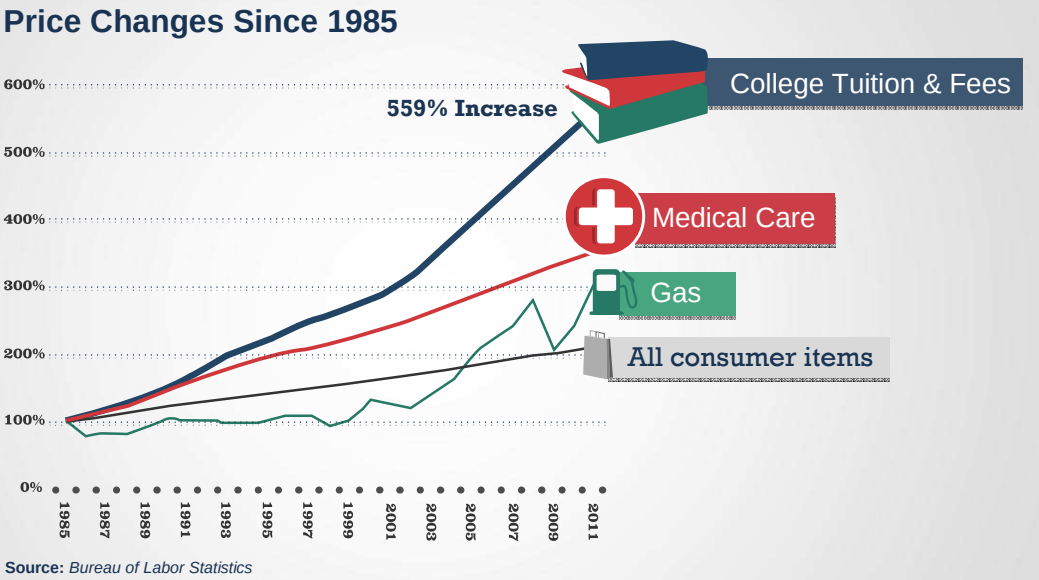
The Online Revolution: Education at Scale

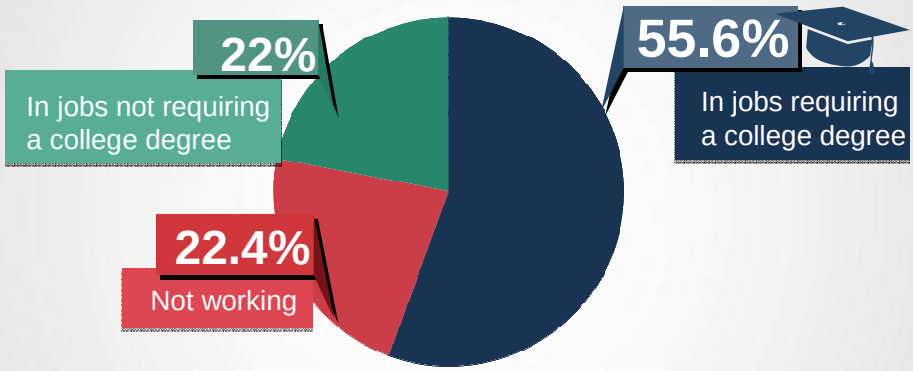
Daphne Koller & Andrew Ng
Stanford University & Coursera

Availability



Source: *Bureau of Labor Statistics*

Affordability

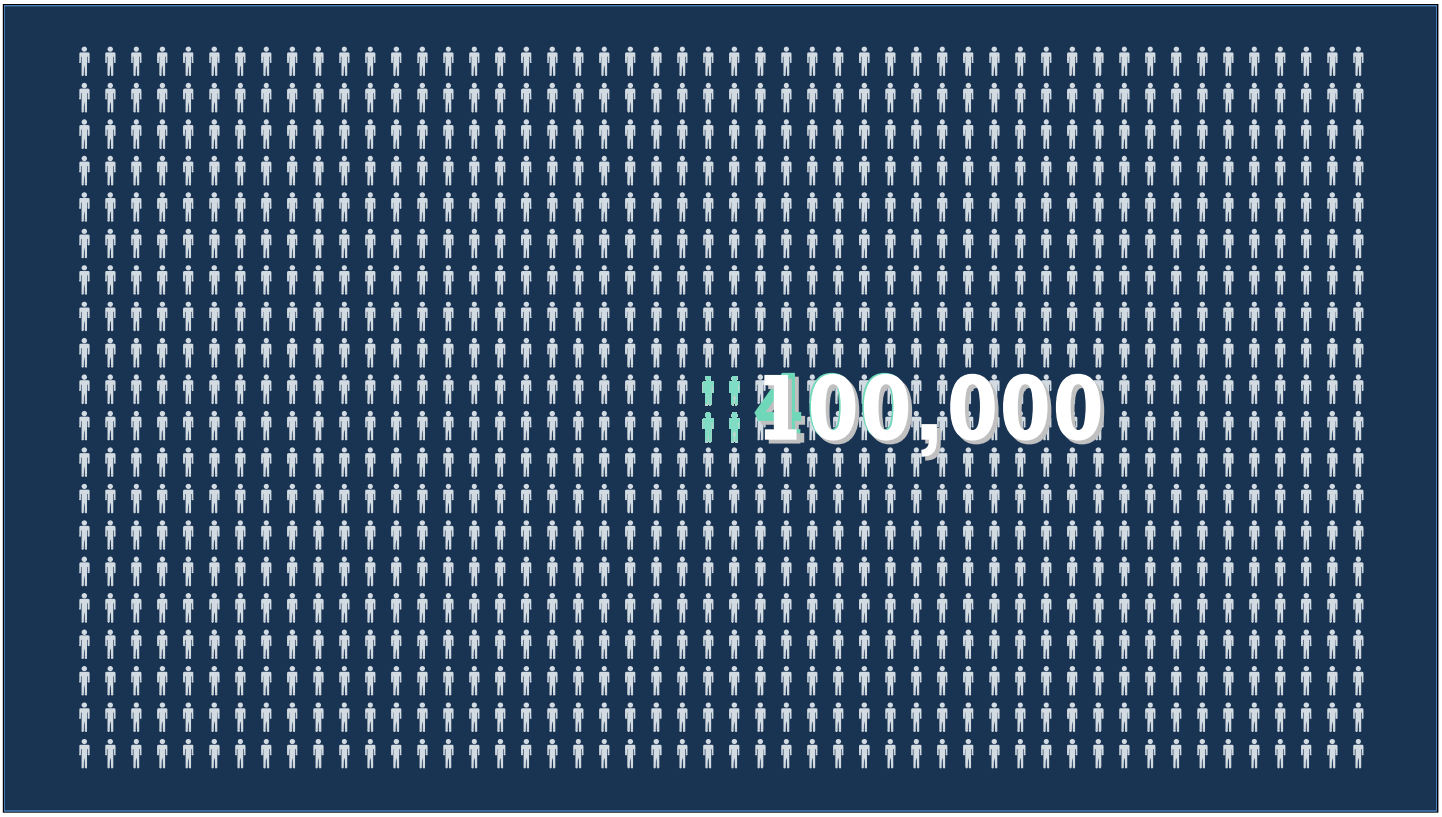


Source: "A College Degree, but Not a College Job." (A. Sum, *New York Times,*19 May 2011)

Opportunity

> **Big breakthroughs happen when what is suddenly possible meets what is desperately necessary.**
>
> —Thomas Friedman
> *May 15, 2012 · New York Times*

Tom Friedman summarized better than anyone what I'm about to tell you: Big breakthroughs are what happens when what is suddenly possible meets with is desperately necessary. We've talked about the desperately necessary. What about the suddenly possible?

