Understanding Inequity in (my) CS Theory Classes

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Illinois Summer CS Teaching Workshop
June 11, 2026

I’m confused and frustrated.

So I must be on to something!

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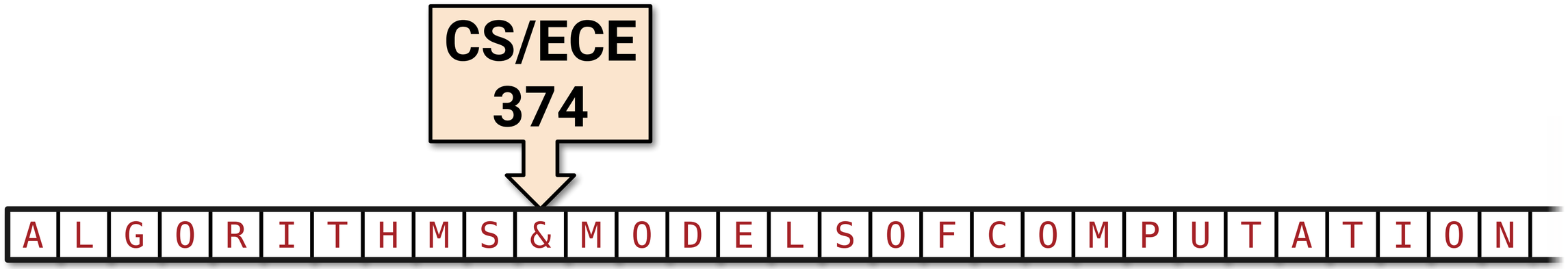
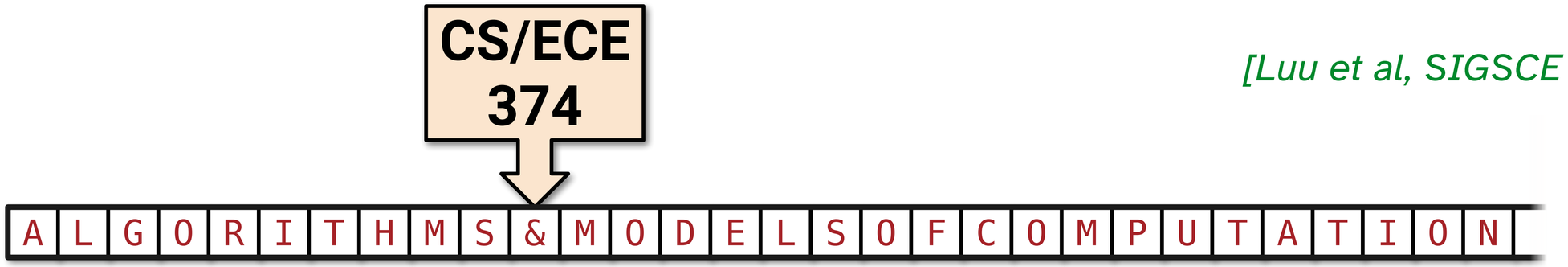
Joint work with

Katherine Braught

Colleen Lewis



- Junior-level theoretical computer science course, required for all computer science and computer engineering majors at Illinois
- 400–450 students per semester
  - 1–2 instructors, 8–10 graduate TAs, 16–20 undergraduate CAs
- Two lectures + two labs (≤40 students) per week



[Luu et al, SIGSCE 2023]

Models of computation (5 weeks)

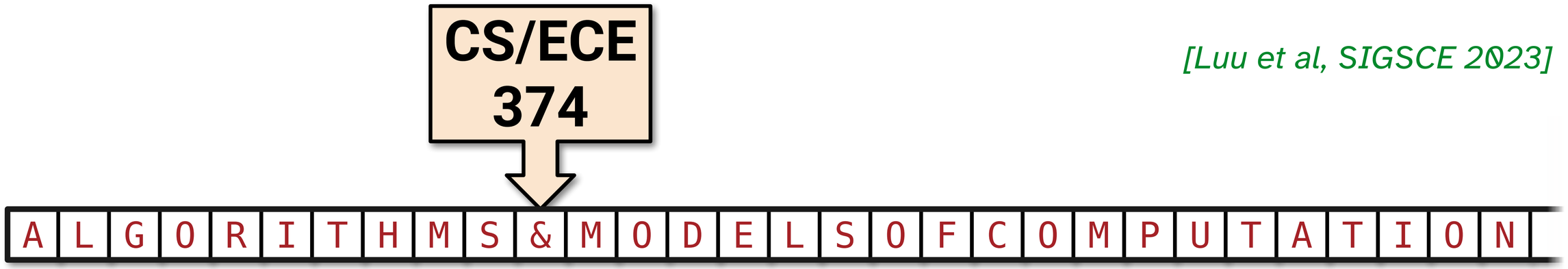
string induction, regular languages, regular expressions, DFAs, NFAs, non-regularity proofs, closure properties / transformations, context-free languages, Turing machines*

