

Machine Learning for Education and Education for Machine Learning

Peter Norvig

INTERVIEW

Do New Technologies Cause Unemployment? Not really. Training is the key

The Director of the OCSE Department of Labour and Social Policies has no doubts: "Automation will not create unemployment. The only way to limit the polarizing effect between workers and high and low qualifications will be continuous training."

PRESS RELEASE | September 26, 2017

World Bank warns of 'learning crisis' in global education

World Development Report 2018 calls for greater measurement, action on evidence

WASHINGTON, September 26, 2017 – Millions of young students in low and middle-income countries face the prospect of lost opportunity and lower wages in later life because their primary and secondary schools are failing to educate them to succeed in life. Warning of 'a learning crisis' in global

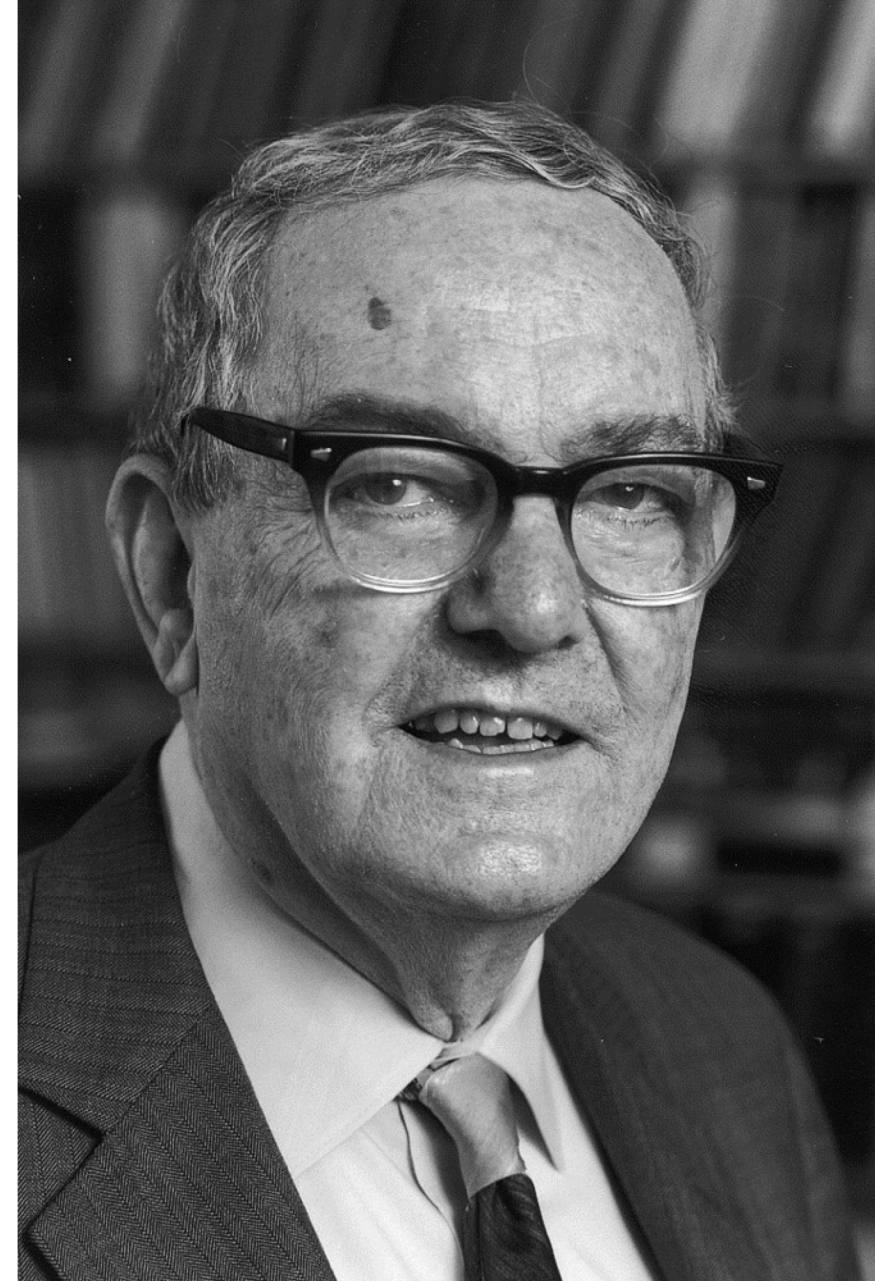
Resources

WORLD BANK

[Website](#)

[Download the Report \(PDF\)](#)

What is Learning?



Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn.

- Herb Simon

Google

the movie in which no babies are born



Google Search

I'm Feeling Lucky



the movie in which no babies are born

Search

About 398,000,000 results (0.21 seconds)

Everything

[Children of Men \(2006\) - IMDb](#)

www.imdb.com/title/tt0206634/

In 2027, in a chaotic world in which humans can **no** longer procreate, a former soldier agrees to help transport a miraculously pregnant woman. **Children of Men** (2006) - IMDb

[Full cast and crew](#) - [Trivia](#) - [Plot Summary](#) - [Photos](#)

Images

Maps

Videos

News

[Children of Men \(2006\) - Plot Summary - The Internet Movie Database](#)

www.imdb.com/title/tt0206634/plotsummary

Top News; **Movie** News; TV News; Celebrity News; Featured News ... Set in a world where no child has been **born** for 18 years and science is at loss to explain

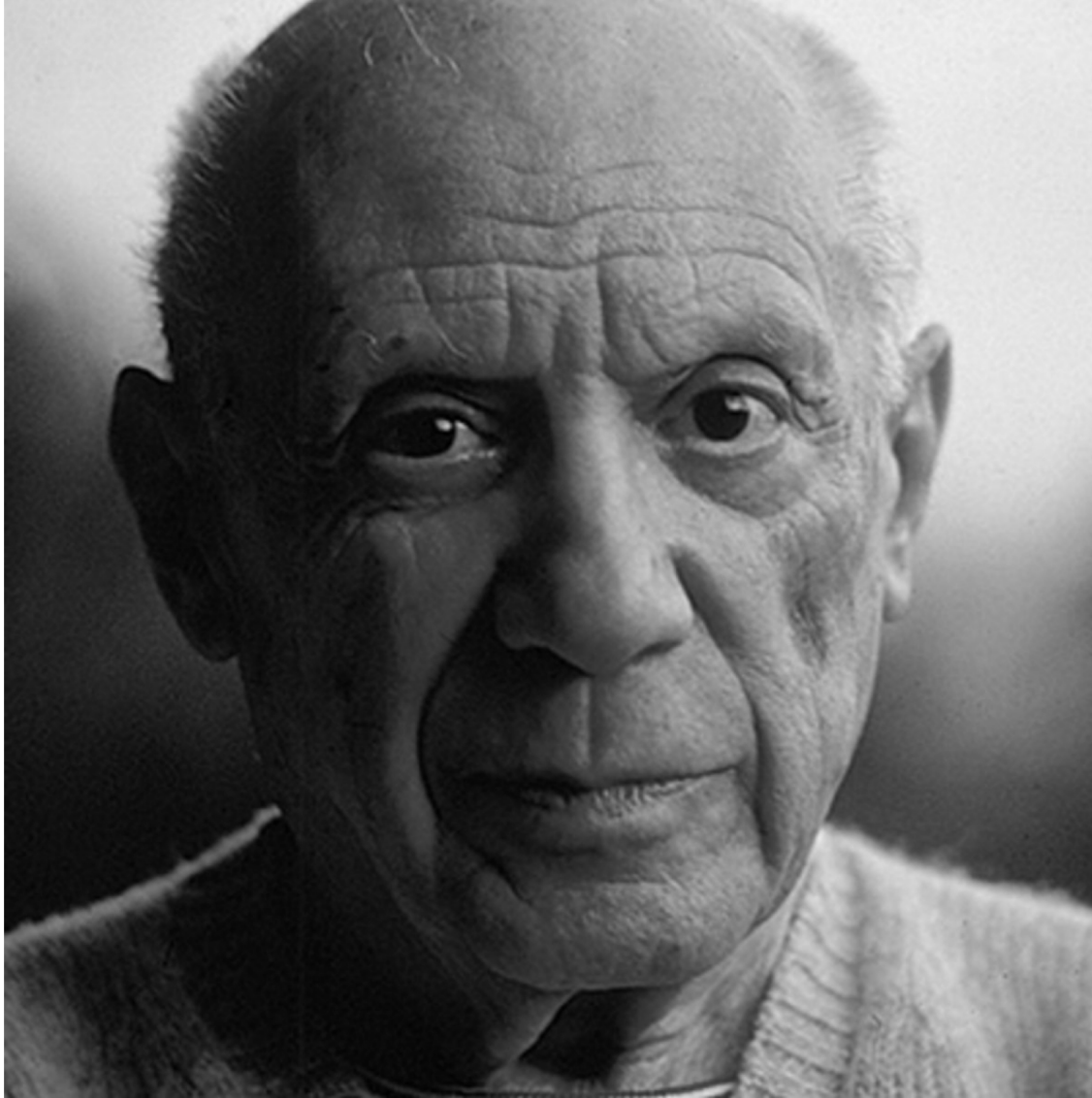
Shopping

More

[Entertainment Today: The Movies in Which No New Babies are Born](#)

[entertainmenttoday.com/blog/2006/06/16/movies-in-which-no-new-babies-are-born/">entertainmenttoday.com/blog/2006/06/16/movies-in-which-no-new-babies-are-born/](#)

Monterey, CA



“Computers are useless. they can only give you answers.” - Pablo Picasso



Stuart
Russell
Peter
Norvig

Artificial Intelligence

A Modern Approach

Third Edition

Statistical Machine Translation

SEHR GEEHRTER GAST!
KUNST, KULTUR UND
KOMFORT IM HERZEN
BERLIN.

