Unit 1: Introduction to data

2. Exploratory data analysis

Sta 101 - Fall 2015

Duke University, Department of Statistical Science

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Slides posted at *http://bit.ly/sta101_f15*

Outline

1. Readiness assessment

2. Housekeeping

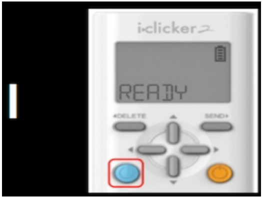
3. Main ideas
    1. Always start your exploration with a visualization
    2. When describing numerical distributions discuss shape, center, spread, and unusual observations
    3. Robust statistics are not easily affected by outliers and extreme skew
    4. Use box plots to display quartiles, median, and outliers

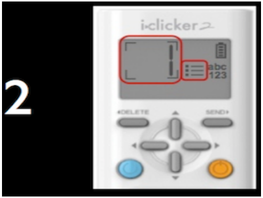
4. Application exercises

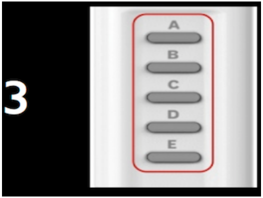
5. Summary

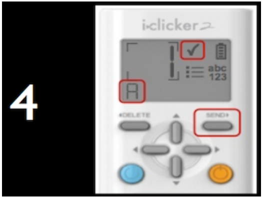
Readiness assessment

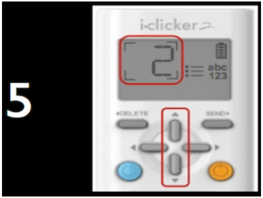
- *Individual:* 15 minutes, using clickers

1


2


3


4


5


- *Team:* 10 minutes, using scratch off sheets (1 per team)

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Announcements

- PS 1 is assigned on the course website, start working on it
- See email / course website for updated TA office hours – and start making use of them

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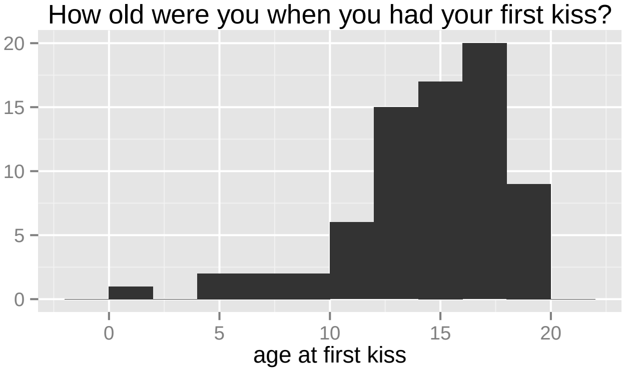
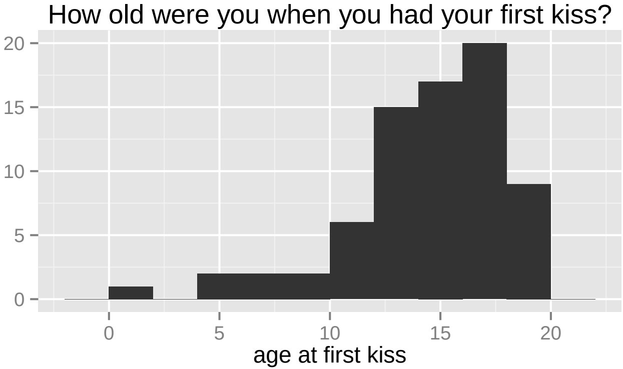
Do you see anything out of the ordinary?



From a past Sta 101 survey...

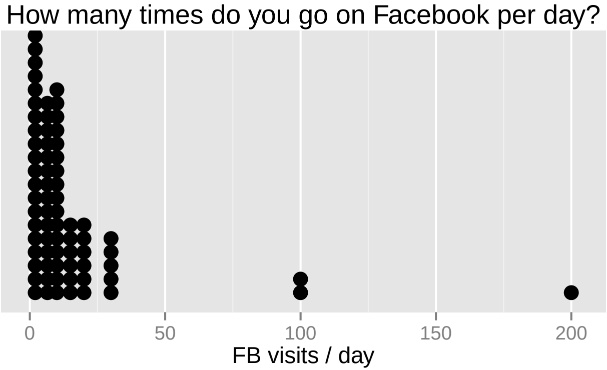
Do you see anything out of the ordinary?



