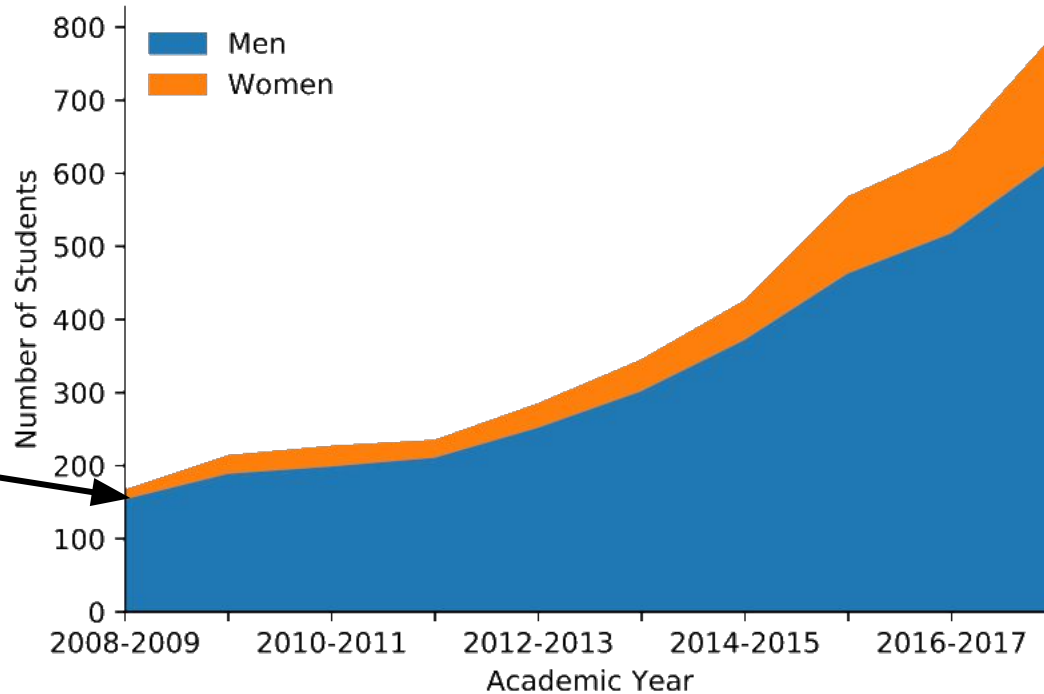# A Longitudinal View of Gender Balance in a Large Computer Science Program

University of Michigan

Amy Baer and Andrew DeOrio

Snapshot of Gender Balance
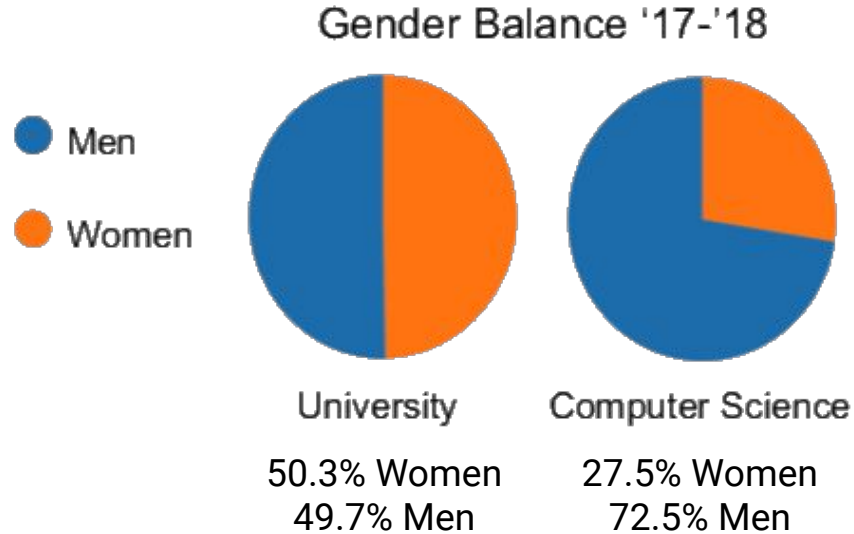
171 Women
617 Men