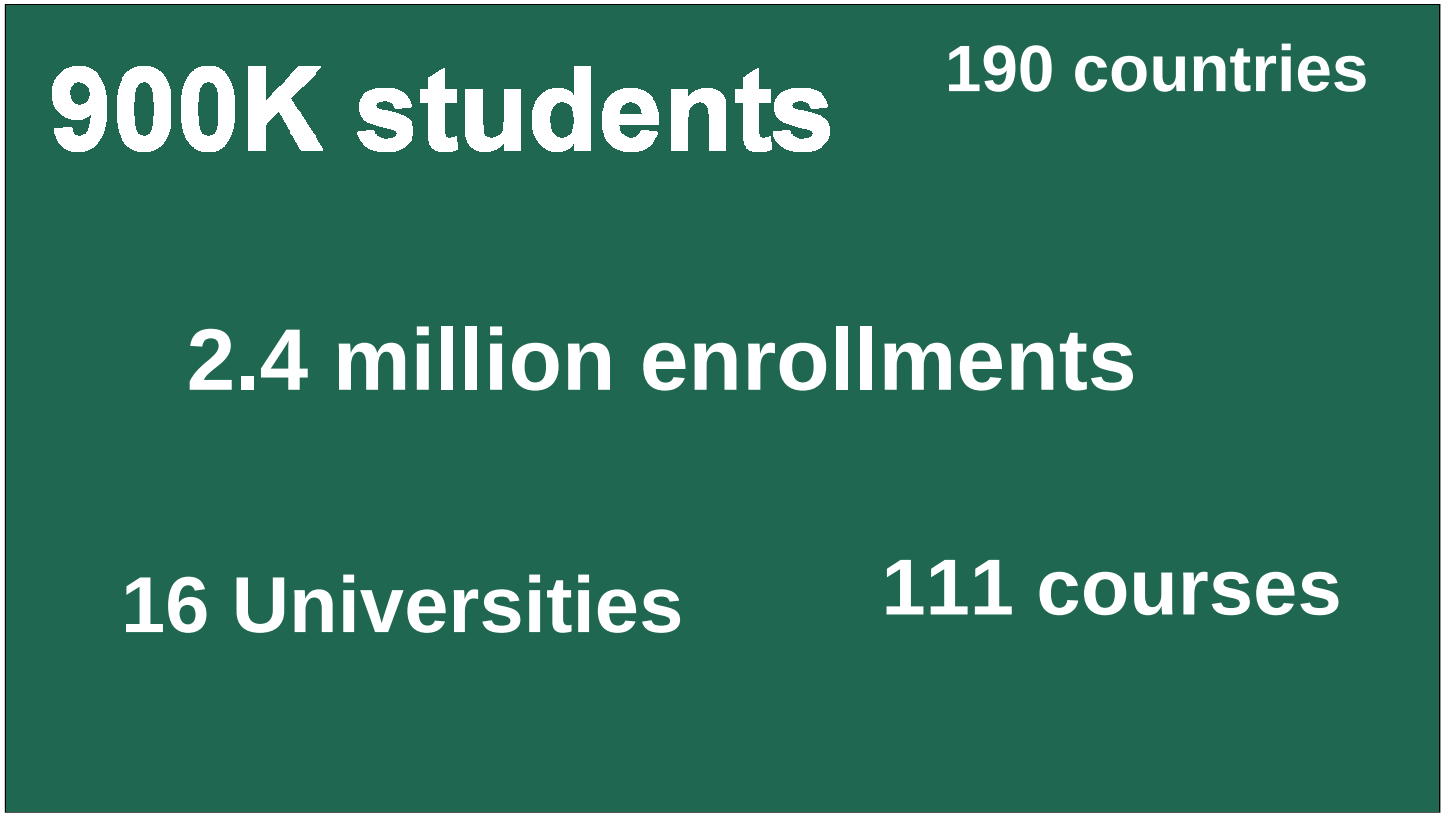


What is suddenly possible is to use technology to offer education at scale. This started with 3 courses that Stanford opened to the world in the fall. For example, the machine learning class was taught by my colleague Andrew Ng. Andrew's ML class is one of the larger at Stanford, with 400 students. Andrew's public machine learning class had an enrollment of over 100K students. So for Andrew to reach the same audience by teaching his Stanford class, he would have to teach it for … 250 years.

Coming from a middle class family from a small town in India. Never had the luck and guidance to reach Stanford for education. Guess what? God has sent the opportunity right across my door step! Heartfelt thanks to the great team and teachers who made this happen! *(Akash Goswami)*

I'm a single mom 39 years old with two college boys... I've been trying to get back to college for my masters and want to learn more about computers. Looking forward to this class!
(Jenny Ramirez)

High academic standards



It turns out that people like to get great content from the best instructors … for free. Since mid-February, when our website opened, we have accumulated more than 600K students from 190 countries. We have close to 1.5 million enrollments in 41 courses, across a range of disciplines. In the 15 courses that have already launched, we have 14 million video views and 6 million quiz submissions.

