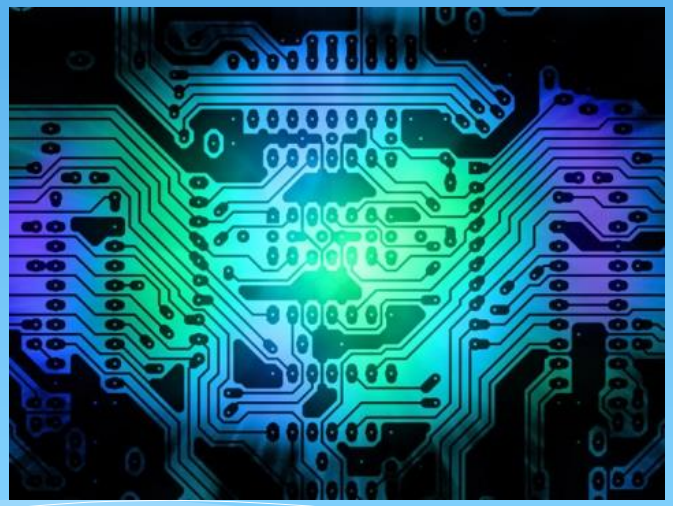
The Gender Gap in STEM: The Unique Case of Computer Science



Linda J. Sax

UCLA

Overview of Two STEM Projects

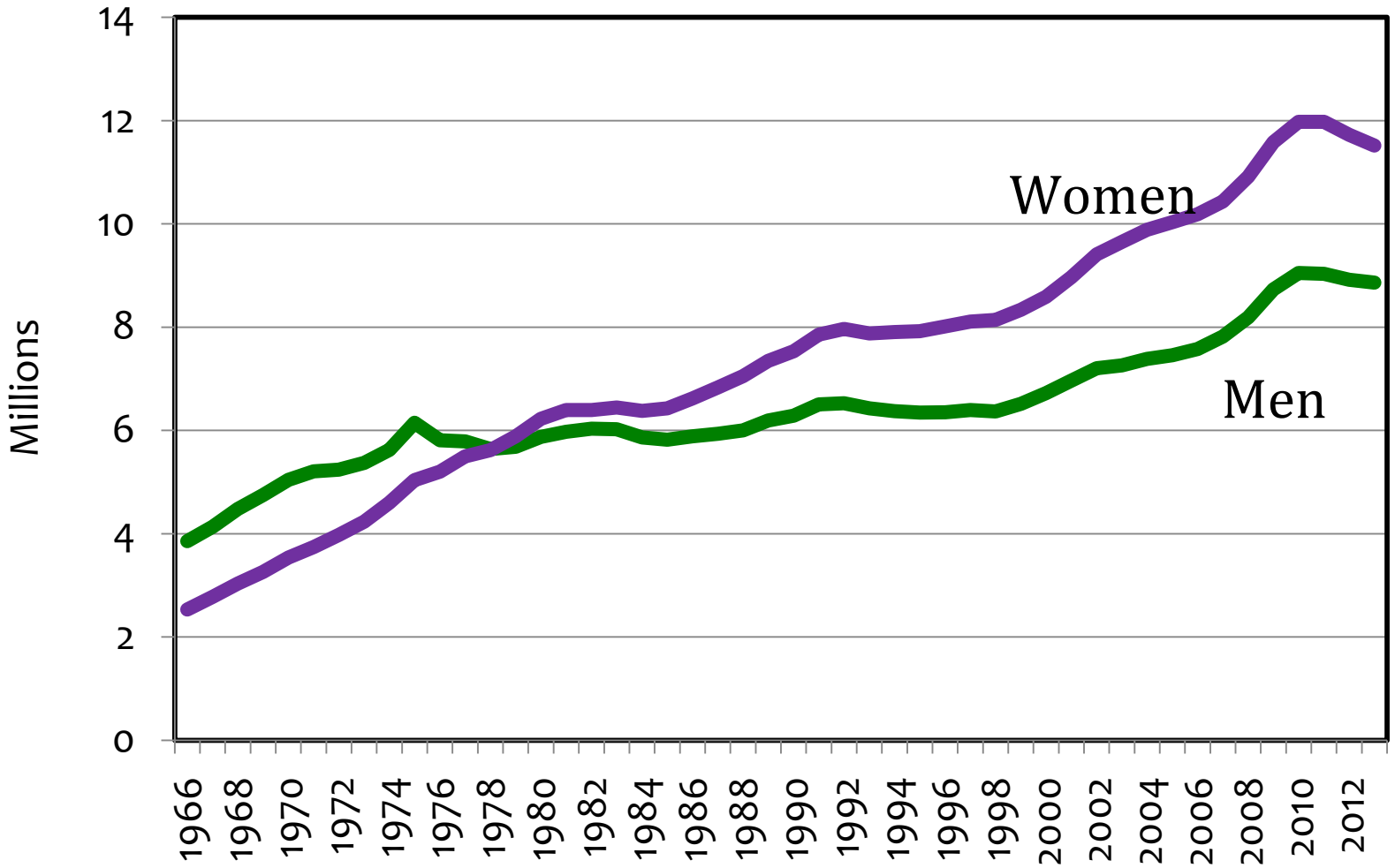
Gender Trends in STEM:
1971-2011

BRAID Initiative to Study Diversity in Computer Science

BRAID

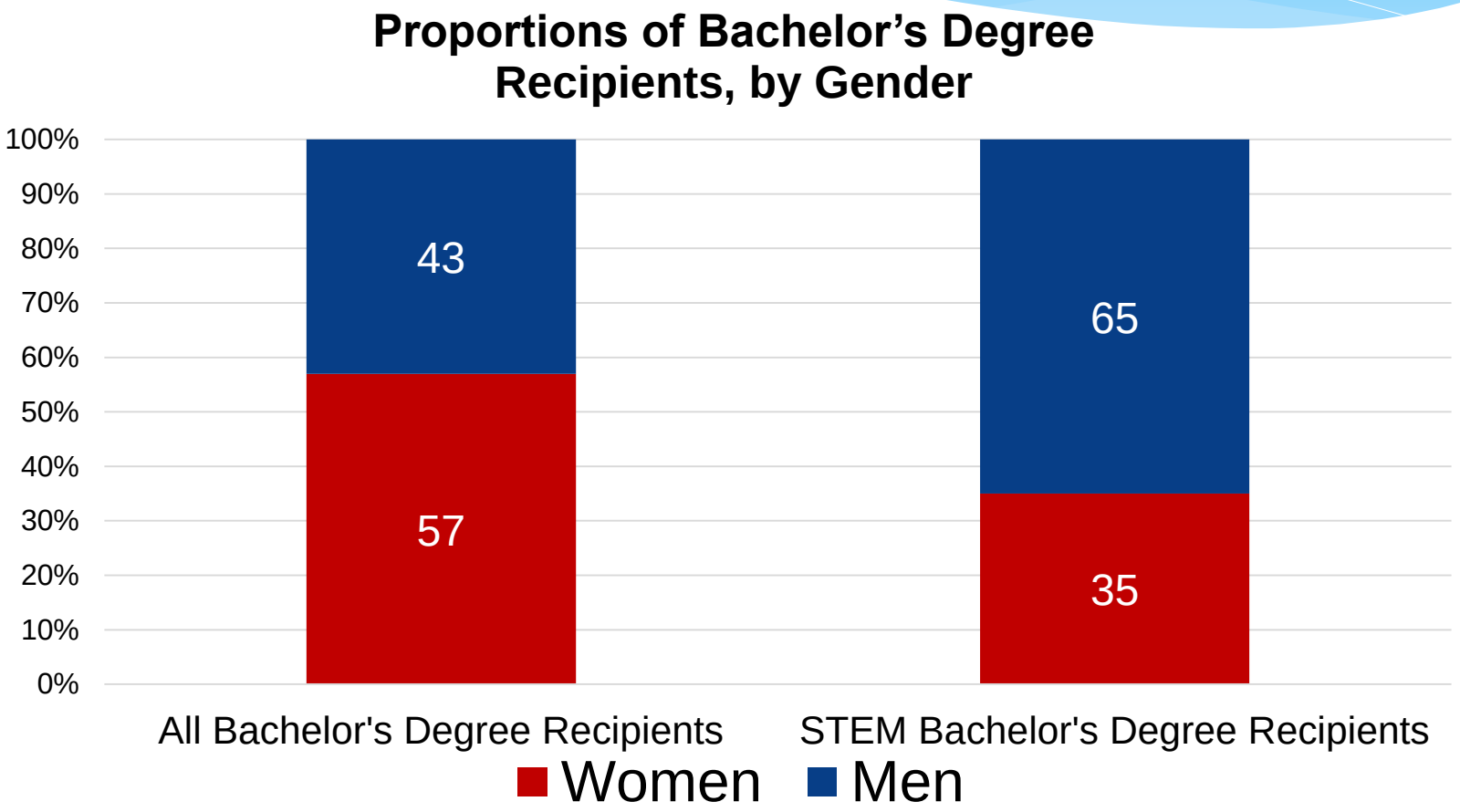
Building Recruiting And Inclusion for Diversity

Total Enrollment in Colleges and Universities (1966-2013)



Source: National Center for Education Statistics, 2015

Women Overrepresented Across All Fields, but Underrepresented in STEM



Source: National Center for Education Statistics, Digest of Education Statistics, 2011

Explanations for the Gender Gap in STEM

- **Educational Settings**
- **Forces Beyond the Classroom**

Educational Settings

* **Women begin to opt out of STEM courses in middle and high school**
  - **Women underrepresented in AP courses in STEM (Calculus, Physics, Chemistry, Computer Science)**
* **Unwelcome climate in many college STEM majors**
  - **Large lecture halls, grading on a curve**
  - **Underrepresentation of women = Less opportunity for female friendship groups in STEM**
* **Teachers/Faculty**
  - **More traditional teaching practices (emphasis on lecturing, not student-centered methods)**
  - **Faculty seen as intimidating (more impactful for female students)**
  - **Lack of female role models and mentors in STEM**

Forces Beyond the Classroom

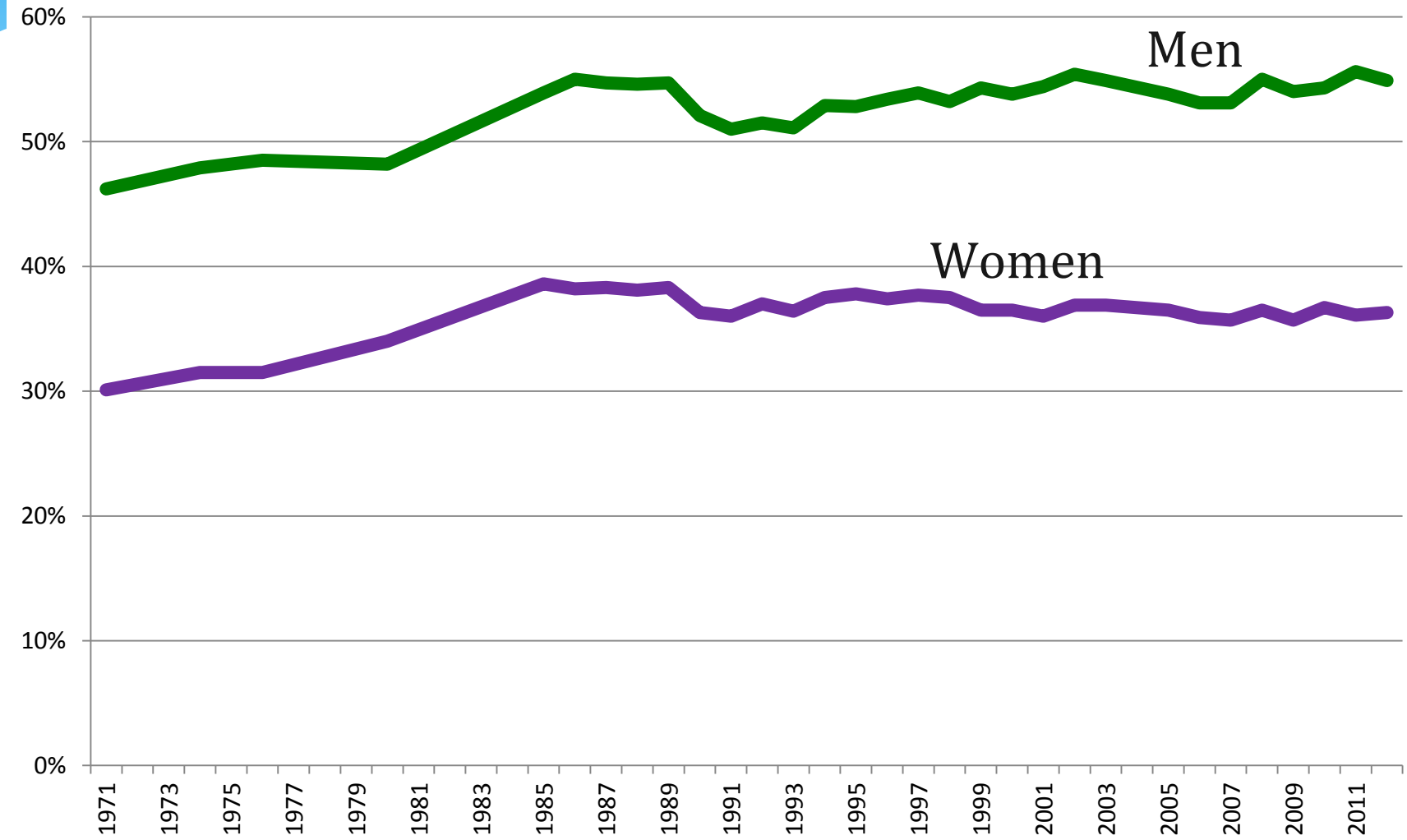
* **Sense of belonging in STEM**
  - Science perceived as masculine domain by students and parents
  - Science careers perceived as competitive, unwelcoming and difficult to balance work-family
  - Societal benefits matter, but not clearly understood

* **Women's Lower Self-confidence**

  (% rating "above average" or "highest 10%" in 2011):
  - Computer abilities (47.4% of men, 30.3% of women)
  - Math abilities (55.6% of men, 36.1% of women)

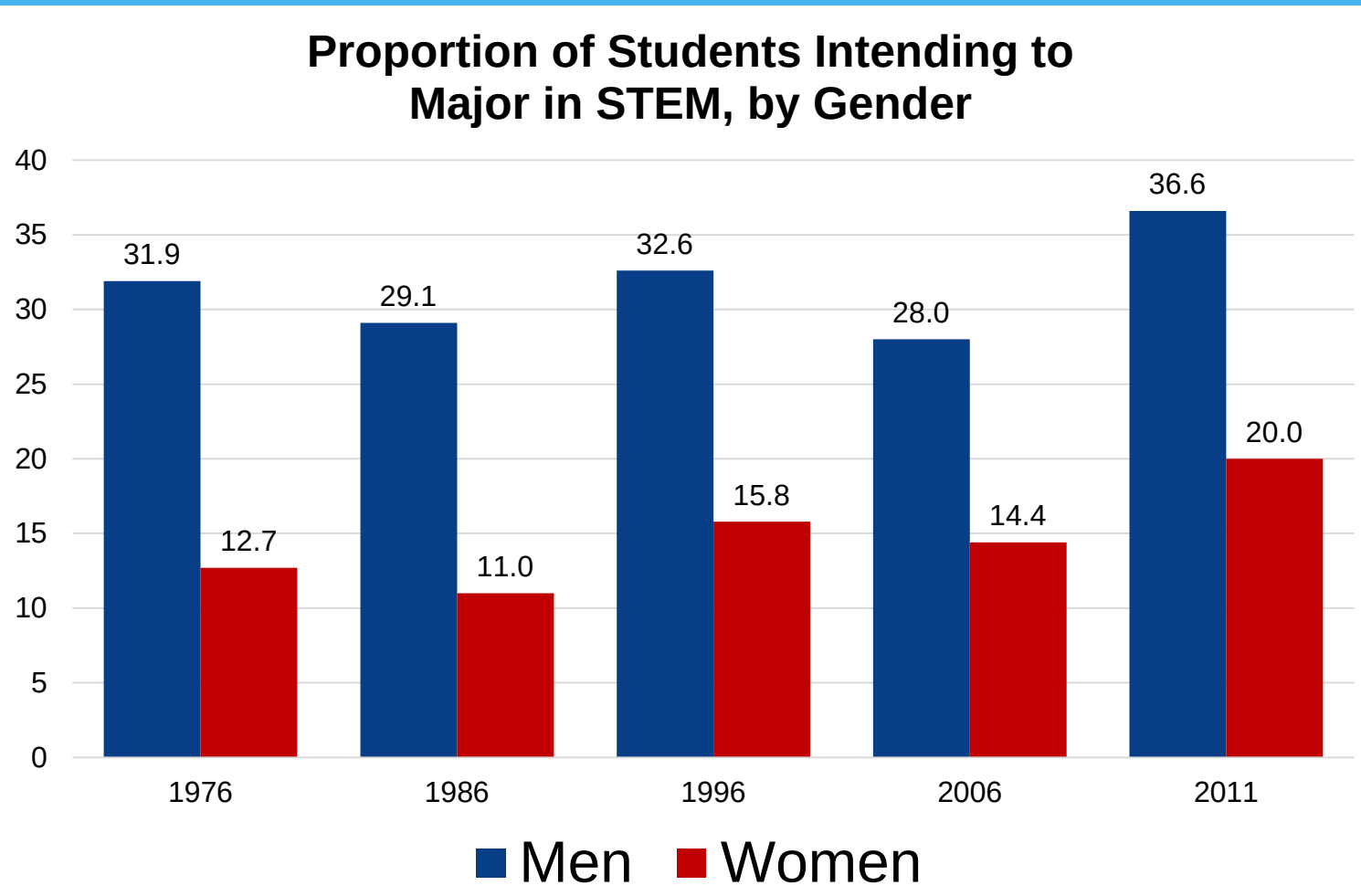
Enduring Gender Gap in Self-Rated Mathematical Ability

