2019

The Higher Education Open-Source Conference

Los Angeles, CA June 2-6

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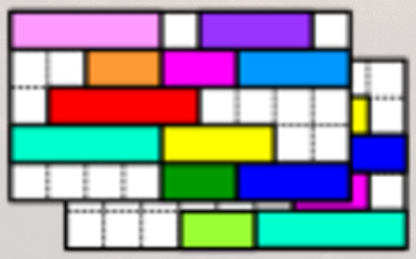


UniTime

UniTime: State of the Project

Tomáš Müller

apereo

Agenda

Agenda

- Short introduction of UniTime
- State of the Project
- UniTime 4.3 (Current Version)
- UniTime 4.4 (New Version, to be released in June 2019)
- Plans for next release & long term
- International Timetabling Competition 2019

This presentation is available at www.unitime.org/present/apereo19-unitime.pdf

UniTime

What is UniTime?

- Comprehensive academic scheduling solution
- Four components: course timetabling, examination timetabling, student scheduling and 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
- Apereo project since March 2015

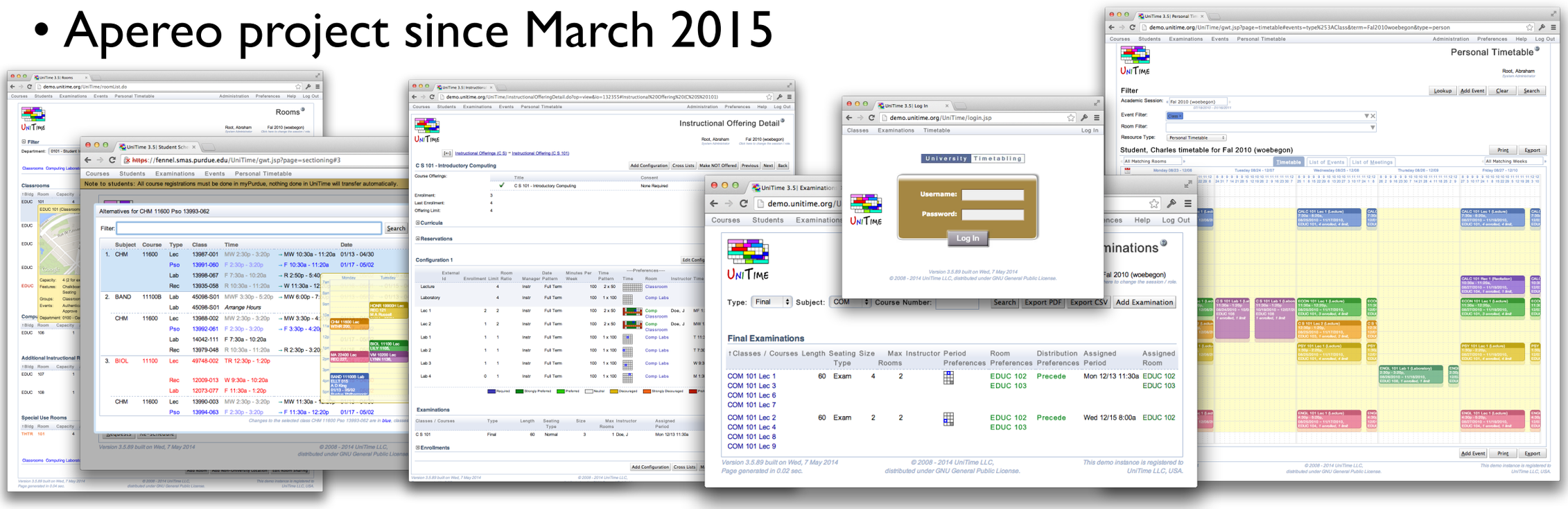


Photo of Griffith Observatory provided by Los Angeles Tourism & Convention

State of the Project

Releases / Achievements

- UniTime 4.3 released in June 2018
  - Course Request Validation & Batch Student Scheduling
- UniTime 4.4 to be released in June 2019
  - Various student scheduling improvements
  - *More to follow in this presentation…*
- UniTime 4.5 specs are being defined
- 51 institutions from 28 countries filled our voluntary registration form during the last 12 months
- 70 institutions indicated that they use UniTime in production
- Steady increase in interest and adoption from literally around the world
  - But still very little outside contributions

Photo of Echo Park Lake provided by L.A. Tourism

UniTime Users

Word cloud from our voluntary registrations (all of them)

Photo by David Mark from Pixabay

Current Release: UniTime 4.3

UniTime 4.3

- Released in June 2018
- Batch Student Scheduling
  - Custom Course Requests Validation
  - Scheduling Dashboard
- Course Timetabling
  - Solver pages rewritten to GWT
  - Improved localization and internationalization
  - A number of new features and improvements
- Scripting & Reporting
  - API, new parameters, Task Scheduler
- Many other improvements across the whole application

See http://bit.ly/unitime43notes (UniTime 4.3 Release Notes) for more details.