Algorithms (6 weeks)

Recursion, divide and conquer, backtracking, dynamic programming, greedy algorithms*, graph representations, graph modeling*, graph traversal, topological sort, strong components*, shortest paths

Hardness (3 weeks)

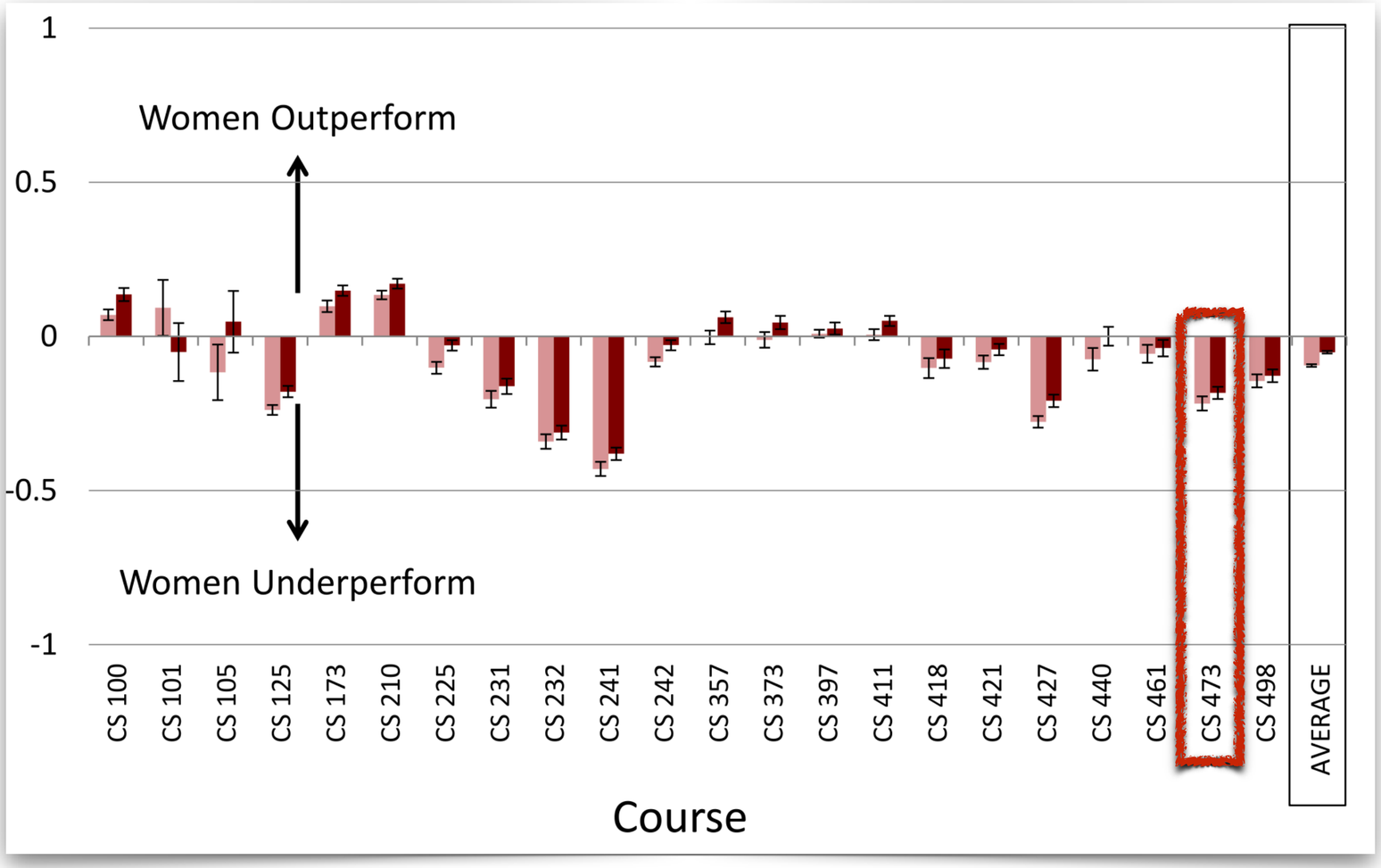
P vs NP, NP-hardness, reductions, undecidability, diagonalization, Rice's theorem