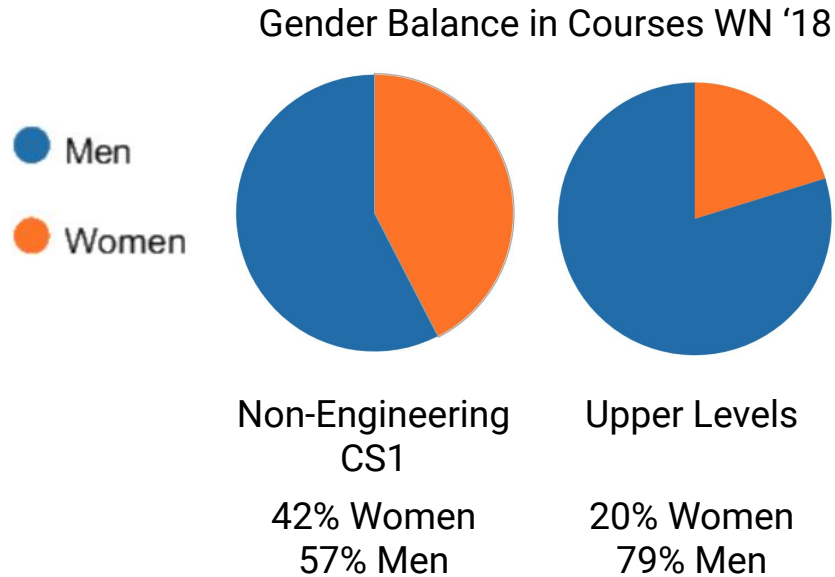14 Women
151 Men

Computing Majors Over Time

Men
Women

Number of Students

800
700
600
500
400
300
200
100
0

2008-2009   2010-2011   2012-2013   2014-2015   2016-2017

Academic Year

Snapshot of Gender Balance

Gender Balance '17-'18

Men
Women

University
Computer Science

50.3% Women
49.7% Men

27.5% Women
72.5% Men

Snapshot of Gender Balance

Gender Balance in Courses WN '18

Men

Women

Non-Engineering
CS1

42% Women
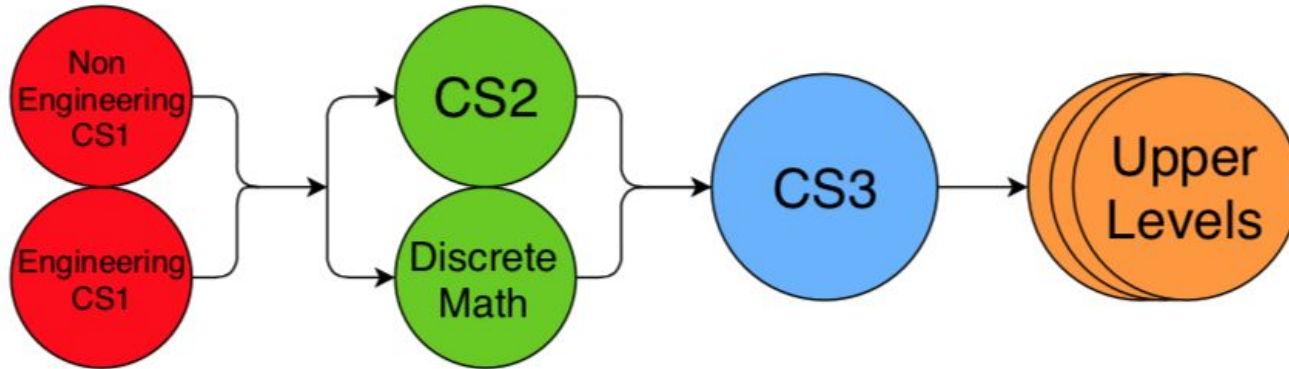57% Men

Upper Levels

20% Women
79% Men

Related Work

- Women are twice as likely to consider leaving a CS major as compared to men [Barker '09]
- Even if they choose to stay, many women do not move to take an industry or academic job in the computing field [Beede '11, Mavriplis '10]
- Why do women and other minorities leave?
    - They feel out of place and as if they do not belong [Sax '18]
    - Lack of self confidence [Beyer '03]