DEAR GUESTS,
ART, CULTURE AND
LUXURY IN THE HEART
OF BERLIN.

DIE ÖRTLICHE
NETZSPANNUNG BETRÄGT
220/240 VOLT BEI 50
HERTZ.

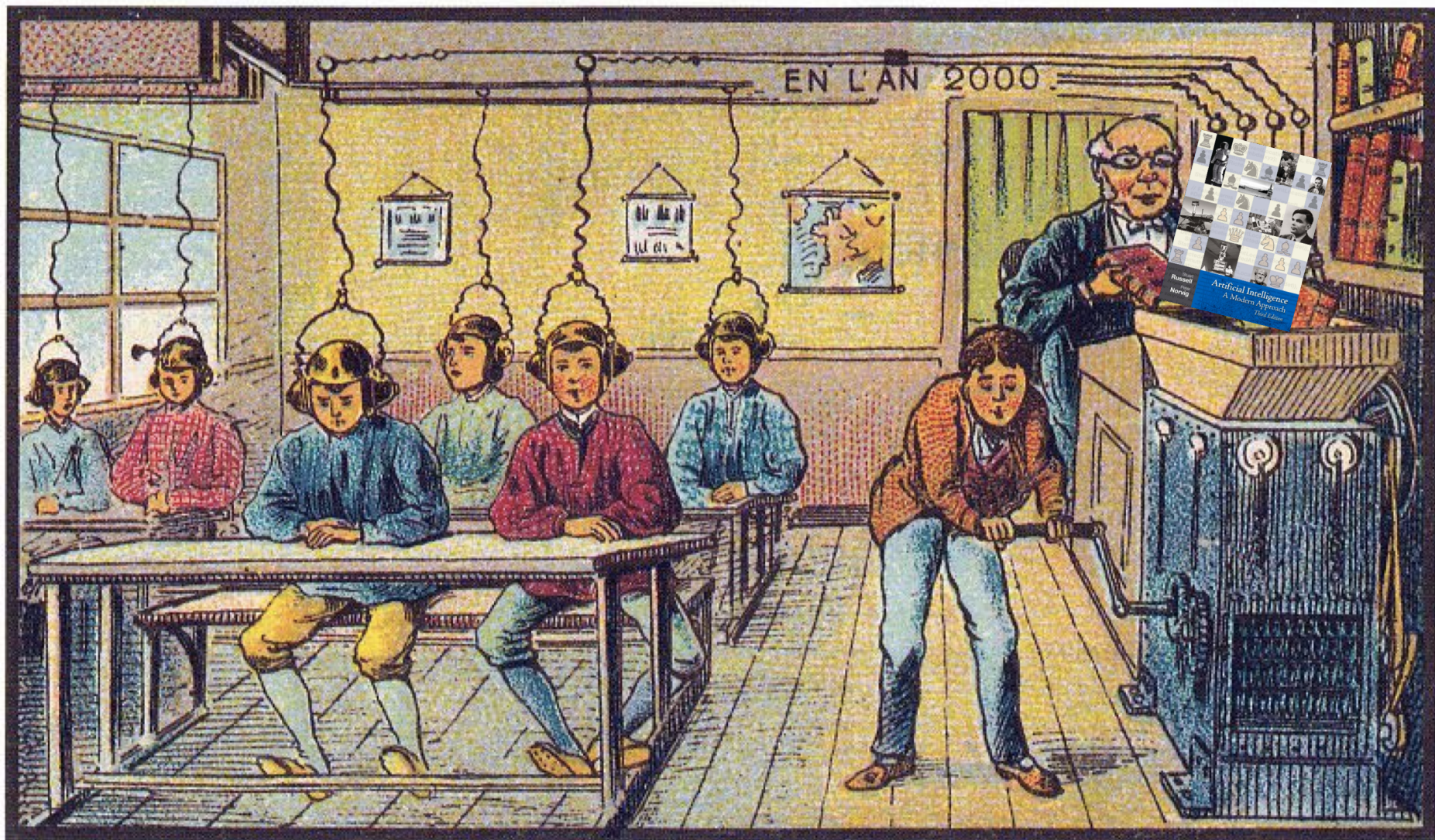
THE LOCAL VOLTAGE
IS 220/240 VOLTS 50 H
EN

DE





Marginal text at the bottom right of the page, partially obscured by the yellow outline.



At School



INTRODUCTION TO Artificial Intelligence

In partnership with



Course

Discussion

Progress

Information

Profile

The instructors



Sebastian Thrun

Sebastian Thrun is a Research Professor of Computer Science at Stanford

University, a Google Fellow, a member of the National Academy of Engineering and the German Academy of Sciences. Thrun is best known for his research in robotics and machine learning.



Peter Norvig

Peter Norvig is Director of Research at Google Inc. He is also a Fellow of the American

Association for Artificial Intelligence and the Association for Computing Machinery. Norvig is co-author of the popular textbook Artificial Intelligence: A Modern Approach. Prior to joining Google he was the head of the Computation Sciences Division at NASA Ames Research Center.

Check out our new classes at www.udacity.com!



My name is Sebastian Thrun. >>I'm Peter Norvig.

Click on 'CC' above to see translations in over 40 languages!
Many thanks to all our volunteer translators!!!



MOTIVATION: Students' motivation determines, directs, and sustains what they do to learn.

CONSTRUCTIVISM: To help students revise inaccurate beliefs and flawed mental models ask them to make predictions ... and give them an opportunity to test those predictions.

Eberly Center
for Teaching
Excellence
& Educational
Innovation

MASTERY: To develop mastery, students

Google's DeepMind developed an IQ test for AI models

KYLE WIGGERS @KYLE_L_WIGGERS JULY 11, 2018 10:52 AM



apply what they have learned.

Eberly Center
for Teaching
Excellence
& Educational
Innovation

DIALOG: Goal-directed practice coupled with targeted feedback enhances the quality of students' learning.

SOCIAL: Students' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning.



"Every time a student makes a mistake in math, they grow a synapse." -- Jo Boaler

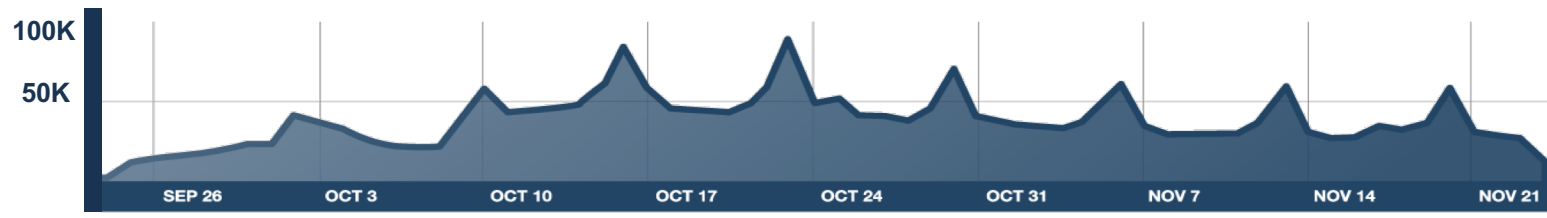


Teacher says, every time a bell rings an angel gets his wings

Optimize Motivation

- Engagement (early adopter, enthusiasts)
- Authenticity (instructors, Stanford)
- Peer support (forums, outside groups)
- Instructor support (email, video)
- Due dates

users on site



Timeline (successful Coursera course)



aiqus:
the ai & cs
learning
comm

All Questions

reddit AI-CLA

↑ 17 ↓

Sign up promoted 9 comm

facebook

↑ 26 ↓ 11

↑ 27 ↓ 7

↑ 28 ↓ 94



YouTube

Office Hours 8 01.mp4

knowitvideos



Subscribe

1,043



Search



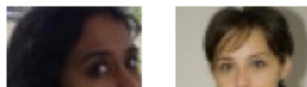
CompScisters



Closed Group

Members (278)