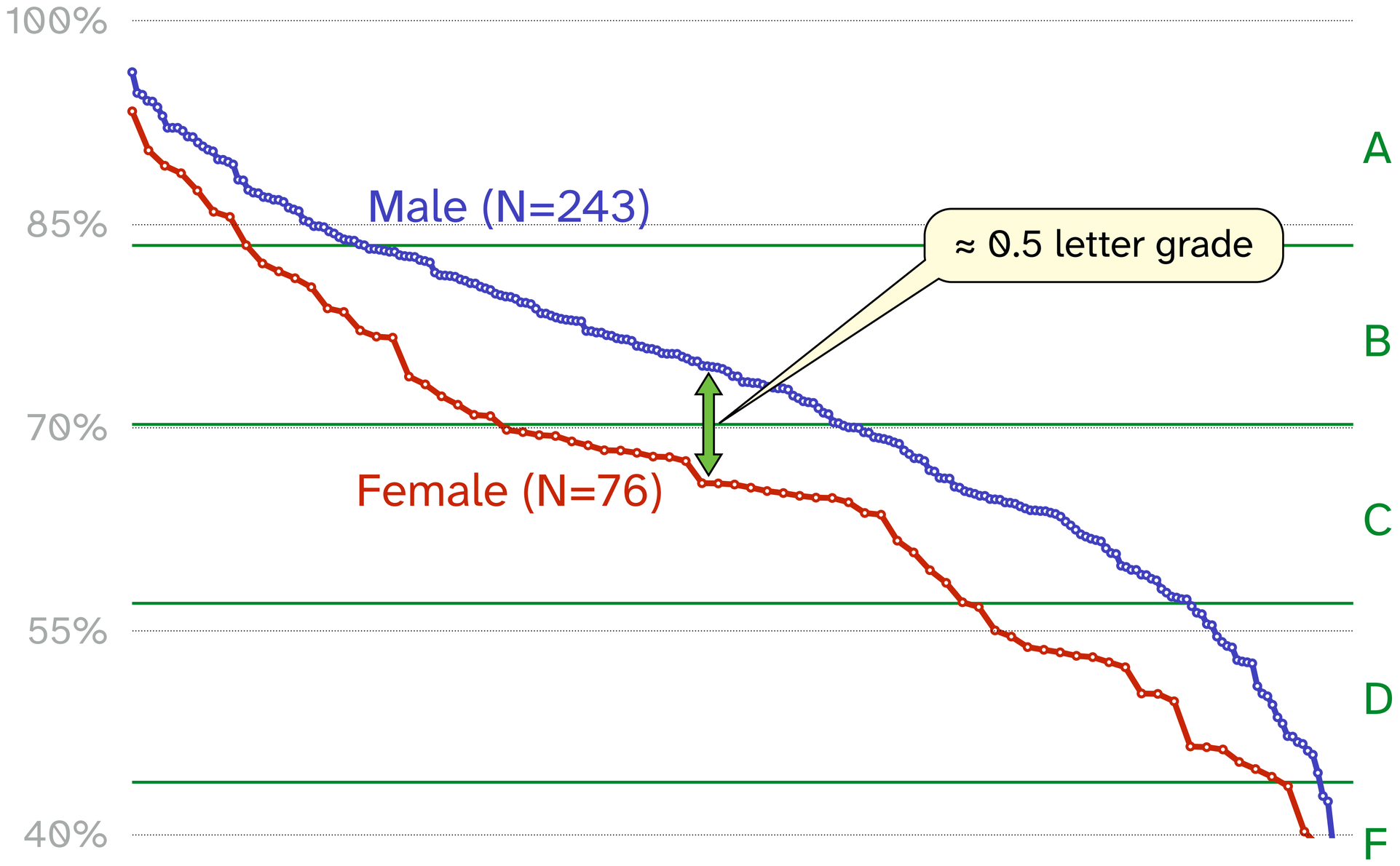
[Luu et al, SIGSCE 2023]

