Lecture 1: Laying the Foundations + Terminology

Chapters 1.1-1.2

Goals for Today

- Go over the syllabus
- Show some fun examples
- Discuss how to evaluate the efficacy of a treatment
- Describe the different kinds of variables we'll consider

What is statistics?

(Direct from text) The general scientific process of investigation can be summed up as follows:

1. Identify the scientific question or problem
2. Collect relevant data on the topic
3. Analyze the data
4. Form a conclusion and communicate it

Statistics concerns itself with points 2 through 4.

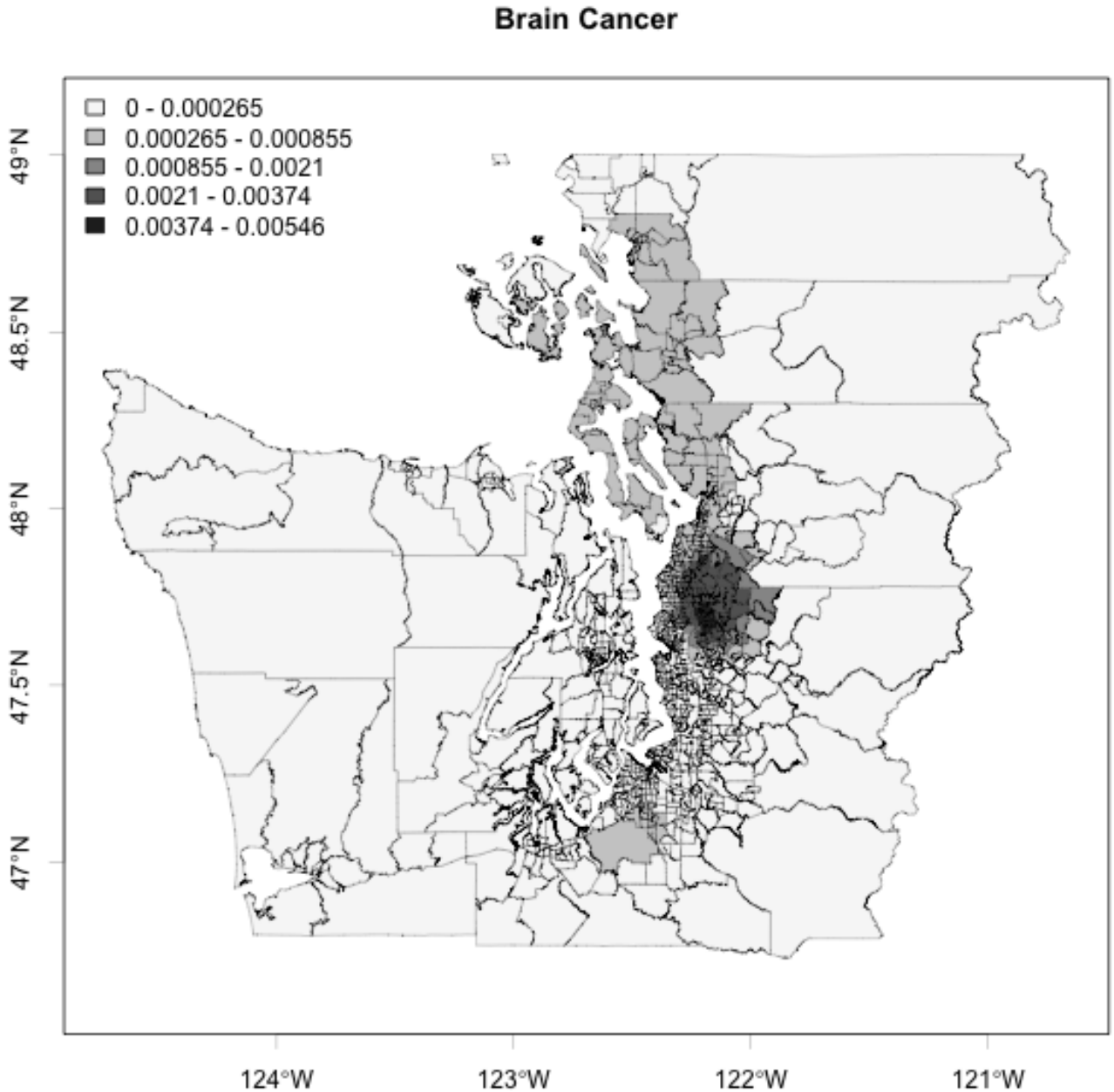
Your Majors

Biology	11
History	4
Mathematics	3
Biochem and Molecular Biology	2
International Policy Studies	2
Undecided	2
Economics/Mathematics	1
Environmental Studies-Pol Sci	1
Sociology	1
Economics	5
Environmental Studies	3
Psychology	3
Chemistry	2
Linguistics	2
Anthropology	1
Environmental Studies-Hist	1
Physics	1

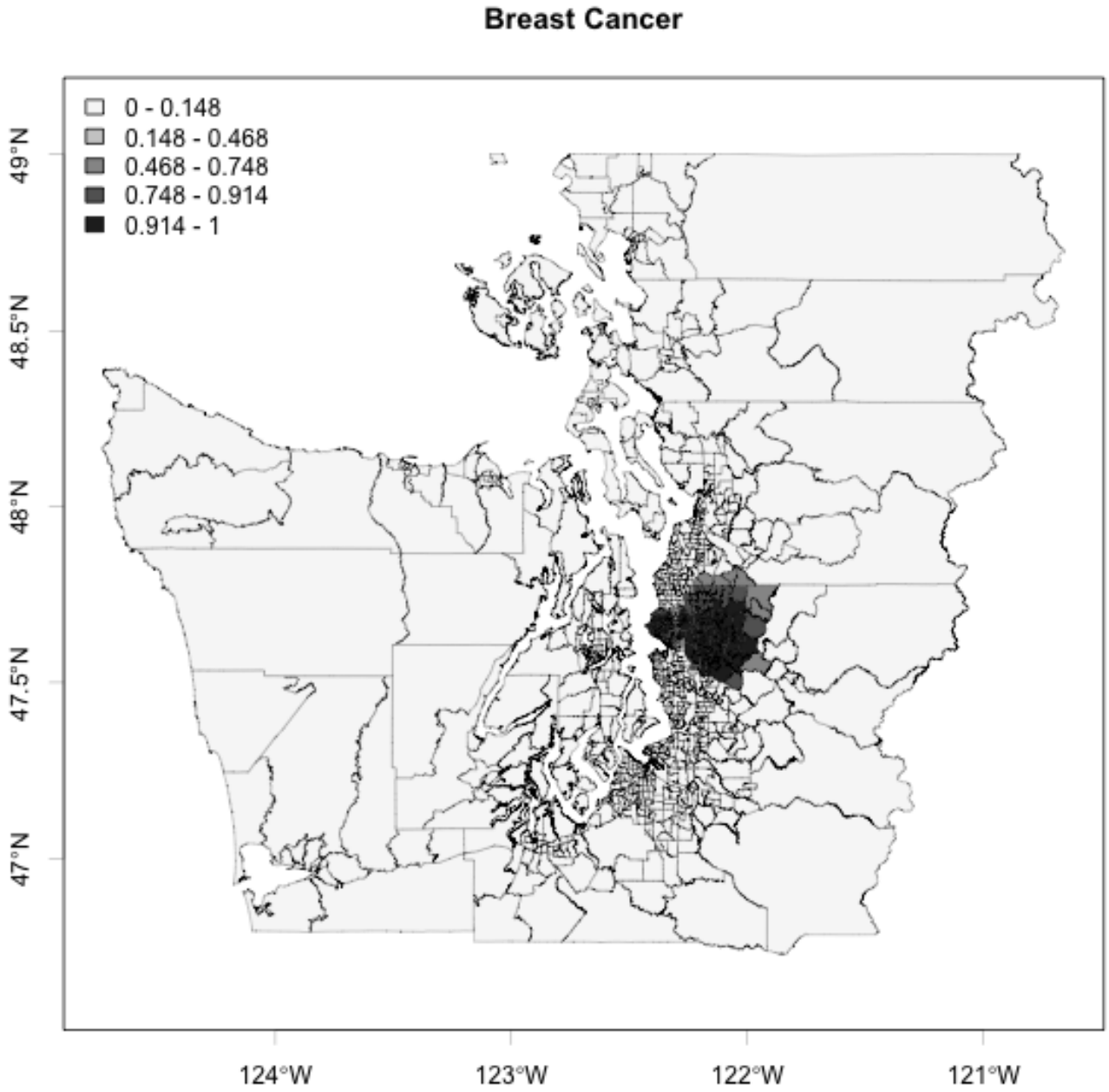
Example: Brain & Breast Cancer in Western Washington

We are interested in detecting cancer "clusters": areas of high residual spatial variation of disease risk.

