




Nancy Reid
University of Toronto



April 22, 2010


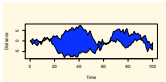

Statistics in the News


- What is statistics?
- What do statisticians do?
- Why do I have to take that statistics course?

Statistics


- **What is statistics?**
- What do statisticians do?
- Why do I have to take that statistics course?

- An information science 
- A guide to randomness 
- A guide to variation
- A framework for understanding surprises 



Statistics

- What is statistics?
- **What do statisticians do?**
- Why do I have to take that statistics course?
- Work on research teams
- Study methods for collection and analysis of data
- Study the science of information
- Teach statistics



Statistics

- What is statistics?
- What do statisticians do?
- Why do I have to take that statistics course?

“Lies, Damned Lies and Statistics”



- Use current news items for topics
- Learn the statistics behind the headlines
- Show the breadth of statistical application



Inspiration

“A course called Chance”

J.Laurie Snell
Dartmouth College



CHANCE

Morrie Degroot
CMU



A publication of the American Statistical Association
Volume 22, Number 1, 2009



This week in the news



The NEW ENGLAND
JOURNAL of MEDICINE

WIRED



Outline

- Can chocolate save your life?
 - Types of studies, “statistically significant”
- Where are all the girls?
 - Experiments and small effects, bell curves
- The Netflix Grand Prize **NetfliX Prize COMPLETED**
 - Supercrunching and data mining, ensemble methods, regularization
- How is your recovery money spent?
 - Graphical displays of information




ONTARIO EDITION - TORONTO WEATHER: AFTERNOON THUNDERSHOWERS, PAGE 32, MAP AND DETAILS, 58 S&P/TSX COMPOSITE 19.38

Can chocolate save your life?

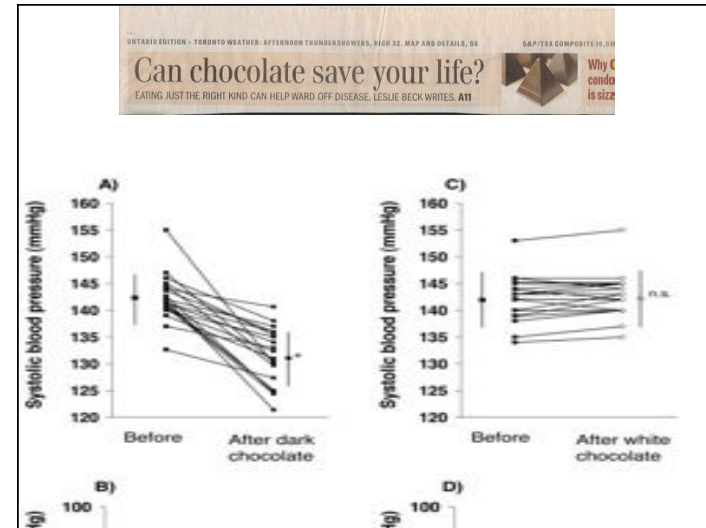
EATING JUST THE RIGHT KIND CAN HELP WARD OFF DISEASE, LESLIE BECK WRITES, A11

Why Canada is sized

- 2005 study: 10 males and 10 females with high blood pressure
- Two week period of "treatment" with dark chocolate
- One week washout period
- Two week period of "treatment" with white chocolate
- Blood pressure decreased during the dark chocolate period: **--11.0 SBP** **--6.2 DBP**
+/- 6.3 +/- 4.2



Institute for Mathematics and Its Applications




ONTARIO EDITION - TORONTO WEATHER: AFTERNOON THUNDERSHOWERS, PAGE 32, MAP AND DETAILS, 58 S&P/TSX COMPOSITE 19.38

Can chocolate save your life?

EATING JUST THE RIGHT KIND CAN HELP WARD OFF DISEASE, LESLIE BECK WRITES, A11

Why Canada is sized

- A randomized, controlled, cross-over study
- 100g chocolate daily for two weeks
- 20 people? two weeks? Convincing?
- Why was the study carried out?
- Cocoa has flavonols, which are thought to have various health benefits
- How else can we study this?



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As luck would have it!

Globe and Mail, March 31, 2010

An ounce of (dark chocolate) prevention

Or less: Researchers find those who eat 75 grams a day have a lower risk of heart disease

BY LEE HANCOCK

After eggs may be good for you, but only if you eat the right ones, researchers are reporting in the latest in a string of scientific studies to show potential health benefits of chocolate.

German researchers studied seven men in just one week who ate the most chocolate - an average of 75 grams a day. They had a lower blood pressure and a 5 per cent lower risk of having a heart attack or stroke than those who ate the least amount of chocolate - an average of 2 grams a day.

