Learning to Code in an Online World

Ben Bederson

University of Maryland
Computer Science Dept.
Human-Computer Interaction Lab
What is Learning?
What Does Technology Offer?
Technology & Education

Long History
MOOC Popularization

Sebastian Thrun

Peter Norvig
MOOCs Trending

UDACITY
udacity.com

coursera

edX

Khan Academy
197,826,333 lessons delivered

Open Learning Initiative
Transforming higher education through the science of learning.
Anatomy of a MOOC

Available units:
- Final (closed)
- 22. Natural Language Processing
- Optional NLP Programming
- 21. Natural Language Processing
- Homework 8 (closed)
- 20. Robotics II
- 19. Robotics I
- Homework 7 (closed)
- 18. Computer Vision III
- 17. Computer Vision II
- 16. Computer Vision I
- Homework 8 (closed)
- 15. Advanced Planning
- 14. Game Theory
- 13. Games
- Midterm (closed)
- 12. NLP Review

Upcoming due dates in the next 7 days:
None

Announcements
Please check out our new site and classes!
AI Class Team - 8 month ago

We're pleased to announce the launch of two new classes: CS101 Building a Search Engine and CS373 Programming a Robotic Car through our new website at http://www.udacity.com

Thank you to the Community
Irvin - 10 month ago

One of the major things that has made this class so special is the community so we'd like to give a huge thanks to the following members who have really contributed to the discussion!

Community Creators, way to take the initiative that has helped so many of your fellow students!
- Xochipilli - reddit
- Terminator - aigus
- Ivan Yurchenko - AI-class - "Introduction to Artificial Intelligence" online course facebook group
- Jacqueline Spiegel - AI-class students now compulsators

Aigus members who helped moderate during the exams, you guys put in a heroic effort and we truly appreciate your help (please let us know if we've left anyone out!)

- L. McLean
- robbrambusch
- sea offer
- francisco
- aca
- Mike H
Recursive Factorial

Define a procedure, factorial, that takes a natural number as its input, and outputs the number of ways to arrange the input number of items.
Why the Excitement?

- Cheaper
- Better learning
- Broader access
Why the Success?

- Free
- Short videos
- Focus on content, not talking head
- Built-in activities
- Community of students
- Name-brand suppliers
Content

Udacity (14 courses)
- Intro to CS
- Intro to Physics
- Intro to Statistics
- Algorithms
- Differential Equations
- Web Development
- Software Testing
- Software Debugging
- Programming Languages
- Intro to Theoretical CS
- How to Build a Startup
- Design of Computer Programs
- Artificial Intelligence
- Applied Cryptography

Coursera (198 courses)
- Networked life (U Penn)
- Social Network Analysis (U Mich)
- Probabilistic Graphical Models (Stanford)
- Neural Networks (Toronto)
- Computational Investing (Georgia Tech)
- Computer Vision (Stanford)
- Comp. Photography (Georgia Tech)
- AI Planning (Edinburgh)
- Control Mobile Robot (Georgia Tech)
- Natural Language Proc. (Columbia)
- Computational Neuroscience (U. Wash)
- Linear Algebra (Brown)
- Computer Vision (Berkeley)
- …
Or, Roll Your Own –
https://code.google.com/p/course-builder/

Welcome to Course Builder!

Course Builder is our experimental first step in the world of online education. It packages the software and technology we used to build our Power Searching with Google online course. We hope you will use it to create your own online courses, whether they’re for 10 students or 100,000 students. You might want to create anything from an entire high school or university offering to a short how-to course on your favorite topic.

Course Builder contains software and instructions for presenting your course material, which can include lessons, student activities, and assessments. It also contains instructions for using other Google products to create a course community and to evaluate the effectiveness of your course. To use Course Builder, you should have some technical skills at the level of a web master. In particular, you should have some familiarity with HTML and JavaScript.

If you have technical issues or feature requests, please report them in our Issues Tracker.

Get Started

Dive Deeper

- Advice for online course design
- Implement course material
- Develop community
- Evaluate course efficacy

Hangouts on Air

Peter Norvig hosted two Hangouts on Air with special guests. They answered your questions about MOOC design and the technical aspects of using Course Builder.

- 19 Sept 10:00am - 10:45am PDT
- 26 Sept 10:00am - 10:45am PDT

Details
Google CourseBuilder

Power Searching with Google

Google Search makes it amazingly easy to find information. Come learn about the powerful advanced tools we provide to help you find just the right information when the stakes are high.