(% Above Average or Highest 10%)



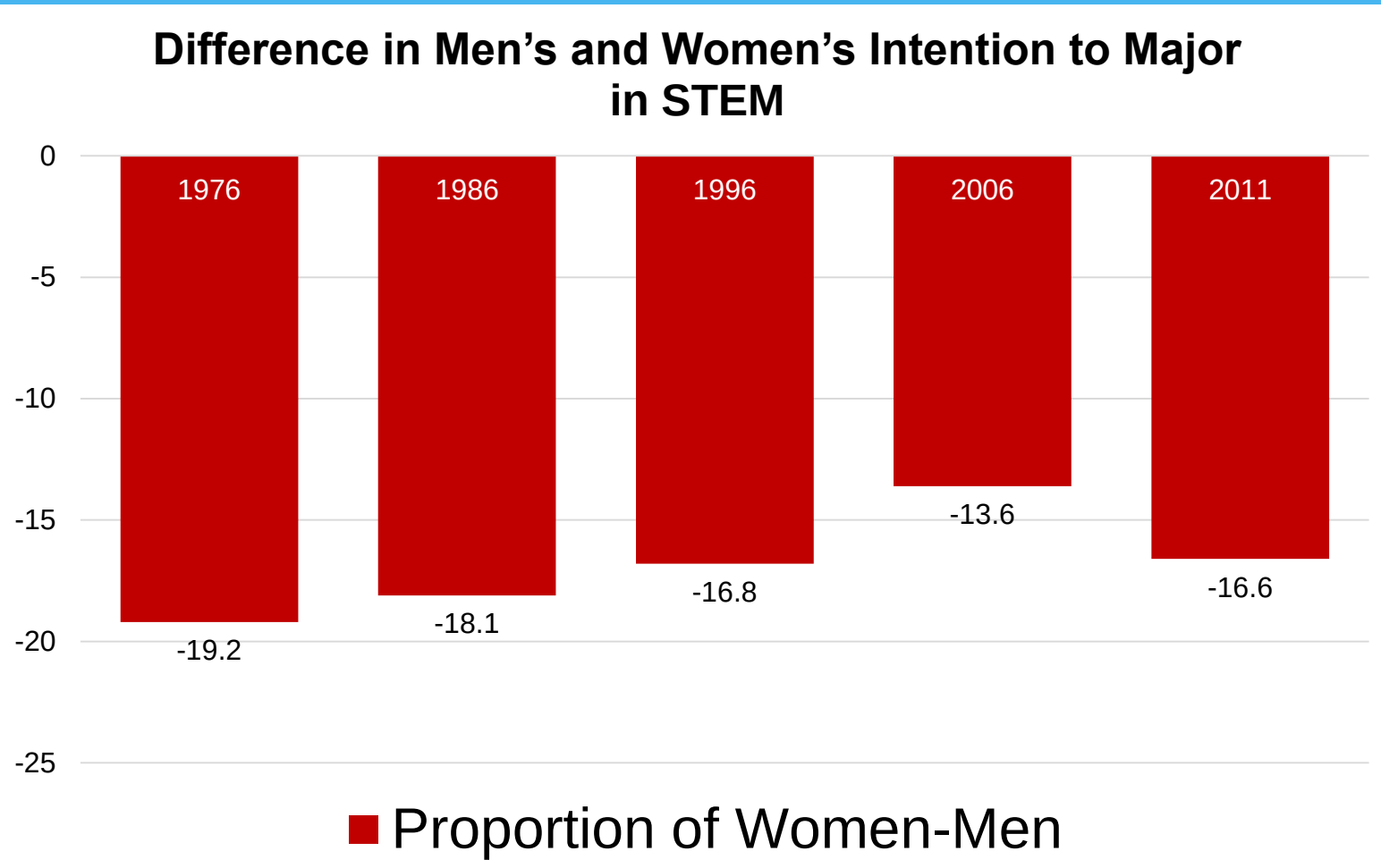
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

How Has the Gender Gap in STEM Changed Over Time?



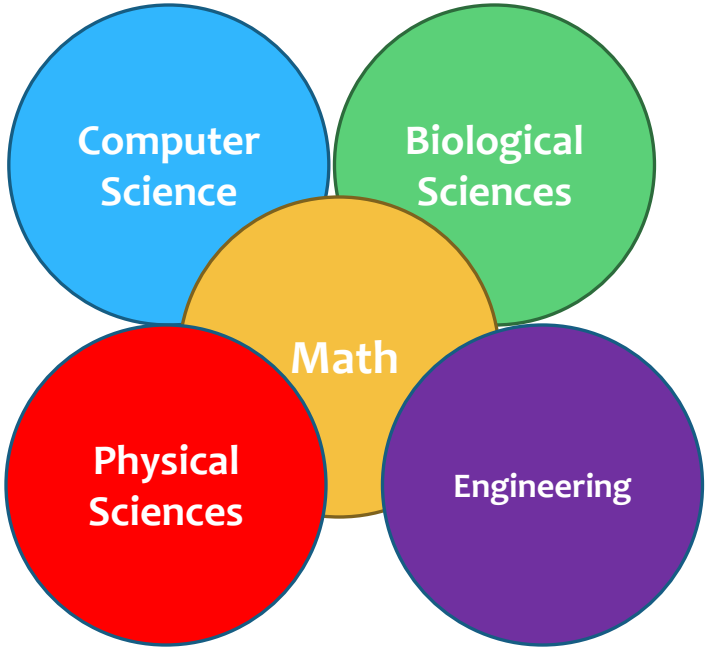
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Gender Gap Narrows… Then Widens

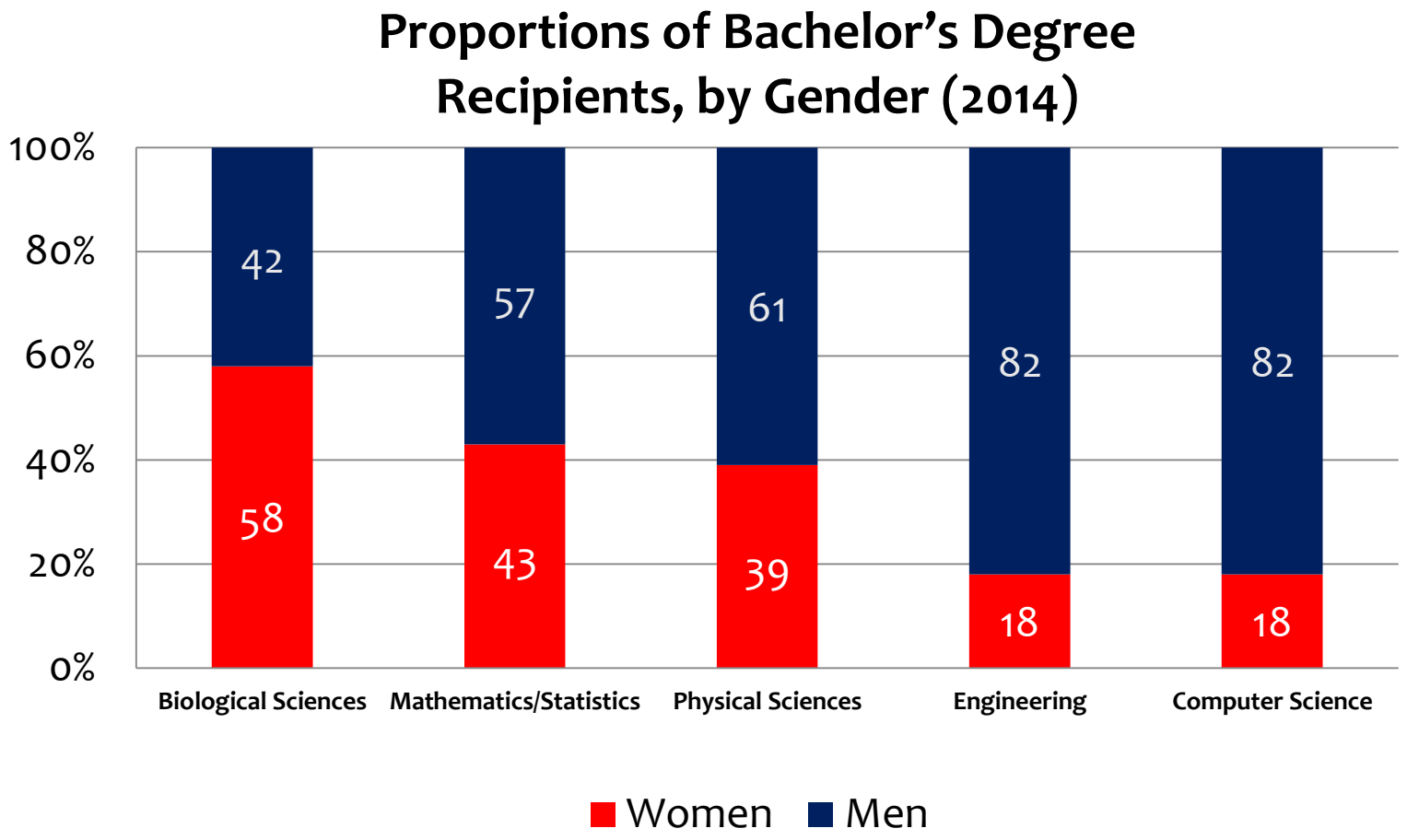


Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Need to Consider Differences Across STEM Fields

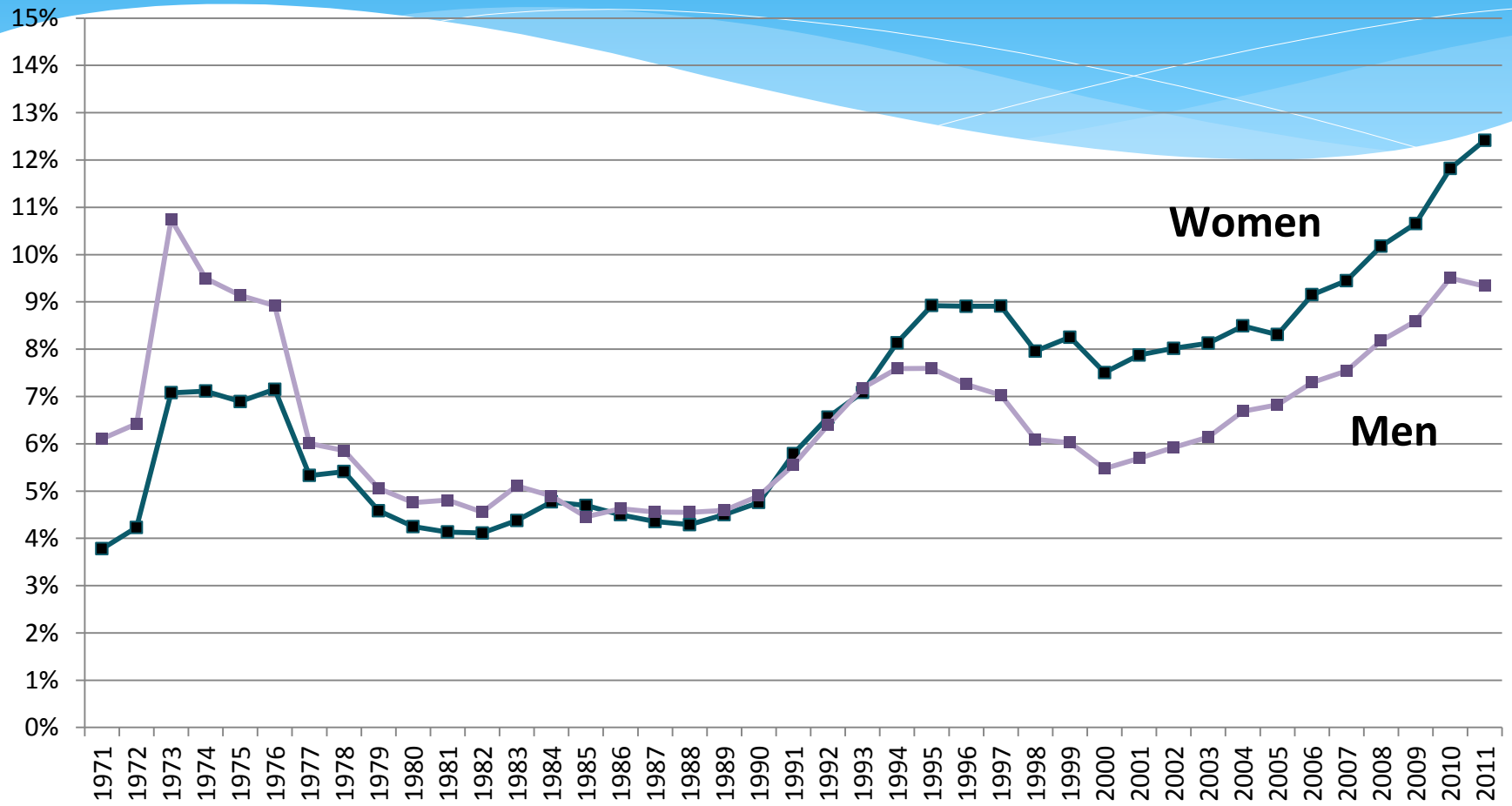


Women's Relative Representation in STEM Varies by Field



Source: National Center for Education Statistics, Digest of Education Statistics, 2015

