

Origins of the Modern MOOC (xMOOC)

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Online education has been around for decades, with many universities offering online courses to a small, limited audience. What changed in 2011 was *scale* and *availability*, when Stanford University offered three courses free to the public, each garnering signups of about 100,000 learners or more. The launch of these three courses, taught by Andrew Ng, Peter Norvig, Sebastian Thrun, and Jennifer Widom, arguably marked the start of the modern, instructor-directed MOOC (sometimes “xMOOC”).

Each of these MOOCs offered learners the opportunity to watch online lectures, do machine-graded homework, and earn a “Statement of Accomplishment” if they passed the class. Two of these courses (Widom’s *Databases* course, and Ng’s *Machine Learning* course) were taught on a platform developed by Ng and a team of students, which eventually became the genesis of Coursera. One course (*Artificial Intelligence*, taught by Sebastian Thrun and Peter Norvig) was taught on a platform led by Thrun, which eventually became the genesis of Udacity. Since then, many other MOOC organizations, such as edX, FUN, FutureLearn, NovoEd, Iversity, J-MOOC, and others, have been started to offer similarly highly scalable online courses.

This article describes the origins of the three 2011 Stanford MOOCs. Because these MOOCs drew inspiration from many sources, it is difficult to trace the origins of every idea. We will try to do so where possible to give due credit, but will otherwise focus on the chronology of actions, rather than ideas, in the drive toward highly scalable models of education.

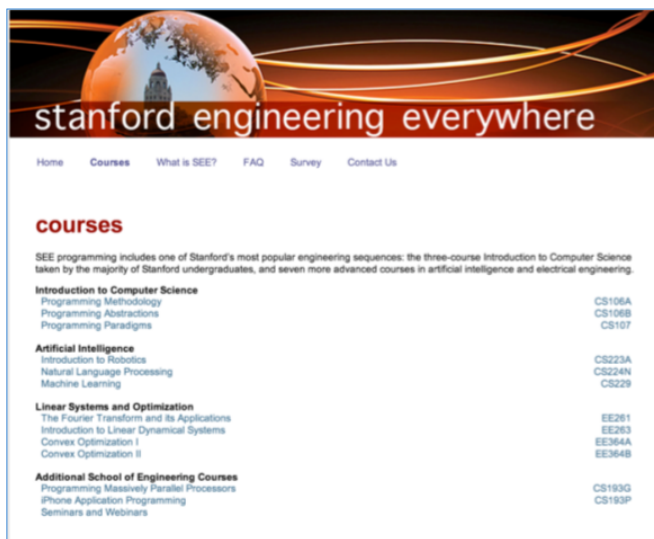
Community of researchers

The modern MOOC launched rapidly into public awareness in 2011, but contrary to popular opinion, MOOCs were not an “overnight success”: The idea of highly scalable education had taken years of germination, false starts, and experimentation, culminating finally in the three highly-visible Stanford offerings. These MOOCs drew from a wide variety of ideas developed by a community of Stanford and non-Stanford researchers interested in online education. Key members of the Stanford group included Daphne Koller, who had been experimenting with and evangelizing blended learning (the “flipped classroom”) at Stanford for several years; John Mitchell, who led a team developing an on-campus learning management system; Bernd Girod, whose students had developed sophisticated lecture-recording technologies; as well as Dan Boneh, Steve Cooper, Tiffany Low, Jane Manning, and Roy Pea, who contributed significantly to early discussions.

Most MOOC platforms today actually pursue two major online learning activities simultaneously: (i) offering highly scalable forms of learning to large numbers of learners, and (ii) offering blended learning to small on-campus classes. The origin of participation by these platforms in blended learning stems mostly from the work of Daphne Koller and John Mitchell, who had experimented extensively with “flipped classroom” teaching in Koller’s on-campus course at Stanford. Outside Stanford, Ng and Thrun both credit Sal Khan (khanacademy.org) as a huge source of inspiration. Ng was also heavily influenced by the work of lynda.com, and the community/forum design of StackOverflow.com.