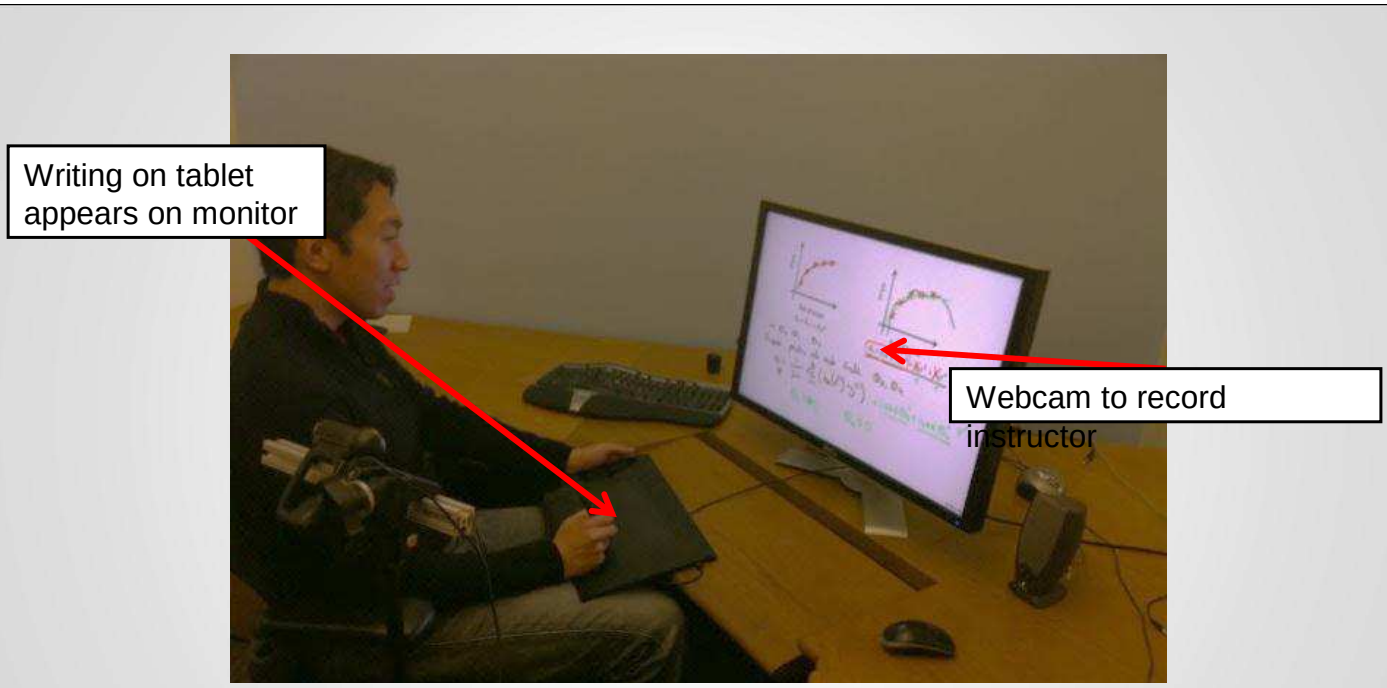

users on site
Course Begins
100K
50K
SEP 26
OCT 3
OCT 10
OCT 17
OCT 24
OCT 31
NOV 7
NOV 14
NOV 21
Timeline

Real Course

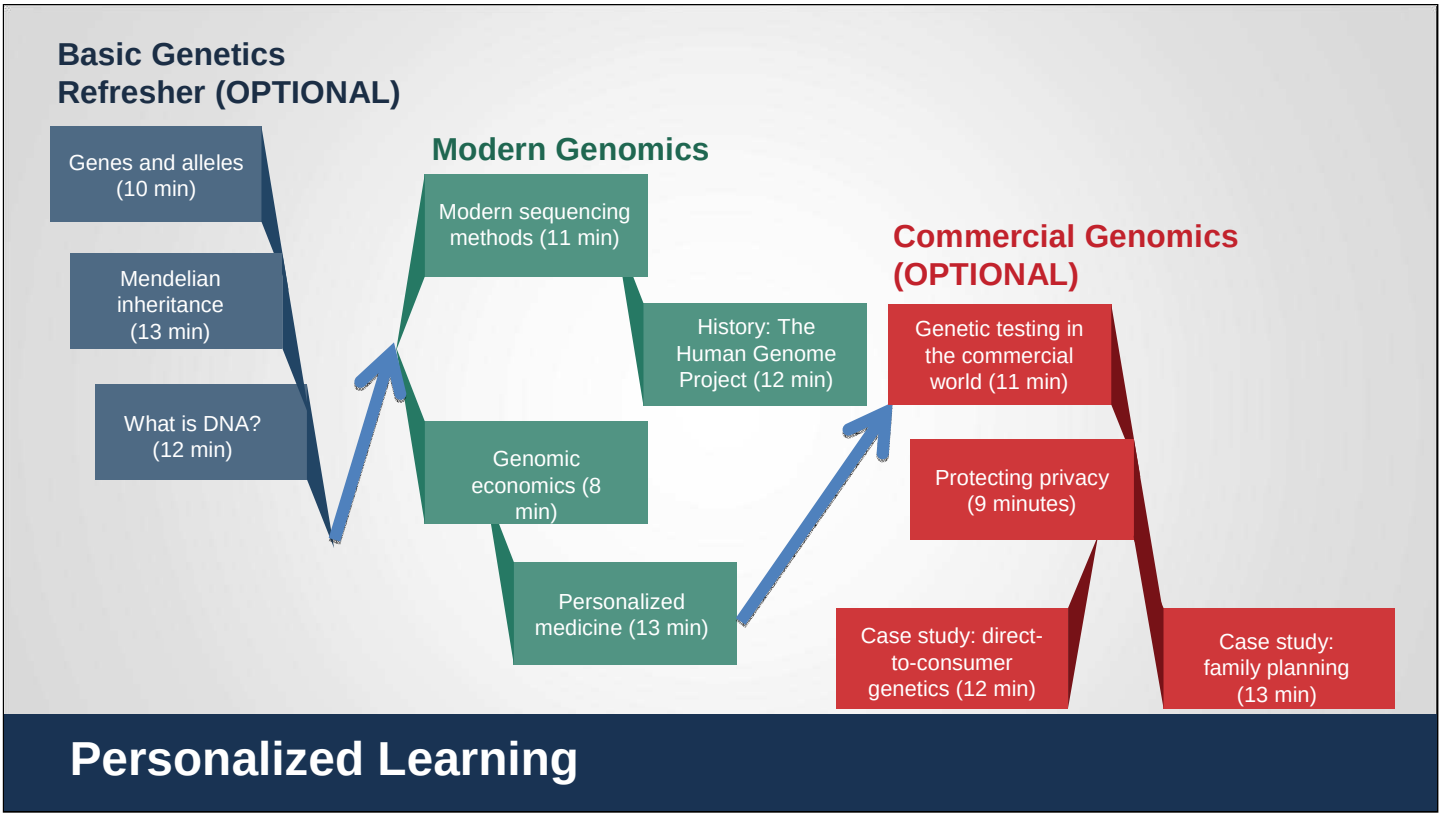
VIDEO-BASED INSTRUCTION

Coursera

ADD GRAPH?



