



desperately
need our
help



the doctor
is in



beyond help

U.S. BUREAU OF LABOR STATISTICS

Software developers

Employment (1)	Employment RSE (3)	Mean hourly wage	Mean annual wage (2)	Wage RSE (3)
302,150	1.4 %	\$39.75	\$82,690	1.3 %

Sales managers

Employment (1)	Employment RSE (3)	Mean hourly wage	Mean annual wage (2)	Wage RSE (3)
358,920	0.6 %	\$60.60	\$126,040	0.3 %

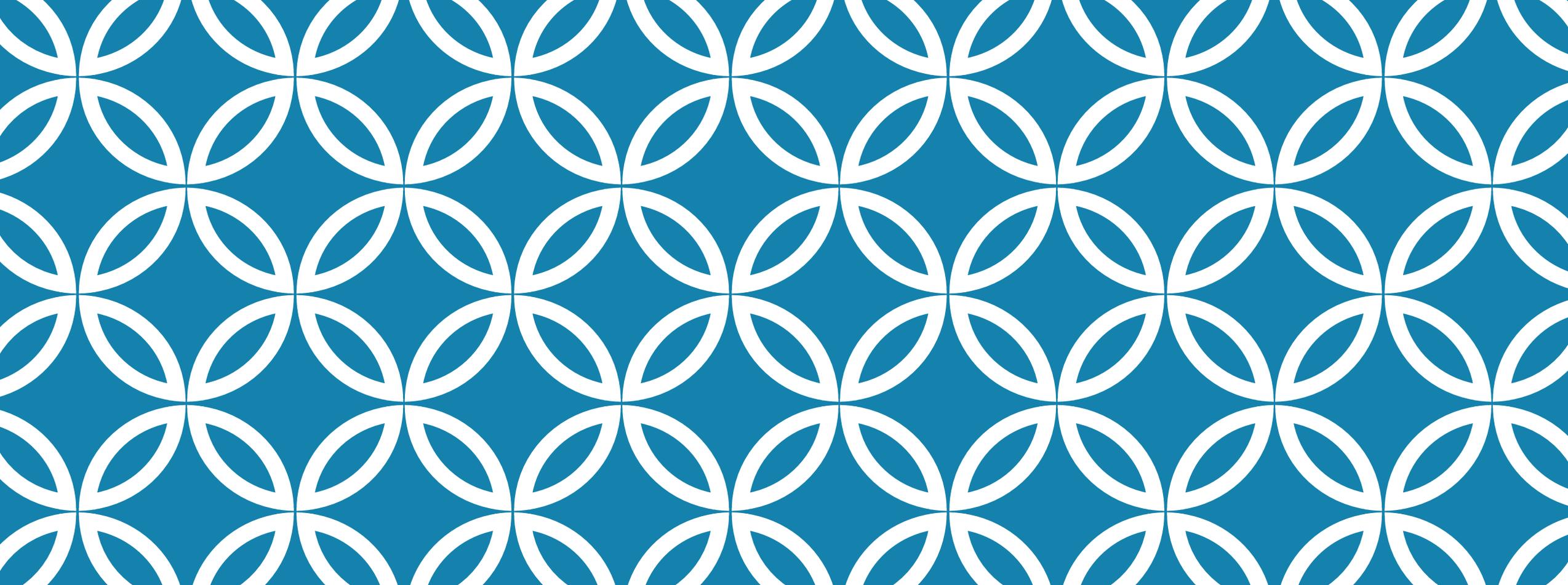
Marketing managers

Employment (1)	Employment RSE (3)	Mean hourly wage	Mean annual wage (2)	Wage RSE (3)
184,490	0.9 %	\$66.06	\$137,400	0.5 %



MARKET RESEARCH QUESTIONS





LARGE-SCALE POLLING WITH

InterPoll

Ben Livshits

Todd Mytkowicz

Microsoft Research

InterPoll 101

We want to give access to polls and survey to the **regular developer**.

```
1 var people = new MTurkQueryable<Person>(true, 5, 100, 2);
2 var liberalArtsPairs = from person in people
3   where person.Employment == Employment.STUDENT
4   select new {
5     Person = person,
6     Value = person.PoseQuestion<bool>(
7       "Are you a liberal arts major?")
8   };
```

This is a LINQ query for asking **college students** whether they are **liberal arts majors**

We want to make access to **human-generated data** as easy as access to **databases**.

SIMPLE LINQ QUERIES

```
var femaleHeight = from person in people where person.Gender ==  
Gender.FEMALE select person.PoseQuestion<int>("What is your height?");  
  
var maleHeight = from person in people where person.Gender ==  
Gender.MALE select person.PoseQuestion<int>("What is your height?");
```

```
if (maleHeight.ToRandomVariable() > femaleHeight.ToRandomVariable()) {  
    Console.WriteLine(  
        "Males are taller than females, according to a t-test.");  
}
```

OUR FOCUS IS ON AN END-TO-END PROCESS



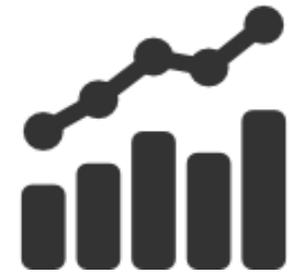
1) idea



2) poll



3) crowd



4) analysis

SAMPLE SURVEYS

Survey

- What is currently preventing
- Time Available
 - Desire and Motivation
 - Weather
 - Laws of Thermodynam
 - Physical Disability

Survey

- What has happened to the US
- Smaller
 - Larger
 - Same as it was a year

Survey

Do you shop locally?

- Always
- Never
- Once in a while
- Usually
- About half the time

Do you make at least one purchase a day at chain stores?

- Yes
- No

Do you shop at local stores daily?

- Yes
- No

Do you consider yourself to be a supporter of small business?

- Yes
- No

The screenshot shows the Amazon Mechanical Turk requester dashboard. At the top, there's a navigation bar with a back arrow, a search icon, and the URL <https://requester.mturk.com/mturk/manage>. Below the navigation bar, there are tabs for "Suggested Sites" and "Travel Home". The main content area displays a list of surveys, sorted by "Creation Date (newest first)". Each survey entry includes the survey title, requester name, HIT expiration date, reward, and assignments requested. On the right side of each entry, there are statistics for "Assignments Pending Review", "Reviewed Assignments", "Remaining Assignments", and "Remaining Time".

Survey Title	Requester	HIT Expiration Date	Reward	Assignments Requested	Assignments Pending Review	Reviewed Assignments	Remaining Assignments	Remaining Time
Height survey (cm)	Ben Livshits	Mar 3 2014, 09:46 PM PST	\$0.10	200	200	0	0	2 days 7 hours
Employment survey with gender	Ben Livshits	Mar 3 2014, 09:10 PM PST	\$0.10	10	10	0	0	2 days 6 hours
Height survey	Ben Livshits	Feb 28 2014, 09:39 PM PST	\$0.10	200	0	85	115	Expired
Employment survey	Ben Livshits	Mar 3 2014, 01:56 PM PST	\$0.10	10	0	10	0	1 day 23 hours
Demographic survey	Ben Livshits	Feb 16 2014, 12:53 PM PST	\$0.10	1000	0	1000	0	Expired
Professional photography survey	Ben Livshits	Feb 16 2014, 12:14 PM PST	\$0.10	1000	0	50	0	Expired

IS THIS NOT A SOLVED PROBLEM?

Create surveys
anywhere, anytime.

4:21 PM 100%

← Edit + ...

Add Logo

Customer Feedback Survey

1. How well did the customer service agent answer your questions?

- Extremely well
- Very well
- Moderately well
- Slightly well
- Not at all well

+ Add Question

+ Add Page

Analyze your survey
results on the go.



Track your results
in real-time.



MOVING AWAY FROM SMALL AND UNREPRESENTATIVE SAMPLES

How many participants should I get for an eye tracking study?

42.

“Experimental psychology is the **study** of the **college sophomore**”

Quinn McNemar, 1946

KEY FEATURES OF INTERPOLL

Programmable: integrates **human** and **machine** computation

Gets results **cheaper**; only as many samples as are needed are obtained (**power analysis**)

Results are **representative** (**unbiasing**)

OUTLINE

- 1) Power analysis
- 2) Unbiasing
- 3) Optimizations

POWER ANALYSIS

Determine the number of samples for a query

We can sample from the crowd sequentially until we satisfy or disprove our hypothesis.

We will poll the crowd for more until our stopping criterion is reached.

The stopping criterion allows us to conclude that the hypothesis can be proven or disproven with the required level of confidence.