The drive to scale

What made MOOCs “revolutionary” was their availability and, especially, their scalability. One of Stanford’s first attempts to offer scalable forms of education was started by Andrew Ng in 2007 together with the Stanford Center for Professional Development. About ten Stanford courses were videotaped, and posted online together with lecture notes and self-graded homeworks. Called the SEE (Stanford Engineering Everywhere) project, it offered a similar experience to MIT’s OpenCourseWare, except a driving tenet in SEE was that every course should offer a “complete course” experience: It should have a complete set of materials - including lectures, homework problems, and solutions - that the learners could work through by themselves. Even though the technology was primitive, SEE videos came to be viewed by millions, and their success inspired Ng and others to spend the next few years developing and iterating on different versions of online education technology.



Screenshot 1: Stanford Engineering Everywhere.
(<http://see.stanford.edu/>)

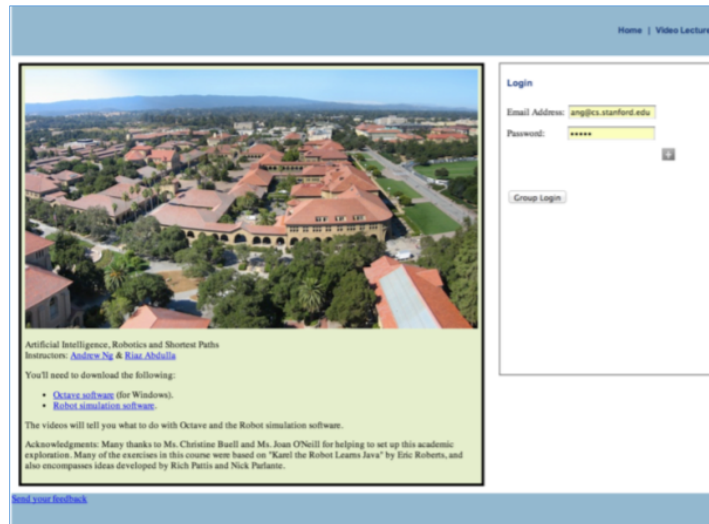
In the intervening years after SEE was launched and before the 2011 MOOCs, Ng launched a number of experimental websites, all designed with the explicit goal of giving every learner a good experience, no matter how many people participated. Screenshots of some of these websites are included below. These websites experimented with ideas such as tablet recording, short-format videos, accelerated video playback, programming exercises, user-generated content (specifically, a Wiki that anyone could edit), and in-video quizzes as inspired by Daphne Koller's blended-learning experiments. Many computer science faculty members contributed to these ideas, and it is difficult to give credit to them all, but notable for his involvement was Dan Boneh, who contributed

significantly to the design of the tablet recording setup, and even wrote code himself for OpenClassroom, one of Ng’s early platforms (openclassroom.stanford.edu). Boneh and Jennifer Widom (together with Ng) were among the most ardent proponents of using Khan-style tablet recordings, and contributed many of the little “techniques” that are now commonplace. Bernd Girod meanwhile developed a platform called ClassX for do-it-yourself lecture recording, which used computer vision for automatic slide synchronization and tracking of the lecturer. By allowing learners to pan-and-zoom in the video while it was playing eliminated the need for a camera operator. Several hundred hours of lecture videos self-recorded by Stanford instructors were uploaded to the system between 2009 and 2011.

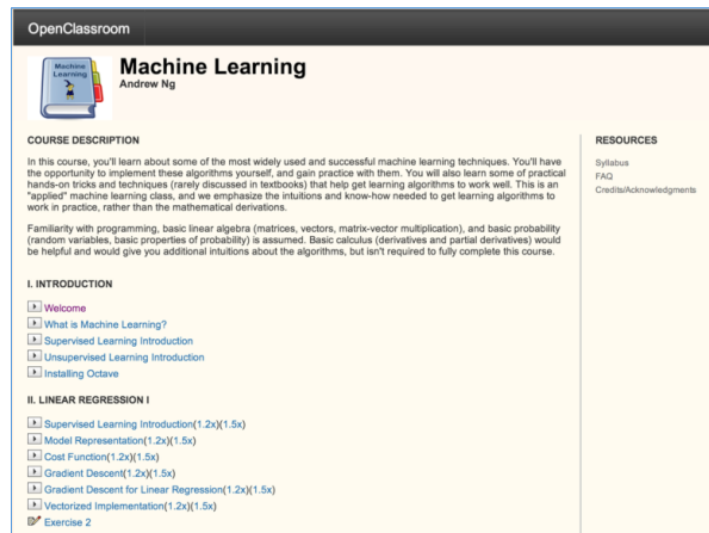
In this period, the Stanford teams made progress but also had several false starts. We learned lessons about both what would and what wouldn’t work. For example:

- We tried recording lectures in a classroom, with the instructor lecturing as usual to a room full of students, and editing this content later to create video segments each around five to ten minutes long. We learned that this approach nearly always resulted in a worse learner experience compared to having the instructor explicitly plan out each five to ten minute segment.

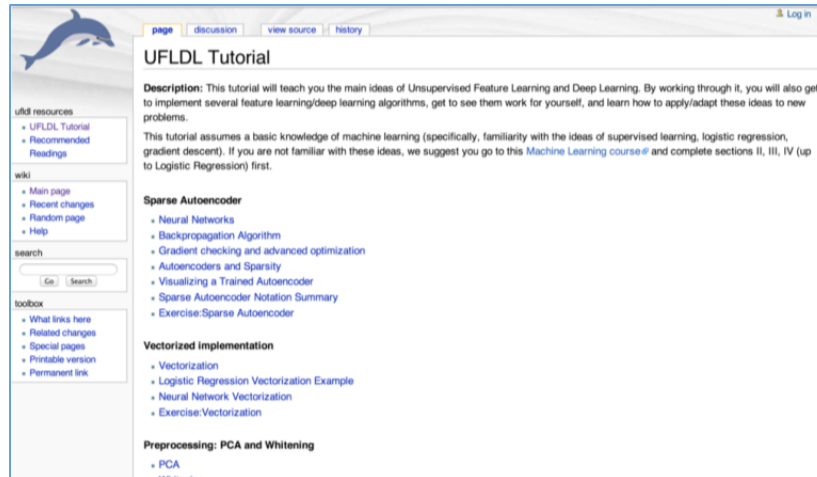
- Working with a high school, Ng experimented with website features that support a team of three to five physically co-present students sitting at a computer working on problems together. This use case was very unpopular as most students preferred to watch videos by themselves so that they could control the pacing. Even today, we are still uncertain how best to support physically co-present learners watching videos.
- During this period, we spent a significant amount of time fine-tuning the set of tools for inexpensively creating MOOC videos, taking inspiration from Salman Khan and from Lynda Weinman's work.



Screenshot 2: OpenClassroom website, version 1. Designed for use within a high school class, with a high school teacher facilitator. (<http://openclassroom.stanford.edu/ai/shcp.php>)



Screenshot 3: OpenClassroom website, version 2, with content on a variety of computer science subjects. (<http://openclassroom.stanford.edu>)



Screenshot 4: Machine learning (deep learning) tutorial site -- self-paced course in Wiki format. Later also gained community translations of content. (<http://bit.ly/deeplearn>)



Screenshot 5: ClassX system by Bernd Girod. System allows pan/zoom during playback, and features slide synchronization. (<http://classx.stanford.edu/>)

