STA 291
Lecture 5 Chap 4

- **Graphical and Tabular Techniques for categorical data**
- **Graphical Techniques for numerical data**

Review: Stratified Sampling

- Suppose the population can be divided into non-overlapping groups ("***strata***") according to some criterion.
  Example: All voters divided into male voters and female voters.
- Select a Simple Random Sample independently from each group.

- how it is different from SRS?
- (SRS) = any possible selection equally likely
- Any selection got discriminated/eliminated here in stratified sampling?

Examples of Stratified Sampling

- The population is divided into male/female sub-populations (Two strata). Within each sub-population do an SRS.
- The population is divided into [Whites, Blacks, Hispanics, Asians, Others.] Five strata. Within each, do a SRS.

  Smaller groups may be ***over-sampled***: For example: select from each group a SRS of same size *n=500*.

How could stratification be useful?

- We may want to draw inference about population parameters for each subgroup
- When done right, estimators from stratified random samples are **more precise** than those from Simple Random Samples

Important Sampling Plans: SRS and variations

- **Simple Random Sampling (SRS)**
  - Each possible sample has the same probability of being selected.
- **Stratified Random Sampling**
  - The population can be divided into a set of non-overlapping subgroups (the strata)
  - SRSs are drawn from each strata
- **Systematic Sampling (eg. Digital music)**

Sampling Error

- Assume you take a SRS of 100 UK students and ask them about their political affiliation (Democrat, Republican, Independent)
- Now take another SRS of 100 UK students
- Will you get the same percentages?

- No, because of sampling variability.
- Also, the result will not be exactly the same as the population percentage, unless you take a "sample" consisting of the whole population of 30,000 students (this would be called a "census")

or if you are very lucky

Sampling Error

- **Sampling Error** is the error that occurs when a *statistic* based on a sample estimates or predicts the value of a population *parameter*.
- In SRS, stratified RS, the sampling error can usually be quantified.
- In other sampling plans, there is also sampling variability, but its extent is not predictable.

Nonsampling Error

- bias due to question wording, question order,
- nonresponse (people refuse to answer),

Chapter 4 Display and Describe Categorical Data

- Summarize data using *graphs, tables*, and *numbers*.
- Condense the information from the dataset
- Bar chart, Pie chart, scatter plot

Bar Graph

- features:
  - The bars are usually separated to emphasize that the variable is categorical rather than quantitative
  - For nominal variables (no natural ordering), order the bars by frequency, except possibly for a category "other" that is always last

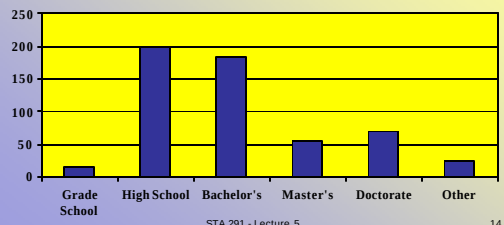
Pie Chart (Nominal/Ordinal Data)

First Step: Create a Frequency Distribution

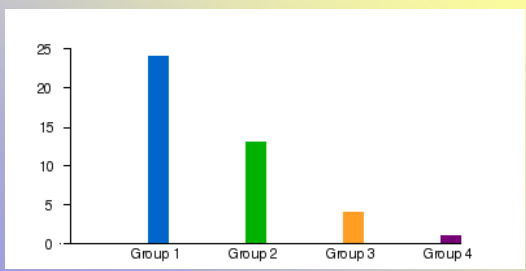
Highest Degree	Frequency (Number of Employees)	Relative Frequency
Grade School	15	
High School	200	
Bachelor's	185	
Master's	55	
Doctorate	70	
Other	25	
Total	550	

We could display this data in a bar chart…

- **Bar Graph:** ***If the data is ordinal, classes are presented in the natural ordering.***



- http://en.wikipedia.org/wiki/Bar_chart

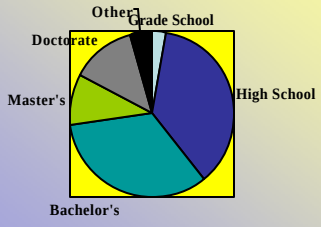


Pie Chart

- Pie Chart: Pie is divided into slices; The area of each slice is proportional to the frequency of each class.

