Analyzing the impact of class scheduling at CSULB on graduation rates

Burkhard Englert & Chung-min Lee

April 18, 2018

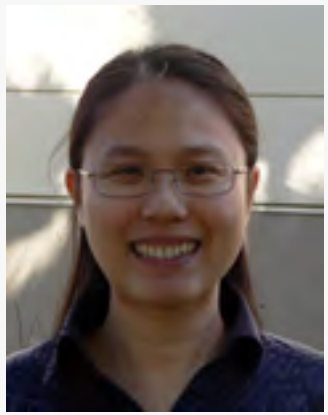
Members

Burkhard Englert

Chair CECS, Interim Chair BME, COE

Chung-min Lee

Associate Professor Math and Stats, CNSM



Neha Tyagi

Master's student CECS, COE

Background

Course scheduling aims to minimize, e.g.

- unused time slots for classrooms
- time between classes for students
- time for students to graduate

Scheduling problems

- are computationally difficult, and
- the objectives may be in conflict such as maximizing classroom usage vs. providing course access to students

Background

Course scheduling in CSULB is handled in departments,

- advantages
  - maximize classroom usage within departments
  - address the individual faculty teaching preferences
- without coordination
  - students with degree required courses in multiple departments may not be able to take courses in the recommended semesters and hence delay progress

Goals and aims of the study

Investigate the class schedule constraints students face when attempting to graduate in four years

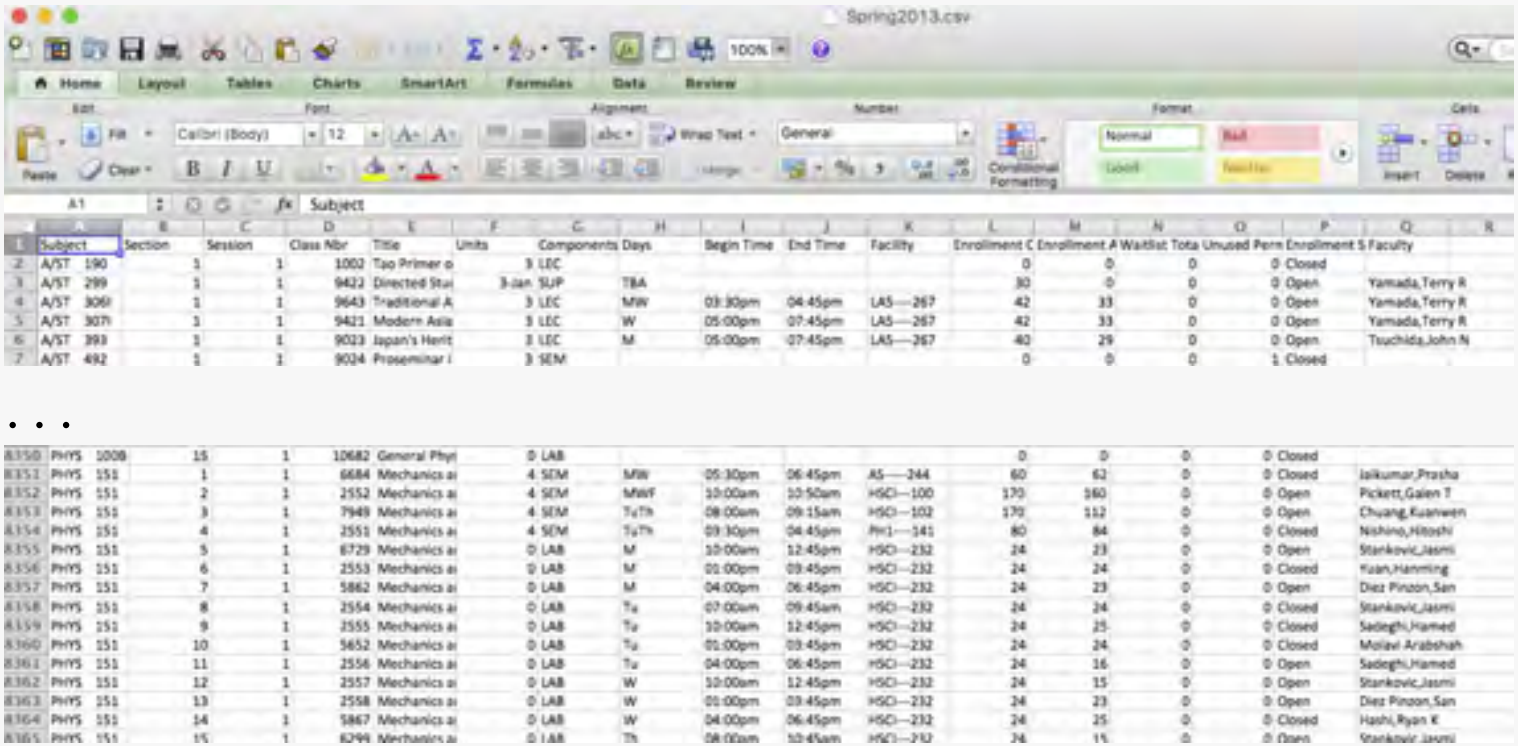
- Following degree roadmaps, do actual class schedules allow FTF students to graduate in four years?
- If yes, what schedule would a FTF student need to complete to graduate?
- What impact would such a schedule have on a student who needs to work to support her/himself?
- Where are the scheduling bottlenecks that affect students progress? How to eliminate them?

Scope of the study for academic year 2017 – 2018

- Develop a program that utilizes actual course offerings to show scheduling conflicts
- Develop a simulation algorithm that estimates the percentage of the students affected by scheduling conflicts
- Analyze highly impacted Bachelor degree programs

Class conflict program

We extract from university websites actual course schedules during Fall 2012 to Fall 2016, and build a small local database for analyzing course conflicts.

