Starting class discussions on the process and nature of science

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The following slides are drawn from lectures I gave in Fall 2008 for my undergraduate subject at MIT, 20.109 Laboratory Fundamentals of Biological Engineering

I have included slides here that were used to initiate a ~10' class discussion about

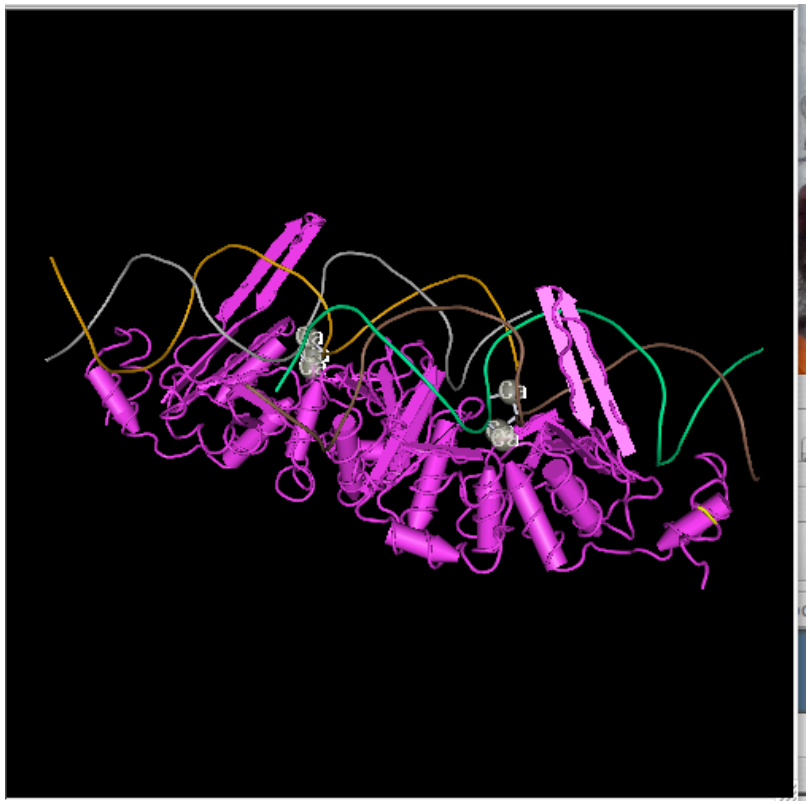
1. Ownership and Sharing
2. Scientists as public figures
3. Intuition and pattern recognition vs. controlled experiments
4. Public engagement with vs. as scientists
5. Democratization of scientific information
6. Data deluge (includes Understanding Sci flowcht)

Each topic is intended to raise issues about the practice of science and scientific investigations and help students articulate their beliefs about these relevant aspects of the world they'll inherit

TOPIC 1:

Ownership and Sharing

Useful Engineering Tools



I-SceI

RR NEBU BSA 37° Yes

Catalog #	Size	Concentration	Price	Qty	
R0694L	1,250 units	5,000 units/ml	$244.00	1	ADD TO CART
R0694S	250 units	5,000 units/ml	$61.00	1	ADD TO CART

Prices are in US dollars and valid only for US orders.

Download: Technical Bulletin | MSDS PDF

Recognition Site:

