



# **Multi-Disciplinary Pathways to Computing: A Scalable and Collaborative Approach to Capitalize on the Demand for Computer Science Education**

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# Computer Science Departments are Scaling - but its still not enough!

Despite strong growth in terms of faculty and enrollments, we are still not close to meeting demand for CS degree programs

Also unmet demand for education and training by non-CS students and people at all career stages

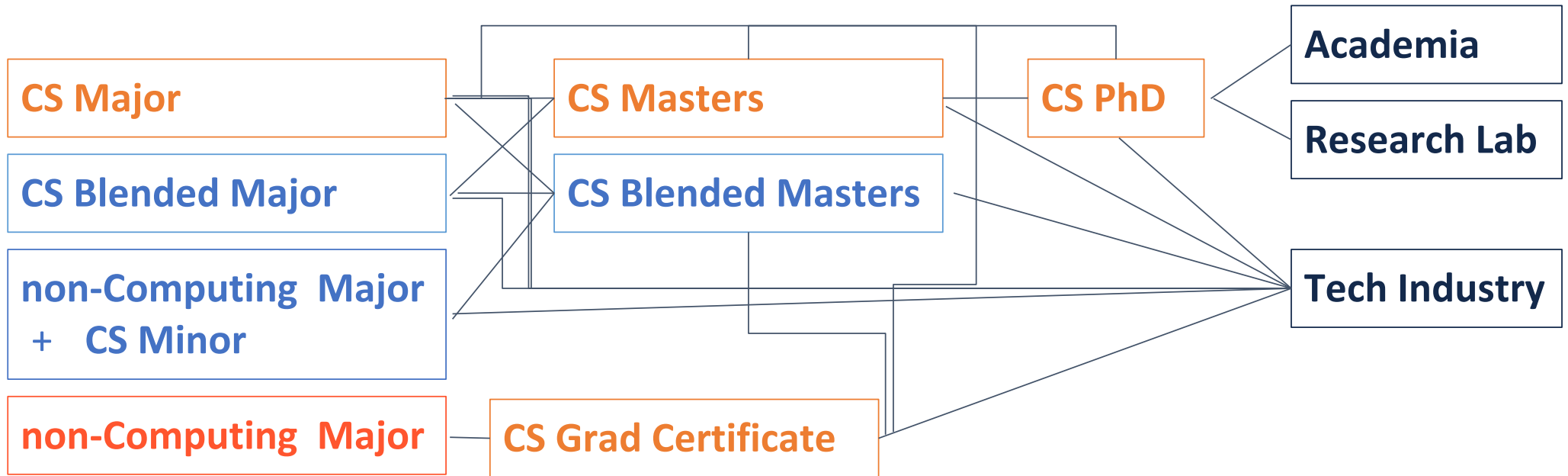
## At Illinois, just since 2019

- more 30% increase in undergraduate, research-based masters, and PhD enrollments
- more the 400% increase in professional Masters enrollments

## Still, applications through the roof

- Roughly 20% of campuses ugrad applications & 45% of engineering applications to CS
- Could have accepted 400% more applications without impacting quality

# Pathways to Computing: Multi-faceted & Multi-disciplinary



## CS + X Blended Degrees Enable Win-Win Partnerships

### Benefits for Computer Science

- Diversity of knowledge among students
- Enable CS to accommodate more students - CS + X students take fewer CS courses
- Campus supports CS growth as it enables more CS + X degrees
- Supports multidisciplinary activity