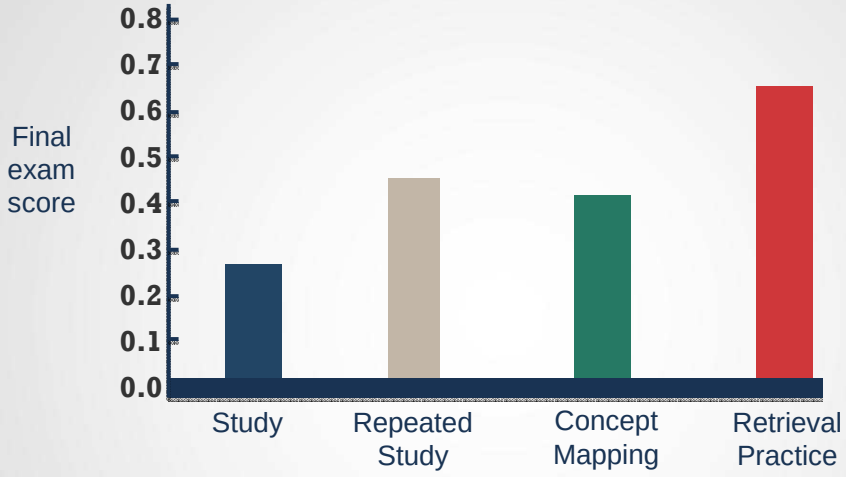
Lecture Recording



Let's talk about some of the key elements that went into these courses. First, when we designs content for the online environment, we can remove the constraints of classroom scheduling, and abandon the monolithic 1hr lecture. The content can be divided into short, coherent modules of 8-12 minutes each, which can be traversed in different ways by different students. Some students might benefit from some additional preparation. Others might want go into depth in certain topics. So we can finally move away from the one-size-fits-all model of education into a much more personalized experience.

ASSESSMENTS

Coursera

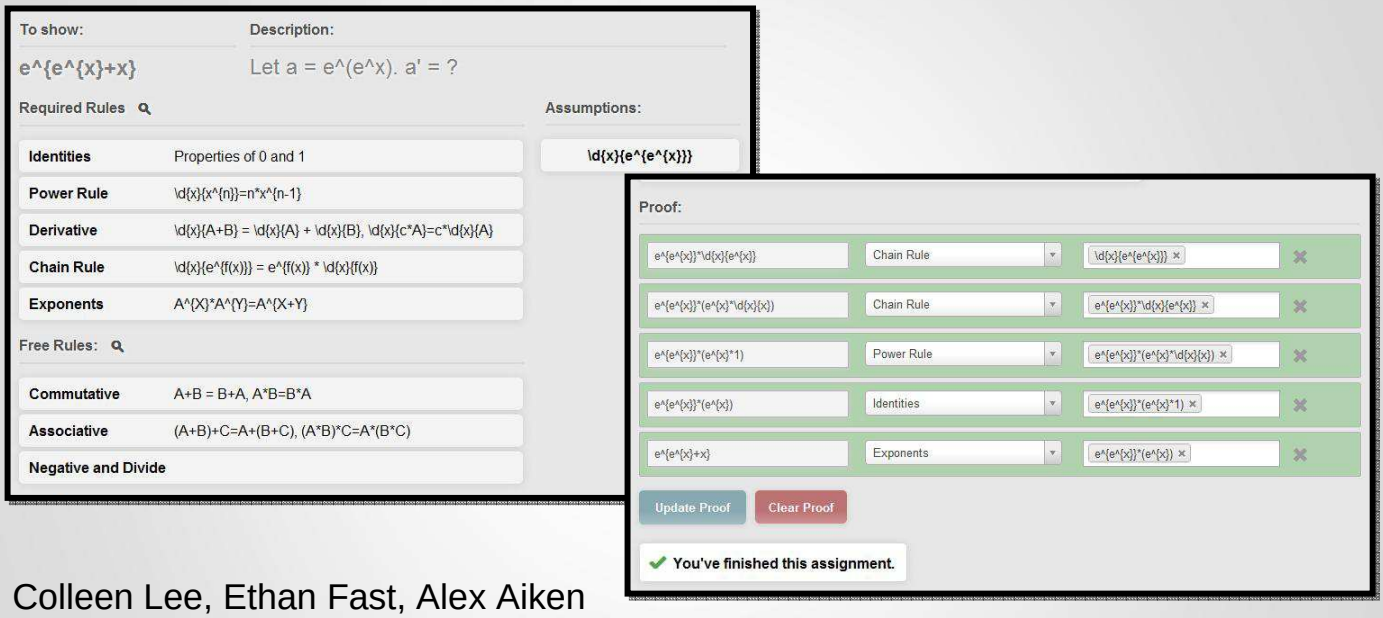


"Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping." J. Karpicke, *J. Blunt. Science* (2011).

Testing Improves Learning

- Multiple-choice (radio button, checkbox)
- Numerical answers
- Short answer
- Math
- Structured outputs: Programming and modeling assignments
- Peer assessment

Multiple forms of assessment



Colleen Lee, Ethan Fast, Alex Aiken

Math assessments

Expression equivalence (e.g., a^2 – b^2 = (a+b)(a-b)..)
Theorem proving

- Programming assignments
  - Support for any language: R, Python, Matlab, Java, …
  - Advanced assessments: timing, memory use, test set performance, …
  - Spell-check, Kinect™ action recognition
- Modeling assignments (e.g., electrical circuits)
- Excel spreadsheets (data analysis, financial models, …)

Grading structured outputs

Question 8

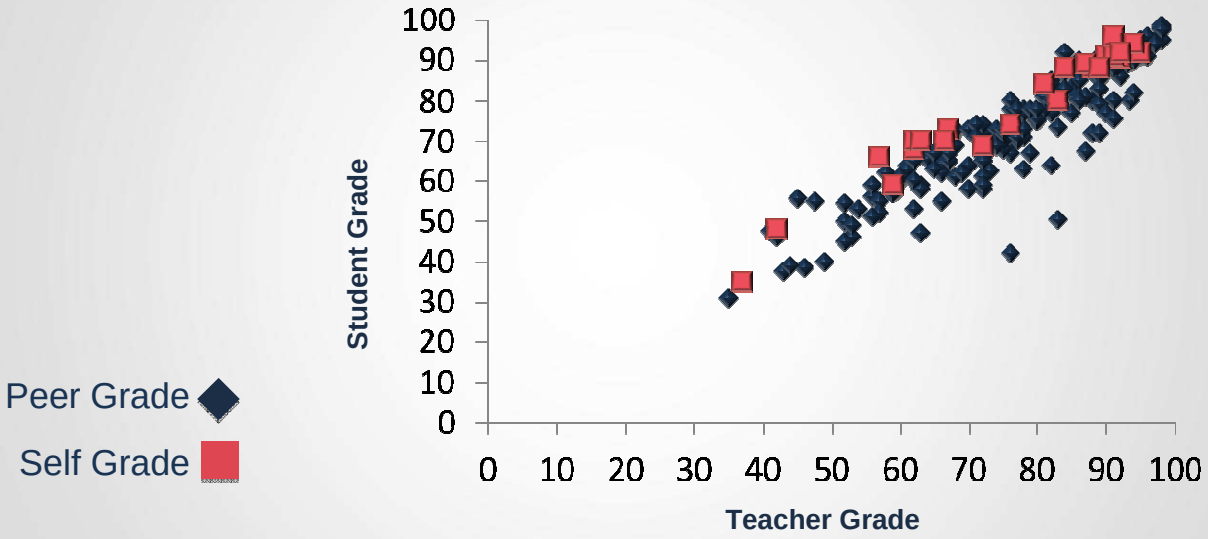
I-maps. I-maps can also be defined directly on graphs as follows. Let $I(G)$ be the set of independencies encoded by a graph G. Then G_1 is an I-map for G_2 if $I(G_1) \subseteq I(G_2)$.

