

## UNITIME

OPEN APEREO 2019

The Higher Education Open-Source Conference

Los Angeles, CA June 2-6

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### PURDUE UNIVERSITY

## Student Scheduling at Purdue University

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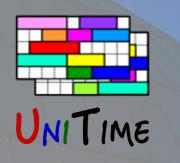
### Agenda

- Short introduction to student scheduling in UniTime
- Components: course timetabling, batch, online
- Student Scheduling at Purdue
  - Input data: course requests (student course & free-time demands)
  - Course request validation
  - Output: student schedules (student class enrollments)
  - Results
  - Lessons learned
  - Future



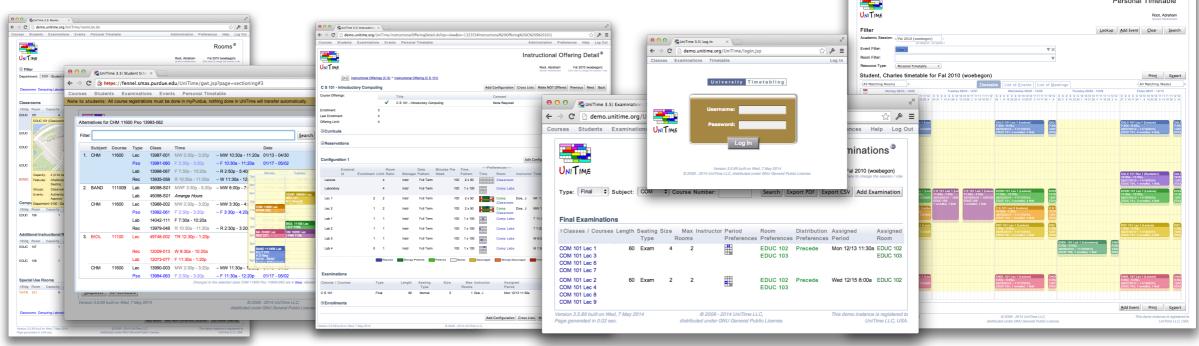
This presentation is available at www.unitime.org/present/apereo19-students.pdf





### 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





## Student Scheduling

### What is Student Scheduling?

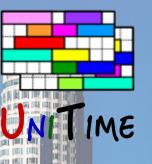
• Enrollment of students into classes in a way that maximizes the ability for students to get the courses they need

### Why needed?

- To ensure that students will be able to get the courses they need in a multi-section environment
- Students who come early may block later students from being able to get the courses they need
- Getting a workable schedule can be a tedious process for a student

### Goal

- Student fills in course requests, including alternatives, free times, etc.
- System provides a schedule that meets student needs
- Students have the ability to modify their schedule



## Student Scheduling Process

## Step I: Course Timetabling

- Minimizing student conflicts together with faculty preferences
  - Last-like student course enrollments
  - Curricula (e.g., list of courses for each program and year)
  - Courses Requests (pre-registration)
  - A combination of these

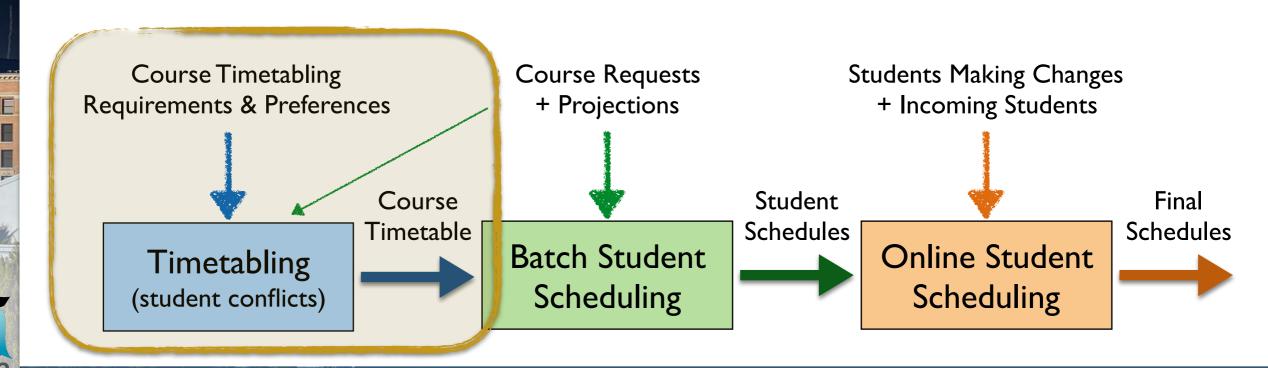


Photo by David Mark from Pixabay

# NITIME

## Student Scheduling Process

## Step 2: Batch Student Scheduling

- After a timetable is produced
- Using pre-registrations and student course demand projections
- To provide students with initial schedules
- An optimization process, using the (student scheduling) solver
- It is possible to iterate
  - With the ability to keep already enrolled students unchanged or to minimize changes