### Benefits for our Partners (X)

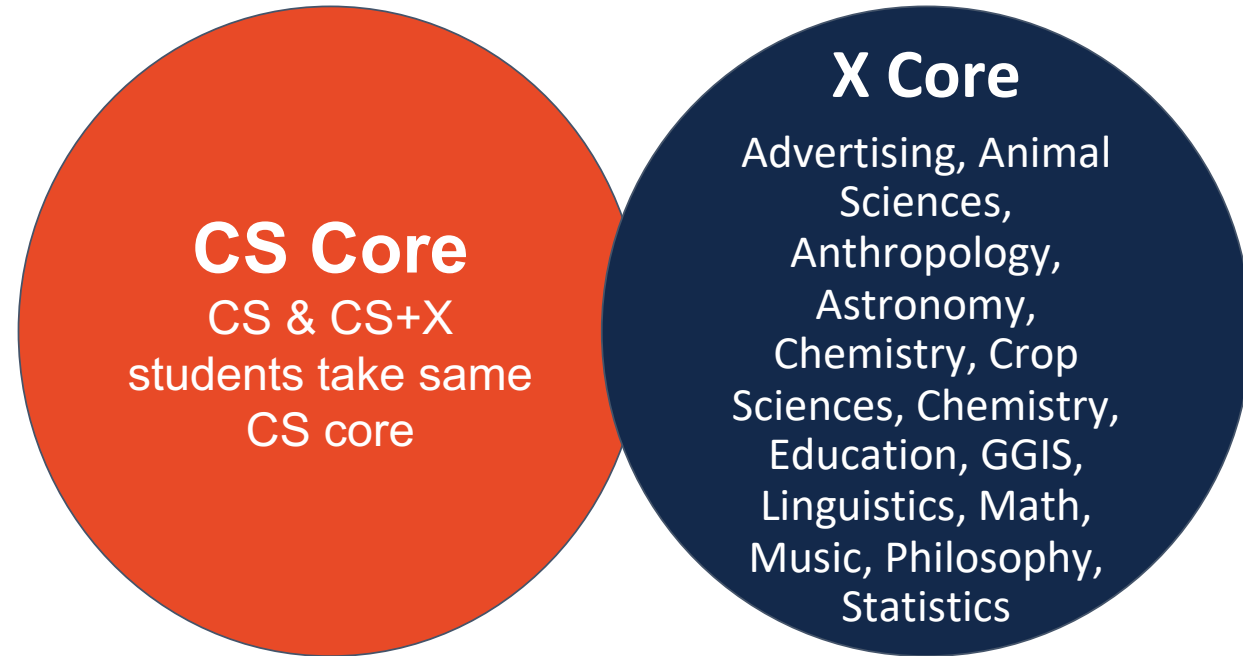
- Attract students and increase enrollments
- Supports growth in X
- Supports multidisciplinary activity

**Benefits for Students: flexible, enduring & highly marketable credential and skill set**

# CS + X Blended BS Degrees: Motivations & Philosophy



- **Today, Computing is ubiquitous and essential for everyone.**
- **Blended degrees:** CS + X students learn core concepts from both CS and X
  - not a minor, not a double major
  - students prepared for careers, including graduate study, in both CS and the X discipline
- **Intellectual diversity:** CS + X students bring diverse intellectual perspectives and enrich the classroom for everyone.