EXAMPLE QUESTION: HEIGHT

```

var people = GetPeople(GetDescription(), 200, false, false);
var height = from person in people
              select new
              {
                  Height = person.PoseQuestion<int>(
                      "What is your height, in centimeters " +
                      "(if you know your height in inches, you can convert to
                      "centimeters using a calculator here: http://www.calculator.net
                      "Please be careful when typing in your height. Invalid input will be rejected.
                      ),
                  Gender = person.Gender,
                  Ethnicity = person.Ethnicity,
              };

var males = from person in height
             where person.Gender == Gender.MALE
             select person.Height;
var females = from person in height
              where person.Gender == Gender.FEMALE
              select person.Height;

if (males.ToRandomVariable(false) > females.ToRandomVariable(false))
{
    Console.WriteLine("Males are taller than females.");
}

```

N=29

Once we remove the outliers

height = from person in height
where

where

person.Height >= 140 &&

person.Height <= 220)

N=27

CONVERGENCE CURVES: SEQUENTIAL PROBABILITY RATIO TEST (SPRT) OR WALD, 1945

Sequential probability ratio test: To implement this, we build a sequential acceptance plan. Let $H_0 : p + \epsilon$ and $H_A : p - \epsilon$ where $p = 0.5$ by default and can be overloaded by a programmer. `Uncertain(T)` calculates the cumulative log-likelihood ratio for each sample:

$$\Delta_L = k \log(H_A/H_0) + (n - k) \log(H_0/H_A)$$

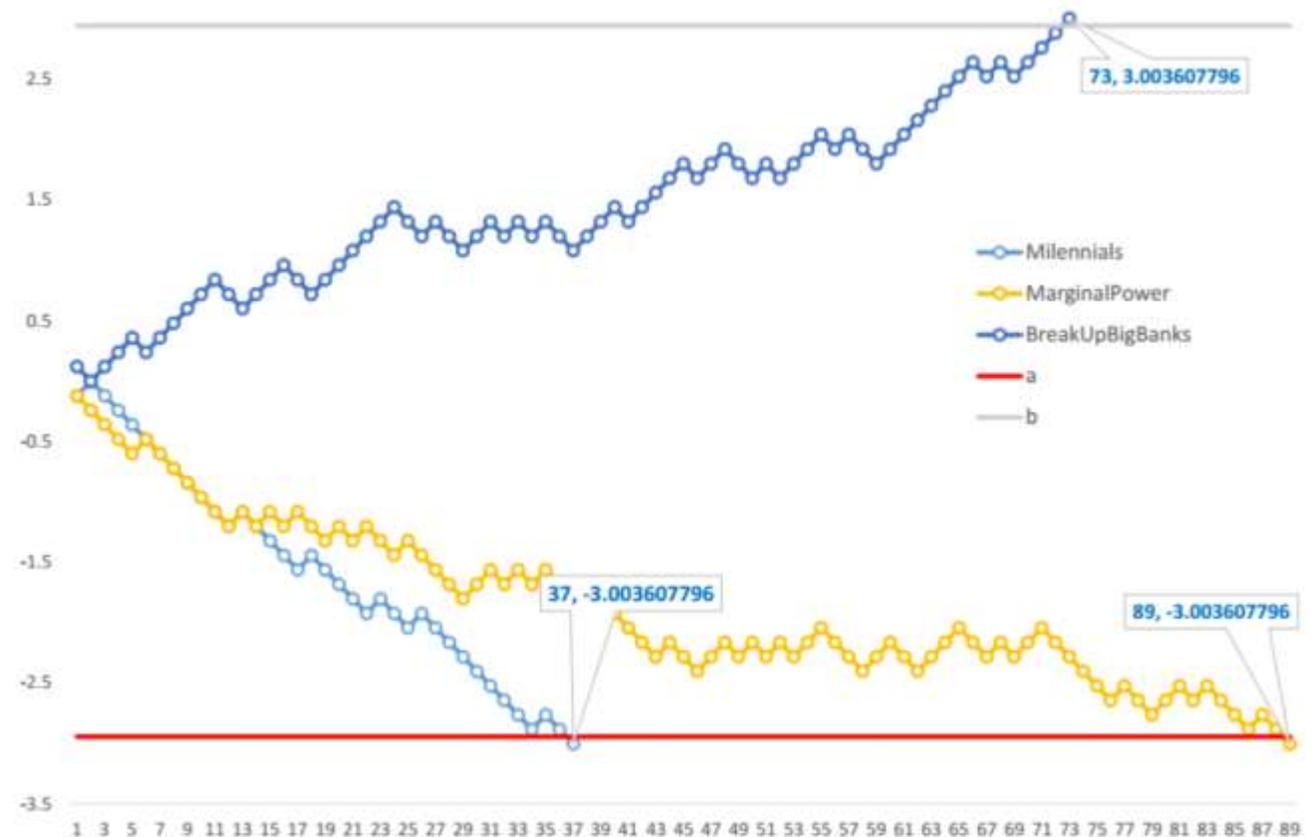
where n is the number of samples taken thus far and k is the number of successes out of those n trials. If

$$\Delta_L \leq \log(\alpha/(1 - \alpha)) = a$$

then `Uncertain(T)` evaluates the conditional as false while if

$$\Delta_L \geq \log((1 - \alpha)/\alpha) = b$$

the conditional is true.



DEBATES: INTELLIGENCE SQUARED

MILLENNIALS DON'T STAND A CHANCE

DEBATE DETAILS THE PANEL RESULTS

Illustration by Thomas James

WEDNESDAY, APRIL 9, 2014



Task	Outcome	Power	Cost
MilennialsDontStandAChance	No	37	\$3.70
MinimumWage	No	43	\$4.30
RichAreTaxedEnough	No	51	\$5.10
EndOfLife	No	53	\$5.30
BreakUpTheBigBanks	Yes	73	\$7.30
StrongDollar	No	85	\$8.50
MarginalPower	No	89	\$8.90
GeneticallyEngineeredBabies	Yes	135	\$13.50
AffirmativeActionOnCampus	Yes	243	\$24.30
ObesityIsGovernmentBusiness	No	265	\$26.50

DOES MONEY BUY HAPPINESS (OR AT LEAST TRANQUILITY)?

```
var rich = from person in scores
           where
               person.Income == Income.INCOME_35_000_TO_49_999 ||
               person.Income == Income.INCOME_75_000_AND_OVER ||
               person.Income == Income.INCOME_50_000_TO_74_999
           select person.Anxiety;

var poor = from person in scores
           where
               person.Income == Income.INCOME_1_TO_4_900 ||
               person.Income == Income.INCOME_10_000_TO_14_999 ||
               person.Income == Income.INCOME_15_000_TO_24_999
           select person.Anxiety;

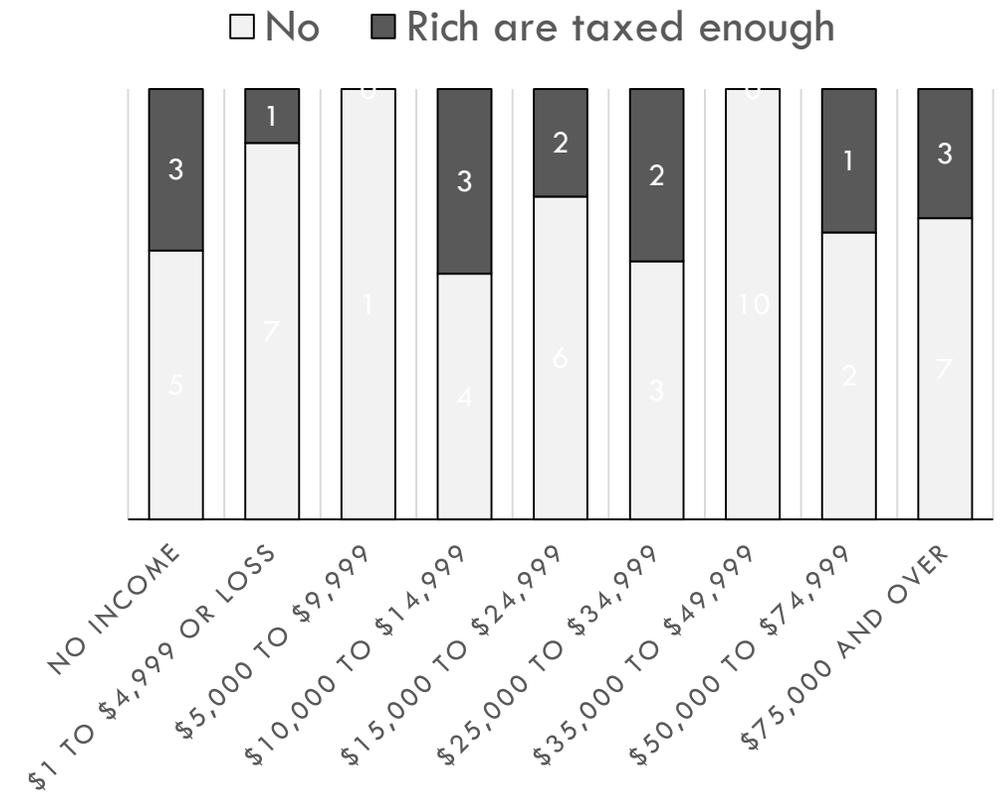
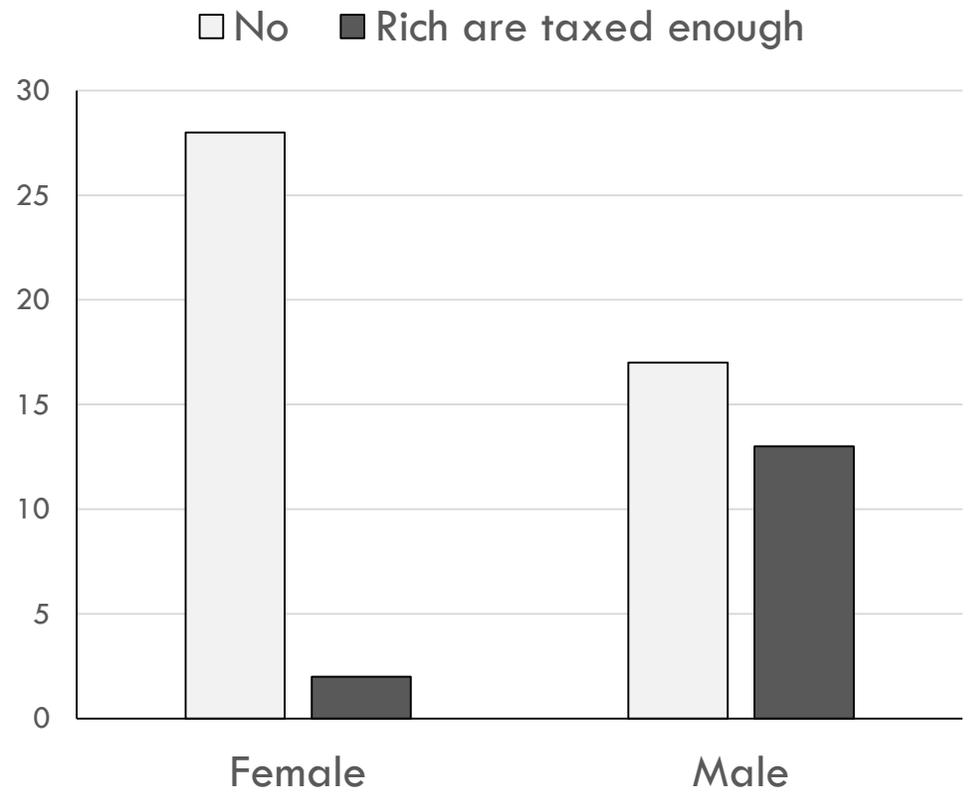
if (rich.ToRandomVariable(false) < poor.ToRandomVariable(false))//p >
{
    Console.WriteLine("Rich are more anxious than poor: " + "\tYes");
}
else
{
    Console.WriteLine("Rich are more anxious than poor: " + "\tNo");
}
```

