

Today's topics:

- **Data graphics (2)**
- **Experiment design**

Background preparation:

- *Kaplan (2016), Appendix, "Statistics brief reference", especially sections A.1.2 and A.3*

0. Today's objectives

After today's class, you should be able to:

- Explain how probability (p -value) is used to evaluate statistical significance
- (Review) Identify the null hypothesis for a particular statistical test
- Recognize common types of data graphic and know when they are appropriate to use
- Discuss factors that are important to consider when designing or evaluating an experiment

1. Inferential statistics and probability

- Finish slides from last time
- See also today's PQ #2

2. Data graphics

- Commonly encountered data graphics
 - bar graph or line graph
 - histogram
 - scatterplot

(see examples of each type in Kaplan, sec A.1.2)

2. Data graphics

Bar graph / line graph

- What kinds of information are these good at showing?

2. Data graphics

Bar graph / line graph

- A good way to compare **values** (numerical) for two or more **groups** across two or more **categories**

2. Data graphics

Bar graph / line graph

- How do we set one up? — try it in your group

- **Pizza consumption** (*invented data*)

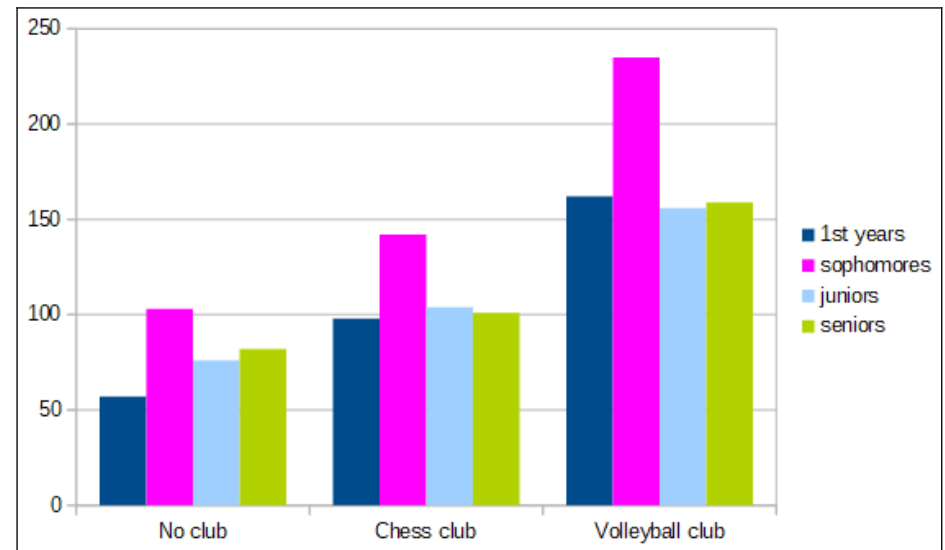
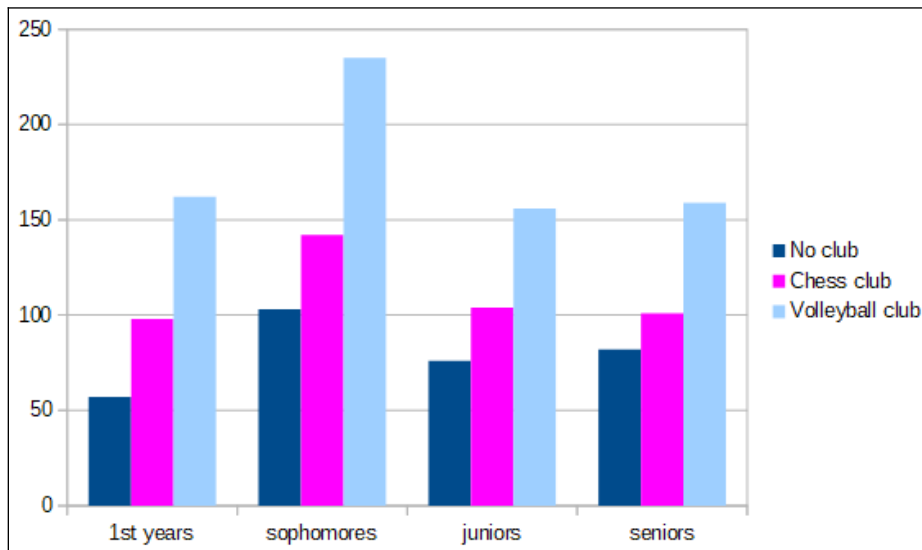
Average number of slices per student per semester