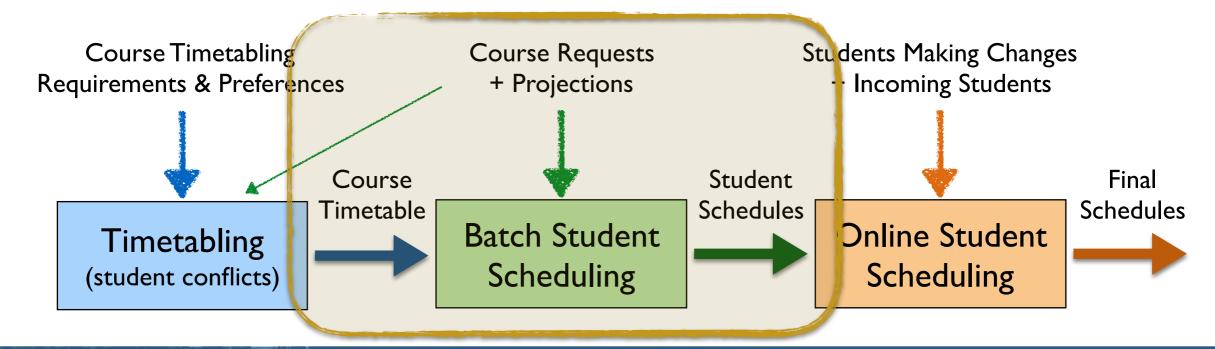


Photo by David Mark from Pixabay

# NITIME

## Student Scheduling Process

## **Step 3: Online Student Scheduling**

- Students without pre-registration can enroll online (incoming freshmen and students that did not register)
- All students can make adjustments to their schedules
- Automatically reserve space in sections based on projections
- Solver provides suggestions
  - Ordered by their quality, with the ability to filter through

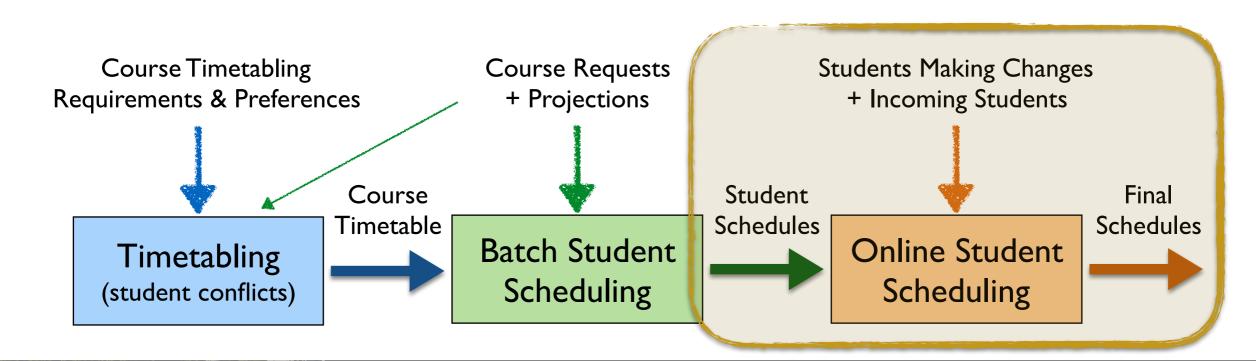


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## Purdue University

## Student Scheduling at Purdue

- Course Timetabling: using last-like demands (and curricula for Mgmt)
- Batch Student Scheduling
  - Starting with Fall 2018, batch scheduling was used for the incoming students (~ 8,600 students)
  - Purdue's Summer Transition, Advising and Registration (STAR) program
- Online Student Scheduling
  - Students are using the Scheduling Assistant to get a schedule and/or to make changes
  - Using Banner XE API to synchronize the changes
- Registration Errors
  - Banner registration errors are checked during both batch and online
  - Students can request overrides, advisors (and others) may approve
  - The approval process is done outside of UniTime (there is an API)