- Almost all graded work is open-ended design/proof questions.
  - Weekly written homework (25%)
  - Two midterms (20% each) and final exam (25%)
- No programming component
- Widely considered one of the most difficult courses in the CS curriculum (typical for CS curricula everywhere)

Jonathan H. Tomkin, Matthew West, and Geoffrey L. Herman. An improved grade point average, with applications to CS undergraduate education analytics. *ACM TOCE*, 2018.



Fall 2019




reactiongifs.us
I'm shocked.

Immediate changes

Moved from strictly curved grading to fixed cutoffs

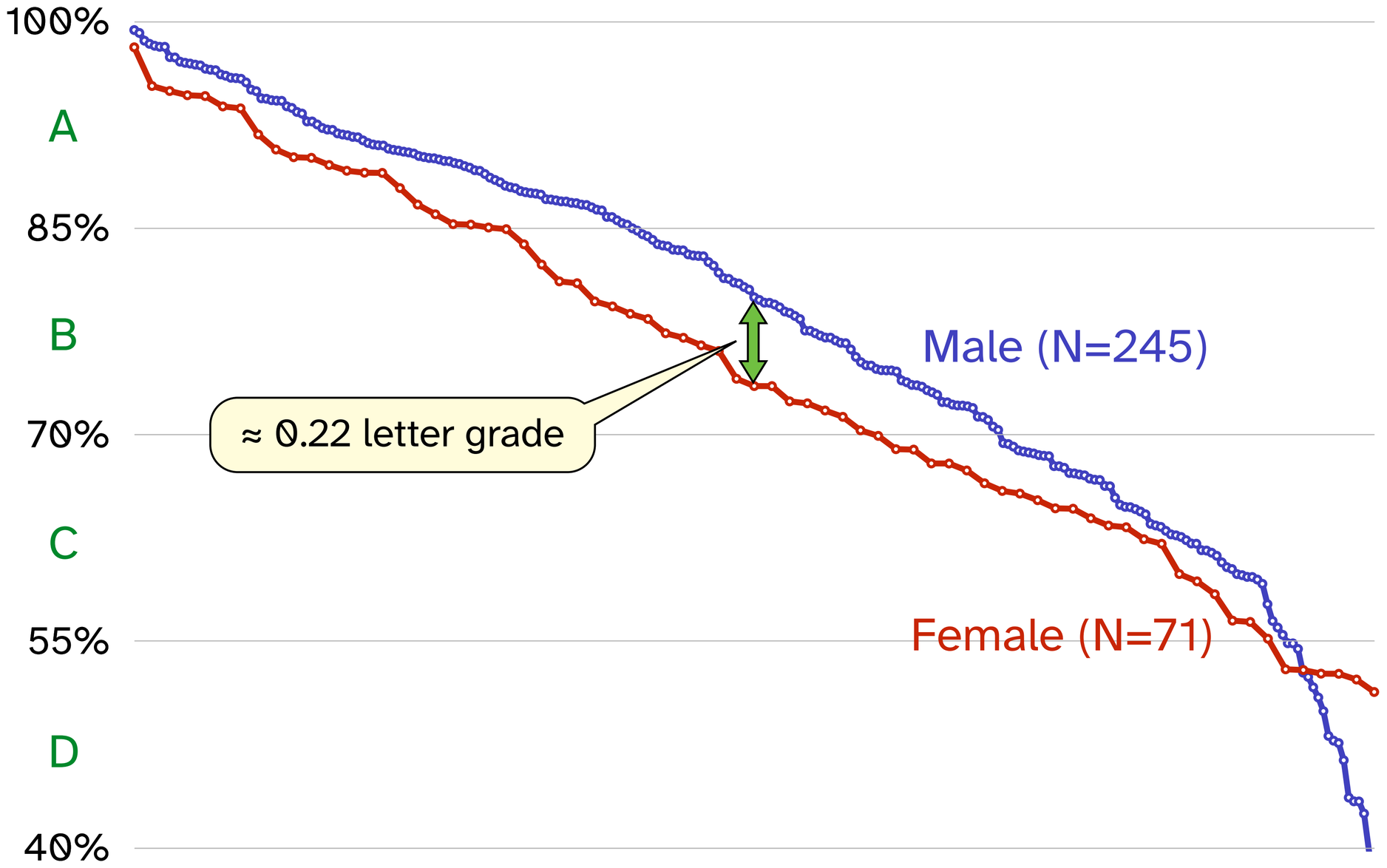
- The curve created more competition and grade anxiety, which (anecdotally) impacted women more than men

