Fall 2019

CS6501: Topics in Human-Computer Interaction

http://seongkookheo.com/cs6501_fall2019

Lecture 6: Quantitative Evaluation 2

Seongkook Heo

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UNIVERSITY of VIRGINIA | SCHOOL of ENGINEERING & APPLIED SCIENCE

What You Learned Last Class

- Setting an experimental task
- Independent and Dependent Variables
- With-in and Between Subjects Designs
- Counterbalancing
- Trials and Blocks

Now Design Yours

Pair up with a partner

Find a research question

Set independent variables

Set dependent variables

Set an experimental task

Set the number of trials and blocks

Within-subject or Between-subject design

Estimate total time

Conducting an Experiment

Conducting an Experiment

Experiments involve humans need IRB (Institutional review board) approval

Reviews research protocols and materials, such as

- Research methodology
- The risks or benefits
- The rights of the participants
- Anonymity and confidentiality

Conducting an Experiment

Participants can be recruited in various ways

- Flyers
- Online Forums
- Crowdworkers

But carefully consider how you can get the right participants: specify the conditions in detail in the recruitment ad.

Conducting an Experiment

Always run a pilot study

- Greet the participant
- Introduce the experiment, get a consent form signed
- Get demographic information and experience
- Give instructions to completing tasks
  – should be consistent across all participants

Be polite, professional, and neutral.

Conducting an Experiment

- **Check if data are valid**
- Analyze data using proper analysis methods,
  as you initially defined in the experiment design
- Do not only report the numbers and test results,
  discuss findings

- you are the most knowledgeable person for that experiment

Analyzing Results

- Observation:
  - How did the independent variables (IV) affect the dependent variables (DV)?
  - What type of trends occurred?
- Analysis:
  - What conclusions can be made?
  - How can future results be predicted?

Conveying Results

- What are the most important findings?
  - Based on fundamental questions
- How can the results be illustrated?
  - Graphs, charts, etc.

Research Hypotheses

- An experiment normally starts with a research hypothesis.
- A hypothesis is a precise problem statement that can be directly tested through an empirical investigation.

Types of Hypotheses

- **Null hypothesis**

  Typically states that there is no difference between experimental treatments

- **Alternative hypothesis**

  A statement that is mutually exclusive with the null hypothesis

- **Goal of experiment**

  Typically to find statistical evidence to reject the null hypothesis in order to support the alternative hypothesis

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  The probability of obtaining the result that we did (10 blk in a row) was 0.001.

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  ➔ Therefore, reject the null hypothesis

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  ➔ Therefore, reject the null hypothesis

  ➔ **Professor is a trickster!**

What is Hypothesis Testing?

- The use of statistical procedures to answer research questions
- Typical research question (generic):

> Is the time to complete a task less using Method A than using Method B?

- For hypothesis testing, we instead use a statement:

> There is no difference in the mean time to complete a task using Method A vs. Method B.

- This is the null hypothesis (assumption of “no difference”)
- Statistical procedures can be used to reject the null hypothesis

Type I and Type II Errors

- All significance tests are subject to the risk of Type I and Type II errors
- Type I error (also called a "false positive"):
  - Rejecting the null hypothesis when it is true
- Type II error (also called a "false negative"):
  - Not rejecting the null hypothesis when it is false
- It is generally believed that Type I errors are worse than Type II errors
  - A Type I error may result in a condition worse than the current state
  - A Type II error can cost the opportunity to improve the current state

Type I and Type II Errors

		Study conclusion	
		No difference	Touchscreen ATM is easier to use
Reality	No difference	√	Type I error
	Touchscreen ATM is easier to use	Type II error	√

Traditional ATM or Touchscreen ATM easier to use?

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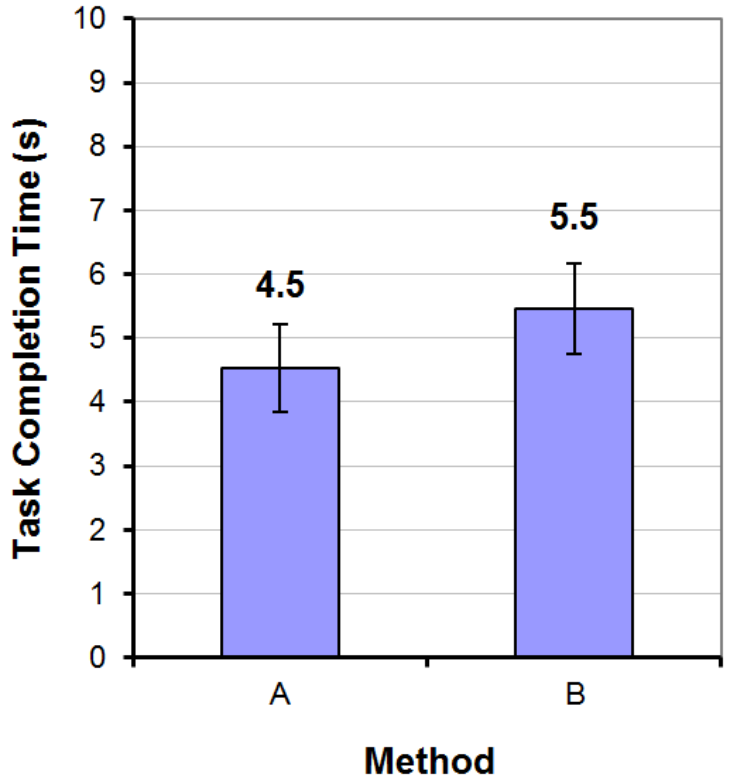
Preparing Data for Analysis