Which of the following statements about I-maps are true? You may select 1 or more options (or none of them, if you think none apply).

- [ ] A graph K is an I-map for a graph G if and only if K encodes exactly the same independencies as G.
- [x] I-maps are Apple's answer to Google Maps.
- [x] An I-map is a function f that maps a graph G to itself, i.e., $f(G) = G$.
- [ ] A graph K is an I-map for a graph G if and only if K and G are identical, i.e., they have exactly the same nodes and edges.
- [x] A graph K is an I-map for a graph G if and only if all of the independencies encoded by K are also encoded by G.

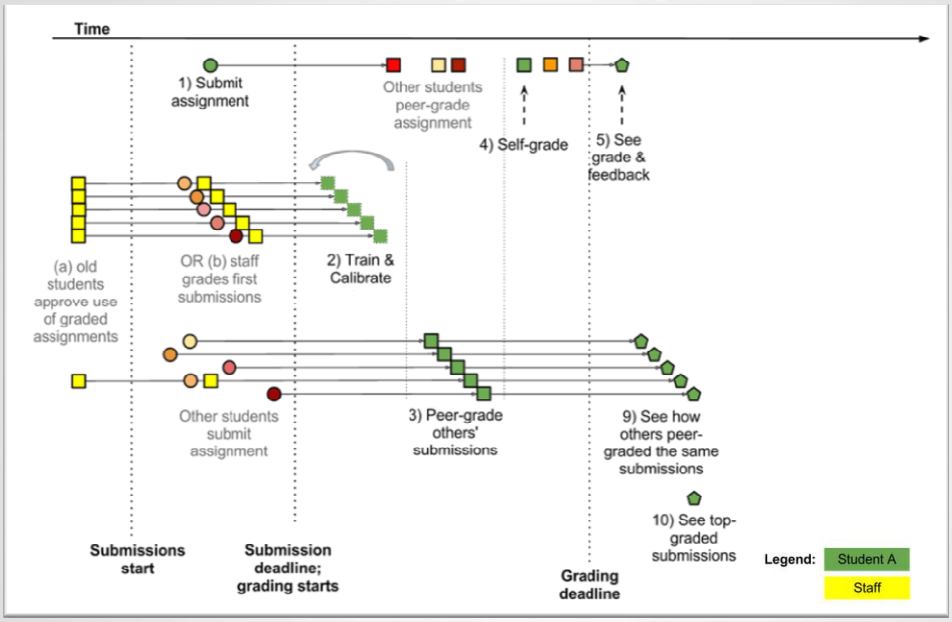
Personalization and Mastery

"The Impact of Self-and Peer-Grading on Student Learning".
P. Sadler, E. Good. *Educational Assessment* (2006).

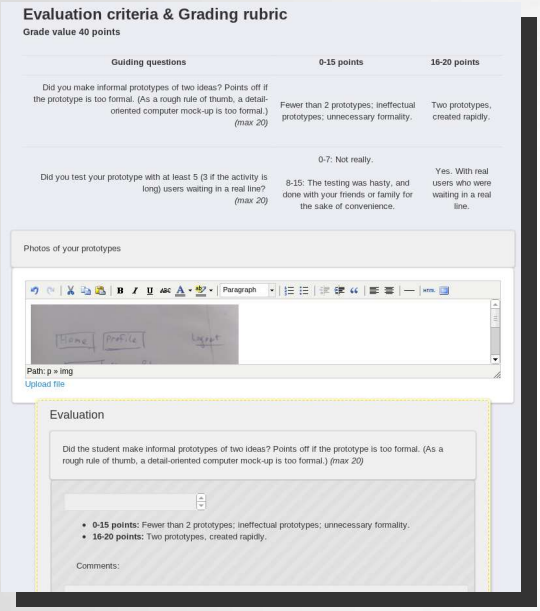


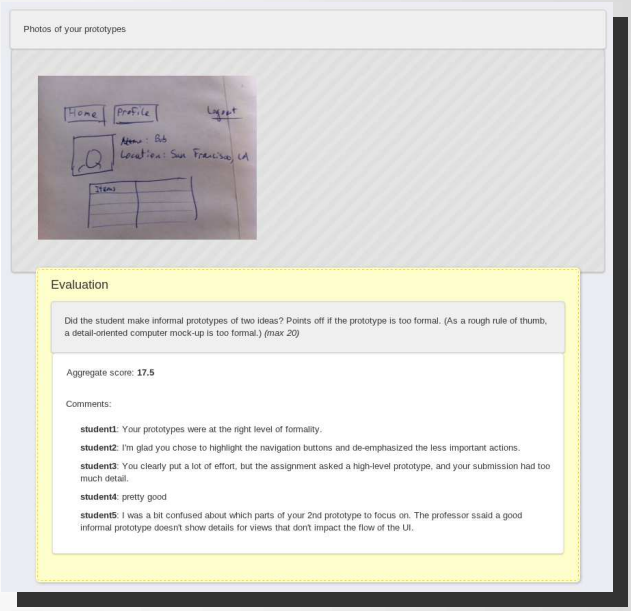
Open-Ended Work

Peer Grading Workflow



Cf. Calibrated Peer Review™ (Chapman, 2001)