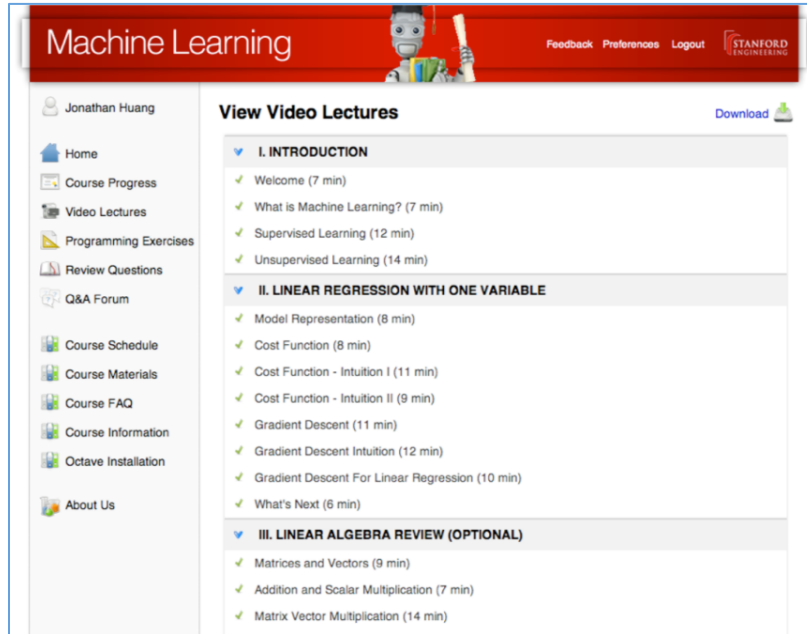
The three 2011 MOOCs

In 2011, the three inaugural MOOCs were launched. They came to be known affectionately by students as ml-class, db-class, and ai-class from the website URLs (ml-class.org, db-class.org and ai-class.com); they were on the subjects of machine learning, databases, and artificial intelligence.

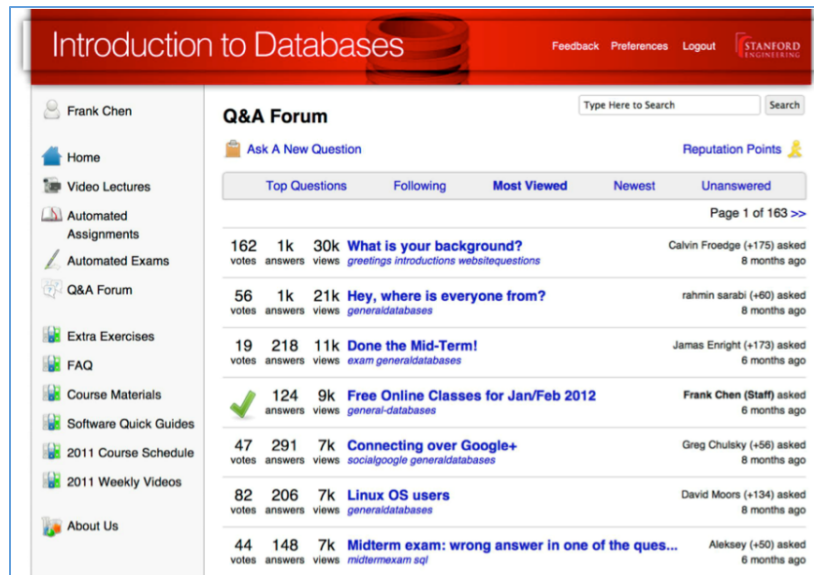
AI-course was the first course to be announced, and ran on a platform developed by Sebastian Thrun, David Stavens, Mike Sokolsky, and a few others. The course featured short-format videos, in-video quizzes, multiple-choice quizzes, subtitles, and subtitle translations.

ML-course and db-course ran on a platform developed by four students (Jiquan Ngiam, Frank Chen, Chuan-Yu Foo, and Yifan Mai) working with Andrew Ng. These courses featured short-format videos, accelerated video playback, subtitles, in-video quizzes, weekly multiple-choice quizzes, machine-graded programming exercises, and a discussion forum in which learners could post and answer questions, and vote questions and answers up or down. Inspired by earlier work of Jeff Ullman and his Gradiance

system, ml-class and db-class further made extensive use of randomized quizzes, and of “mastery learning” in which students are encouraged to attempt an assignment multiple times until they get it right. Ng's team developing the ml/db-class platform set “Do What’s Best for Students” as a guiding principle, a mantra that has continued at Coursera.



Screenshot 6: The machine learning course (ml-class) taught by Ng in 2011.



Screenshot 7: The databases course (db-class) taught by Widom in 2011.

Launching these free online courses generated a substantial amount of policy discussion within Stanford. The issue of whether completion “certificates” could be offered may have sparked the most discussion. Ultimately, in a series of meetings with the University Registrar, Legal Office, and the School of Engineering Dean’s office, Ng and Thrun secured permission to offer “Statements of

Accomplishment” instead. This term has stuck, and today, over 1,000,000 Statements of Accomplishment have been issued across multiple platforms.

