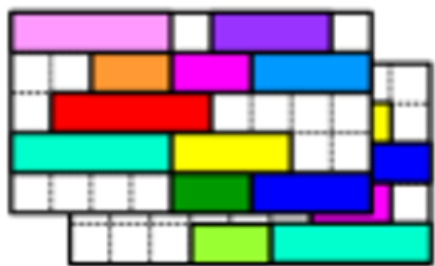




Instructor Scheduling in UniTime



UniTime

Tomáš Müller

August 2026



What is UniTime?

- Comprehensive academic scheduling solution
- Open-source, web-based, written in Java
- 100+ institutions worldwide, data contributed to ITC 2019

Courses: time & rooms

- time preferences
- room requirements
- availability
- course structure
- avoid time clashes
- student course demand
- distributions

Events: room bookings

- course-related events
- personal schedule
- approval process
- unavailabilities

Exams: period & rooms

- minimize student conflicts
- period & room prefs
- distributions
- room sharing or splitting

Instructors: teaching assignments

- teaching load
- availability
- qualifications / skills
- preferences

Students: class schedule

- course requirements
- alternatives / free times
- reservations
- section balancing
- schedule quality



Instructor Scheduling

Highlights

- Assignment of instructors to classes
 - Motivated by TA assignments at Purdue (*Math, Chemistry, Computer Science*)
 - Course timetable has been already published
 - Professors and full-time faculty already assigned to lectures
 - Instructors can also be students
- Requirements
 - One assignment can contain one or more classes
 - Availability (*including other classes taught or attended*)
 - Teaching load
 - Skill/qualification/experience matching
 - Same course & same lecture/professor
 - Minimize outside help needed
 - Additional preferences and requirements (E.g., back-to-back assignments)



Teaching Assistants for Chemistry

- Each course has
 - One or more lectures (*already assigned to a professor*)
 - Many labs and practices (*forming pairs and related to a particular lecture*)
- Each teaching assistant should teach one or two pairs of a lab and a practice
 - Full time TAs get two assignments, half-time TAs get just one
 - A TA can only teach one course
 - Preferably of the same lecture (*same professor*)
 - Must be available for the classes and the lecture
 - Each course may have a different set of skills and qualifications needed
 - Some (higher level) courses may require particular TAs
- Each course also needs one or two teaching assistant supervisors
 - These get assigned as course coordinators (do not show up for classes)
 - TA supervisors must be available for all of the lectures



Data Entry Example

-----Timetable-----						
	External Id	Limit	Time Pattern	Time	Room	Room Cap
CHM 11100		240	General Chemistry			
Lecture		240	2 x 50			
Practice Study Observation		240	1 x 50			
Laboratory		240	1 x 150			
Lec 1	13773-001	120	2 x 50	TTh 10:30a-11:20a	WTHR 200	480
Pso 1	13782-026	24	1 x 50	T 8:30a-9:20a	BRWN 3100	30
Lab 1	13765-009	24	1 x 150	W 11:30a-2:20p	BRWN 1164	24
Pso 2	13784-028	24	1 x 50	T 7:30a-8:20a	BRWN 3104	30
Lab 2	13767-011	24	1 x 150	W 11:30a-2:20p	BRWN 1135	24
Pso 3	13774-018	24	1 x 50	T 1:30p-2:20p	BRWN 3104	30
Lab 3	13757-017	24	1 x 150	W 11:30a-2:20p	BRWN 1134	24
Pso 4	13775-019	24	1 x 50	M 1:30p-2:20p	BRWN 3104	30
Lab 4	13758-002	24	1 x 150	W 2:50p-5:40p	BRWN 1125	24
Pso 5	13779-023	24	1 x 50	M 3:30p-4:20p	BRWN 3102	30
Lab 5	13762-006	24	1 x 150	W 11:30a-2:20p	BRWN 1124	24
Lec 2	13823-001	120	2 x 50	TTh 11:30a-12:20p	AR 106	180
Pso 6	13777-021	24	1 x 50	T 12:30p-1:20p	BRWN 3104	30
Lab 6	13760-004	24	1 x 150	W 2:50p-5:40p	BRWN 1134	24
Pso 7	13783-027	24	1 x 50	T 9:30a-10:20a	BRWN 3100	30
Lab 7	13766-010	24	1 x 150	W 11:30a-2:20p	BRWN 1125	24
Pso 8	13778-022	24	1 x 50	T 3:30p-4:20p	BRWN 3100	30
Lab 8	13761-005	24	1 x 150	W 2:50p-5:40p	BRWN 1164	24
Pso 9	13776-020	24	1 x 50	T 2:30p-3:20p	BRWN 3104	30
Lab 9	13759-003	24	1 x 150	W 2:50p-5:40p	BRWN 1135	24
Pso 10	13781-025	24	1 x 50	T 4:30p-5:20p	BRWN 3100	30
Lab 10	13764-008	24	1 x 150	W 2:50p-5:40p	BRWN 1124	24