Peer Grading

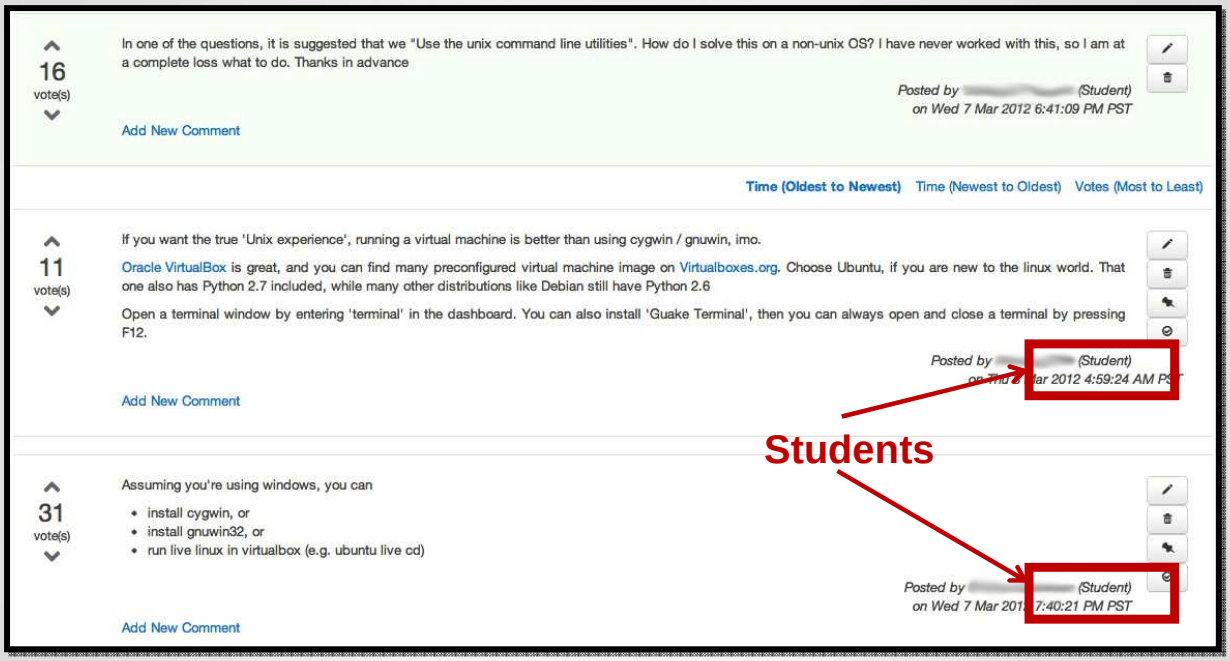
COMMUNITY

** font size proportional to sqrt(number of participants)

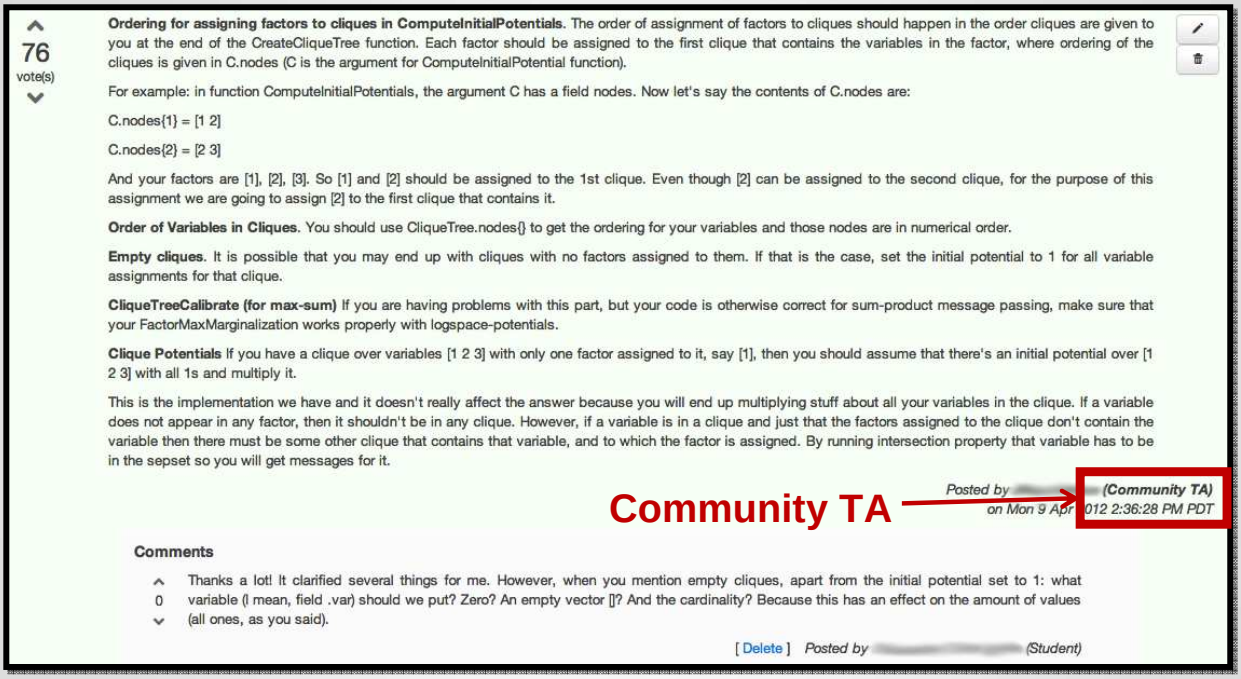
Coursera

Sociology 101 Student Map

Global community of learners



Discussions



Community TAs

Fellow students on these forums really gave the sense that I wasn't just sitting in my office working on it by myself. The spirit of cooperation and information sharing has been far more than any "non-virtual" course I ever took. *(Sanjaya Kumar)*