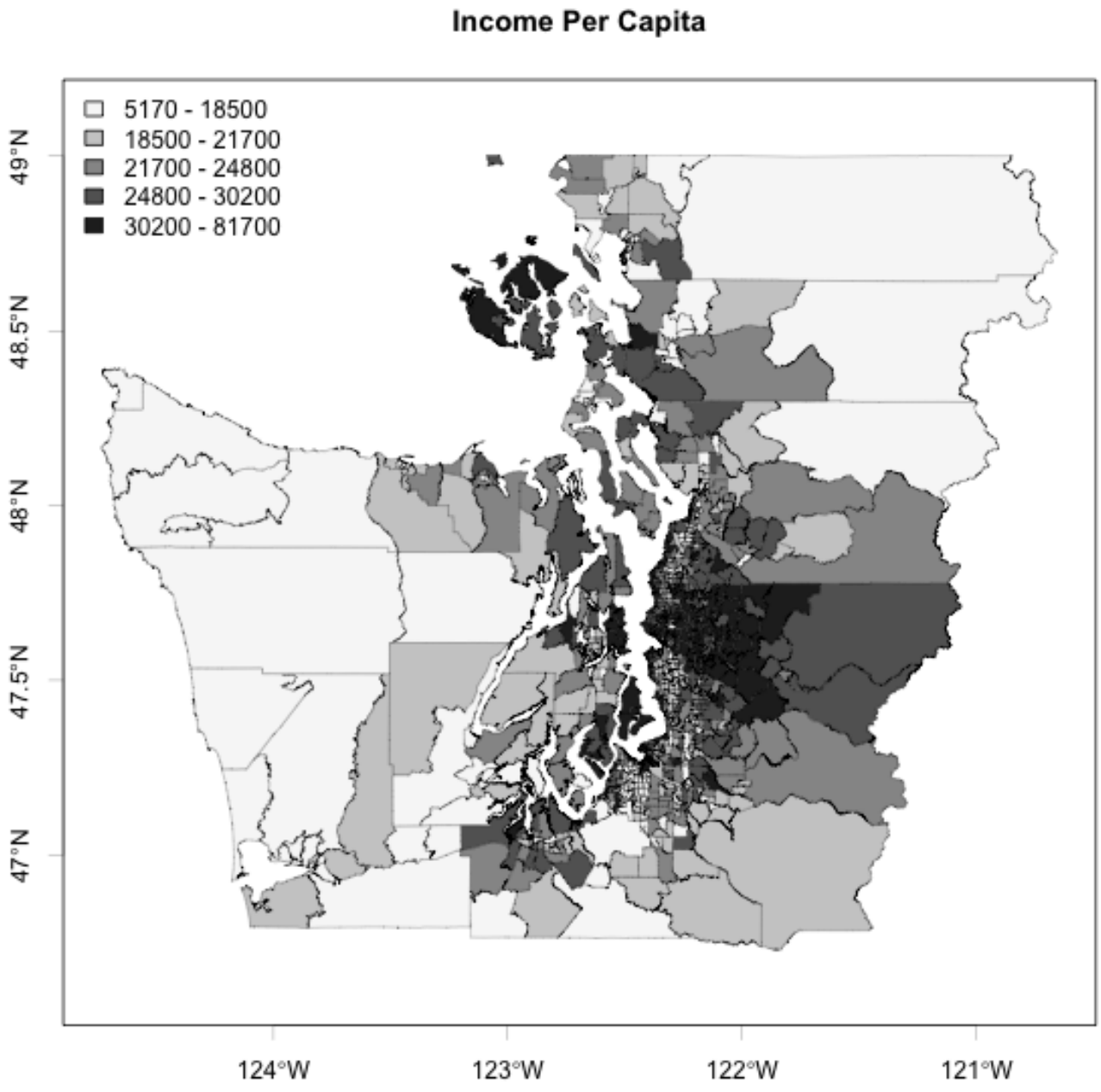
Brain Cancer



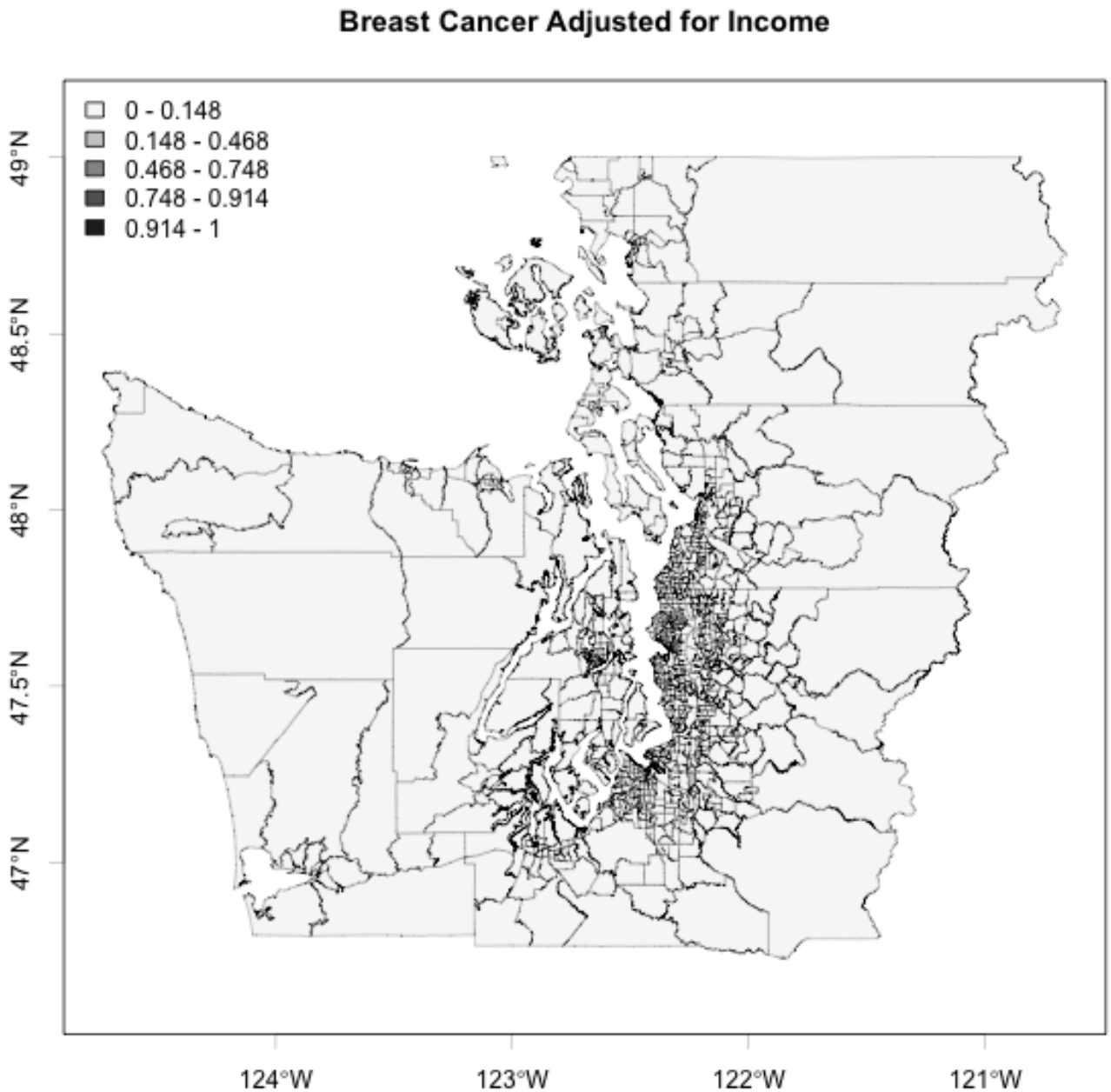
Breast Cancer



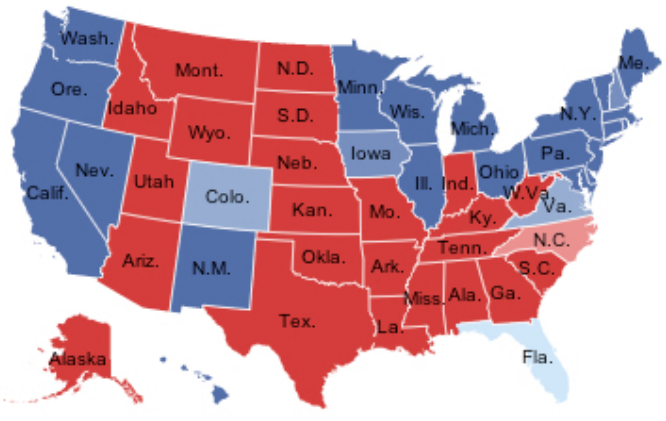
Income Quintiles



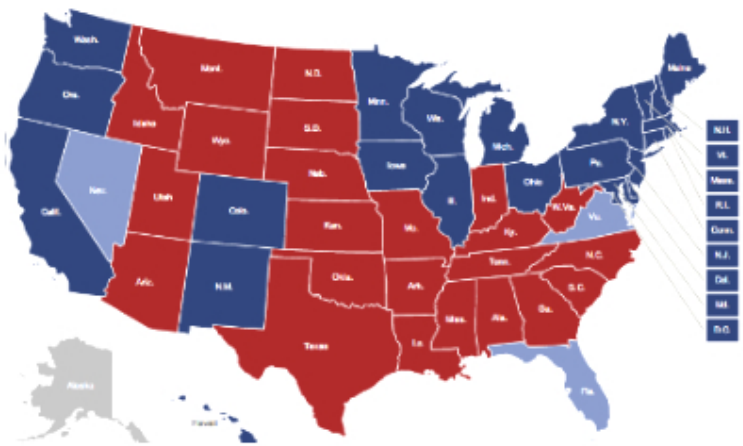
Breast Cancer Adjusted for Income



Example: 2012 Election - Nate Silver's Predictions vs Actual Results