But the difference between the two groups was not less than 66 grams of chocolate a day. And that's not all: they were in a study in the European Heart Journal in the published today.

It's the British of the German members of the German National Institute of Health Research in Vascular, who led the study, and they say the study will work as an excuse to stuff themselves with chocolate.

"Small amounts of chocolate may help to prevent heart disease by improving the blood vessel's ability to relax and contract," he said.


Although they need more research, the researchers think the flavonols in cocoa may be the reason why chocolate seems to be good for blood pressure and heart health.

Researchers think the flavonols in cocoa may be the reason why chocolate seems to be good for heart health. But whether a chocolate is good for you, it's not just the amount you eat that matters. It's also the type of chocolate you eat. Dark chocolate, which is high in flavonols, is the best choice. White chocolate, which is high in sugar and fat, is not.

Before you rush to add dark chocolate to your diet, be aware that one gram contains roughly one calorie.

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Can chocolate save you life? **The EPIC Study** Why chocolate is size

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EATING JUST THE RIGHT KIND CAN HELP WARD OFF DISEASE, LESLIE BECK WRITES, A11

- European Prospective Investigation into Cancer
- 19,357 people, aged between 35 and 65
- Followed for at least ten years
- Asked about diet at beginning of study
- Other factors measured at the beginning of study
- Information collected on heart attacks and strokes and blood pressure




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Can chocolate save you life? **The EPIC Study** Why chocolate is size

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- Prospective observational study
- Subjects followed over time
- See if group with lowered chocolate intake has better outcomes
- Need to worry about confounding factors
- Amount of chocolate consumed?
- Approximately 6g/day difference between top and bottom doses




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Can chocolate save you life? **Confounding factors** Why chocolate is size

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- Do people who eat more chocolate eat more everything? ✓
- How do people report how much chocolate they eat? ✓
- How do we know who had heart attacks and strokes? ✓
- Do people who eat more chocolate already have lower blood pressure? ✓

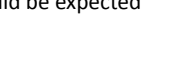


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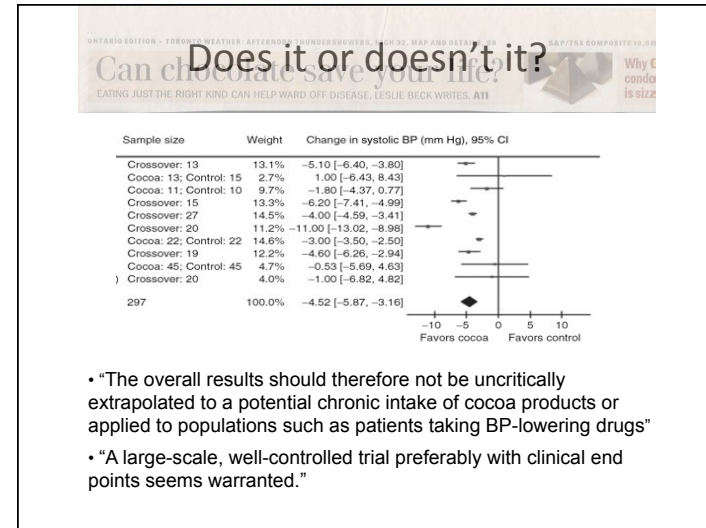
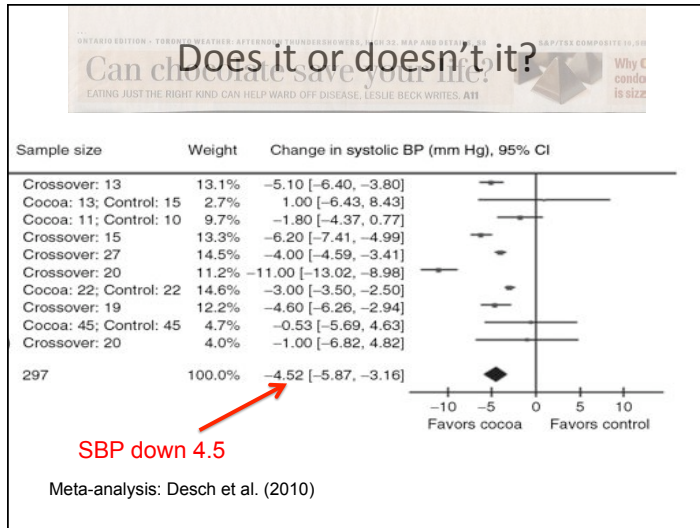
Can chocolate save you life? **Results of the EPIC Study** Why chocolate is size

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EATING JUST THE RIGHT KIND CAN HELP WARD OFF DISEASE, LESLIE BECK WRITES, A11

- Decrease in blood pressure **--1.0 SBP; -0.9 DBP**
+/- 0.4 +/- 0.3
- Relative risk of heart attack and stroke
0.61 (0.44–0.87)
- 39% reduction in relative risk
- From top quartile of consumption to bottom
- “if people in the group eating the least amount of chocolate increased their chocolate intake by six grams a day, **85 fewer heart attacks and strokes per 10,000** people could be expected to occur over a period of about **ten years**”



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Aside: why the headline?