	No club	Chess club	Volleyball club
1st years	57	98	162
sophomores	103	142	235
juniors	76	104	156
seniors	82	101	159

2. Data graphics

Bar graph / line graph

- How do we set one up? — Bar graph

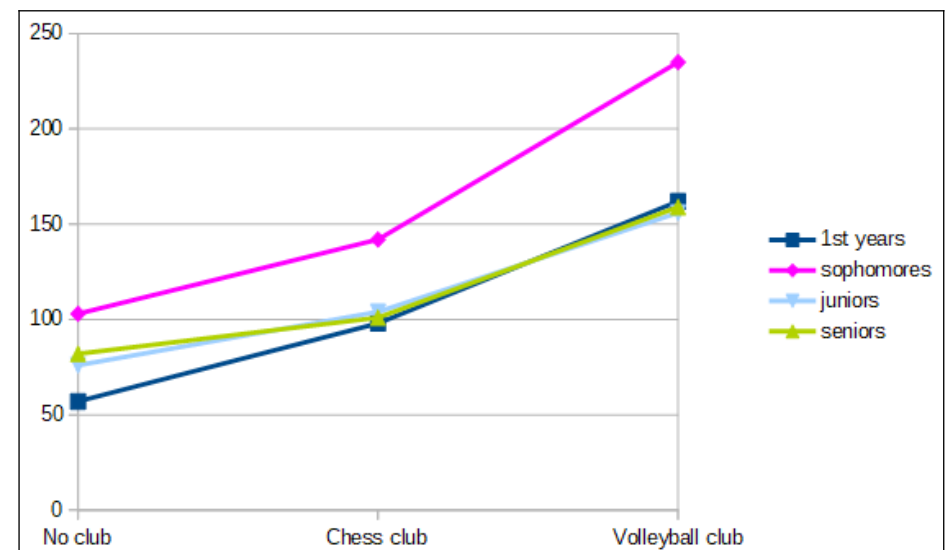
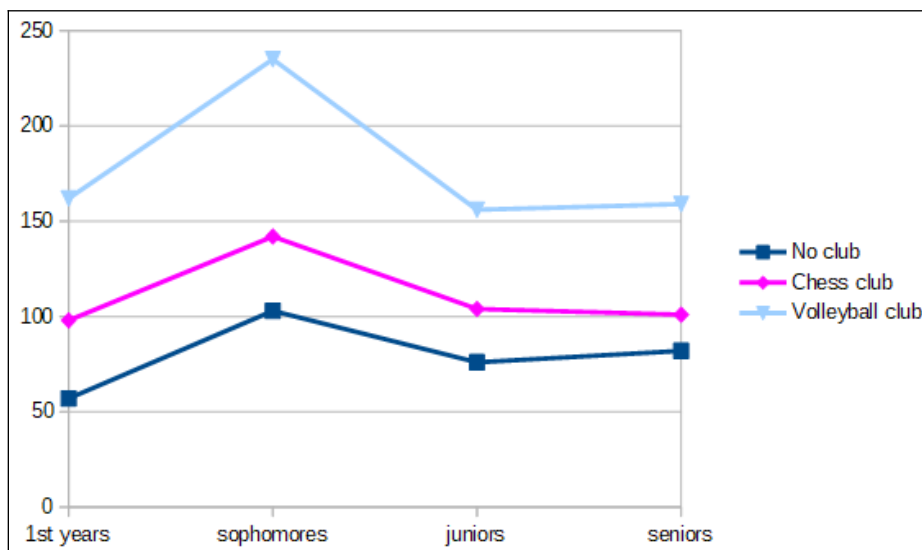


- Which comparisons are easier in each graphic?
What “research question” is each better for?

2. Data graphics

Bar graph / line graph

- How do we set one up? — Line graph



- Which comparisons are easier in each graphic?
What “research question” is each better for?

Note: Some researchers do not use connecting lines between points representing *categories* (because there are no intermediate values)

2. Data graphics

Histogram

- What kinds of information are these good at showing?