5′...AGTTACGCTAGGGATAACAGGGTAATATAG...3′
3′...TCAATGCGATCCCTATTGTCCCATTATATC...5′

isoschizomers | compatible ends | single letter code

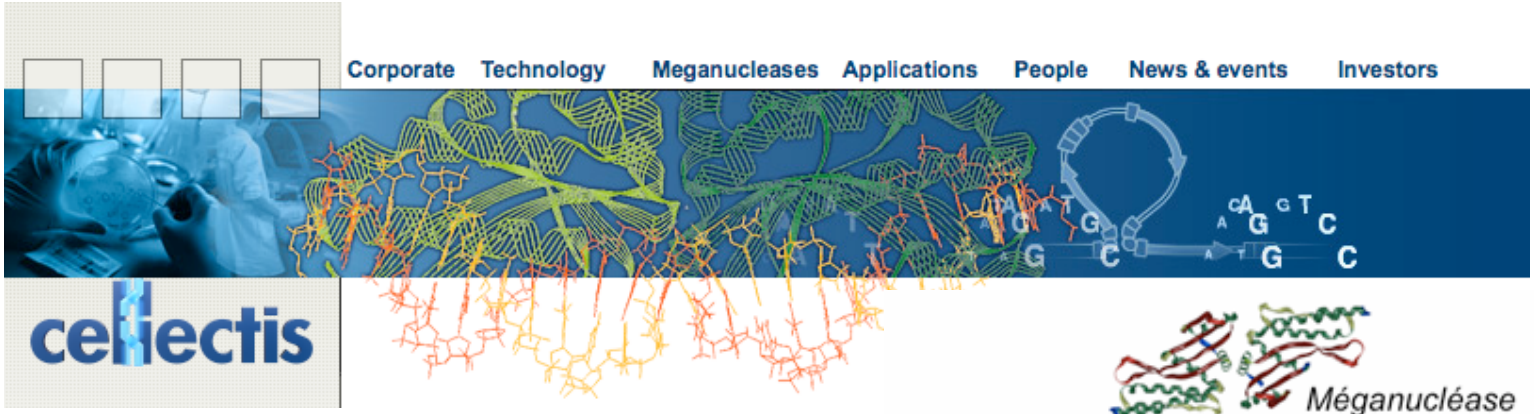
Description:
I-SceI is an intron-encoded endonuclease. The intron encoding I-SceI is present in the mitochondria of *Saccharomyces cerevisiae*.

Source:
A *E. coli* strain that carries the I-SceI mitochondrial gene from *Saccharomyces cerevisiae* (B. Dujon).

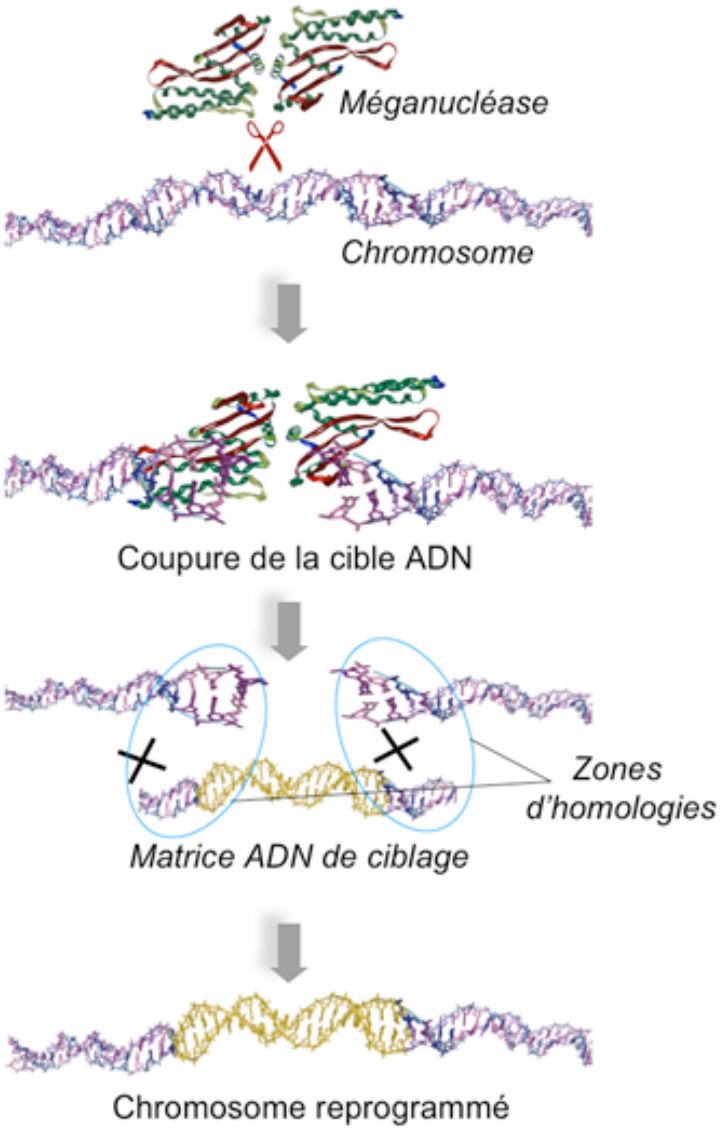
Reagents Supplied:
NEBuffer I-SceI (10X)
BSA (100X)
pGPS2 NotI-linearized Control Plasmid (5 µg)