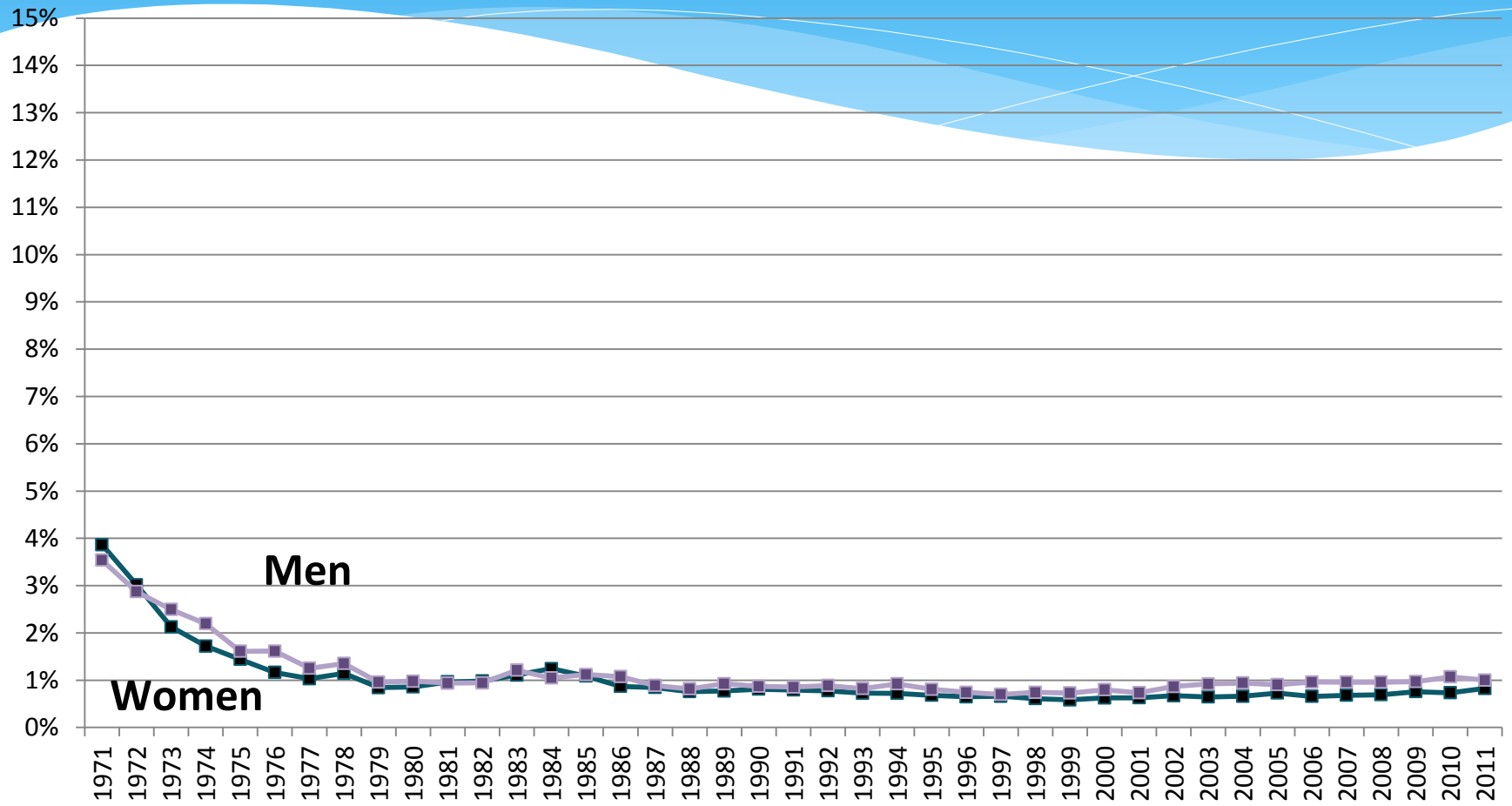
Biological Sciences
Gender Gap Reversal



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

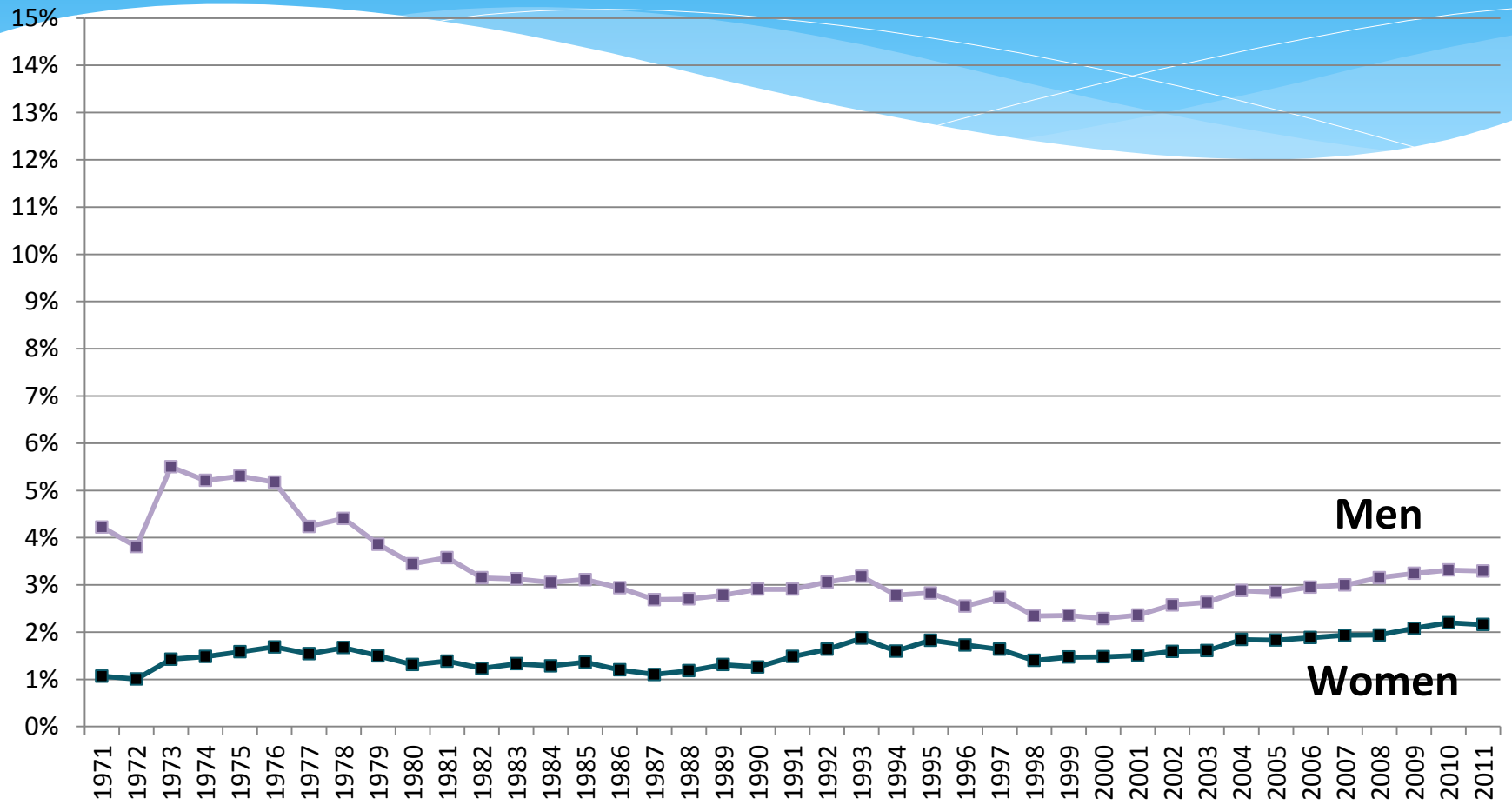
Math/Statistics

No Gender Gap



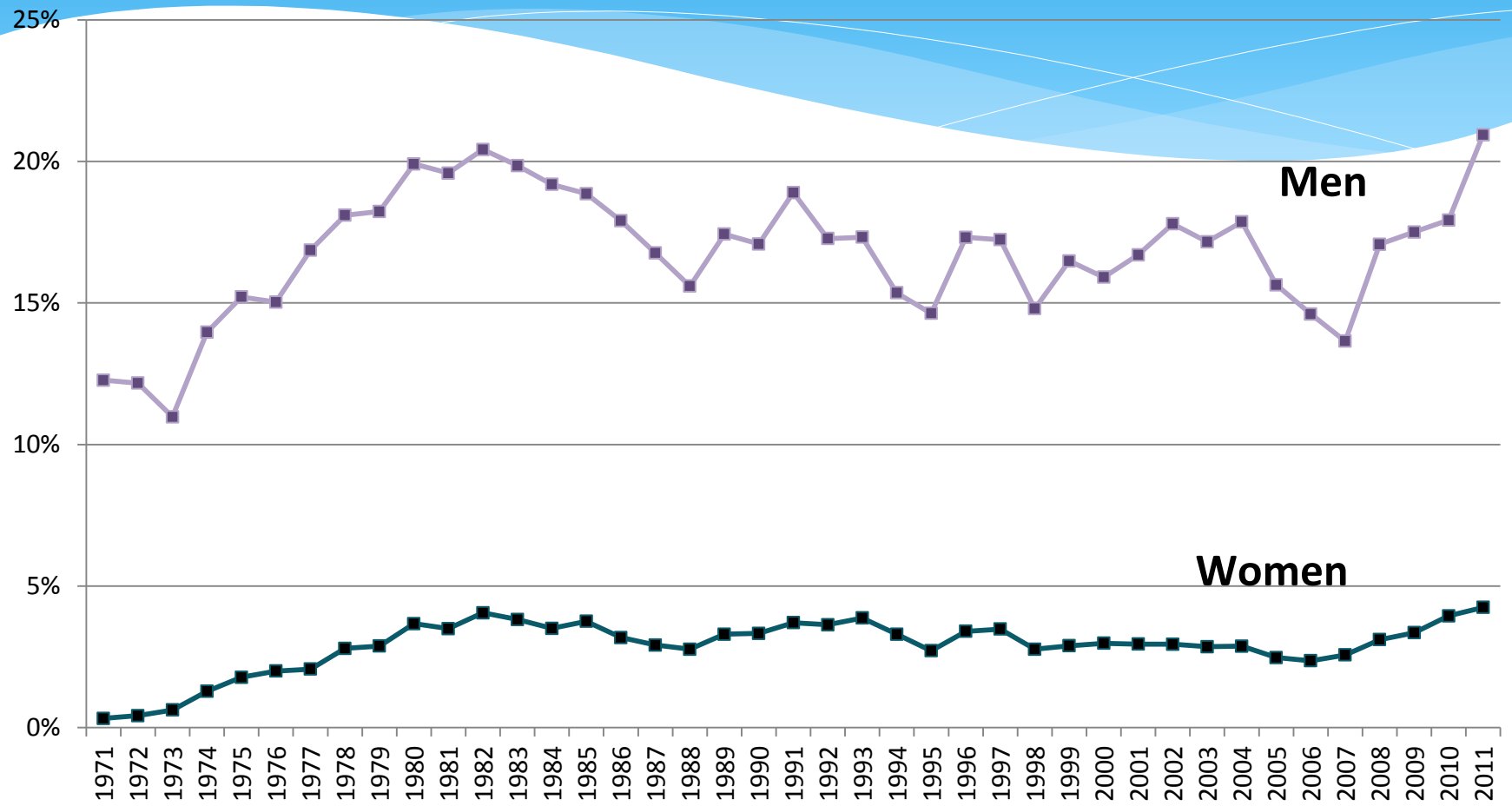
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Physical Sciences
Diminished Gender Gap



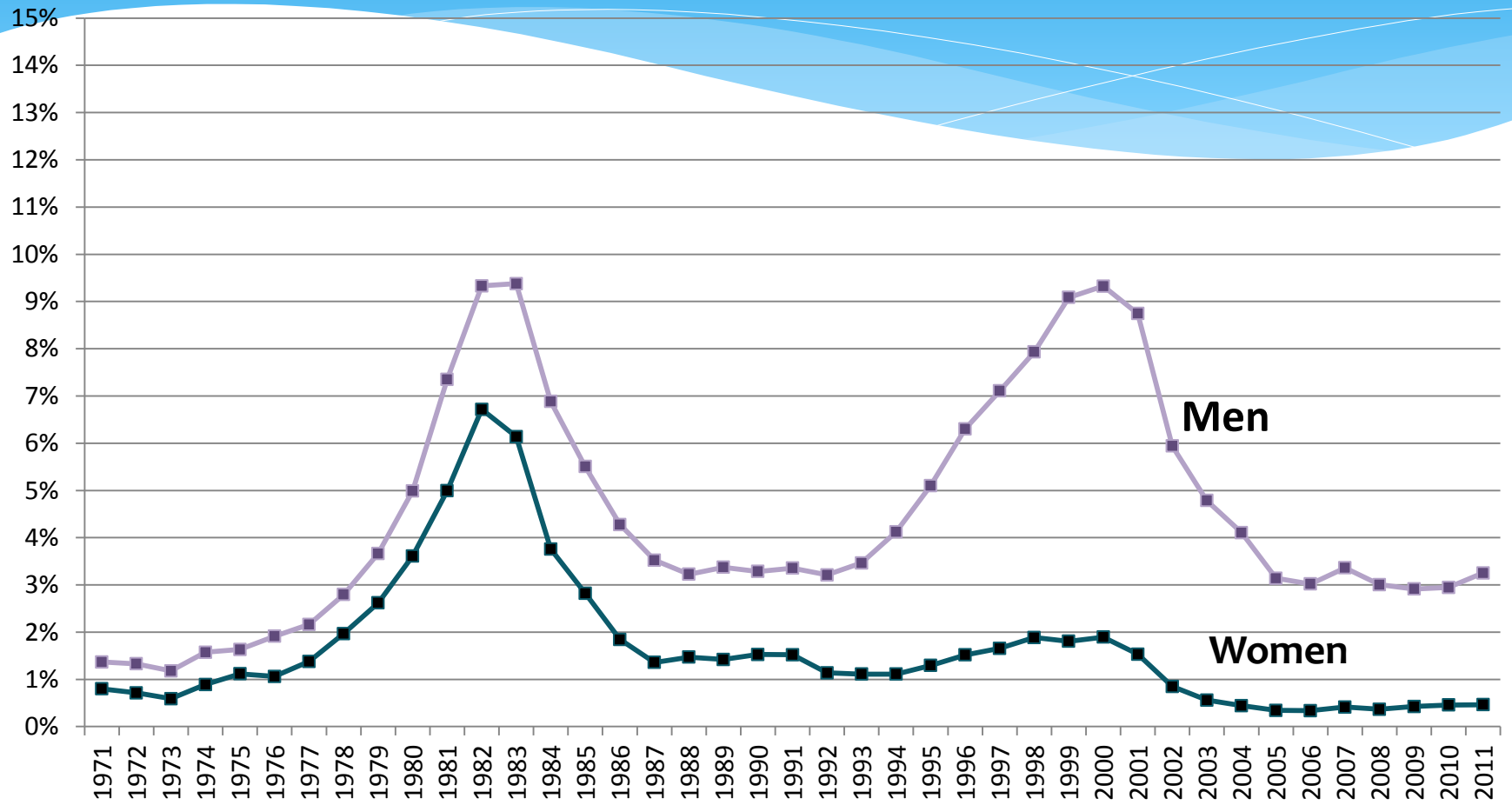
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Engineering
Stable(ish) Gender Gap



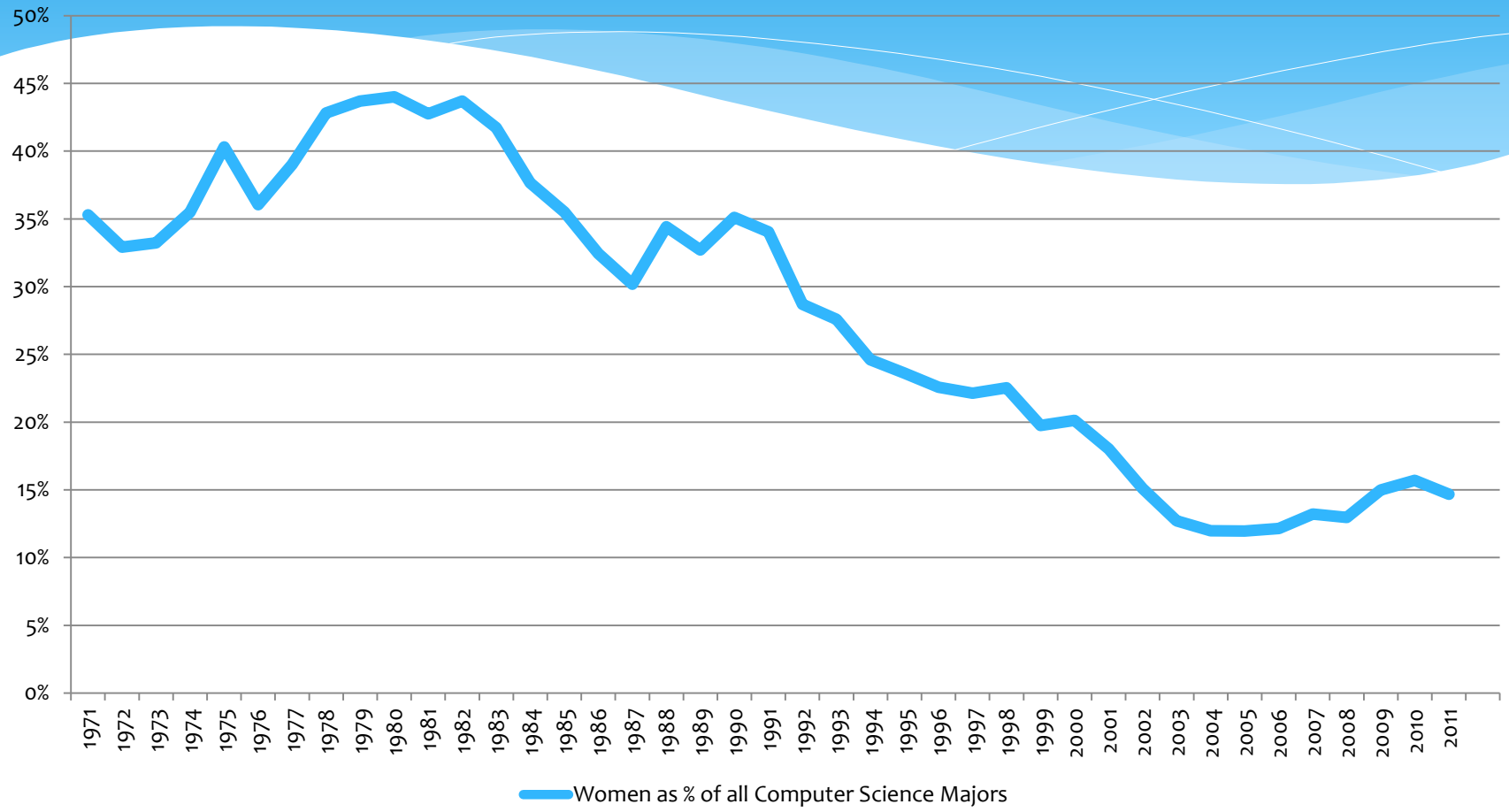
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Computer Science
Fluctuating Gender Gap



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Proportion of Prospective Computer Science Majors who are Female (1971-2011)



Why Focus on Computer Science?