## STAR / Virtual STAR

## Summer Transition, Advising and Registration (STAR)

- A day long program (mid June mid July)
  - New undergraduate students meet their academic advisor
  - Create initial academic plan and request their fall courses
  - Learn about degree requirements, complete optional placement testing, explore student support options, attend sessions on dining plans, residential life, etc.
- Virtual STAR for international (and other) students
  - Complete an online VSTAR course, meet the advisor online, request fall courses
- Purdue creates course schedules for all participants (mid July) to meet the greatest possible number of student priorities
- Students can start making schedule changes immediately afterwards



## Course Requests

### Entered by students

- Each requested course can have alternatives
- There can also be additional alternate course requests to get the desired number of courses
- There can be free time requests in the list
- Preferences on sections and instructional methods

## New in UniTime 4.4

- University core courses
- Critical courses
- Required preferences

| Course Re     | quests                                   |   |          |              |     |
|---------------|--|---|----------|--------------|-----|
| 1. Priority   | ECE 27000                                | \$ ∧ <b>X</b>   |          | $\downarrow$ | Ĩ   |
|               |  | College Restriction<br>Prerequisite error. See the Schedule of Classes.             |          |              |     |
| 1. Alter      | native 🔔 HTM 29101                       | + > ×   |          |              |     |
|               |  | Field of Study Restriction - Major  |          |              |     |
| 2. Priority   |  | Prerequisite error. See the Schedule of Classes.                                    | 1        | 1            | ť   |
| 2. Phoney     | CHH 23300                                | Prerequisite error. See the Schedule of Classes.                                    |          | ¥            |     |
| 1. Alter      | native 🔔 HTM 29102                       | + > ×   |          |              |     |
|               |  | Field of Study Restriction - Major  |          | -            |     |
| 3. Priority   | HTM 23100                                | Eield of Study Destriction Main   | T.       | Ļ            | ť   |
|               |  | Field of Study Restriction - Major<br>No alternative course provided.               |          |              |     |
|               |  | Prerequisite error. See the Schedule of Classes.                                    |          |              |     |
| _             | Alternative to HTM 23100                 | ×م<br>×   | _        | _            |     |
| 4. Priority 🤇 | PSY 63100                                |   | <b>1</b> | Ļ            | Ĩ   |
|               |  | Student Level Restriction (UG, PR, GR)<br>No alternative course provided.           |          |              |     |
|               |  | Permission from Department  |          |              |     |
| 1. Alter      | Alternative to PSY 63100                 | <b>x</b> ۹  |          |              |     |
| 5. Priority 💙 | PHYS 25200                               | <b>x</b> ۵  | 1        | $\downarrow$ | ť   |
|               |  | No alternative course provided.   |          |              |     |
| 1. Alter      | Alternative to PHYS 25200                | ×۹  | _        | _            | _   |
| 6. Priority   | MA 42800                                 | <b>X</b> ۵  | 1        | Ļ            | ť   |
|               |  | No alternative course provided.<br>Prerequisite error. See the Schedule of Classes. |          |              |     |
| 1. Alter      | native Alternative to MA 42800           | <b>x</b> ۵  |          |              |     |
| 7. Priority   |  | <b>x</b> م  | ↑        | ↓            | Ĩ   |
| 8. Priority   |  | <b>x</b> م  | ↑        | Ť            | f   |
| 9. Priority   |  | ×م  | ↑        | T            | Ĩ   |
| 10. Priority  |  | ×a  | Ŷ        | Ť            | 1   |
| 11. Priority  |  | ×م  | Ŷ        | Ť            | 1   |
| 12. Priority  | ourse with the lowest priority.          | <b>x</b> م  | ↑        | Ť            | 1   |
|               |  | Tip: Enter a free time to aviod getting classes in time you need fo                 | or som   | ethin        | g e |
| lternate C    | Course Requests                          | (used only if a course requested above is not available)                            |          |              |     |
|               | ternate request if course(s) above not a | vailable.   | 1        | $\downarrow$ | 1   |
| _             |  |   |          | -            |     |

| Degree Plan  | Current Registration          | Total Credit: 14 - 17   | Submit Requests |   |              | sts |
|--------------|-------------------------------|-------------------------|-----------------|---|--------------|-----|
| 3. Alternate |                               |                         | ۶X              | 1 |              | Û   |
| 2. Alternate |                               |                         | ۶X              | 1 | $\downarrow$ | Û   |
| 1. Alternate | Alternate request if course(s | ;) above not available. | νx              | 1 | <b>1</b>     | D   |

You have made some changes in your course requests. Please click the Submit Requests button to update your submission.