Are rich **more anxious** than poor?

N = 105

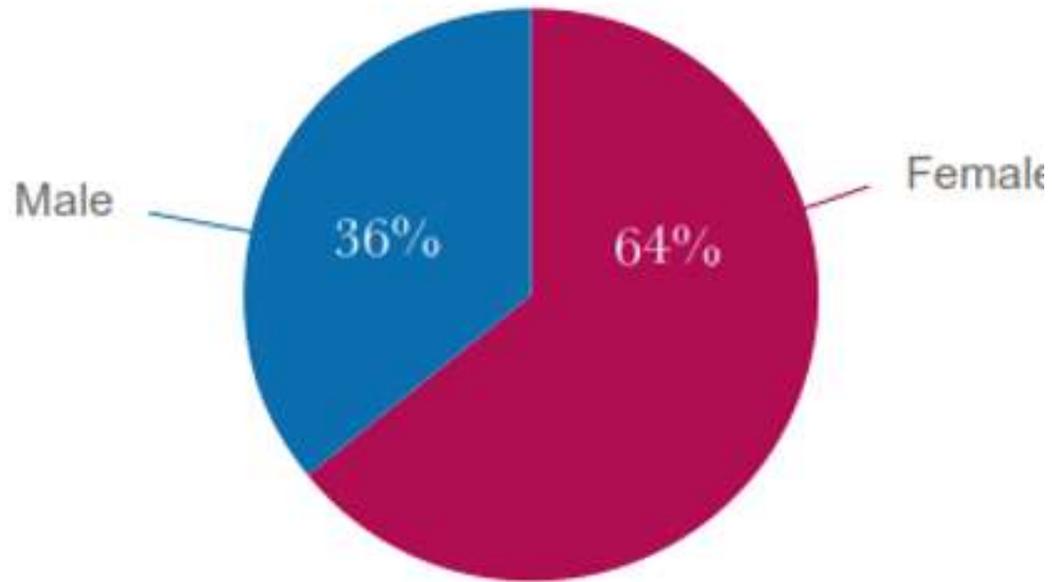
expected value for poor=8.5714,
expected value for rich=7.9619

TAXATION, BY GENDER AND INCOME

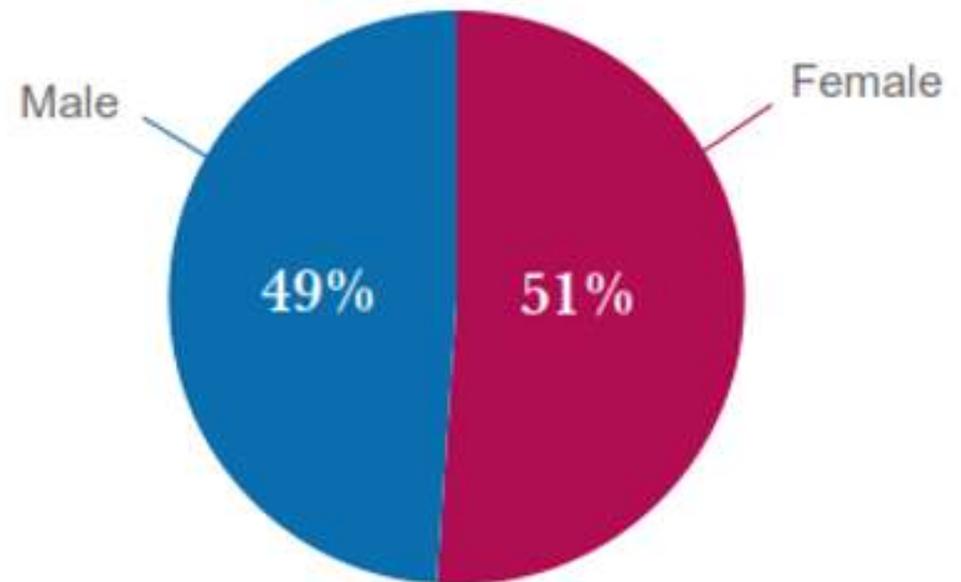


PRIORS FOR THE CROWD

Instant.ly crowd



US census



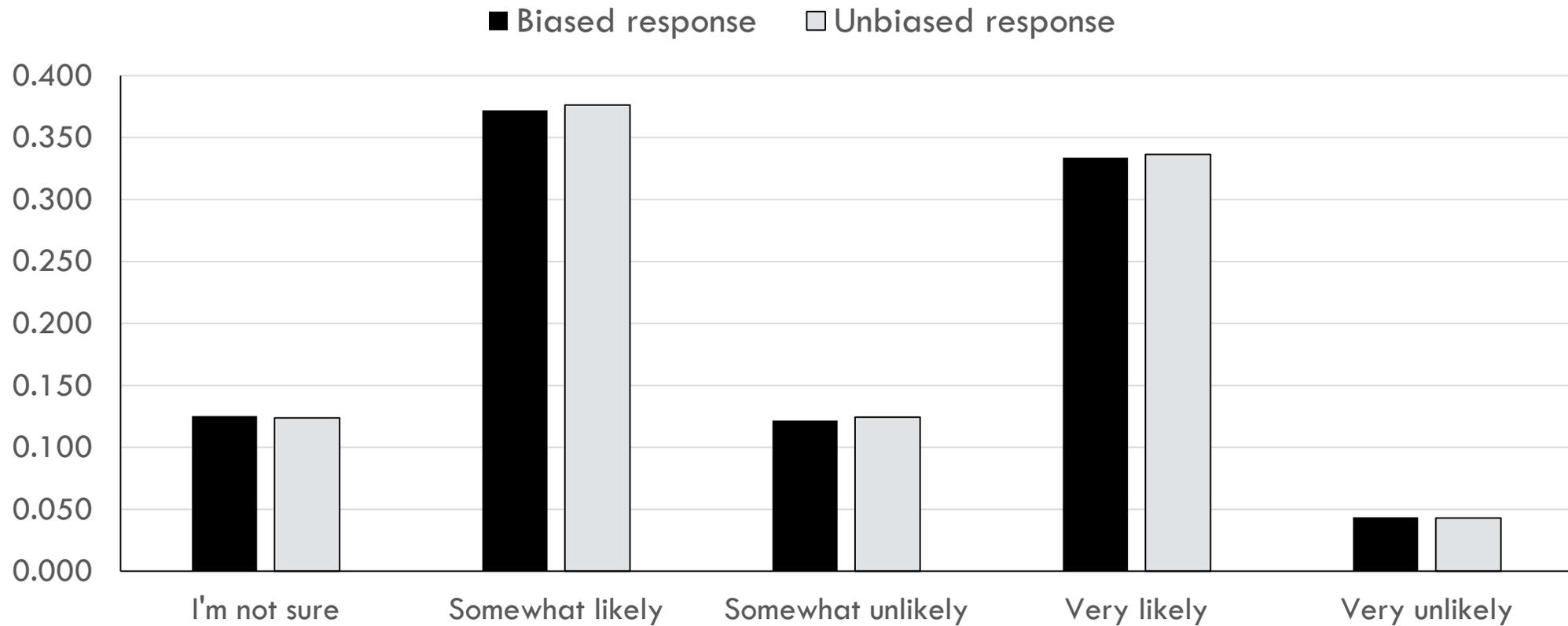
THE UNBIAS OPERATOR

```
var photoAttitudes = (from person in people
    select new
    {
        Used = person.PoseQuestion<bool>(
            "Have you ever hired a professional photograph
        WorthIt = person.PoseQuestion<bool>(
            "Do you feel the money you spent was worth the
        Quality = person.PoseQuestion(
            "How would you rate the quality of the pictures
            "\u2605", "\u2605\u2605", "\u2605\u2605\u2605",
        HowLikely = person.PoseQuestion(
            "How likely are you to
            "Very likely", "Somew
        WhatDidYouEnjoy = pers
            "What did you most en
```

```
// priors for demographics.
var mturk = MTurkPriors.DefaultPriors;
var census = CSPSlicedPriors.DefaultPriors;

var correctedAttitudes = Unbiasing.Unbias(photoAttitudes,
    p => p.HowLikely,
    p => p.Gender, mturk, census);
```