Some people reported very low ages, which might suggest the survey question wasn't clear: romantic kiss or any kiss?

From a past Sta 101 survey...

How are people reporting lower vs. higher values of FB visits?



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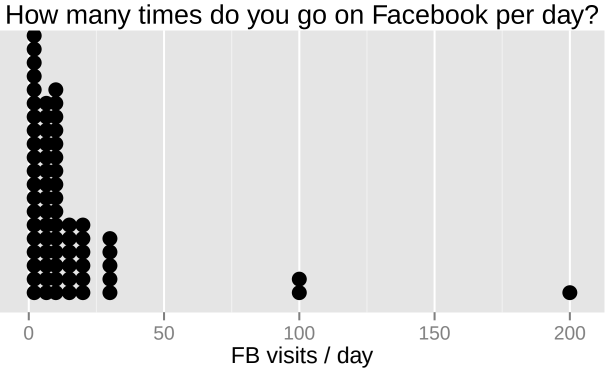
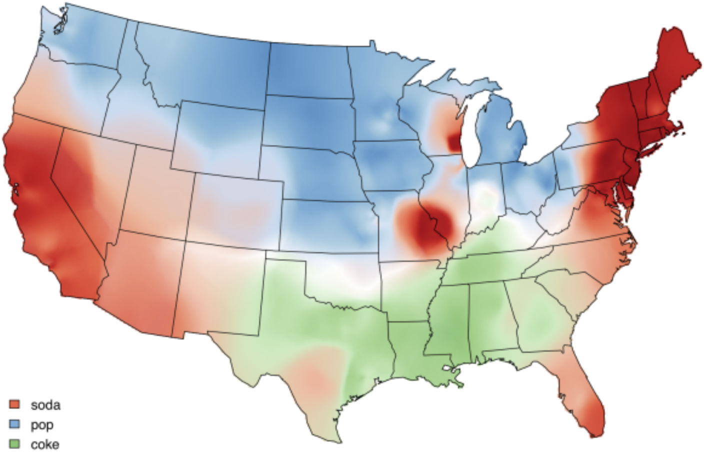


Finer scale for lower numbers.

Describe the spatial distribution of preferred sweetened carbonated beverage drink.

What is your generic term for a sweetened, carbonated beverage?

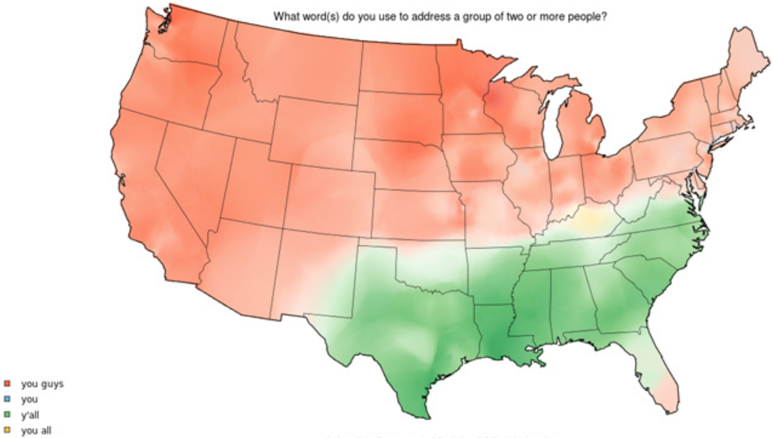


Map by Joshua Katz, Department of Statistics, NC State University

Based on survey data from Bert Vaux, Department of Linguistics, University of Cambridge

http://spark.rstudio.com/jkatz/SurveyMaps

What is missing in this visualization?


What word(s) do you use to address a group of two or more people?
🟥 you guys
🟦 you
🟩 y'all
🟨 you all

Joshua Katz, Department of Statistics, NC State University

http://spark.rstudio.com/jkatz/SurveyMaps

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- *Shape*: skewness, modality
- *Center*: an estimate of a *typical* observation in the distribution (mean, median, mode, etc.)
  - Notation: μ: population mean, $\bar{x}$: sample mean
- *Spread*: measure of variability in the distribution (standard deviation, IQR, range, etc.)
- *Unusual observations*: observations that stand out from the rest of the data that may be suspected outliers

Clicker question

Which of these is most likely to have a roughly symmetric distribution?

