The Early Bird Gets the Worm: Major Retention in CS3
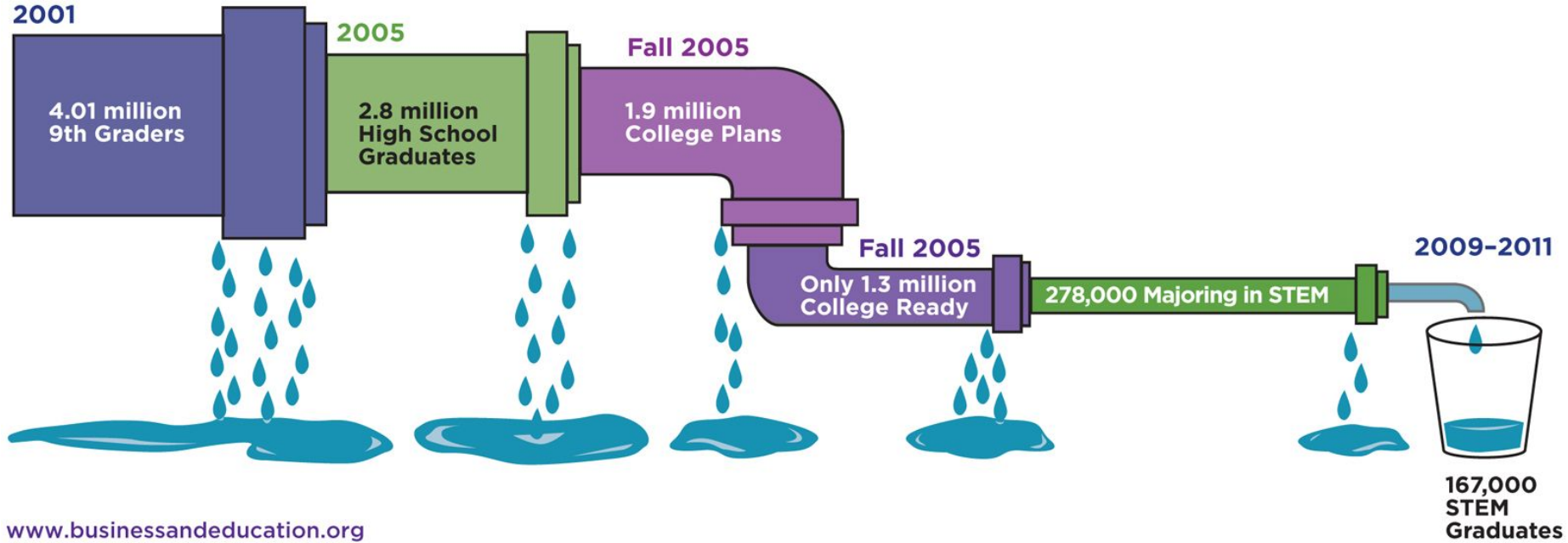
Fee Christoph[1], Westley Weimer[1], Kevin Angstadt[2]

