Three Approaches to HCI Research

Test
Empirical science

Look
Ethnography

Make
Engineering and design
Empirical Approach

Research question

Observation

Hypothesis
Initial Observation

- Begin with casual or informal observation
- Usually comes from personal experience that catches your attention or raises questions in your mind
- Example: “Cloth has an affordance of pinching. Could this be useful for interaction design?”
• Identify variables and hypothesis that are associated with your observation

• **Variables**: characteristics or conditions that change or have different values for different individuals

• **Research question**: a statement that describes or explains a relationship between or among variables
  
  • A proposal to be tested

  • Example: “For pinching cloth, different **areas** of the body would differ in **preference** and the way people pinch”
• Concrete and testable statements derived from the research question

• Operational definition: a specific set of operations for measuring external, observable behavior

• In-class exercise: try giving an operational definition for the variables highlighted below
  
  • “There would be a difference in user’s preference for pinching cloth among different areas on the body.”
Research Example: Pinstripe

- Karrer et al., CHI ’11
- Recall the prediction:
  - “There would be a difference in user’s preference for pinching cloth among different areas on the body.”
- Method:
  - Identify 16 different body areas
  - Ask the participants to perform the pinching gesture in these areas
  - Collect convenience rating in 5-point Likert scale
Collect data to support, refute, or refine the original hypothesis

Three strategies

Descriptive research: X happens
- Focus on the current state of each individual variable

Relational research: X and Y happen together
- Measure two or more variables that exist naturally from each participant

Experimental research: X causes Y
- Manipulate one or more variables and observe their effects to other variables
Descriptive Research

• Describe a naturally-occurring phenomenon
• Measure and report individual variables without claiming relationships
• Natural phenomena can occur when using a new technology as well
• Methods: observation, survey, case study
Research Example: Natural Troubles of Driving with GPS

- Brown (Sweden) and Laurier (Edinburgh), Best paper CHI ’12
- Goal: To understand users’ interaction with GPS navigation system in non-controlled setting
- 14 drivers, 2 video cameras, field notes
  - 9 hours of video ⇒ 75 clips ⇒ 37 detailed transcriptions
  - Analyzed the data to find common patterns/themes and construct theories that explain them
Figure I: Following GPS instructions

While the driver 'follows' what the GPS recommends the driver still needs skill to read what the GPS says and even to ignore GPS instructions.
Natural Troubles of Driving with GPS

• Contribution & benefits:
  • “Presents a video analysis study of driving using GPS navigation systems in natural settings. The paper argues for [understanding] driving with [a] GPS as an active process and not as ‘docile driving’.”

• Conclusion
  • Designer should take “driver intelligence” into account
    • E.g., less persistent instructions when the user decided to deviate from them
  • Normal natural trouble: “GPS is used in the way that was not foreseen. The driver must take instructions and the map and fit them with the situation.”
Relational Research

- Measure a set of variables for each participant
- Examine to identify patterns of relationship
  - Changes in one variable are consistently and predictably accompanied by changes in another variable
- Measure the strength of the relationship
Research Example: Social Network Activity and Social Well-Being

• Burke (CMU), Marlow, and Lento (Facebook), Best paper CHI ’10 🏆
  • “An empirical analysis of the relationship between direct and passive communication on Facebook and social well-being, including loneliness, bridging, and bonding social capital.”

• Survey in Likert scale (N=1193)

• Analyze the past two months of users’ Facebook activity data, e.g.,
  • Friend count (actual)
  • Directed communication: comments, likes
  • Passive consumption of broadcast items such as status updates
Patterns in the Relationship between Variables

Simulated data for instructional purpose, based on the result from [Burke et al., CHI '10]
Strength of the Relationship between Variables

Simulated data for instructional purpose
Limitations of Relational Research

- Correlation does not imply causation
  - E.g., loneliness ⇒ less direct communication?
  - or less direct communication ⇒ loneliness?
  - or third variable ⇒ direct communication and loneliness?

- Third variable problem: unidentified variable controls the correlated variables
Limitations of Relational Research

- Shallow data from large number of people instead of deep data
- Can be improved by follow-up interviews, follow-up surveys
- Participant sampling method limits the conclusion
- Method: advertisement on Facebook
- Participants: only English-speaking users, but compensated by many countries of origin
Experimental Research

- Purpose: To infer cause-and-effect relationship
- Controlling independent variable
- Observe the change in the dependent variables
- In-class exercise: recall the following experimental designs
  - Between-group vs. within-group
  - Benefits and drawbacks
- More details in next lecture
Research Example: Mid-air Pan-and-Zoom on Wall-sized Displays

• Nancel et al. (Paris), Best paper CHI ’11

• Contributions & Benefits:
  • “Design and evaluation of multiscale navigation techniques for very large displays based on three key factors: number of hands involved, type of movement, type of feedback.”
Guidance through Passive Haptic Feedback

Two main categories of techniques have been studied for mid-air interaction on wall-sized displays: freehand techniques based on motion tracking [32, 36]; and techniques that require the user to hold an input device [5, 10, 19, 23]. Input devices provide some guidance to the user in terms of what gesture to execute, as all of them provide some sort of passive haptic feedback: A finger operating a knob or a mouse wheel follows a specific path; gestures on touch-enabled devices are made on planar surfaces. Freehand techniques, on the contrary, provide essentially no feedback to the user who can only rely on proprioception [24] to execute the gesture. We call this dimension the degree of guidance.

Gestures can be guided to follow a particular path in space (1D path); they can be guided on a touch-sensitive surface (2D surface) ; or they can be totally free (3D free). These three values correspond to decreasing amounts of passive haptic feedback for the performance of input gestures.

DESIGN CHOICES

Panning.
For all techniques, controlling the cursor's position is achieved naturally by ray-casting from the dominant hand to the wall display (dashed arrows in Figure 2). As mentioned earlier, first order of control was discarded for both pan and zoom operations. Panning is achieved by dragging, as in applications such as Adobe Illustrator™ or Google Maps™ with their typical hand-shaped cursor.

Zooming.
As in desktop applications such as Google Maps™ or NASA's WorldWind, linear techniques zoom in by moving forward towards the display and zoom out by moving backwards; circular techniques zoom in by turning clockwise and zoom out by turning counter-clockwise (solid arrows in Figure 2). Pointing plays an important role when zooming, as it specifies the focus of expansion (zoom in)/contraction (zoom out). Letting users specify this focus point is very important on displays of that physical size, as they will typically not be standing right in the center. A focus of expansion implicitly located at the center of the screen would make zooming operations tedious and hard to control as every zoom operation would require multiple panning actions to compensate drifts induced by the offset focus.

Bi-manual interaction.
All bimanual techniques (Figure 2, bottom row) are grounded in Guiard's study of asymmetric division of labor in bimanual actions that led to the Kinematic chain model [14]. Following the observation that motion of the dominant hand typically finds its spatial reference in the results of motion of the non-dominant-hand, we assign
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