## **Custom Validation**

Course Requests / UniTime

Log in

Enter / Change

**Course Requests** 

TIME

RESTful API / JSON

Check Eligibility to Register, Check Status

Is student eligible, returns existing override requests

Registration errors, overrides needed

max requested credit, other warning

#### Validate Requests

Request Overrides

The following registration errors have been detected

HTM 29101 Field of Study Restriction - Major

HTM 29102 Field of Study Restriction - Major

COM 21000 Prerequisite error. See the Schedule of Classes

Prerequisite error. See the Schedule of Classes.

consult with your advisor before coming back to your Course Request page

If you have already discussed these courses with your advisor and were advised to request registration in them please select Request Overrides & Submit. If you aren't sure, click Cancel and

Request Overrides & Submit

Request Overrides

Submit Override Requests

Cancel

Override status

Special Registration / SIS

tracks overrides, escalatior placement credit, etc Notify advisors, dvanced



## **Batch Student Scheduling**

## **Student Scheduling Solver**

- Using student course requests of all STAR/VSTAR participants
- Provide students with initial schedules
- An optimization process, using the (student scheduling) solver
  - **Constraints**: course structure, time conflicts, class/course limits, reservations, ...
  - **Optimization**: request priority, overlapping time (where allowed), distance conflicts, ...
- Requested Overrides
  - Course requests are re-validated (for the AP credits etc.)
  - Course requests that have not been approved are ignored
- Test runs, reporting
- Interface with Banner XE (validation, enrollment)



## Student Schedule

### Student Schedule

- As complete as possible (alternatives are used when a course is not available)
- Priorities are used to resolve conflicts
- The amount of overlapping time is minimized (where allowed)
- Distance conflicts are minimized (consequent classes too far)
- Maximize section and instructional method preferences

## **Additional Criteria**

- Section balancing
- Avoid arrange hour classes
- Keep students of the same group together