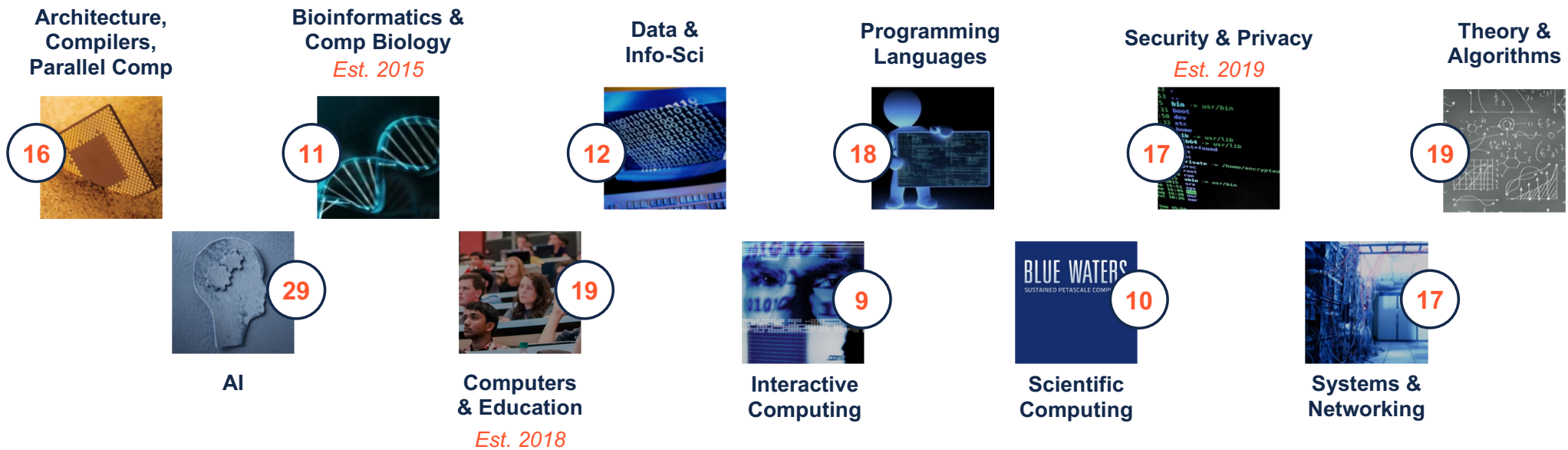


## CS + X Blended Degrees

# CS+X: Build on foundations of multi-disciplinary research



Illinois CS has longstanding and deep engagement with multidisciplinary research - these were bootstrapped into CS+X partnerships, and we hope new CS+X will spawn new ones



**#** Core CS faculty doing research in each area

**121** 121 Core Faculty:  
87 Tenure-Track  
23 Teaching  
11 Research

18 ACM Fellows  
20 ISEE Fellows  
47 NSF CAREERS

**64** 64 Affiliate faculty from 9 colleges across campus

# Timeline: Illinois CS Bachelor's Degree Programs

1964: Digital Computer Lab becomes the Department of Computer Science.

1965: Undergraduate degree program in Mathematics & CS established.

1972: First students begin coursework in the new CS – Engineering curriculum in the fall.

1988: Statistics & CS degree program established.

2014: First CS + X degrees launched in the College of LAS: CS+ Anthropology, CS + Astronomy, CS+ Chemistry, & CS+ Linguistics.

2018: CS + Economics, CS + Crop Sciences & CS + Music launch bringing in two new colleges.

2019: CS + GIS, CS + Advertising & CS + Philosophy launched

2021: CS + Animal Sciences launched

2023: CS + Education launched

202?: CS + Physics, CS + Bioengineering, CS + ???

1960

1970

1980

1990

2010

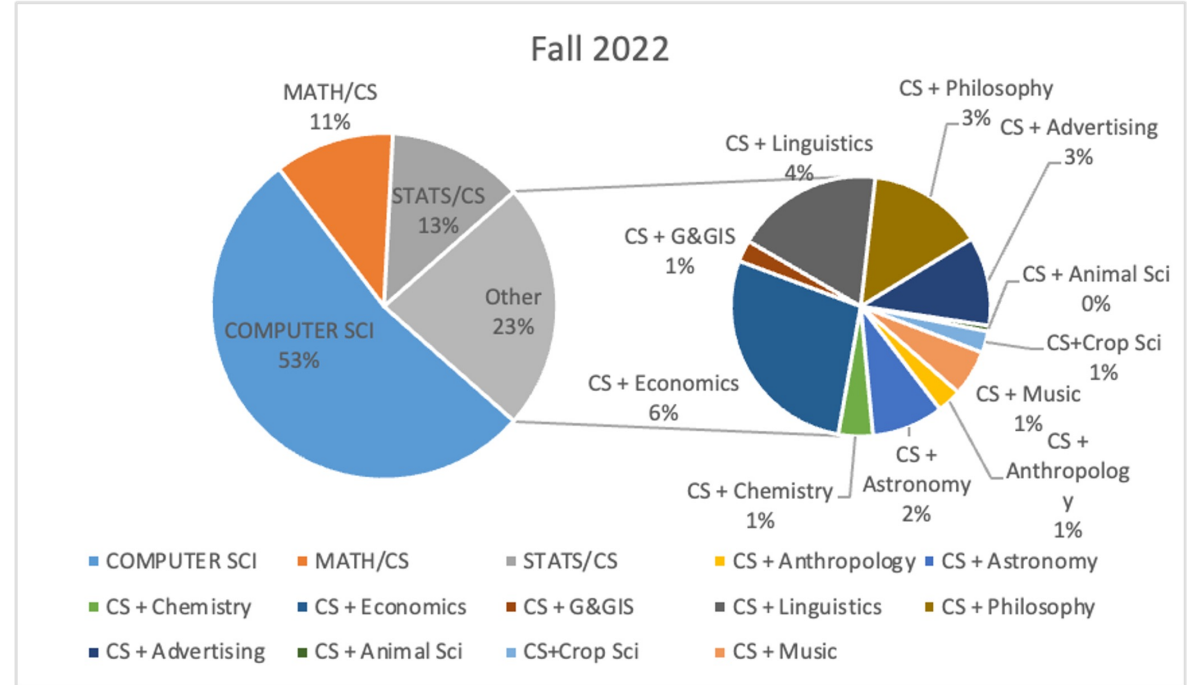
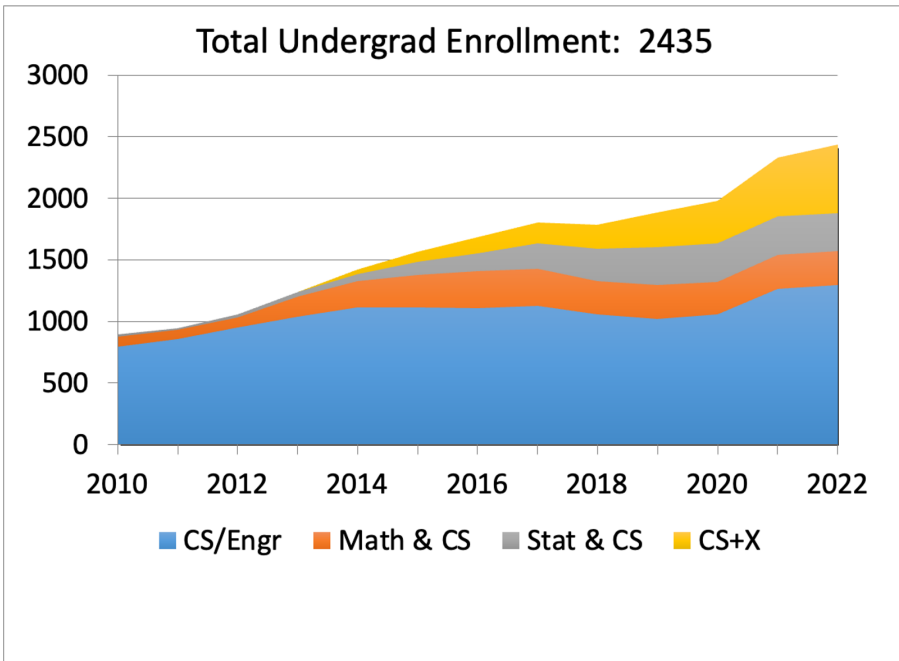
2020