When building out these early MOOC platforms, one lesson we learned repeatedly was that if a piece of software is not designed from the outset to scale to a huge number of learners, then it will probably not work in a MOOC. The pedagogy of effective MOOC teaching is also very different from on-campus instruction, and one has to constantly keep scale in mind. It isn't simply an issue of whether the software will stand up under the onslaught of 5,000 simultaneous users; rather, it pertains to the fundamental design of the platform and pedagogy. For example, in a class of 100 students, almost any discussion forum design will work, since each student could conceivably read what everyone else writes. But in a class with 100,000 students, unless the user interface is designed from the outset to handle the correspondingly larger volume of discussion, then there will be many repeated/redundant comments, making the whole discussion forum unusable. The ml-class/db-class platform modeled its discussion forum after StackOverflow.com, a website for discussion about software programming, which Ng had frequently used in his work. The ai-class platform initially did not have a discussion forum, but a group of students launched a separate forum site (aiqus.com), which subsequently came to be the de facto course forum, used for much of the course communication. Key to any scalable discussion forum is the ability to vote posts up or down, so that the most helpful questions and answers quickly bubble to the top of the list, and so that spam can be quickly rejected by the community.

Word about the three courses in the summer of 2011 spread mostly via social media and the popular press. All three courses started on the same day, and ran for ten weeks. In the end, around 7,000 learners completed db-class and earned a “Statement of Accomplishment;” 13,000 learners completed ml-class; and 23,000 completed ai-class.