[1] University of Michigan, Ann Arbor
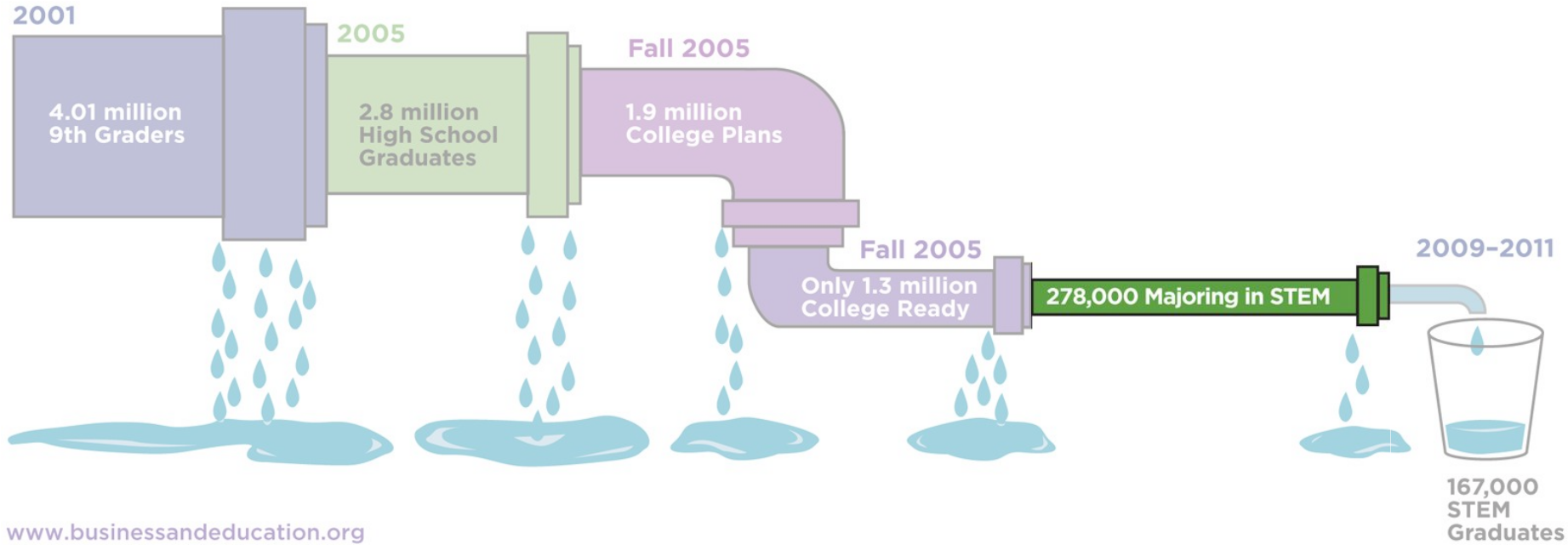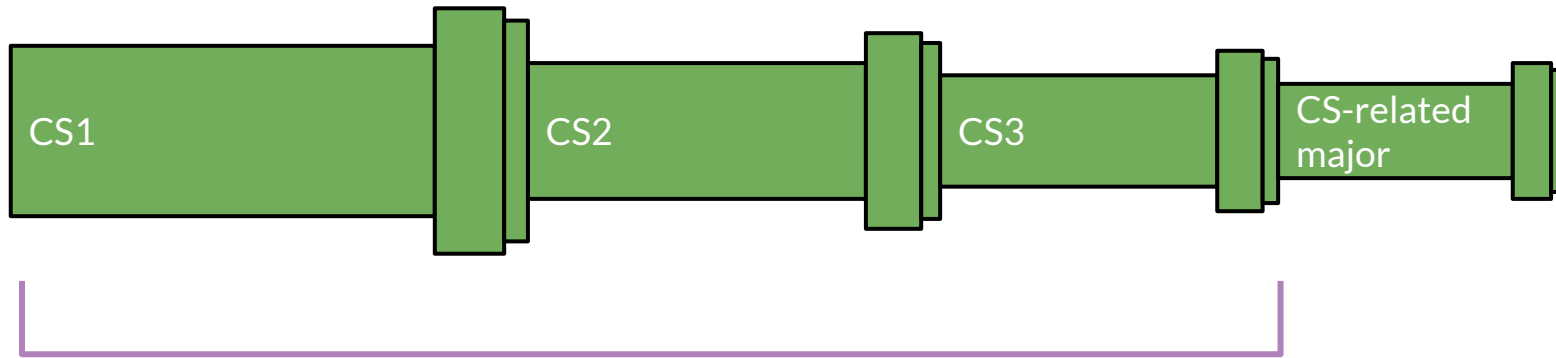[2] St. Lawrence University

A Leaking STEM Pipeline

2001 — 4.01 million 9th Graders
2005 — 2.8 million High School Graduates
Fall 2005 — 1.9 million College Plans
Fall 2005 — Only 1.3 million College Ready
278,000 Majoring in STEM
2009–2011 — 167,000 STEM Graduates

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CS1　CS2　CS3　CS-related major