• EPIC Study drafted a [press release](#)

Deutsches Institut für Ernährungsforschung Potsdam-Rehbrunn

Press releases

2010

31.03.2010

Those Easter eggs may be good for you! Study shows chocolate reduces blood pressure and risk of heart disease

Easter eggs and other chocolate may be good for you – at least in small quantities and preferably if it's dark chocolate – according to research that shows just one small square of chocolate a day can lower your blood pressure and reduce your risk of heart disease. The study is published online today (Wednesday 31 March) in the European Heart Journal [1].

Researchers in Germany followed 19,357 people, aged between 35 and 65, for at least ten years and found that those who ate the most amount of chocolate – an average of 7.5 grams a day – had lower blood pressure and a 39% lower risk of having a heart attack or stroke compared to those who ate the least amount of chocolate – an average of 1.7 grams a day. The difference between the two groups amounts to six grams of chocolate: the equivalent of less than one small square of a 100g bar.

Dr Brian Buijssse, a nutritional epidemiologist at the German Institute of Human Nutrition, Nutritional, Germany, who led the research said: "People who ate the most amount of chocolate were at a 39% lower risk than those with the lowest chocolate intakes. To put it in terms of absolute risk, if people in the group eating the least amount of chocolate (of whom 219 per 10,000 had a heart attack or stroke) increased their chocolate intake by six grams a day, 85 fewer heart attacks and strokes per 10,000 people could be expected to occur over a period of about ten years. If the 39% lower risk is generalised to the general population, the number of avoidable heart attacks and strokes could be higher because the absolute risk in the general population is higher." [2]

However, he warned that it was important people ensured that eating chocolate did not increase their overall intake of calories or reduce their consumption of "healthy" foods. "Small amounts of chocolate may help to prevent heart disease, but only if it replaces other energy-dense food, such as snacks, in order to keep body weight stable," he said.

This just in

Nutrition and health

Protection racket

Eating lots of fruit and vegetables may not help stave off cancer, after all

Apr 9th 2010 | From The Economist press editor

Fruit and Vegetable Intake and Overall Cancer Risk in the European Prospective Investigation Into Cancer and Nutrition (EPIC)

Paolo Boffetta, Elisabeth Couto, Janine Wichmann, Pietro Ferrari,

Outline

- Can chocolate save your life?



- Where are all the girls?



- The Netflix Grand Prize



- How is your recovery money spent?



Can girls really do math?



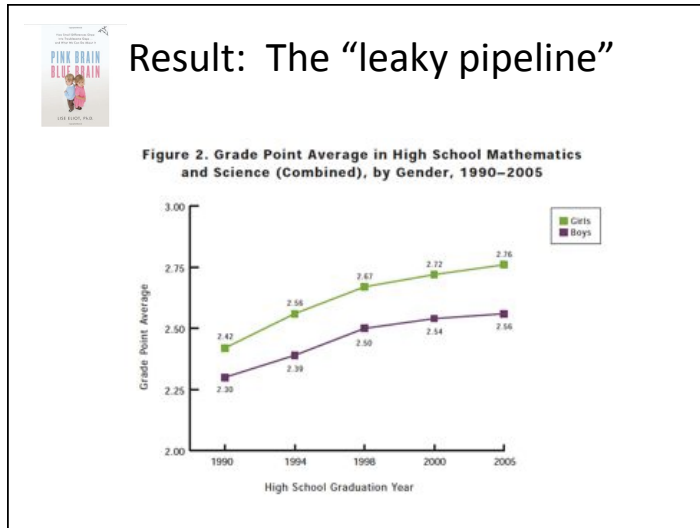
Why don't girls do math?



Why don't girls do math?

- Lack of abilities, e.g. spatial skills
- Lack of beliefs about abilities
- “Stereotype threat”
- Lack of supportive environment for college students
- Lack of supportive environment for college faculty
- Implicit bias <https://implicit.harvard.edu/implicit/>
- Workplace bias






Result: The “leaky pipeline”

Advanced placement calculus


	Boys	Girls	Difference
Numbers	114,285	108,249	5.2 %
Grade	3.1	2.8	9.7 %



Result: The “leaky pipeline”

Mathematics Degrees


	Men	Women
Bachelor’s	56 %	34 %
Doctoral	70 %	30 %




Result: The “leaky pipeline”

College Faculty



	Men	Women
Untenured	77.2 %	22.8 %
Tenured	79.4 %	20.6 %





Why don't girls do math?