Highest Degree	Relative Frequency	Angle (= Rel. Freq. x 360°)
Grade School	15/550 = .027	9.72
High School	200/550 = .364	131.04
Bachelor's	185/550 = .336	120.96
Master's	55/550 = .1	36.0
Doctorate	70/550 = .127	45.72
Other	25/550 = .045	16.2

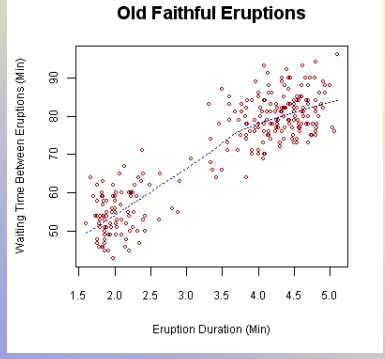
Pie Chart for Highest Degree Achieved



Scatter plot

- Plots with two variables

(reveal the relationship between the two variables)

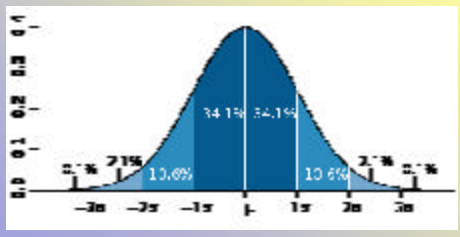


- Dynamic graph: graph change over time – movie or animation.
- Try watch more of those movies at http://www.gapminder.org

Distribution of a (continuous, numerical) variable

- Histogram
- Smoothed histogram – distribution

A distribution



Frequency Tables

- Suppose the variable can only take one of 5 possible values.
- We can condense a large sample (n=2000) to

value	1	2	3	4	5
frequency	365	471	968	134	62

Contingency tables

- More complicated tables
- by rows and columns (cross tabulation)

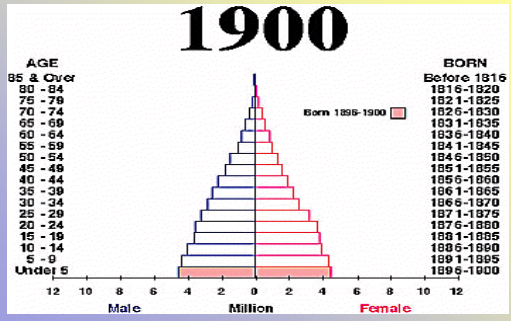
Homework 2

- Due Tuesday next week (Feb 5,11 PM).
- Online homework assignment.

Attendance Survey Question 5

- On a 4"x6" index card (or little piece of paper)
  - Please write down your *name* and *section number*.
  - Today's Question: What is "SRS" stands for in statistical observational study?

Histogram of Numbers of Males vs. Females



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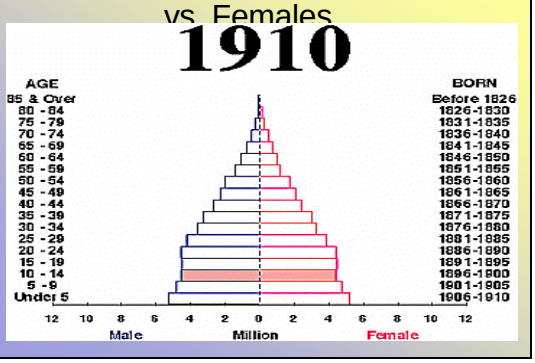

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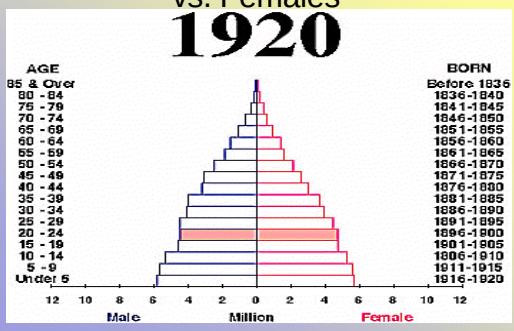

