Taking Computing+Data Wide Across the Curriculum: The Illinois CS+X and MCS-DS Degree Programs

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University of Illinois
Yes, They Are Coming In Front Door...

- At Illinois, this is the CS major in Engineering

%Freshman Applications Fa16 by ENGIN Major UIUC
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**

**α Illinois CS Class Seats**

- Math
- CS
- Chem
- ECE
- Econ
- Physics

- ½ CS Majors
- ¼ Engineers
- ¼ Everybody Else

Instructional Units ‘15-16
Wave Creates Novel Side-Effects

- CS tenure track faculty teaching at maximum intensity in Engineering

CS
Physics
ECE
MechSE
IESE
MatSE
CEE
Aero
NPRE
BioE

Engineering IUs/Faculty AY14-15
Response the First: Go Deep

Add ...
More Teaching Staff
More TAs
More UG graders/asst
More Classes
More Seats/Sections
More Faculty...
decanal, adj.

View as: Outline | Full entry

Quotations: Show all | Hide all

Keywords: On | Off

Pronunciation: /ˈdrɪˌkɛnəl/

Frequency (in current use): 

Etymology: < Latin decānus DEAN n. + -AL suffix.

1. Of or pertaining to a dean or deanery.

1707 London Gaz. No. 4386/3 Libraries of 3 degrees, viz. General, Decanal or Lending, and Parochial.

1862 Sat. Rev. 14 705/2 The specially Decanal virtues.

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...

- **Science**
- **Business/Law**
- **Health, Med**
- **Societal**
- **Social Sci**
- **Art/Design**
- **Humanities**
- They are *not*: Minor in CS/X. Dual degree.
- They are: \(\text{CS}(1/2) + \text{X}(1/2) = \text{Bachelors in Dept of +X}\)

**Diagram:**

- **Computer Science** + **Discipline “X”** = **CS + “X”**

  - *Same CS core classes for all +X*
Positive pressure

Negative pressure

The data deluge

The Morbid Fascination With the Death of the Humanities

Why professors, librarians, and politicians are shunning liberal arts in the name of STEM

CS + X, for all X

Opinion

Alfred Spector
January 18th, 2012

The impact of information-based technologies will continue to grow—probably at an accelerating rate. In nearly every segment of society, we see both quality and productivity improvements because of increased use of automation and digital communication. The impact is obviously huge in some sectors such as finance and publishing. And it will only grow in the laggards, such as education and healthcare, despite the immense challenges due to inertia, privacy, and access.

In Feb 12, I bought all the csplusx.*** domain names...

Name widely circulated in Xconomy blog post Jan 12

Alfred Spector, former VP Research Google, coined name “CS+X” around 2004
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, "(K)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 degree, our graduates are poised to launch their career or pursue graduate studies in a wide variety of fields.
Joint Majors: CS+X

An experiment in learning, known informally as "CS+X", is providing students with unique educational experiences to pursue a new Joint Major in computer science and a number of disciplines at Stanford. The chance to become a new type of era requires the potential strength of this new educational initiative. The department is jointly ranked as the nation's strongest in the top 10 Humanities cluster is ranked as No.1 in the world in the 21st century. Intersecting opposites create altered perspectives, fresh and new ideas and analytic robustness by acquiring skills in separate but related fields, the imagination while literature, philosophy and language inTEGRATE into computer science. The new Joint Major degrees, which will lead to conferral of a degree, is the keynote of the Joint Major is integrative learning. These degrees will lead to mastery in two fields by blending the vibrant inter
Legacy degrees, decades old

Design started in 2010, approved 2013, admits 2014
Levels of Governance for Program and Curricular Changes
University of Illinois at Urbana-Champaign