- Lack of abilities, e.g. spatial skills
- Lack of beliefs about abilities
- **Stereotype threat**
- Lack of supportive environment for college students
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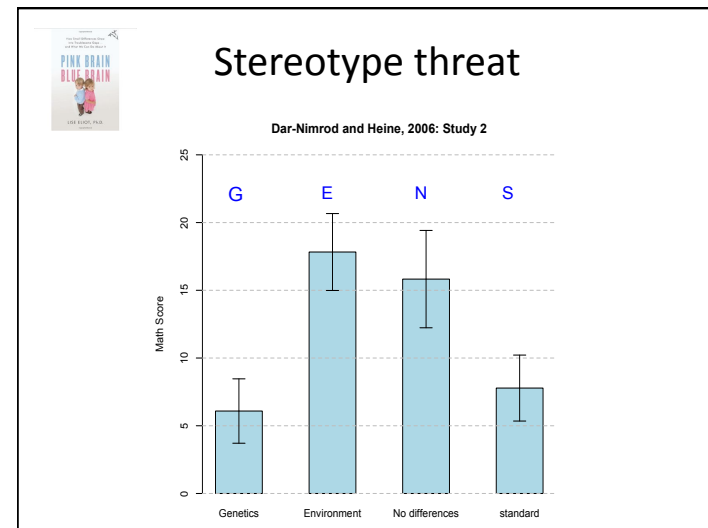
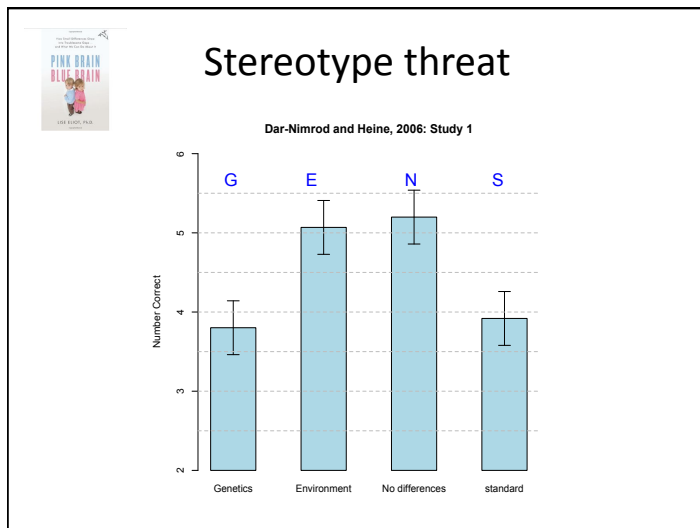
Stereotype threat

N There are **no gender differences** in mathematical abilities, Researchers Say

S **Stereotype**: Women's body in art; Women's unique experience

E **Expectations** are responsible for gender differences in mathematical abilities, Researchers Say

G **Genes** are involved in mathematical abilities, Researchers Say

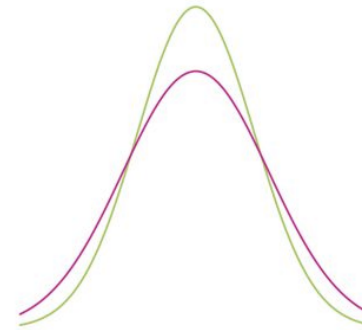





The bell curve strikes

- Assume scores are drawn from normal distribution
- Compute probability of an observed difference if the scores came from the same normal distribution
- If this probability is small, result is “statistically significant”
- Effect of stereotype threat in Dar-Nimrod and Heine’s experiment is statistically significant

Aside: the bell curve and Larry Summers



$$\int \frac{\partial^2 f(x, y)}{\partial s(x)u(y)} dx dy$$

Advanced Calculus

- **Stereotype threat**
 - “math test aimed at measuring your mathematical abilities”
- **Non-threat condition**
 - “this mathematics test shows no gender differences”

	Female	Male
Threat	3.13	3.08
Non-threat	3.60	2.60

- Course grades similar between men and women

Outline

- Can chocolate save your life?



- Where are all the girls?



- **The Netflix Grand Prize**



- How is your recovery money spent?



Netflix Prize

COMPLETED



source: Getty Images

Netflix Prize The Data

COMPLETED

- 18,000 movies; 500,000 users; 7 years
- 100 million ratings

★ ★ ★ ★ ★

- Build a prediction model for ratings
- Netflix tests this on a hold-out set of 4 million
- Computes a measure of prediction error

Netflix Prize The Contest

COMPLETED

- Cinematch© error 0.9525
- Goal 10% reduction
- Target error **0.8572**
- Winners, July 26, 2009 **0.8567**

Leaderboard Showing Test Score. [Click here to show quiz score](#)
Display top 20 leaders.