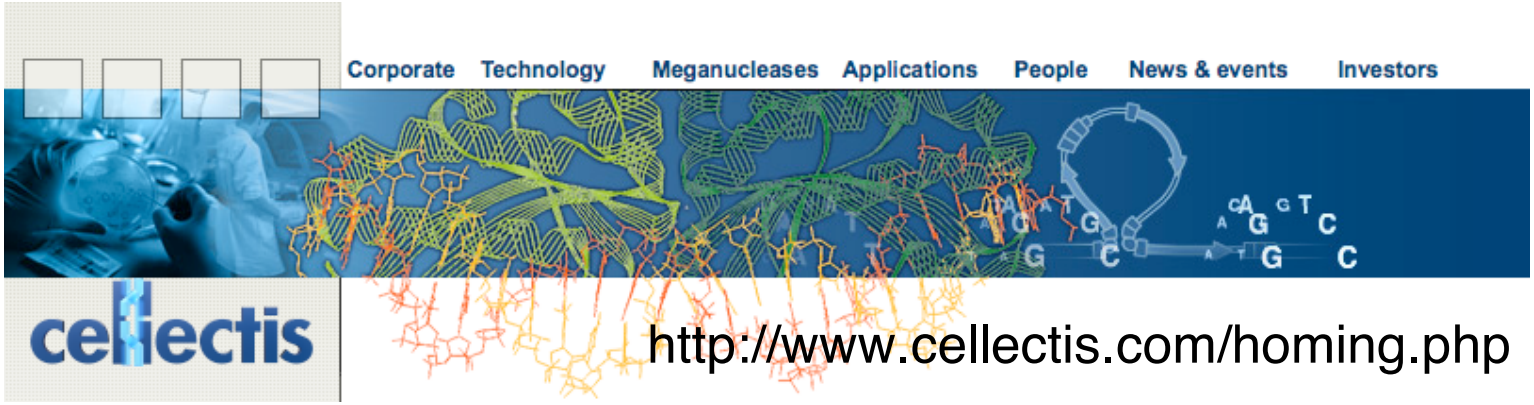
Enzyme Properties

Activity in NEBuffers:
NEBuffer 1: 10%
NEBuffer 2: 50%
NEBuffer 3: 50%
NEBuffer 4: 50%



"The Company designs protein 'scissors' capable of cleaving the Deoxyribonucleic Acid (DNA) at precise sites in living cells. It commercialises 'systems of recombination by meganuclease' "





http://www.cellectis.com/homing.php

Frequently Asked Questions

Is Homologous Recombination patented?

Use of Homologous Recombination to target a sequence in a living cell is a CELLECTIS patented technology.

TOPIC 2:

Scientists as Public Figures

Caroline Suh, Erika Frankel

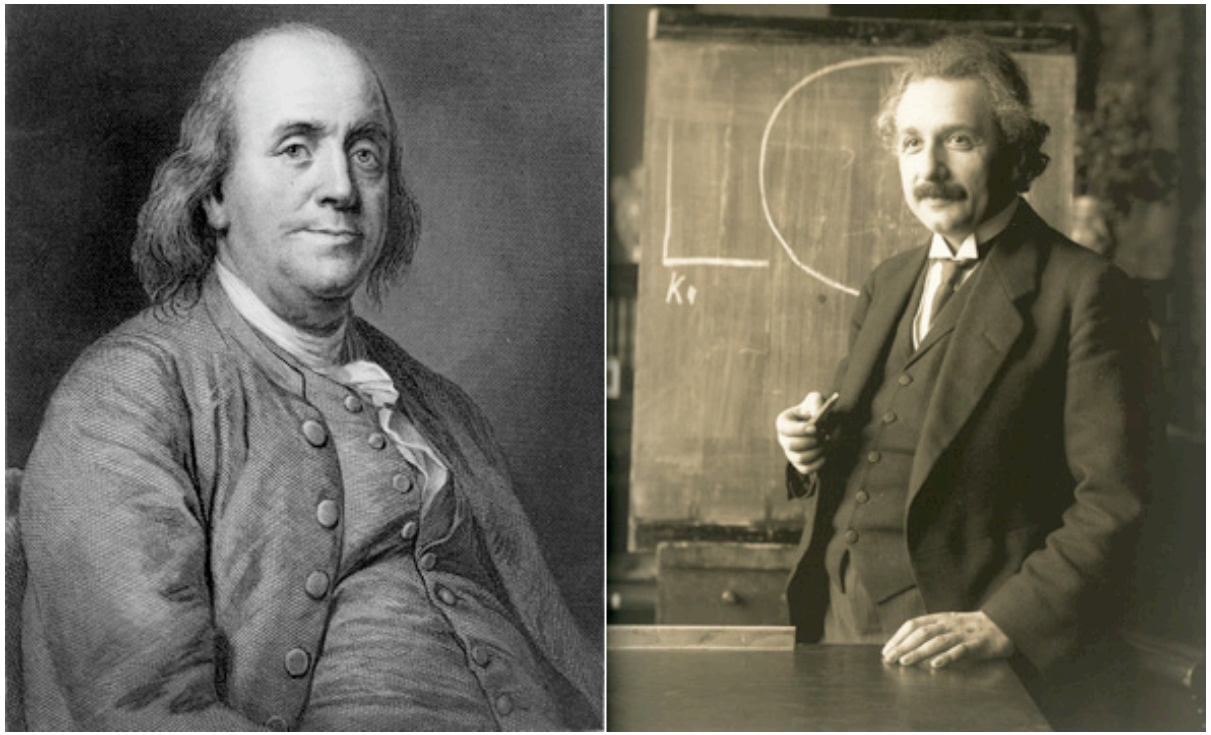
“They’ve learned from what they’ve seen in the world.”

“They’ve all kind of internalized what they’ve seen on the national scene.”

http://www.youtube.com/watch?v=yMhqCjlwMd8

Quick, name a major American living scientist

When polled in late 2007 and asked to name scientific role models, the best Americans could come up with were the names of people who were either not scientists, or not alive: Bill Gates, Al Gore, Benjamin Franklin, and Albert Einstein.



http://www.scienceprogress.org/2008/08/the-standing-of-science-in-america/

TOPIC 3:

Intuition and pattern recognition vs. controlled experiments

Three questions about “the hot hand”

1. Toss a coin 100 times. What do you expect for the overall distribution of heads:tails? ***50H:50T***

2. Given a coin that’s landed heads up 19 times straight, what’s your expectation for the 20th toss? ***50H:50T***

3. Which of the two lines below represents real data after 32 coin tosses? Both have 16H:16T.

HHH T HH T HH TT H TT HH T HHH T H TTTT H TTTT H

T H T HHHHHH T HH TT H TT H T H T HH T H T H TTTTT

New study about pattern perception

Part 1: Imposed "lack of control" mindset

"Decode these symbols. Complete the task to the best of your abilities"

Group A: no feedback

Group B: told right/wrong randomly, not when right/wrong

Part 2: Tested pattern perception : both groups shown B/W grainy pictures

12 with embedded patterns

patterns recognized by Group A = Group B

12 pattern-less

patterns recognized by Group A < Group B

Conclusion: a need for control leads us to impose patterns where none exist

Science 3 October 2008 322:115 - 117

TOPIC 4:

Public engagement with
vs as scientists

DIYbio

"developing safety resources that anyone trying molecular biology as a hobby will voluntarily use"

"Science without Scientists" (blog post by Jason Bobe)

Fish Tale Has DNA Hook: Students Find Bad Labels

NY Times 08.21.08

They hit 4 restaurants and 10 grocery stores in Manhattan. Once the samples were home, whether in doggie bags or shopping bags, they cut away a small piece and preserved it in alcohol. They sent those off to the University of Guelph in Ontario, where the Barcode of Life Database project began. A graduate student there, Eugene Wong, works on the Fish Barcode of Life (dubbed, inevitably, Fish-BOL) and agreed to do the genetic analysis. He compared the teenagers' samples with the global library of 30,562 bar codes representing nearly 5,500 fish species. (Commercial labs will also perform the analysis for a fee.)