UNBIASING RESULTS



FINANCIAL OPTIMIZATIONS

PL optimizations

Maybe 10% of the runtime

Maybe milliseconds

Even that is difficult and unpredictable

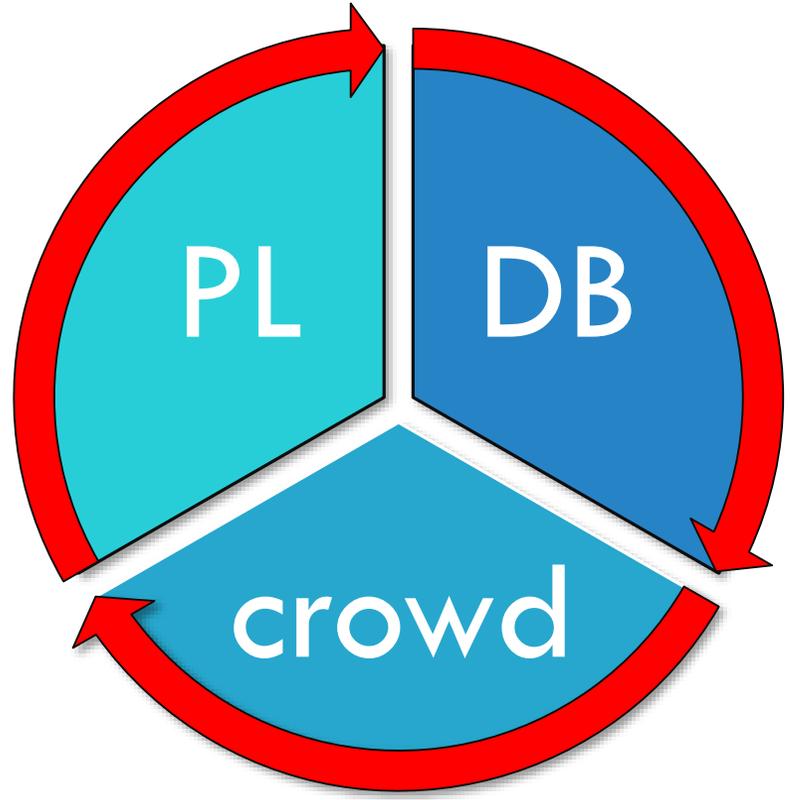
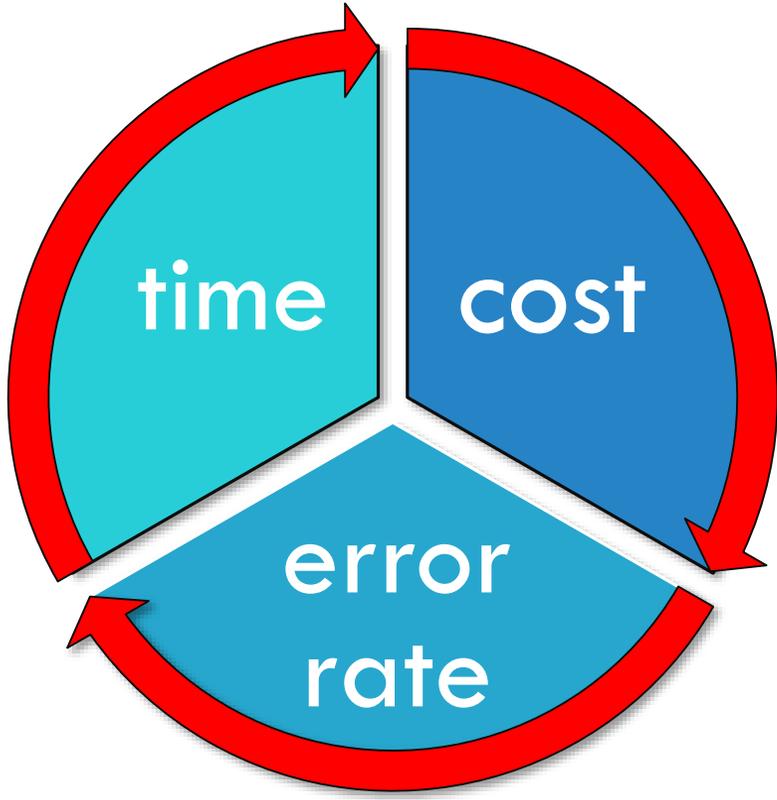
InterPoll optimizations

Saving **hundreds** of dollars

Waiting hours and **days** (or weeks) less

Replacing tedious and expensive manual polling effort with large-scale automation

WHY OPTIMIZE INTERPOLL QUERIES AND HOW?..



WHY OPTIMIZE: COST

[t-deokas] Quick Poll: Are you optimistic about the economy right now?

Requester:	Research Project	Assignments Pending Review:	0
HIT Expiration Date:	Oct 16 2014, 09:43 AM PDT	Reviewed Assignments:	22 Download results
Reward:	\$0.10	Remaining Assignments:	5288 Add assignments
Assignments Requested:	5310	Remaining Time:	days 21 hours Add time Expire this HIT early

Description: Quick Poll: Are you optimistic about the economy right now?
Keywords: survey,poll,demographics

Quick Poll: Are you optimistic about the economy right now?

Yes

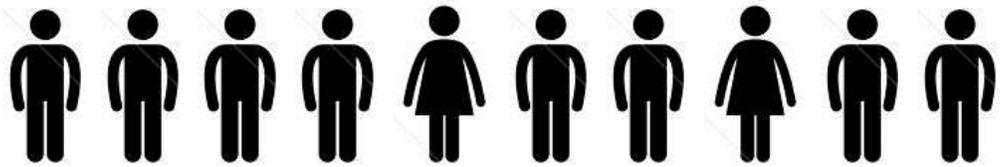
No

$$\begin{aligned} &5,288 \text{ workers} * 10\text{¢ reward} \\ &= \\ &\$528 \end{aligned}$$

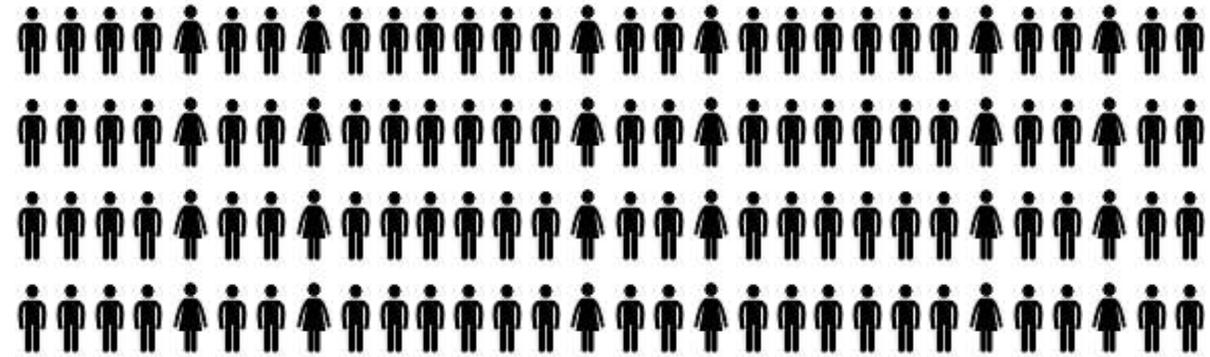
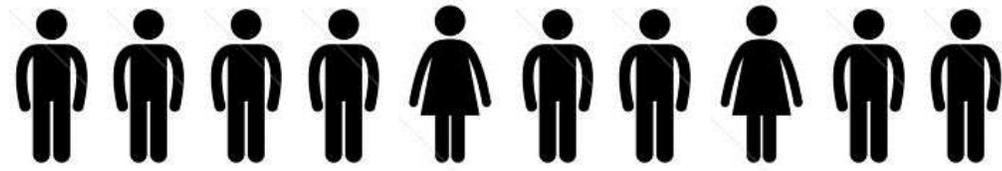
QUERY YIELD

```
var females = from person in population1  
where person.Gender == Gender.FEMALE  
select person.Employment;
```

```
var males = from person in population2  
where person.Gender == Gender.MALE  
select person.Employment;
```



DEPENDS ON THE QUERY: SOME FILTERS HAVE LOW YIELD



20% or 10% yield is not great...