Rank	Team Name	Best Test Score	% Improvement	Best Submit Time
Grand Prize - RMSE = 0.8567 - Winning Team: BellKor's Pragmatic Chaos				
1	BellKor's Pragmatic Chaos	0.8567	10.06	2009-07-26 18:18:28
2	The Ensemble	0.8567	10.06	2009-07-26 18:38:22
3	Grand Prize Team	0.8582	9.90	2009-07-10 21:24:40

Netflix Prize The Statistics

COMPLETED

1. **The Amazon strategy:** "people who liked this movie also liked..."

- Nearest neighbour models

$$\hat{r}_{ui} = \frac{\sum_{j \in N(i;u)} s_{ij} r_{ij}}{\sum_{j \in N(i;u)} s_{ij}}$$

- $N(i; u)$ Set of movies i rated by user u
- s_{ij} Similarity between movies i and j

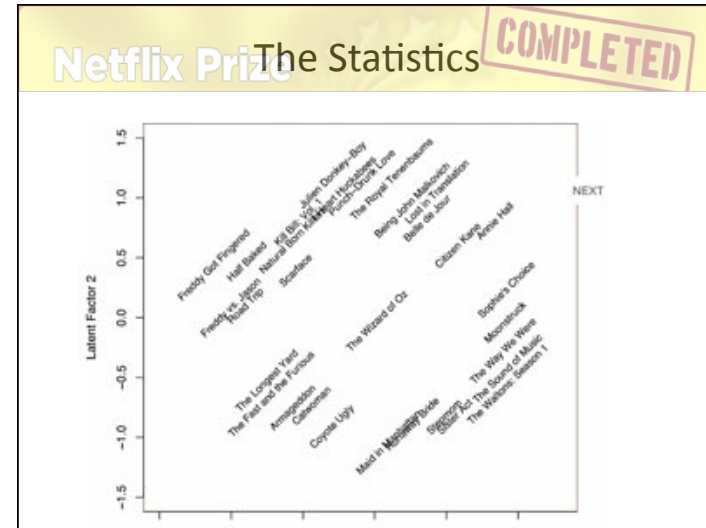
Netflix Prize The Statistics **COMPLETED**

2. Matrix factorization

- Characterize movies by latent factors
- Characterize users by latent factors
- Amount of violence, drama/comedy, chick flick
- User preferences for these

$$\hat{r}_{ui} = q_i^T p_u$$

- Vectors of movie/user factors $q_i \quad p_u$



Netflix Prize The Statistics **COMPLETED**

3. Baseline predictors

- Some movies are more popular than others
- Some users are easier to please than others

$$\hat{r}_{ui} = \mu + b_i + b_u + q_i^T p_u$$

- These things change over time $b_i(t), b_u(t)$
- And so do latent factors $q_i(t)^T p_u(t)$

Netflix Prize The Statistics **COMPLETED**

- Estimating the unknowns
- Least squares

$$\min_{b,p,q} \sum_{(u,i) \in \mathcal{T}} (r_{ui} - \mu - b_u - b_i - q_i^T p_u)^2 + \lambda_1 \left(\sum_u b_u^2 + \sum_i b_i^2 \right) + \lambda_2 \sum_i \|q_i\|^2 + \lambda_3 \sum_u \|p_u\|^2$$

- Regularization/shrinkage

Netflix Prize The Surprises **COMPLETED**

- Averaging predictions from different methods was quick and effective
- “At the end of the first year of the competition, our submission was a linear combination of 107 prediction sets”
- 8.43% improvement
- Different teams on the leaderboard also merged
- Big Chaos/ BellKor/ Pragmatic Theory

Netflix Prize The Surprises **COMPLETED**

- “After nearly 33 months, our combined team became the first to achieve a 10% improvement over Cinematch, triggering a 30-day period in which all competitors were allowed to produce their best and final submissions.”
- “A new team, the Ensemble, which included members from 23 original teams, leapfrogged slightly ahead of us in the public standings, but the winner was left unclear”
- “the actual winner was to be determined by a held-out test set” (at Netflix)
- The two top teams were tied!