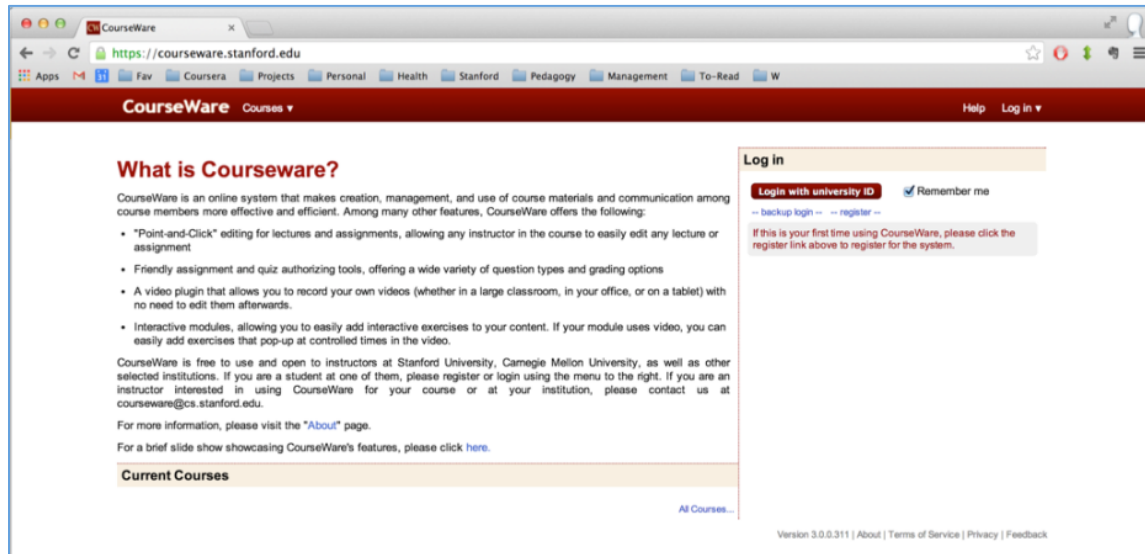
After the initial MOOCs

With the successful launch of the initial MOOCs, Ng and Thrun both started to explore ways to move their projects forward. Ng recruited Jane Manning to Stanford to help with faculty support, and began recruiting a number of faculty colleagues at Stanford and at UC Berkeley to teach MOOCs. Some of the early Stanford faculty members recruited included Dan Boneh, who taught a very successful cryptography course, Daphne Koller, and Scott Klemmer, who was later instrumental in helping to develop a system for peer grading. Dawn Song at UC Berkeley also played a significant role in thinking through possible paths forward. Bernd Girod, Daphne Koller, and John Mitchell were also key players during this period; indeed, Girod, Koller, Mitchell, and Ng had also previously collaborated on sharing resources across their earlier platforms (Girod's ClassX, Mitchell's Courseware, described below, and Ng's OpenClassroom). Soon after, Koller joined forces with Ng and his team to form Coursera, while Thrun turned his project into Udacity. Today, Coursera seeks to be a platform that works with existing universities, while Udacity seeks to build the university of the future. Mitchell and Girod both took administrative leadership positions at Stanford around online education.

Blended learning

Most modern MOOC platforms such as Coursera, Udacity, and edX support two related but distinct visions: scalable forms of education, and blended learning for on-campus teaching. The latter of these visions stems greatly from the work of Daphne Koller and John Mitchell at Stanford during the period 2008-2011.

For many years, John Mitchell had been developing Courseware, a new LMS (learning management system) for use at Stanford and elsewhere. Although not designed explicitly to scale, the system had many features that served as inspiration for the early MOOCs, including machine-graded homework, a discussion forum, and sophisticated instructor dashboards.



Screenshot 8: Courseware website, built by John Mitchell and used for Koller's early blended learning experiments.

Daphne Koller was able to use Mitchell's platform to experiment with her early ideas on blended learning. In 2010, Koller was inspired by a talk about YouTube, and realized that on-campus education can be more engaging and make better use of student and faculty time if students learn the core material online at home in video format, leaving class time to discussions or experiential activities. This set of ideas, now widely known as the "flipped classroom" was little known at the time. Koller started videotaping her own lectures and hosting them on Mitchell's LMS, in order to "flip" her own classroom. In creating her videos she also invented the idea of "in-video quizzes," which today remains one of the best-loved features of many MOOCs. Her on-campus course also included a number of auto-graded interactive assessments, and used Courseware's discussion forum. Koller and Mitchell worked together to further his platform to experiment with blended learning in on-campus settings, for example, creating designs for instructor dashboards to assist just-in-time teaching. Some of these features have also served as inspiration for various MOOCs.

Even though blended learning hasn't received the broad popular attention that MOOCs have enjoyed, they remain a key motivation for universities to partner with platforms such as Coursera and edX. In early 2012, when universities were joining the MOOC movement, some were joining more to experiment with blended learning than with MOOCs.

Summary

Even though the MOOC movement appears to have emerged suddenly in 2011, the developments and inspirations behind the movement were many years and people in the making. A huge community of Stanford and non-Stanford personnel contributed ideas, and there were many years of quiet germination and iteration before the courses and course format were ready to "go viral." Perhaps ironically, none of Ng, Thrun, or Widom had heard the term "MOOC" at the time they were launching

their initial courses, nor were they aware at the time of George Siemens and Stephen Downes' groundbreaking work on "connectivist MOOCs" (cMOOCs). We are still uncertain who subsequently first used the term "MOOC" to describe these three courses. The term xMOOC has since been proposed to distinguish them from cMOOCs.

This article covers only the origins of the modern MOOC at Stanford, through the end of 2011. Many, many people at numerous institutions have since contributed significantly to building up the MOOC movement, which today continues to accelerate.

We are thrilled at the innovations and cultural changes that the three 2011 courses have sparked. Scalable forms of education give instructors the opportunity to have a much greater impact on the world than was ever possible before. We eagerly await what universities, instructors, companies, and others will invent in the future.

Acknowledgments: We are grateful to Daphne Koller for her input on the evolution of blended learning at Stanford, and to members of the ai-class team (Sebastian Thrun, David Stavens, Mike Sokolsky and Peter Norvig) for discussions about their course. Bernd Girod also provided many helpful comments.

[Article in Hollands, F. M., & Tirthali, D. (2014). *MOOCs: expectations and reality. Full report*. Center for Benefit-Cost Studies of Education, Teachers College, Columbia University, NY.

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