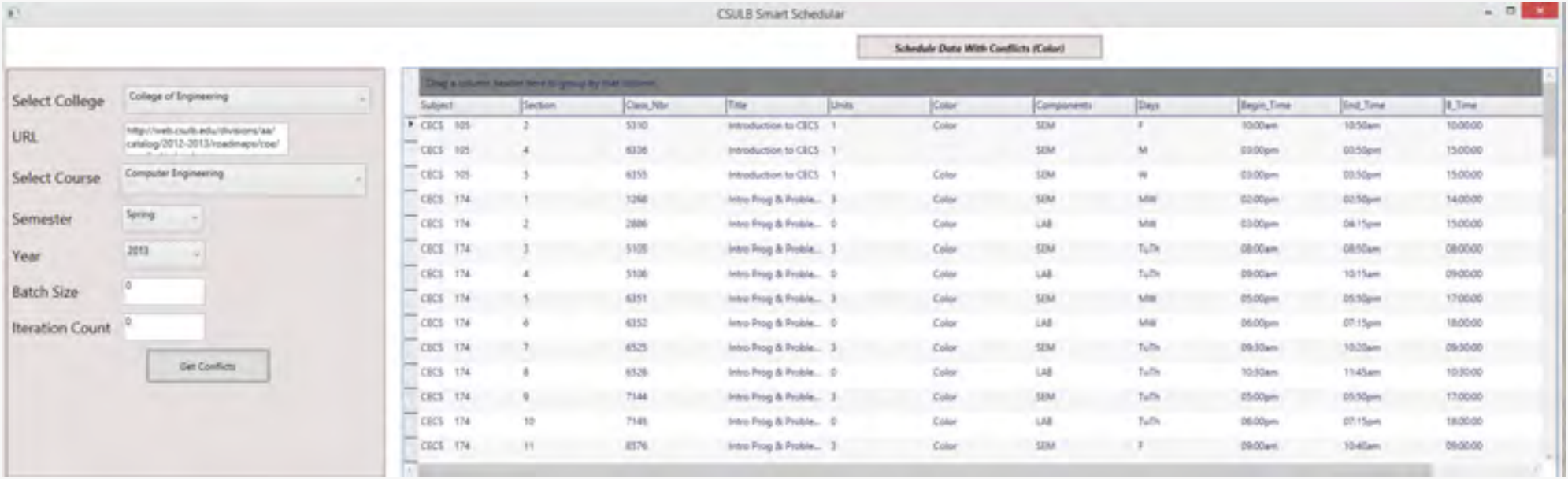


. . .

. . .

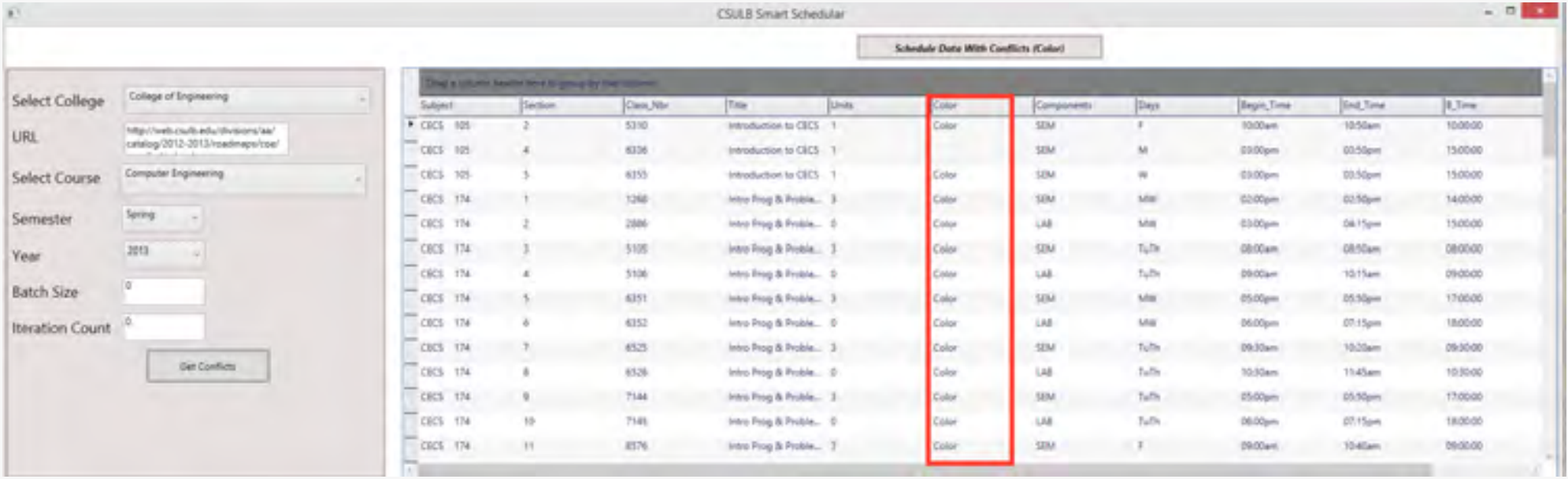
Class conflict program

For example, in Spring 2013 the actually offered courses required for a second semester Computer Engineering are:



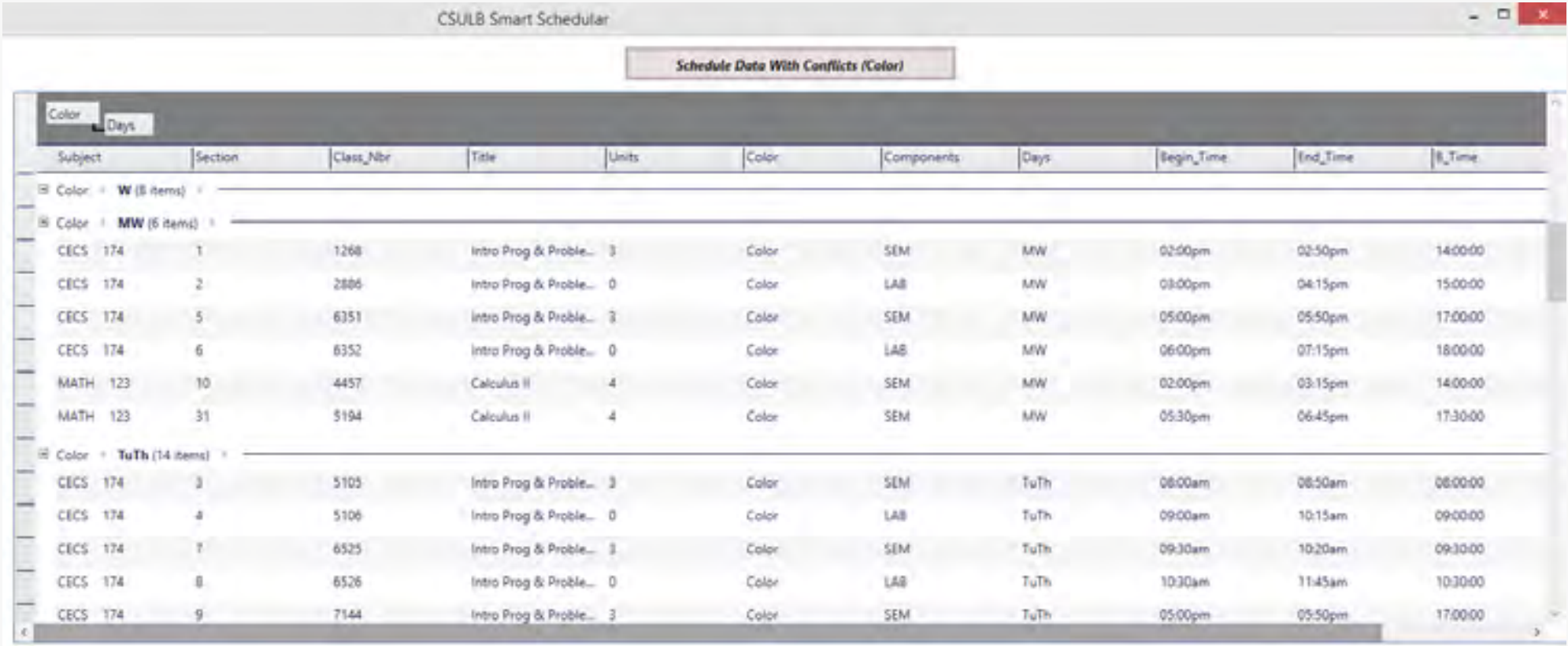
Class conflict program

For example, in Spring 2013 the actually offered courses required for a second semester Computer Engineering are:



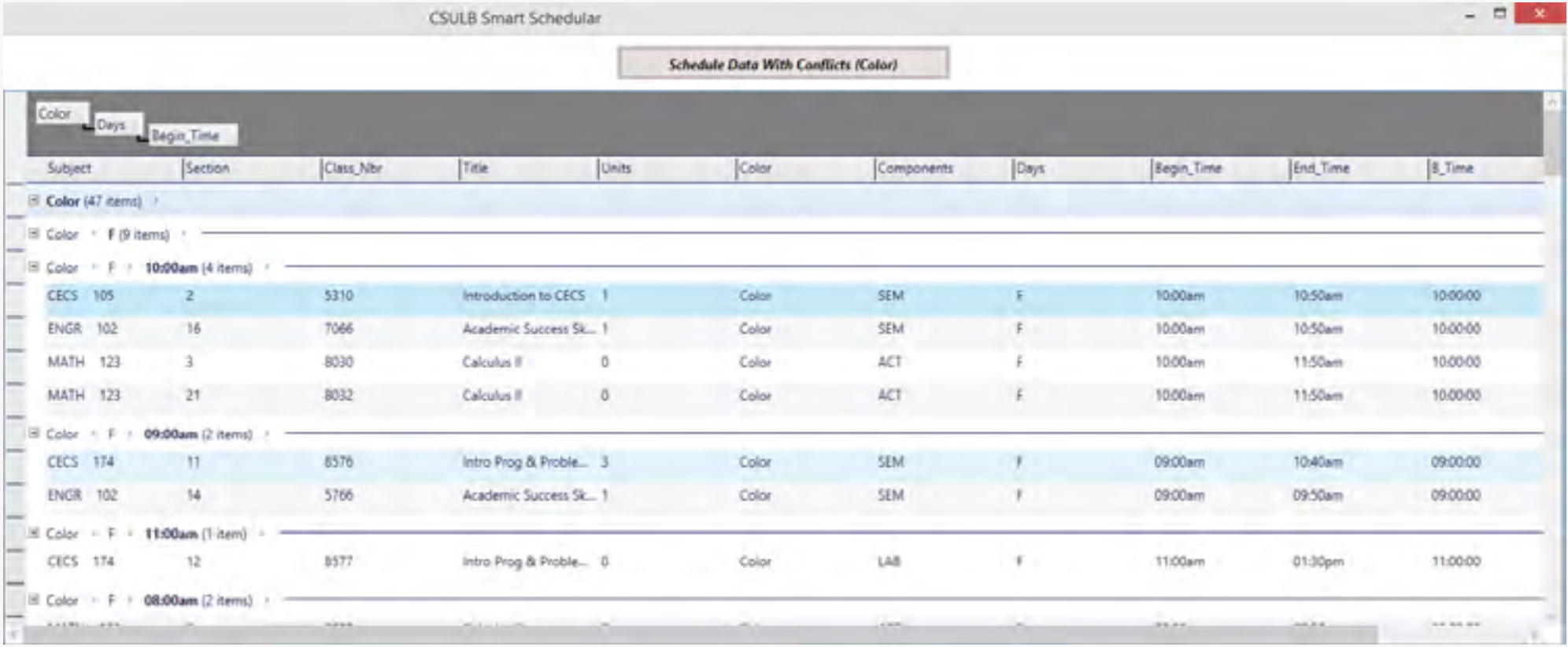
Class conflict program

For example, in Spring 2013 the actually offered courses required for a second semester Computer Engineering are:



Class conflict program

For example, in Spring 2013 the actually offered courses required for a second semester Computer Engineering are:



Impacts of course conflicts

Science and engineering majors have many course dependencies in beginning years of study. E.g. Computer Engineering (2012-2013 roadmap)

Four Year Plan - 121 Units Required

Course	Units	Course	Units
Semester 1		*Semester 2*	
ENGR 101 Intro to Engrg Profession (GE-E)	1	ENGR 102 Academic Success Skills (GE-E)	1
MATH 122 Calculus I (GE-B2) *	4	CECS 105 Intro to Comp Eng & Comp Sci (GE-E)	1
CECS 100 Crit Thinking in Dig Info Age (GE-A3)	3	CECS 174 Intro to Prog & Problem Solv CECS 100	3
CECS 201 Computer Logic Design	3	MATH 123 Calculus II (GE Elective-B) * MATH 122	4
Written Communication (GE-A1)	3	CECS 211 Principles of CpE I MATH 122	3
		Oral Communication (GE-A2)	3
Total Units	14	**Total Units**	15
Semester 3		*Semester 4*	
CECS 228 Discrete Structures with Comp Applic CECS 174	3	General Education	3
CECS 274 Obj Orient Prog & Data Struct CECS 174	3	CECS 282 C for Embedded Programming CECS 174, MATH 123	3
CECS 301 Computer Logic Design II CECS 174, 201	3	CECS 282 C++ for Java Programmers CECS 274	3
CECS 311 Principles of CpE II CECS 201, 211	3	EE 380 Prob & Stat & Stochastic Modeling MATH 123	3
PHYS 151 Mech & Heat (GE-B1b) * MATH 122	4	EE 210 / 210L Electro-Mag Foundations in EE / Lab PHYS 151	4
		(or PHYS 152 Electricity & Magnetism)	(4)
Total Units	16	**Total Units**	16
Semester 5		*Semester 6*	
General Education	3	GE Capstone course	3
CECS 271 Intro to Numerical Methods CECS 174, MATH 123	3	CECS 326 Operating Systems CECS 282	3
CECS 346 Microprocessors+Controllers I CECS 274	3	CECS 347 Microprocessors+Controllers II CECS 301, 311, 346	3
General Education **	3	CECS 360 IC Design Software	3
MATH or Science Elective	3-4	MATH or Science Elective	3-4
Total Units	15-16	**Total Units**	15-16
Semester 7		*Semester 8*	
GE Capstone course	3	GE Capstone course	3