<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>Senators Conf.</th>
<th>BOT</th>
<th>IBHE</th>
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<tr>
<td><strong>Creating and Eliminating Degree Programs</strong></td>
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<tr>
<td>1. Creation or elimination of a non-credit program or a program of study</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
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<td>composed of credit courses that does not result in the formal award of a degree</td>
<td>Grad</td>
<td>✓</td>
<td>✓</td>
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<td>(e.g., certificates of completion, professional development sequences, etc. that</td>
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<td>do no appear on students’ transcripts).&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>2. Addition or elimination of a concentration within an existing major or</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
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<td>Consent</td>
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<td>Report List</td>
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<td>degree program.</td>
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<td>✓</td>
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<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>Consent</td>
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<td>Report List</td>
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<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>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report</td>
</tr>
<tr>
<td>4. Creation or elimination of a certificate program (as defined by IPEDS&lt;sup&gt;3&lt;/sup&gt;) in a field in which there is a previously approved degree program.</td>
<td>All</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>Consent</td>
<td>✓</td>
<td>Report List</td>
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<tr>
<td>5. Creation or elimination of a certificate program (as defined by IPEDS) in a field or at a level in which there is not a previously approved degree program at that level or higher level.</td>
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<td>✓</td>
<td>✓</td>
<td></td>
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<td>Consent</td>
<td>✓</td>
<td>Report RME</td>
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<tr>
<td>6. Creation or elimination of a program that results from the reorganization or restructuring of the curricular elements of an existing program that have over time evolved into separate and distinct programs (e.g., split into two or options have evolved into separate programs).</td>
<td>All</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>Action</td>
<td>✓</td>
<td>Action RME</td>
</tr>
<tr>
<td>7. Creation of a degree program (excluding certificate programs) in a new field or at a new level (based on CIPS or IPEDS definitions).</td>
<td>All</td>
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<td>✓</td>
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<td></td>
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<td>Action</td>
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<tr>
<td>8. Elimination of an existing degree program.</td>
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<td>✓</td>
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<td></td>
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<tr>
<td>9. Minor revision of existing degree programs (i.e., minor changes that do not affect the number of hours needed for graduation such as the mix of required/elective courses, minor changes in the list of specifically required courses, etc.)</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Consent</td>
<td>✓</td>
<td>Report4</td>
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<tr>
<td>10. Substantial revisions of existing degree programs.</td>
<td>UG</td>
<td>✓</td>
<td>✓</td>
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<td>Consent</td>
<td>✓</td>
<td>Report4</td>
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</table>

<sup>1</sup> Consent, ✓ Report, List
<sup>2</sup> as defined by IPEDS
<sup>3</sup> as defined by CIPS
<sup>4</sup> as defined by IPEDS
<sup>5</sup> as defined by CIPS
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, 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
CS Part of **CS+X**

- **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.
Illinois CS+X: Traction

Anthropology

Astronomy

Linguistics

Statistics

~11% Of students

~25% Of students

~28% Of students

~36% Of students
Illinois CS+X: Course Demand Examples

**Introductory**

- **CS Data Structures**
  - Enrollment 2016

**Advanced**

- **CS Databases**
- **CS Datamining**
Illinois CS+X: Recent Numbers

- CS+X approaching 30% of all CS
- CS+X approaching 50% of admitted Freshman ‘16 class
- CS+X new degrees now 28% female
Illinois CS+X....

... creates more demand
Illinois CS+X: Rising Popularity

- Huge interest to be “next X” – but clear some X’s better served by "more data, less compute" → DS+X

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

11 More X’s

- CS+CropSci
- CS+Advertise
- CS+Philosophy
- CS+Music
- CS+GeoScience

- Educat
- Economics
- Poli-Sci
- English
- Art/Design
- Business

In discussion
The world doesn’t need any more engineers. We didn’t run out of planes and television sets. We ran out of food.
Newest Illinois **CS+X**:  $X=\text{Crop Science}$

**Crop Sciences Core**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>CPSC 112</td>
<td>Introduction to Crop Sciences</td>
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Select two of the following:

<table>
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<tr>
<th>Course Code</th>
<th>Course Name</th>
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<td>CPSC 226</td>
<td>Introduction to Weed Science</td>
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<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>
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<td>CPSC 261</td>
<td>Biotechnology in Agriculture</td>
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<tr>
<td>CPSC 265</td>
<td>Genetic Engineering Lab</td>
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<tr>
<td>CPSC 352</td>
<td>Plant Genetics</td>
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<td>CPSC 440</td>
<td>Applied Stats Methods I</td>
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Select two of the following:

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<td>CPSC 418</td>
<td>Crop Growth and Management</td>
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<tr>
<td>CPSC 452</td>
<td>Advanced Plant Genetics</td>
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<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 Develpmt</td>
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BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND MUSIC (BS in CS + Music — Sample 4-year plan)

<table>
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<tr>
<th>Year 1</th>
<th>Hours</th>
<th>Year 2</th>
<th>Hours</th>
<th>Year 3</th>
<th>Hours</th>
<th>Year 4</th>
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<td>FALL</td>
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<tr>
<td>MUS 101 (Music Theory &amp; Practice I)</td>
<td>2</td>
<td>MUS 201 (Music Theory &amp; Practice III)</td>
<td>2</td>
<td>MUS 313 (The History of Music I)</td>
<td>3</td>
<td>MUS 299 (Thesis Adv/UG Honors — Research)</td>
<td>1</td>
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<tr>
<td>MUS 107 (Musicianship I)</td>
<td>2</td>
<td>MUS 207 (Musicianship III)</td>
<td>2</td>
<td>MUS 407 (Electroacoustic Techniques I)</td>
<td>3</td>
<td>MUS 4xx (Advanced Music History course)</td>
<td>3</td>
</tr>
<tr>
<td>MUS 105 (Computation &amp; Music I)</td>
<td>2</td>
<td>MUS 110 (Intro Art Mus: Intl Perspective)</td>
<td>2</td>
<td>CS 241 (System Programming)</td>
<td>4</td>
<td>CS 374 (Intro to Algorithms &amp; Models of Computation)</td>
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<td>CS 125 (Intro to Computer Science)</td>
<td>4</td>
<td>MUS 172 (Group Piano I)</td>
<td>2</td>
<td>General Education Courses</td>
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<td>MATH 220 (Calculus I)</td>
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<td>MUS 102 (Music Theory and Practice II)</td>
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<td>MUS 208 (Musicianship IV)</td>
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<td>MUS 314 (The History of Music II)</td>
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<td>MUS 299 (Thesis/Adv UG Honors — Writing and Presentation)</td>
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<td>MUS 108 (Musicianship II)</td>
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<td>MUS 205 (Computation &amp; Music II)</td>
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<td>MUS 409 (Electroacoustic Techniques II)</td>
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<td>CS 126 (Software Design Studio)</td>
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<td>MUS 173 (Group Piano II)</td>
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<td>CS 361 (Probability &amp; Statistics for CS)</td>
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<td>MUS 4xx (Advanced Music Theory course)</td>
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<td>CS 173 (Discrete Structures)</td>
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<td>CS 233 (Computer Architecture)</td>
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<td>ECE 403 (Audio Engineering)</td>
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<td>CS 421 (Programming Languages &amp; Compilers)</td>
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<td>MATH 231 (Calculus II)</td>
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<td>15</td>
<td>Semester Total</td>
<td>15</td>
<td>Semester Total</td>
<td>14</td>
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1 New Music Course
2 General Education course plan includes credit for QRI, QR2 and HUM & ARTS with these required courses: CS 125, CS 225 and MUS 313, MUS 314.
3 Students must take the ALEKS placement exam for course entry.
4 It is possible to proficiency out of Group Piano courses: MUS 172 and MUS 173 are for non-keyboard majors. Keyboard majors take MUS 454.
5 Students who are more interested in systems building can substitute CS 427 (Software Engineering I) for CS 361.

Music/FAA courses | CS Courses | Math courses | ECE course | General Education Requirements (outside of courses in Footnote #2) |
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<td>46 hours</td>
<td>32 hours</td>
<td>11 hours</td>
<td>6 hours</td>
<td>28 hours</td>
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V-16_November 2016
Illinois CS+X: Plans…

- STEM +X
  - Astronomy
  - Chemistry
  - Economics
  - Mathematics
  - Etc...

- non-STEM +X
  - Art/Design
  - Education
  - Music
  - Philosophy
  - Etc...