Friends



Find

a Meetup Group

Start

a Meetup Group

Stanford Artificial Intelligence Meetup Groups



Groups
9

Members
801

Interested
370

Cities
9

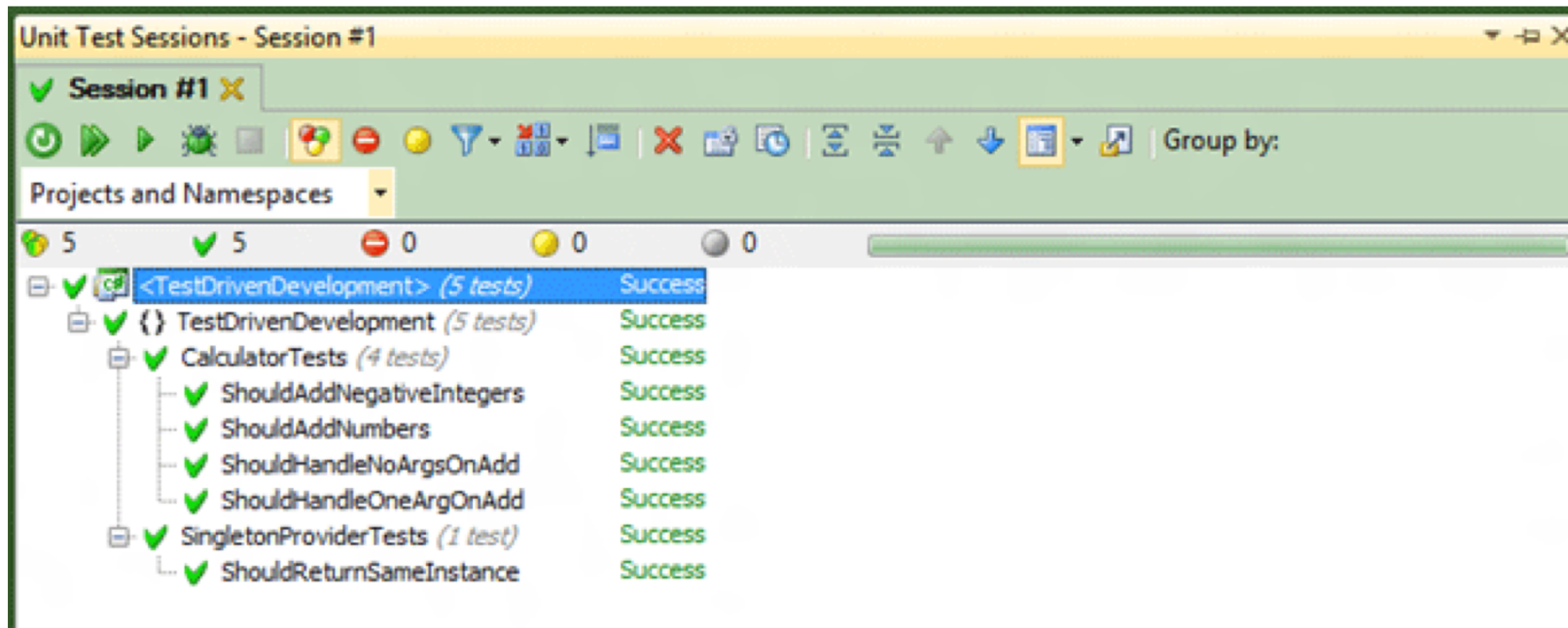
Related topics: [Stanford Machine Learning Course CS 229](#), [Free Stanford Predictive Modeling](#), [Artificial Intelligence](#), [Machine Learning](#), [Stanford AL](#), [Predictive Analytics](#), [Computer Science](#)

Largest Meetup Groups

Put this list on your website

1 [Seattle Data/Analytics/Machine-Learning MeetUp Group](#)
Seattle, WA

Monthly MeetUp group for practitioners of Machine Learning, Statistical aspects of "Data Science". Do you want to learn more about using Apache Mahout and Giraph? Do you write your own custom NLP



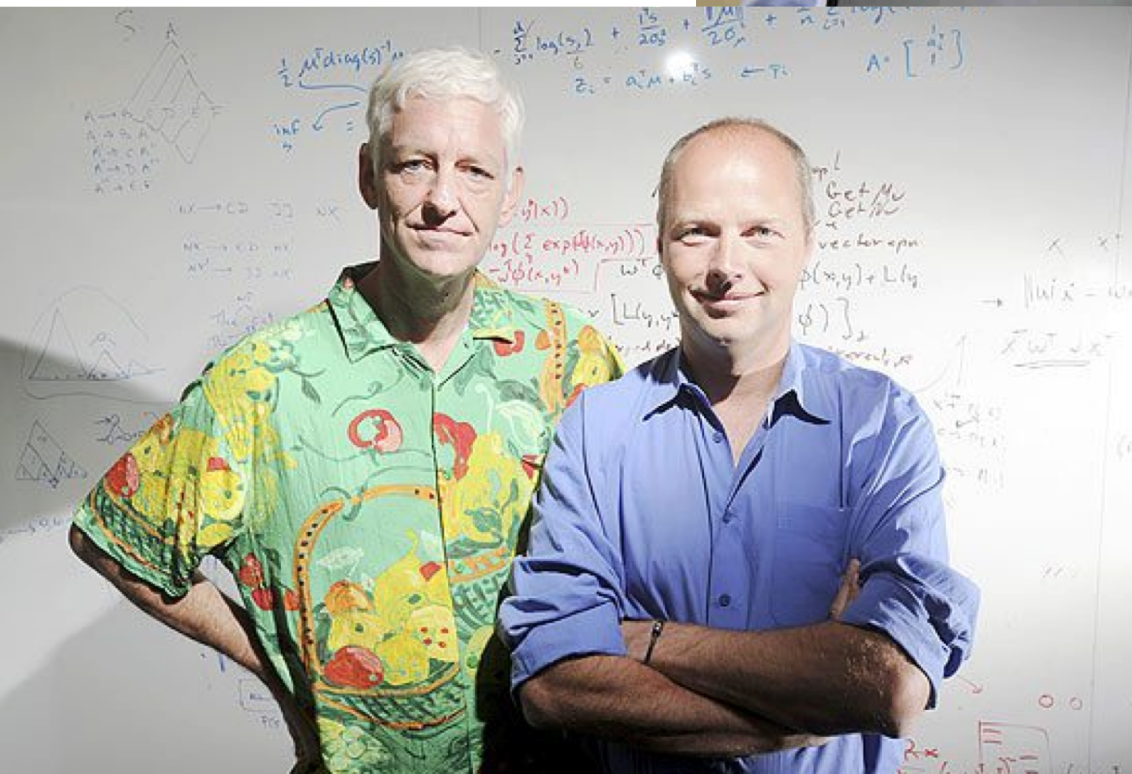
“Richard Hamming told me his secret: First get together the problem sets and exams that you want the students to be able to solve. Then write a book that will teach them how to solve them.”

-- Hal Varian

What does this
have to do with
Machine Learning?

Ng Koller

Norvig Thrun



MOOCs
and
Machine
Learning

Your School Name Here

Your School Address

Name: Your Name

ID# : Your Student ID

DOB: Your Date of Birth

Dept	Course No.	Title	Units Attempted	Units Earned	GRADE	GRADE POINTS
*** ACADEMIC TRANSCRIPT ***						
FALL	1968					
COM	101	Introduction to Speech Communication	3.0	3.0	A-	12.0
CIS	101	Introduction to Business Computers	3.0	3.0	B	9.0
ENG	121	English Composition	3.0	3.0	A	12.0
FRN	101	Beginning French I	3.0	3.0	B	9.0
MTH	111	Analytical Geometry & Calculus I	3.0	3.0	B-	9.0
PHY	113	Classical Physics	3.0	3.0	A	12.0
SEMESTER TOTALS			18.0	18.0	3.50	63.0
SPRING	1969					
ENG	122	Critical Writing and Reading	3.0	3.0	A	12.0
FRN	102	Beginning French II	3.0	3.0	B	9.0
MTH	112	Analytical Geometry & Calculus II	3.0	3.0	A	12.0
PHY	114	Classical Physics II	3.0	3.0	B	9.0
PSY	101	Introduction to Psychology	3.0	3.0	A-	12.0
SEMESTER TOTALS			15.0	15.0	3.60	54.0
CUMULATIVE TOTALS			33.0	33.0	3.55	117.0
FALL	1969					
ART	123	Art Appreciation	3.0	3.0	B-	9.0
BIO	121	General Biology I	3.0	3.0	B	9.0
ECO	201	Intro to Microeconomics	3.0	3.0	A-	12.0
FIN	101	Personal Finance Decision	3.0	3.0	A	12.0
HIS	122	World History 1877 to Present	3.0	3.0	A	12.0
SEMESTER TOTALS			15.0	15.0	3.60	54.0
SPRING	1970					
ACC	201	Moniers Accounting I	3.0	3.0	A	12.0
ART	131	Intro to Music Appreciation	3.0	3.0	B	9.0
BIO	127	General Biology II	3.0	3.0	A	12.0
ECO	202	Intro to Macroeconomics	3.0	3.0	A-	12.0
FIN	266	Principles of Finance	3.0	3.0	A	12.0
ENG	206	Written Business Communications	3.0	3.0	A-	12.0
SEMESTER TOTALS			18.0	18.0	3.83	69.0
CUMULATIVE TOTALS			66.0	66.0	3.64	240.0

Memoranda & Footnotes:

- CG Change of grade
- IR Incomplete removed
- IC Incomplete charged
- RC Repeated class
- S Substitution
- BP By petition
- TC Transfer credit
- AO Audit only, no credit received

Student is in good standing unless otherwise indicated.

TRANSCRIPT IS ONLY VALID WITH THIS SIGNATURE

Thomas Alan Carothers

OFFICE OF THE REGISTRAR

Transcripts Issued

06/09/1991

Degree or Credential Certification

BBA 06/09/1991



20 bits per year



Dinner with Jenny in 30 min

20:30 - 22:00 | 10°C



12 Mbps

ML / Data Analysis

- Who drops out? When? Why? (Explain / Predict)
- What does each student know?
- Create content that maximizes impact on students
- What should we present next to this student?
- How to best allocate human assistant time?
- Who learns / teaches what in forums?
- Which students should partner together?
- How do students rate the course?
- How do students succeed beyond the course?
- Timing of due dates and of spaced repetition
- What responses cluster together?