2030





# Illinois CS + X By The Numbers



	Male	Female	URM
<b>CS Engineering</b>	67.13%	32.87%	8.10%
<b>Math &amp; CS, Stat &amp; CS</b>	82.94%	17.06%	1.72%
<b>CS+X</b>	70.13%	29.87%	3.22%



# X + Data Science Blended BS Degrees: <https://datascience.illinois.edu>

## New Series of Undergraduate Degrees that Combine Data Science with Other Disciplines

- Modeled after CS + X framework
- Core provided by CS, Statistics, Math, iSchool
- 4 so far & more coming (including engineering)

### College of Liberal Arts & Sciences

- **Astronomy + Data Science**

### Gies College of Business

- **Accountancy + Data Science**
- **Information Sciences + Data Science**

### iSchool

- **Information Sciences + Data Science**



**Applications Open Now for Fall 2023 Admissions**

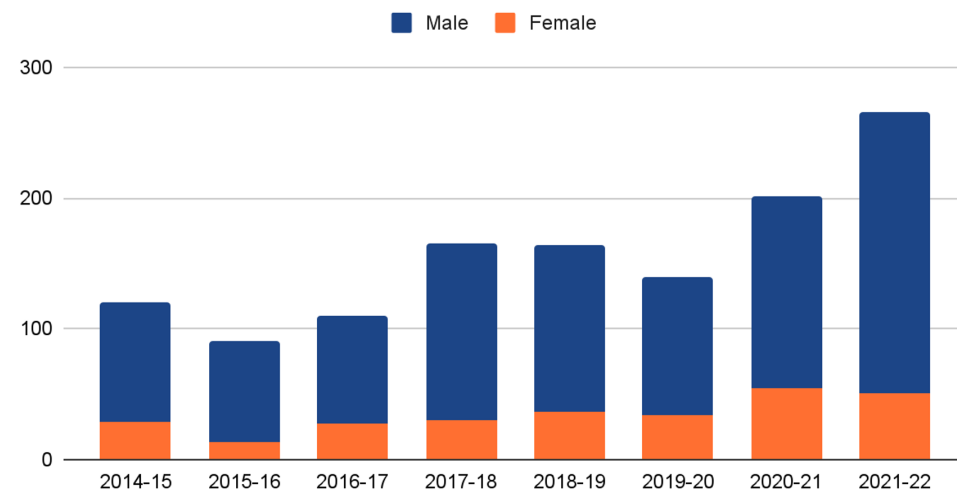
# Providing more options for non-CS students