(a) salaries of a random sample of people from North Carolina

(b) weights of adult females

(c) scores on an well-designed exam

(d) last digits of phone numbers

Clicker question

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(a) salaries of a random sample of people from North Carolina

(b) *weights of adult females*

(c) scores on an well-designed exam

(d) last digits of phone numbers

Mean vs. median

Clicker question

How do the mean and median of the following two datasets compare?

Dataset 1: 30, 50, 70, 90
Dataset 2: 30, 50, 70, 1000

(a) $\bar{x}_1 = \bar{x}_2$, $median_1 = median_2$

(b) $\bar{x}_1 < \bar{x}_2$, $median_1 = median_2$

(c) $\bar{x}_1 < \bar{x}_2$, $median_1 < median_2$

(d) $\bar{x}_1 > \bar{x}_2$, $median_1 < median_2$

(e) $\bar{x}_1 > \bar{x}_2$, $median_1 = median_2$

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- Most commonly used measure of variability is the *standard deviation*, which roughly measures the average deviation from the mean
  - Notation: σ: population standard deviation, s: sample standard deviation
- Calculating the standard deviation, for a population (rarely, if ever) and for a sample:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{n}} \qquad s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

- Square of the standard deviation is called the *variance*.

Why divide by $n - 1$ instead of n when calculating the sample standard deviation?

More on SD

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Lose a “degree of freedom” for using an estimate (the sample mean, $\bar{x}$), in estimating the sample variance/standard deviation.

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Why divide by $n - 1$ instead of n when calculating the sample standard deviation?

Lose a “degree of freedom” for using an estimate (the sample mean, $\bar{x}$), in estimating the sample variance/standard deviation.

Why do we use the squared deviation in the calculation of variance?

- To get rid of negatives so that observations equally distant from the mean are weighed equally.
- To weigh larger deviations more heavily.

Clicker question

True / False: The range is always at least as large as the IQR for a given dataset.

(a) Yes

(b) No

Clicker question

True / False: The range is always at least as large as the IQR for a given dataset.

(a) *Yes*

(b) No

Range = max - min, IQR = Q3 - Q1

Clicker question

True / False: The range is always at least as large as the IQR for a given dataset.

(a) *Yes*

(b) No

Range = max - min, IQR = Q3 - Q1

Is the range or the IQR more robust to outliers?

Clicker question

True / False: The range is always at least as large as the IQR for a given dataset.

(a) *Yes*
(b) No

Range = max - min, IQR = Q3 - Q1

Is the range or the IQR more robust to outliers?

IQR

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Robust statistics

- Mean and standard deviation are easily affected by extreme observations since the value of each data point contributes to their calculation.
- Median and IQR are more robust.
- Therefore we choose median&IQR (over mean&SD) when describing skewed distributions.

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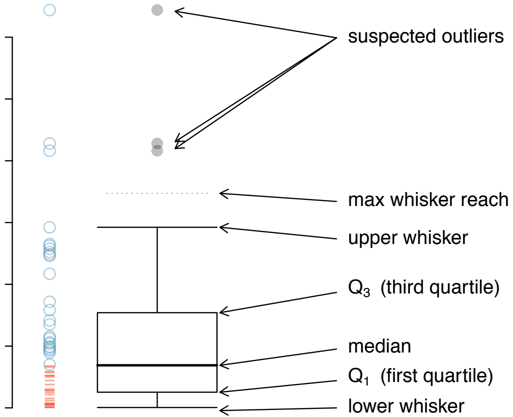
A *box plot* visualizes the median, the quartiles, and suspected outliers. An *outlier* is defined as an observation more than 1.5×IQR away from the quartiles.



suspected outliers

max whisker reach

upper whisker

Q_3 (third quartile)

median

Q_1 (first quartile)

lower whisker

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Application exercise: 1.1 Distributions of numerical variables

See the course website for instructions.

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