DIYbio

"developing safety resources that anyone trying molecular biology as a hobby will voluntarily use"

DIYbio Boston meeting: tonight 7-9pm, 56-114

TOPICS

1. Public Wetlab (Mac Cowell): A lab where anyone can learn how to tinker with biology and get hands-on training in cutting edge techniques.
2. FlashLabs BioWeatherMap (Jason Bobe): Compare microbial communities on cross-walk buttons in Boston, San Francisco, Manhattan, or the cross-walk nearest your home.
3. Smart Lab (Jason Morrison): Hardware hacking lab instruments, large-format multitouch displays… to learn, research, visualize, and share your work. And go open source or go home!

TOPIC 5:
Democratization of scientific information

23andMe genetics just got personal.

23andMe Democratizes Personal Genetics.

More Data, New Features, Now $399.

Health and Traits: What do your genes mean for your health?
Information on 90+ traits and diseases, with more added monthly.

Ancestry: Where are your ancestors from?
Ancestry features trace continental origins plus parental lineage.

Compare Your DNA: How similar are you to friends and family?
Tools for side-by-side comparisons, family inheritance and global similarity.

23andWe Research: Be part of the discovery process!
Anyone can help advance science by participating in our research program.

Learn More >>> buy $399 USD try a demo

"Spit Party" NYTimes 09.12.08

23andMe genetics just got personal.

Humans differ from one another by only 0.5% of DNA sequence. Differences are called “SNPs”

~10 million SNPs in the human genome

https://www.23andme.com/you/gen101/01/

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A A T C G T
A A C C G T

Some SNPs account for person to person differences

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23andMe genetics just got personal.

Clinical Reports: disease risks

Elevated Risk

Name
Prostate Cancer ♂

Decreased Risk

Name
Celiac Disease
Type 2 Diabetes
Crohn's Disease
Rheumatoid Arthritis
Age-related Macular Degeneration