2. Data graphics

Histogram

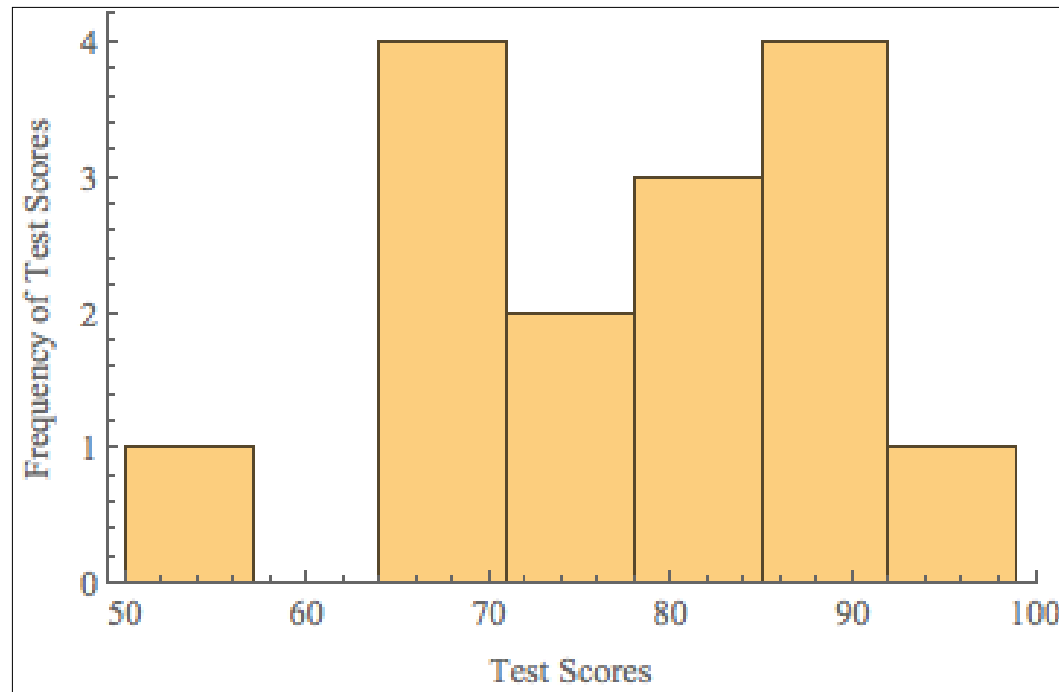
- One way to see how the values in your data set are distributed over **subdivisions** of the range of values
 - Which values are frequent? Rare?
 - Are there two distinct groups of values in your data set (bimodal distribution)?
- How do we set one up?

Test scores for a geometry class:

53, 67, 69, 70, 74, 75, 79, 83, 84, 88, 88, 90, 91, 97

2. Data graphics

Histogram



- Is this how you would have done a histogram for these test scores?
(What is a crucial decision for histograms?)

2. Data graphics

Scatterplot

- What kinds of information are these good at showing?