Daniel Russell
Senior Research Scientist
Google, Inc.

Schedule

- Pre-course assessment
- Unit 1 - Introduction
- Unit 2 - Interpreting results
- Unit 3 - Advanced techniques
- Mid-course assessment
- Unit 4 - Find facts faster
- Unit 5 - Checking your facts
An Introduction to Computer Networks

Recent Announcements


**Update: 2 additional videos posted for week 3**

We decided to include two additional videos in the course materials for week 3:

- 37 - Congestion Control - RTT Estimation and Self Clocking
- 38 - TCP Reno and New Reno

The corresponding problem sets and slides have also been posted. The concepts are not too complicated, so it should not represent much more workload. We hope you enjoy them!

Oct. 19, 2012, 1:25 a.m.

**First Screenside Chat**

We're both very excited at how many of you have learned about the Internet from the videos we’ve recorded as well as how many interesting questions there have been on the forums. We’ve recorded the first of our Screenside Chat series to talk about what you’ve learned so far and how the course is going. We of course don’t want to add a lot more for you to view, so it’s quite short. We hope you enjoy it!

- Phil & Nick
Video Not The Only Online Strategy

Features:
- Learn by doing
- Did I get this?
- Learning objectives
- Exams
Sufficient to Teach Programming Skills?
<table>
<thead>
<tr>
<th>Tracks</th>
<th>Tracks are series of courses grouped to help you master a topic or language. Choose one to start learning!</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JavaScript Fundamentals</strong></td>
<td>Learn to create simple applications and games with this introduction to the JavaScript language. By the end of this track, you’ll make your own Blackjack game!</td>
</tr>
<tr>
<td>What you’ll learn...</td>
<td>Programming basics, Make JavaScript apps, Build a real game</td>
</tr>
<tr>
<td><strong>Web Fundamentals</strong></td>
<td>Learn the building blocks of web development with HTML and CSS. Build a basic webpage by the end of the first course, and a complete website by the end of the track!</td>
</tr>
<tr>
<td>What you’ll learn...</td>
<td>How to build websites, HTML and CSS, Style and design</td>
</tr>
<tr>
<td><strong>Python</strong></td>
<td>Python is the language of choice for beginners and experts alike. Learn how to create a variety of interactive applications with one of the most popular languages.</td>
</tr>
<tr>
<td>What you’ll learn...</td>
<td>Versatile language, Beautiful syntax, Useful libraries</td>
</tr>
<tr>
<td><strong>Ruby</strong></td>
<td>Ruby is an incredibly popular programming language that helps power websites all over the world. Learn how to create a number of useful applications quickly and easily.</td>
</tr>
<tr>
<td>What you’ll learn...</td>
<td>Ruby fundamentals, Beautiful syntax, Rapid prototyping</td>
</tr>
</tbody>
</table>

**Languages**
- JavaScript
- JQuery
- HTML/CSS
- Python
- Ruby
Live Coding – www.khanacademy.org

Intro to Animation

background(252, 255, 214);
noStroke();

// position of the car
var x = 10;

// draw the car body
fill(255, 0, 115);
rect(x, 200, 100, 20);
rect(x + 15, 178, 70, 40);

// draw the wheels
fill(77, 66, 66);
ellipse(x + 25, 221, 24, 24);
ellipse(x + 75, 221, 24, 24);

var draw = function() {
  // this is the draw loop! everything inside these

Next Steps

Previous Tutorial
Drawing Bonus: Rotation!

Next Tutorial
Incrementing Shortcuts

Explore!
LEARN programming by visualizing code execution

Online Python Tutor is a free educational tool that helps students overcome a fundamental barrier to learning programming: understanding what happens as the computer executes each line of a program's source code. Using this tool, a teacher or student can write a Python program directly in the web browser and visualize what the computer is doing step-by-step as it executes the program.

