Midterm Review

CS160: User Interfaces
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Upcoming Schedule

• Midterm next Tuesday March 18

• Interactive Prototype + Presentations (due Apr 1)
  – First working implementation
  – Can include Wizard of Oz parts where justified
Topics

- Gestalt Principles
- Midterm Review

Gestalt Principles
Principles

- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency

Figure/Ground

Principle of surroundedness

Principle of relative size

http://www.aber.ac.uk/media/Modules/MCI0220/visper06.html
Figure/Ground

Ambiguous

Unambiguous

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

Proximity

Dots that are near one another are grouped
Dots that are concentrated are grouped

[from Ware 00]
Similarity

Rows dominate due to similarity [from Ware 04]

Symmetry

Bilateral symmetry gives strong sense of figure [from Ware 04]
**Connectedness**

Connectedness overrules proximity, size, color shape [from Ware 04]

**Continuity**

We prefer smooth not abrupt changes [from Ware 04]

Connections are clearer with smooth contours [from Ware 04]
Continuity: Vector Fields

Prefer field that shows smooth continuous contours [from Ware 04]

Closure

We see a circle behind a rectangle, not a broken circle [from Ware 04]

Illusory contours [from Durand 02]
Common Fate

Dots moving together are grouped

http://coe.sdsu.edu/eet/articles/visualperc1/start.htm

Transparency

Requires continuity and proper color correspondence [from Ware 04]
Summary

• Design is about communication, form and function
  – Simplicity and elegance are keys to good design
  – Minimalism constrains you and reduces chances of bad design

• Use a small palette of colors
  – Let others pick them for you (colorbrewer.org)

• Human vision is organized by Gestalt Principles
  – Be aware of these principles as you design the visual look

Midterm Review
General Information

• Closed book, no cheatsheets, no electronic devices
• Format
  – Short answer and longer answer questions
  – Will involve some recall (I know this is bad interface design)
• Test-taking strategy
  – Questions will not be ordered in difficulty
  – Go through entire test, read questions, answer simple ones first
  – Read questions thoroughly
• Covers all material in lectures, sections and readings
  – Lectures mostly go over material in readings
  – Use lectures as guide to most important aspects of readings

The Design Cycle

![Diagram of the Design Cycle]

1. Acceptance
2. Analysis
3. Definition
4. Ideation
5. Idea selection
6. Implementation
7. Evaluation

[Koberg & Bagnall]
Evaluation reveals problems with design. Re-design requires cycling the process.

**Design Cycle Over Project Lifespan**

- 1. Acceptance
- 2. Analysis
- 3. Definition
- 4. Ideation
- 5. Idea selection
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- 7. Evaluation

**IDEO’s Brainstorming Rules**

1. Sharpen the Focus
2. Playful Rules
3. Number your Ideas
4. Build and Jump
5. The Space Remembers
6. Stretch Your Mental Muscles
7. Get Physical

**Aim for quantity**
Hope for quality
**Affordances**

What is an affordance?

“... the term **affordance** refers to the *perceived* and *actual* properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.

Some affordances obvious
- Knobs afford turning
- Buttons afford pushing
- Glass can be seen through

Some affordances learned
- Glass breaks easily
- Floppy disk
  - Rectangular – can’t insert sideways
  - Tabs prevent backwards insertion

*The Design of Everyday Things. 1988. Don Norman*
Why Mobile Devices Matters

6.5 billion people in the world
- 1.5 billion cell phones worldwide
- 500 million PCs (?)
- 46 million PDAs
- 1 million TabletPCs

Cell phone is the primary medium for communication
**Question**: How can we improve it’s interface?

Key Challenges

- **Limited Physical Resources**
  - CPU, Memory, Screen Size, Input Devices, Battery Life etc
- **Diversified Context of Use**
- **Different Activities**
- **Limited Attention**
Comparisons

- Mobile vs. Desktop
- Mobile vs. Laptop
- Mobile vs. Paper Notebook

Conceptual Models

- What is the user's conceptual model?
- How does the user form the conceptual model?
- What if the designers model doesn’t match the user's model?
Norman’s Design Principles

• Make controls visible
• Make sure mapping is clear
• Provide feedback

Task Analysis Questions

1. Who is going to use system?
2. What tasks do they now perform?
3. What tasks are desired?
4. How are the tasks learned?
5. Where are the tasks performed?
6. What’s the relationship between user & data?
7. What other tools does the user have?
8. How do users communicate with each other?
9. How often are the tasks performed?
10. What are the time constraints on the tasks?
11. What happens when things go wrong?