2 Lectures

10 Pso-Lab pairs
(5 full time TAs)

1 TA supervisor



Instructor Scheduling

Instructors

- Teaching preference
- Maximal teaching load
- Attributes: *skills, qualifications, seniority, certifications, etc.*
- Availability and preferences (*on time and courses*)
- Distributions: *back-to-back / same day / same room preferences/requirements*

Courses

- Teaching requests (*classes that need an instructor*)
- Teaching load
- Number of instructors needed
- Requirements and preferences (*instructor and attributes*)
- Other: *same course, same lecture preferences*

Goal: assign instructors to teaching requests in a way that maximizes satisfaction while all the hard constraints are met



Instructor Scheduling

Hard Constraints

- Teaching load
- Availability (*including enrolled classes*)
- Time conflicts (*teaching assignments of the same instructor cannot overlap*)
- Required/prohibited attributes, instructors, courses, and distributions
- Required/prohibited same-course, same-common

Soft Constraints / Objectives

- Teaching preference
- Preferences on time, course, instructor, attribute, and distribution
- Preferences on same-course, same-common
- Unused instructor load
- Minimize overlaps (where allowed)

	Required
	Strongly Preferred
	Preferred
	Neutral
	Discouraged
	Strongly Discouraged
	Prohibited



Data Entry Example

-----Timetable-----						
	External Id	Limit	Time Pattern	Time	Room	Room Cap
CHM 11100		240	General Chemistry			
Lecture		240	2 x 50			
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Lab 10	13764-008	24	1 x 150	W 2:50p-5:40p	BRWN 1124	24

2 Lectures

10 Pso-Lab pairs
(5 full time TAs)

1 TA supervisor



Data Entry Example

1. Teaching Request

[Remove Request](#)

Teaching Load:

10

Scheduling Subpart:

CHM 11100 Lab

Classes:

	Class	External Id	Enrollment	Limit	Time	Date	Room
☐	CHM 11100 Lab 1	13765-009	22	24	W 11:30a - 2:20p	Full Term	BRWN 1164
☐	CHM 11100 Lab 2	13767-011	21	24	W 11:30a - 2:20p	Full Term	BRWN 1135
☐	CHM 11100 Lab 3	13757-017	20	24	W 11:30a - 2:20p	Full Term	BRWN 1134
☐	CHM 11100 Lab 4	13764-008	23	24	W 2:50p - 5:40p	Full Term	BRWN 1124
☐	CHM 11100 Lab 5	13758-002	22	24	W 2:50p - 5:40p	Full Term	BRWN 1125
☐	CHM 11100 Lab 6	13762-006	22	24	W 11:30a - 2:20p	Full Term	BRWN 1124
☐	CHM 11100 Lab 7	13760-004	23	24	W 2:50p - 5:40p	Full Term	BRWN 1134
☐	CHM 11100 Lab 8	13766-010	21	24	W 11:30a - 2:20p	Full Term	BRWN 1125
☐	CHM 11100 Lab 9	13761-005	24	24	W 2:50p - 5:40p	Full Term	BRWN 1164
☐	CHM 11100 Lab 10	13759-003	20	24	W 2:50p - 5:40p	Full Term	BRWN 1135

Include Subparts:

	Instructional Type	Assign	Share	Lead	Can Overlap	Common
☒	CHM 11100 Lec (1 parent class)	☐			☐	☒
☒	CHM 11100 Pso (1 parent class)	☒	100	☒	☐	☐
☒	CHM 11100 Lab	☒	100	☒	☐	☐

Same Course Preference:

Required

Same Common Part:

Preferred

Qualification Preferences:

CHM 11100

Select...