Typical Risk

Name
Type 1 Diabetes
Venous Thromboembolism
Psoriasis

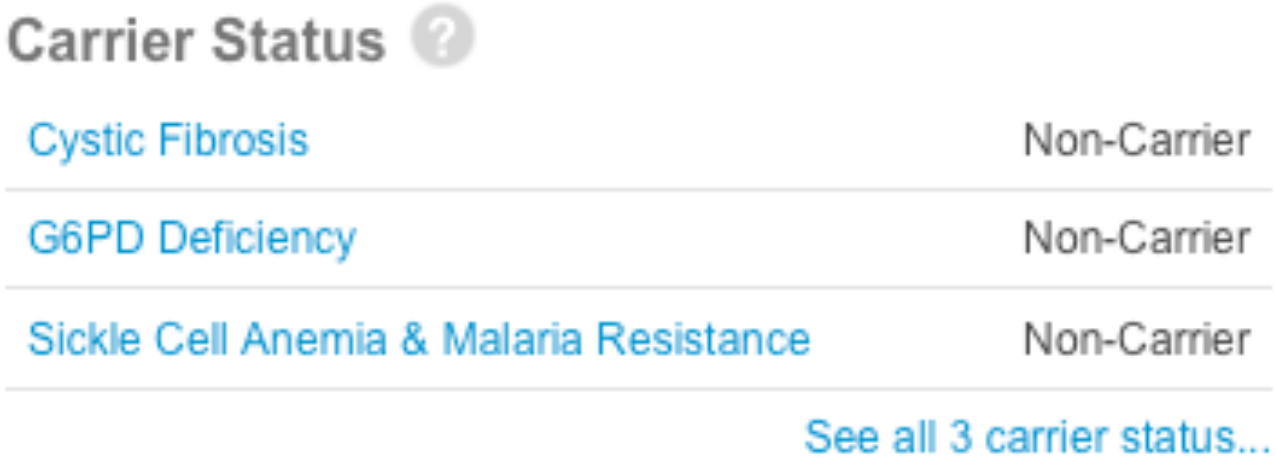
Opt-In Reports

	Name
🔒	Parkinson's Disease new

https://www.23andme.com/you/health/

23andMe genetics just got personal.

Clinical Reports: carrier status



https://www.23andme.com/you/health/

23andMe genetics just got personal.

Clinical Reports: traits

Name ▲	Outcome
Alcohol Flush Reaction	Does Not Flush
Bitter Taste Perception	Unlikely to Taste
Earwax Type	Wet
Eye Color	Likely Blue
Lactose Intolerance	Likely Intolerant
Malaria Resistance (Duffy Antigen)	Not Resistant
Muscle Performance	Likely Sprinter
Non-ABO Blood Groups	See Report
Norovirus Resistance	Not Resistant
Resistance to HIV/AIDS	Not Resistant

https://www.23andme.com/you/health/

23andMe genetics just got personal.

Reporter's genotype

TRACKING SNPS

Using the Web site of 23andMe, a company that queried 550,000 SNPs in a sample of her DNA, the reporter determined that her genotype for adult lactose intolerance is **GG** (she is lactose intolerant). Some of her other genotypes are below:

SNP	Location	Genotype	Genotype associated with
rs662799	APOA5	AA	Tendency to gain weight when eating fatty foods
rs174575	FADS2	CC	Higher I.Q. if breast fed for nine months as infant
rs6920220	6q23	GG	Low risk of rheumatoid arthritis
rs17070145	KIBRA	CC	Relatively poor verbal memory
rs1801260	CLOCK	AA	Early rising
rs1953558	OR11H7P	CC	Sensitivity to smell of sweat
rs17822931	ABCC11	CC	Wet earwax
rs4613903	TAS2R38	CG	Ability to taste certain bitter flavors
rs3751812	FTO	GG	Lower body-mass index

Sources: 23andMe

THE NEW YORK TIMES

Some SNPs account for
person to person differences

NYTimes 11.16.07

= medical testing or personal genetic information services

"This doesn't say you have a illness," said Mari Baker, the chief executive of Navigenics, which is based in Redwood Shores, Calif., and whose service costs $2,500. "It says you carry a genetic predisposition for the disease and should deliberate with a … professional."

"We think if you're telling people you have increased risk of adverse health effects, that's medical advice," related Ann Willey, director of the office of laboratory policy and planning at the New York State Department of Health.

http://saliva-drug-test.org/gene-testing-questioned-by-regulators-nytimescom-via-

23andMe genetics just got personal.

= social networking or exhibitionism

maternal line » community

Maternal Line Community « Haplogroup D Community

irequirepudding asks:

Anybody else in Haplogroup D? Where are you from?

I'm from haplogroup D, which corresponds with my mother's family being from Shanghai. I'm just curious to see who else is out there. Apparently group D is also prevalent in South America too...

genetic exhibitionists (Score:5, Insightful)

by circletimessquare (444983) <circletimessquare.gmail@com> on Monday October 20, @07:02PM (#25447311)

"Exhibitionists are those who flaunt in public happily that which conventional wisdom has decided should be kept private, usually not for a better intellectual or moral reason, mainly just because of ego. Mostly harmless"

23andMe genetics just got personal.

= social networking or exhibitionism

WIRED MAGAZINE: 16.08

How the Personal Genome Project Could Unlock the Mysteries of Life

When you're rich and tenured... (Score:3, Insightful)

by dstates (629350) on Monday October 20, @11:54PM (#25449493) Homepage

"It is one thing to release your genome sequence when you are wealthy and have tenure at Harvard. It is quite another thing to do this (as) an ordinary citizen who might want to change jobs and is not in a position to personally endow their children's health care."

http://www.wired.com/print/medtech/stemcells/magazine/16-08/ff_church#

Topic 6:

Data deluge

WIRED MAGAZINE: ISSUE 16.07

"will enough data someday answer all our questions?"