- Global demand for individuals with computer science training (valuable in any field)
- Computer-related careers among the fastest growing and highest paying occupations
- Number of colleges offering a CS degree has grown from 123 to 600 in past forty years
- Women remain vastly underrepresented in CS occupations
  - Women only 20% of software developers = women's voices not reflected in many emerging technologies

NSF-Funded Research

(HRD #1135727)

- **In order to attract more women to CS, we need to better understand female CS majors**
  - **How do they differ from male computer science majors?**
  - **How do they differ from women in other STEM fields?**
  - **How have they changed over the past four decades?**

Data Source

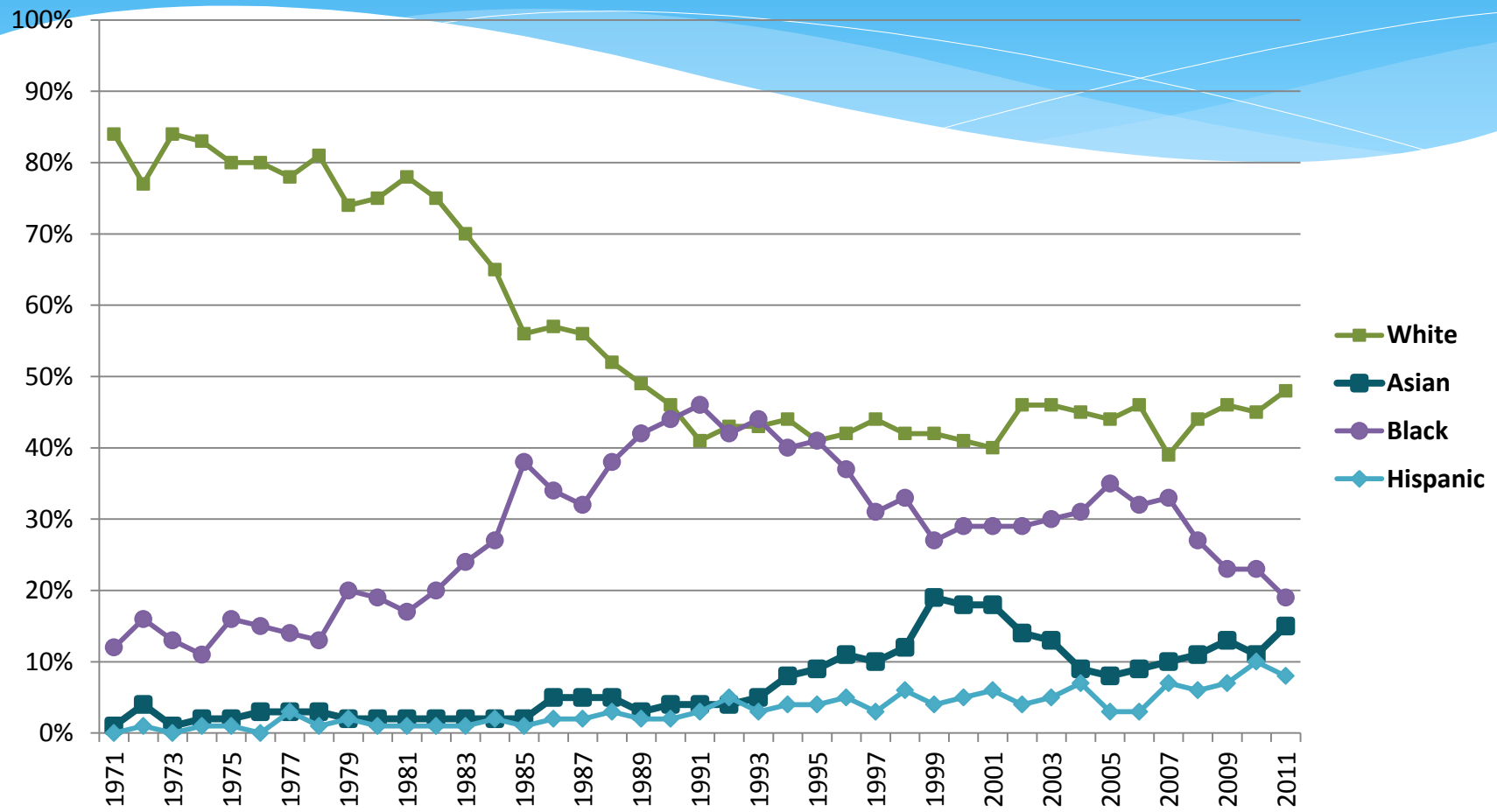
* CIRP Freshman Survey
  * Over 8 million students entering over 1,000 baccalaureate institutions
* Focuses on 5 STEM fields: Biological sciences, Computer Science, Engineering, Math/statistics, Physical Sciences
* Analyzes female and male STEM majors over the past 40 years (1971-2011)

Methods

- Data Source:
  - CIRP Freshman Survey
  - Over 8 million students entering over 1,000 baccalaureate institutions between 1971-2011
- Key comparison groups
  - 54,845 women and 149,766 men planning to major in CS
  - More than 1.7 million students planning to major in biological sciences, physical sciences, math/stats, and engineering
- Summary of findings in:
  - Background traits
  - Self-ratings
  - Community orientation
  - Career aspirations

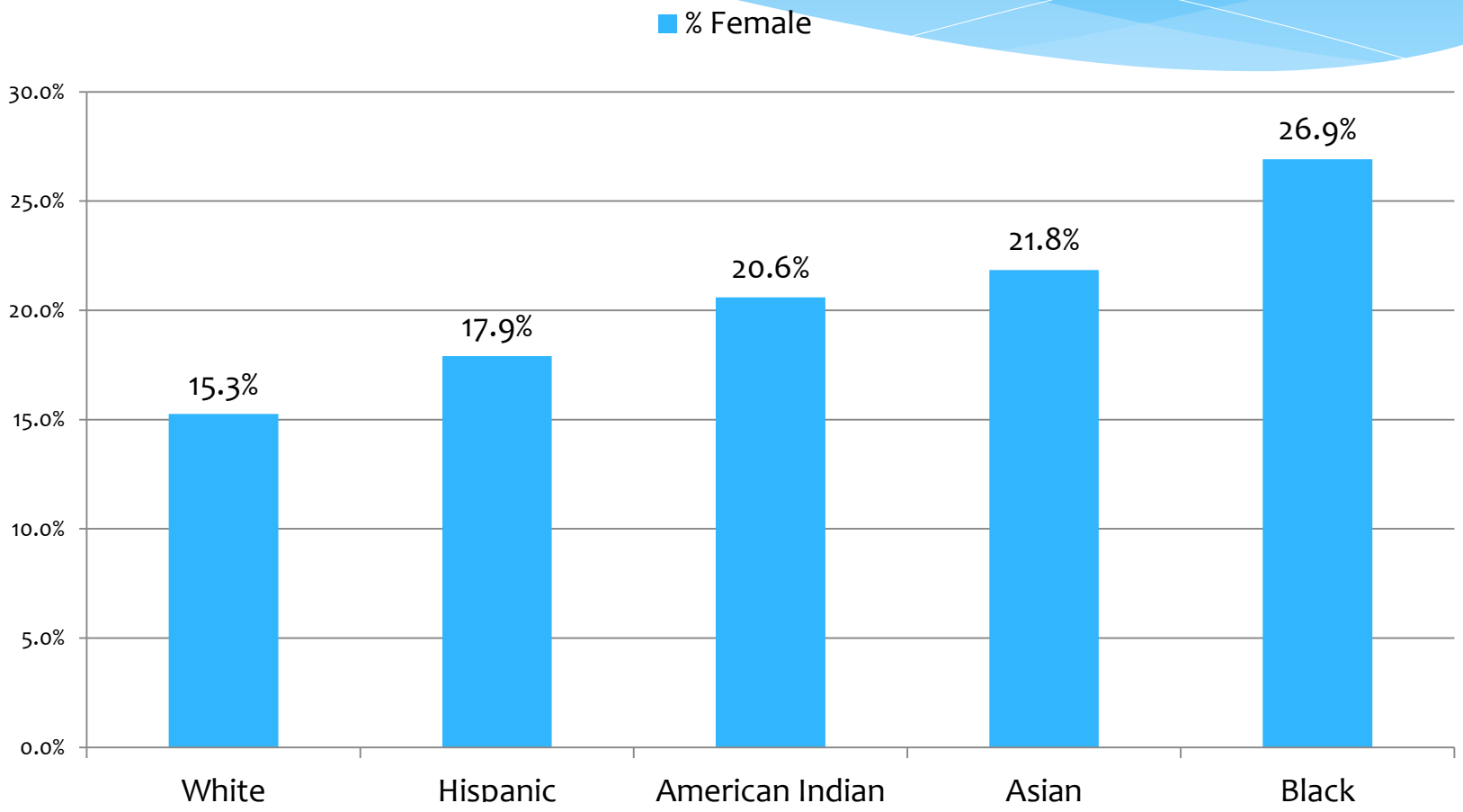
Key Findings: Background Traits

Racial/Ethnic Distribution of Female Computer Science Majors (1971-2011)

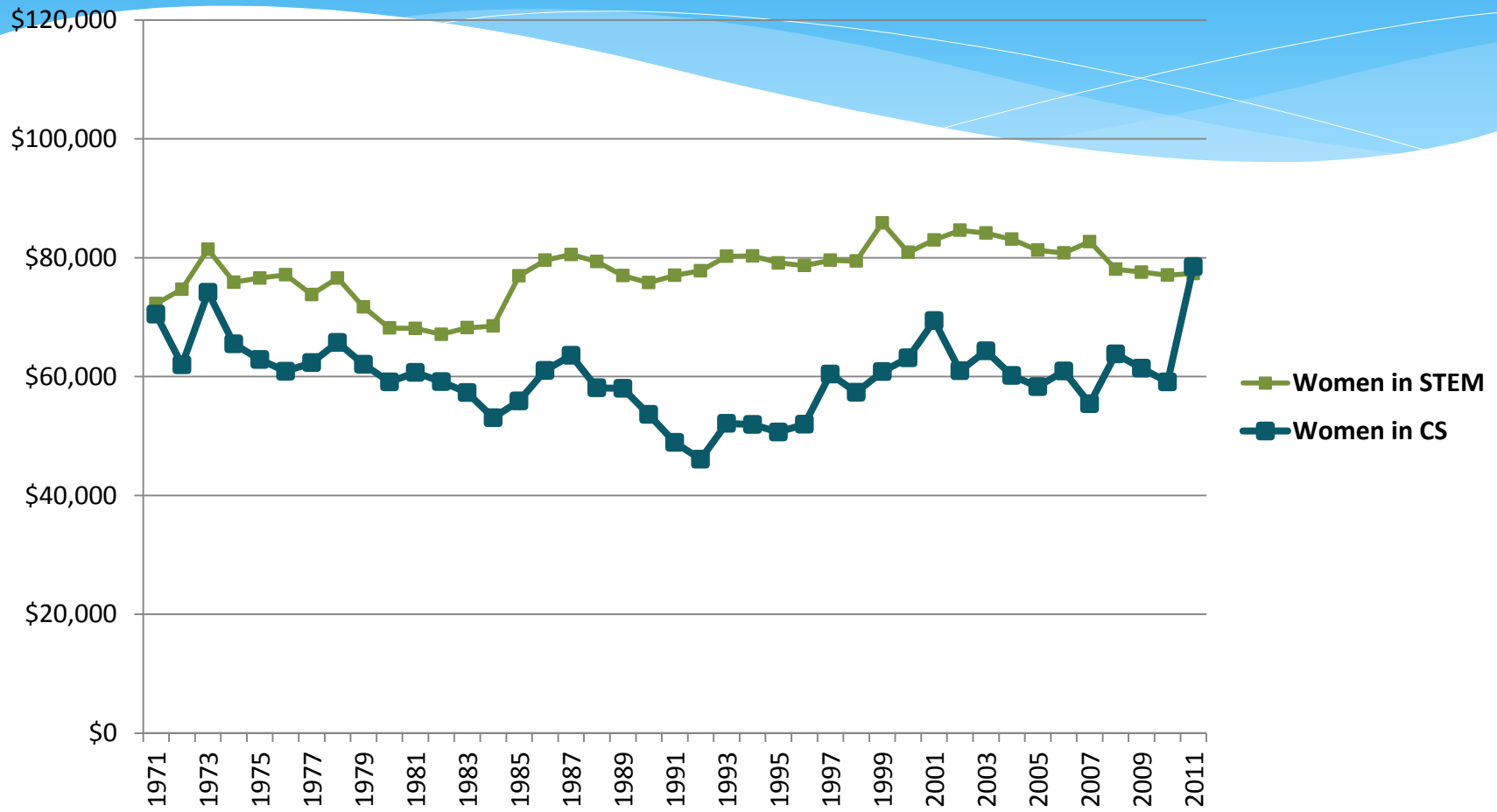


Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Percentage of CS Bachelor's Degree Earners who are Female, by Race/Ethnicity

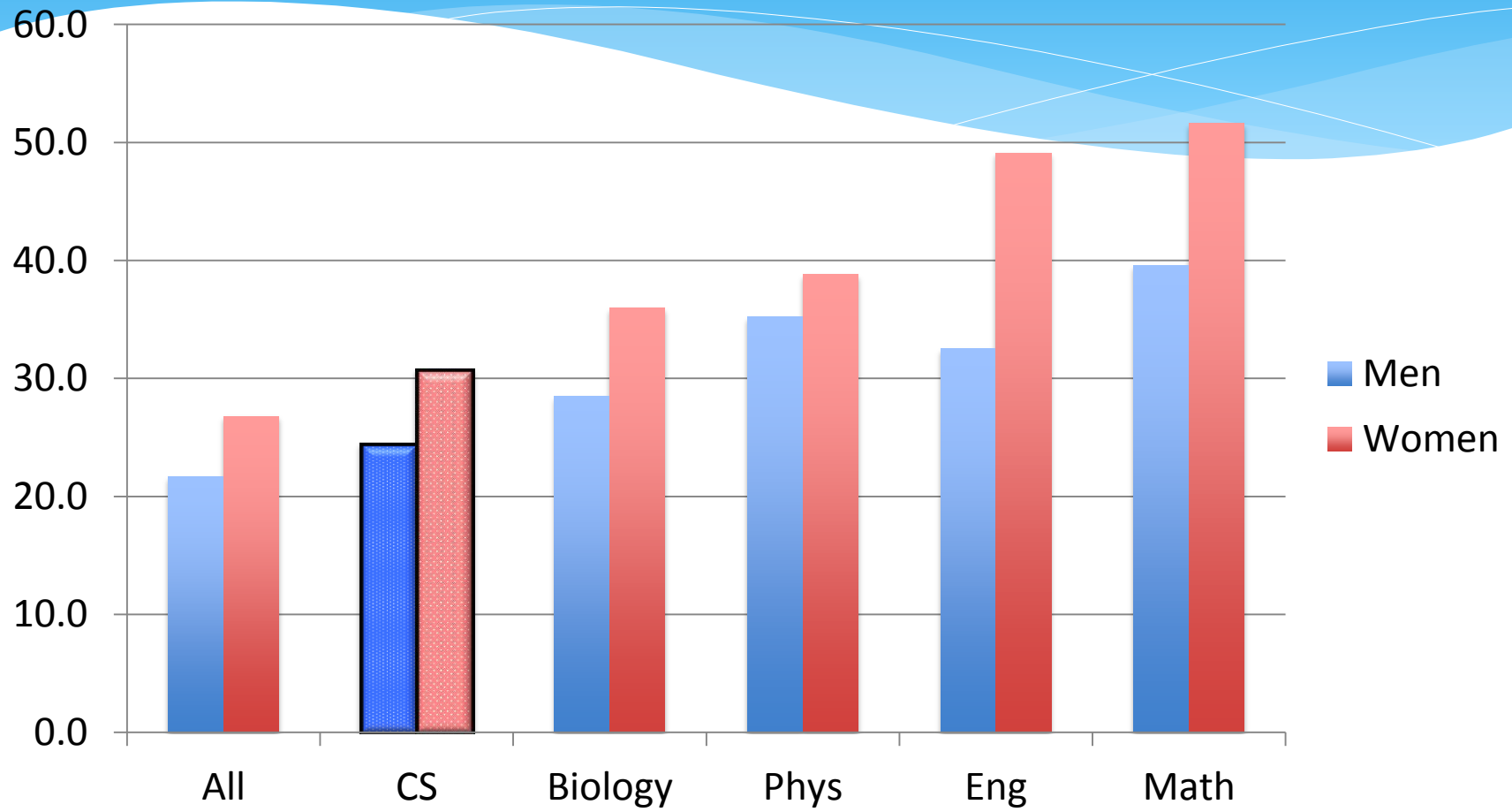


Median Family Income (1971-2011)
(In 2011 Dollars)