Real-Time Dashboard

Key	Lesson	Title	Pct Correct
48686495	Problem Set 1	Seven Card Stud	97
47645966	Problem Set 1	Jokers Wild	82
48727299	Lesson 2	Neighbors	96
48734111	Lesson 2	Timed Calls	80
48739030	Lesson 2	All Ints	89
48240896	Lesson 2	Solving Cryptarithmic	89
48703205	Lesson 2	Filling In Fill In	81
48536981	Lesson 2	Compile Word	86
48258993	Problem Set 2	No Leading Zeros	87
48696508	Problem Set 2	Floor Puzzle	94
48704217	Problem Set 2	Subpalindrome	87
48683736	Lesson 3	Regular Expressions Review - Quiz 1	13
48664996	Lesson 3	Regular Expressions Review - Quiz 2	92
48740074	Lesson 3	Regular Expressions Review - Quiz 3	8
48664984	Lesson 3	Matchset	89
48665977	Lesson 3	Filling Out The Api	82
48665968	Lesson 3	Search And Match	87
48667936	Lesson 3	Alt	94
48741070	Lesson 3	Simple Compilers	95
48667934	Lesson 3	Oneof And Alt	89
48667943	Lesson 3	N Ary Function	84
48667937	Lesson 3	Trace Tool	94

Experimentation

- Challenge 2 E
- Challenge 3 M
- Challenge 4 M
- Challenge 5 M
- Challenge 6 H
- Challenge 7 E
- Challenge 8 E
- Challenge 9 M
- Challenge 10 M
- Challenge 11 M
- Challenge 12 M

Step 1: Explore skills relevant for this challenge.

Lessons

- Google Scholar Video (3:10) Text
- Legal Scholar Video (6:21) Text
- Google News / News Archive Video (4:36) Text
- Using site structure Video (3:21) Text
- Comparing multiple sources Video (6:43) Text
- All skills Videos Texts

[Quick Reference Guide](#)

Examples

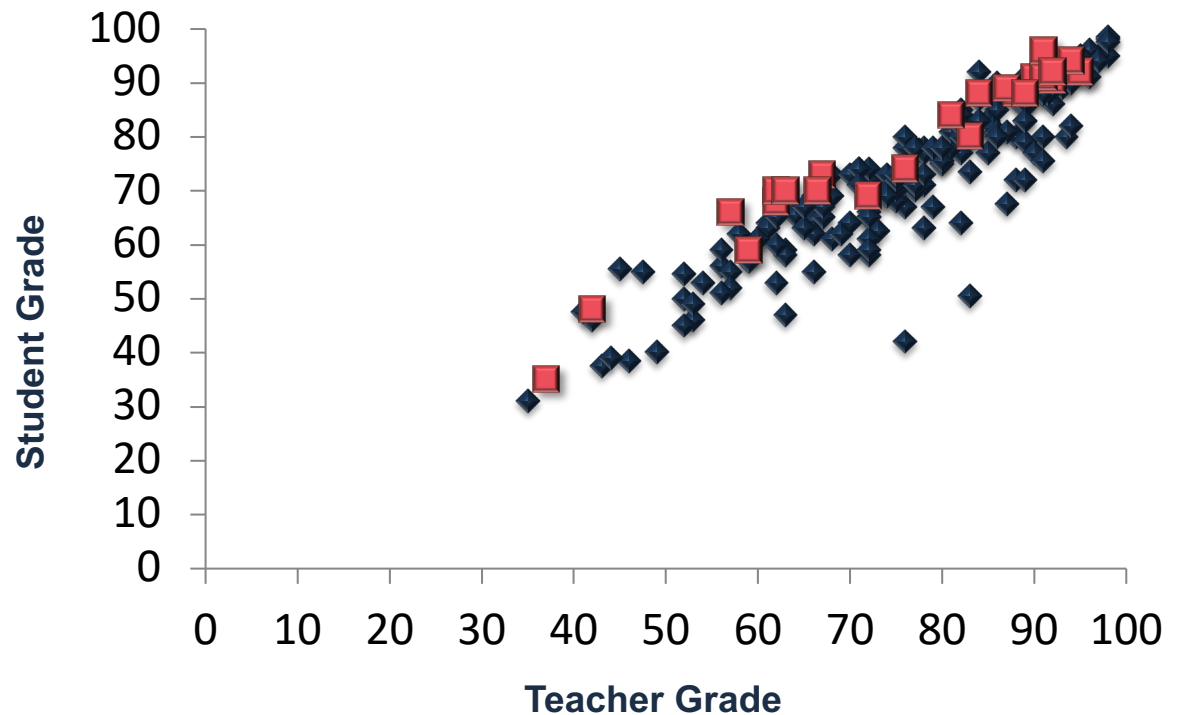
- [King Tut's curse](#)
- [Which anthropologists?](#)
- [PT Barnum's notebook](#)

Step 2: Solve the challenge and check your answer.

Hints

Show Answer

Peer Grade ◆
Self Grade ■



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

“Tuning Models of Peer Assessment in MOOCs”.
C. Piech et al, International Conference on Educational Data Mining (2013)

SISYPHUS! YOU ARE CURSED TO
PUSH A STONE UP A HILL, ONLY TO
SEE IT FALL DOWN OVER
AND OVER AGAIN!

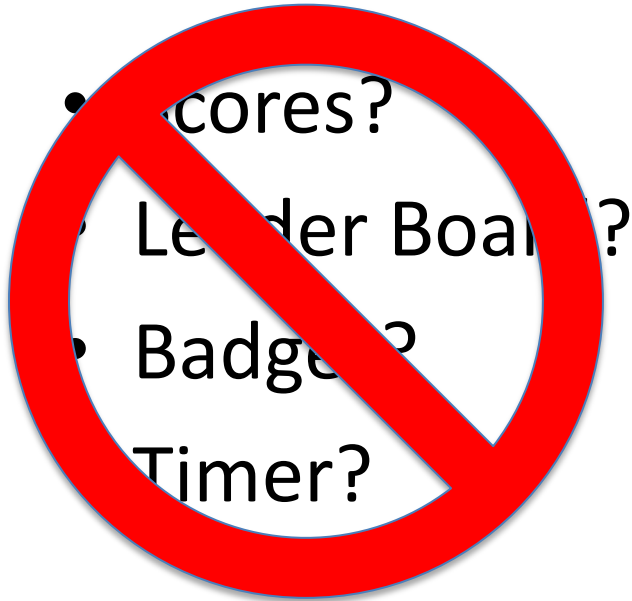
NOOOO!





Gamification

Gamification



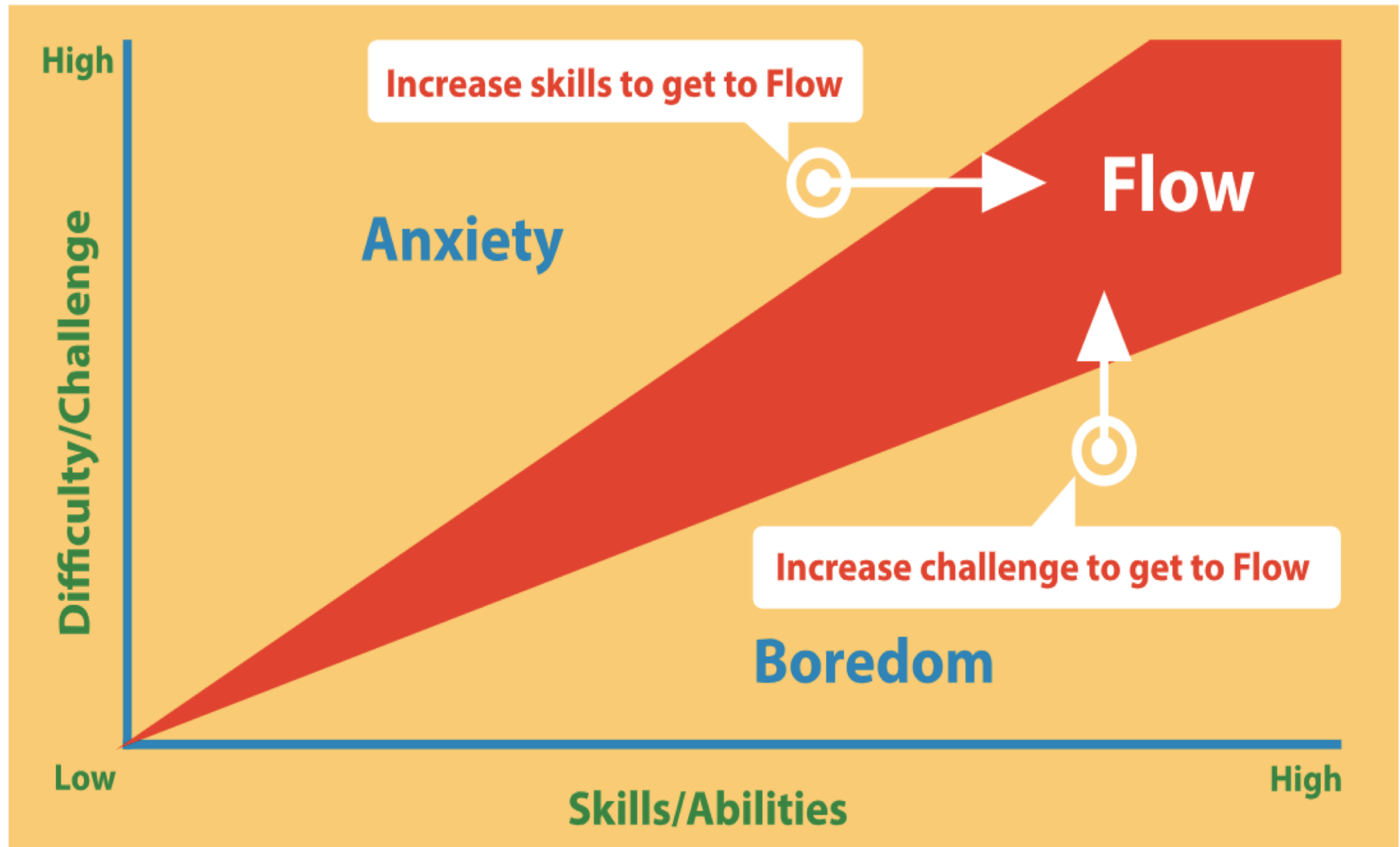
• scores?