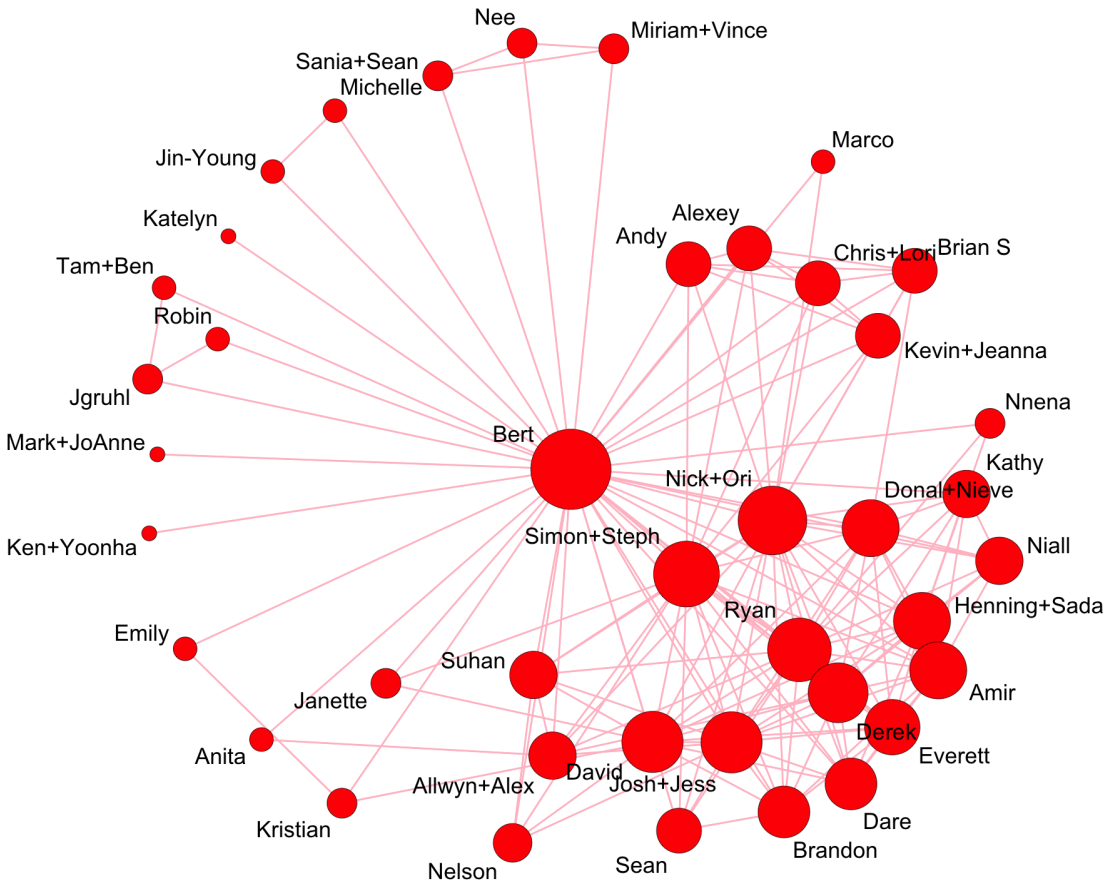


Nate Silver's Map



The Actual Map

Example: Social Network Display of a Recent Party I Had



Say we want answer the following questions:

- Does a new kind of cognitive therapy alter levels of depression in patients?