Next Release: UniTime 4.3

UniTime 4.4

- To be released in June 2019
- Student Scheduling
  - Test Runs / Reporting
  - Min/Max Credit Checking
  - Student Schedule Quality
  - Custom Registration Overrides Approval Process
  - Student Preferences/Requirements
  - Critical Courses
  - Reservations, Dashboard, …
- Many other improvements across the whole application

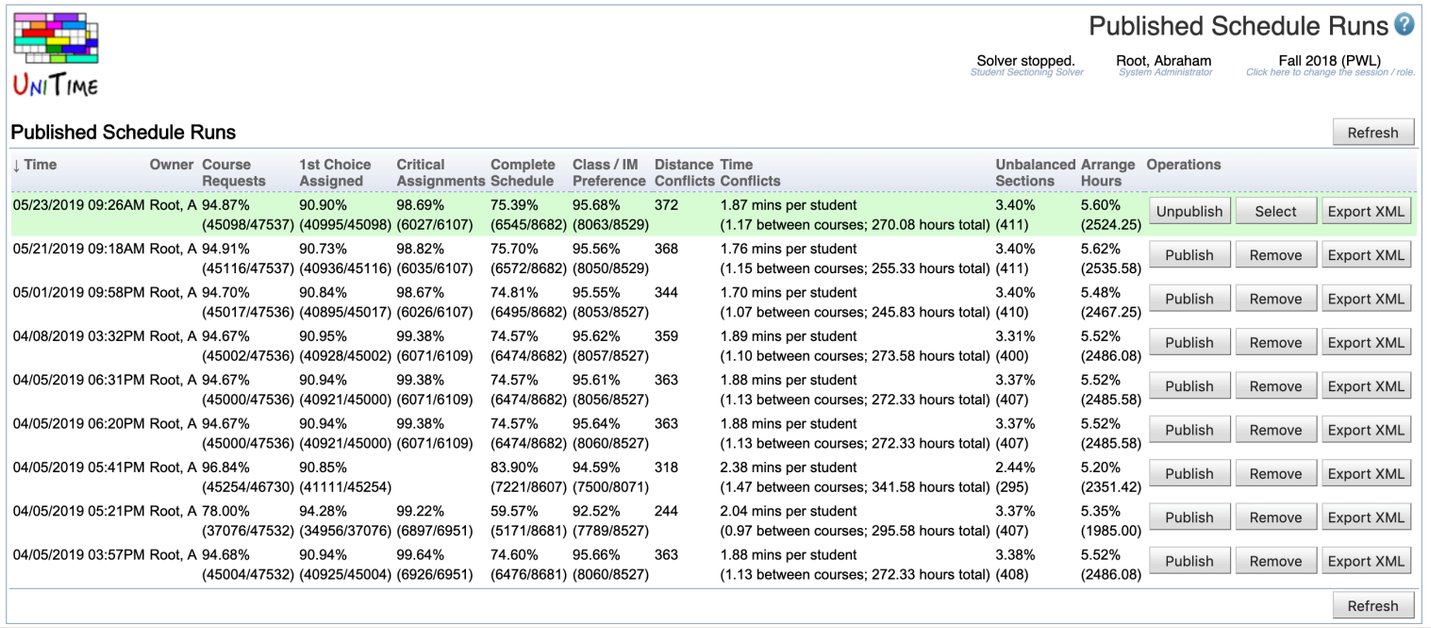
See http://bit.ly/unitime44notes (UniTime 4.4 Release Notes) for more details.