- Record the data
  - Be thorough (if possible: be able to recreate the study)
    - Small file that summarizes each trial + Large log that records everything with time stamp
  - **Check for bugs!**
- Clean the data
  - Detect errors
  - Formatting
- Remove the outliers
  - Follow guidelines
  - Be consistent

Descriptive Statistics

- Measures of central tendency
  - Mean
  - Median
  - Mode
- Measures of spread
  - Range
  - Variance
  - Standard deviations



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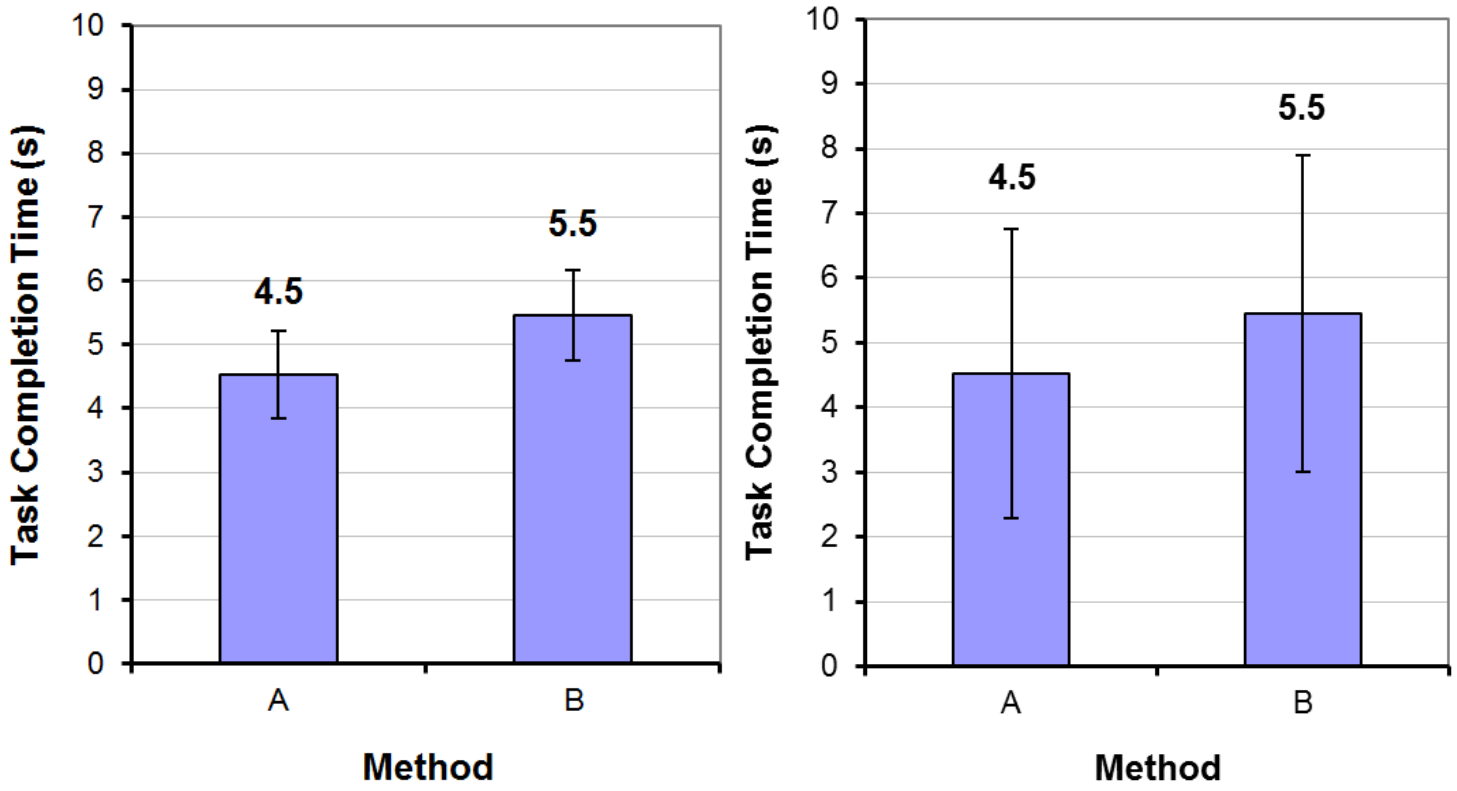


