Taking Computing+Data Wide Across the Curriculum: The Illinois CS+X Programs

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University of Illinois

Truth in advertising disclosure...
Some Context Setting…

- Apologies in advance for schizophrenic pronouns
  - “Our”, “We”, “My”, etc
  - All should de-reference to Illinois

- Chronology
  - Core of this talk is a 2017 “How We Did It” overview
  - Updates from 2019 included herein
Yes, They Are Coming In Front Door…

- At Illinois, this is the CS major in Engineering

![Graph showing percentage of Freshman Applications Fa16 by ENGIN Major UIUC for various majors including CS, ECE, MechSE, Aero, Civil, Undec, BioE, MatSci, Phy, ISE, and NPRE from 2008 to 2016.](image)

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1.0 Oh, it’s just like the *Internet Bubble*, again.
1.1 Oh, well, here’s a few more TAs.
1.2 Oh, well, here’s a few more faculty lines.
2.0 Uh oh...
The Wave Keeps Growing

Illinois CS Majors

~ Illinois CS Class Seats

Instructional Units ‘15-16

½ CS Majors
¼ Engineers
¼ Everybody Else
Response the First: Go Deep

Add ...
More Teaching Staff
More TAs
More Undergrads
More Classes
More Seats/Sections
More Faculty...
Response the First: Go Deep

Necessary

But...

Not sufficient
“It’s technology married with liberal arts, married with the humanities, that yields the results that make our heart sing.”

Steve Jobs
Wider Response: Become a Hub For...

Compute + Data

- Science
- Business/Law
- Health, Med
- Humanities
- Social Sci
- Art/Design
- Societal
Our Response: Illinois CS+X Degrees

- They are **not**: Minor in CS/X. Dual degree.
- They are: \[ \text{CS}(1/2) + \text{X}(1/2) = \text{Bachelors Degree in X} \]
Illinois CS+X: Why Go WIDE?

Positive pressure

Negative pressure

The data deluge

The Morbid Fascination With the Death of the Humanities

Should Colleges Let Ailing Majors Die or Revamp Them?

By Bianca Quillantan | MAY 20, 2018

Morgan Wessel (center) is a sophomore in the combined computer science and linguistics program at the U. of Illinois at Urbana-Champaign. The major was developed in part by Leonard Pitt (left), a computer scientist at Illinois, and Roxana Girju (right), a linguist there.

When majors aren’t thriving, you can soup them up or let them go. Both tactics are complicated, and neither carries a guarantee. But, say administrators, doing nothing is not an option.

"The University of Illinois at Urbana-Champaign is updating and reinvigorating a number of traditional majors by combining them with computer science. The reasoning is that liberal-arts, arts, and agricultural fields increasingly encompass data analysis that requires computer-science skills.”

The Chronicle of Higher Education
Credit for Coinage: Alfred Spector

- Alfred Spector, former VP Research Google, coined name “CS+X” around 2004
- Name widely circulated in Xconomy blog post Jan 12

In Feb 12, I bought all the csplusx.*** domain names...
CS + X Degree Programs

Always at the forefront of computer science education, the University of Illinois has designed a new degree option, called CS + X, that allows students to pursue a flexible program of study incorporating a strong grounding in computer science with technical or professional training in the arts and sciences.

Computing is ubiquitous, with application areas in virtually any field imaginable – from developing gene-sequencing algorithms, to designing methods for high frequency trading, creating computer-generated graphics and special effects, analyzing social data from internet communications, and creating embedded real-time systems for medical devices.

In fact, according to the National Science Foundation, "[w]nowledge of computer science and computer programming is becoming a necessary skill, in marketing, advertising, journalism, and the creative arts."

After earning their CS + X degrees, our graduates are poised to launch their careers or pursue graduate studies in a wide variety of fields.
CS+X pilot to be discontinued end of spring quarter

Currently declared CS+X students and those who declare by the end of spring quarter, will have the opportunity to complete the joint major.