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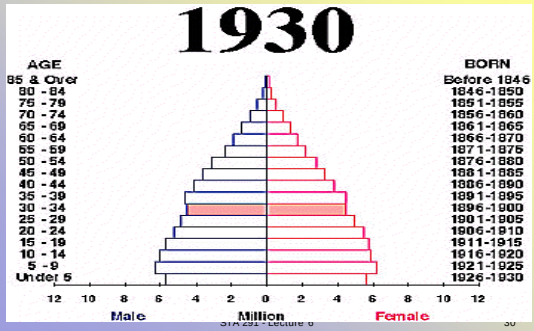

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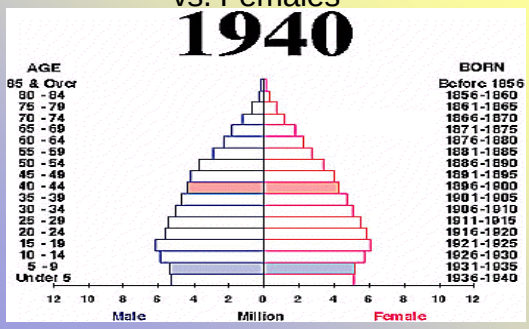

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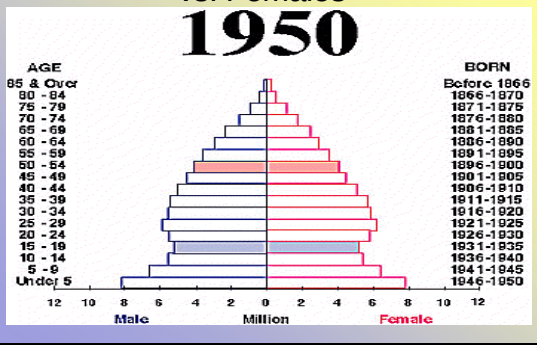

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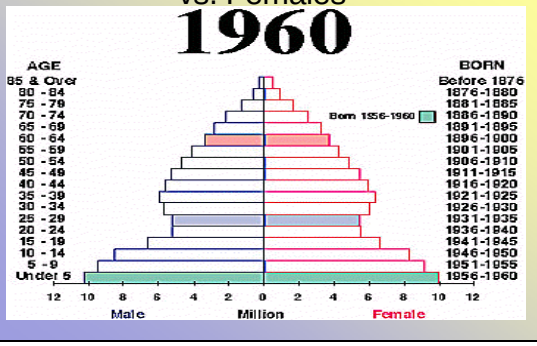

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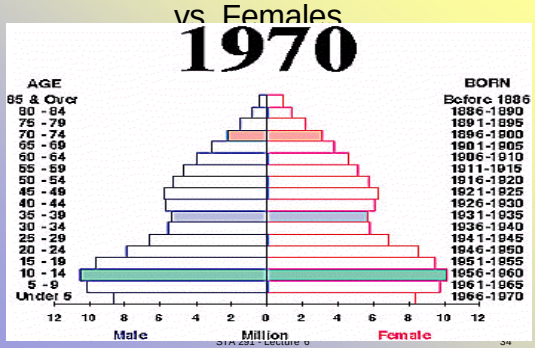

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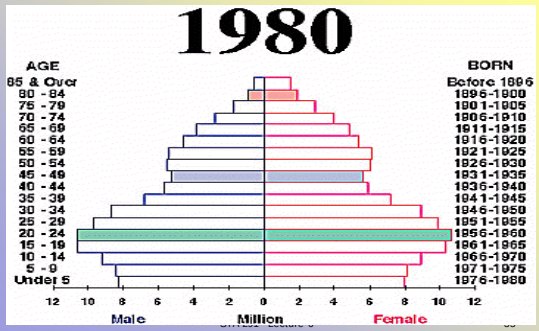