Strongly Preferred

Neutral

Role Preferences:

TA

Select...

Required

Neutral

Skill Preferences:

Select...

Neutral

Instructor Preferences:

Select...

Neutral

✗

✗

✗

✗

✗

✗



Data Entry Example

Common: two assignment can share (*typically the lecture*)
TA Supervisor gets assigned as course coordinator

2. Teaching Request

[Remove Request](#)

Number of Instructors:

Teaching Load:

Assign Coordinator:

☒

Coordinator Percent Share:

Classes:

	Class	External Id	Enrollment	Limit	Time	Date	Room	Assign	Share	Lead	Can Overlap	Common
☒	CHM 11100 Lec 1	13773-001	218	240	TTh 10:30a - 11:20a	Full Term	WTHR 200	☐			☐	☒
...												
☒	CHM 11100 Lec 2	13823-001	0	120	TTh 11:30a - 12:20p	Full Term	AR 106	☐			☐	☒
...												

Same Course Preference:

Same Common Part:

Qualification Preferences:

✗

✗

Role Preferences:

✗

✗

Skill Preferences:

✗

Instructor Preferences:

✗

help.unitime.org/manuals/instructor-scheduling



Instructor Scheduling Solver

**UniTime**

Instructor Scheduling Solver ?

Solver stopped.
Instructor Scheduling Solver

Muller, Tomas
Administrator

Spring 2017 (PWL)
[Click here to change the session / role.](#)

Instructor Scheduling Solver

Input Data Loaded: 05/04/2017 03:59PM

Status: Solver stopped. 

Solver Configuration:

Solver Mode:

When Finished:

Owner:

Host:

Best Timetable

Assigned variables 100.00% (109/109)

Overall solution value 35992.00

Time 0.12 min

Iteration 35827

Speed 5184.68 it/s

Assigned Load 100.00% (109.00 / 109.00)

Course Preferences 3.57% (-8)

Same Lecture 100% (177)

Time Overlaps 3 h

Time Preferences 100% (0)

Unused Instructor Load 100% (0)

Current Timetable

Assigned variables 100.00% (109/109)

Overall solution value 35992.00

Time 0.42 min

Iteration 127227 (0.00% failed)

Speed 5093.29 it/s

Assigned Load 100.00% (109.00 / 109.00)

Best Iteration 35827

Best Time 0.12 min (5184.68 it/s)

Course Preferences 3.57% (-8)

Same Lecture 100% (177)

Time Overlaps 3 h

Time Preferences 100% (0)

Unused Instructor Load 100% (0)

- Just like any other solver in UniTime
- Using the same constraint-based solver framework and algorithms, just a different constraint model
- Fully automated or interactive
- MPP (*minimize changes*)
- Variable: teaching request
(*one or more classes that need an instructor*)
- Value: teaching assignment
(*assignment of an instructor to a teaching request*)

Solver Framework

Problems

Course Timetabling

Examination Timetabling

Instructor Scheduling

Student Scheduling

Constraint-based Model

Variables

Values

Constraints

Criteria

Solver

Configuration

Parameters

General

Problem Specific

Neighborhoods

Algorithms

IFS

HC

SA

GD



UniTime Solver

Construction Phase (IFS)

- Incomplete but feasible
- Pick an unassigned variable
- Find the best assignment
 - Unassign conflicts
- Conflict statistics (CBS)
 - To prevent cycling
 - Provides feedback when over-constrained

$$A \neq a \Leftarrow \begin{cases} 3 \times B = a \\ 4 \times B = c \\ 2 \times C = a \\ 120 \times D = a \end{cases}$$

Improvement Phase

- Complete and feasible
- Random selection of a candidate change
- Various acceptance criteria
 - HC, SA or GD
- Reheating
- Parameter adjustments
- Until time runs out



Instructor Scheduling

More Features...