Introductory Courses

Fast-tracking

CS1   CS2   CS3   CS-related major

Introductory Courses

5

CS1

CS2

CS3
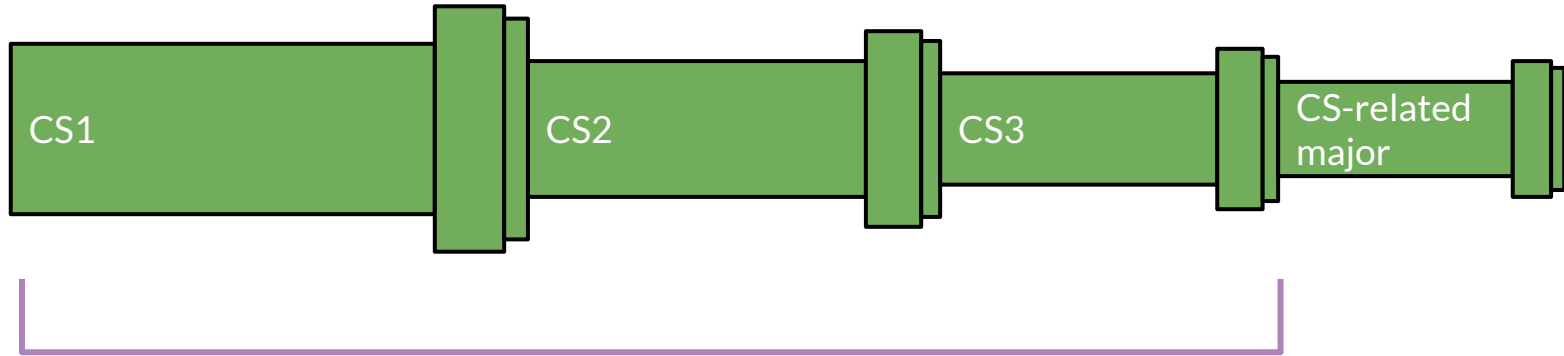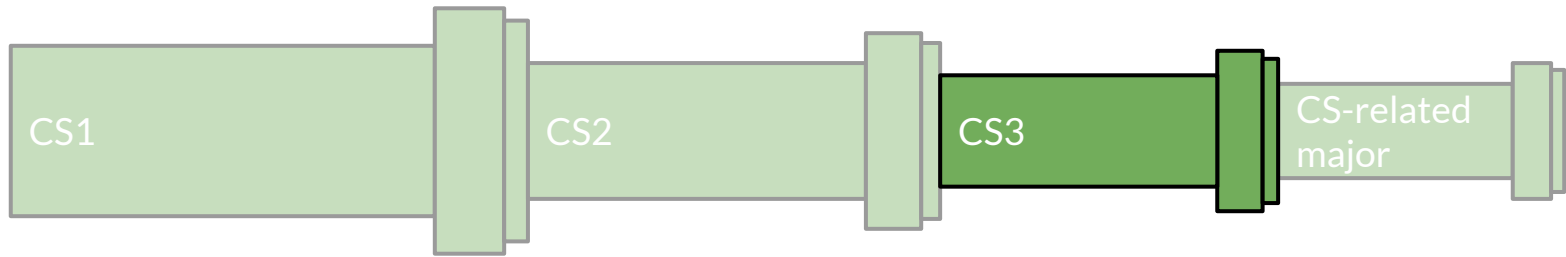
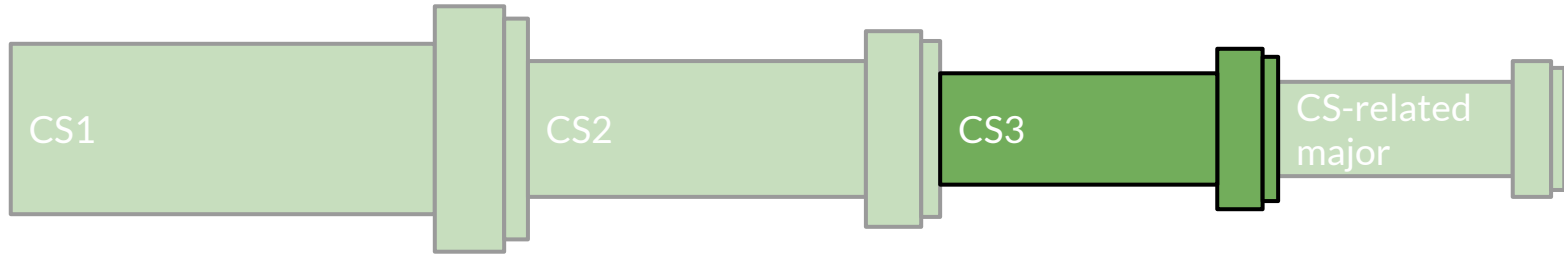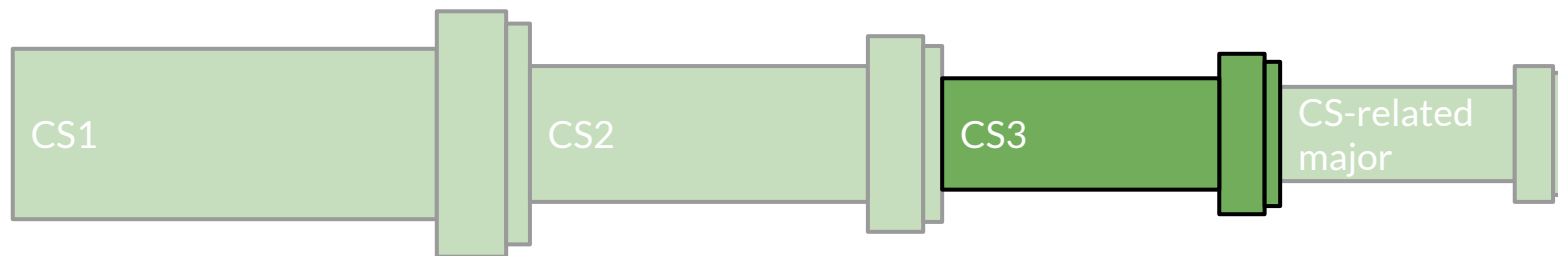CS-related major

What happens in the middle of the college pipeline?