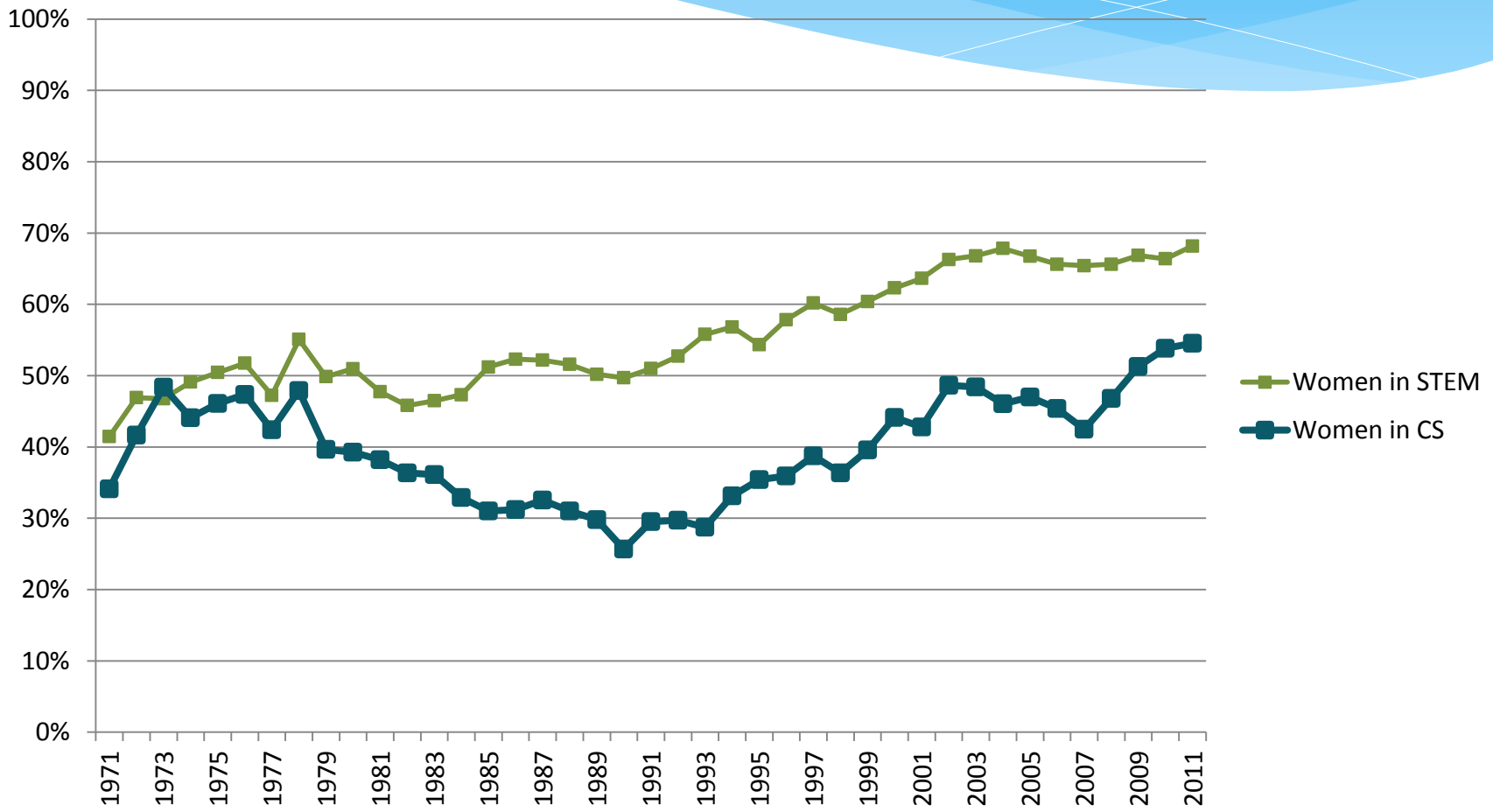
Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

A+/A High School GPA, by Field and Gender (2011)



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Women Averaging A+, A, or A- Grades in High School (1971-2011)

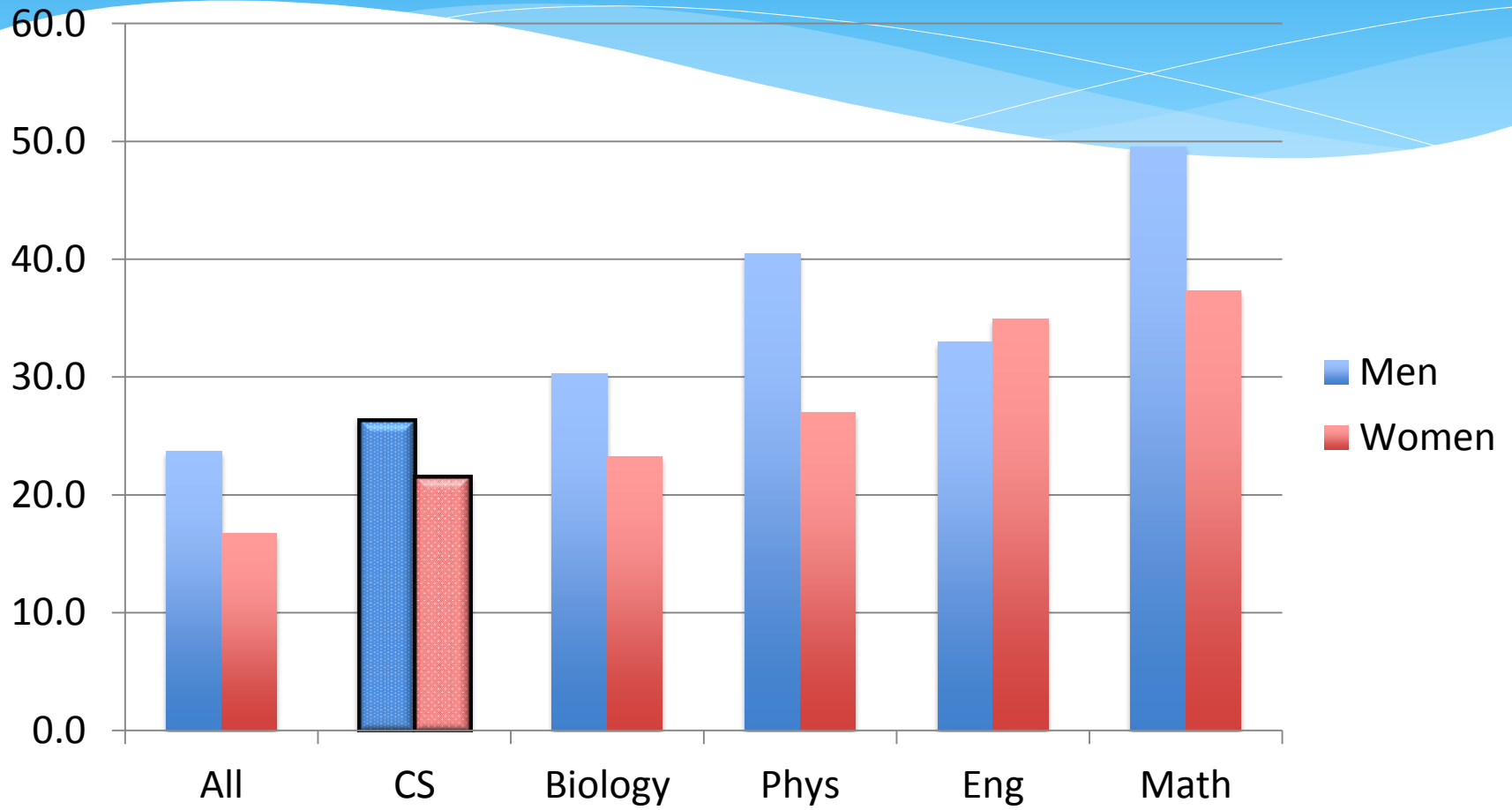


Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Key Findings: Self-Ratings

Self-Rating Academic Ability (2011)

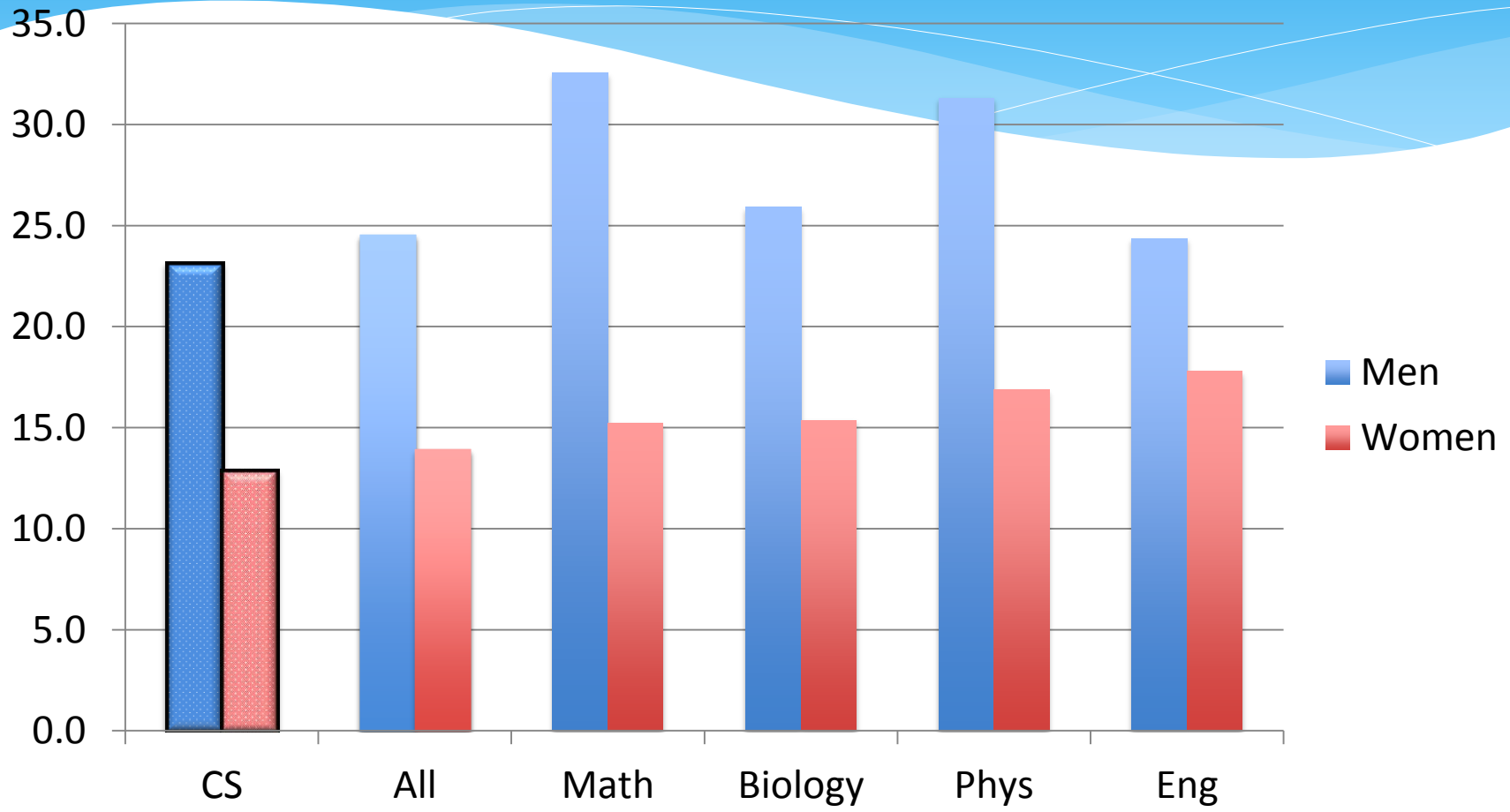
(% Indicating "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

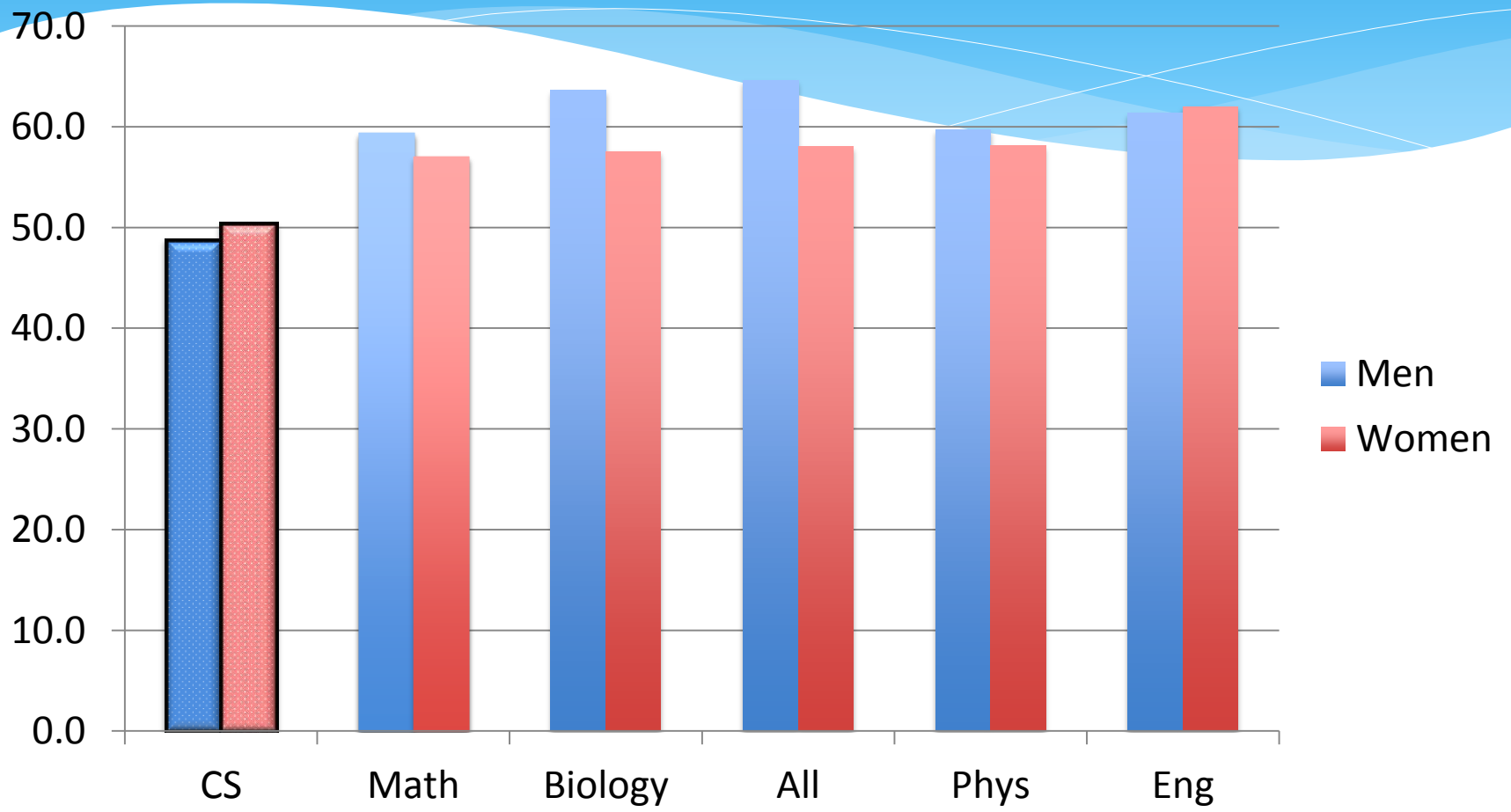
Self-Rating Intellectual Self-Confidence (2011)

(% Indicating "Highest 10%")



Self-Rating Leadership Ability (2011)