Vietnam

Czechoslovakia

Nigeria Miami

Austin, Texas

Russian speaking students

Minnesota

Guatemala

Arabic speaking students

A multilingual universal study group

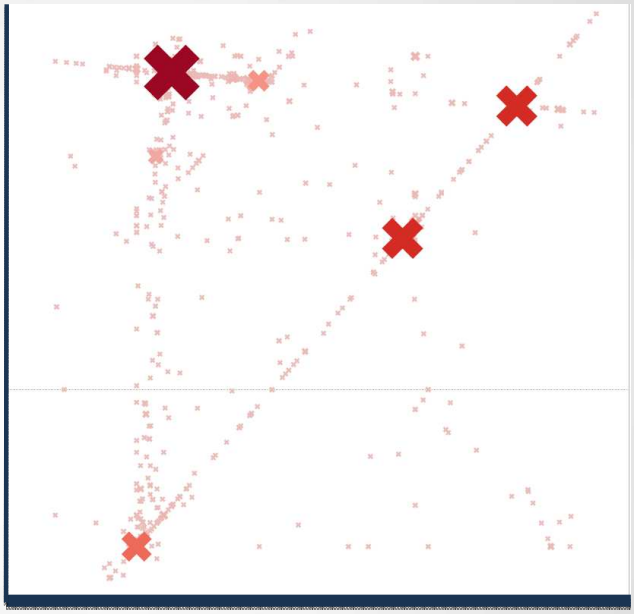
Athens Nepal Kenya

Student Study Groups

STATISTICS & ANALYTICS

Coursera

Wrong answers submitted for machine learning class programming assignment



New Window into Human Learning

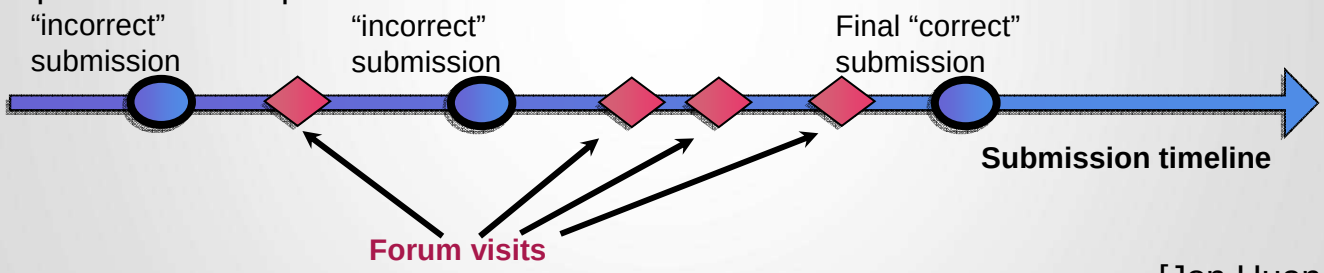
ON HOLD

For each forum question **q**, estimate:

Increase in probability of transitioning to correct response given that a user viewed question q

(focusing only one "cluster" of incorrect responses at a time)

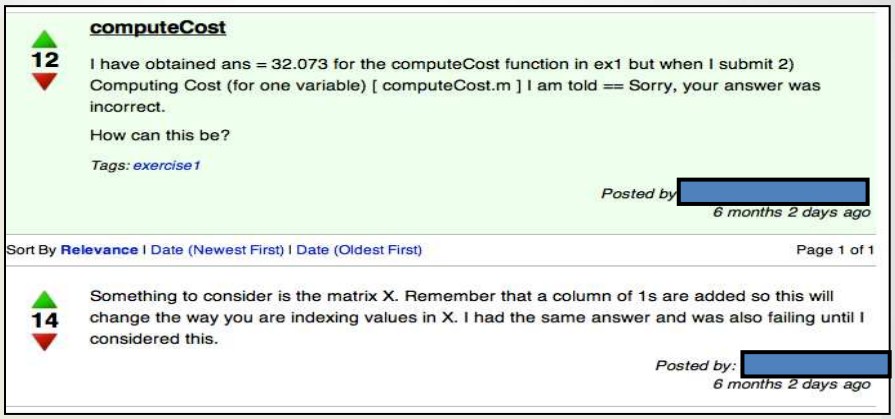
Experimental setup:



[Jon Huang]

New Window into Human Learning

Question 830: 98 views and 1949 not viewed.
- Fraction transitioned to correct if viewed: 0.643
- Fraction transitioned to correct if not viewed: 0.34
- Fraction improvement by viewing: 1.893



computeCost

12

I have obtained ans = 32.073 for the computeCost function in ex1 but when I submit 2) Computing Cost (for one variable) [computeCost.m] I am told == Sorry, your answer was incorrect.

How can this be?

Tags: exercise1

Posted by [redacted]
6 months 2 days ago

Sort By **Relevance** I Date (Newest First) I Date (Oldest First) Page 1 of 1

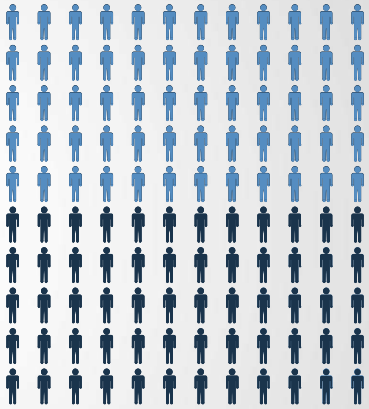
14

Something to consider is the matrix X. Remember that a column of 1s are added so this will change the way you are indexing values in X. I had the same answer and was also failing until I considered this.

Posted by: [redacted]
6 months 2 days ago

[Jon Huang]

What helped the most?



"The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring." *B. Bloom, Educational Researcher* (1984).

The 2 Sigma Problem

College is a place where a professor's lecture notes go straight to the students' lecture notes, without passing through the brains of either.

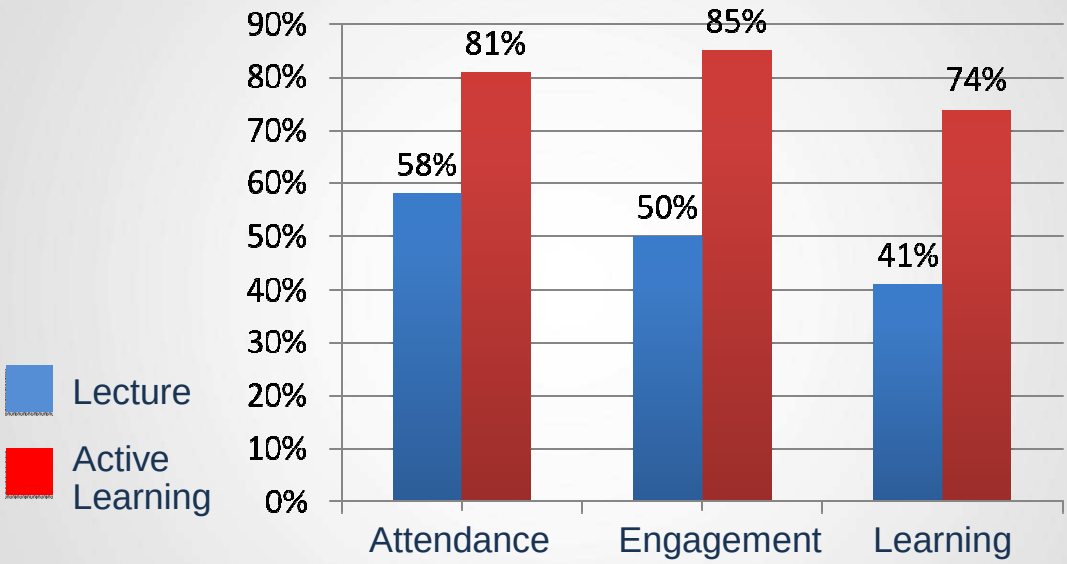
—Mark Twain

The mind is not a vessel that needs filling, but wood that needs igniting.

