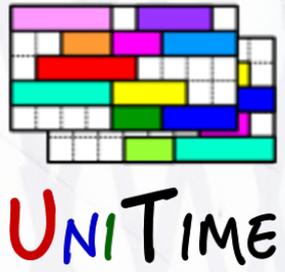
# 2020

June 15-19

## Using UniTime to improve institutional efficiency

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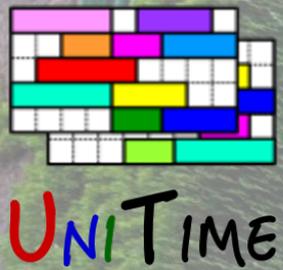




# Agenda

## Using UniTime to improve institutional efficiency

- Introduction to UniTime
- Benefits of using UniTime
- Enrollment growth simulation from Purdue University



# Introducing UniTime

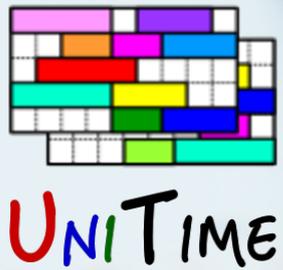
## What is UniTime?

- 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

The collage displays several key features of the UniTime system:

- Rooms:** A page for managing classrooms, showing a list of rooms with columns for building, room number, capacity, area, and availability.
- Instructional Offerings:** A page for managing course offerings, showing details for a specific offering like 'C S 101 - Introductory Computing'.
- Log In:** A simple login form with fields for 'Username' and 'Password' and a 'Log In' button.
- Examinations:** A page for managing final examinations, showing a table of exam details including course, length, seating size, and room.
- Personal Timetable:** A calendar view showing a student's schedule for a specific term, with colored blocks representing different classes.





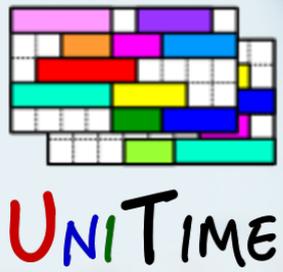
# Course Timetabling

## 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

	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 Scheduling

## 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

**Student Scheduling Assistant** ?  
User: Student, Imogene Eugenia (A) Session: Fall 2019 (PWL)  
[Click here to log out.](#) [Click here to change the session.](#)

Degree Plan Current Registration Build Schedule →

### Course Requests

1. Priority	ENGR 13100	12664-004 × 14811-005 ×	⌕ ×	↓	🗑️	
1. Alternative	Alternative to ENGR 13100		⌕ ×			
2. Priority	MA 16500		⌕ ×	↑	↓	🗑️
1. Alternative	MA 16100		+ ⌕ ×			
3. Priority	CHM 11500	Traditional ×	⌕ ×	↑	↓	🗑️
1. Alternative	PHYS 17200		+ ⌕ ×			
4. Priority	ENGL 10600		⌕ ×	↑	↓	🗑️
1. Alternative	SCLA 10100		⌕ ×			
2. Alternative	ENGL 10800		+ ⌕ ×			
5. Priority	PSY 12000	Hybrid ×	⌕ ×	↑	↓	🗑️
1. Alternative	SOC 10000	Hybrid ×	+ ⌕ ×			
6. Priority	Free MWF 7:30a - 8:30a		⌕ ×	↑	↓	🗑️
7. Priority			⌕ ×	↑	↓	🗑️
8. Priority			⌕ ×	↑	↓	🗑️
9. Priority			⌕ ×	↑	↓	🗑️
10. Priority			⌕ ×	↑	↓	🗑️
11. Priority			⌕ ×	↑	↓	🗑️
12. Priority	Course with the lowest priority.		⌕ ×	↑	↓	🗑️

Tip: Use Esc to hide suggestions, Ctrl+L (or Ctrl+Alt+L in some browsers) to show suggestions.