For example, I wrote the following Python program to recursively find the sum of a linked list of numbers. Click the "Forward" button to see what happens as the computer executes one line of code at a time.

```python
1  def listSum(numbers):
2      if not numbers:
3          return 0
4      else:
5          (f, rest) = numbers
6          return f + listSum(rest)
7  myList = (1, (2, (3, None)))
8  total = listSum(myList)
```

So far, over 100,000 people have used Online Python Tutor to understand and debug their programs, often as a supplement to learning from textbooks, lecture notes, and online programming tutorials.
## UMD 101: Java exercises

*Demo Student2 (demo-student2)*

### Projects

<table>
<thead>
<tr>
<th>project</th>
<th>submissions</th>
<th>last submission test results</th>
<th>web submission</th>
<th>download starter files</th>
<th>Due</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>view</td>
<td>0 / 25</td>
<td>submit</td>
<td>download</td>
<td>23 Mar, 11:59 PM</td>
<td>Multi-tap text entry</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>submit</td>
<td>download</td>
<td></td>
<td>21 Mar, 11:59 PM</td>
<td>FizzBuzz</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>submit</td>
<td>download</td>
<td></td>
<td>08 Mar, 11:59 PM</td>
<td>Java warmup</td>
</tr>
<tr>
<td>0</td>
<td>view</td>
<td>NEW</td>
<td>submit</td>
<td>download</td>
<td>07 Mar, 11:59 PM</td>
<td>Compute square of an int</td>
</tr>
</tbody>
</table>

25 Oct, 11:55 AM
1: Java warmup

Implement several simple functions in java
Deadline: Thu, 08 Mar at 11:59 PM

Jaime Spacco (jspacco)
jaime.spacco@gmail.com

Grant Jaime Spacco (jspacco) an extension on project 1

Submissions

<table>
<thead>
<tr>
<th>#</th>
<th>date submitted</th>
<th># changed lines</th>
<th>Results P</th>
<th>R</th>
<th>I</th>
<th>S</th>
<th>I</th>
<th>F</th>
<th>release tested</th>
<th># FindBugs warnings</th>
<th># Student written tests</th>
<th>view source</th>
<th>Download</th>
<th>Public</th>
<th>Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21 Feb 11:35 PM</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>view</td>
<td>download</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>23 Feb 11:31 AM</td>
<td>13</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>view</td>
<td>download</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
1: Java warmup

Implement several simple functions in java

Deadline: Thu, 08 Mar at 11:59 PM

Jaime Spacco (jspacco), Submission # 2, 23 Feb, 11:31 AM

- 16/20 points for public test cases.
- 20/80 points for release test cases.

Test results

<table>
<thead>
<tr>
<th>type</th>
<th>test #</th>
<th>outcome</th>
<th>source coverage</th>
<th>points</th>
<th>name</th>
<th>short result</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBLIC</td>
<td>1</td>
<td>passed</td>
<td>source</td>
<td>4</td>
<td>testIsOddFor0_2</td>
<td>PASSED</td>
</tr>
<tr>
<td>PUBLIC</td>
<td>2</td>
<td>passed</td>
<td>source</td>
<td>4</td>
<td>testFirstDigitSimple</td>
<td>PASSED</td>
</tr>
<tr>
<td>PUBLIC</td>
<td>3</td>
<td>passed</td>
<td>source</td>
<td>4</td>
<td>testFirstDigitTeens</td>
<td>PASSED</td>
</tr>
<tr>
<td>PUBLIC</td>
<td>4</td>
<td>passed</td>
<td>source</td>
<td>4</td>
<td>testDistinctValues</td>
<td>PASSED</td>
</tr>
<tr>
<td>PUBLIC</td>
<td>5</td>
<td>not_implemented</td>
<td>source</td>
<td>4</td>
<td>testBitCount</td>
<td>java.lang.UnsupportedOperationException: You must implement this at</td>
</tr>
</tbody>
</table>
Inspiration by Competition

Tron leaderboard from tournament 2010-05-26 16:57:11 [past tournaments]

<table>
<thead>
<tr>
<th>Pos</th>
<th>TA</th>
<th>Entrant</th>
<th>Wins</th>
<th>Ties</th>
<th>Losses</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FURRIESFTW</td>
<td>brockfanning</td>
<td>176</td>
<td>0</td>
<td>34</td>
<td>352</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>brockfanning</td>
<td>162</td>
<td>0</td>
<td>48</td>
<td>324</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>T3</td>
<td>148</td>
<td>0</td>
<td>62</td>
<td>296</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>JP</td>
<td>137</td>
<td>0</td>
<td>73</td>
<td>274</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>player(s)</td>
<td>136</td>
<td>0</td>
<td>74</td>
<td>272</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>KualityPlay</td>
<td>135</td>
<td>0</td>
<td>75</td>
<td>270</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Undra</td>
<td>135</td>
<td>0</td>
<td>75</td>
<td>270</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Jovial Joe</td>
<td>131</td>
<td>0</td>
<td>79</td>
<td>262</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>OaftheBear</td>
<td>128</td>
<td>0</td>
<td>82</td>
<td>256</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>ibid</td>
<td>127</td>
<td>0</td>
<td>83</td>
<td>254</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>cs131186</td>
<td>126</td>
<td>0</td>
<td>84</td>
<td>252</td>
</tr>
</tbody>
</table>