Photo of Griffith Observatory provided by Los Angeles Tourism & Convention

Test Runs / Reporting

Publish Test Runs

- Batch scheduling test runs during pre-registrations
  - Can be executed automatically, e.g., on a nightly basis
- Results can be published for other users to see
  - Additional reports provided
- Advisors and schedule deputies may be allowed to access the dashboard
- History of past published solutions is kept
  - Students > Published Runs



↓ Time	Owner	Course Requests	1st Choice Assigned	Critical Assignments	Complete Schedule	Class / IM Preference	Distance Conflicts	Time Conflicts	Unbalanced Sections	Arrange Hours	Operations
05/23/2019 09:26AM	Root, A	94.87% (45098/47537)	90.90% (40995/45098)	98.69% (6027/6107)	75.39% (6545/8682)	95.68% (8063/8529)	372	1.87 mins per student (1.17 between courses; 270.08 hours total)	3.40% (411)	5.60% (2524.25)	Unpublish Select Export XML
05/21/2019 09:18AM	Root, A	94.91% (45116/47537)	90.73% (40936/45116)	98.82% (6035/6107)	75.70% (6572/8682)	95.56% (8050/8529)	368	1.76 mins per student (1.15 between courses; 255.33 hours total)	3.40% (411)	5.62% (2535.58)	Publish Remove Export XML
05/01/2019 09:58PM	Root, A	94.70% (45017/47536)	90.84% (40895/45017)	98.67% (6026/6107)	74.81% (6495/8682)	95.55% (8053/8527)	344	1.70 mins per student (1.07 between courses; 245.83 hours total)	3.40% (410)	5.48% (2467.25)	Publish Remove Export XML
04/08/2019 03:32PM	Root, A	94.67% (45002/47536)	90.95% (40928/45002)	99.38% (6071/6109)	74.57% (6474/8682)	95.62% (8057/8527)	359	1.89 mins per student (1.10 between courses; 273.58 hours total)	3.31% (400)	5.52% (2486.08)	Publish Remove Export XML
04/05/2019 06:31PM	Root, A	94.67% (45000/47536)	90.94% (40921/45000)	99.38% (6071/6109)	74.57% (6474/8682)	95.61% (8056/8527)	363	1.88 mins per student (1.13 between courses; 272.33 hours total)	3.37% (407)	5.52% (2485.58)	Publish Remove Export XML
04/05/2019 06:20PM	Root, A	94.67% (45000/47536)	90.94% (40921/45000)	99.38% (6071/6109)	74.57% (6474/8682)	95.64% (8060/8527)	363	1.88 mins per student (1.13 between courses; 272.33 hours total)	3.37% (407)	5.52% (2485.58)	Publish Remove Export XML
04/05/2019 05:41PM	Root, A	96.84% (45254/46730)	90.85% (41111/45254)		83.90% (7221/8607)	94.59% (7500/8071)	318	2.38 mins per student (1.47 between courses; 341.58 hours total)	2.44% (295)	5.20% (2351.42)	Publish Remove Export XML
04/05/2019 05:21PM	Root, A	78.00% (37076/47532)	94.28% (34956/37076)	99.22% (6897/6951)	59.57% (5171/8681)	92.52% (7789/8527)	244	2.04 mins per student (0.97 between courses; 295.58 hours total)	3.37% (407)	5.35% (1985.00)	Publish Remove Export XML
04/05/2019 03:57PM	Root, A	94.68% (45004/47532)	90.94% (40925/45004)	99.64% (6926/6951)	74.60% (6476/8681)	95.66% (8060/8527)	363	1.88 mins per student (1.13 between courses; 272.33 hours total)	3.38% (408)	5.52% (2486.08)	Publish Remove Export XML

Refresh

Photo of Echo Park Lake provided by L.A. Tourism

Solver Improvements

Schedule Quality: New Criteria

- Avoid early morning and late evenings
- Have time for lunch
- Minimize overall travel time
- Avoid holes in the schedule (prefer back-to-back assignments)
- Avoid long days (time between first and last class on a day)

Min/Max Credits Handling

- Maximize the number of students that are over min credit
  - Assign only up to the min credit first
  - Do not allow to swap student out of a course if he/she gets below min
- Solver cannot assign over max credit
  - No need to move the last course to Alternates