- Why do women and other minorities stay?
    - Same-gender student interaction, pace and workload of classes, prior experience, and faculty encouragement, etc [Barker '09, Cohoon '08, Sax '18, Miliszewska '06]
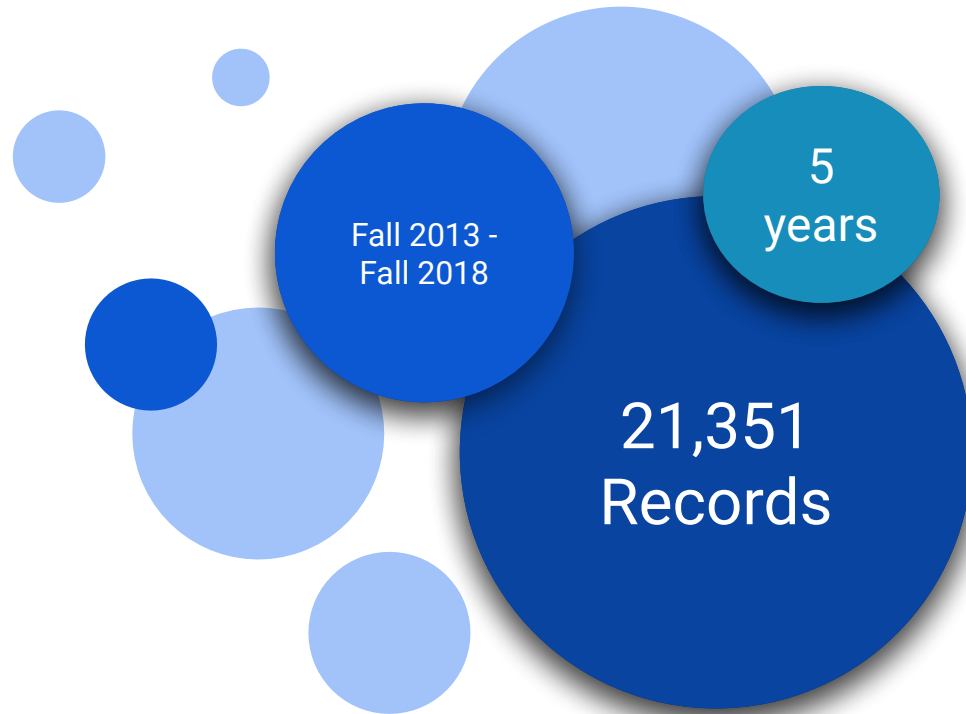
Research Questions

- Where in the Computer Science curriculum does the gender balance change?

- Do grades play a role in this change?

Curriculum Overview
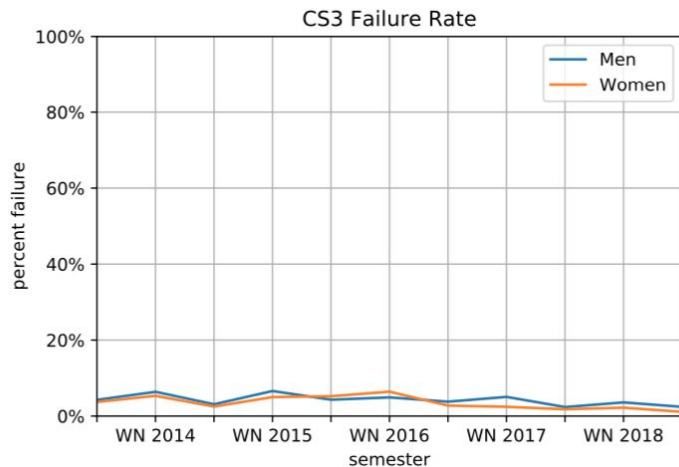## UofM's Course Sequence

Dataset

Fall 2013 - Fall 2018

5 years

21,351 Records

Outline

Are women failing?

CS3 Failure Rate

	Mean Failure		
Class	Women	Men	P-Value
Non-Engineering CS1*	2.6%	3.5%	0.030
Engineering CS1	2.5%	2.3%	0.677
CS2*	1.8%	3.1%	0.002
Discrete Math	5.3%	4.2%	0.051
CS3	3.2%	4.1%	0.142
Upper Levels*	1.9%	3.0%	0.001

● Women fail less than men in non-engineering CS1, CS2, and in Upper Levels*

*statistically significant, $p < 0.05$

Are women withdrawing?