How about 1%?

WHY OPTIMIZE: COST (2)

[t-deokas] Quick Poll: Are you optimistic about the economy right now?

Requester:	Research Project	Assignments Pending Review:	0
HIT Expiration Date:	Oct 16 2014, 09:43 AM PDT	Reviewed Assignments:	22 Download results
Reward:	\$0.10	Remaining Assignments:	5,288 Add assignments
Assignments Requested:	5,310	Remaining Time:	3 days 21 hours Add time Expire this HIT early

Description: Quick Poll: Are you optimistic about the economy right now?
Keywords: survey,poll,demographics

Quick Poll: Are you optimistic about the economy right now?

Yes

No

$$5,288 \text{ workers} * 10\text{¢ reward at a 10\% yield} = \$5,288$$

$$5,288 \text{ workers} * 10\text{¢ reward} = \$528$$

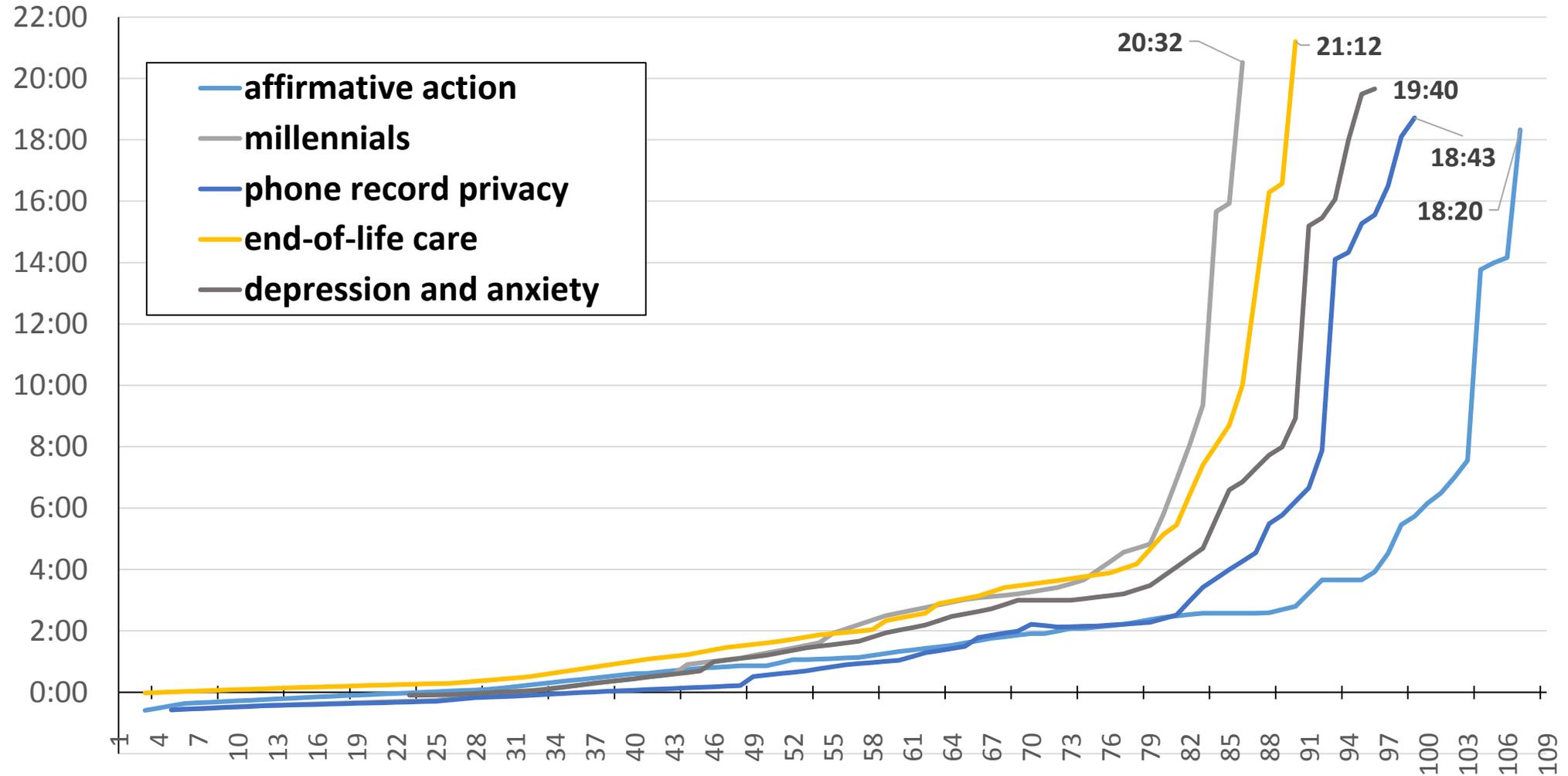
WHY OPTIMIZE: TIME

The screenshot displays a HIT interface for a quick poll. On the left, a sidebar lists details: Requester (Res), HIT Expiration Date (Oct), Reward (\$0.1), Assignments Requested (531), Description, and Keywords. The main content area shows the poll question: "Quick Poll: Are you optimistic about the economy right now?" with radio buttons for "Yes" and "No". To the right, a summary box provides key statistics: "Assignments Pending Review: 0", "Reviewed Assignments: 22" (with a "Download results" link), "Remaining Assignments: 5288" (with an "Add assignments" link), and "Remaining Time: 4 days 21 hours" (with "Add time" and "Expire this HIT early" links).

Category	Value	Action
Assignments Pending Review	0	
Reviewed Assignments	22	Download results
Remaining Assignments	5288	Add assignments
Remaining Time	4 days 21 hours	Add time Expire this HIT early

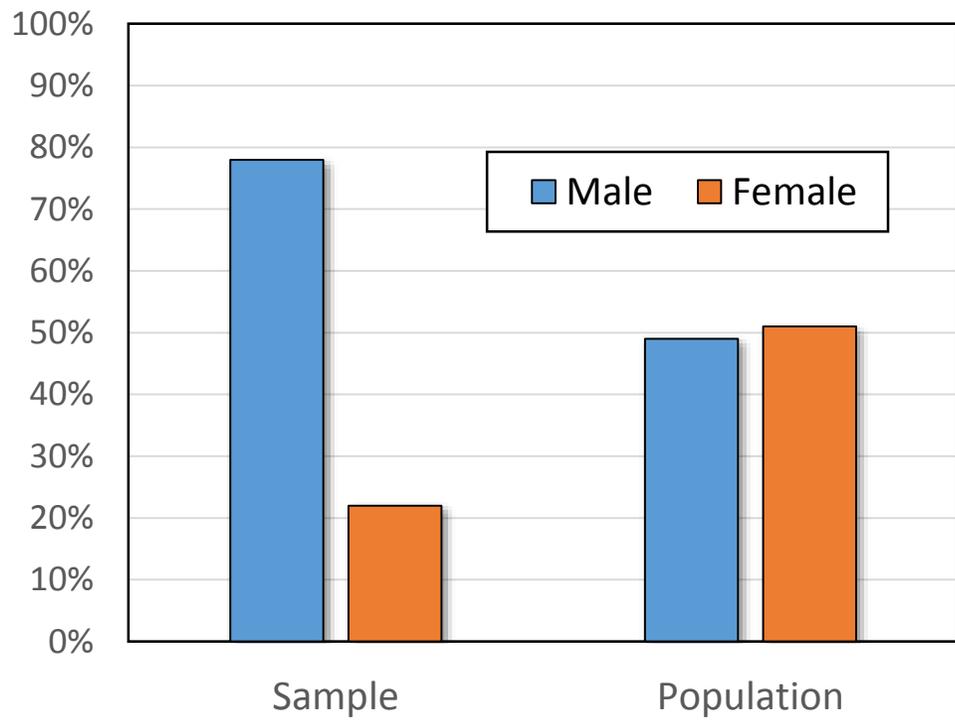
At this rate we will have to wait **10 days** for all assignments to finish!