—Plutarch

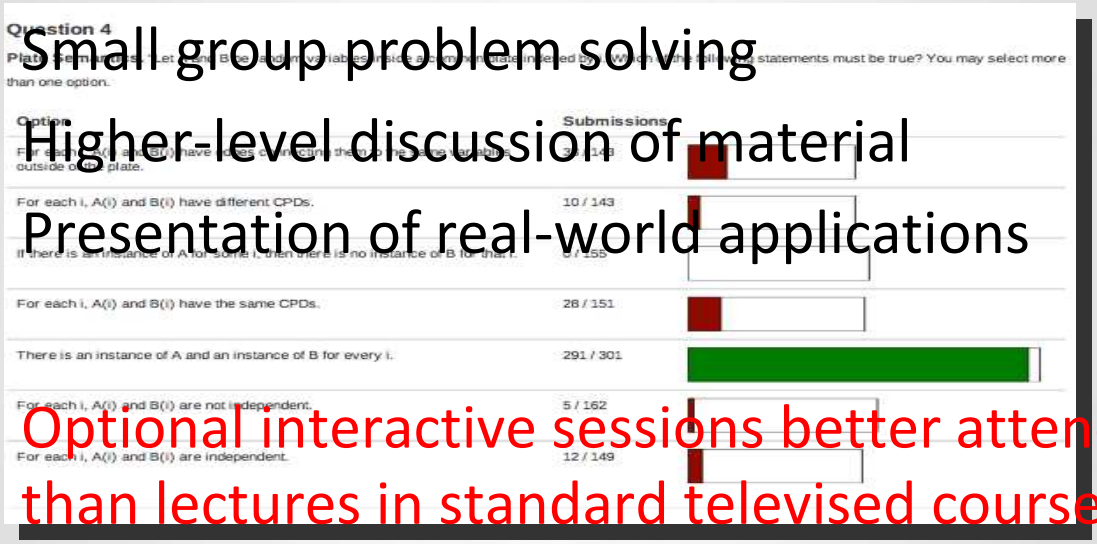
from Ian Kidd's translation of Essays

"Improved Learning in a Large-Enrollment Physics Class."
L. Deslauriers, E. Schelew, and C. Wieman. *Science* (2011).



Igniting Minds

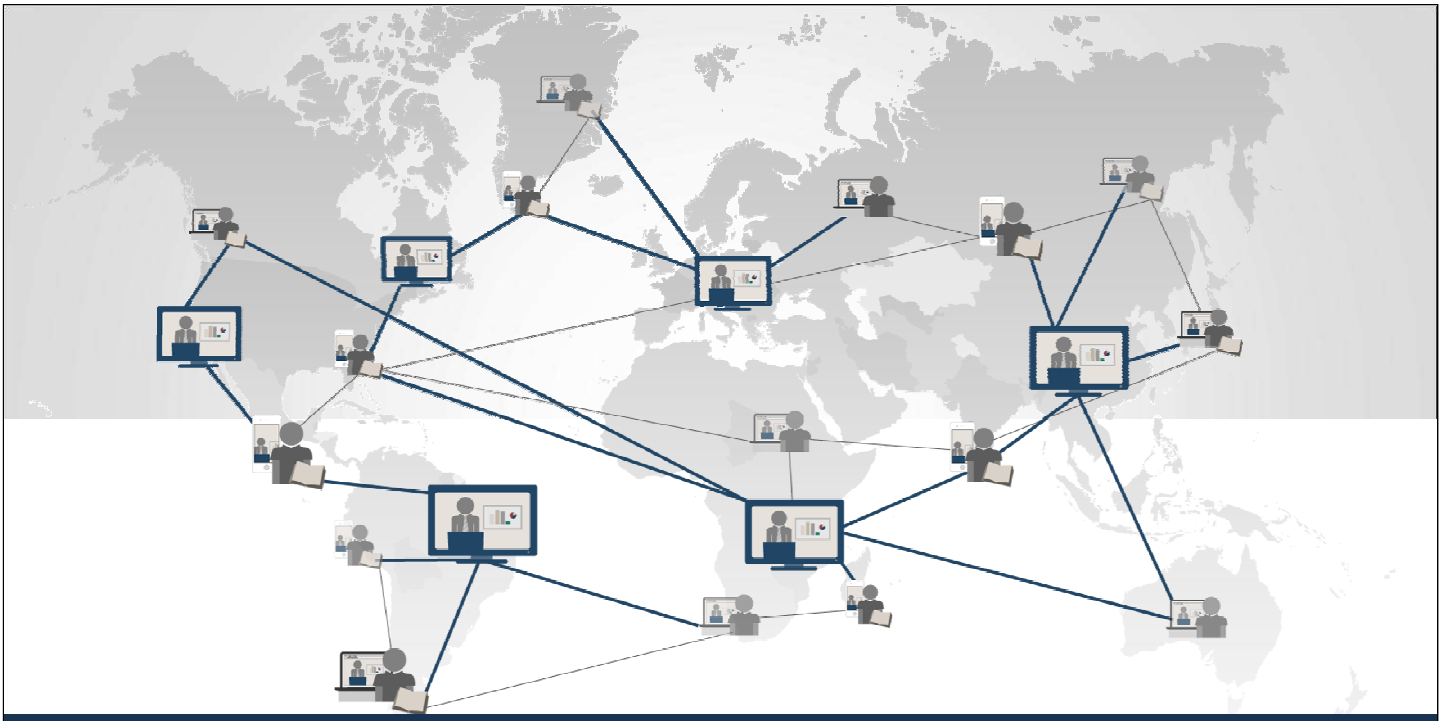
- Just-in-time teaching
- Small group problem solving
- Higher-level discussion of material
- Presentation of real-world applications
- Optional interactive sessions better attended than lectures in standard televised courses



In-class activities

- Enhanced interaction, with immediate feedback
- Individual tailoring of flow and pace through content
- Less threatening environment for students
- Detailed analytics to improve courses
- Time for meaningful engagement between students and faculty, students and peers
- **Interaction and creative problem solving are the real value of top universities**

Benefits to on-campus teaching



Universal Access to Education

What would we get if we could offer a free high-quality education to everyone? First, it establishes education as a basic human right, so that anyone with the motivation and the ability would have the opportunity to get the skills that they need to make a better life for themselves, their families and their communities. Second, it enables lifelong learning. It's a shame that for most of us, learning stops when we finish our formal education. With these amazing courses, we would always have the opportunity to explore new directions, whether to expand our minds or to make a change in our livesk. Finally, it opens the door to a wave of innovation. Because talent can be found everywhere. Maybe the next Albert Einstein or the next Steve Jobs is living in some remote village in Africa. With access to education, he or she can come up with the next big idea, and help make the world a better place for all of us.