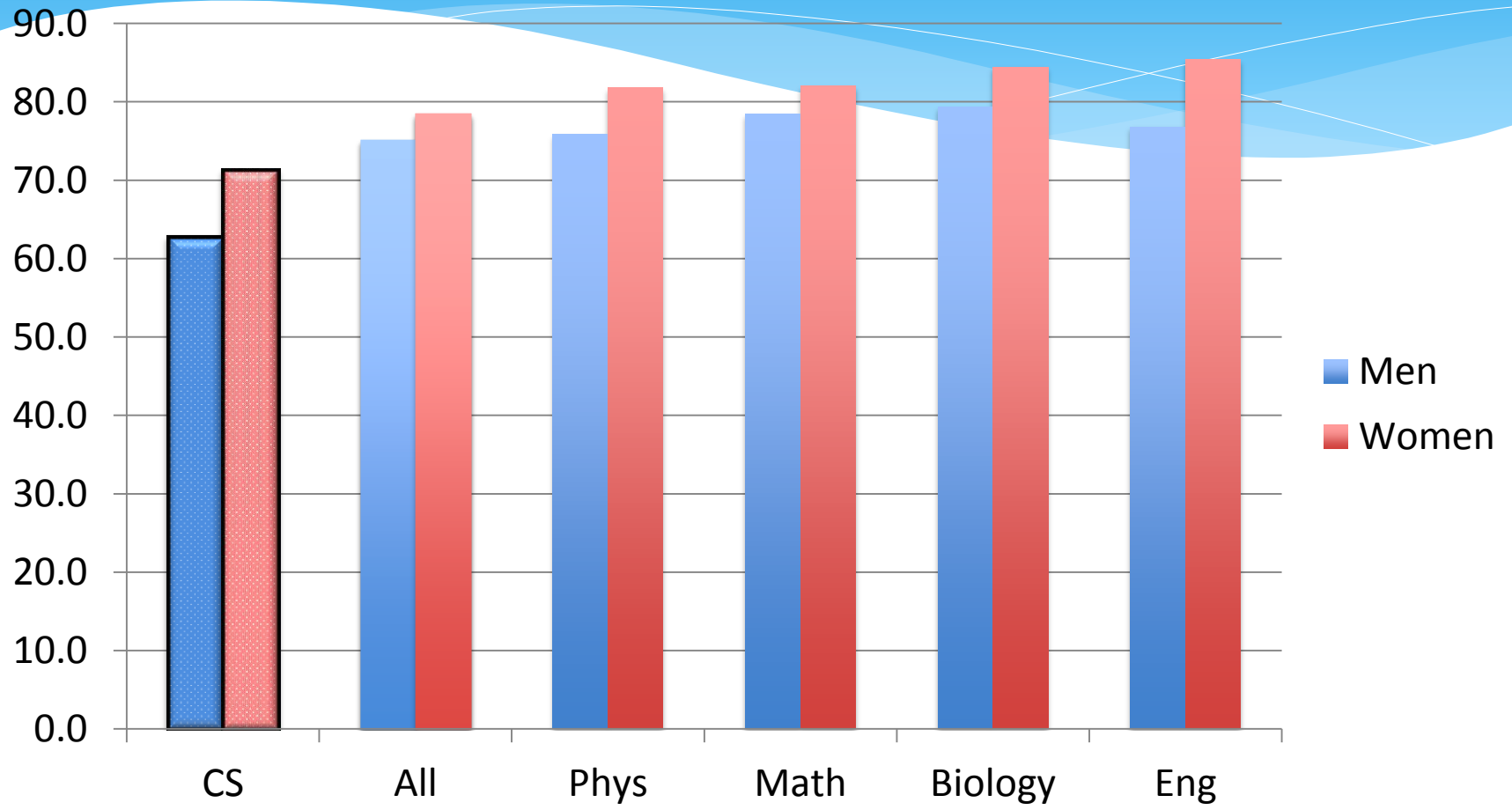
(% Indicating "Above Average" or "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Self-Rating Drive to Achieve (2011)

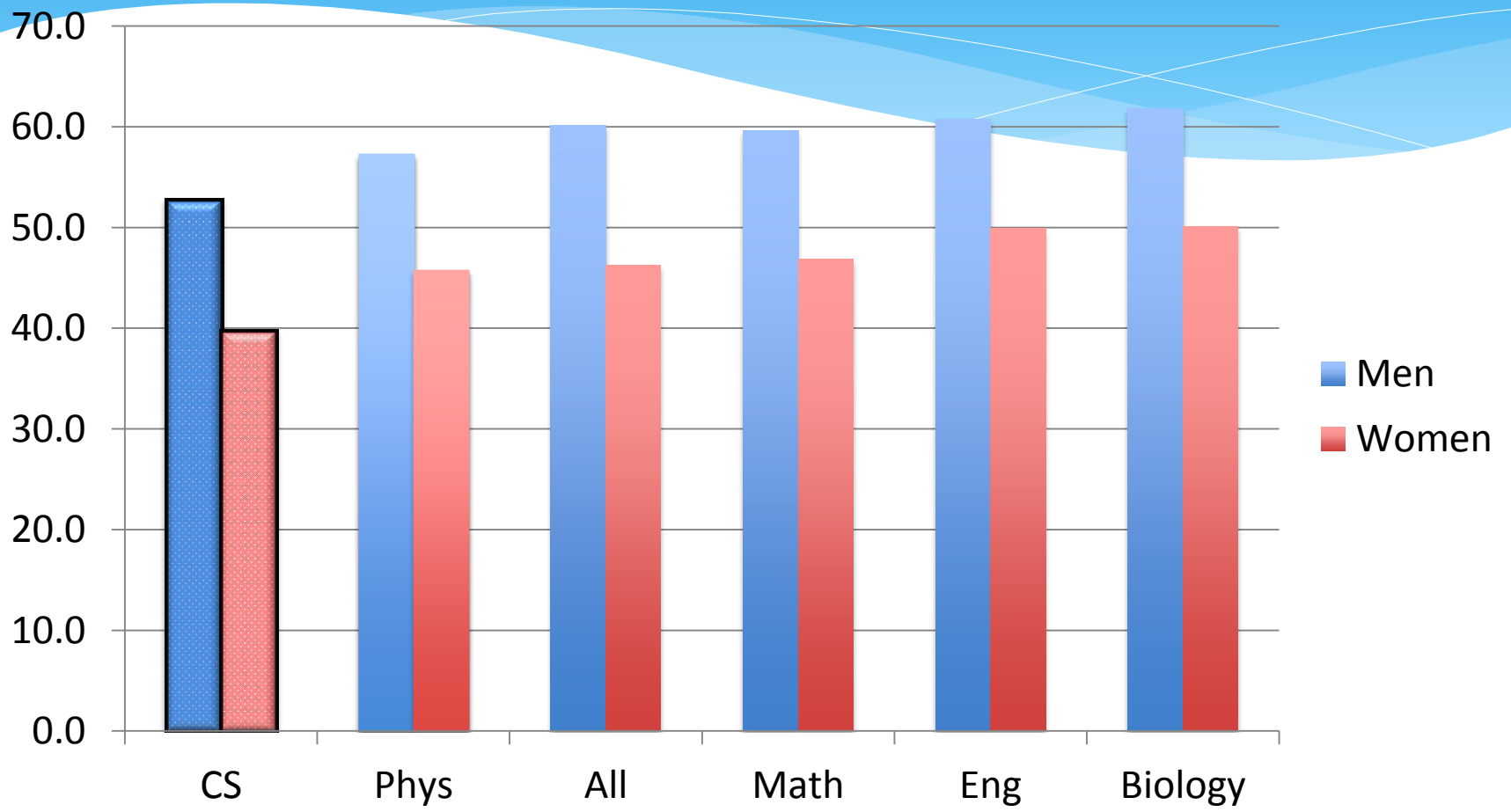
(% Indicating "Above Average" or "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Self-Rating Emotional Health (2011)

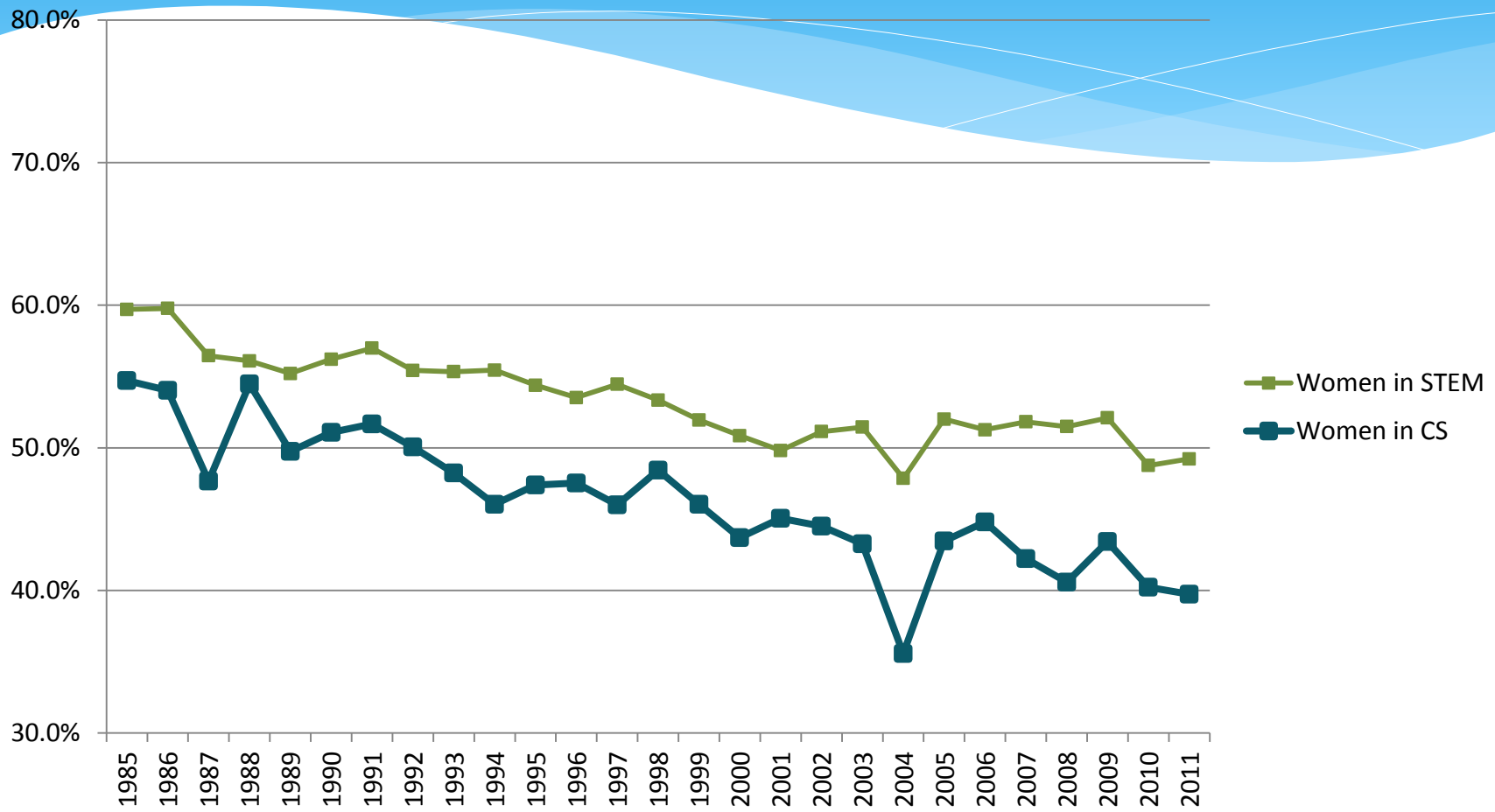
(% Indicating "Above Average" or "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Women's Self-Rating Emotional Health (1985-2011)

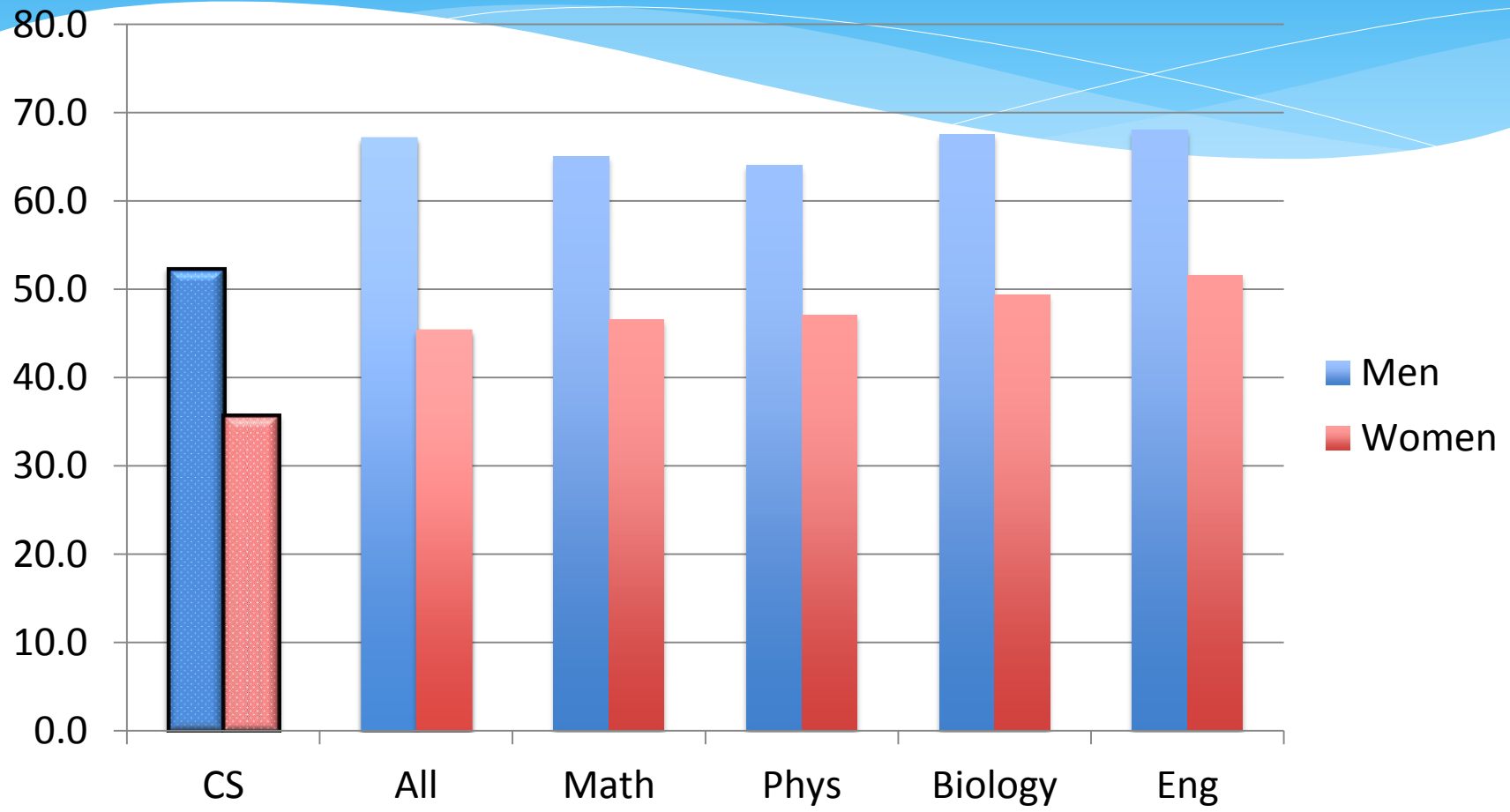
(% Indicating "Highest 10%" or "Above Average")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Self-Rating Physical Health (2011)

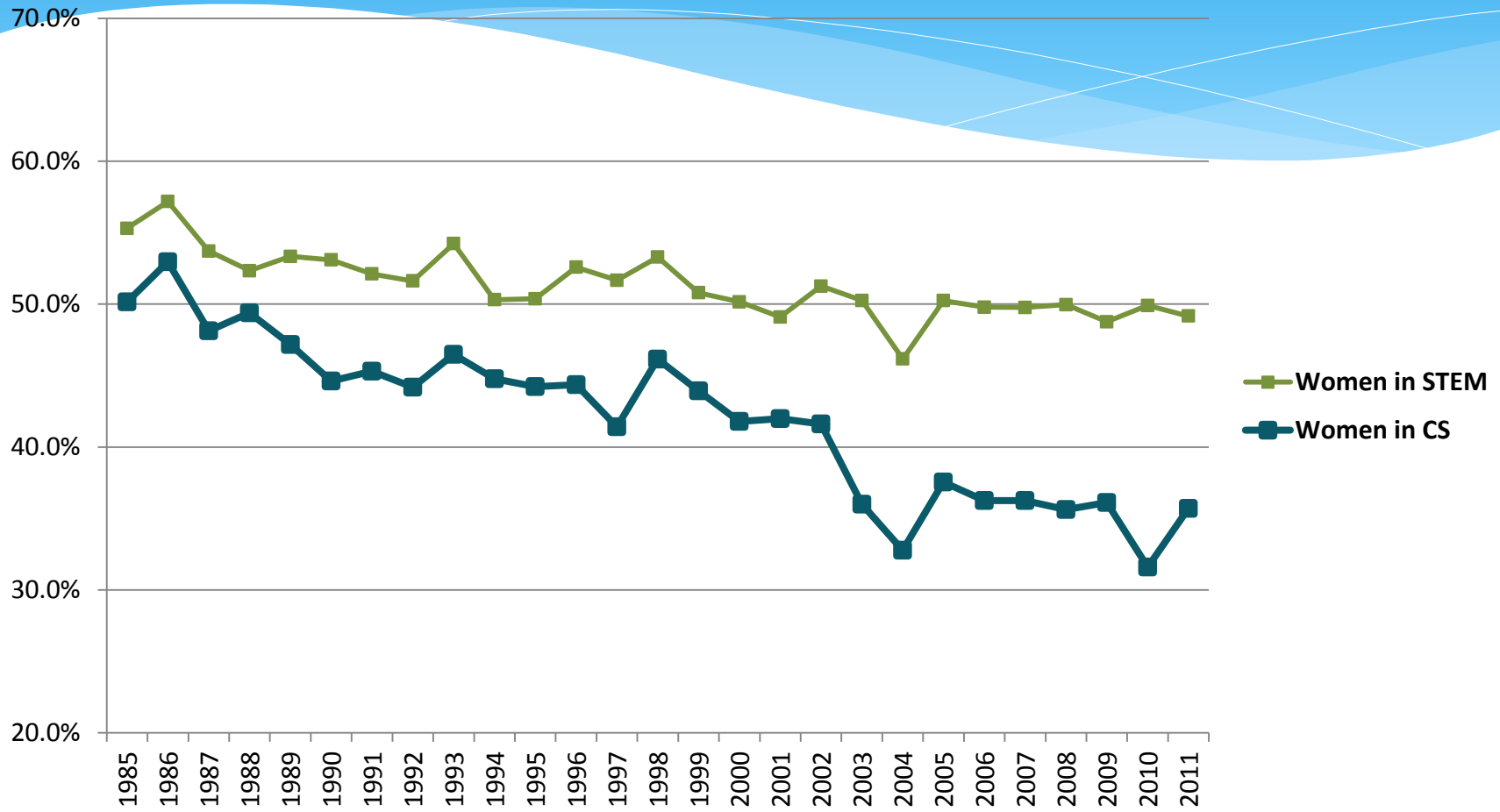
(% Indicating "Above Average" or "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