• Leader Board?

• Badge?

Timer?

Attaining Flow in eLearning Using Gamification



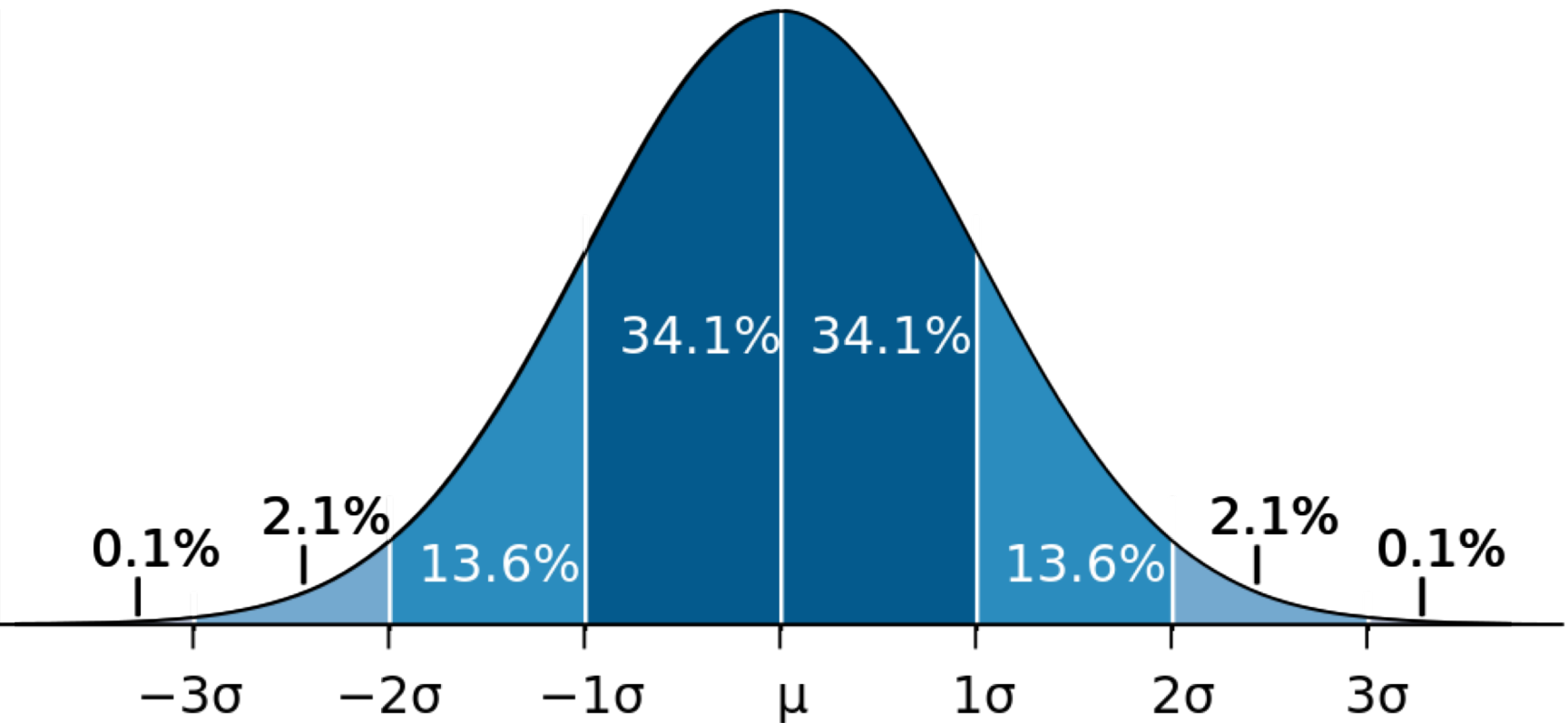
Adapted from Csikszentmihalyi (2004)



Benjamin Bloom

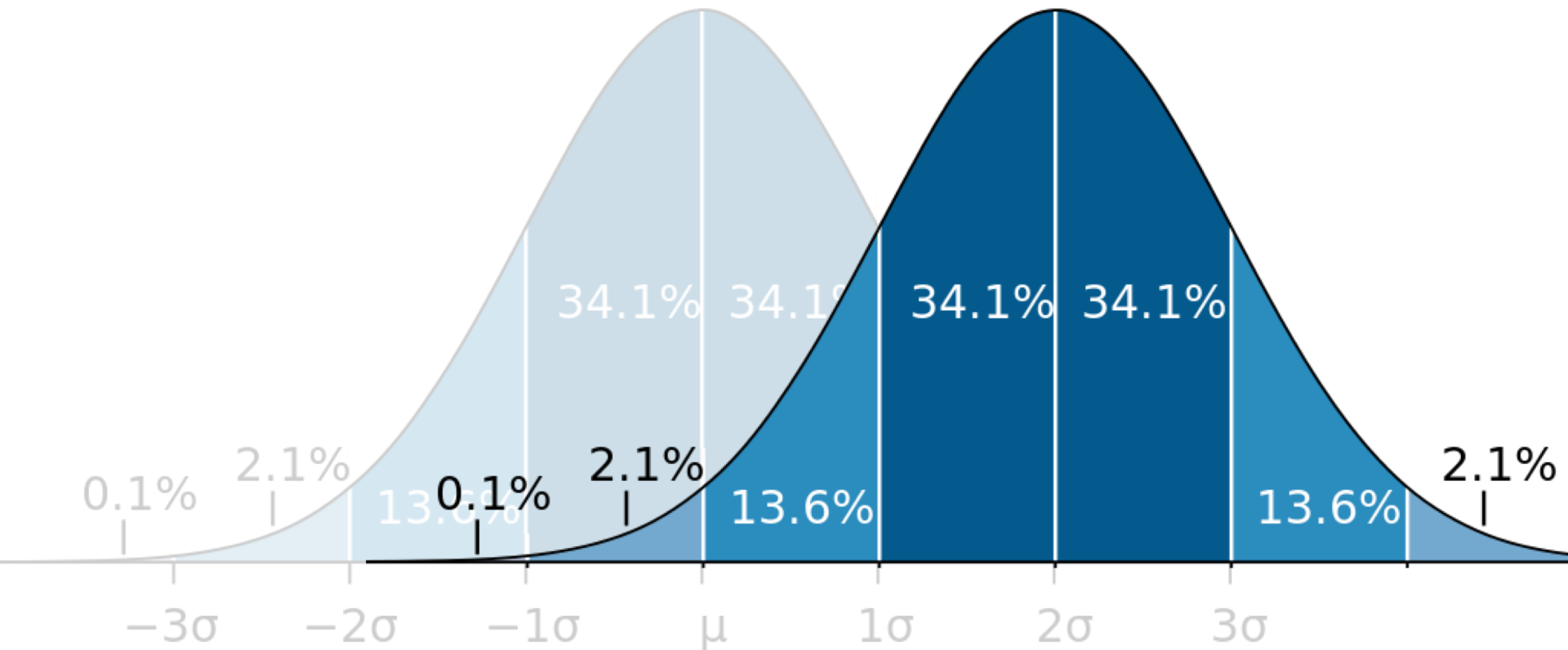


Neal Stehenson



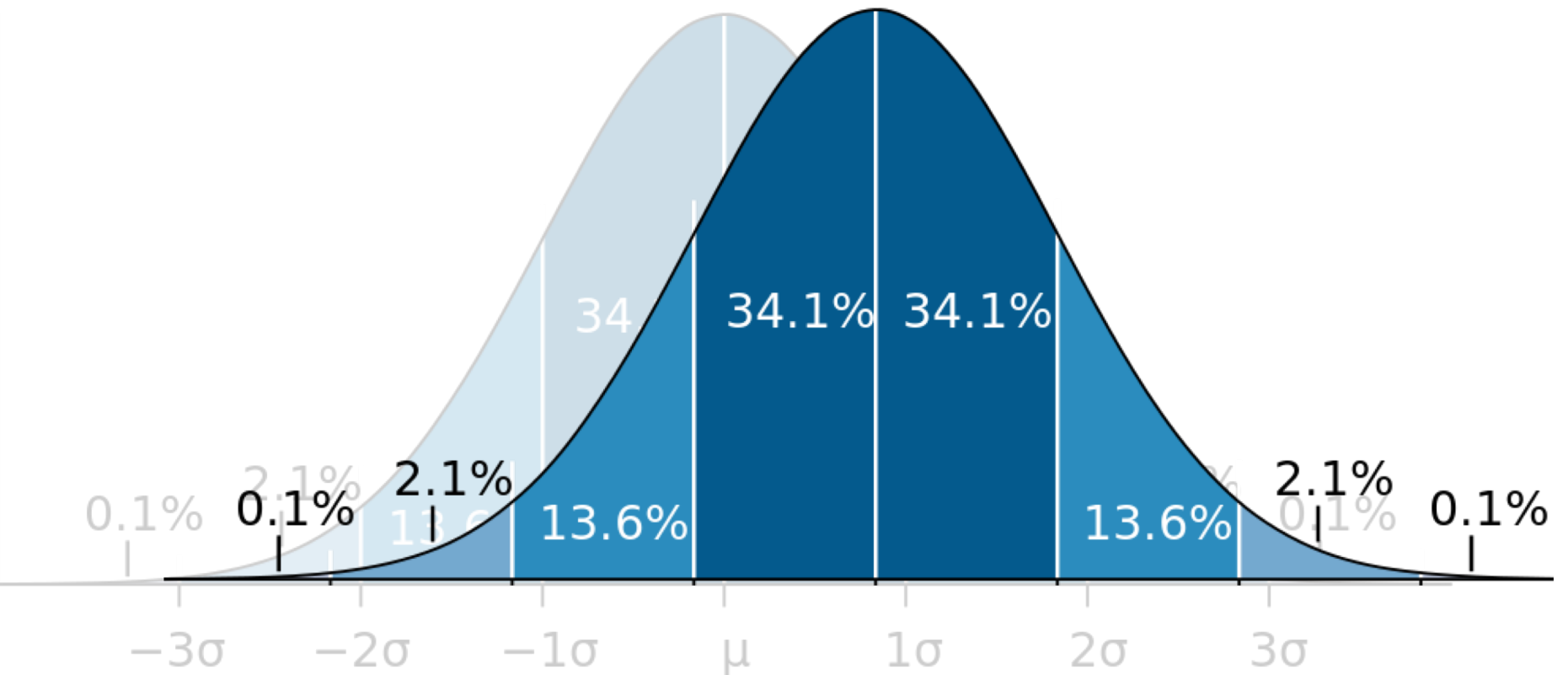
Benjamin Bloom: “Two Sigma Effect”