The End of Theory: The Data Deluge Makes the Scientific Method Obsolete

by Chris Anderson
Editor-in-Chief WIRED 06.23.08

First point: ever more data is publicly available

Now: so much data is available it forms a “cloud”

1950s	1980s	1990s
Computers make data digital <u>readable</u>	Internet make digital data <u>reachable</u>	Search engines <u>unify</u> data into single database
“folders”	“file cabinet”	“library”

The End of Theory: The Data Deluge Makes the Scientific Method Obsolete

by Chris Anderson
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First point: ever more data is publicly available

Second point: Google's success shows correlation is enough

Google™

PageRank™ algorithm → pages you want

to examine the web's link structure

It doesn't need to develop a theory as to why a given pattern of links satisfy the query/why one page ranks higher than another

The End of Theory: The Data Deluge Makes the Scientific Method Obsolete

by Chris Anderson
Editor-in-Chief WIRED 06.23.08

There is now a better way. Petabytes allow us to say: "Correlation is enough." We can stop looking for models. We can analyze the data without hypotheses about what it might show.

ars technica
the art of technology

Why the cloud cannot obscure the scientific method

By John Timmer | Published: June 25, 2008

Anderson's argument distills down to the suggestion that science can operate on the same level (as Google)—mechanisms, models, and theories are all dispensable as long as something can pick the correlations out of masses of data.
I can't possibly imagine how he comes to that conclusion.

http://arstechnica.com/news.ars/post/20080625-why-the-cloud-cannot-obscure-the-scientific-method.html