Netflix Prize The Surprises **COMPLETED**

Rank	Team Name	Best Test Score	% Improvement	Best Submit Time
Grand Prize - RMSE = 0.8567 - Winning Team: BellKor's Pragmatic Chaos				
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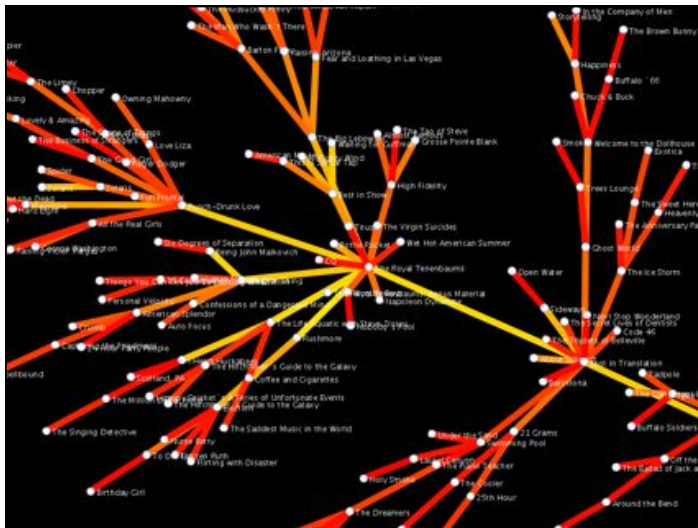
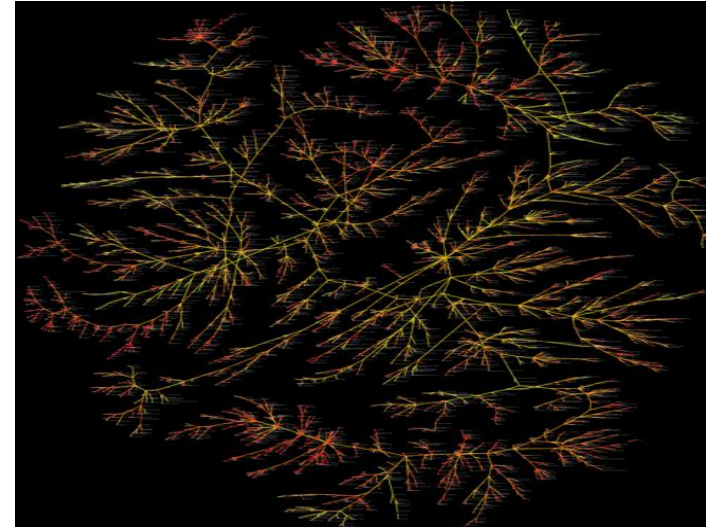
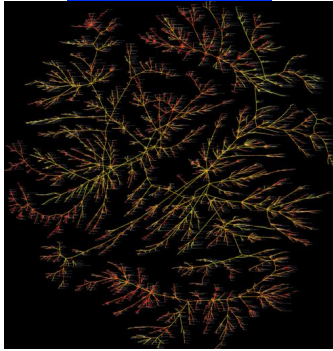
The Ensemble: members from 23 original teams, several companies

Netflix Prize The Lessons **COMPLETED**

- Generated interest in recommender systems
- Increased collaboration among computer scientists, statisticians, engineers
- Benefits of ensemble methods remarkable
- Combination of first and second place teams reduced error to **0.8555** 0.9525 0.8572
0.8567
- None of these things are easy! (contest 2)

Visualization

http://www.flickr.com/photos/chef_ele/3791293142/sizes/l/in/set-72157621825510293/



Outline

- Can chocolate save your life?



- Where are all the girls?



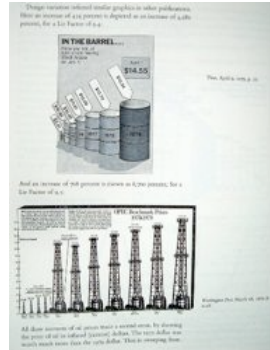
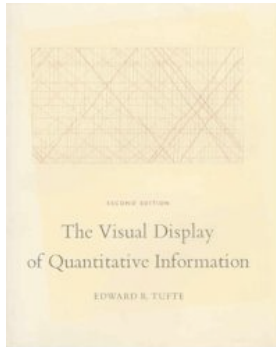
- The Netflix Grand Prize



- How is your recovery money spent?

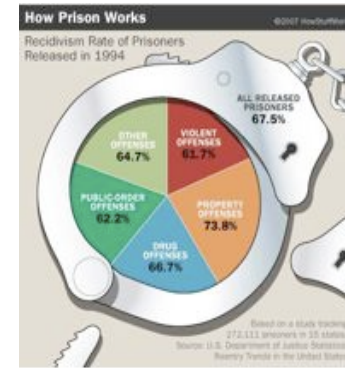


Statistical Graphics



1983

Bad Graphs!