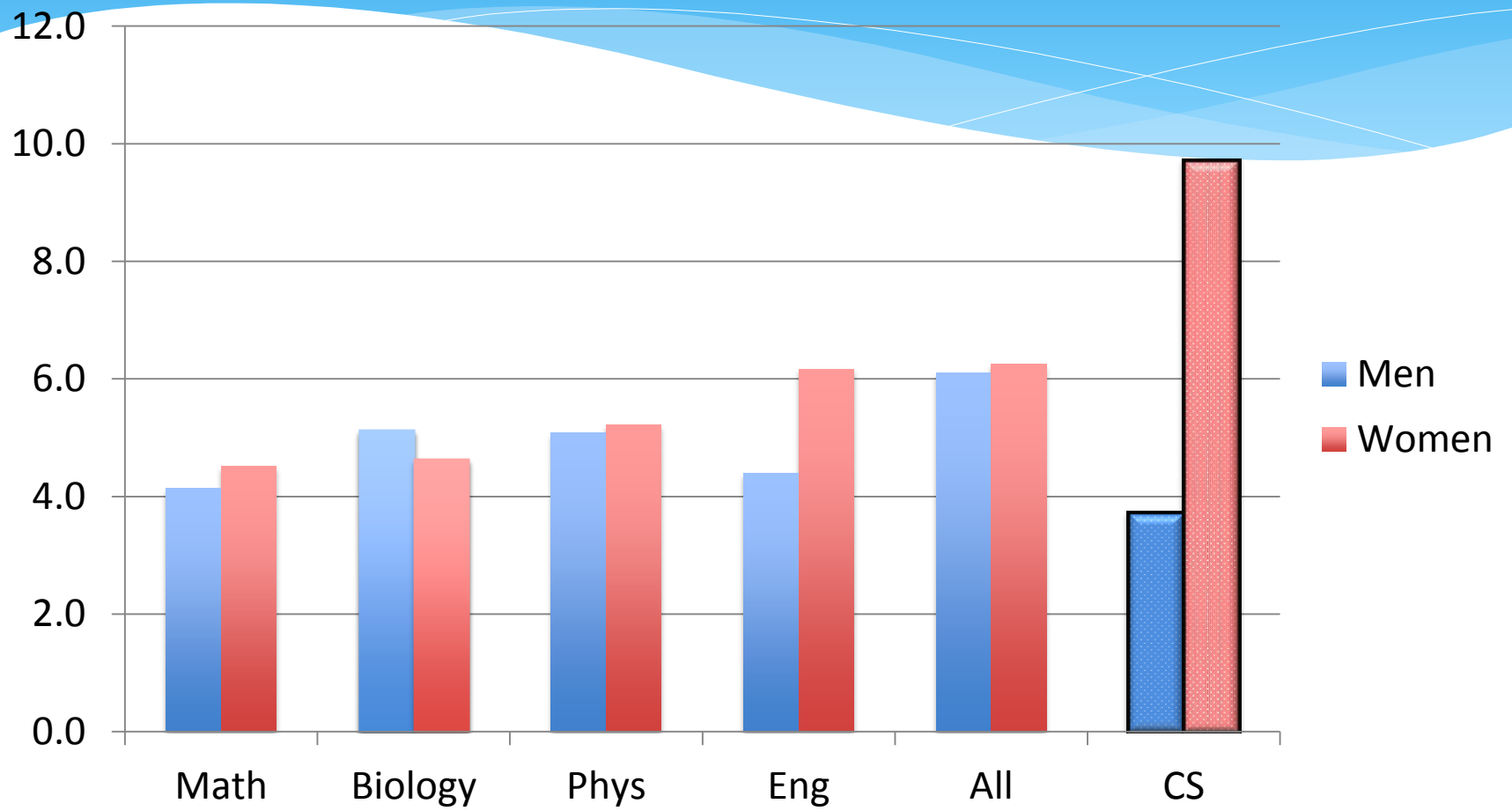
Women's Self-Rating Physical Health (1985-2011)

(% Indicating "Above Average" or "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

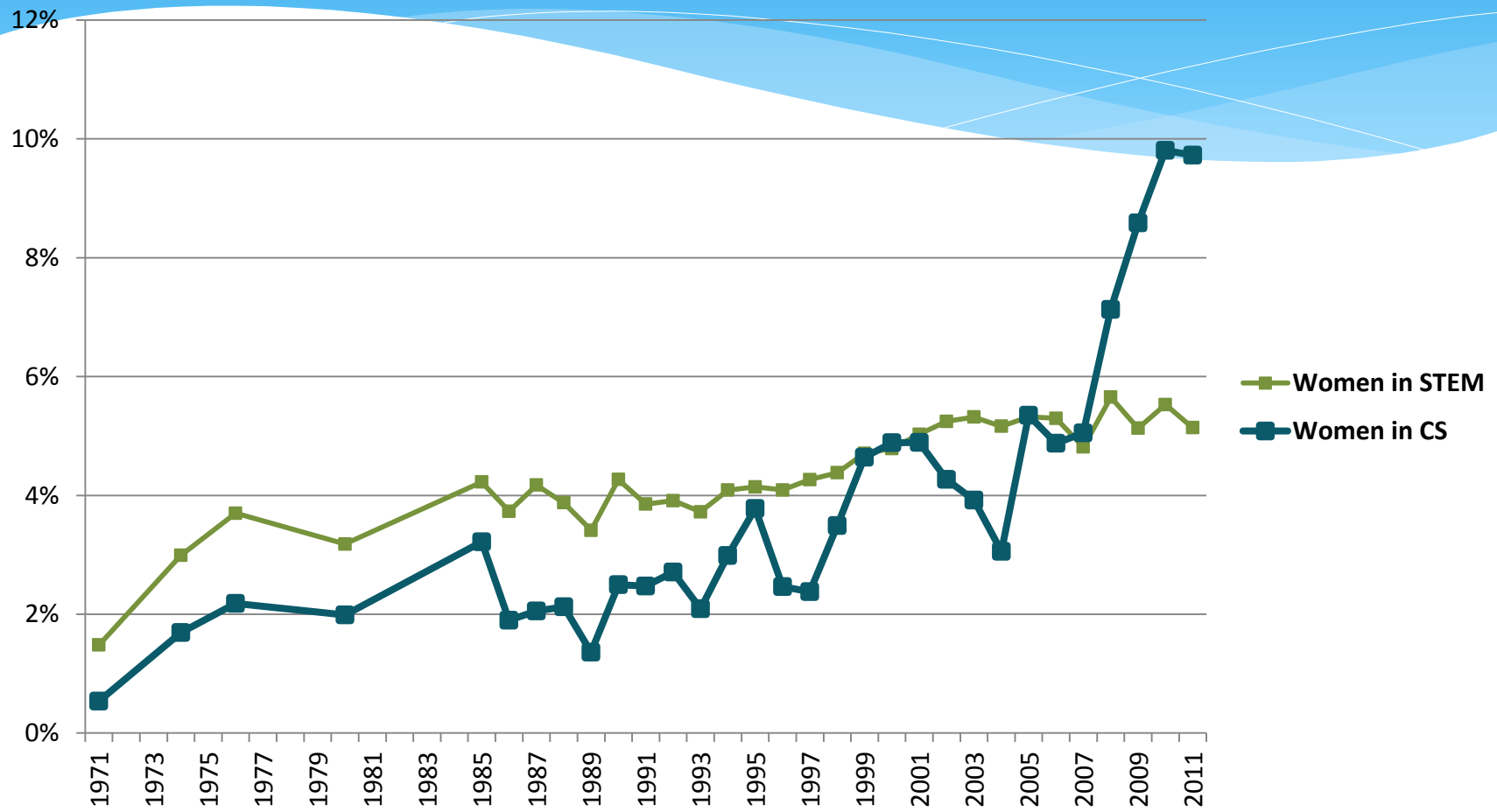
Self-Rating Artistic Ability (2011)
(% Indicating "Highest 10%")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Women's Self-Rating Artistic Ability (1971-2011)

(% Indicating "Highest 10%")

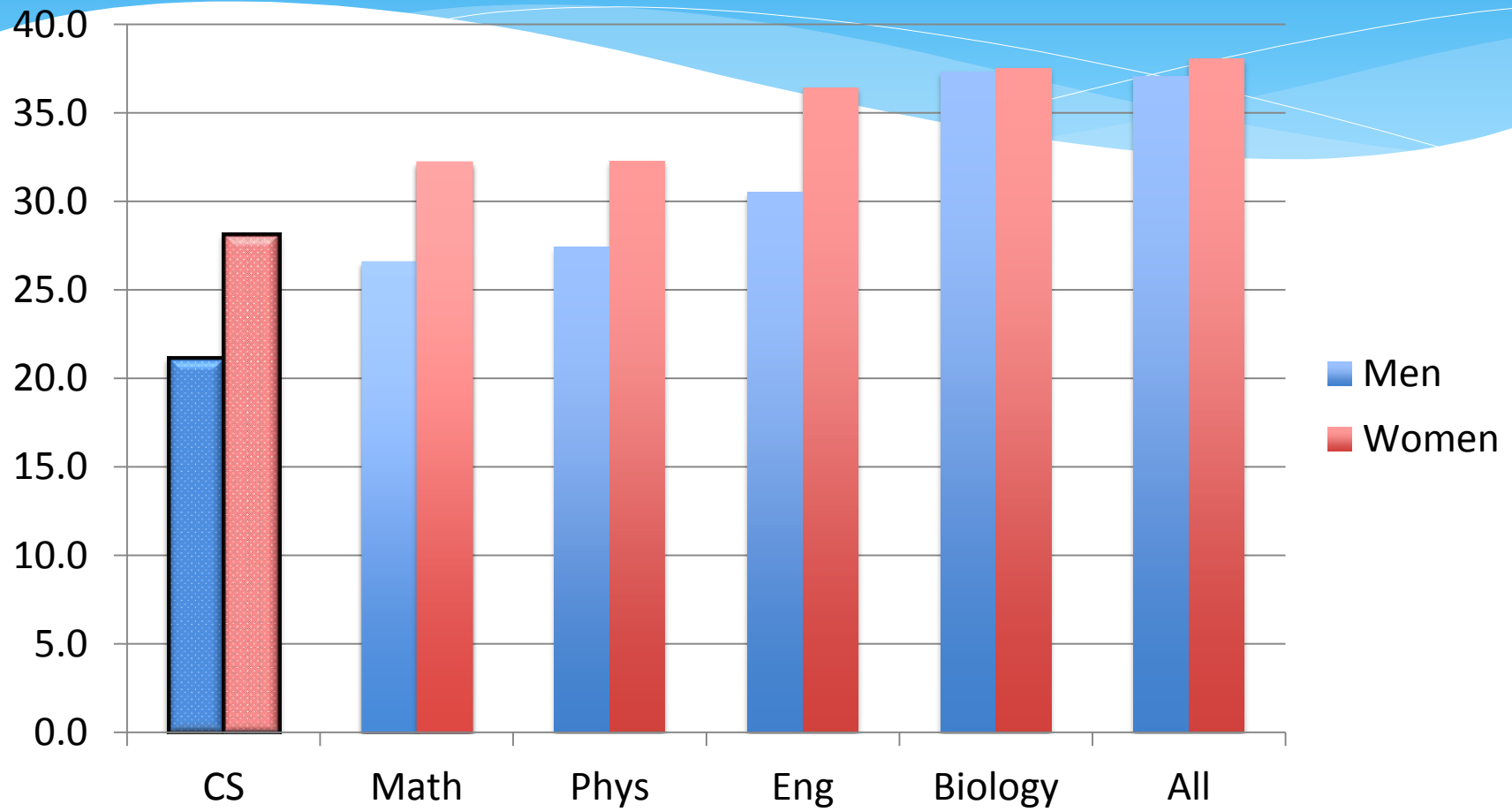


Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Key Findings: Community Orientation

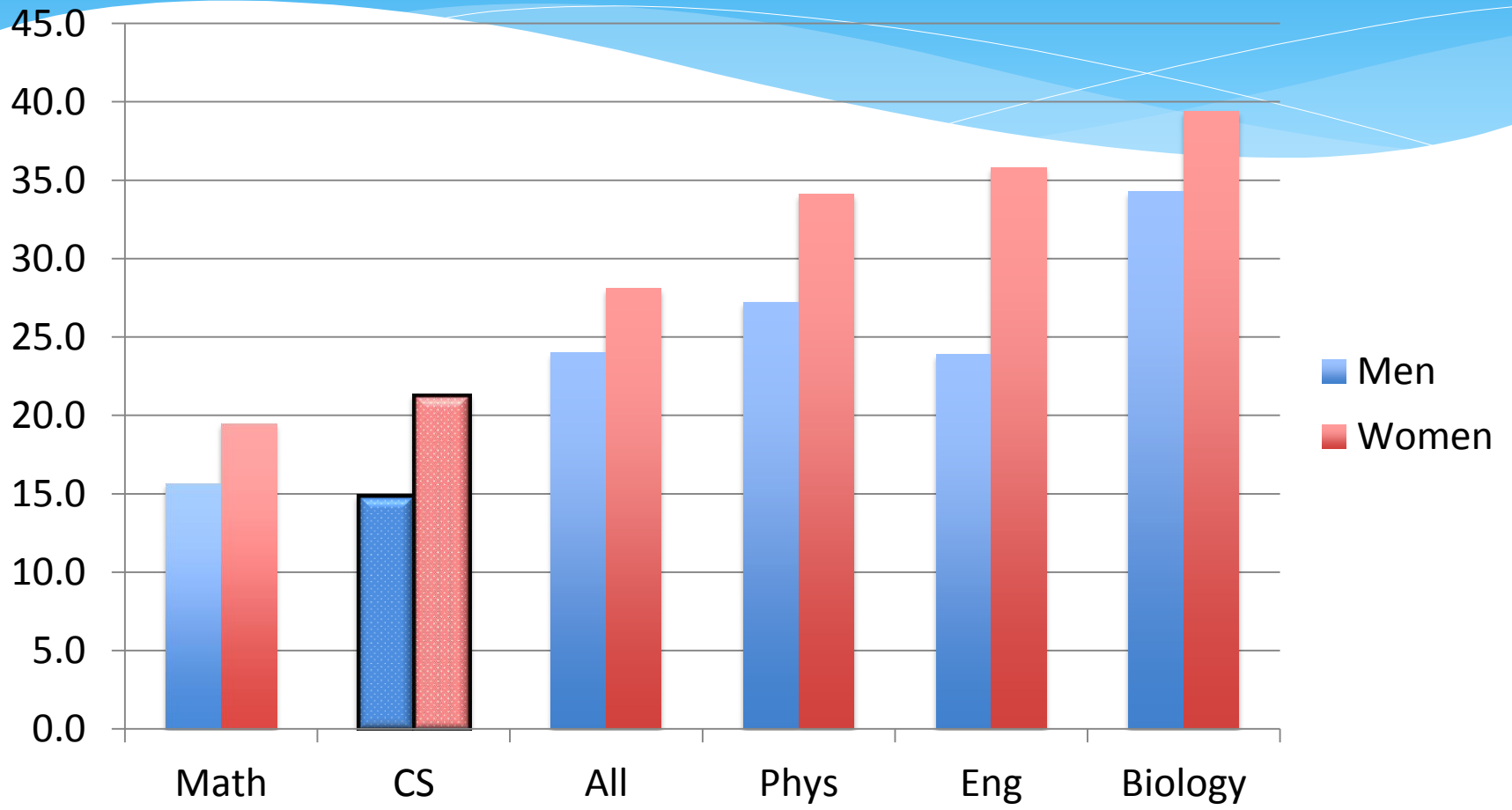
Goal: Become a Community Leader (2011)