- Or you question the effectiveness of antioxidants in preventing cancer.
- Will reassuring potential new users to a gambling website that we won't spam them increase the sign-up rate?

Evaluating the efficacy of a 'treatment'

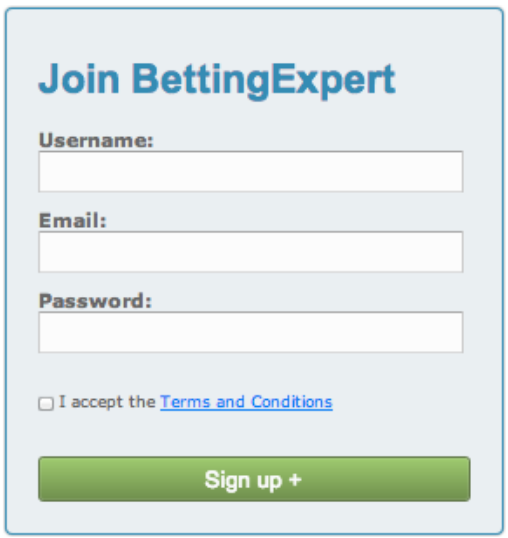
In all the above cases, you are questioning the efficacy of a treatment/intervention. One way to evaluate the efficacy is via an experiment where you define

- A control group: the "business as usual" baseline group
- A treatment group: the group that receives/is subject to the treatment/intervention

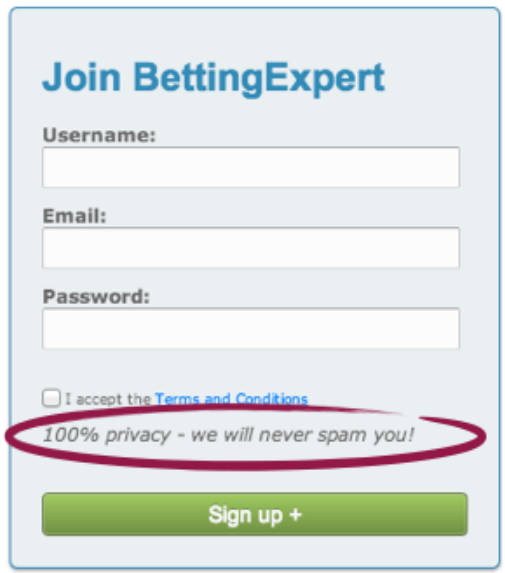
and make comparisons.