Class	Mean Withdrawal		P-Value
	Women	Men	
Non-Engineering CS1*	8.1%	6.7%	0.026
Engineering CS1	1.3%	1.2%	0.753
CS2*	7.5%	5.6%	0.001
Discrete Math	7.5%	6.2%	0.106
CS3*	9.5%	7.3%	0.013
Upper Levels	3.1%	3.1%	0.877

- Women withdraw more in non-engineering CS1, CS2, and CS3*

  - Difference in means is at most 2.2%

*statistically significant, $p < 0.05$

Failure Rate Discussion

- **No evidence** that women are failing out of the CS sequence

- In **CS2** and **non-ENGR CS1**, men fail more but women withdraw more

  - Reaction to poor performance may differ depending on their gender

  - **Conjecture**: Women withdraw when they would have passed while men do not

    withdraw when they are in danger of failing, resulting in more men failing.

Withdrawal Rate Discussion

- In **non-ENGR CS1**, **CS2**, and **CS3**, women withdraw at a higher rate than men

- Differences in withdrawal rates between men and women could partly explain the lack of women in CS courses

- **However**, this is likely not a large contributor

  - Magnitude of the difference in withdrawal rates is not great

  - Difference only exists in half of the courses in the sequence

  - Largest difference comes in CS3 with around a 2%
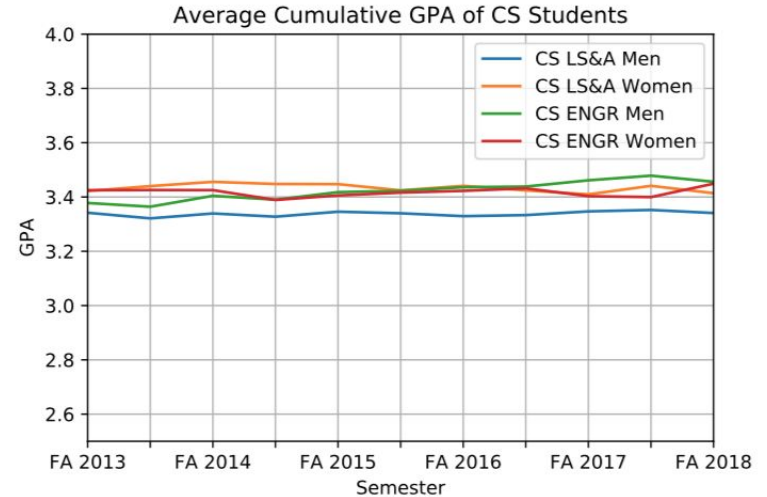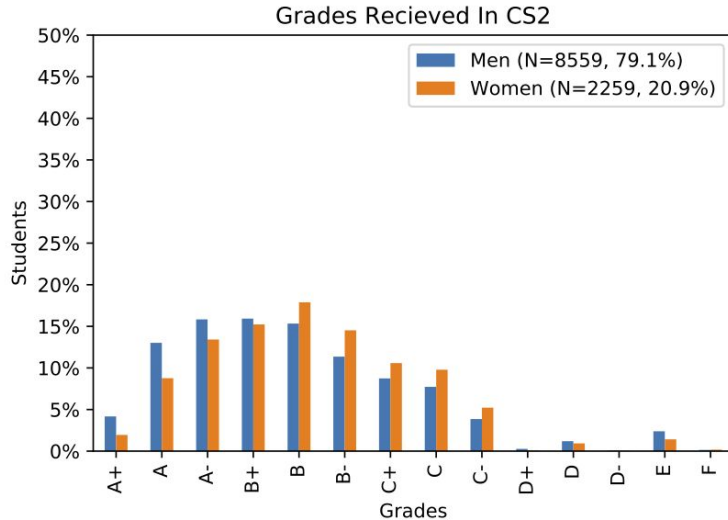
Are women passing and choosing not to go on?
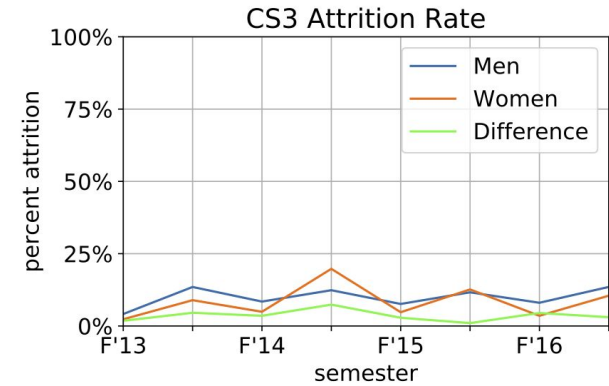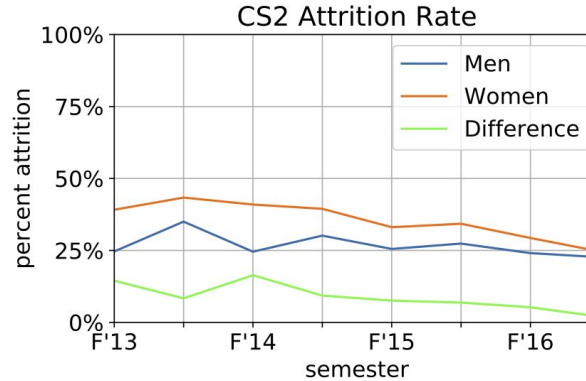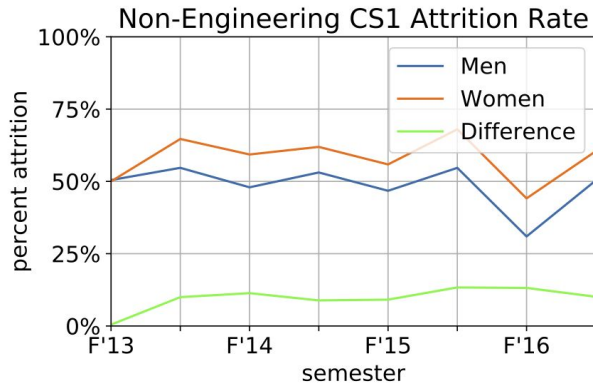
- Women have higher attrition rates than men in both CS1 courses, CS2, and Discrete Math*