ars technica
the art of technology

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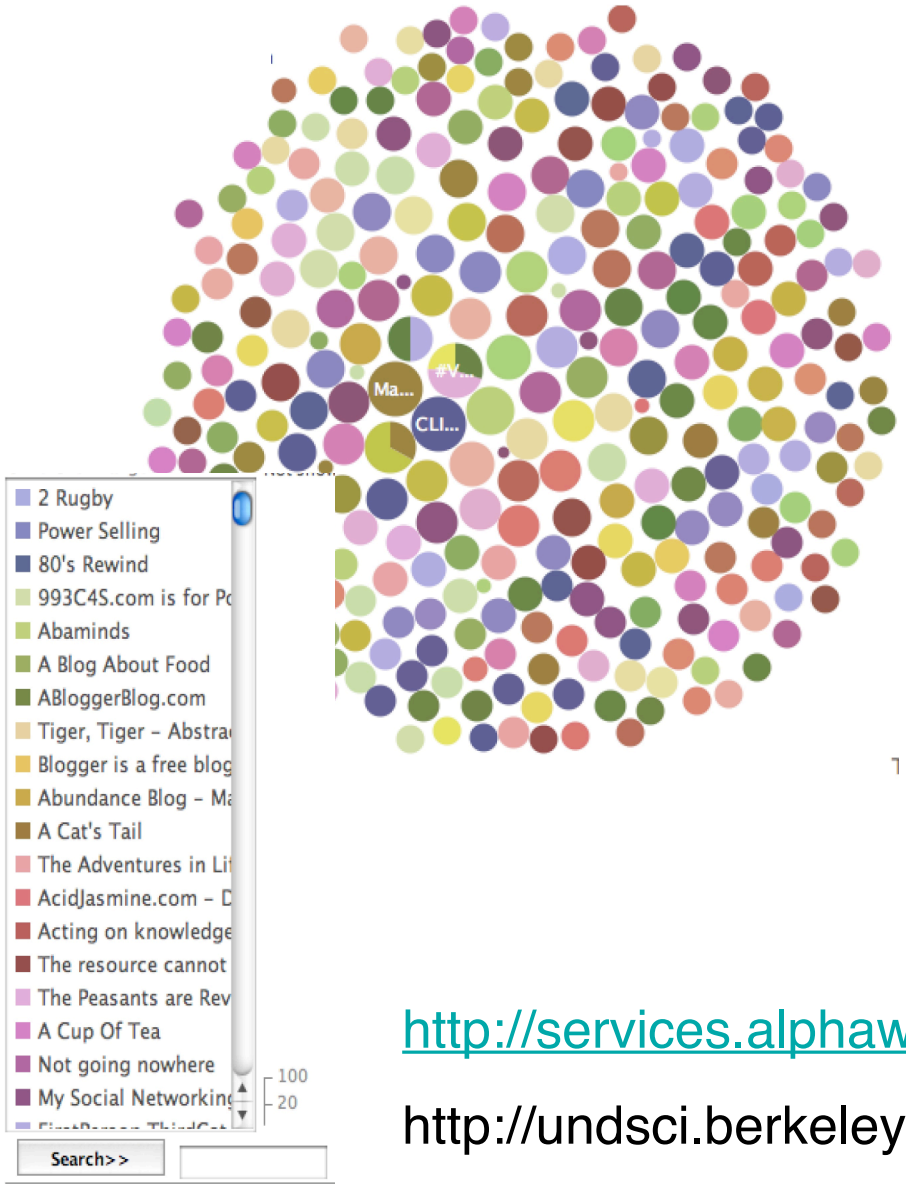
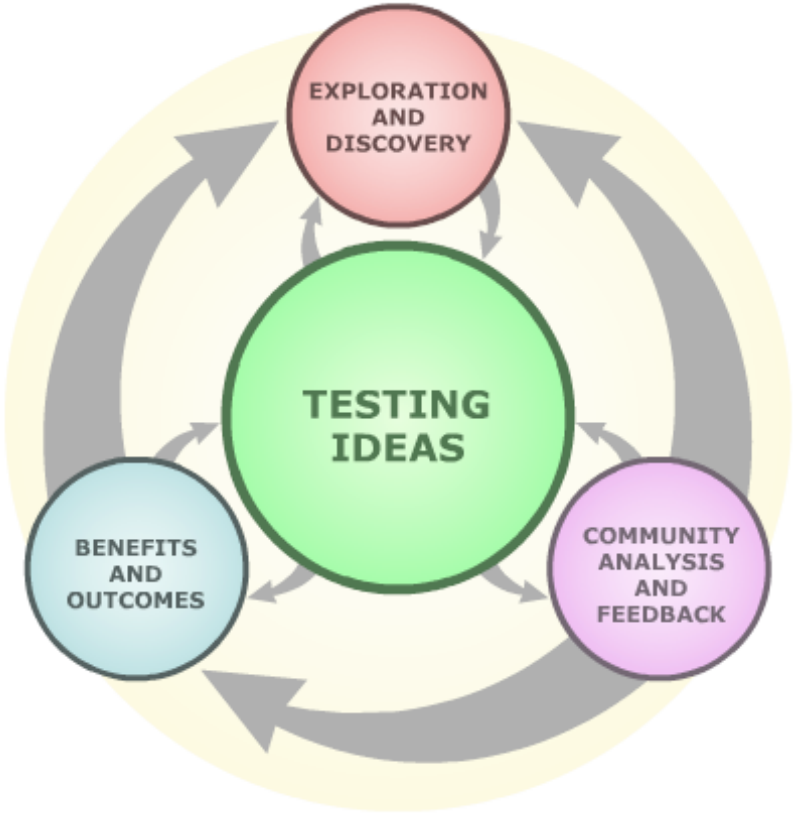
The fact is that we couldn't have even reached this Google-level understanding without the models and mechanisms that he suggests are doomed to irrelevance.

But, more importantly, nobody, including Anderson himself if he had thought about it, should be happy with stopping at this level of understanding of the natural world.

http://arstechnica.com/news.ars/post/20080625-why-the-cloud-cannot-obscure-the-scientific-method.html

Data cloud vs the scientific method





http://services.alphaworks.ibm.com/manyeyes/browse/visualizati

http://undsci.berkeley.edu/article/0_0_0/howscienceworks_02