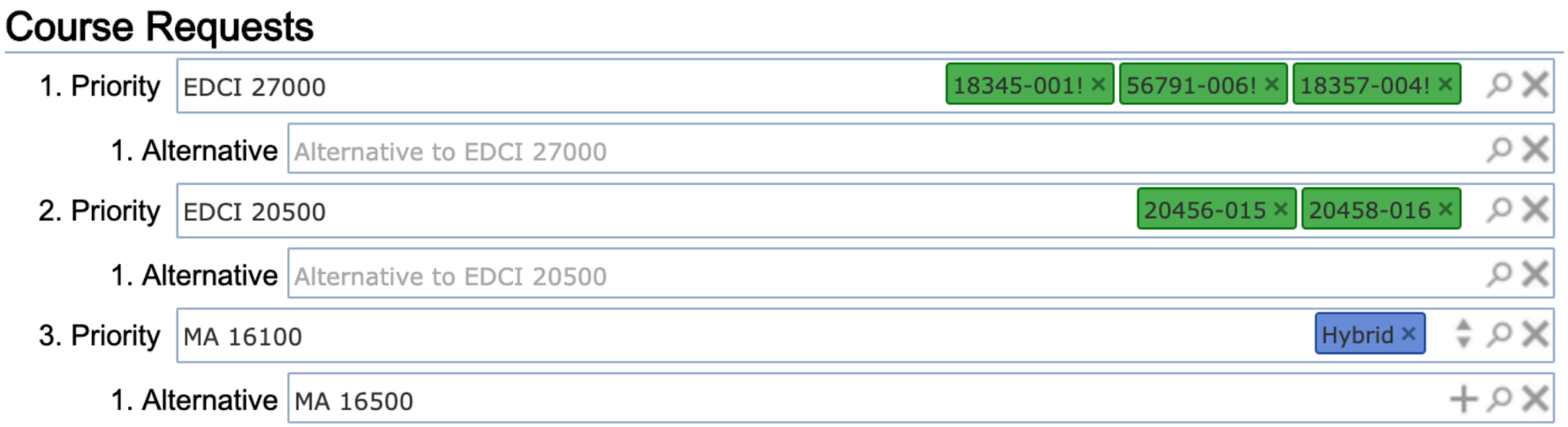
Class / IM Preferences

Instructional Method

- Can prefer "traditional" (default) with no changes to existing courses

Requirements

- Students may require sections or instructional methods (!)
  - Can be controlled by student status (for students)
  - Or with permissions (for advisors and admins)
- This is NOT a reservation: just a restriction on which enrollments are valid for a student



Scheduling Dashboard

Dashboard Improvements

- Added pagination when showing too many lines
- Can now exclude pending, cancelled, and/or rejected requests in the enrollment counts
- Student groups split by type (LC, STAR, etc.)
- Added ability to type in multiple courses
- Show (unmet) required preferences for Not Assigned requests
- Filter by preference
- Various performance improvements

Student Status

- Student statuses can be session-dependent (only for Summer or Fall)

Reservations

Pre-Assigned Courses

- Courses with (not-expired) individual or student group reservation
- Students cannot delete, change, provide alternatives
- Add Learning Community Reservation type (course & student group)

Locking

- Reservations can be edited without locking the course
- The online student scheduling server is only notified about the change

Reservation Overrides

- Added more customizable individual and student group override reservations
  - Can set: allow time conflict, allow over limit, must be used, do not reserve space (work as override / expired reservation)

Photo of Echo Park Lake provided by L.A. Tourism

Long Term

Future Plans

- More Student Scheduling
  - Pre-registration, batch scheduling, online
  - Variable credits, grade modes, …
- Incremental improvements across all the functionality
- Technology (more pages to be rewritten using GWT)
- Localization (and more languages)
- Accessibility improvements
- Documentation (tutorials)
- Integration with external systems
- Team building solver
  - Assign students to teams based on their characteristics
  - Diversify students (e.g., males/females, GPA, nationality, …)
  - Piloted at Purdue by various departments

UniTime

ITC 2019

International Timetabling Competition 2019

See www.itc2019.org for more details about the competition.