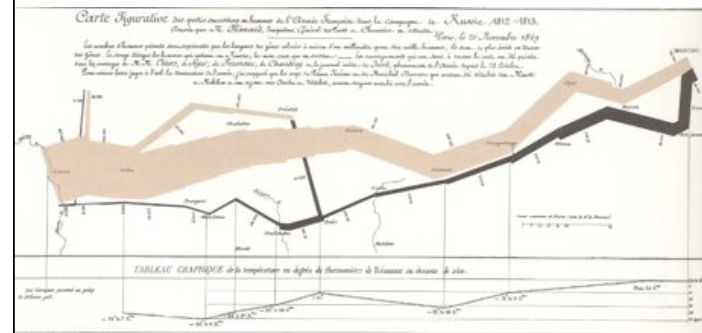
USA TODAY Snapshot

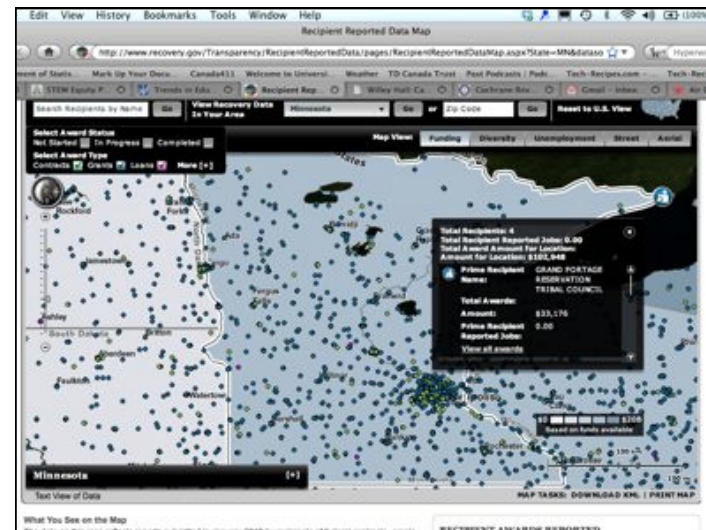
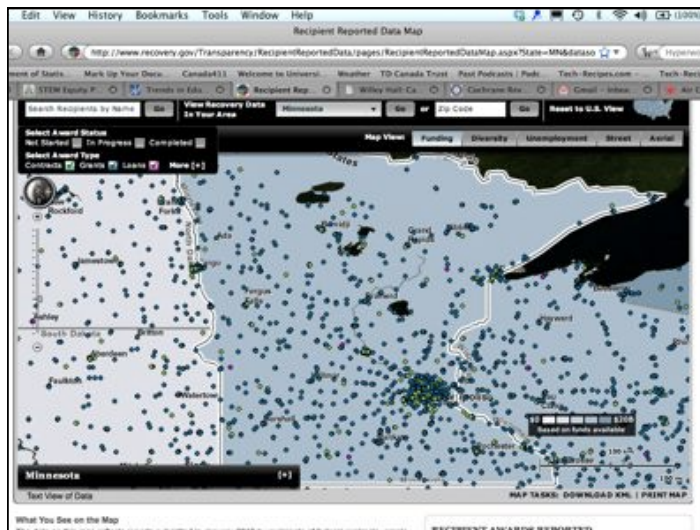
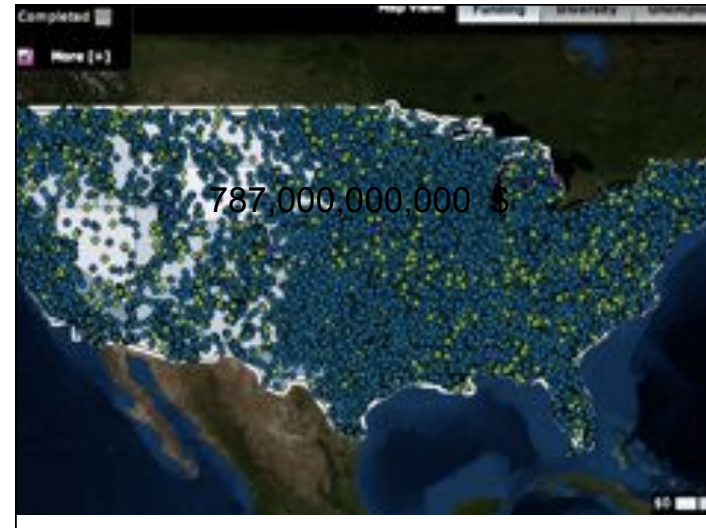
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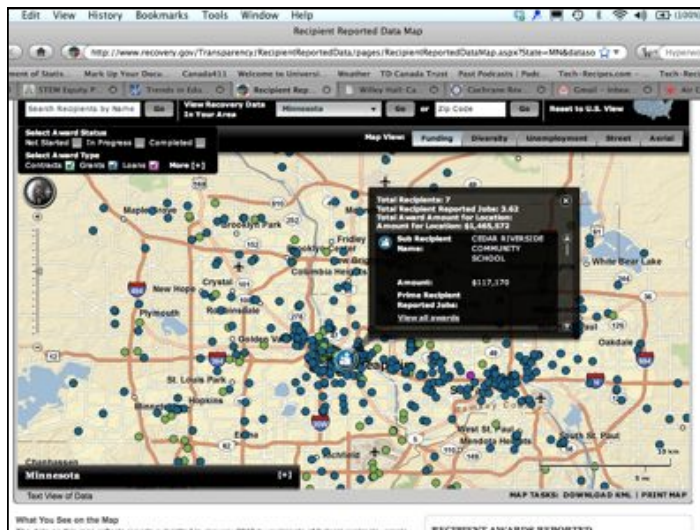
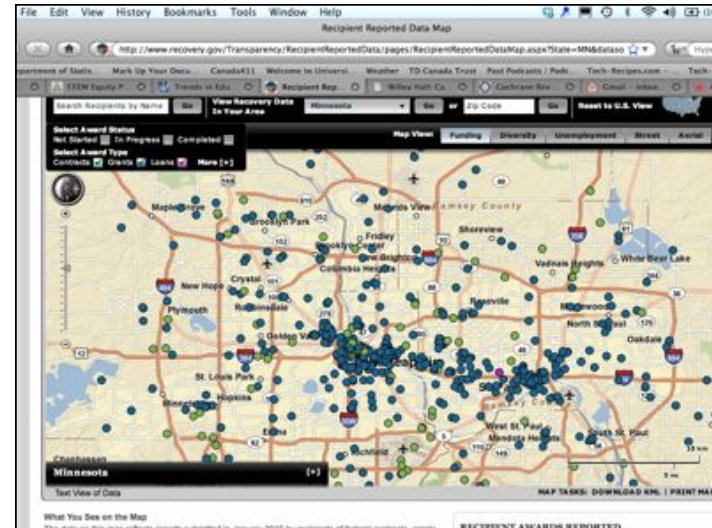
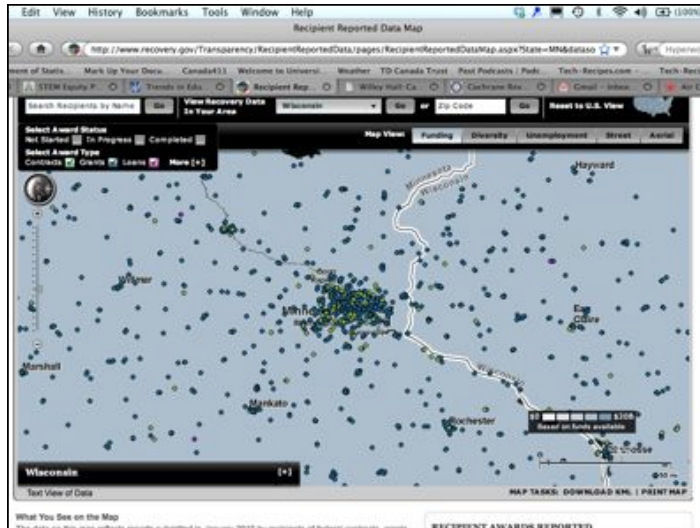
There were more than 7.3 million high school athletes in the 2006-07 school year. Top state in athletes: Texas, with nearly 764,500.