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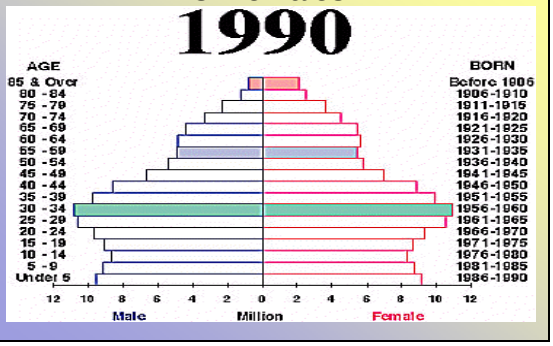
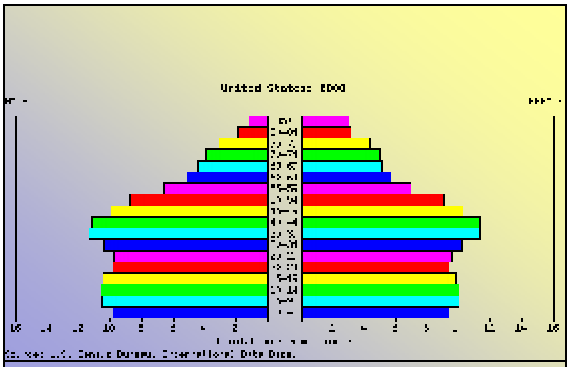




- Dynamic graph: graph changes over time
- www.gapminder.org
- http://www.gapminder.org/videos/ted-talks/hans-rosling-ted-talk-2007-seemingly-impossible-is-possible/

Histogram (for continuous numerical type data)

- Divide the range of possible values into many (contiguous, non-overlap) intervals, then count how many times data falls into each interval.
- Plot based on this table is called histogram.

Data Table: Murder Rates per1000

Alabama	11.6	Alaska	9.0
Arizona	8.6	Arkansas	10.2
California	13.1	Colorado	5.8
Connecticut	6.3	Delaware	5.0
D C	78.5	Florida	8.9
Georgia	11.4	Hawaii	3.8
……		……	

- Difficult to see the “big picture” from these numbers
- Try to condense the data…

Frequency Distribution

- A listing of intervals of possible values for a variable
- Together with a tabulation of the number of observations in each interval.

Frequency Distribution

Murder Rate	Frequency
0-2.9	5
3-5.9	16
6-8.9	12
9-11.9	12
12-14.9	4
15-17.9	0
18-20.9	1
>21	1
Total	51

Frequency Distribution

- Use intervals of same length (wherever possible)
- Intervals must be mutually exclusive: Any observation must fall into one and only one interval

Relative Frequencies

- Relative frequency for an interval: The proportion of sample observations that fall in that interval
- Sometimes, percentages are preferred to relative frequencies

Frequency and Relative Frequency and Percentage Distribution

Murder Rate	Frequency	Relative Frequency	Percentage
0-2.9	5	.10	10
3-5.9	16	.31	31
6-8.9	12	.24	24
9-11.9	12	.24	24
12-14.9	4	.08	8
15-17.9	0	0	0
18-20.9	1	.02	2
>21	1	.02	2
Total	51	1	100

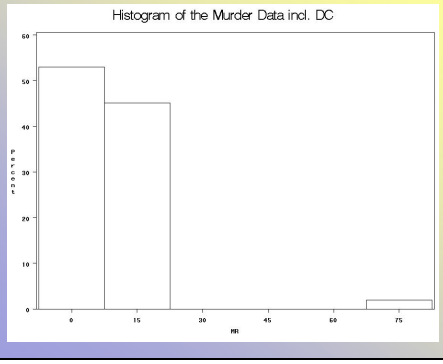
Frequency Distributions

- Notice that we had to group the observations into intervals because the variable is measured on a continuous scale
- For discrete data, grouping may not be necessary (except when there are many categories)

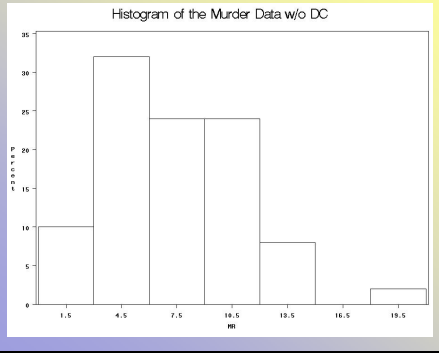
Histogram (for continuous numerical Data)

- Use the numbers from the frequency distribution to create a graph
- Draw a bar over each interval, the height of the bar represents the (relative) frequency for that interval
- Bars should be touching; I.e., equally extend the width of the bar at the upper and lower limits so that the bars are touching.

Histogram



Histogram w/o DC



Histogram

- Usually produced by software. We need to understand what they try to say.
- http://www.shodor.org/interactivate/activities/histogram/