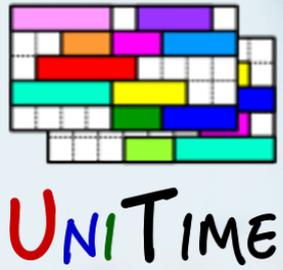
### Substitute Course Requests

*(used only if a course requested above is not available)*

1. Substitute	FR 10100	+ ⌕ ×	↑	↓	🗑️
2. Substitute		⌕ ×	↑	↓	🗑️
3. Substitute		⌕ ×	↑	🗑️	

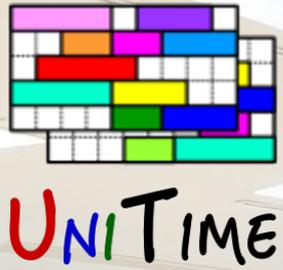
Degree Plan Current Registration Build Schedule →

**!** You are not registered for any classes yet. Please click the Build Schedule button in order to complete your registration.



## 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



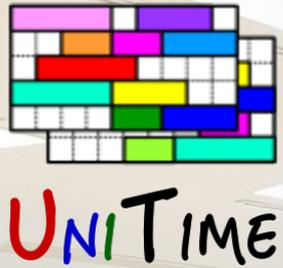
# Use Resources Efficiently

## 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



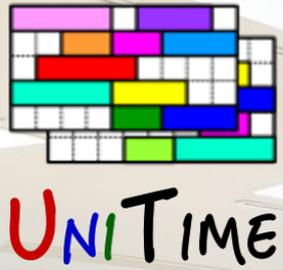
# Transparent Process

## 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



# Student Scheduling

## 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

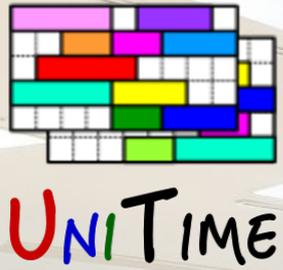
## Balanced sectioning, student schedule quality, accommodations

### 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.



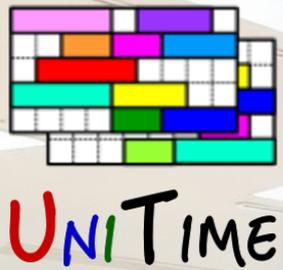
# Minimizing Disruptions

## 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*)



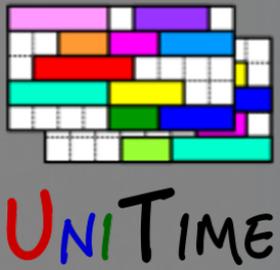
# What-if Scenarios

## 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



# Enrollment Growth Simulation

## Purdue University Quick Facts



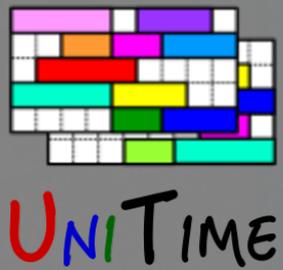
### Enrollment Fall 2019

• 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

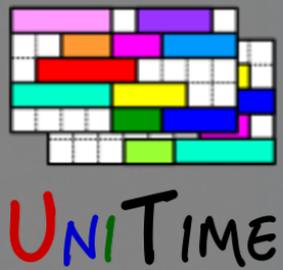
Fall 2019 Census

Area	Major	01	02	03	04	05	06	07	08	Total
M		312	162	280	237	324	278	309	448	2350
M	ACCT	7	3	13	17	38	38	35	100	251
M	ECON	7	8	9	22	28	37	39	34	184
M	FINC	6	16	22	34	84	74	74	101	411
M	GMGT	10	4	11	24	39	29	16	9	142
M	...									



Fall 2025 Projection

Area	Major	01	02	03	04	05	06	07	08	Total
M		492	217	313	253	333	292	374	481	2755
M	ACCT	7	6	14	19	34	36	40	86	242
M	ECON	8	12	10	27	25	40	46	41	209
M	FINC	10	14	21	34	76	75	86	121	437
M	GMGT	12	11	17	20	29	31	36	32	188
M	...									