TIME SAVINGS FROM REBALANCING OPTIMIZATIONS

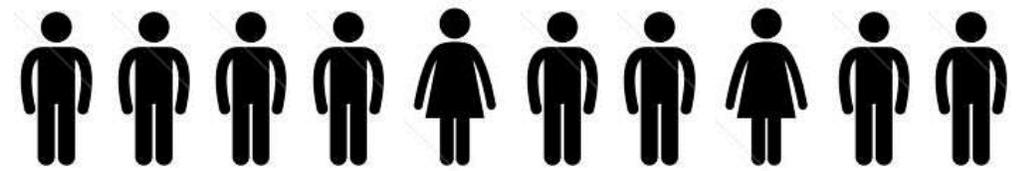


WHY OPTIMIZE: MARGIN OF ERROR

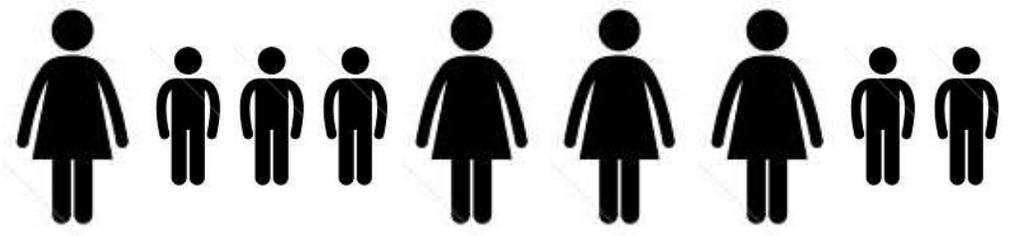
Unbiasing



initial



unbiased

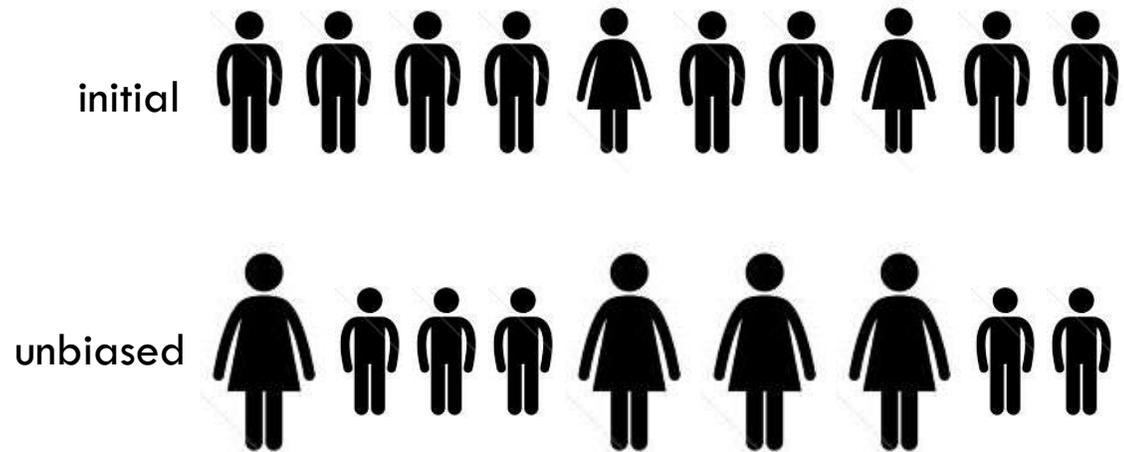


unbiasing
increases
margin of
error



PANEL BUILDING

Unbiasing increases error rates



Would it be possible to automatically construct a **balanced panel**?

This is what human polling experts do: they invite people to participate depending on which profile is needed



OVERVIEW OF OPTIMIZATIONS IN THIS PROJECT

Static optimizations

1. **Flattening** of complex LINQ trees
2. **Query splitting**
3. **Common sub-expression** elimination

Runtime optimizations

1. **Yield:** cost
2. **Rebalancing:** time
3. **Panel building:** error rates

DEMO

```
1 using ...
4
5 namespace Microsoft.Research.RiSE.InterPoll
6 {
7     public partial class Runner
8     {
9         [TestMethod]
10        public void EmploymentSurvey() {
11
12        }
13    }
14 }
```

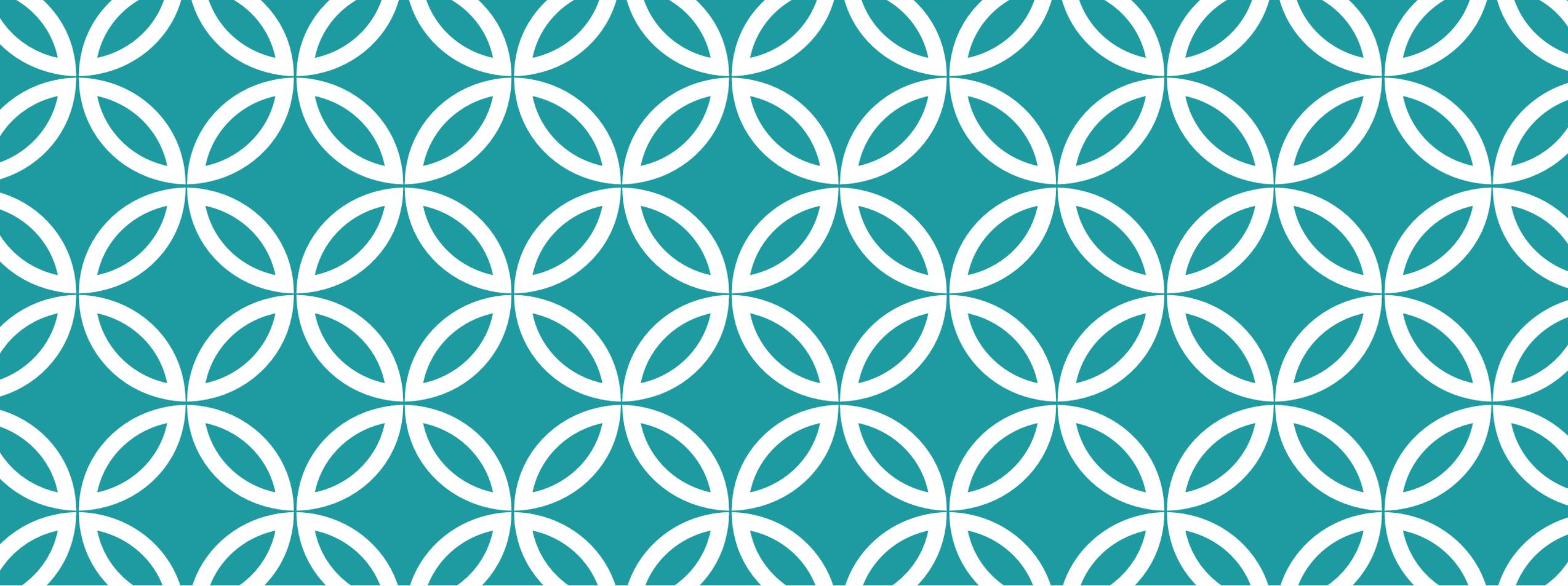
CONCLUSIONS

InterPoll: a system for large-scale crowd-sourced polling

Geared toward

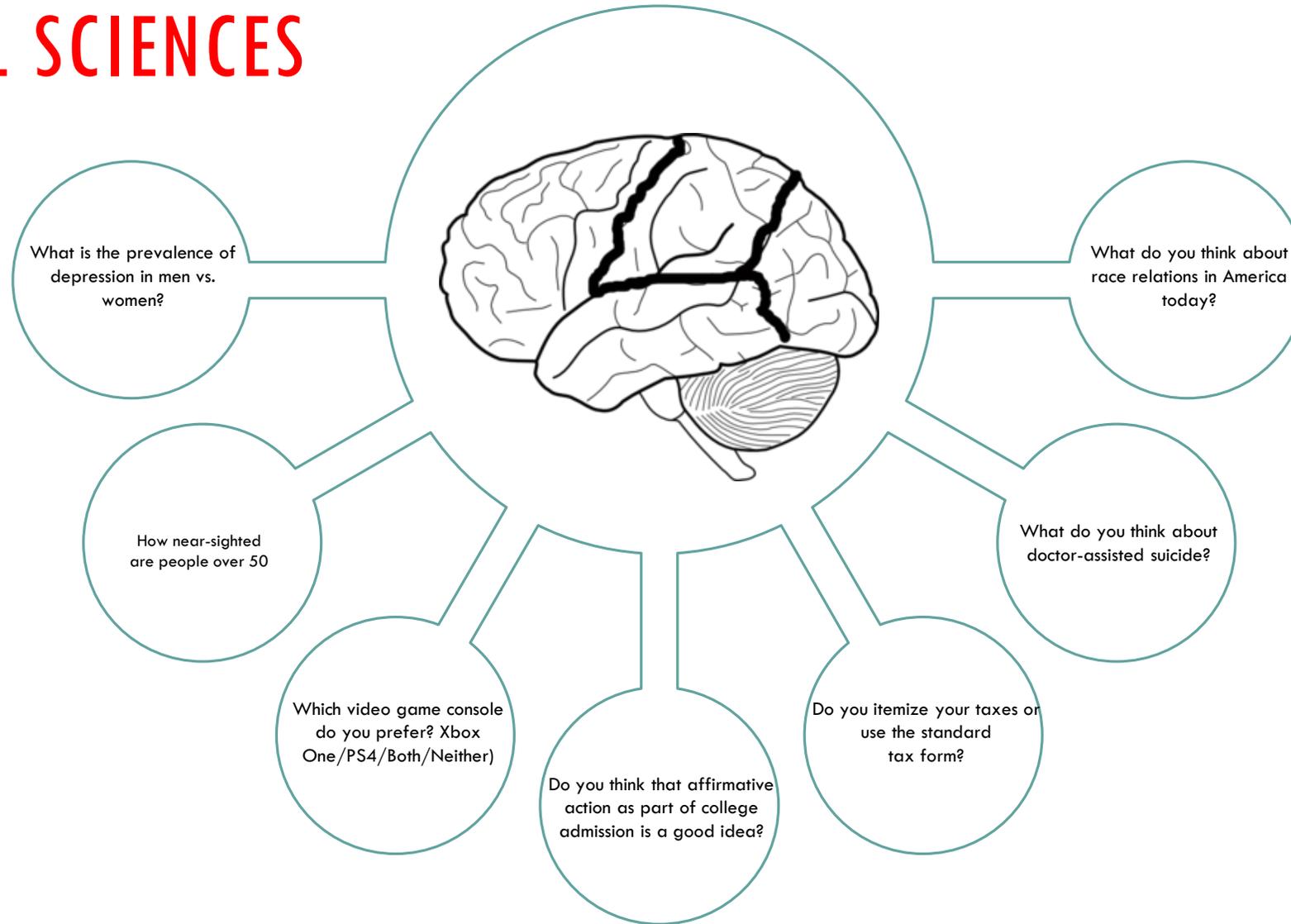
- Developers who want to incorporate human data into their applications
- But also social scientists
- Marketing professionals
- Campaign pollsters