What happens in the middle of the college pipeline?
Particularly, at the "gateway" to a CS-related major?

CS1   CS2   CS3   CS-related major

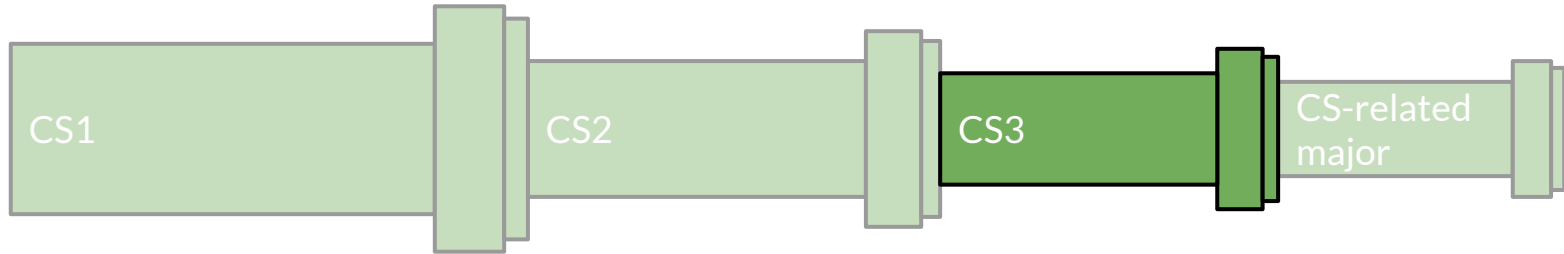What happens in the middle of the college pipeline?
Particularly, at the "gateway" to a CS-related major?
Particularly, for students who *intend* to declare?
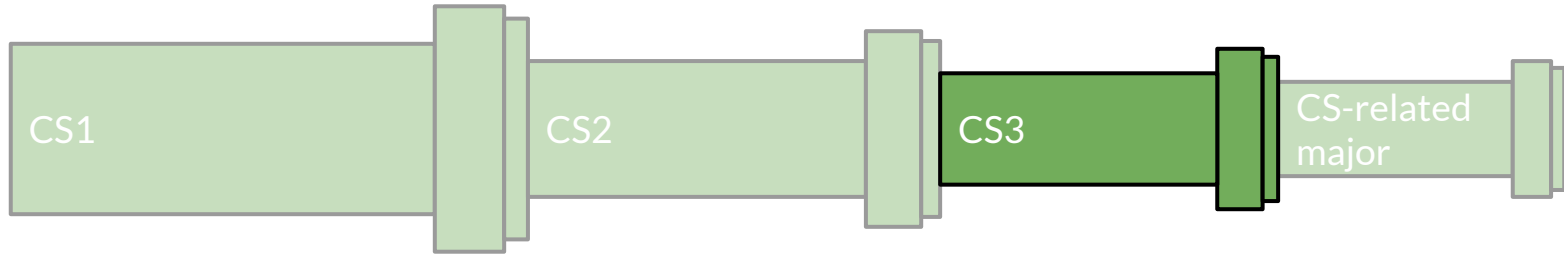
What happens in the middle of the college pipeline?
Particularly, at the "gateway" to a CS-related major?
Particularly, for students who *intend* to declare?

Who are we losing that *wants* to be here?