BY JOY LEIGHTON
Stanford Schools of Engineering and Humanities and Sciences have announced that they will not renew the CS+X Joint Major Program (JMP), which was approved by the Faculty Senate in 2014 and began as an experimental pilot program in fall quarter that year.

The decision was presented to the Committee on Undergraduate Studies and Policies (CUSP) on January 22 by Susan Weersing, associate dean for graduate and undergraduate studies in the School of Humanities and Sciences. The School of Engineering presented their decision to CUSP in fall 2018.

All currently declared CS+X students have the opportunity to complete their joint major. Students who plan to declare the CS+X joint major must do so by June 18, 2019, which is the end of spring quarter. After that date, no new joint major declarations will be approved.
Illinois **CS+X**: Portfolio

**CS+Math**

**CS+Statistics**

Legacy degrees, decades old

**CS+Anthropology**

**CS+Chemistry**

**CS+Astronomy**

**CS+Linguistics**

Design started in 2010, approved 2013, admits 2014

- Fresh admit 2017
- Soph admit 2016
- Junior admit 2015
- Senior admit 2014

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# Creating and Eliminating Degree Programs

<table>
<thead>
<tr>
<th>Program Change</th>
<th>Level</th>
<th>College</th>
<th>Grad College</th>
<th>Provost Office</th>
<th>Ed Pol</th>
<th>UIUC Senate</th>
<th>Senates Conf.</th>
<th>BOT</th>
<th>IBHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Creation or elimination of a non-credit program or a program of study</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>composed of credit courses that does not result in the formal award of a</td>
<td>Grad</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>degree (e.g., certificates of completion, professional development sequences,</td>
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<td>etc. that do no appear on students’ transcripts).</td>
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<tr>
<td>2. Addition or elimination of a concentration within an existing major or</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td>List</td>
</tr>
<tr>
<td>degree program.</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td>List</td>
</tr>
<tr>
<td>Addition or elimination of an organized set of courses within a major (e.g.,</td>
<td>Grad</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td>Report</td>
<td>List</td>
</tr>
<tr>
<td>option, specialization, or sequence) to an existing degree program.</td>
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<tr>
<td>3. Creation or elimination of a minor.</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td></td>
</tr>
<tr>
<td>4. Creation or elimination of a certificate program (as defined by IPEDS) in</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td>List</td>
</tr>
<tr>
<td>a field in which there is a previously approved degree program.</td>
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<tr>
<td>5. Creation or elimination of a certificate program (as defined by IPEDS) in</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td>RME</td>
</tr>
<tr>
<td>a field or at a level in which there is not a previously approved degree</td>
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<tr>
<td>program at that level or higher level.</td>
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<tr>
<td>6. Creation or elimination of a program that results from the reorganization</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Action</td>
<td>✓</td>
<td>Action</td>
<td>RME</td>
</tr>
<tr>
<td>or restructuring of the curricular elements of an existing program that</td>
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<tr>
<td>have over time evolved into separate and distinct programs (e.g., split into</td>
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<tr>
<td>two or options have evolved into separate programs).</td>
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</tr>
<tr>
<td>7. Creation of a degree program (excluding certificate programs) in a new</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Action</td>
<td>✓</td>
<td>Action</td>
<td>Action</td>
</tr>
<tr>
<td>field or at a new level (based on CIPS or IPEDS definitions).</td>
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<tr>
<td>8. Elimination of an existing degree program.</td>
<td>All</td>
<td>✓</td>
<td>*</td>
<td>✓</td>
<td>✓</td>
<td>Action</td>
<td>✓</td>
<td>Action</td>
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# Revising Degree Programs