(% Indicating "Essential" or "Very Important")



Goal: Become Involved in Environmental Programs (2011)

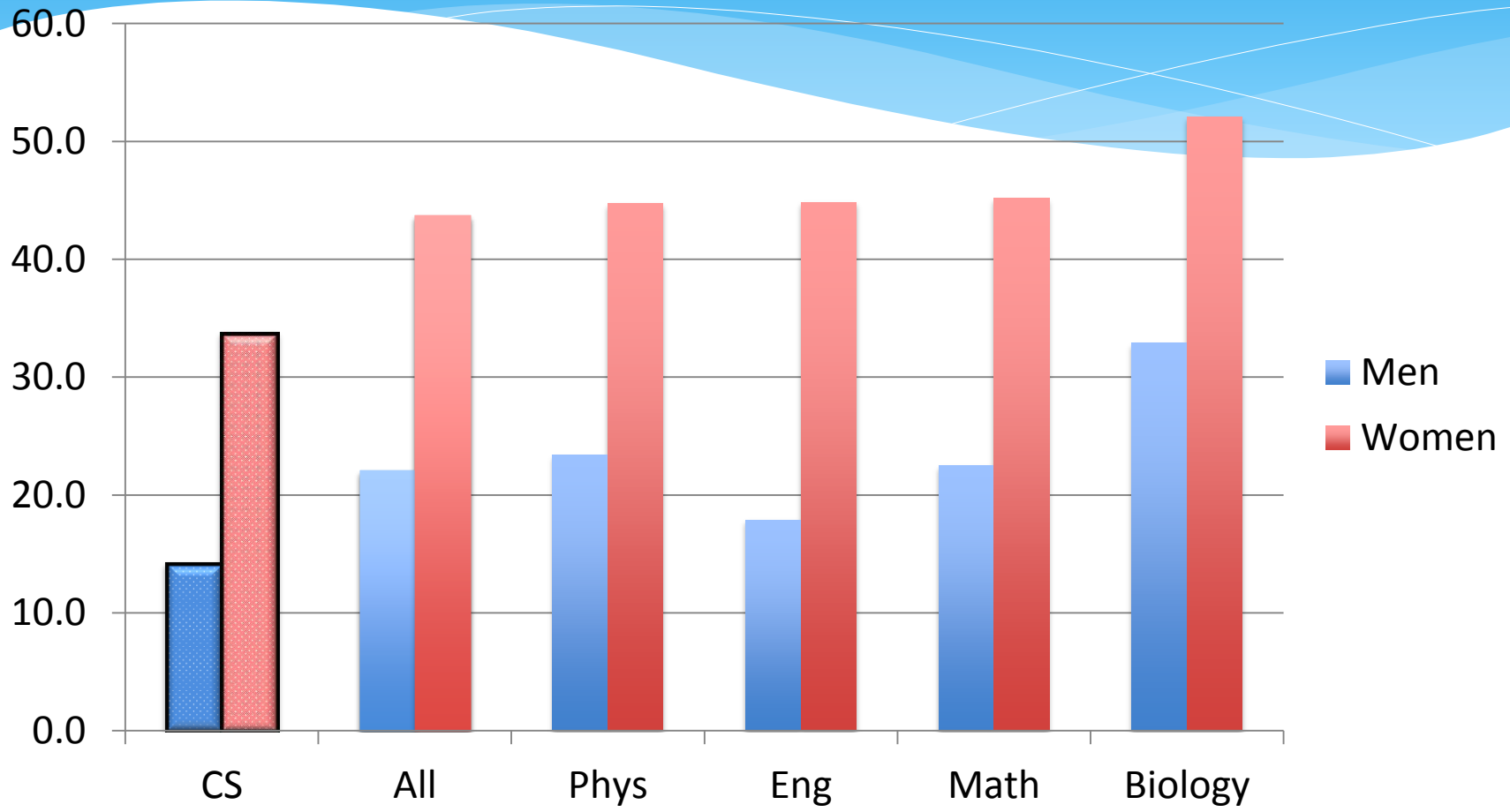
(% Indicating "Essential" or "Very Important")



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

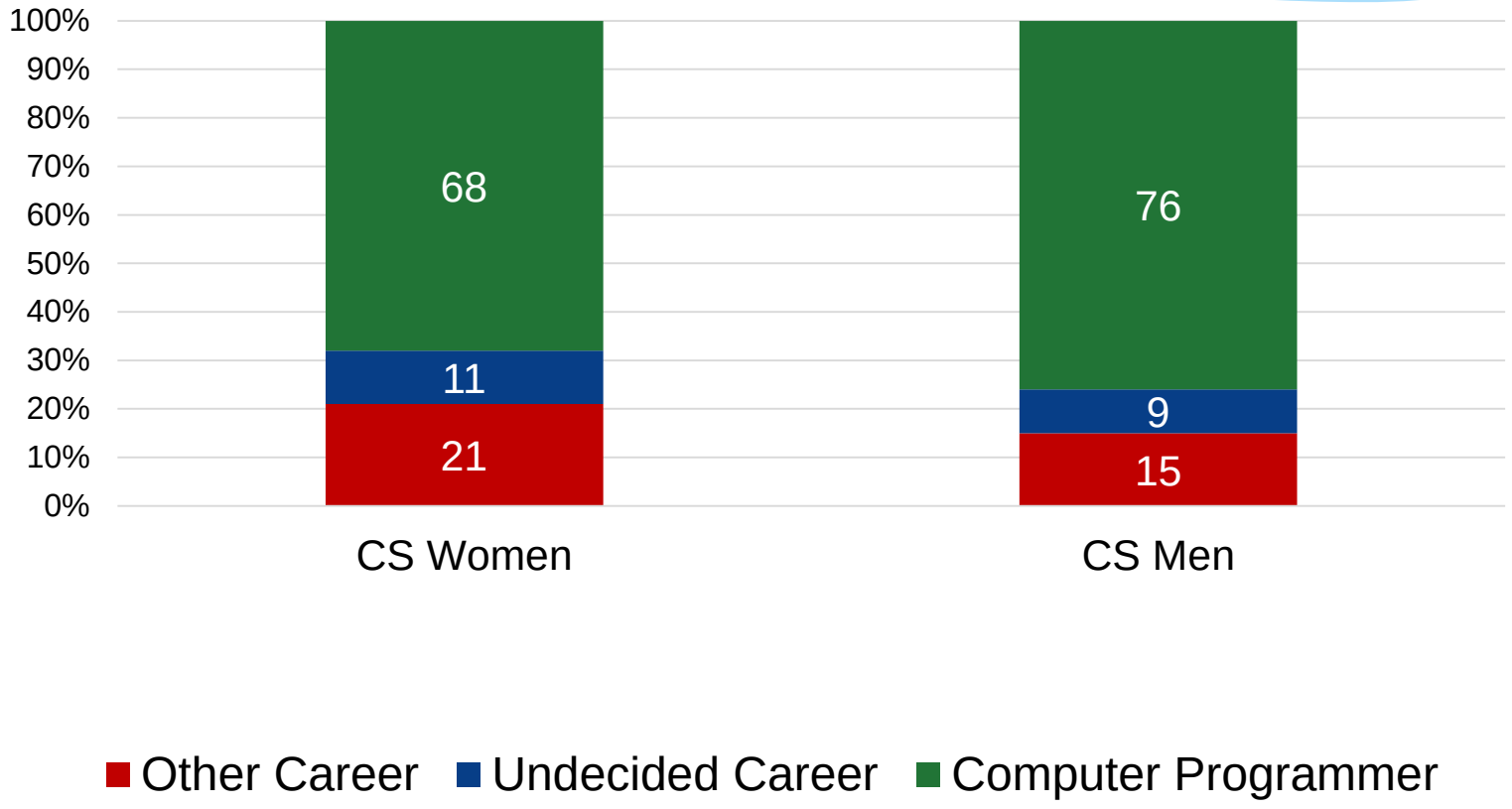
Will Participate in Community Service or Volunteer Work (2011)

(% Indicating "Very Good Chance")

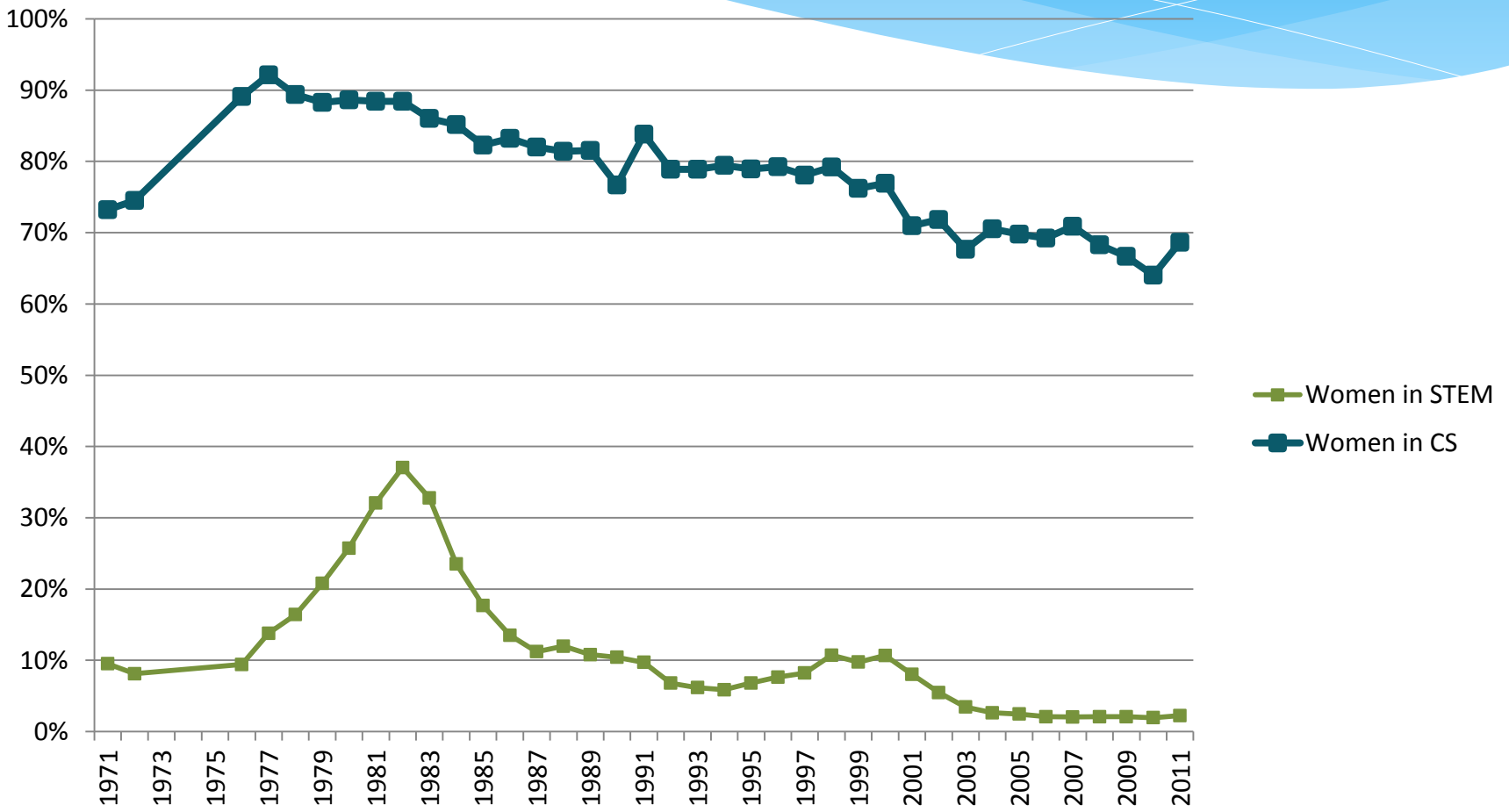


Key Findings: Career Aspirations

Career Aspirations of Male and Female CS Majors

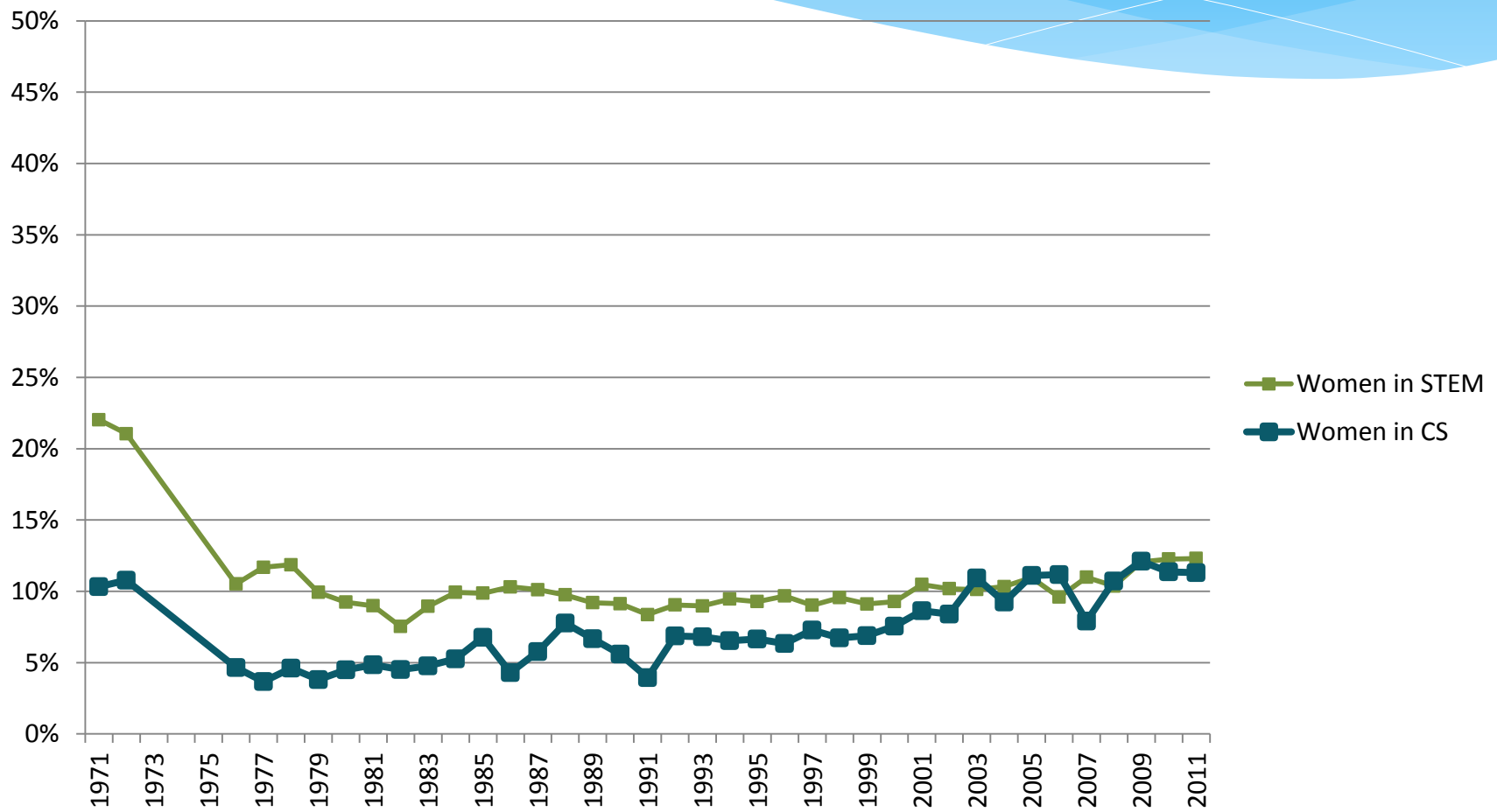


Proportion of Entering Female CS Majors Who Aspire to be Computer Programmers (1971-2011)



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Proportion of Entering Female CS Majors Who Are Undecided about their Career Aspirations (1971-2011)



Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Conclusion and Implications

- **CS tends to attract women who…**
  - Have low ratings of their emotional and physical health
    - Need to understand which comes first (Chicken-egg phenomenon)
  - Are less committed to serving communities
    - How to rebrand CS to emphasize impact on society?
  - Are increasingly creative and artistic
    - Do these women stay in CS and what do they do?
  - Not necessarily planning on careers as programmers
    - What happens to these career plans over time?

Next Steps…

* Examines strategies to promote gender and racial/ethnic diversity in undergraduate computing
  * Revamp intro courses
  * Promote interdisciplinary CS
  * Build community
  * K-12 outreach
* $2.3 million in research funding
  * National Science Foundation, the Anita Borg Institute , Google, Facebook, Microsoft, Intel, and the Computing Research Association
* Mixed-methods study:
  * Five-year longitudinal study of students taking introductory CS courses nationwide
  * Surveys of computer science faculty
  * Interviews with department chairs

BRAID

Building Recruiting And Inclusion for Diversity