Talk Overview

Set up research scenario

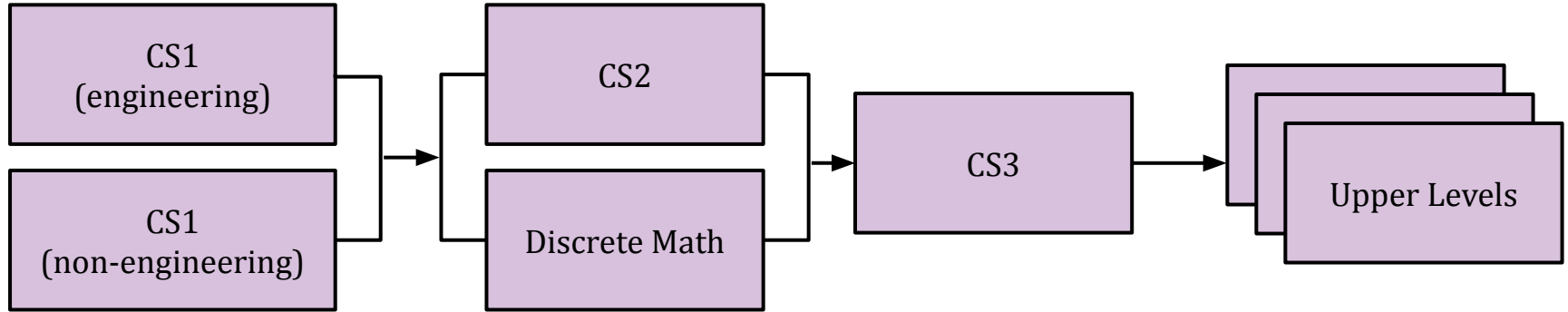Findings highlight: *Fast-Tracking*

Conclusions and open questions

Research Scenario

At the University of Michigan, CS3 (Data Structures & Algorithms) is the gateway for major declaration.

The course consists of:
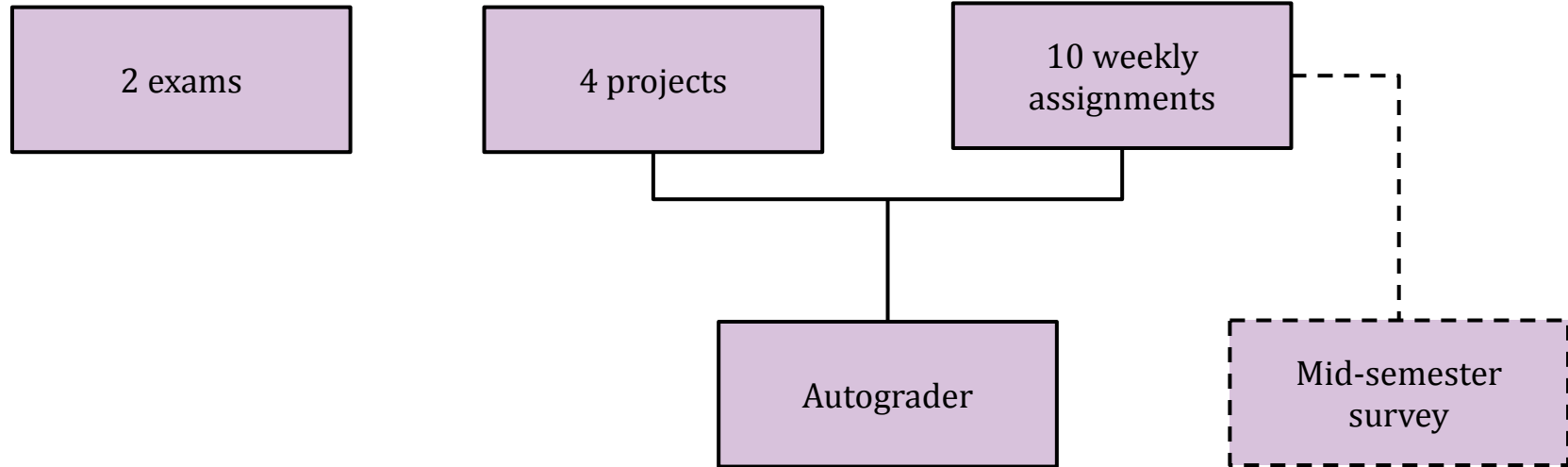
We combined archival course data from one 2019 semester of CS3 with university student records through the following semester to allow for quantitative and qualitative analysis.

Of 582 students, at the midpoint of the semester, 391 intended to declare a CS-related major (67%), and 191 did not (33%).

	Intend to Declare	Do Not Intend to Declare
Declare	352	97
Do Not Declare	39	94
	391	191

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Research Questions

RQ1: Is there a correlation between **biological sex** and declaration rates for CS-related majors?

RQ2: Is there a correlation between **student grades** in CS3 and declaration rates of CS-related majors?

RQ3: How does student *fast-tracking* **through core CS courses** relate to declaration rates of CS-related majors?

RQ4: Can **autograder data** help identify CS3 students at risk of leaving CS-related majors?

Research Questions

RQ1: Is there a correlation between biological sex and declaration rates for CS-related majors?

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RQ3: How does student *fast-tracking* **through core CS courses** relate to declaration rates of CS-related majors?

RQ4: Can autograder data help identify CS3 students at risk of leaving CS-related majors?