- Means differ as much as 14.6% (engineering CS1)

- Attrition decreases as we move through the course sequence

*statistically significant, $p < 0.05$

Attrition Rate Discussion

- Women, despite passing, do not move to the next class in the sequence

    - True for **Engineering CS1**, **Discrete Math**, and **CS2** but not for **CS3**

    - Means differ by **14.6%** in ENGR CS1, **9.2%** in Discrete Math, and **8.1%** in CS2.

- Once students reach CS3, most, regardless of gender, move on to upper level courses

- *Why* are women choosing not to go on, particularly in courses before CS3?

Are women receiving the same grades as men?

Grades Recieved In CS2
Men (N=8559, 79.1%)
Women (N=2259, 20.9%)

Average Cumulative GPA of CS Students
CS LS&A Men
CS LS&A Women
CS ENGR Men
CS ENGR Women

- Women receive lower grades in engineering CS1, CS2, Discrete Math, and CS3*

- Women have the same or higher cumulative GPAs than men*

*statistically significant, $p < 0.05$

Grades Discussion

- **ENGR CS1**, **CS2**, **Discrete Math**, and **CS3**: women receive lower grades than men.

- ENGR and non-ENGR women have **equally high GPAs** as ENGR men and **higher GPAs** than non-ENGR men

  - Women perform just as well if not better in other non-CS, technical courses

- **Why** are women receiving lower grades in CS courses but not others?

How do grades and gender effect attrition?

	df	SS	MS	F Stat	P-Value
Discrete Math	1.0	45.92	45.92	229.89	3.79e-51
CS2	1.0	45.11	45.11	225.85	2.72e-50
Gender	1.0	3.75	3.75	18.76	1.50e-05
Residual	7264.0	1451	0.20	N/A	N/A

- Grades are the largest factor in a student's decision to move on

- Gender, independent of grade, has an effect on a student's decision to move on*

*statistically significant, $p < 0.05$

What causes Attrition Rate discrepancy?

- Gender, **independent of any grade received**, has an effect on whether or not the student moves on

- Grades have the largest effect on a student's decision to move on

- **What this means:** eliminating the grade disparity will improve gender balance but it **would not** bring the balance to equality

Outline

Conclusions & Future Work

- Despite increase in women, there is still a lack of women continuing through the entire program

- Gender disparity in attrition rates in CS1, CS2, and Discrete Math
    - Suggests the problem lies in classes before CS3

- There are factors other than grades that affect a student's decision to move on in CS

Future Work

- **Why** is there a grade imbalance in some classes but not others?

- **How** can we rid of the grade imbalance?

- **What** factors contribute to a student's decision to move on (other than gender/grades)?

- **Why** is gender a contributing factor to whether a student moves on?

- **How** can we rid of gender as a factor in a student's decision to move on?

- Study replications at other institutions will help solidify this work