Have explored **power analysis**
and are doing experiments
on **unbiasing**
and various **optimizations**

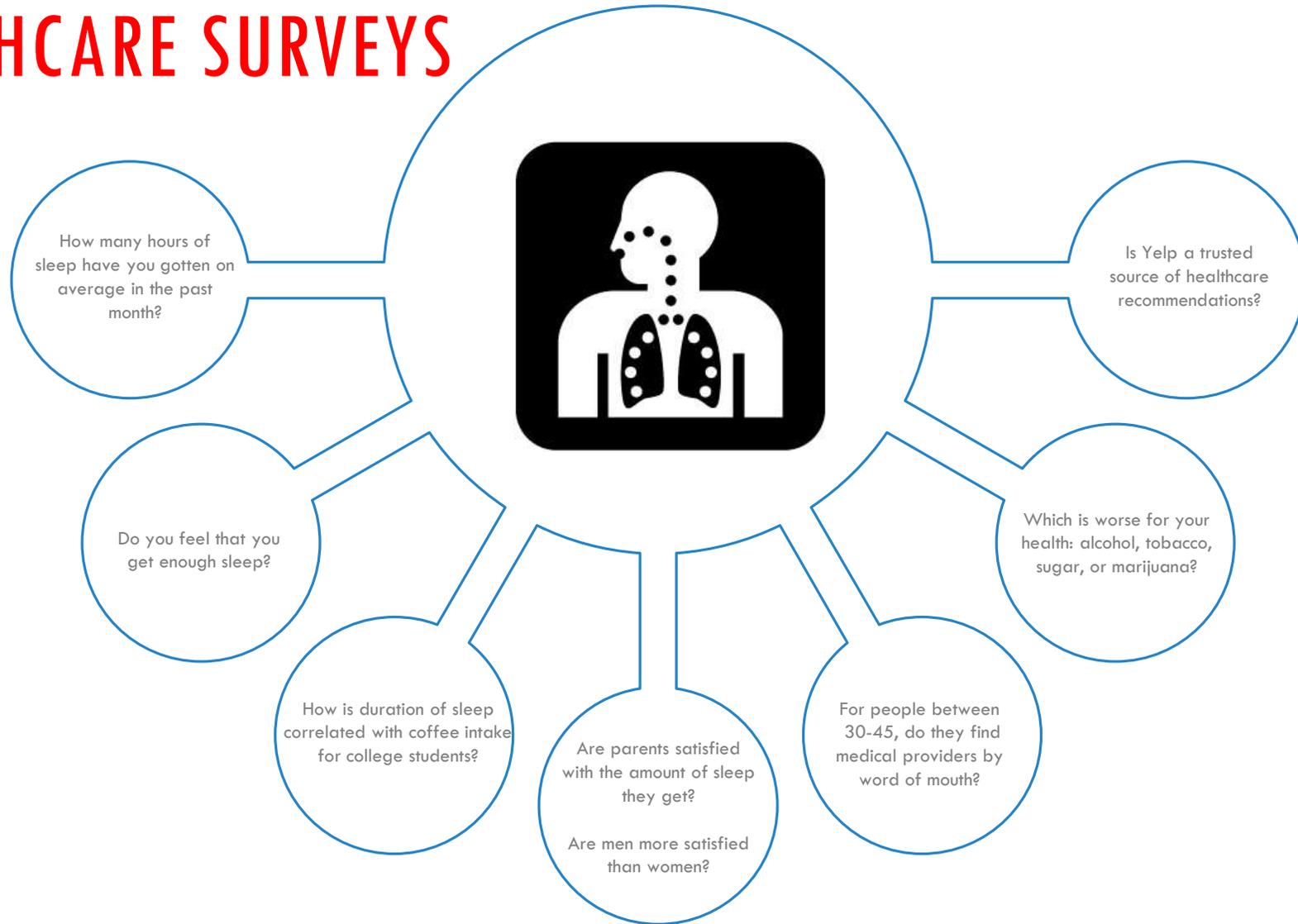


BUILDING INTERPOLL APPLICATIONS

SOCIAL SCIENCES

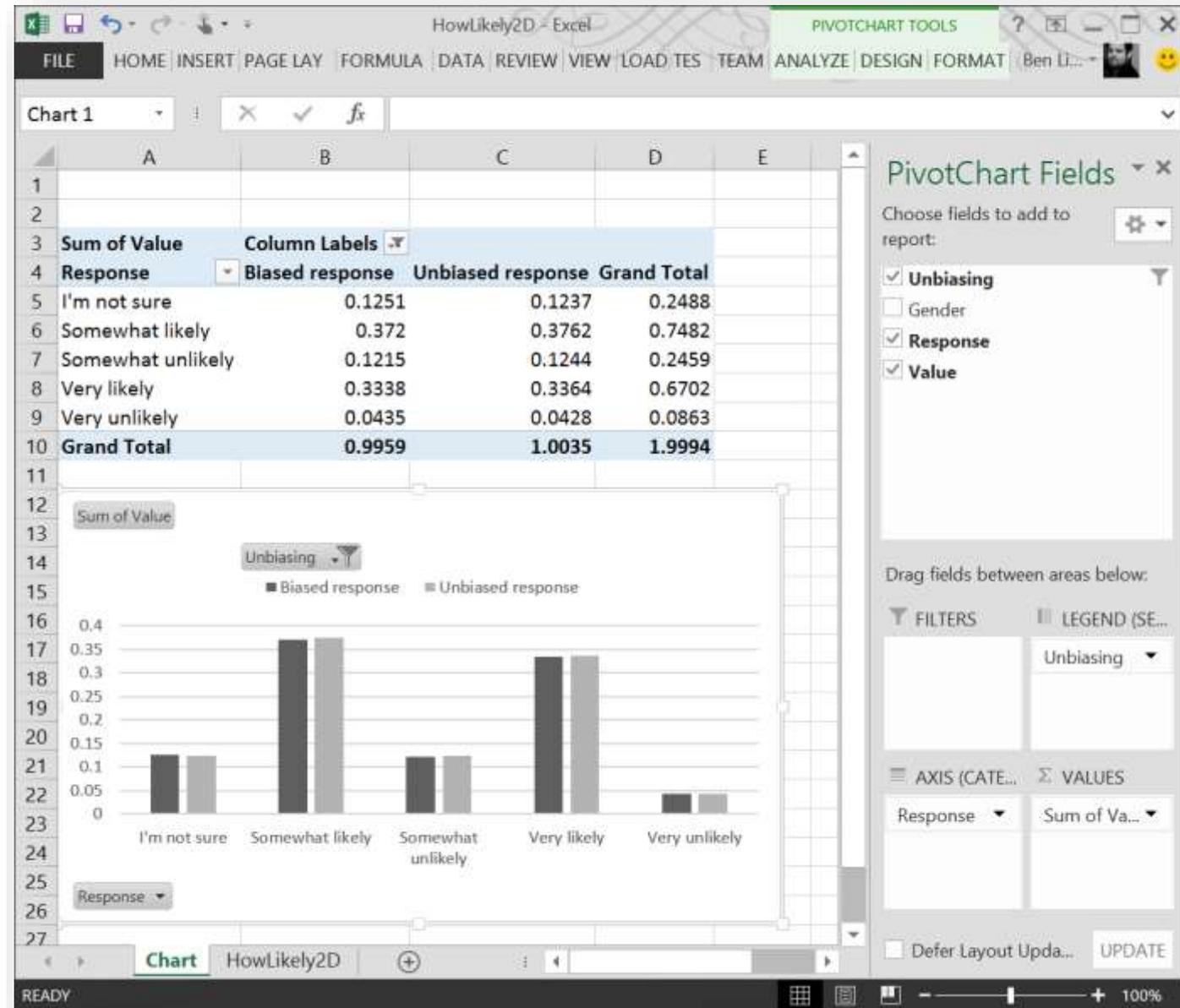


HEALTHCARE SURVEYS

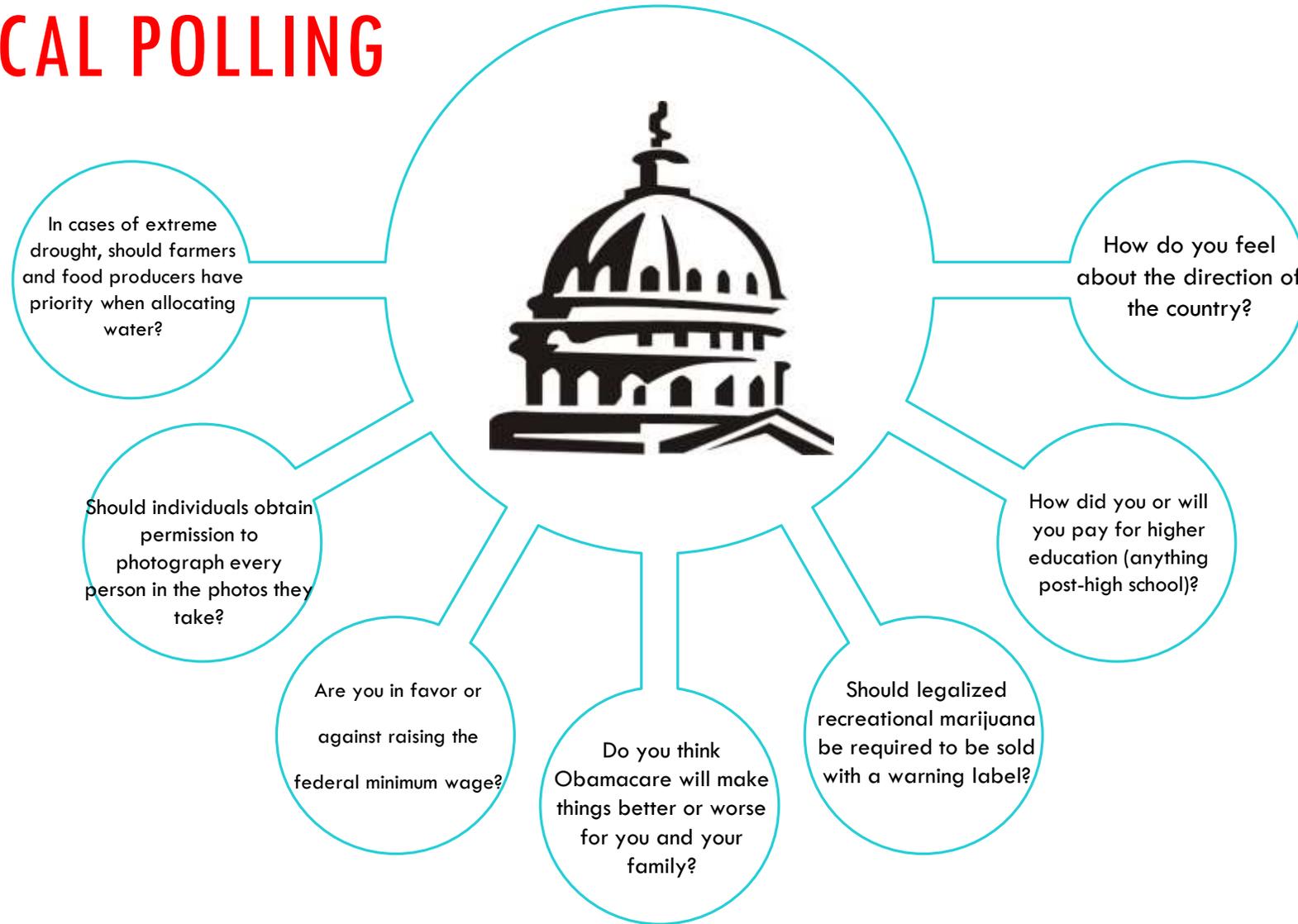


EXPLORING THE DATA

Age	Gender	Race	Education	Income	Employment	Relationship	Zip	Answer 9	Answer 10	Answer 11
48	Female	Two or more races	Bachelor's	\$75,000 to \$99,999	Worked full-time	Married, Spouse	98275	From time to time	Definitely not likely	Not at all
24	Female	Black or African American	Bachelor's	\$5,000 to \$9,999	Worked full-time	Never married	60638	Not at all	Only a little likely	Not at all
22	Male	White alone	High school or less	\$15,000 to \$24,999	Worked full-time	Married, Spouse	81003	From time to time	Hardly at all	A little likely
31	Male	White alone	Bachelor's	\$35,000 to \$49,999	Worked full-time	Married, Spouse	14226	A lot of times	Not quiet	Yes, a lot
18	Male	White alone	High school or less	\$1 to \$4,999	Did not work	Never married	77388	From time to time	Definitely not likely	A little likely
53	Male	White alone	Some college	\$75,000 to \$99,999	Worked full-time	Married, Spouse	90606	A lot of times	Not quiet	A little likely
28	Female	Asian alone	Bachelor's	\$50,000 to \$74,999	Worked full-time	Never married	98056	From time to time	Not quiet	Yes, a lot
50	Male	White alone	High school or less	\$75,000 to \$99,999	Worked full-time	Married, Spouse	29730	From time to time	Definitely not likely	Not at all
22	Female	White alone	Bachelor's	\$1 to \$4,999	Worked full-time	Never married	6612	From time to time	Not quiet	Yes, a lot
28	Male	White alone	Bachelor's	\$10,000 to \$14,999	Worked full-time	Never married	95776	A lot of times	Hardly at all	Very unlikely
33	Female	White alone	Bachelor's	No income	Did not work	Married, Spouse	89012	From time to time	Not quiet	A little likely
30	Female	Two or more races	Some college	\$1 to \$4,999	Did not work	Never married	92869	From time to time	Not quiet	Not at all



POLITICAL POLLING





Demo: basic surveys

OTHER INTERFACES

SkiResortMashup v2 - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW POWER VIEW DESIGN LAYOUT POWER QUERY POWERPIVOT

Clipboard Undo/Redo Themes Background Image Data View

Ski Trip Planning

Traffic Center

- Sacramento
- Stockton
- Truckee

Pricing (2012)

Ski Area	Price
Granlibakken Ski Resort	\$24.00