Impacts of course conflicts

Also Nursing E.g. Registered Nurse 2-year plan, for a student entering with a minimum of 60 transferable units, an Associate Degree, and an RN license (2012-2013 roadmap)

Two Year Plan - 120 Units Required

Course	Units	Course	Units
Semester 1		*Semester 2*	
CHEM 140 or 302 Biochemistry	5	BIOL 305 Pathophysiology	3
N 309 Dimensions Professional Nrsg	2	NRSG 312 Physical Assessment	3
N 451 Leadership and Management	2	Upper Division General Education	6
Statistics (PSY 310 or EDP 419)	4		
Total Units	13	**Total Units**	12
Semester 3		*Semester 4*	
		NRSG 450 Nursing Research NRSG 400	3
		NRSG 451 Nursing Leadership NRSG 402	2
NRSG 400 Health Care Delivery System NRSG 309	3	NRSG 452 Adv Nsg in Critical Care	6
NRSG 402 Community Health Nursing NRSG 312	7	Or N 453 Adv Nsg Maternal Child Hlth	
Electives/General Education	3	Or N 454 Adv Nsg Community Mental Hlth	
		Upper Division General Education	3
Total Units	13	**Total Units**	14

Impacts of course conflicts

Or for a set of courses that affects a large number of majors. (2012-2013 roadmap) E.g.

- all CBA majors (Accounting, Finance, Management Information System, International Business, Management, Operations and Supply Chain Management, Human Resources Management, Marketing) need to take ECON 100 and STAT 108 in the first semester.
- CNSM majors Chemistry, BioChemistry, Biology; COE majors Chemistry Engineering, Civil Engineering, Mechanical Engineering; all need to take Chem 111A in the first two semesters with other Science or Engineering course requirements.

Impacts of course conflicts

Or for a set of courses that affects large number of majors. (2012-2013 roadmap)
E.g.

- all CBA majors (Accounting, Finance, Management Information System, International Business, Management, Operations and Supply Chain Management, Human Resources Management, Marketing) need to take ECON 100 and STAT 108 in the first semester.
- CNSM majors Chemistry, BioChemistry, Biology; COE majors Chemistry Engineering, Civil Engineering, Mechanical Engineering; all need to take Chem 111A in the first two semesters with other Science or Engineering course requirements.

Study class conflict impact

Exact percentage of students affected by scheduling conflict is difficult (computationally costly) to determine.
E.g., Second semester of requirement for Physics majors:
PHYS 152, MATH 123, CHEM 111A
In Spring 2013 schedule:

- PHYS 152: 4 seminar sections + 17 lab sections
- MATH 123: 12 sections of 1 seminar + 2 activities
- CHEM 111A: 3 lecture sections + 22 lab sections

Need $17 \times 24 \times 22 = 8976$ comparisons of schedules (assuming if a student gets into a lab/activity section can get into a non conflicting seminar/lecture section).

Study class conflict impact

Exact percentage of students affected by scheduling conflict is difficult (computationally costly) to determine.
E.g., Second semester of requirement for Physics majors:
PHYS 152, MATH 123, CHEM 111A
In Spring 2013 schedule:

- PHYS 152: 4 seminar sections + 17 lab sections
- MATH 123: 12 sections of 1 seminar + 2 activities
- CHEM 111A: 3 lecture sections + 22 lab sections

Need $17 \times 24 \times 22 = 8976$ comparisons of schedules (assuming if a student gets into a lab/activity section can get into a non conflicting seminar/lecture section).

Study class conflict impact

Exact percentage of students affected by scheduling conflict is difficult (computationally costly) to determine.
E.g., Second semester of requirement for Physics majors:
PHYS 152, MATH 123, CHEM 111A
In Spring 2013 schedule:

PHYS 152: 4 seminar sections + 17 lab sections

MATH 123: 12 sections of 1 seminar + 2 activities

CHEM 111A: 3 lecture sections + 22 lab sections

Need $17 \times 24 \times 22 = 8976$ comparisons of schedules (assuming if a student gets into a lab/activity section can get into a non conflicting seminar/lecture section).

Monte Carlo Method

It is a numerical simulation method to estimate underlying distributions.

- Start with a (deterministic) function of a set of parameters
- Input randomly selected values for the parameters (repeat many times)
- Compute the function values for each set of (randomly selected) parameters
- Observe the behavior of the output values (such as the fraction of values with a certain property)

Monte Carlo Method

Assumptions:

- capacity of classroom is not an issue
- seminar/lecture courses are the only ones pose conflicts

  (lack of class association database)
- GE can always be satisfied with any schedule
- department courses are scheduled to minimize conflicts for its own majors
- students have equal chances choosing any sections of a course

For a batch of students in a given major at a given semester, simulate the course selections and find how many would have course conflicts.

Monte Carlo Method

Assumptions:

- capacity of classroom is not an issue
- seminar/lecture courses are the only ones pose conflicts

  (lack of class association database)
- GE can always be satisfied with any schedule
- department courses are scheduled to minimize conflicts for its own majors
- students have equal chances choosing any sections of a course

For a batch of students in a given major at a given semester, simulate the course selections and find how many would have course conflicts.

Monte Carlo Method

Assumptions:

- capacity of classroom is not an issue
- seminar/lecture courses are the only ones pose conflicts

  (lack of class association database)
- GE can always be satisfied with any schedule
- department courses are scheduled to minimize conflicts for its own majors
- students have equal chances choosing any sections of a course