Eliminated the “I don’t know” policy

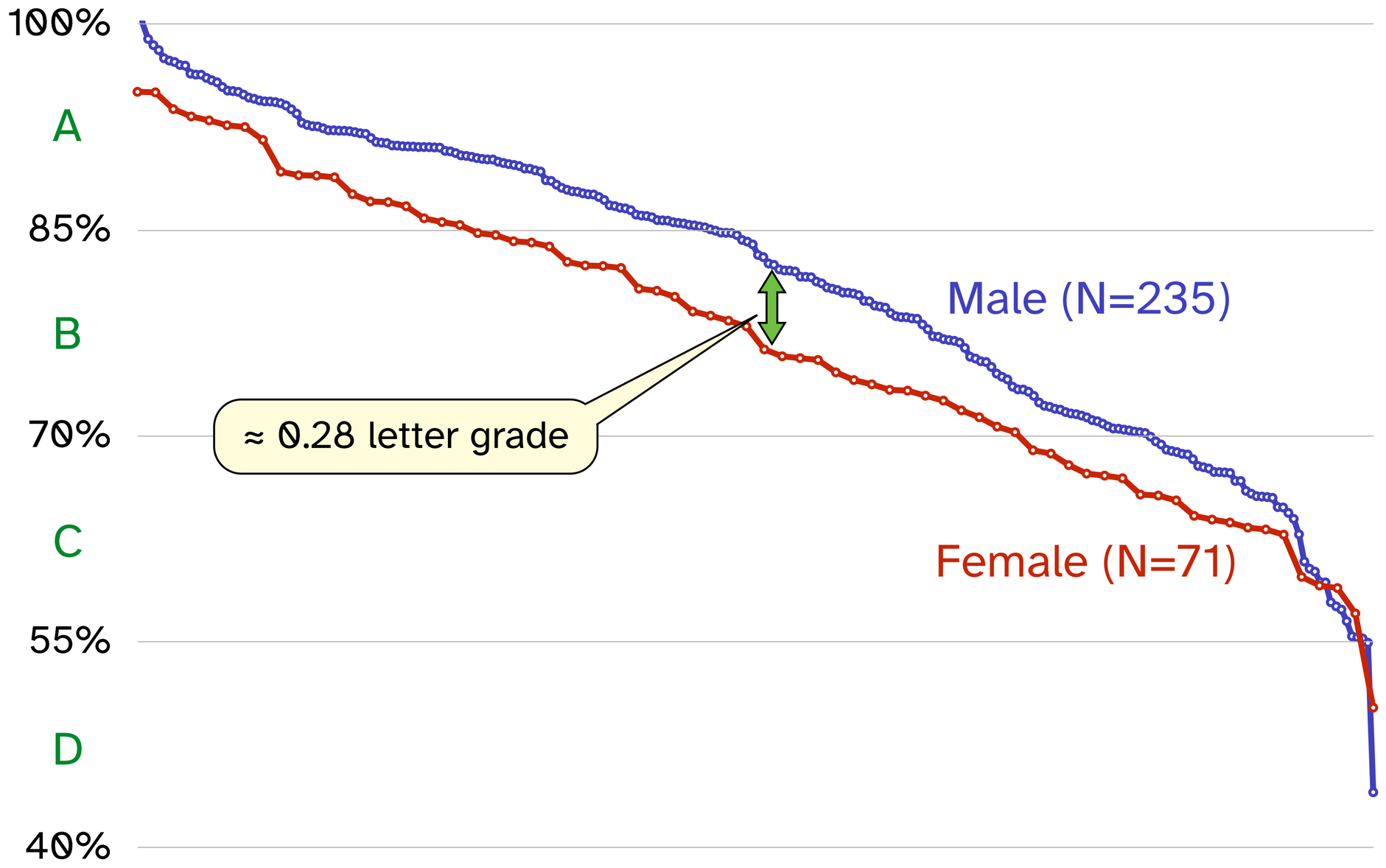
- “IDK” or equivalent was worth 25%. Meant to reward *self-awareness*.
- In practice a test of *self-confidence*, used more often by women.