Tutoring + Mastery



Benjamin Bloom: “Two Sigma Effect”

Human *or* Computer Tutoring + Mastery



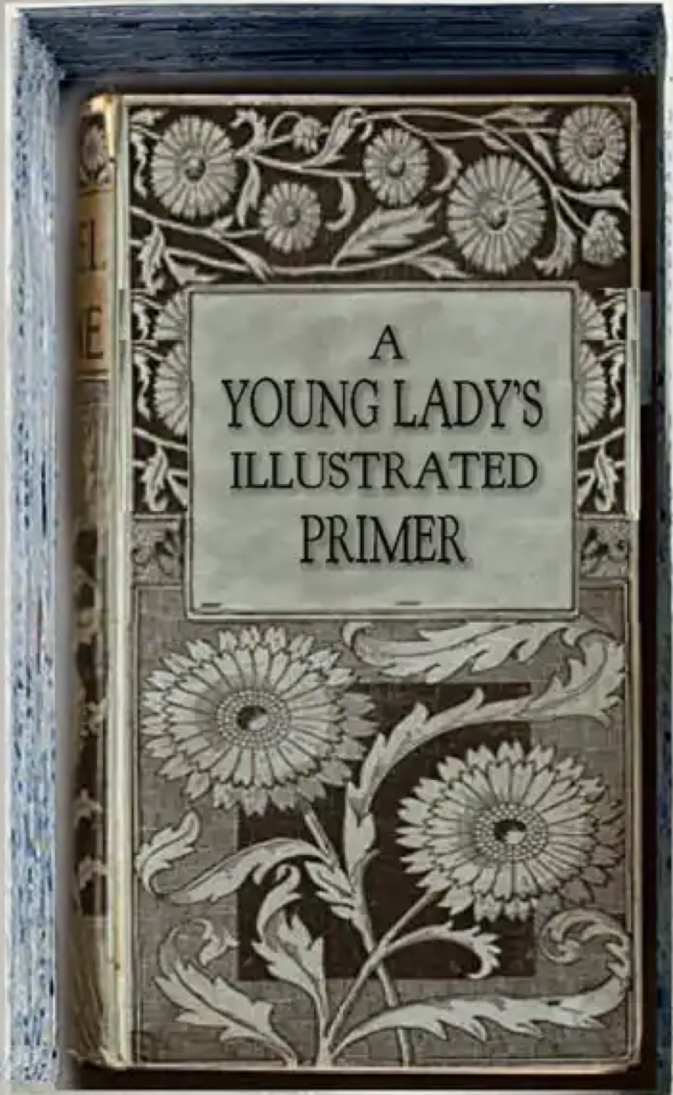
Replication: “0.8 Sigma Effect”

from

THE
DIAMOND
AGE

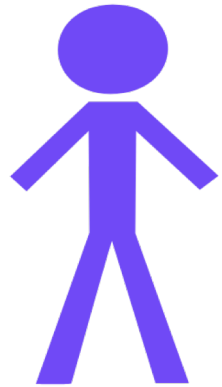
by

NEAL
STEPHENSON

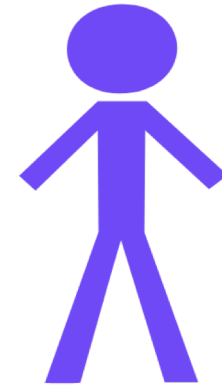
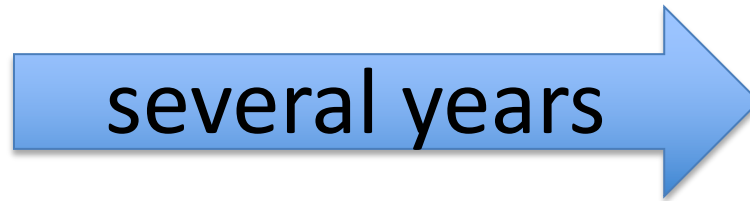