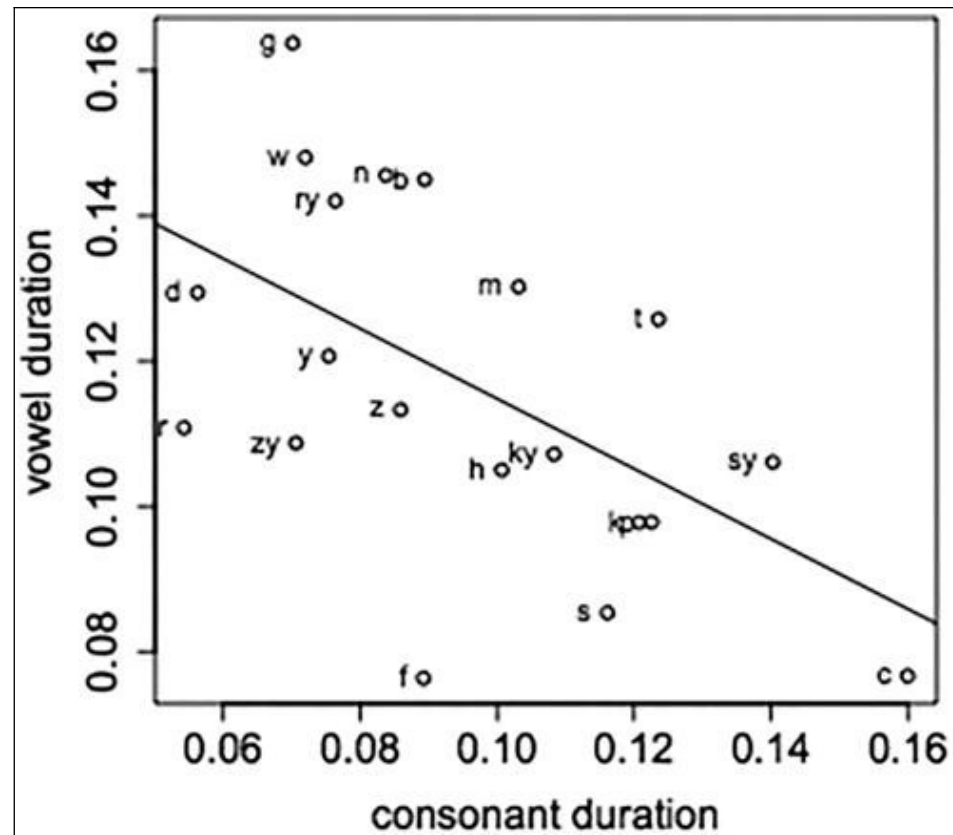
2. Data graphics

Scatterplot

- Useful when predictor and outcome are both *continuous*
 - versus when predictor has a small number of *categories*
- Which axis to use for each variable? Usually:
 - Independent / predictor variable: x-axis
 - Dependent / outcome variable: y-axis

2. Data graphics

Scatterplot | Example from Kawahara (2017)



- Are the x- and y-axis values correlated?

2. Data graphics

- The *Economist* (UK-based news magazine) generally has good data graphics
- Here's a blog post discussing some that could have been done better and why!

<https://medium.economist.com/mistakes-weve-drawn-a-few-8cdd8a42d368>

2. Data graphics

We discussed this briefly last time:

What are some **reasons** to use data graphics?

2. Data graphics

What are some **reasons** to use data graphics?

- **Communication:** making your results easy for your audience to see and understand
 - Be clear on what point you most want to communicate about your data, and choose a type of data graphic that highlights that point

2. Data graphics

What are some **reasons** to use data graphics?

- **Analysis check:** Making sure you know what your data set is actually like
 - Before you start any inferential statistical analysis — look to see if there is anything going on in the data that you should take into account or be careful about
 - Remember the Harry Potter movies bar graph from last time!

3. Experiment design

- What are some of the factors that Kaplan identifies that help us evaluate whether a study is well-designed or has trustworthy results?

The topics in her discussion:

- Subject selection
- Task design
- Data analysis
- Publication bias and replication

3. Experiment design

Participants

- Are they representative of the groups of people we want to know about?
- Many study participants in linguistics or psychology are university undergraduates...
 - WEIRD! = from Western, educated, industrialized, rich, and democratic societies (Henrich et al. 2010)
 - typically aged 18-24 or so

Henrich, J., Heine, S., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences* 33(2-3): 61-83.

3. Experiment design

Task design (see PQ #1)

- Is the experimental task really similar to what we want to study?
 - Is it likely to affect different groups of participants differently?
 - Does observing participants change the data?
- What potential confounding factors can we identify?
 - Can we reduce or eliminate them, or at least include them explicitly in our analysis?

3. Experiment design

Data analysis

- How is the data to be coded? Is the coding protocol explicit? Is it reliable across coders? (Can we avoid coder bias?)
- Should outliers be excluded from analysis? If so, how can they be safely (objectively) identified?
- Appropriateness of statistical analysis: the right test; not too many tests ('fishing')

3. Experiment design

Problems in replication and underreporting of null results

- More exciting to publish a non-null result than a null result
- More exciting to publish a new study than a replication
- So it might be the case that various effects are not as robust as the literature makes it seem

4. Summary and upshot

Statistics

- A little background in statistics can help us get a sense of what the results section in a research paper is saying
- Inferential statistics can help us understand whether an (apparent) numerical difference is meaningful

4. Summary and upshot

Data graphics

- Useful for communication and for checking your analysis

Experiment design

- It is difficult to design a good experiment
- When reading a research article, keep an eye out for some of these pitfalls