And then COVID happened, which led to even more changes.

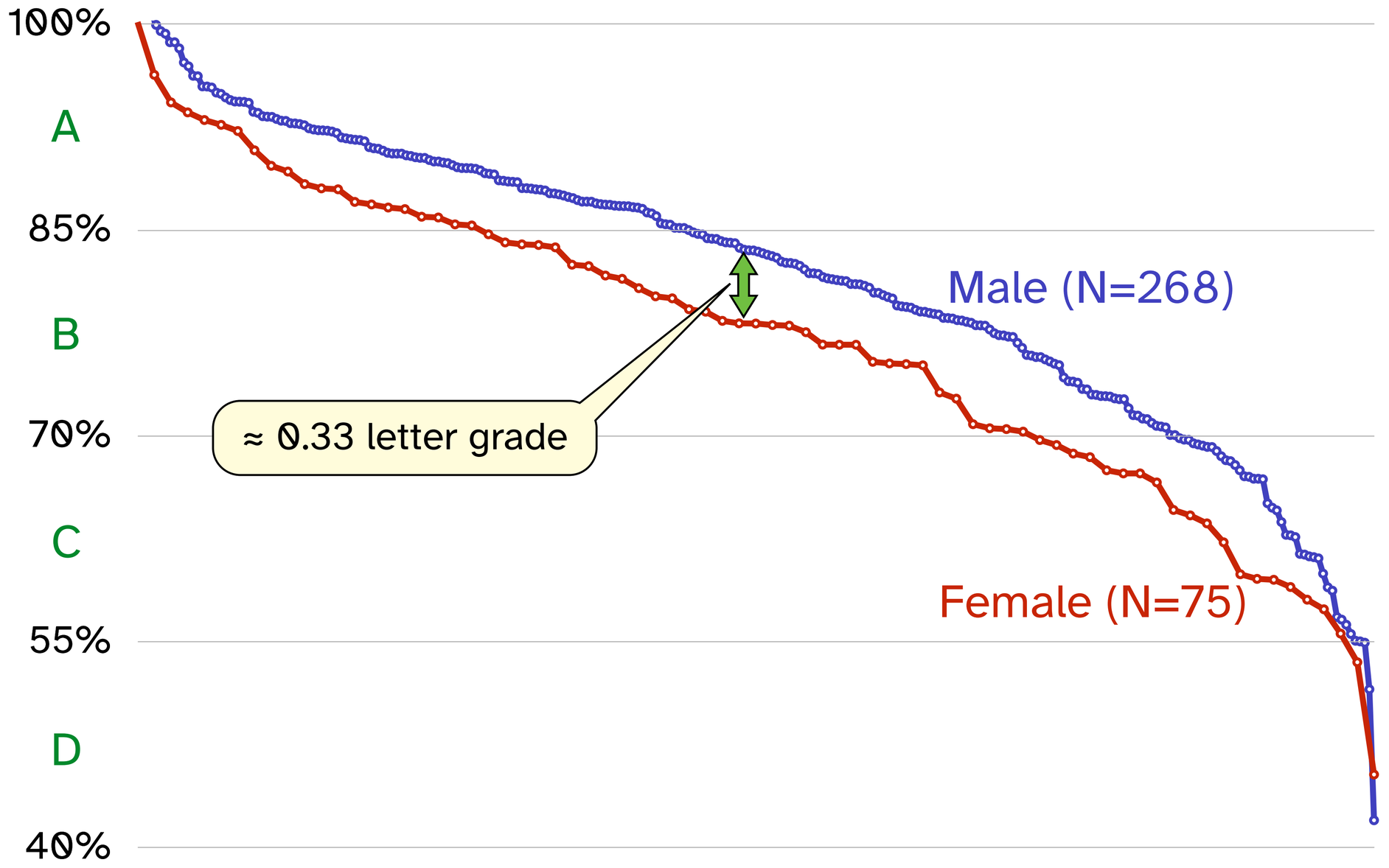
Fall 2021



Fall 2023



Fall 2025



Summary

Changes to the course, including removing some obviously bad course policies appears to have narrowed the gap.