Findings Highlight: *Fast-Tracking*

* looking only at students who intend to declare a CS-related major at the midpoint of their CS3 semester

At CS3, commonly studied factors no longer seem to apply:
- Students are more similarly prepared, technically, after CS1 and CS2.
- We found no significant difference between percentages of male and female student following through on intending to declare a CS major. *(replicates Baer and DeOrio, SIGCSE 2020)*

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Which factors might be more relevant for CS3 retention efforts?

Fast-tracking

We define *fast-tracking* to be the process of taking CS courses in rapid succession early in one's college career.

A fast-tracked student:

1) Completes CS3 in first two years
2) 0-1 semester gap with CS2

|	Fast-tracked	Non-fast-tracked
Declare	259	93
Do Not Declare	17 (~6%)	22 (~19%)
	276	115

* only considering students who intend to declare

Fast-tracked students are 13 percentage points **more likely** to follow through with declaring a CS major. *(p = 0.00005)*
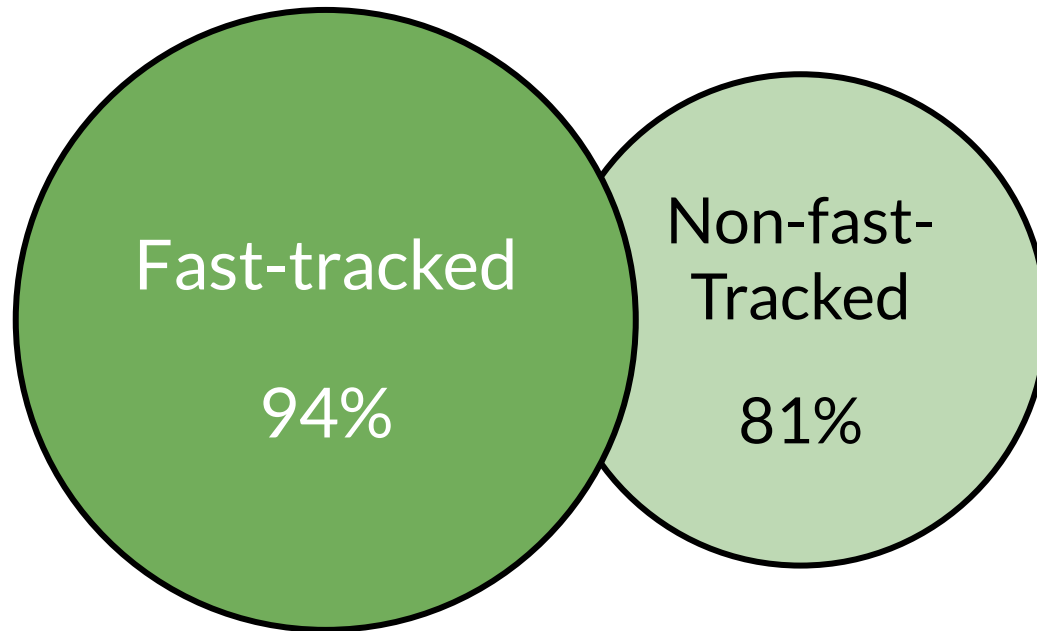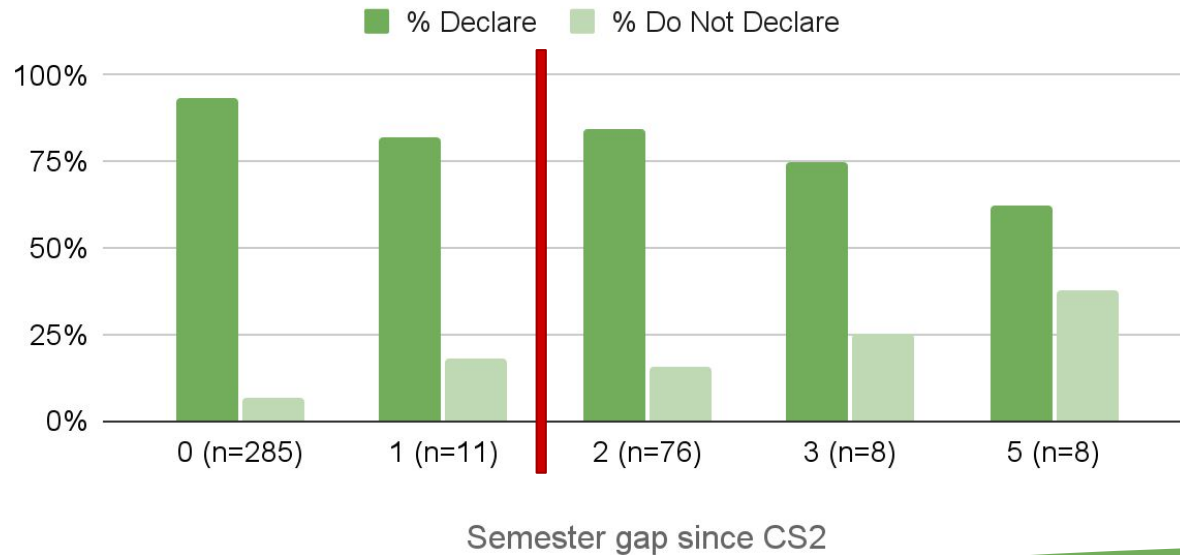
Looking just at the progression from CS2 to CS3...