<table>
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<tr>
<th>Program Change</th>
<th>Level</th>
<th>College</th>
<th>Grad College</th>
<th>Provost Office</th>
<th>Ed Pol</th>
<th>UIUC Senate</th>
<th>Senates Conf.</th>
<th>BOT</th>
<th>IBHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Minor revision of existing degree programs (i.e., minor changes that do</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>not affect the number of hours needed for graduation such as the mix of</td>
<td>Grad</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>required/elective courses, minor changes in the list of specifically required</td>
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<tr>
<td>courses, etc.)</td>
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<td></td>
</tr>
<tr>
<td>10. Substantial revisions of existing degree programs.</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
<td></td>
</tr>
</tbody>
</table>
CS+X: Design Principles

- TTM matters
  - Optimize design to get approvals fast

- Minimum viable degree
  - Same set of CS courses for all X’s

- First pitch: Just like Sand Hill Road
  - 15mins: value prop, team, $$, upside

- Need ”early adopter” customers
  - Find partner X’s and faculty inside X who really, really want CS+X

- Need a business model early
  - CS+X is like ENG: tuition differential is paid. We split it (ENG && College[X]).
Synopsis of Proposal

- A new BS degree in LAS: CS+X
- 3 intellectual components
  - Foundation in LAS GenEd
  - Foundation in CS
  - Depth in LAS areas (the “X”)
- Business model
  - CS+X tuition includes the engineering surcharge
  - LAS + COE split this
  - Net new $ into both COE+LAS

Mechanics: Proposed Starting Point for CS+LAS

I. LAS REQ’S: up to 47 hours
   - Gen-Ed (24), Foreign Lang (0-16), Rhet (0-4), Adv. Comp (0-3)
II. MATH REQ’S: 12 hours
   - Calc I, II, linear algebra (2), prob/stat (3)
III. CS CORE REQ’S: 30 hours
   - CS 125,173, 225, 231, 241, 242, 237, 373, 421, 473
IV. NON-CS UPPER LEVEL REQ’S: 21-24 hours of X
   - a minor, or coherent collection of courses
   - a course integrating CS, X (could be indep. study)

TOTAL HOURS = 120 for degree
To first order, same CS courses in
- Intro Programming
- Software Programming Studio
- Discrete Math
- Prob/Stat for CS
- Data Structures
- Systems Programming
- Digital Design & Architecture
- Programming Languages
- Algorithms
- …getting CS faculty buy-in on this “spanning basis” is critical

Basic philosophy: Get solid foundation of CS “stuff” across theory, software, hardware → go do “X”
Q: Are you *really* making anthropologists take Comp Arch?

A: YES

Unexpected response: Leadership in Liberal Arts very positive that the CS part of CS+X not watered down to accommodate their students. Selling point for them.
2019: CS side of CS+X Refined...

- Not all exactly the same, but pretty close...
- Interestingly
  - Anthro kids still taking CompArch
  - Advertising kids are not...
Illinois CS+X: Traction (~2016)

- **Anthropology**: ~11% Of students
- **Astronomy**: ~25% Of students
- **Linguistics**: ~28% Of students
- **Statistics**: ~36% Of students
Illinois CS+X: ‘16 Course Demand Examples

Introductory

CS Data Structures
Enrollment 2016

Advanced

CS Databases

CS Datamining
- CS+X approaching **30%** of all CS
- CS+X approaching **50%** of admitted Freshman ‘16 class
- CS+X new degrees now **28%** female
... created more demand
Huge interest to be “next X” at Illinois