|            |           |          |        |                |              |          |        |        |               |            |              |           | Student Scheduling                                   | Assis       | tant 🔮     |
|------------|-----------|----------|--------|----------------|--------------|----------|--------|--------|---------------|------------|--------------|-----------|--|-------------|------------|
| NIT        | IME       |          |        |                |              |          |        |        |               |            |              | Us        | er: Student, Imogene Alice<br>Click here to log out. | SSION: Fall |            |
|            | f Classes | Time G   | irid   |                |              |          |        |        | Class         | Schedule   |              |           |  |             |            |
| Lock       | Subject   | Course   | Туре   | CRN            | Avail        | Days     | Start  | End    | Date          | Room       | Instructor   | Requires  | Note   | Credit      | t          |
| <b>_</b>   | ENGL      | 10600    | Lec    | 65646-859      | 0/3          | т        | 7:30a  | 8:20a  | 08/23 - 12/06 | HEAV 105   |              |           |  | 4           | <b>v</b>   |
| ſ          |           |          | Lec    | 65646-859      | 0/3          | F        | 7:30a  | 8:20a  | 08/26 - 12/09 | HEAV 104   |              | 65646-859 |  |             | <b>V</b>   |
| ſ          |           |          | Lec    | 65646-859      | 0/3          | R        | 7:30a  | 8:20a  | 08/25 - 12/08 | BRNG B275  |              | 65646-859 |  |             | <b>v</b>   |
| ſ          |           |          | Rec    | 45178-630      | 0/2          | W        | 7:30a  | 8:20a  | 08/24 - 12/07 | HEAV 223   |              | 65646-859 |  |             | <b>~</b>   |
| ſ          | COM       | 11400    | Lec    | 69540-736      | 23 / 25      | т        | 8:30a  | 9:20a  | 08/23 - 12/06 | BRNG B230  |              |           |  | 3           | <b>v</b>   |
| <b>.</b>   |           |          | Lec    | 69540-736      | 23 / 25      | R        | 8:30a  | 9:20a  | 08/25 - 12/08 | BRNG B230  |              | 69540-736 |  |             | <b>~</b>   |
| <b>.</b>   |           |          | Lec    | 69540-736      | 23 / 25      | F        | 8:30a  | 9:20a  | 08/26 - 12/09 | BRNG B232  |              | 69540-736 |  |             | <b>~</b>   |
|            | Free      | Time     |        |                |              | М        | 7:00a  | 12:00p |               |            |              |           |  |             |            |
| ſ          | CHM       | 11500    | Lec    | 14183-002      | 68 / 95      | MF       | 3:30p  | 4:20p  | 08/22 - 12/09 | WTHR 200   | 🖂 C Das      |           | Supplemental Instruction (SI) stu                    | J 4         | <b>v</b>   |
| Ē          |           |          | Lab    | 42365-183      | 4/5          | R        | 11:30a | 2:20p  | 08/25 - 12/08 | BRWN 2124  |              | 14183-002 | Supplemental Instruction (SI) stu                    | J           | <b>~</b>   |
| <b>.</b>   |           |          | Rec    | 42498-236      | 4/5          | w        | 12:30p | 1:20p  | 08/24 - 12/07 | WTHR 362   |              | 42365-183 | Supplemental Instruction (SI) stu                    | J           | <b>~</b>   |
| ſ          | BIOL      | 11000    | Lec    | 12061-001      | 360 / 445    | TR       | 2:30p  | 3:20p  | 08/23 - 12/08 | LILY 1105  | A R Anderson |           | Supplemental Instruction (SI) stu                    | J 4         | <b>v</b>   |
| ſ          |           |          | Rec    | 12088-027      | 35 / 40      | R        | 4:30p  | 5:20p  | 08/25 - 12/08 | WTHR 420   |              |           | Supplemental Instruction (SI) stu                    | J           | <b>~</b>   |
| <b>.</b>   |           |          | Lab    | 12131-071      | 23 / 29      | т        | 6:00p  | 7:50p  | 08/23 - 12/06 | WTHR 316   |              |           | Supplemental Instruction (SI) stu                    | J           | <b>~</b>   |
|            | HIST      | 37100    | Not av | vailable (cour | se is full). |          |        |        |               |            |              |           |  | 🗆 Wa        | nit-List   |
| Î          | AD        | 11300    | Stdo   | 10191-006      | 3 / 14       | MWF      | 1:30p  | 3:20p  | 08/22 - 12/09 | PAO 3108   |              |           | \$100 course fee.                                    | 3           | <b>v</b>   |
| + <u>N</u> | lew Cours | e        |        |                |              |          |        |        | Total         | Credit: 18 |              |           |  | Show una    | ssignments |
|            | /Drop Cou | Press Dr | orropo | e Schedule     | Current F    | Pogietra | tion   |        |               |            |              |           | Submit S   | abadula     | Print      |





## Fall 2018 STAR

### How did we did?

- 8,600 students (original plans were about 8,000 students)
- 96.8% assigned course requests (over 45k course enrollments)
- 83.9% students received a complete schedule
  - 94% students did not get one course
- 91.4% first, 7.2% second, 1.2% third choice course assigned
- 94.6% student preferences met
- Well balanced
- 300 distance conf.