Tron played between brockfanning and YOOHOO in game #8194 on 2010-05-26 16:57:11

<table>
<thead>
<tr>
<th>Round</th>
<th>Player</th>
<th>Game State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>2</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>3</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>4</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>5</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>6</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>7</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>8</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>9</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>10</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>11</td>
<td>brockfanning</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>12</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
<tr>
<td>13</td>
<td>YOOHOO</td>
<td>-1,-1,-1,-1,-1</td>
</tr>
</tbody>
</table>
Online ONLY Not The Only Strategy

• Blended learning / “Flipped” classroom

Lectures ➔ Homework
Homework ➔ Class work
Peer Learning
Peer Learning

Student View

```
Task
1. Crops

Problem
Native Americans had a name for the moon associated with the most widely grown crop in America. During what month would you see that moon?

Response
August

Note

Search History
Milk moon
Corn moon
Moon Names
full moon names h...
Corn Moon

Milk moon

What is a 'milk moon' anyway? - CSMonitor.com
May 26, 2010 ... The full moon of May, also known as the "Milk moon," will occur at 7:27 p.m. EDT Thursday. What better time to discuss this brightest object in...

Milkmoon
Aug 23, 2012 ... I am working on some other significant changes here at Milkmoon, too. Something which just seems like the right thing to do. I have come to...

Supermoon Saturday: Why it's the biggest, brightest of 2012 (video)
May 4, 2013 ... Supermoon Saturday! It's also called the 'Flower Moon,' and 'Milk Moon.' The 'supermoon' will be only 221,862 miles from Earth, the closest to...

Full moon - Wikipedia, the free encyclopedia
This full moon was near its greatest northern ecliptic latitude, so the southern ... Mid Spring, May; Milk Mooe, When woman want corn, Corn Planting Moon, ...

milkmoonkids — Welcome
Home · Shop · Growth Charts · Wall Art · Screen Prints · About Us · FAQ · Contact Us. Featured Items · Dino Dance, $28.00 · Dino Smiles, $29.00 · Dinosaur Head!

Moon Milk Review
Moon Milk Review is now The Doctor T. J. Eckleburg Review.

Greg Brown - Lyrics for MILK OF THE MOON
List It By: A Little Excited; Let Me Be Your Jigdo; Smell of Coffee; Milk of the Moon; Mutt, Anheinest of Our Love; Steady Love; The Moon Is Nearly Full; Telling ...

milkmoonkids --- Growth Charts
D-1-N-O Height; (pale); $4.95; D-1-N-O Height; (purple); $4.95; Flying High; $4.95. Geometrically Grown (lime); $4.95. Geometrically Grown (primary); $4.95 ...

Milk Moon Kids Whimsical Children's Art by milkmoonkids on Etsy
Milk Moon Kids, Columbus & Cincinnati, United States. Contact · Favorites · Circles: 13 ... milkmoonkids. Milk Moon Kids Whimsical Children's Art. Favorite ...

hameaufarm.com x BELTANE/MAY DAY/MILK MOON
May 2 2010 ... BELTANE/MAY DAY/MILK MOON ... And last, but certainly not last, Milk Moon. ... The full moon that falls right near Beltane is the Milk Moon.
```

powered by Google™ Custom Search
Native Americans had a name for the moon associated with the most widely grown crop in America. During what month would you see that moon?

Response: August

Rate This Page: Helpful Unhelpful

Show: Helpful Unhelpful Unrated

Queries: corn moon a name for the moon associated... corn moon native american corn planting moon Crop moon crops cropsey green corn moon Harvest moon harvest moon Maple sugar milk moon month named after corn native

Wiki Loves Monuments: Historic sites, photos, and prizes!

Crop
From Wikipedia, the free encyclopedia
Teacher View - Queries

Task
1. Cloth weaving

Problem
What style of cloth weaving is named for the world's oldest continuously-inhabited city?