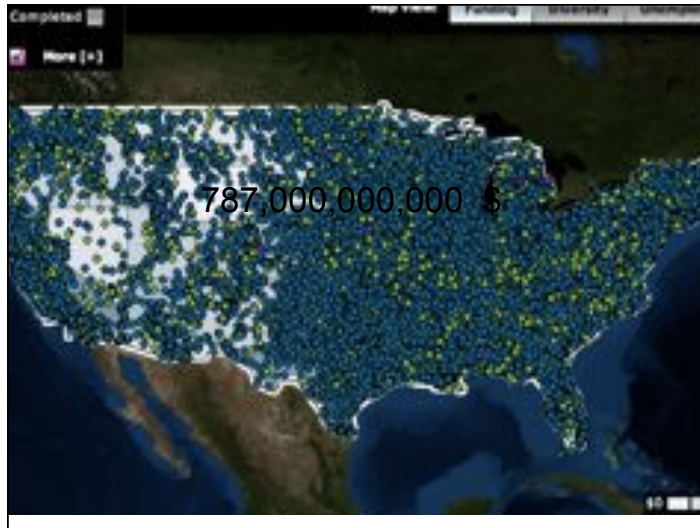


And good









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Chocolate

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Girls

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Netflix

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Graphics

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[Link](#)