A
YOUNG LADY'S
ILLUSTRATED
PRIMER

Question we can't answer



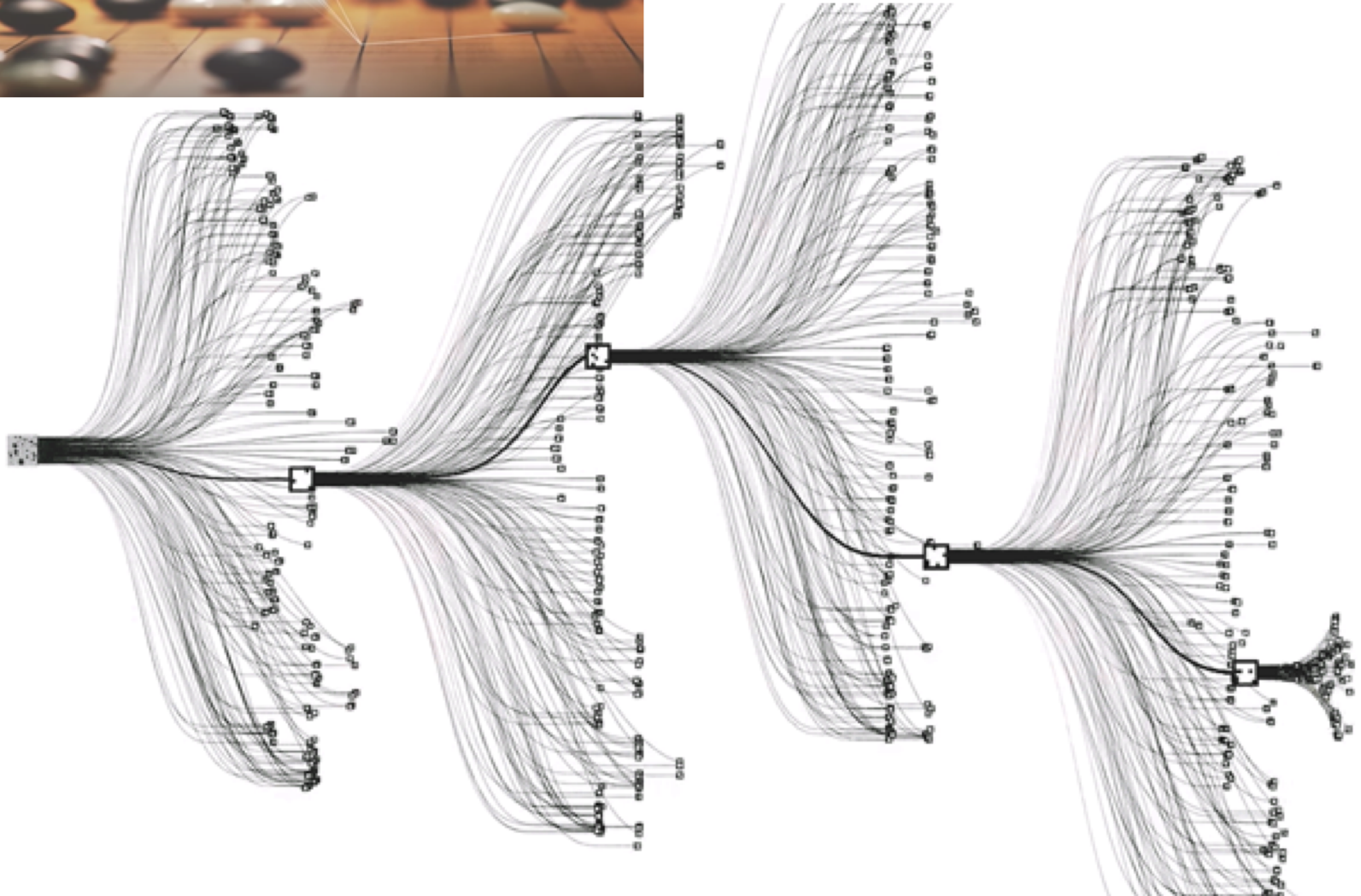
novice

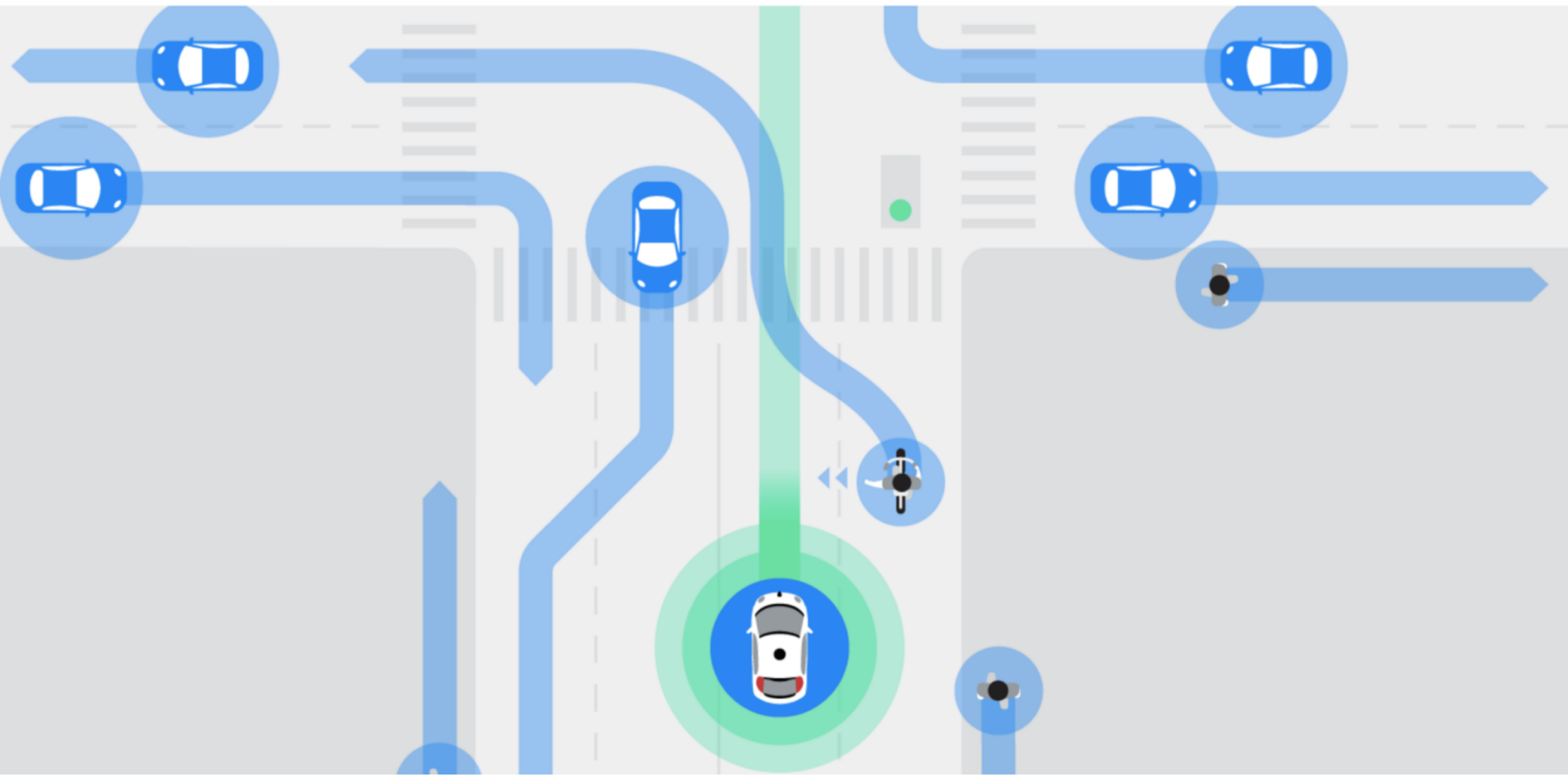


master

AlphaGo Zero

Discovering new knowledge





“The first million miles are always
the hardest.”

“The Journey of a billion miles
starts with a million data points.”

Courseware Engineering?



Authored Multipath Sequence

Basic Genetics Refresher (OPTIONAL)

Genes and alleles
(10 min)

Mendelian inheritance
(13 min)

What is DNA?
(12 min)

Modern Genomics

Modern sequencing methods
(11 min)

History: The Human Genome Project
(12 min)

Genomic economics
(8 min)

Personalized medicine
(13 min)

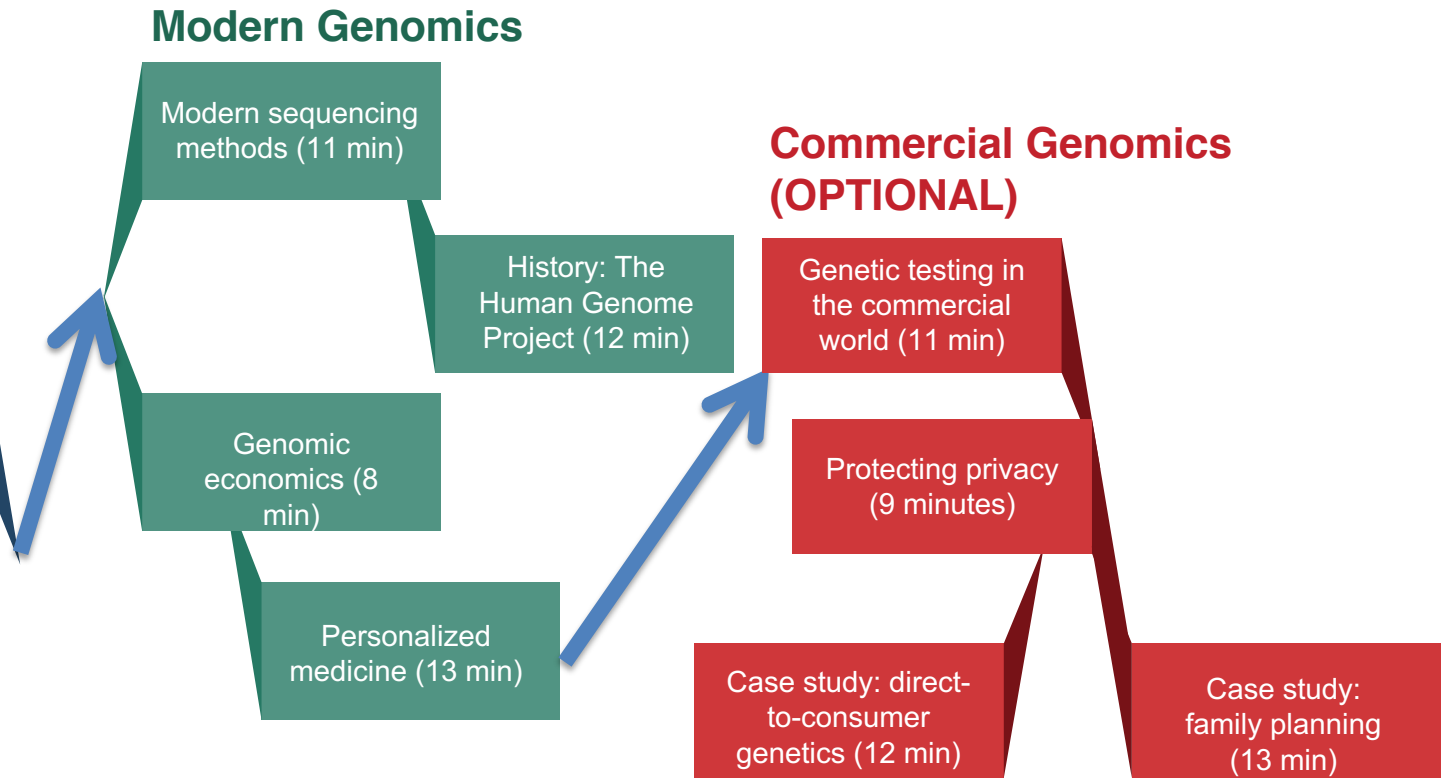
Commercial Genomics (OPTIONAL)