As the gap between CS2 and CS3 increases, the percentage of students following through on their intention to declare a major **decreases**.
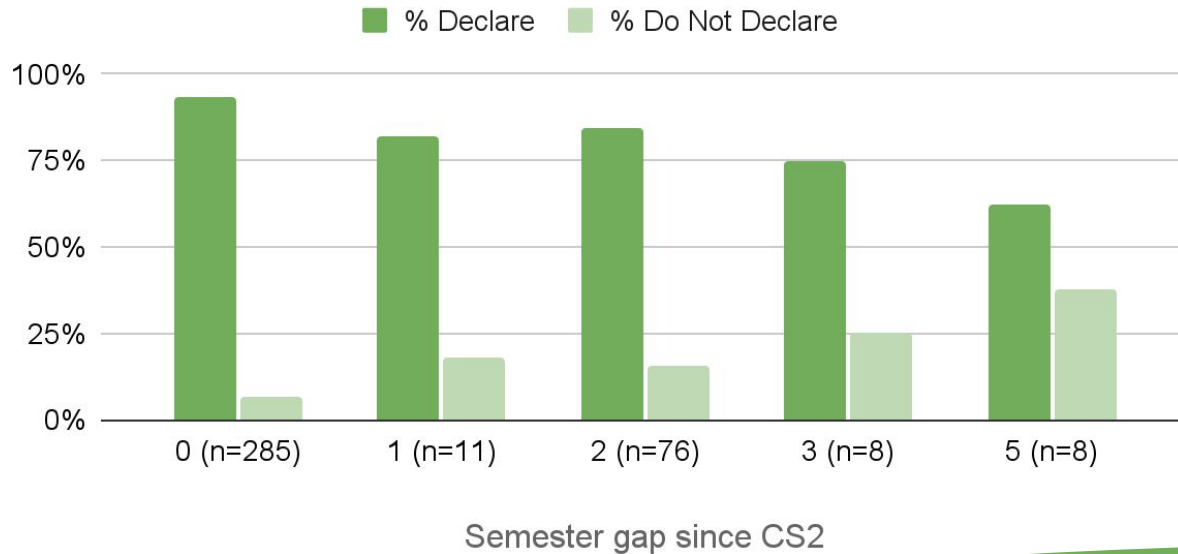
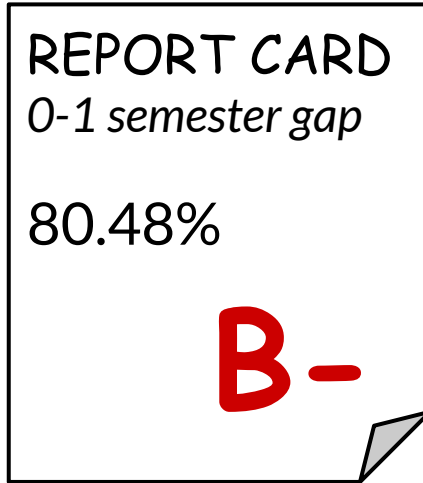As the gap between CS2 and CS3 increases, the percentage of students following through on their intention to declare a major **decreases**.

Students who take CS3 immediately after CS2 or who take only a one-semester break have an 11 point **higher** mean final grade. *(p = 0.00008)*

REPORT CARD
0-1 semester gap

80.48%

B-

REPORT CARD
2+ semester gap

69.22%

C
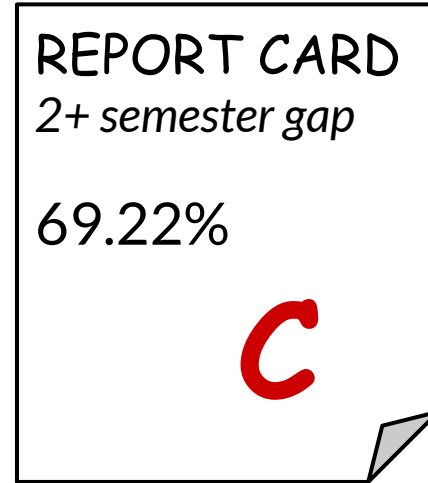
Is this grade difference visible in projects?

