Techniques for User Evaluation

Lecture #12: User Evaluation
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Usability Testing

- Not exact science (but we try!!)
- Want to evaluate users
  - performance
  - preference
  - feedback
- Goals
  - learn about individual UI techniques
  - learn about applications
  - learn about hardware

Basic Strategy

- "What do I want to learn?"
  - based on observations, theory, etc…
- Generate hypotheses (if applicable)
- Determine how to test the hypotheses
  - experimental setup and design
- Pilot studies
  - confirm study is sound
- Conduct study
- Analyze data
  - use statistics
- Report findings

Experimental Strategies

- Formative – gather feedback on evolving system, set of techniques, etc…
  - examine prototypes to refine system
  - improve UI techniques
- Summative – learn about system as a whole
  - does it do what it is designed to do
- Qualitative approaches
  - survey data, preference data, open ended questions
- Quantitative data
  - time to completion, error, number of clicks. etc…

Experimental Setup

- Want to make user comfortable
- Allow moderator to observe without getting in the way

Subject

Video Camera

Moderator

Experimental Design

- Difficult task
  - need to remove as much variability as possible
  - always want to err on the side of more data collection
  - art more than science
  - conditions (4 x 2, 2 x 2 x 2, etc…)
- Between subjects
  - subjects broken up into groups
  - each group gets one condition
  - requires more subjects
- Within subjects
  - every subject gets every condition
  - less subjects but have to deal with ordering effects
  - slightly harder to analyze
- Mixed
  - combines both between and within

Experimental Procedure

- How is the experiment carried out?
- Need to come up with plan for running subjects
- How does the experiment get administered?
- Need to ensure procedure is the same for all subjects

Pre- and Post-questionnaires

- Pre-questionnaire
  - Want to find about subject background
    - age, gender, handedness
    - particulars about experiment
      - experience with similar software
      - experience in particular area
- Post-questionnaire
  - valuable tool
  - used to gather qualitative data
  - used for qualitative data quantitatively
    - Lickert scale
  - open ended questions

Pilot Studies

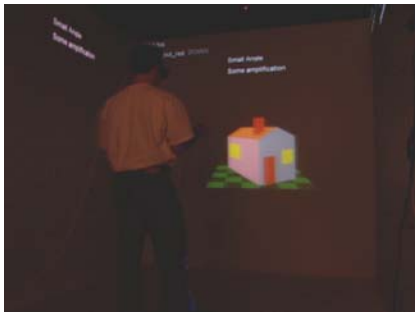
- Run one or two subjects through experiment
- Why?
  - make sure experiment is sound
  - make last minute changes to design
  - convince yourself hypotheses make sense

Analyzing Data

- Look for trends, patterns, and statistical significance
- Understanding statistical tests and procedures is crucial
- Need to know
  - what kind of data (nominal, scale, ordinal)?
  - what tests to perform (T-Test, ANOVA, Friedman)?
  - what corrections to make (Bonferroni, Tukey)?
  - how to interpret results (α, confidence intervals, mean, median)?
- Statistical packages are your friend
  - SAS, SPSS, Matlab, etc…
- Sometimes there is no statistical test to apply

Example Experiment

- Not pen-UI related but techniques still apply
- Exploration of non-isomorphic rotation in VE



LaViola, J. and Katzourin, M. "An Exploration of Non-Isomorphic 3D Rotation in Surround Screen Virtual Environments", *Proceedings of the IEEE Symposium on 3D User Interfaces 2007*, 49-54, March 2007.

Example Experiment – Goals

- Further explore non-isomorphic rotation of virtual objects
- Systematic evaluation of different rotation amplifications
- Understand benefits of non-isomorphic in SSVE
  - head tracking
  - stereoscopic vision

Example Experiment -Design

- 16 subjects (13 male, 3 female)
- Conducted in Brown "Cave"
- Based on Poupyrev 2000 → Hinckley 1997 → Chen 1988
- 4 x 2 x 2 balanced, within-subjects design (16 conditions)
- Independent variables
  - amplification (1,2,3,4)
  - rotation amplitude (20-60, 70-180 degrees)
  - Error threshold (6, 18 degrees)
- Dependent variables
  - completion time
  - orientation error