Statistical Significance

- Null Hypothesis:
  - IV x has no effect on DV y
- “P-Value”:
  - Probability of obtaining your results, assuming the null hypothesis is true
- When $p < .05$
  - Reject the null hypothesis
  - IV x does have an effect on DV y

Analysis of Variance

- The *analysis of variance* (ANOVA) is the most widely used statistical test for hypothesis testing in factorial experiments
- Determine if an IV has a significant effect on a DV
  - e.g., one of the test conditions is faster/slower than the other
- Remember, an IV has at least two levels

Why Analyse the Variance?

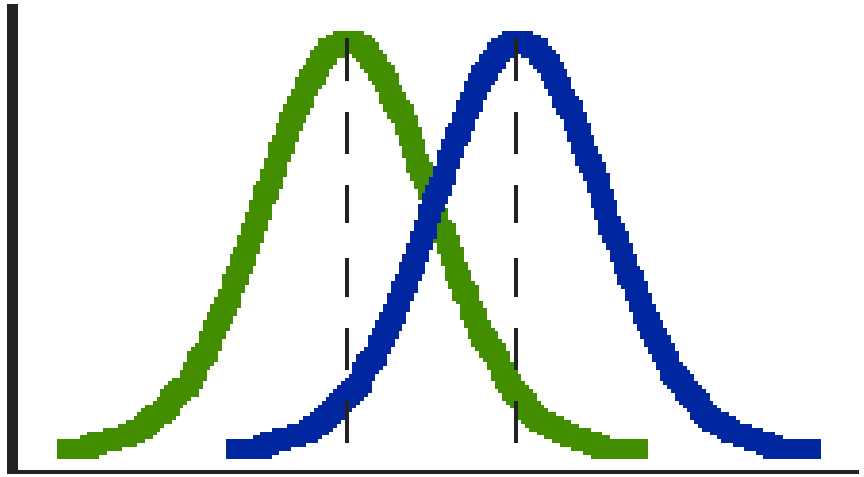
- Seems odd that we analyze the variance, when the research question is concerned with the overall means:

> Is the time to complete a task less using Method A than using Method B?

- Let’s explain through the t-test…

Comparing Two Means: t-test

- Test if means are statistically different
- Equation produces t value
- t value maps to a probability



$$t = \frac{\overline{x}_1 - \overline{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Comparing Two Means: t-test

- Independent-samples t test: between-group design

Group	Participants	Task completion time	Coding
No prediction	Participant 1_a	245	0
No prediction	Participant 2_a	236	0
No prediction	Participant 3_a	321	0
No prediction	Participant 4_a	212	0
No prediction	Participant 5_a	267	0
No prediction	Participant 6_a	334	0
No prediction	Participant 7_a	287	0
No prediction	Participant 8_a	259	0
With prediction	Participant 1_b	246	1
With prediction	Participant 2_b	213	1
With prediction	Participant 3_b	265	1
With prediction	Participant 4_b	189	1
With prediction	Participant 5_b	201	1
With prediction	Participant 6_b	197	1
With prediction	Participant 7_b	289	1
With prediction	Participant 8_b	224	1

Comparing Two Means: t-test

- Paired-sample t test: within-group design

Participants	No prediction	With prediction
Participant 1	245	246
Participant 2	236	213
Participant 3	321	265
Participant 4	212	189
Participant 5	267	201
Participant 6	334	197
Participant 7	287	289
Participant 8	259	224

Comparing Two Means: t-test

- Test if means are statistically different
- Equation produces t value
- t value maps to a probability
  - Lower variance -> Higher t value -> Lower probability
- Only compares two groups

Soylent

A Word Processor with a Crowd Inside

Michael S. Bernstein msbernst@csail.mit.edu

Greg Little, Robert C. Miller,
David R. Karger, David Crowell,
Katrina Panovich

Bjoern Hartmann

Mark Ackerman

Assignment #1: Quantitative Evaluation

- Use GoFitts software (http://www.yorku.ca/mack/FittsLawSoftware/doc/index.html?GoFitts.html)
- Choose two pointing devices of your choice: e.g., Touchpad and Mouse
- Run an experiment with four participants
- Measure the throughput for each device
- Report should include:
  - Experiment design (1 paragraph)
  - Experiment results (1 paragraph) + Graphs
  - Your reflections on the study

Due Sep 23 (Mon) 23:59 pm

Assignment instruction will be on the course webpage

Design Project Team Up

- Team of 3 (or 4)
- Team up based on the interest on which usability problem to solve
- Most liked problems + problems you want to solve

Acknowledgements

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  - Tovi Grossman, Univ. of Toronto
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Thank you!