Activity
EIST 2012
Activity code: 58647

Queries
- cloth weaving (✓ 1, 2 unrated)
- Cloth (2 unrated)
- cloth weaving (✓ 1, 1 unrated)
- cloth weaving city oldest (2 unrated)
- oldest continuously inhabited city (✓ 1, 1 unrated)
- cesar (X 1)
- city weaving (1 unrated)
- city weaving old (1 unrated)
Teacher View - Words

Task
1. Cloth weaving

Problem
What style of cloth weaving is named for the world’s oldest continuously-inhabited city?

Activity
EIST 2012
Activity code: 58647

Words
Show: Helpful Unhelpful Unrated

- cloth, Cloth weaving oldest, Oldest city style, styles inhabited named, names of continuously-inhabited for world's, world, worlds continuously What, what city? History, history <empty> ottolhu world,e

Sort by: Frequency ABC
- cloth, Cloth (✓ 7, × 2, 11 unrated)
- weaving (✓ 7, × 2, 10 unrated)
- oldest, Oldest (✓ 8, × 1, 8 unrated)
- city (✓ 6, × 2, 9 unrated)
- style, styles (✓ 2, 4 unrated)
- inhabited (✓ 3, 2 unrated)
- named, names (✓ 4, 1 unrated)
- of (✓ 3, 2 unrated)
Teacher View - Responses

Task
1. Cloth weaving

Problem
What style of cloth weaving is named for the world's oldest continuously-inhabited city?

Activity
EIST 2012
Activity code: 58647

Responses
Damask Damascus Damask http://www.wired.com/geekdad/... twill

Sort by: Frequency ABC
- Damask (4)
- Damascus (2)
- Damask (1)
- http://www.wired.com/geekdad/tag/a-google-a-day/ Has this exact question :) (1)
- twill (1)
Teacher View - Students

Queries
- Damascus cloth weaving (1 unrated)
- World oldest continuously inhabited city (✓ 1)
- World oldest continuously inhabited city (1 unrated)

Words
- City (✓ 1)
- Cloth (1 unrated)
- Continuously (✓ 1)
- Damascus (1 unrated)
- Inhabited (1 unrated)
- Inhabited (✓ 1)
- Oldest (✓ 1)
- Weaving (1 unrated)
- World (✓ 1)

Links Followed
- Damascus - Wikipedia, the fre... (1 unrated)
- List of cities by time of c... (✓ 1)

Responses
- Damascus (1)
Does Online Learning Work?

- Three Studies
Does Online Learning Work?

- Three Studies

1) **ITHAKA**

   Introductory Statistics classes
   Blended Learning style
   Compared across 6 public universities
   - Learning the same as in classroom
   - 25% reduction in time spent
Does Online Learning Work?

• Three Studies

2) BRYN MAWR
Small liberal arts college
10 courses (biology, chemistry, economics, math, French)
Blended Learning style
⇒ Disadvantaged students did just as well
⇒ Nearly 100% retention
⇒ Performed better than traditional classes in all but 1 course
Does Online Learning Work?

- Three Studies

3) Meta Study

*no difference* between online & face-to-face

But, wide variability — depends on the details

Exs — meta-studies of 232 distance education studies:

- [http://rer.sagepub.com/content/79/3/1243.short](http://rer.sagepub.com/content/79/3/1243.short)
- [http://rer.sagepub.com/content/74/3/379.abstract](http://rer.sagepub.com/content/74/3/379.abstract)
Does Online Learning Work?

Other studies generally show:

➔ *no difference* between online & face-to-face
But, wide variability – depends on the details

Exs – meta-studies of 100’s of distance education studies:

- [http://rer.sagepub.com/content/79/3/1243.short](http://rer.sagepub.com/content/79/3/1243.short)
- [http://rer.sagepub.com/content/74/3/379.abstract](http://rer.sagepub.com/content/74/3/379.abstract)
Are We Done?

- Retention
- Cheating
- Assessment
- Feedback
- Certification / Credentials
- Quality of course
- Effectiveness of approach
Suggestions

- Consider blended approaches
- Consider motivation – attrition a big problem
- Consider cheating – anonymity risky
Questions?

Benjamin B. Bederson
Computer Science Department
Human-Computer Interaction Lab
Institute for Advanced Computer Studies

University of Maryland

www.cs.umd.edu/~bederson
@bederson