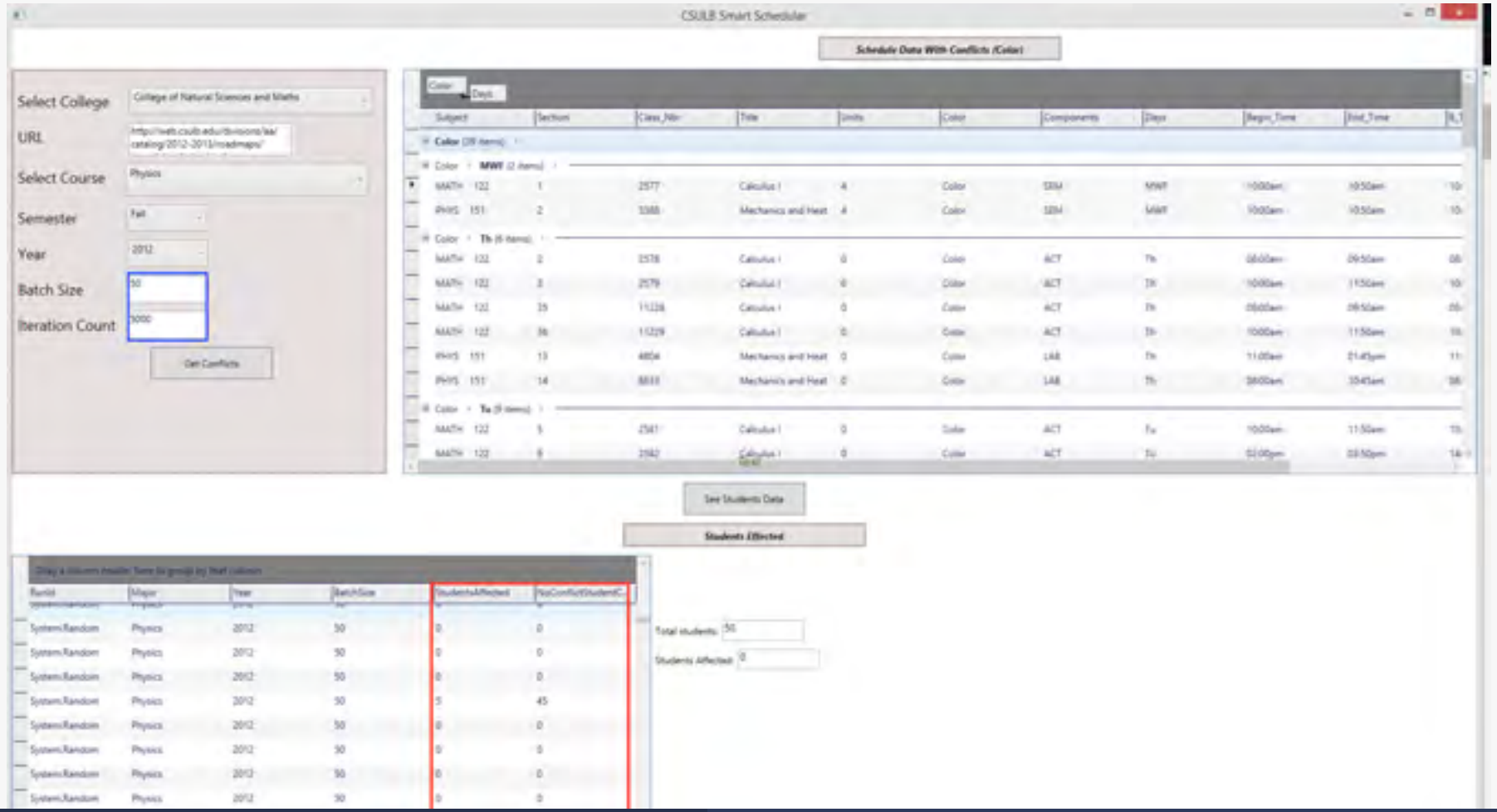
For a batch of students in a given major at a given semester, simulate the course selections and find how many would have course conflicts.

It will be an underestimation.

Impact Examples – one semester

Physics, first semester requirement using Fall 2012 schedule

MATH 122 (11 sections of 1 seminar + 2 activities), PHYS 151 (4 seminar sections and 18 lab sections)



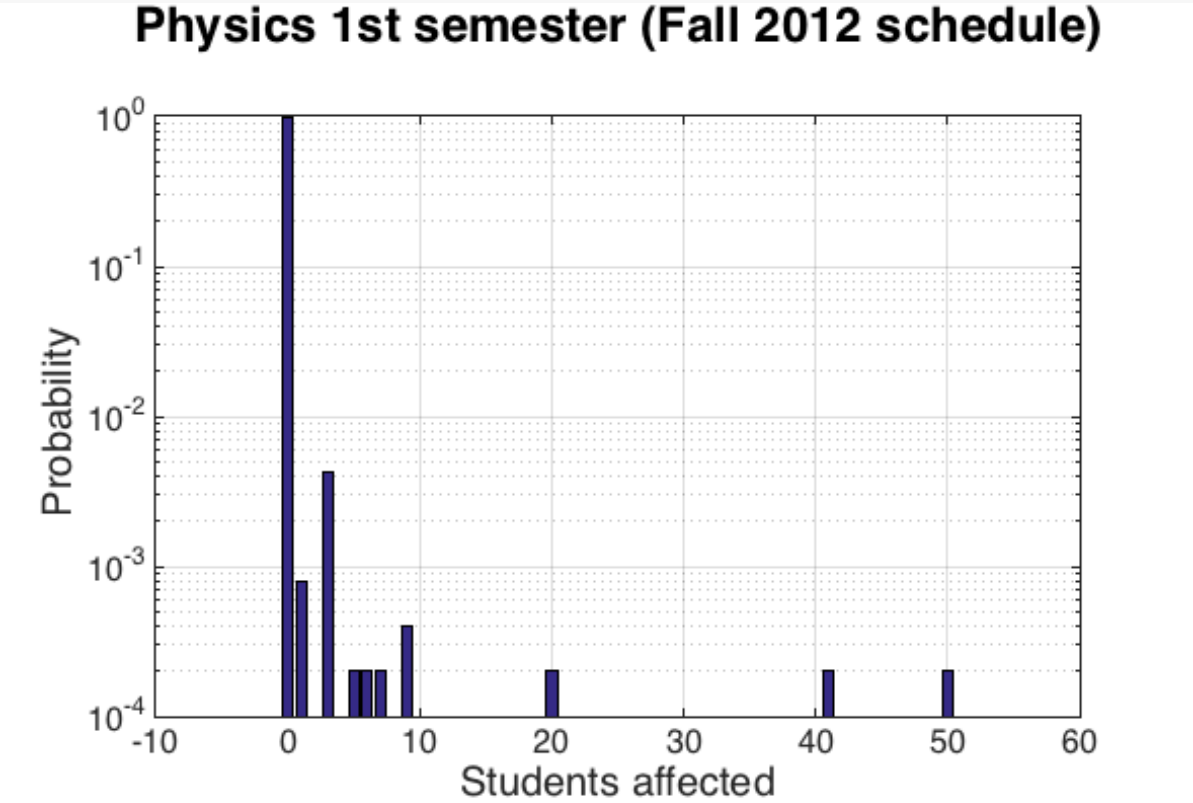
Impact Examples – one semester

Physics, first semester requirement using Fall 2012 schedule

MATH 122 (11 sections of 1 seminar + 2 activities), PHYS 151 (4 seminar sections and 18 lab sections)