Website Experiments

Control:



Treatment:



Example of a treatment vs control

Two other examples in the media of late

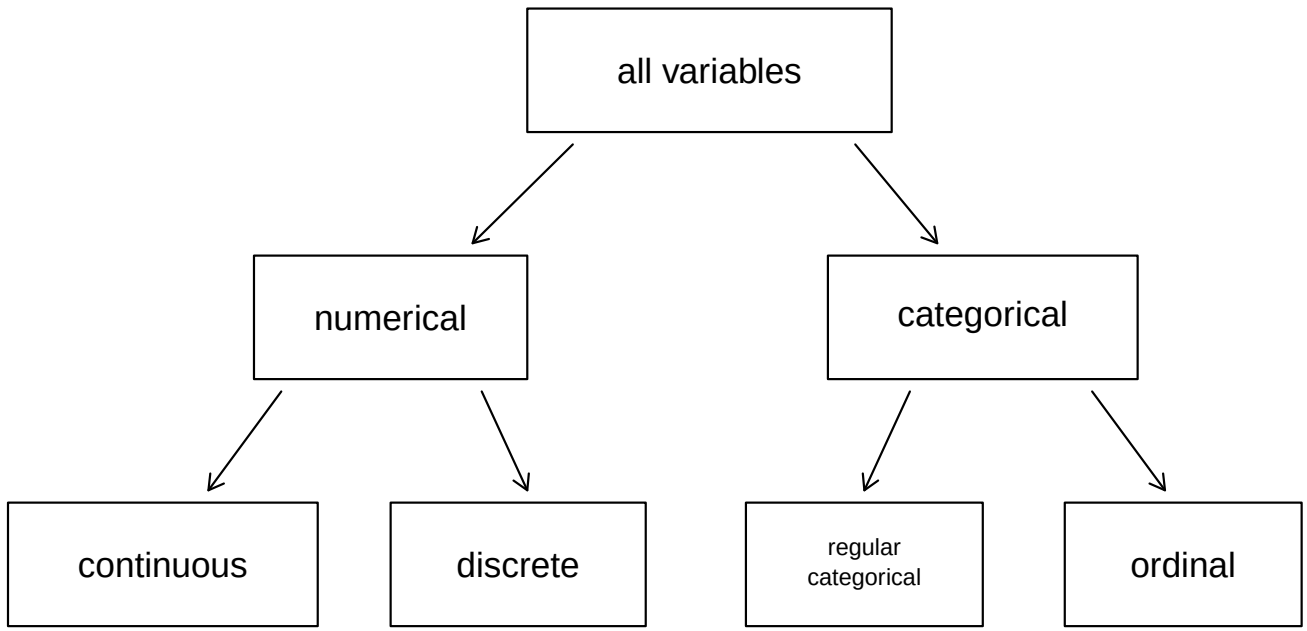
- Facebook's tinkering of user's emotions (link)
- OkCupid's admission that they experiment on human beings (link)

Variables

A variable is a description of any characteristic whose value may change from one unit in the population to the next:

1. gender of an engineer: categorical variable
2. level of education (high school/GED, college, grad school): ordinal variable
3. number of major defects on a newly manufactured phone: discrete variable i.e. something you can count
4. temperature of the battery in a phone after 1 hour of use: continuous variable; its possible values consist of an interval on the number line

Variables Flow Chart



Data

At its simplest, data are presented in a data table or matrix where (almost always) each

- row corresponds to cases or units of observation/analysis
- column represents the variables corresponding to a particular observation

It is almost always the case that

- n is the number of observations
- p is the number of variables

Data Summaries

Consider the variable "federal spending per capita" in each of the 3,143 counties in the US. One can hardly digest this:

```
   [1]   6.068095   6.139862   8.752158   7.122016   5.130910   9.973062   9.311835  15.439218
   [9]   8.613707   7.104621   6.324061  10.640378   9.781442   8.982702   6.840035  20.330684
  [17]   9.687698  11.080738   7.839761   9.461856   9.650295   7.760627  25.774791  13.948106
   ...
[3121]   7.520731  10.246400   3.106800  17.679572   4.824044   7.247212   8.484211   8.794626
[3129]   9.829593   8.100945  17.090715   4.855849   6.621378  22.587359  10.813260  11.422522
[3137]   9.580265   4.368986   5.062138   6.236968   4.549105   8.713817   6.694784
```