One CS Fits All…

Bifurcate CS core to better match non-STEM +X partners
Non-STEM **CS+X**: Up the Stack

The full “stack”

- **CS+X** Non-STEM
- **CS+X** STEM

- data / social
- people & uix
- systems / apps
- software
- architecture
- circuits
- transistors
- physics
Data isn't fissile material. It doesn't spontaneously reach critical mass and start producing insights...
This Wave Hitting **Statistics Depts**

- Just like CS – *same* story, *different* exponents…

**STATISTICS ENROLLMENTS**

- Liberal Arts & Sci: IUs/Faculty
  - AY14-15
Our Wide Response: **Master of CS-Data Sci**

- **Illinois MCS-DS**: 1st MOOC Data Sci MS, launched Fa’16

- **CS**: Platform (cloud), Database/mine ML
- **STATS**: Prob/Stat Adv methods
- **I-SCHOOL**: Data life cycle Curation Stewardship

---

**coursera**

**About the Masters Program**
- Curriculum
- Pricing
- About Illinois
- Admissions
- FAQ

---

**Become a Professional Data Scientist**

Accelerate your career with a flexible, fully-accredited online professional Master of Computer Science in Data Science.
Most of Us Somewhere in this Space

- Coursera
- edX
- Udacity
- CMU
- Stanford
- MIT
- Berkeley
- ILLINOIS
- GaTech
- Princeton
- Cornell
Illinois is a Large Coursera Partner

- 3rd largest academic partner
  - 0.9M registered in CS MOOCs

- Degree #1: iMBA, from the UIUC Business School

- Degree #2: MCS-DS from CS
  - 150 admitted in first cohort
  - Aiming for ~2^12 in degree pipe

- Coursera market surveys suggest huge interest in DataSci degree opportunity
MOOC History and Context

- **MOOCs version 1.0**
  - Looked like a semester/quarter class (10-16 weeks long)
  - Offered once/twice per year
  - Video lectures, online homeworks, auto-grade/peer-grade projects
  - Mostly free, diverse topics

- **MOOCs version 2.0**
  - Sequences of **month-long** focused courses, called **Specializations**
  - Offered (semi) **regularly/continuously**
  - **Same** teaching modalities: video, HW, projects, etc
  - Pivot to **prof-edu**, **monetization**: pay for access to graders, etc
About This Specialization

The Cloud Computing Specialization takes you on a tour through cloud computing systems. We start in the middle layer with Cloud Computing Concepts covering core distributed systems concepts used inside clouds, move to the upper layer of Cloud Applications and finally to the lower layer of Cloud Networking. We conclude with a project that allows you to apply the skills you've learned throughout the courses.

Created by: University of Illinois at Urbana-Champaign

6 courses
Follow the suggested order or choose your own.

Projects
Designed to help you practice and apply the skills you learn.

Certificates
Highlight your new skills on your resume or LinkedIn.
The Data Mining Specialization teaches data mining techniques for both structured data which conform to a clearly defined schema, and unstructured data which exist in the form of natural language text. Specific course topics include pattern discovery, clustering, text retrieval, text mining, and analytics, and data visualization. The Capstone project task is to solve real-world data mining challenges using a restaurant review data set from Yelp.

Created by: [University of Illinois at Urbana-Champaign]

- **6 courses**: Follow the suggested order or choose your own.
- **Projects**: Designed to help you practice and apply the skills you learn.
- **Certificates**: Highlight your new skills on your resume or LinkedIn.
From MOOC(s) \(\rightarrow\) Degree…?

- Degree is 32 units = 8 courses @ $600/unit
- Course is 2 MOOCs + “For Credit” engagement

15 week semester

- Open public
  - Coursera MOOC 1
  - Coursera MOOC 2
    - Comprehensive proctored exam
    - Comprehensive proctored exam

- MCS-DS only
  - Additional assignments and projects, with guidance and grading from course TA’s and instructors
**Idea:** Stackable Degrees

- Can take an **individual** MOOC...
- ...then extend to **sequence** of MOOCs (specialization)
- ...then apply for **degree** (add “for credit” engagement)
Summary: **Wide** (and Deep)

- **Go WIDE:**
  - MOOC
  - MOOC
  - MOOC
  - MOOC

- **Go DEEP:** For CS Majors