## Pathway for every Illinois student to obtain computing education & later a degree

- CS Minor - really available for all:  
Since Fall 2020, we have provided capacity for all qualified undergraduates to complete a CS minor
  - Scaling core courses using innovative instruction technologies
- Pathway to CS Master's degree: Since Fall 2021, we have provided a performance-based pathway via a CS minor to our online MCS for all UIUC undergraduates

### CS Minors Completed - 2014-2021



# Pathways to CS for post-baccalaureate students



We must provide options for people who discover computing later in their studies and careers

- help build computing workforce
- crucial for equity & diversity

## iCAN (Illinois Computing Accelerator for Non-Specialists)

- 1-year (Fall, Spring, Summer) graduate certificate program in computing fundamentals, culminating with capstone in tech, research, or entrepreneurship
- Started online in 2020 with 5 students - now 32 students in 2022 Cohort
  - Fall 2022: 33% Women, ~50% non-STEM, 72% Illinois residents, and all ages - 60% in 20s, 21% in 30s and 19% are 40+
- Of 12 iCAN grads, 11 enrolled in our MCS and 1 has already graduated

**iCAN**  
ILLINOIS COMPUTING ACCELERATOR FOR NON-SPECIALISTS



# Masters – Non-traditional Delivery & Blended Degrees



## Professional Masters Degrees offered in many formats

- traditional full-time residential program
- part-time program, offered online - highly accessible to students worldwide
- part-time in person program offered in urban centers – attractive to underserved populations

## Blended Masters Degrees with Computing Focus

- extend the blended degree program philosophy to the graduate level
- provide additional entry points to computing education
- seed new research collaborations

## At Illinois, we have/are adding

- **online MCS:** delivered on Coursera platform, 1200+ students
- **MCS in Chicago:** starting in January 2023, motivated by high-demand and desire to reach new populations
- **Master of Engineering in Digital Agriculture:** Blended degree motivated by new research focus
- **Master of Engineering in Autonomy & Robotics:** Blended degree to support expanded research activity in this space
- **And many more under consideration....**

# Educational Technologies are essential for Effective Teaching at



## Grading: Autograders & tools supporting manual grading

- to provide fair, consistent, and quick feedback
- Allowing students to get feedback online ensure more students see feedback/grades

## Support for flexible exam scheduling

- Large classes need tests to be scheduled at different times to support unexpected emergencies
- Offering multiple tests helps with logistics of finding a large room

## Randomization in question generation

- To ensure the integrity of tests administered to students at different times

## At Illinois, we have developed

- **Computer-Based Testing Facility:** Used across campus & online
  - Under consideration at Berkeley
- **Prairie Learn:** Open-source platform for mastery-based learning with support for randomization in questions and auto-grading
  - Used at Berkeley, Maryland, UBC
- **Relate:** Open-source environment for authorship of course content with interspersed and interactive assessment support
- **Queue:** Online queueing system to manage office hours

**Large classes require large course staffs that need to be managed - a new phenomenon for CS**

**Training staff:** Graduate and undergraduate students on a course staff need to be trained on

- best practices in pedagogy
- educational technologies
- building an inclusive learning environment
- ethical standards that need to be followed

**Managing course staff:** Large course staff needs to be organized, giving more administrative responsibilities to senior course staff

**At Illinois, we have added specialized educational IT staff to**

- **Develop:** Create and maintain educational technologies
- **Advise & Train:** Advise faculty and train course staff
- **Operational Resilience & Agility:** We started before pandemic, but proved to be crucial to maintaining agile operations

# Multi-faceted & Multi-disciplinary Pathways to Computing

## – The Way Forward



**It is imperative both for CS and for other disciplines, and indeed society as a whole, that all institutions**

- grow multidisciplinary educational partnerships across campus
- provide multiple pathways to computing that support students, and at all levels



**At Illinois, supporting many pathways to computing allows us to deliver on both**

- our imperative to expand the frontier of research & education Innovation
- our land grant mission of providing accessible opportunities to all