Data Summaries

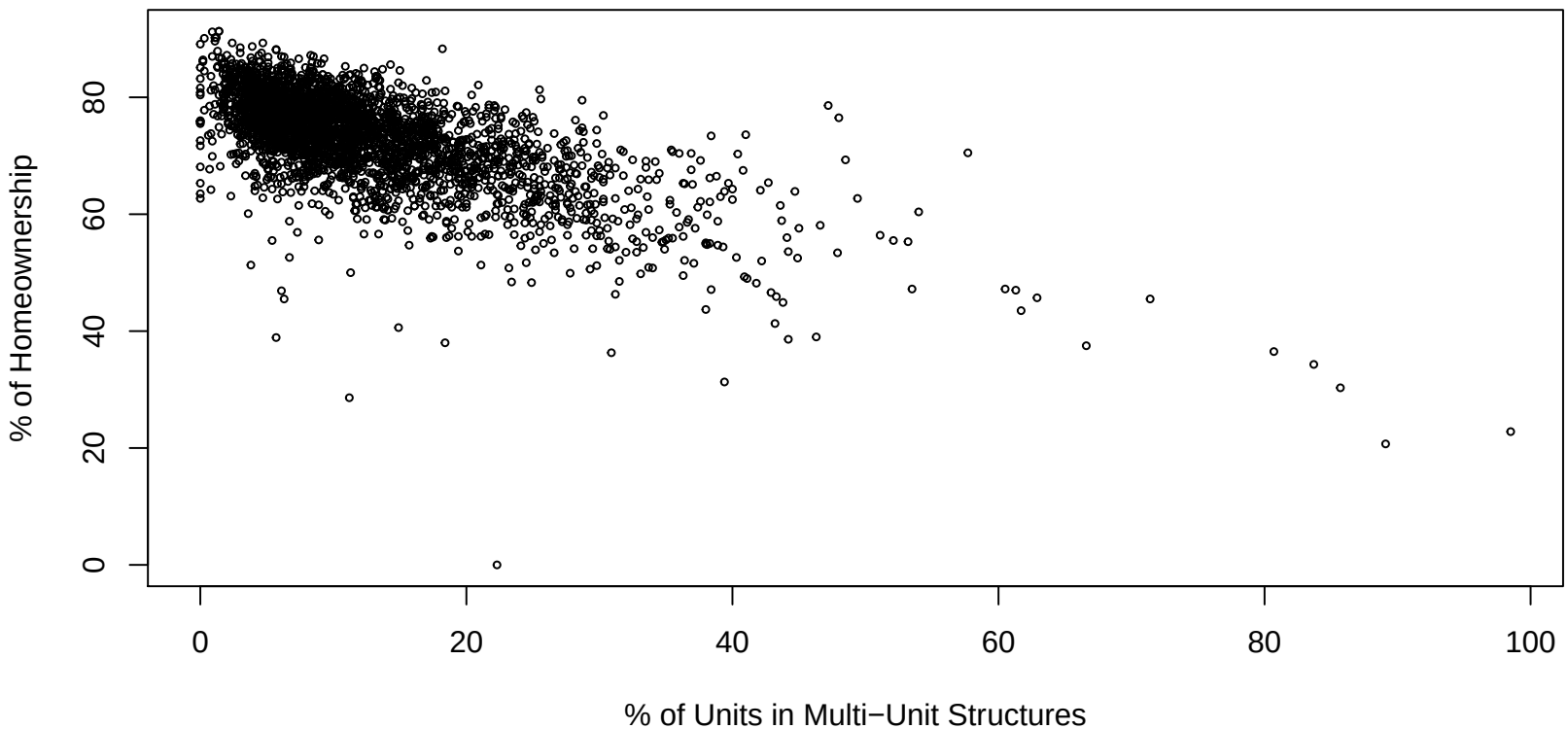
We can't interpret all the data at once; we need to boil it down via summary statistics, single numbers summarizing a large amount of data.

Using the `summary()` command in `R`:

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  0.000   6.964   8.669   9.991  10.860 204.600       4
```

Relationships between variables

We can best display the relationship between two variables using a scatterplot AKA bivariate plot:



Relationships between variables

Almost always we are interested in the relationship between two or more variables.

A pair of variables are either related in some way (associated) or not (independent). No pair of variables are both associated and independent.

We can have either a negative association (as the value of one variable increases, the other decreases) or a positive association.

Relationships between variables

We can consider a third variable in the previous plot.