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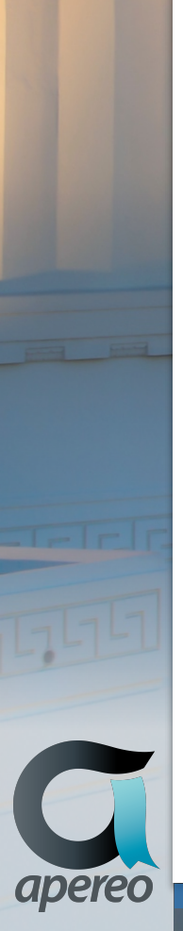
Photo of Chinatown provided by Los Angeles Tourism & Convention Board

UniTime

International Timetabling Competition 2019

Course Timetabling Competitions

- The aim is to bridge the gap between research and practice
- Provide common ground for comparing algorithms
- Hundreds of research papers
- ITC 2002
  - Computer-generated problems
  - 13 teams
- ITC 2007
  - Three tracks (2 with real-world instances)
  - UniTime solver among the winners
- ITC 2019
  - Real-world course timetabling problem
  - Data collected from UniTime
  - 11 institutions from six continents



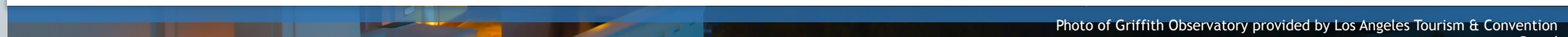


Photo of Griffith Observatory provided by Los Angeles Tourism & Convention

Competition Problem

- Assignment of times and rooms to events (classes)
- Student sectioning based on course demands
- Optimization by minimizing penalties of
  - time and room assignments,
  - violated soft distribution constraints,
  - student conflicts
- Course structure for student sectioning
- Rooms with travel times and unavailabilities
- Events not meeting every week

Goal

- Simplified formulation (comparing to UniTime)
  - E.g., each class has a list of possible times and available rooms
- Same (or very similar) computation complexity

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International Timetabling Competition 2019

Organization

- Announced at PATAT 2018, winners at PATAT 2020
- 2 milestones, final submission by November 18, 2019
- Early (published), Middle (Sep 18), and Late (Nov 8) data sets

Winners

- 1000, 500, and 250 EUR for the first three
- Free PATAT 2020 registrations
- 500 USD for the best open-source solver
- 150 EUR for the best solution for each of the late instances

PATAT

ORTEC

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EWG PATAT AUTOMATED TIMETABLING

FACULTAS ARTIS INFORMATICÆ • UNIVERSITAS MASARYKIANA •

Photo by David Mark from Pixabay

Highlights

- No time limit (looking for the best solutions)
- Commercial solvers are allowed
- Any number of cores or machines
- Early, middle, and late data sets (to avoid the Mongolian horde approach)
- Two mile-stones with small prices
- Website will be maintained after the competition
- Solution validator (based on UniTime, with a RESTful API)
- F1-like rating (but with more points for later instances)

Second Milestone (June 1, 2019)

- 138 registered researchers / teams from 45 countries
- Best results on each of 10 early instances
- 300, 200, and 100 EUR for the first three

UniTime

International Timetabling Competition 2019

Second Milestone (June 1, 2019)

- 5 teams uploaded solutions, F1-like raking (10, 7, 5, 3, 2, 1 points)
- 1st place (73 points)
  - Edon Gashi, Kadri Sylejmani
  - University of Prishtina, Kosovo
- 2nd place (69 points)
  - Dennis Holm, Rasmus Ørnstrup Mikkelsen, Matias Sørensen
  - MaCom, Denmark
- 3rd place (61 points)
  - Karim Er-rhaimini
  - Ministère de l'éducation nationale, France

Instance	Total Cost Milestone #1	Total Cost Milestone #2
agh-fis-spr17	7,419	6,030
agh-ggis-spr17	75,123	49,901
bet-fal17	324,294	301,725
iku-fal17	74,335	19,080
mary-spr17	26,745	14,927
muni-fi-spr16	6,918	4,112
muni-fsps-spr17	25,526	5,601
muni-pdf-spr16c	97,898	74,186
pu-llr-spr17	34,962	10,046
tg-fal17	8,990	4,215

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Conclusion

For more details, please see us at the conference

- ~~Introducing UniTime (Sunday, 1:30pm - 4:30pm in Crocker)~~
- UniTime: State of the Project (Monday, 11:15am - 12:00pm in Watercourt A)
- UniTime at Faculty of Medicine (Monday, 1:30pm - 2:15 pm in Watercourt A)
- Student Scheduling at Purdue (Tuesday, 11:15am - 12:00pm in Watercourt A)
- Event Management in UniTime (Wed, 11:00am - 11:45am in Watercourt A)
- Or visit www.unitime.org

International Timetabling Competition

- Web site www.itc2019.org
- There is still time to compete!