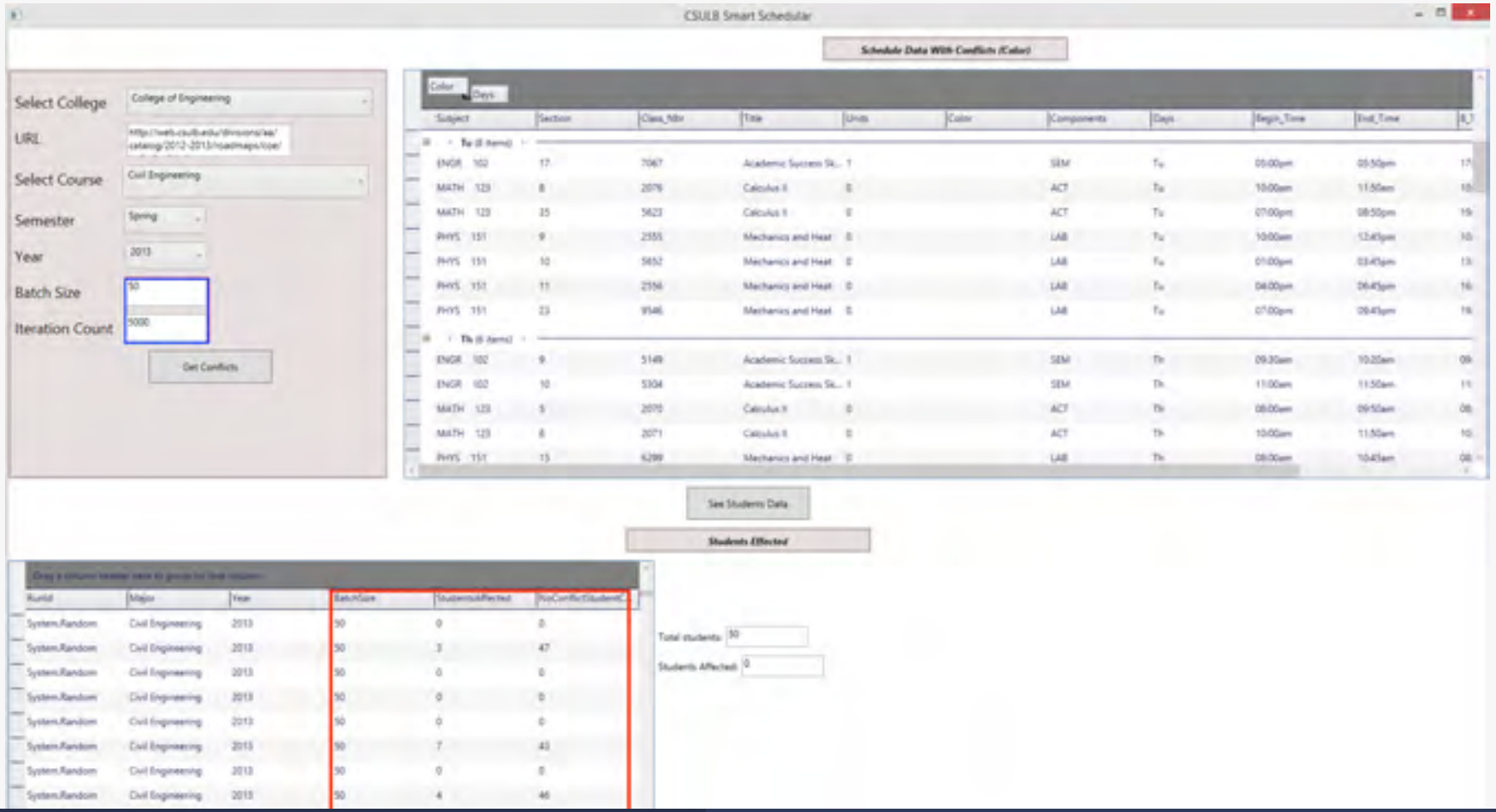
50 students, 5000 simulation runs: Students affected

Mean: 0.0428, Standard deviation 1.0038



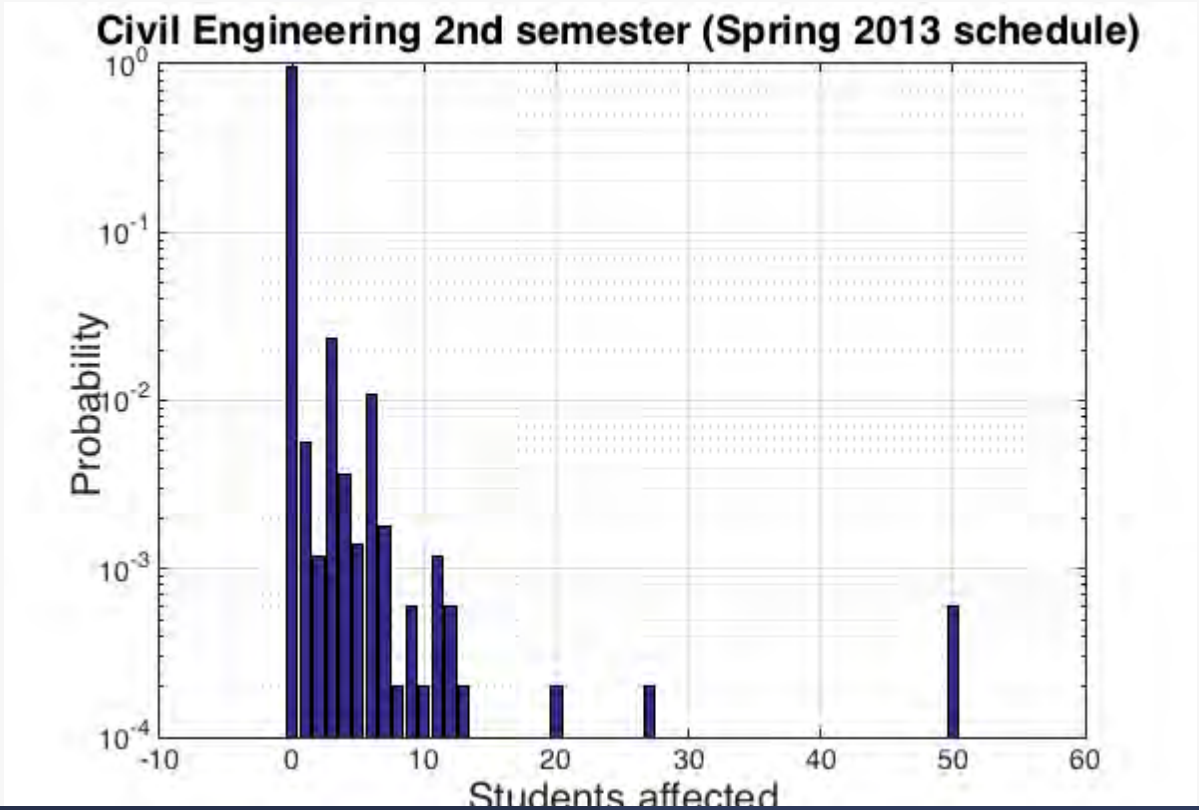
Impact Examples – one semester

Civil Engineering, second semester requirement using Spring 2013 schedule ENGR 102 (13 seminar sections), MATH 123 (12 sections of 1 seminar + 2 activities), PHYS 151 (4 seminar sections and 20 lab sections), CE 101, CE 130