| Subject |                      |           | Consent | Available                 | Projection | Enrollment | ↑ Not-Enrolled | Alternative |
|---------|----------------------|-----------|---------|---------------------------|------------|------------|----------------|-------------|
| Туре    | <b>CRN-SectionId</b> | Time Date | Room    |                           |            |            |                |             |
| 🛨 ENGL  | 10600                |           |         | 0 / 819                   | 1364       | 819        | 493            | 112         |
| ± COM   | 11400                |           |         | 1 / 1122                  | 1790       | 1121       | 195            | 362         |
| + ME    | 29700C               |           |         | 0 / 74                    | 59         | 74         | 86             | 4           |
| 🗄 BIOL  | 13500                |           |         | 0 / 125                   | 118        | 125        | 77             | 9           |
| HONR 🗄  | 19900W               |           |         | 0 / 25                    | -          | 25         | 37             | -           |
| ± EDPS  | 31500                |           |         | 0 / 172                   | 230        | 172        | 28             | 134         |
| ± SCLA  | 10100                |           |         | 2 <sup>r)</sup> / 547     | 539        | 545        | 24             | 235         |
| 🗄 BIOL  | 11000                |           |         | 2 + 2 <sup>r)</sup> / 996 | 1360       | 992        | 19             | 4           |
| 🗄 ENGL  | 10800                |           |         | 0 / 209                   | 258        | 209        | 19             | 75          |
| ± AT    | 10200                |           |         | 0 / 66                    | 132        | 66         | 14             | -           |
| 🛨 FR    | 10200                |           |         | 0 / 41                    | 108        | 41         | 13             | 1           |
| 🛨 ENGR  | 10300MED             |           |         | 0 / 48                    | 37         | 48         | 12             | 4           |



## Reporting

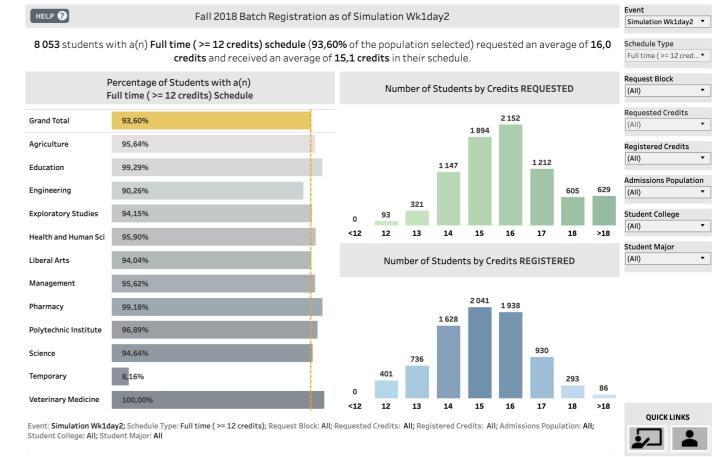
## Student Scheduling Dashboard

- Monitor student progress (requested courses / credit, etc.)
- Advisors: can allow students in and out (student status)
- Various information, including overlaps, distances, credits, alternatives, student details, and logging
- Last test runs

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## **Additional Reports**

Additional APIs



OFFICE OF THE REGISTRA BATCH REGISTRATION POPULATION HEALT



## Lessons Learned

### Lessons Learned

- Nightly schedule test runs are very useful
  - Find issues early (e.g., courses with not enough space)
  - Added ability to share results within the community
- It is important to provide alternatives
  - Two alternative courses are often enough
- Timing can be an issue (e.g., AP/transfer credits)
- If there is not enough space, preferential treatment may be needed
  - Critical courses (courses needed to make progress)
  - Reservations
- No need to grant short time windows
  - Much smaller peaks (no need to be the first one in)
- It is important to get everyone on board





## Fall 2019

- (Almost) same as Fall 2018
  - Only the STAR/VSTAR students
  - There will be more of them than last year (again)
  - With various improvements done to the process and UniTime
  - A couple of pilots: communication courses, using degree plan, Spring 2020 pre-registration for Aviation Tech. students

## Spring 2020+

- Extending pre-registration to other students
- Various scenarios on the table, including one with all undergraduate students doing pre-registration
- Work in progress...





## Fall 2019 Pre-Registration

### **UniTime 4.4 Improvements**

- Published Schedule Runs (sharing results of a test run)
- Student Schedule Quality (early/late times, lunch, travel, etc.)
- Min/Max Credits (e.g., ensure students get at least min credits)
- Critical Courses (courses essential to graduate)
- Solver Reports API (additional reports for higher ups)
- Student Preferences & Requirements (improved handling + required)

## **Process Changes**

- Learning Communities (batched together with other students, using reservations)
- Communication Courses (pre-populated with default alternatives)
- Degree Planning (+critical course indication, ap/transf. credit)
- University Core Courses (easier lookup, degree plan)



## Conclusion

## Student Scheduling at Purdue University

- So far, introducing batch student scheduling has been a success
- There is a clear commitment at Purdue to continue this direction
- Still a lot of work ahead of us

## 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 <u>www.unitime.org</u>



An online demo is available at https://demo.unitime.org