Example Experiment – Procedure

- Task – rotate house from random to target orientation
- Pre-questionnaire
- 16 practice trials
- 16 sets of 10 trials each
- Ordering was randomized
- Post-questionnaire

Example Experiment –Results

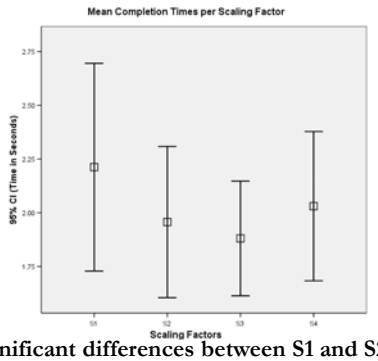
- Repeated measures, three way ANOVA

Effect	Time	Error
S	$F_{3,13}$=3.26, p=0.056	$F_{3,13}$=4.8, p<0.05
T	$F_{1,15}$=13.66, p<0.05	$F_{1,15}$=22.96, p<0.05
A	$F_{1,15}$=55.46, p<0.05	$F_{1,15}$=0.001, p=0.98
S x T	$F_{3,13}$=0.29, p=0.83	$F_{3,13}$=1.575, p=0.243
S x A	$F_{3,13}$=0.87, p=0.523	$F_{3,13}$=0.562, p=0.649
T x A	$F_{1,15}$=5.03,p<0.05	$F_{1,15}$=0.573, p=0.46
S x T x A	$F_{3,13}$=0.73, p=0.55	$F_{3,13}$=0.97, p=0.436

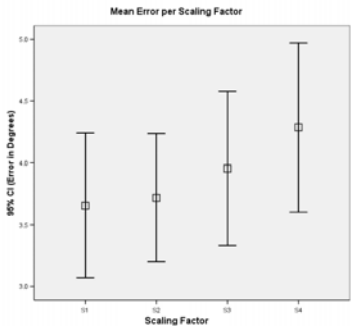
S = scaling factor T = error threshold A = angle

Example Experiment – Results: Post Hoc Analysis

- Pairwise comparisons on scaling factor using Holm's sequential Bonferroni adjustment

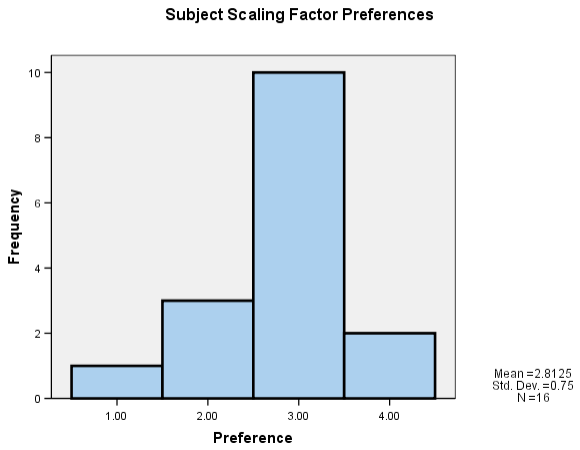


Significant differences between S1 and S2 and S1 and S3



Significant difference between S1 and S4

Example Experiment – Results: Subject Preferences



Example Experiment – Summary

- Subjects performed 11.5% faster with S2 and 15.0% faster with S3 with no statistically significant loss in accuracy
- Appears to be correlation between subject preferences and mean completion time
  - scaling factor of 3 is preferable amplification coefficent

Readings

- LaViola, J. "An Initial Evaluation of a Pen-Based Tool for Creating Dynamic Mathematical Illustrations", In the proceedings of the Eurographics Workshop on Sketch-Based Interfaces and Modeling 2006, 157-164, September 2006.
- Bragdon, A., Zeleznik, R., Williamson, B., Miller, T., and LaViola, J. "GestureBar: Improving the Approachability of Gesture-based Interfaces", Proceedings of ACM CHI 2009, 2269-2278, April 2009.
- LaViola, J., Leal, A., Miller, T., and Zeleznik, R. “Evaluation of Techniques for Visualizing Mathematical Expression Recognition Results”, *Proceedings of Graphics Interface 2008*, 131-138, May 2008.