- Teaching conflicts reporting
- Data exchange and roll forward
- Teaching assignments in Student Scheduling Assistant



Student Scheduling Assistant ?
User: Student, David [Click here to log out.](#) Session: Fal 2010 (woebegon) [Click here to change the session.](#)

List of Classes Time Grid

Class Schedule

Lock	Subject	Course	Type	Class	Avail	Days	Start	End	Date	Room	Instructor	Requires	Note	Credit
	CHM	10100	Lec	1	0 / 4	MW	12:30p	1:20p	Full Term	EDUC 101 (Display Name)				
			Lec	3	0 / 4	TR	11:30a	12:20p	Full Term	EDUC 101 (Display Name)				
			Lab	9	0 / 1	R	3:00p	5:50p	Full Term	EDUC 107	D Student	3		
			Lab	4	0 / 1	T	3:00p	5:50p	Full Term	EDUC 107	D Student	1		
			Rec	9	0 / 1	T	1:30p	2:20p	Full Term	EDUC 104	D Student	9		
			Rec	4	0 / 1	M	2:30p	3:20p	Full Term	EDUC 102	D Student	4		
	BIOL	10100	Lec	2	2 / 4	TR	7:30a	8:20a	Full Term	EDUC 101 (Display Name)	G Newman			✓
			Rec	6	0 / 1	F	9:30a	10:20a	Full Term	EDUC 104				✓
			Lab	5	0 / 1	F	3:30p	5:20p	Full Term	EDUC 107				✓
			Pso	3	1 / 4	R	8:30a	9:20a	Full Term	EDUC 101 (Display Name)	G Newman			✗
			Pso	2	1 / 4	W	9:30a	10:20a	Full Term	EDUC 101 (Display Name)	G Newman			✗
	CHM	10100	Lec	2	0 / 4	TR	9:30a	10:20a	Full Term	EDUC 101 (Display Name)				✓
			Lab	7	0 / 1	W	3:00p	5:50p	Full Term	EDUC 106	J Novak	2		✓
			Rec	7	0 / 1	W	10:30a	11:20a	Full Term	EDUC 104	J Novak	7		✓
	CALC	10100	Lec	A	0 / 4	MWF	7:30a	8:20a	Full Term	EDUC 101 (Display Name)	J Doe			✓
			Rec	A2	0 / 1	M	10:30a	11:20a	Full Term	EDUC 104	J W Smith	A		✓
	PHAR	10100	Lec	1	1 / 4	T	8:30a	9:20a	Full Term	EDUC 101 (Display Name)				✓
	ENGL	10100	Lec	6	0 / 1	MWF	1:30p	2:20p	Full Term	EDUC 103				✓
			Lab	6	0 / 1	M	3:30p	4:20p	Full Term	EDUC 108		6		✓
	ALG	10100	Dist (Online)	2	∞	Arrange Hours			Full Term					3 ✓

New Course Total Credit: 3 ☒ Show unassignments

[Add/Drop Courses](#) [Rearrange Schedule](#) [Current Registration](#) [Submit Schedule](#) [Print](#)

You have made some changes in your schedule. Please click the Submit Schedule button to update your registration.



Instructor Scheduling Solver


UNITIME

Instructor Scheduling Solver

Input Data Loaded: 05/04/2017 03:59PM
Status: Solver stopped.
Solver Configuration: Default
Solver Mode: Initial
When Finished: No Action
Owner: 1393 - Chemistry
Host: auto

Start Reload

Best Timetable
Assigned variables: 100.00% (109/109)
Overall solution value: 35992.00
Time: 0.12 min
Iteration: 35827
Speed: 5184.68 it/s
Assigned Load: 100.00% (109.00 / 109.00)


UNITIME

Department: 0101

External Id	Name	Assigned Load	Attributes
100	Doe, Joe	10 / 20	P1, Beginner
101	Newman, George	10 / 10	P2, Advanced
	Novak, Josef	20 / 20	P1, Calculus
102	Smith, John William	10 / 20	P1, Expert
1001	Student, Andrew	10 / 20	Oral English, P0, Chemistry
1002	Student, Brian	10 / 20	Oral English, P0, Biology, Chemistry
1003	Student, Charles	0 / 20	Oral English, P0, Chemistry
1004	Student, David	10 / 20	Oral English, P0, Chemistry
1018	Student, Steve	20 / 20	Oral English, P1, Chemistry

Solver stopped.
Instructor Scheduling Solver

Muller, Tomas
Administrator

Spring 2017 (PWL)
[Click here to change the session / role.](#)


UNITIME

Subject Area: CHM

Details of CHM 10100 Lab 9 and Rec 9

Teaching Request
Course: CHM 10100
Sections:

Section	Time	Date	Room
Lec 3	TTh 11:30a - 12:20p	Full Term	EDUC 101
Lab 9	Th 3:00p - 5:50p	Full Term	EDUC 107
Rec 9	T 1:30p - 2:20p	Full Term	EDUC 104

Load: 10
Attribute Preferences: P0, P1, Chemistry
Assigned Instructors:

External Id	Name	Assigned Load	Attributes	Course Preferences	Time Preferences	Distribution Preferences	Objectives
1004	Student, David	20 / 20	Oral English, P0, Chemistry				Attribute Preferences: +1 Different Lecture: +1

Selected Assignment

Course	Section	External Id	Name	Attributes	Course Preferences	Time Preferences	Distribution Preferences	Objectives
CHM 10100	Lec 3, Lab 9, Rec 9	1004	Student, David	Oral English, P0, Chemistry				Attribute Preferences: -1 Different Lecture: -1

Score: +998,000.00
Objectives: Attribute Preferences: -1
Different Lecture: -1
Unused Instructor Load: +10

Available Instructors

External Id	Name	Assigned Load	Attributes	Course Preferences	Time Preferences	Distribution Preferences	Conflicts	Objectives
1004	Student, David	20 / 20	Oral English, P0, Chemistry					
1001	Student, Andrew	10 / 20	Oral English, P0, Chemistry				CHM 10100 Lec 2 TTh 9:30a - 10:20a Attribute Preferences: -1 Lab 6 W 7:30a - 10:20a Different Lecture: -1 Rec 6 Th 11:30a - 12:20p Unused Instructor Load: +10	
	Novak, Josef	20 / 20	P1, Calculus, Chemistry				CHM 10100 Lec 2 TTh 9:30a - 10:20a Attribute Preferences: -1 Lab 8 T 11:30a - 2:20p Same Common: +8 Rec 8 F 12:30p - 1:20p Unused Instructor Load: +10	

Suggestions

Score	Course	Section	External Id	Name	Objectives
(all 5 possibilities up to 3 changes were considered, no suggestion found)					

Not-Assigned Teaching Requests

Root, Abraham
Administrator

Fal 2010 (woebegon)
[Click here to change the session / role.](#)

Search

Export CSV

Export PDF

Assigned Instructors	Attribute Preferences	Instructor Preferences
0 / 1	Beginner, Experienced, Chemistry	
0 / 1	Beginner, Experienced, Chemistry	

Teaching Assignments

Solver stopped.
Instructor Scheduling Solver

Root, Abraham
Administrator

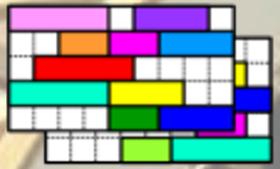
Fal 2010 (woebegon)
[Click here to change the session / role.](#)

Search

Export CSV

Export PDF

Date	Room	Load	Attribute Preferences	Instructor Preferences	Objectives
Full Term EDUC 101	No Dates No Room	10	P1		Course Preferences: -4 Time Overlaps: +12 Time Preferences: +4
Full Term EDUC 103		10	P2, Algorithms		Attribute Preferences: -1 Teaching Preferences: -4 Time Overlaps: +72 Time Preferences: +4
Full Term Eiffel Tower, THTR 101					
Full Term EDUC 101					
Full Term EDUC 101		10	P0, P1, Chemistry		Attribute Preferences: -3 Same Common: -8
Full Term EDUC 106					
Full Term EDUC 104					
Full Term EDUC 101		10	P0, P1, Chemistry		Attribute Preferences: -3 Same Common: -8
Full Term EDUC 106					
Full Term EDUC 103					
Full Term EDUC 101		10	Calculus		Time Overlaps: +24 Time Preferences: +4
Full Term EDUC 101					
Full Term EDUC 101					
Full Term EDUC 101		10	P0, P1, Chemistry		Attribute Preferences: +1
Full Term EDUC 106					
Full Term EDUC 104					
Full Term EDUC 101		10	P0, P1, Chemistry		Attribute Preferences: +1
Full Term EDUC 107					
Full Term EDUC 102					
Full Term EDUC 101		10	P0, P1, Chemistry		Attribute Preferences: +1
Full Term EDUC 107					
Full Term EDUC 102					
Full Term EDUC 101		20	P1, Chemistry		Time Overlaps: +60 Time Preferences: +4



UNITIME

Conclusion

Thank you!

www.unitime.org