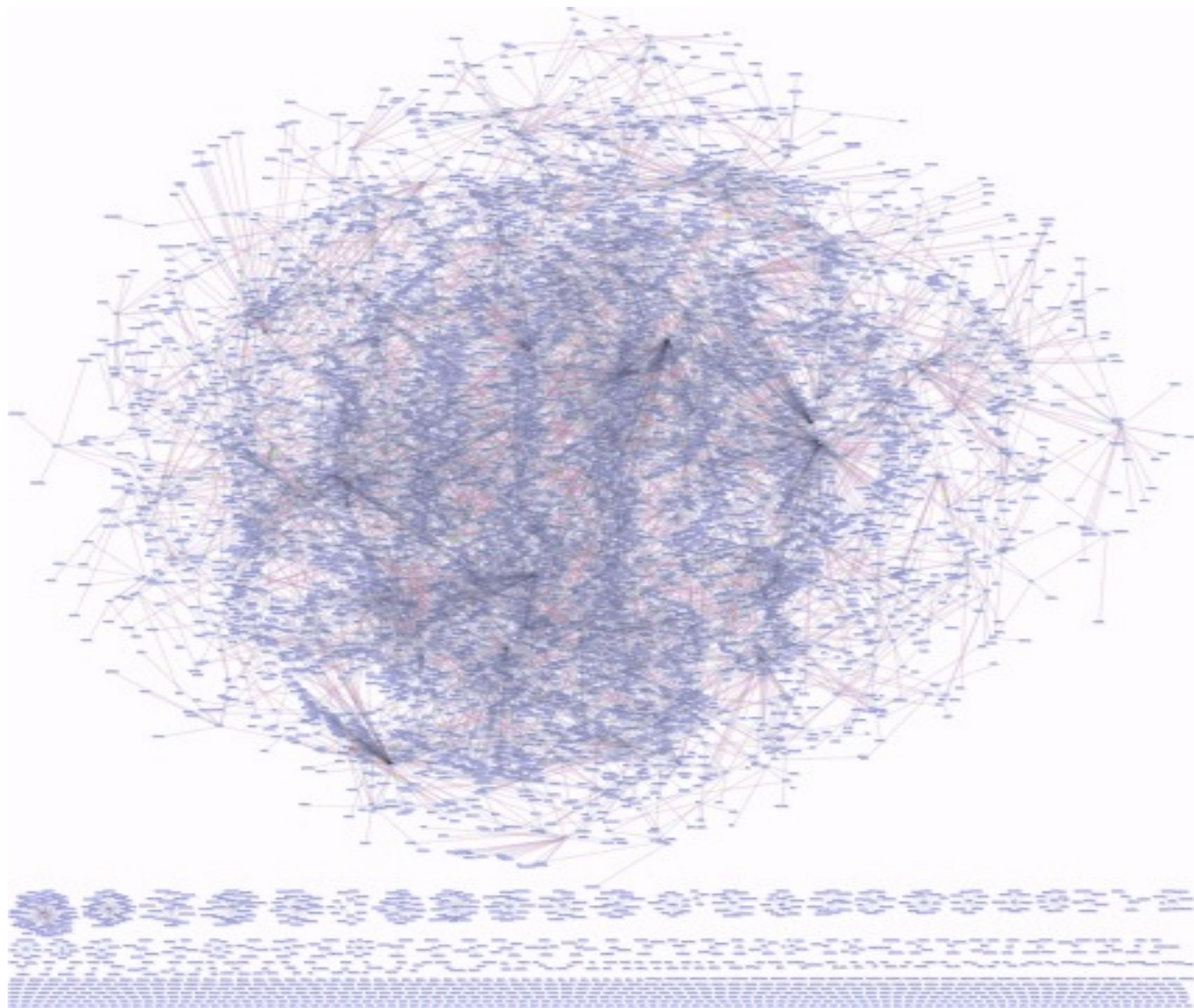
Genetic testing in the commercial world
(11 min)

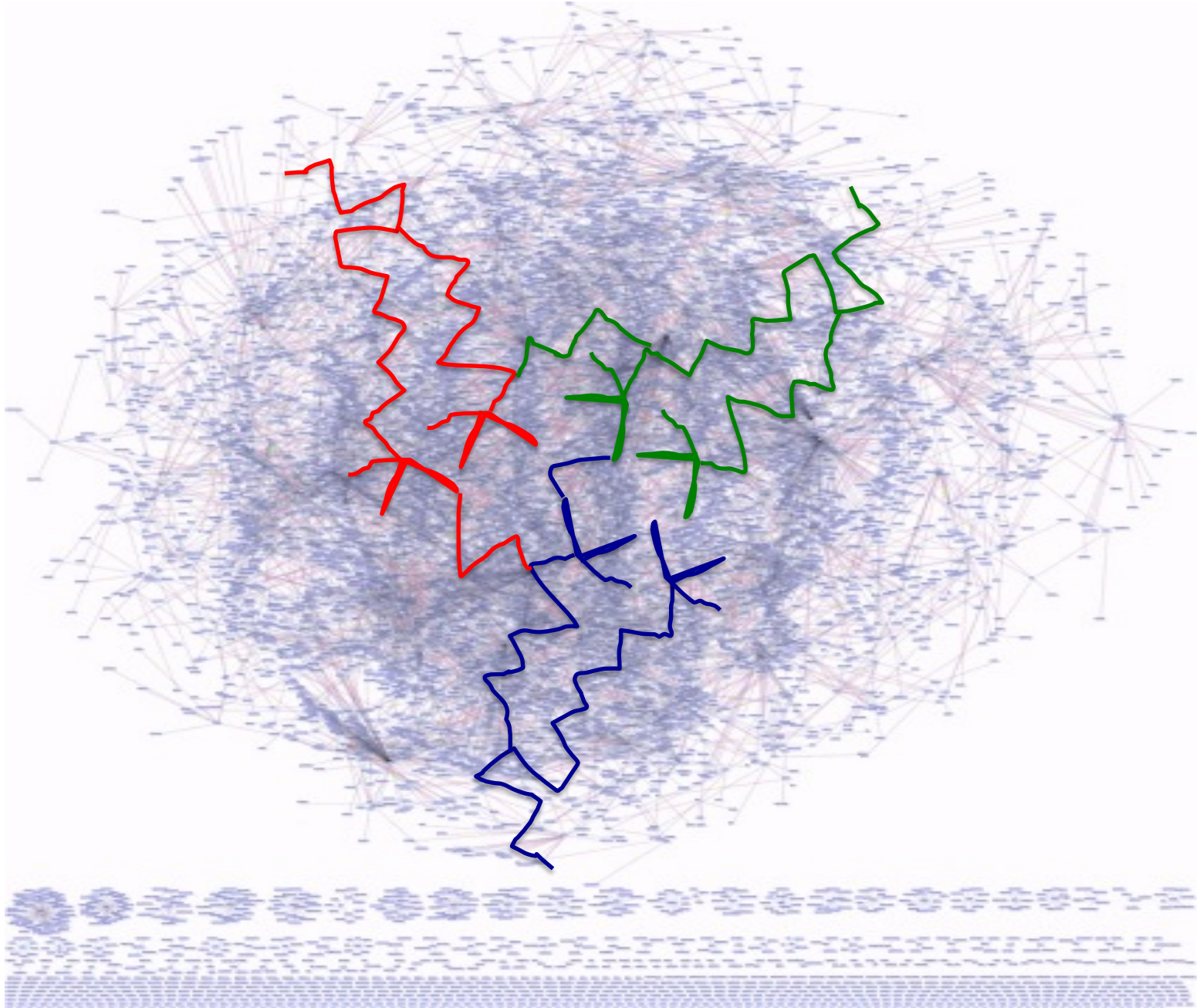
Protecting privacy
(9 minutes)

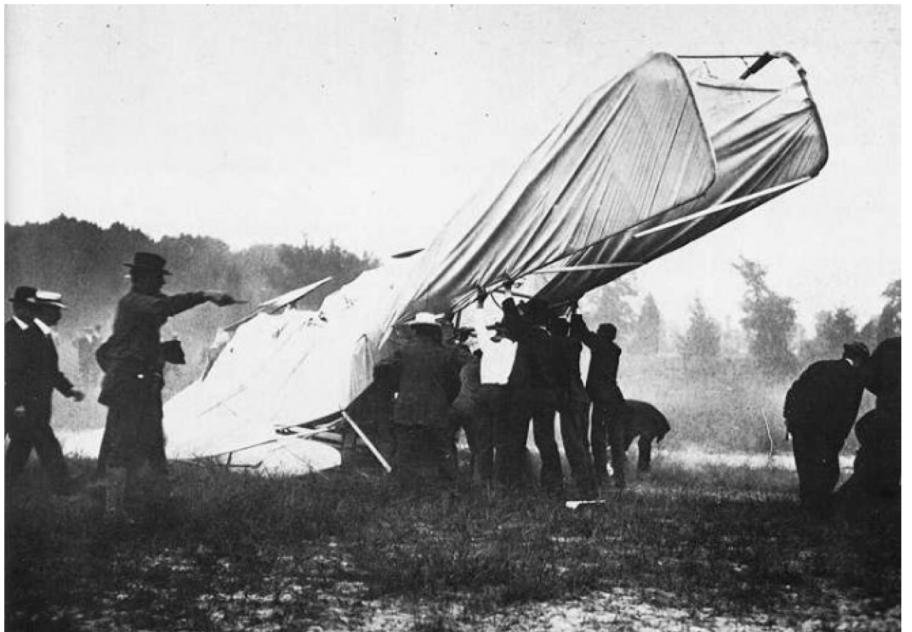
Case study: direct-to-consumer genetics
(12 min)

Case study: family planning
(13 min)











£ 100 million



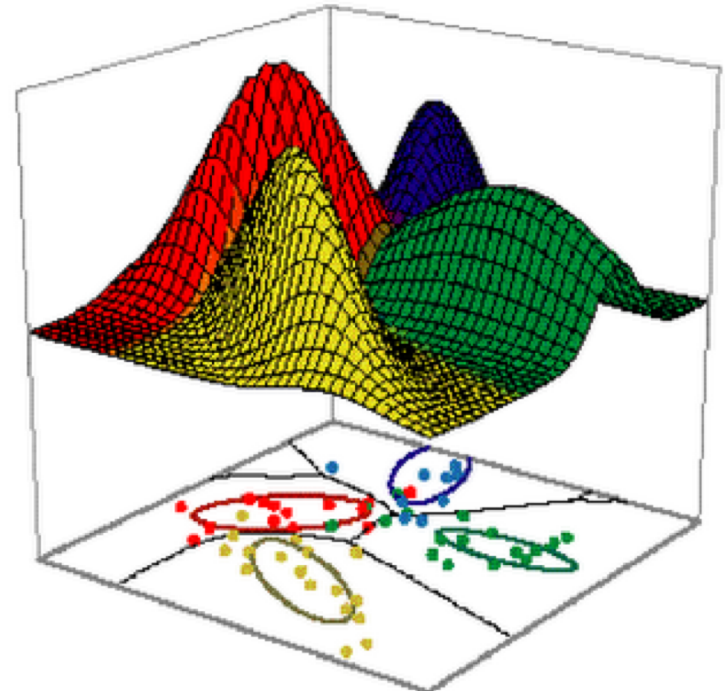
One on One Tutoring; Mastery Learning



Social;
Motivation



Large-Scale Courseware Engineering



Machine Learning; Continual Improvement