What is the purpose of task analysis?
**Master-Apprentice Model**

Allows user to teach us what they do
- Master (user) works & talks
- We interrupt to ask questions as they go
- Each step reminds master of the next
  - Better than asking user to summarize work habits

What are other models?
How do other models compare?
What is a persona?

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**Action Cycle**

- Goals
  - Execution
    - Intention to act
  - Evaluation
    - Evaluation of interpretations
    - Interpreting the perception
    - Perceiving the state of the world

- The World

start here
Metaphor

Definition
The transference of the relation between one set of objects to
another set for the purpose of brief explanation

Examples?
When are they effective?
When are they not effective?

Direct Manipulation

Direct Manipulation
– An interface that behaves as though the interaction was with a real-world
  object rather than with an abstract system

Central ideas
– Visibility of the objects of interest
– Rapid, reversible, incremental actions
– Manipulation by pointing and moving
– Immediate and continuous feedback
Semantic & Articulatory Distance

Cognitive Conscious/Unconscious
- What are they?

Locus of Attention
- What is it?
- Why locus rather than focus?
Modes

Definition
– The same user actions have different effects in different situations

Noun-Verb VS Verb-Noun

Noun-Verb: Select object, then perform action
Verb-Noun: Select action, then perform it on object

What are some examples of these two approaches?
What are the pros and cons of these two approaches?
**Event Driven Interfaces**

- **Event Queue**: Queue of input events
- **Event Loop** (runs in dedicated thread):
  - Remove next event from queue
  - Determine event type
  - Find proper component(s)
  - Invoke callbacks on components
  - Repeat, or wait until event arrives

**Component**:
- Invoked callback method
- Update application state
- Request repaint, if needed

**Model-View-Controller**

Architecture for interactive apps
- **Model**: Info the application manipulates
- **View**: Visual display of the model
- **Controller**: Receives input & decides what they do
Storyboarding

Series of key frames depicting key steps in reaching a goal
- Can use a pin board for easy rearrangement/editing
- Describe the interaction in context
- Often useful to show user in at least 1st frame (establishing shot)

Fidelity in Prototyping

Fidelity refers to the level of detail
High fidelity
- Prototypes look like the final product
Low fidelity
- Artists renditions with many details missing

Why do we create prototypes?
Testing Prototypes

Observer (or video camera)

“A bit slow for a computer - but it works!”

“Computer”

“Computer”

Interface elements

User

Interface

Model Human Info Processor

5 Parts
- Perceptual
- Cognitive
- Motor
- Working memory
- Long-term memory

Unified model
- Probably inaccurate
- Predicts perf. well
- Very influential
Review: Memory

Working memory is small
- Temporary storage
  - decay
  - displacement

Long term memory
- Rehearsal
- Relate new to learned material
- Link to existing knowledge
- Attach meaning
  - Make a story

Design interface to facilitate retrieval
- Recognition rather than recall

Review: Pop-Out and Causality
Recognition over Recall

Recall
  – Information reproduced from memory

Recognition
  – Presentation of info helps retrieve info (helps remember it was seen before)
  – Easier because of cues to retrieval

Decision Making

Hick’s Law – cost of taking a decision:

\[ T = a + b \log_2 (n + 1) \]

– Time depends on number of options
  - Choosing a movie at Blockbuster
**Power Law of Practice**

Task time on the nth trial follows a power law

\[ T_n = T_1 n^{-a} + c \]

where \( a = .4 \), \( c \) = limiting constant

Applies to skilled behavior
- Sensory
- Motor

**Fitts’ Law**

Hand movement based on series of microcorrections
\( X_i \) = remaining distance after ith move
relative movement accuracy remains constant \( \frac{X_i}{X_{i-1}} = \varepsilon \)

Then
\[ T = I_m \log_2 \left( \frac{2D}{S} \right) \]
Fitts’ Law

\[ T = a + b \log_2(D/S + 1) \]

- \( a, b \) = constants (empirically derived)
- \( D \) = distance
- \( S \) = size

ID is Index of Difficulty = \( \log_2(D/S + 1) \)

- Models well-rehearsed selection task
- \( T \) increases as the distance to the target increases
- \( T \) decreases as the size of the target increases
KLM

Describe the task using the following operators:

- **K**: pressing a key or a pressing (or releasing) a button
  \[ t_K = 0.08 - 1.2s \]  
  (0.2 good rule of thumb)
- **P**: pointing
  \[ t_P = 1.1s \]  
  (without button press)
- **H**: Homing (switching device)
  \[ t_H = 0.4s \]
- **D**: Drawing segmented lines
  \[ t_D = 0.9n + .16l \]
- **M**: Mentally prepare
  \[ t_M = 1.35s \]
- **R(t)**: system response time
  \[ t_R = t \]

GOMS Advantages/Disadvantages

**Advantages**

- Gives qualitative & quantitative measures
- Model explains the results
- Less work than user study – no users!
- Easy to modify when UI is revised

**Disadvantages**

- Not as easy as other evaluation methods
  - Heuristic evaluation, guidelines, etc.
- Takes lots of time, skill, & effort
- Only works for goal-directed tasks
- Assumes tasks expert performance without error
- Does not address several UI issues,
  - readability, memorizability of icons, commands
Usability Heuristics

“Rules of thumb” describing features of usable systems
– Can be used as design principles
– Can be used to evaluate a design

Example: Minimize users’ memory load

Pros and cons
– Easy and inexpensive
  • Performed by experts
  • No users required
  • Catch many design flaws
– More difficult than it seems
  • Not a simple checklist
  • Cannot assess how well the interface will address user goals

Phases of Heuristic Eval. (1-2)

1) Pre-evaluation training
   – Provide the evaluator with domain knowledge if needed

2) Evaluation
   – Individuals evaluate interface then aggregate results
     • Compare interface elements with heuristics
   – Work in 2 passes
     • First pass: get a feel for flow and scope
     • Second pass: focus on specific elements
   – Each evaluator produces list of problems
     • Explain why with reference to heuristic or other information
     • Be specific and list each problem separately
Phases of Heuristic Eval. (3-4)

3) Severity rating
   – Establishes a ranking between problems
     • Cosmetic, minor, major and catastrophic
   – First rate individually, then as a group

4) Debriefing
   – Discuss outcome with design team
   – Suggest potential solutions
   – Assess how hard things are to fix

Review: Managing Participants

• Testing is distressing
• Treat participants with respect
   – Follow human subjects protocol
   – Obtain informed consent
   – Make sure experiment is ethical
Steps in Designing an Experiment

1. State a lucid, testable hypothesis
2. Identify variables (independent, dependent control, random)
3. Design the experimental protocol
4. Choose user population
5. Apply for human subjects protocol review
6. Run pilot studies
7. Run the experiment
8. Perform statistical analysis
9. Draw conclusions

Experiment Design

Testable hypothesis
– Precise statement of expected outcome

Factors (independent variables)
– Attributes we manipulate/vary in each condition
– Levels – values for independent variables

Response variables (dependent variables)
– Outcome of experiment (measurements)
– Usually measure user performance
  • Time
  • Errors
**Experiment Design**

Control variables
- Attributes that will be fixed throughout experiment
- Confound – attribute that varied and was not accounted for
  - Problem: Confound rather than IV could have caused change in DVs
  - Confounds make it difficult/impossible to draw conclusions

Random variables
- Attributes that are randomly sampled
- Increases generalizability

**Between vs. Within Subjects**

Between subjects
- Each participant uses one condition
  - +/- Participants cannot compare conditions
  - + Can collect more data for a given condition
  - - Need more participants

Within subjects
- All participants try all conditions
  - + Compare one person across conditions to isolate effects of individual diffs
  - + Requires fewer participants
  - - Fatigue effects
  - - Bias due to ordering/learning effects
**Results: Statistical Analysis**

Compute central tendencies (descriptive summary statistics) for each independent variable
- Mean
- Standard deviation

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**Are the Results Meaningful?**

Hypothesis testing
- **Hypothesis**: Manipulation of IV effects DV in some way
- **Null hypothesis**: Manipulation of IV has no effect on DV
- Null hypothesis assumed true unless statistics allow us to reject it

Statistical significance (p value)
- Likelihood that results are due to chance variation
- $p < 0.05$ usually considered significant (Sometimes $p < 0.01$)
  - Means that $< 5\%$ chance that null hypothesis is true

Statistical tests
- T-test (1 factor, 2 levels)
- Correlation
- ANOVA (1 factor, > 2 levels, multiple factors)
- MANOVA ( > 1 dependent variable)
Next Time

Midterm Exam