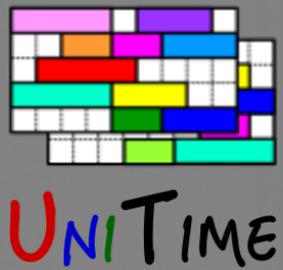


# Course Enrollments

## 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

Course	Enrollment Census 2019	Projected Demand 2020	Projected Demand 2023	Projected Demand 2025
ENGL 106	473	480	558	574
CS 242	75	122	240	316
STAT 355	59	92	185	230
STAT 190	569	599	684	710
CHM 115	2,561	2,526	2,643	2,675



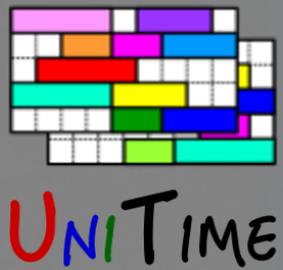
# Course Timetabling

## 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

	Fall 2019 - actual	Fall 2020 - base simulation	Fall 2020 with extended day	Fall 2023 simulation with 1-180 LALR	Fall 2023 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs	Fall 2025 with 1-180 LALR	Fall 2025 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs
<b>Assigned sections</b>	100.00% (8,527)	100.00% (8,693)	100.00% (8,693)	100.00% (8,807)	100.00% (8,807)	100.00% (8,917)	100.00% (8,917)
<b>Student conflicts</b>	distance:650, hard:1199	distance:579, hard:1256	distance:524, hard:1035	distance:627, hard:1153	distance:592, hard:1143	distance:820, hard:1195	distance:552, hard:1090
<b>Time preferences</b>	90.55% (20,883)	89.82% (22,920)	90.09% (22,374)	89.63% (23,491)	89.61% (23,555)	89.35% (24,281)	89.38% (24,219)
<b>Room preferences</b>	86.36% (1,632)	86.95% (1,598)	86.99% (1,557)	86.00% (1,761)	86.24% (1,691)	85.68% (1,842)	85.82% (1,779)



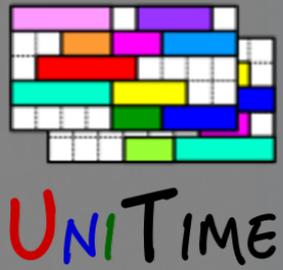


# Simulation Reports

## Various reports can be generated from the results

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

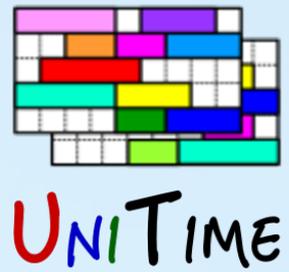
Room	Capacity	Fall 2019 - actual frequency	Fall 2020 - base simulation frequency	Fall 2020 with extended day frequency	Fall 2023 simulation with 1-180 LALR frequency	Fall 2023 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs frequency	Fall 2025 with 1-180 LALR frequency	Fall 2025 with 1-480 LLR, 2-180 LALR, 2-60 PC Labs, 2-30 Linux Labs frequency
<b>NEW ROOM</b>	480					87.9%		88.7%
<b>WTHR 200</b>	480	88.8%	97.7%	92.7%	96.7%	94.7%	98.7%	97.7%
<b>CL50 224</b>	470	88.7%	94.7%	83.7%	95.7%	89.7%	94.7%	92.7%
<b>EE 129</b>	468	90.7%	93.7%	86.7%	94.7%	88.8%	96.7%	92.7%
<b>LILY 1105</b>	446	82.1%	95.7%	83.9%	85.9%	74.0%	86.8%	84.1%



# Simulation Results

## 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)



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**Thank you!**

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Purdue University

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