Impact Examples – one semester

Civil Engineering, second semester requirement using Spring 2013 schedule
ENGR 102 (13 seminar sections), MATH 123 (12 sections of 1 seminar + 2 activities), PHYS 151 (4 seminar sections and 20 lab sections), CE 101, CE 130
50 students, 5000 simulation runs: Students affected
Mean: 0.2496, Standard deviation 1.6759



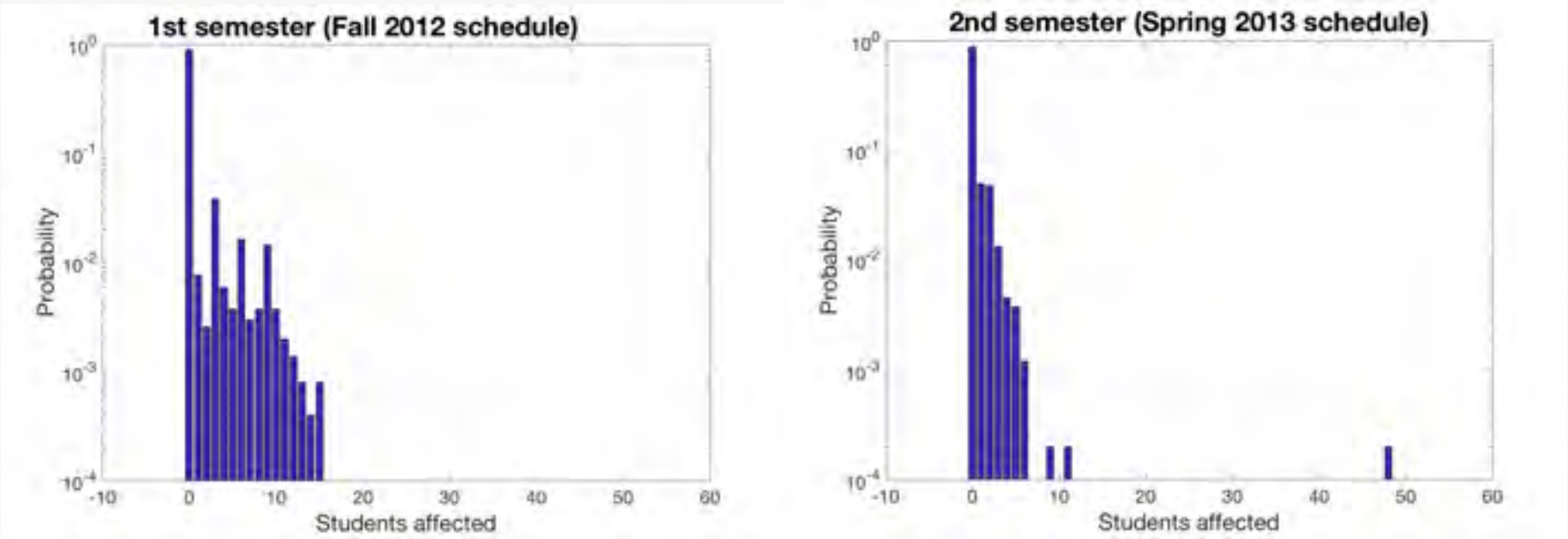
Impact Example – two semesters

Computer Engineering

first semester: ENGR 101, MATH 122, CECS 100, CECS 201 (Fall 2012)

second semester: ENGR 102, MATH 123, CECS 105, CECS 174, CECS 211 (Spring 2013)

1st semester: Mean 0.5528, Std 1.8982; 2nd semester: Mean 0.2426, Std 1.0066



50 students, 5000 simulation runs: Students affected

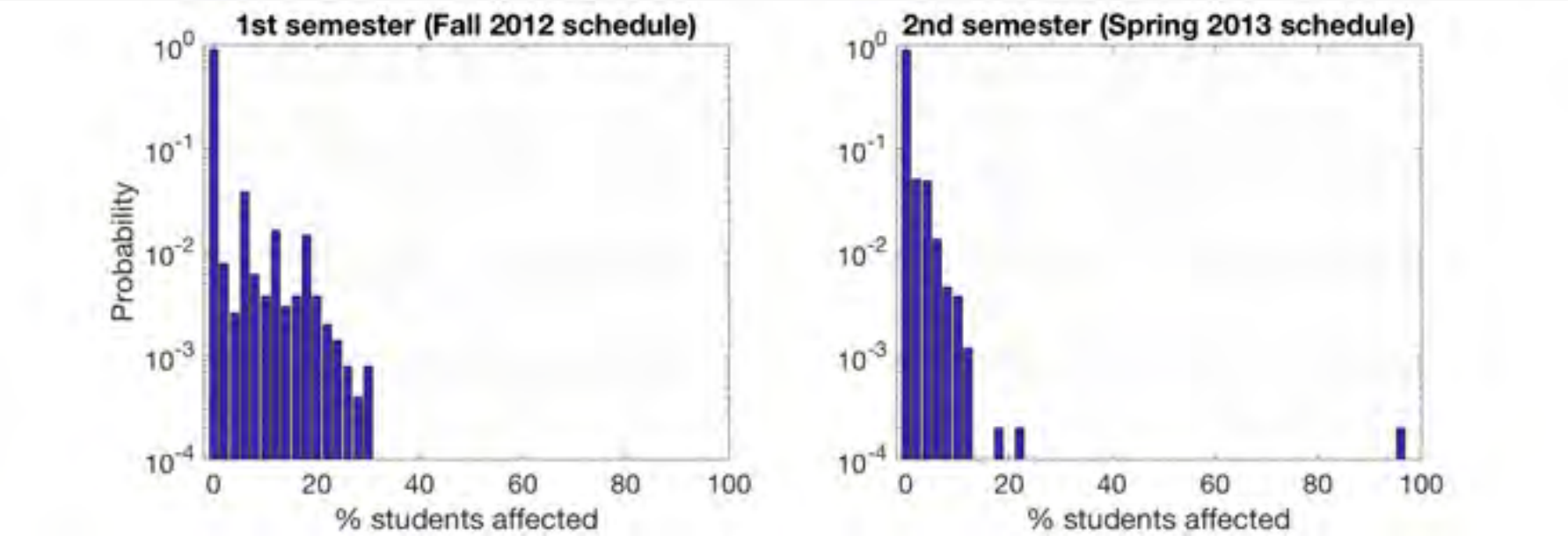
Impact Example – two semesters

Computer Engineering

first semester: ENGR 101, MATH 122, CECS 100, CECS 201 (Fall 2012)

second semester: ENGR 102, MATH 123, CECS 105, CECS 174, CECS 211 (Spring 2013)

1st semester: Mean 0.5528, Std 1.8982; 2nd semester: Mean 0.2426, Std 1.0066



This is an underestimate.