Donner Ski Ranch	\$25.00
Homewood Mountain Resort	\$25.00
Soda Springs	\$36.00
Tahoe Donner	\$41.00
Boreal Mountain Resort	\$49.00
Heavenly Ski Resort	\$61.00
Dodge Ridge Ski Area	\$64.00
Bear Valley Mountain Resort	\$67.00
Sierra at Tahoe	\$77.00
Sugar Bowl Resort	\$77.00
Kirkwood	\$79.00
Northstar	\$91.00
Alpine Meadows Ski Area	\$96.00
Squaw Valley USA	\$99.00

More Information

SkiArea Name	Year	Opening Year	Lift Count	Night Skiing
Alpine Meadows Ski Area	1964	Custom opening year	3	No
Sierra at Shirley Meadows	1982	Custom opening year	3	No
Badger Pass Ski Area				

Most Recent Road Conditions

Traffic Center	Location	Time	Traffic Inc Type	Location Desc.
Sacramento	Jefferson Blvd / Babel Slough Rd	03:15 AM	Car Fire	NB JNO 3/4 MILE
Sacramento	Main St	05:18 AM	Assist with Construction	RIO VISTA PD
Sacramento	Mm50 / Still Meadow Rd	03:02 AM	Traffic Hazard	WB
Sacramento	Watt Ave / Don Julio Blvd	08:58 PM	SILVER Alert	FREWILL BAPTIST CHURCH
Sacramento	Watt Ave / S Watt Ave	03:19 PM	SILVER Alert	WATT AVE IN SACRAMENTO
Stockton	3330 N Ad Art Rd	03:19 PM	SILVER Alert	STOCKTON CHP OFFICE
Truckee	10077 Frates Ln	03:15 PM	SILVER Alert	TRUCKEE CC
Truckee	180 E / 180 E Rainbow Rd Ofr	04:25 PM	CLOSURE of a Road	

Power View Fields

ACTIVE | ALL

- FactPricing
- Ski Areas
- TrafficCenters

Drag fields between areas below:

TILE BY

VALUES

- LiftPrice

AXIS

- SkiArea Name

LEGEND

- Traffic Center

VERTICAL MULTIPLES

HORIZONTAL MULTIPLES

Edit Survey

Jam Session Planning

Let's get together to make some music. Let me know when you're free and what you play!

What's your name?

What instrument do you play?

When's best for you?

Add New Question

Share Survey Save and View Close

EDIT QUESTION

Question: What's your name?

Question Subtitle:

Response Type: Text

Required:

Default Answer:

Done Delete Question

COSTLY... ESPECIALLY AT SCALE

SurveyMonkey Audience pricing

A technology accessory company wants feedback on their latest iPhone case design. They have a 14-question survey and would like 200 responses from an audience of only female iPhone users, delivered on the 2-business day schedule.

14 question survey	\$1.50 per response
2 specific targeting options added	\$1.25 per response (Gender targeting & iPhone ownership targeting)
2-business day turnaround	\$1.00 per response
Project cost for 200 responses	\$750.00 (\$3.75 per response)

Instant.ly cost per completed survey