But there is a still a meaningful discrepancy,
and it appears to be slightly increasing.

Questions

- **What is going on?**
  - Non-answer #1: Women can't do math/theory? Please.
  - Non-answer #2: Larger inequities in CS education, STEM education, and computing culture.
- Does CS 374 *feed* this inequity? Are we making things worse?
- What can we do *in CS 374* to change, or at least mitigate, these effects, *at least in CS 374*?

Time for professional help!

Katherine Braught

Colleen Lewis


SLOW
WORK ZONE
AHEAD


WARNING
PRELIMINARY
RESULTS

Initial questions

Do related courses show similar discrepancies?

- CS 173: discrete math — prerequisite, theoretical
- CS 225: data structures — prerequisite
- CS 421: prog. languages & compilers — postrequisite, theoretical, exam-based
- CS 340/341: systems programming — other hardest course in the CS program

How is this discrepancy affected by controlling for other factors?

- Specific major — CS, Math&CS, Stat&CS, other CS+X
- Overall GPA before CS 374
- Grades in related courses
- First math class at Illinois — proxy for math background
- . . .

Record survey

We collected and analyzed data for the Fall 2021 and Fall 2023 cohorts

- Outputs: **Overall numerical grade**, individual exam scores
- Inputs: **Gender**, major, cohort, overall GPA before CS 374, grades in related classes, credits in same semester, first math class at Illinois

Collection and analysis of data from other semesters (with different instructors) is ongoing.

Record survey results

Is this discrepancy significant?

- **Yes** (~0.34σ, p<0.0001)
- **Significantly larger for algorithms** (Midterm 1, ~0.46σ, p<0.0001) than for models of computation (Midterm 2, ~0.28σ, p≈0.0002)

Do related courses show similar discrepancies?

- **NO.**

How is this discrepancy affected by controlling for other factors?

- **NO significant effect.**

Followup questions

- How do students' lived experiences, motivations, beliefs, and other affective factors affect performance in CS 374?
- How do these factors differ between men and women?
- To what extent do these factors explain the observed relationship between gender and course performance?

Survey components

We surveyed the Fall 2025 and Spring 2026 cohorts (N ≈ 500) about several factors, including:

- Expectancy
- Growth mindset
- Group work experience
- Course culture
- Psychological safety
- Test anxiety
- Course performance goals
- Interest / value
- Problem solving skills

Subsets of existing validated surveys

Expectancy

How well students expect to do in the course

- I’m certain I can understand the most difficult material presented in the readings for CS 374.
- I expect to do well in CS 374.
- I’m confident I can understand the most complex material presented by the instructor in CS 374.
- When I take a test in CS 374, I feel confident.

Positive correlation with grades, less agreement from women

Course interest / value

How much students intrinsically value the course

- It is important to me to feel that my coursework offers me real challenges.
- I am very interested in the content of CS 374.
- I like the subject matter of CS 374.
- I think the course material in CS 374 is useful for me to learn.

Positive correlation with grades, less agreement from women

Problem solving skills / beliefs

Specific skills helpful for solving problems, especially in CS 374

- In CS 374, I am able to introduce notation to help communicate my solution.
- I can translate a word problem into a formal representation.
- I struggle to identify what algorithm to use to solve a CS 374 problem. (N)
- When solving a CS 374 problem, I can determine a specific algorithm or data structure that is helpful.

Positive correlation with grades, less agreement from women

Take-home message

- There is a significant grade discrepancy between male and female students in CS 374.
- This discrepancy appears to be course-specific, and stronger for algorithms than for models of computation.
- This discrepancy is strongly correlated with gender differences in expectancy, interest/value, and problem-solving skills/beliefs.

More detailed analysis is ongoing; future surveys are planned.

Questions for discussion

- **Research:** What should we dive into next?
- **Communication:** How best to frame this work to avoid toxic misinterpretation? To avoid mere “gap gazing”?
- **Action:** What should we change in/about the course?