Impact Example – two semesters

If there are 4% (2 out of 50) of students affected in each semester, then they cannot be on track for the next semester's courses. After two semesters totally 7.84% of students will not be on track for their 4-year graduation plan.

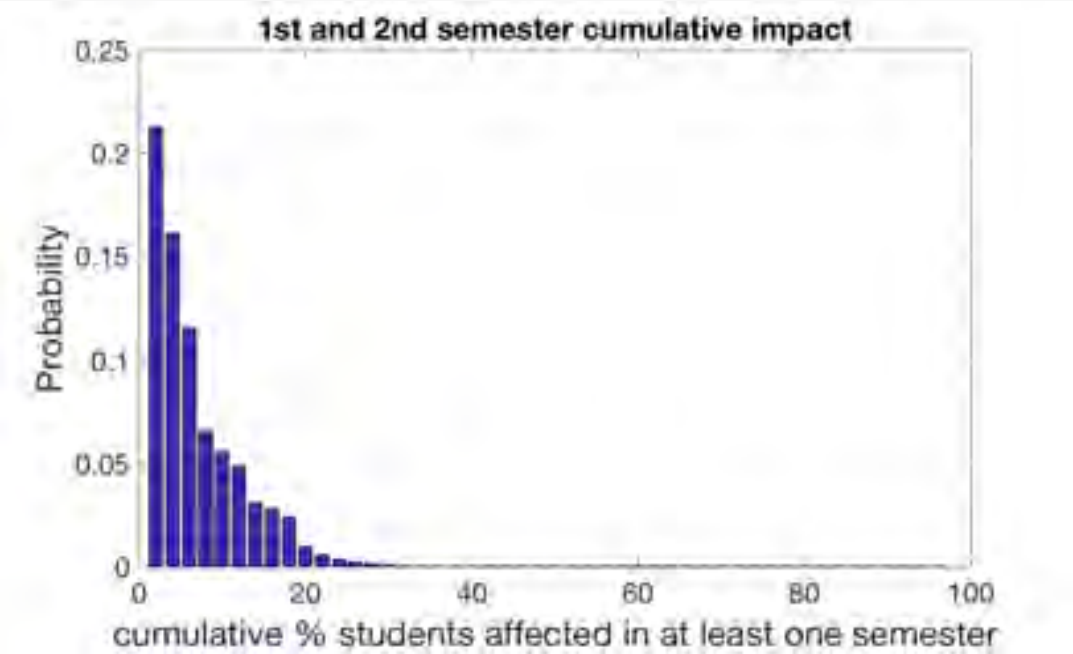
Impact Example – two semesters

If there are 4% (2 out of 50) of students affected in each semester, then they cannot be on track for the next semester's courses. After two semesters totally 7.84% of students will not be on track for their 4-year graduation plan.

Computer Engineering

first semester: ENGR 101, MATH 122, CECS 100, CECS 201 (Fall 2012)

second semester: ENGR 102, MATH 123, CECS 105, CECS 174, CECS 211 (Spring 2013)

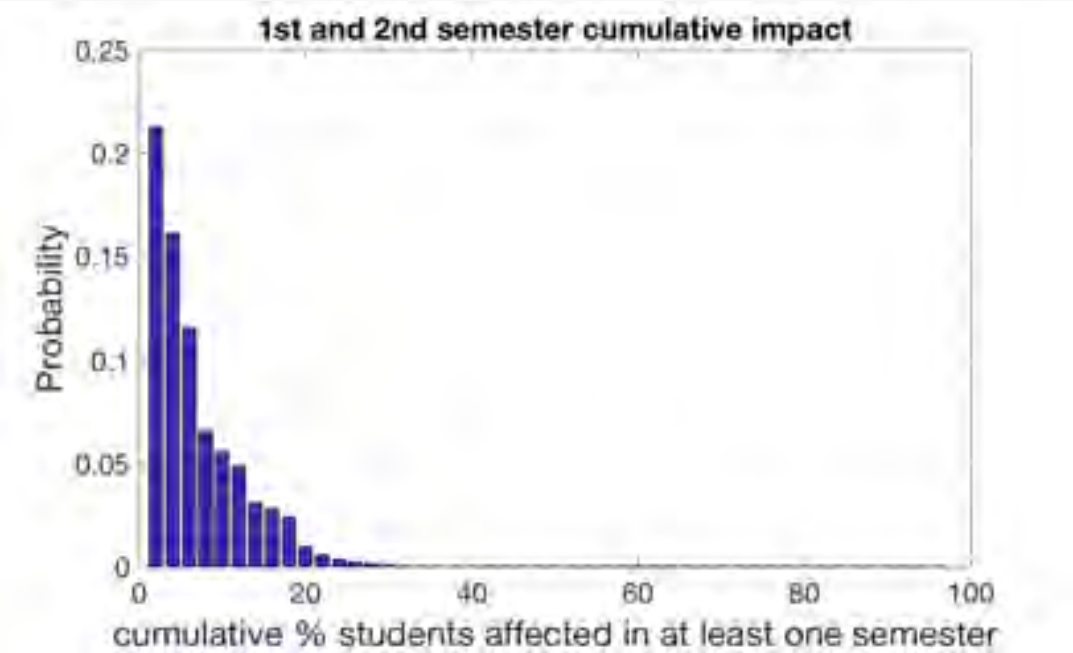


Impact Example – two semesters

Computer Engineering

first semester: ENGR 101, MATH 122, CECS 100, CECS 201 (Fall 2012)

second semester: ENGR 102, MATH 123, CECS 105, CECS 174, CECS 211 (Spring 2013)



at least 2% of students are affected in at least 1 semester: 21% chance
at least 4% of students are affected in at least 1 semester: 16% chance
at least 6% of students are affected in at least 1 semester: 12% chance

Summary and extension

We developed a program that

- illustrates course schedule conflicts for a given major requirement from actual CSULB schedules, and
- simulates students class choices from the actual schedules.

This allows us to

- estimate the impact of course schedule conflict on students' progress according to degree roadmaps
- possibly adjust course schedules before implementation

Summary and extension

Recall the impact estimates are likely to be underestimates.
We could

- include the constraints from lab and activity sessions
- incorporate classroom capacity limitations
- impose students time preferences (3-day, 4-day, before 4:00 pm schedules)

for more realistic evaluations.