Next 5 X’s -- approved by CS & “X” Units

In discussion

11 More X’s
# Illinois CS+X: 2019 Numbers

## Spring 2019 Enrollments

<table>
<thead>
<tr>
<th>Program</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>973</td>
</tr>
<tr>
<td>Five Year BS/MS</td>
<td>19 / 5</td>
</tr>
<tr>
<td>Five Year BS/MCS</td>
<td>26 / 34</td>
</tr>
<tr>
<td>Mathematics &amp; Computer Science</td>
<td>265</td>
</tr>
<tr>
<td>Statistics &amp; Computer Science</td>
<td>260</td>
</tr>
<tr>
<td>CS + Advertising</td>
<td>1</td>
</tr>
<tr>
<td>CS + Anthropology</td>
<td>33</td>
</tr>
<tr>
<td>CS + Astronomy</td>
<td>40</td>
</tr>
<tr>
<td>CS + Chemistry</td>
<td>35</td>
</tr>
<tr>
<td>CS + Crop Sciences</td>
<td>5</td>
</tr>
<tr>
<td>CS + Economics</td>
<td>10</td>
</tr>
<tr>
<td>CS + Geography and GIS</td>
<td>1</td>
</tr>
<tr>
<td>CS + Linguistics</td>
<td>71</td>
</tr>
<tr>
<td>CS + Music</td>
<td>1</td>
</tr>
<tr>
<td>MCS</td>
<td>77</td>
</tr>
<tr>
<td>Online MCS / MCS in Data Science</td>
<td>716</td>
</tr>
<tr>
<td>MS</td>
<td>115</td>
</tr>
<tr>
<td>MS in Bioinformatics</td>
<td>7</td>
</tr>
<tr>
<td>PhD</td>
<td>324</td>
</tr>
<tr>
<td><strong>Total Undergraduate Enrollment</strong></td>
<td>1,740</td>
</tr>
<tr>
<td><strong>Total Graduate Enrollment</strong></td>
<td>1,286</td>
</tr>
</tbody>
</table>

**Legacy** Since 2013

**New in the last 12-24mo**
## Crop Sciences Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC 112</td>
<td>Introduction to Crop Sciences</td>
</tr>
<tr>
<td>CPSC 226</td>
<td>Introduction to Weed Science</td>
</tr>
<tr>
<td>CPSC 270</td>
<td>Applied Entomology</td>
</tr>
<tr>
<td>PLPA 204</td>
<td>Introductory Plant Pathology</td>
</tr>
<tr>
<td>CPSC XXX</td>
<td>New Course- Data in Bio &amp; Agric</td>
</tr>
<tr>
<td>CPSC 261</td>
<td>Biotechnology in Agriculture</td>
</tr>
<tr>
<td>CPSC 265</td>
<td>Genetic Engineering Lab</td>
</tr>
<tr>
<td>CPSC 352</td>
<td>Plant Genetics</td>
</tr>
<tr>
<td>CPSC 440</td>
<td>Applied Stats Methods I</td>
</tr>
</tbody>
</table>

Select two of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSC 418</td>
<td>Crop Growth and Management</td>
</tr>
<tr>
<td>CPSC 452</td>
<td>Advanced Plant Genetics</td>
</tr>
<tr>
<td>CPSC 453</td>
<td>Principles of Plant Breeding</td>
</tr>
<tr>
<td>CPSC 466</td>
<td>Genomics for Plant Improvement</td>
</tr>
<tr>
<td>CPSC 498</td>
<td>Crop Sci Professional Develpmnt</td>
</tr>
</tbody>
</table>
Technology in the agricultural industry continues to expand, and with it, the demand for employees prepared to work for agricultural companies. In an effort to build a talent pipeline, The Climate Corporation (Climate), a subsidiary of Bayer, made a $500,000 investment in a new major at the University of Illinois.

Leading the digital agriculture revolution, the Department of computer Science and Department of Crop Sciences last year launched the first-of-its-kind major combining computer science and crop sciences.

Climate’s gift, which will provide scholarships to students in the new program, stretches over a five-year period and aims to help it grow.

Assistant Professor Nico Martin, part of the Crop Sciences faculty, works with a student to analyze data.
CS+X Convos: Where in the Stack

The full “stack”

- data / social
- people & uix
- applications
- software
- architecture
- circuits
- transistors
- physics

CS+X STEM

CS+X Non-STEM

Reminder: these are intentional engineered decisions for best CS+X curriculum “fit”
Summary:  **Wide** (and **Deep**)

- **Go WIDE:**
  - Fish labeled with "+X"

- **Go DEEP:** For CS Majors
  - Large fish with red circle and "+X" label