Fast-tracked students have a **higher** daily project average on the autograder throughout a project. *(p = 0.00003)*
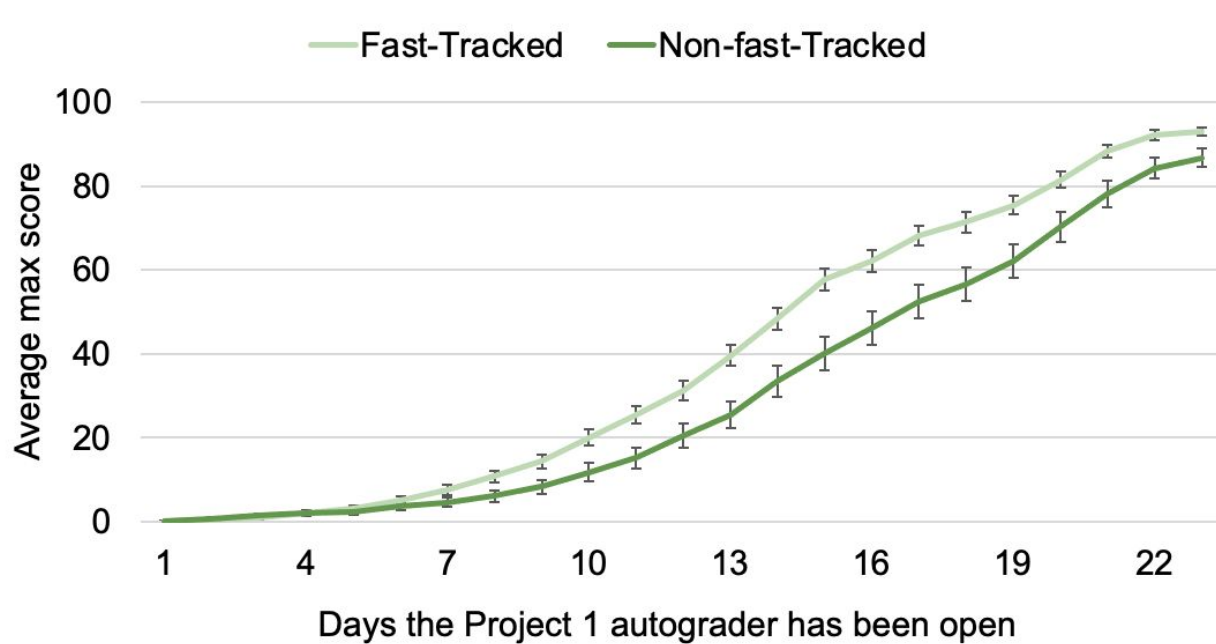
Conclusions and Open Questions

Fast-tracking seems to be working!

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Onboarding programs should be aware of this relationship and structured to support this progression.

Fast-tracking seems to be working! … except when it doesn't.

Onboarding programs should be aware of this relationship and structured to support this progression.

Additional support may be necessary to help those who reach CS3 later or with more of a gap after CS2.

Open Questions

Replication across institutions

Impact of major declaration as a gatekeeping device

Effective forms of support for non-fast-tracked students

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Impact of major declaration as a gatekeeping device

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Summary

By CS3 students have invested a **significant amount of time** in the CS pipeline.

We identify several factors that correlate with students "leaking from the pipeline" at this point, by combining archival course data with university student records.

Students who declare a CS major: (1) **fast-track** introductory CS courses, (2) have **higher course grades**, and (3) **complete CS3 earlier** in college.

Fast-tracked students are **13 percentage points more likely to follow through** with declaring a CS major.

Additional findings on biological sex, student grades and autograder data can be found in the paper.

Additional Slides

Students who intend and declare have a significantly **lower**:

Mean number of semesters since taking CS2

Mean months in college before completing CS3

1.54 vs 2.36

25.26 vs 30.67

p = 0.00007

p = 0.00006

15 / 597 students removed from data

Excluded students who:
● Chose to opt out of research
● Were younger than 18 years of age at time of taking CS3
● Did not have a final grade for the course
  (dropped or incomplete)
● Did not complete the mid-semester survey assignment

Fast-tracked

Non-fast-tracked

only considering students who intend to declare

	CS3 in first 2 years	CS3 after first 2 years	
0-1 semester gap to CS2	276	20	296
2+ semester gap to CS2	70	25	95
	346	45	391

What constitutes a CS-related major?

2 Computer Science	**1** Computer Engineering	**2** Data Science