# First Half Review

**CS6501: Human-Computer Interaction**

Seongkook Heo

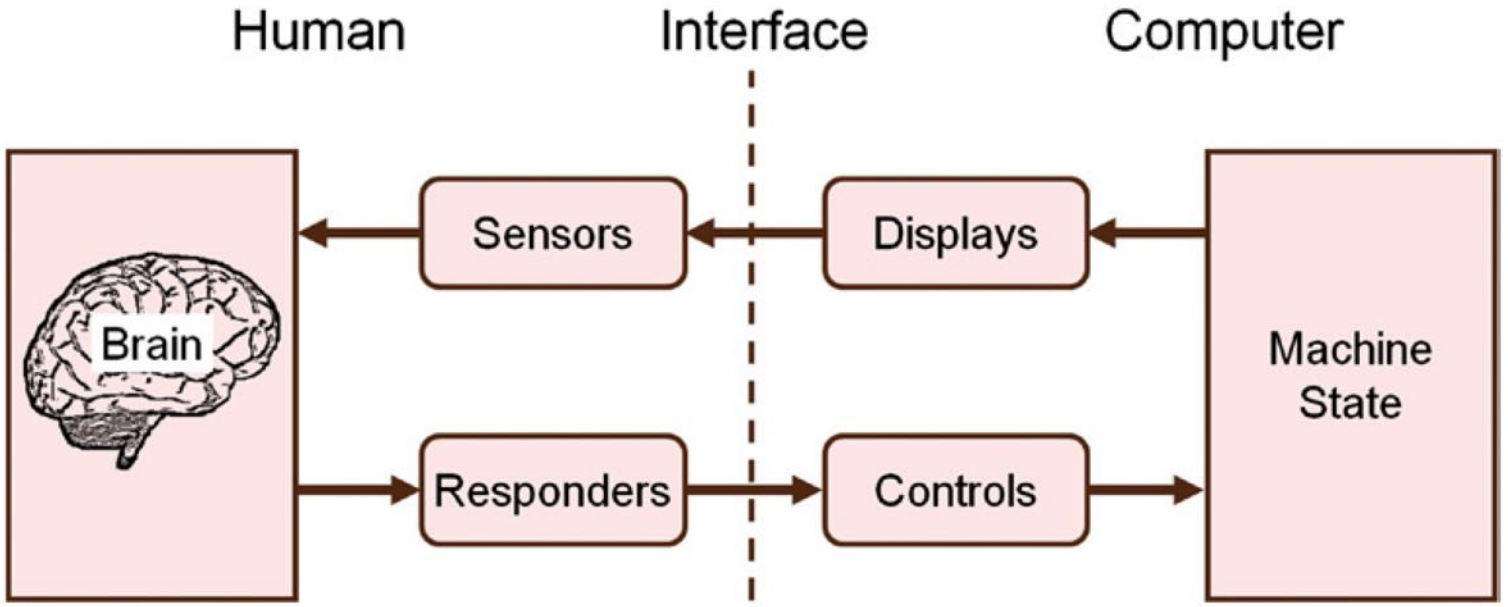
Fall 2020, Department of Computer Science

UNIVERSITY of VIRGINIA | SCHOOL of ENGINEERING & APPLIED SCIENCE

# What you’ve learned so far

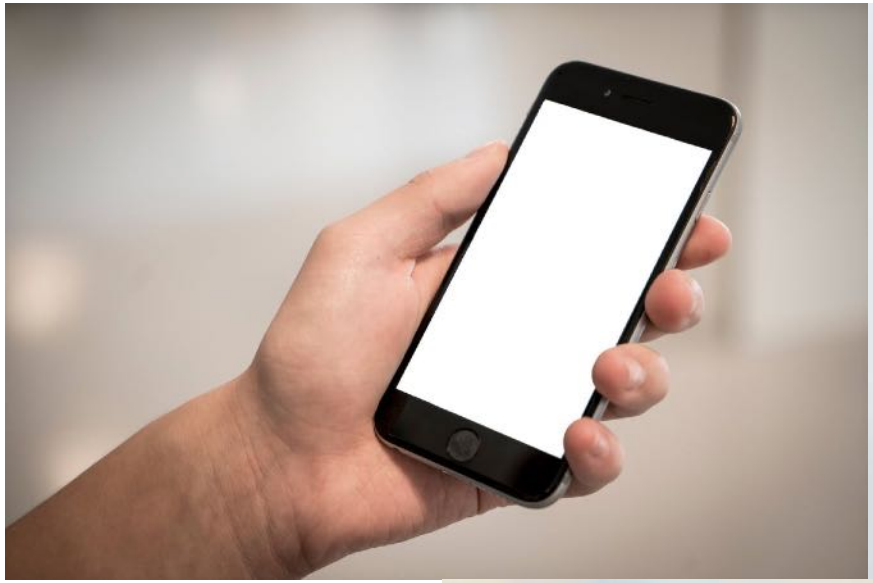
# What is HCI, and what is HCI Research?

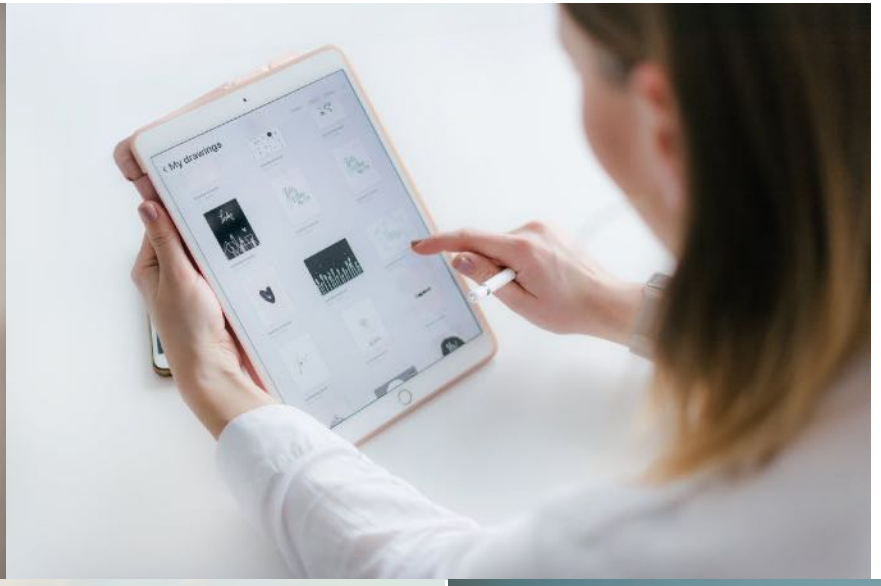
*Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.*




Kantowitz, B. H., & Sorkin, R. D. (1983).
*Human factors: Understanding People-System Relationships*

# What is HCI, and what is HCI Research?






# What is HCI, and what is HCI Research?

TECHNOLOGY

## Crazy: 90 Percent of People Don't Know How to Use CTRL+F

ALEXIS C. MADRIGAL AUG 18, 2011

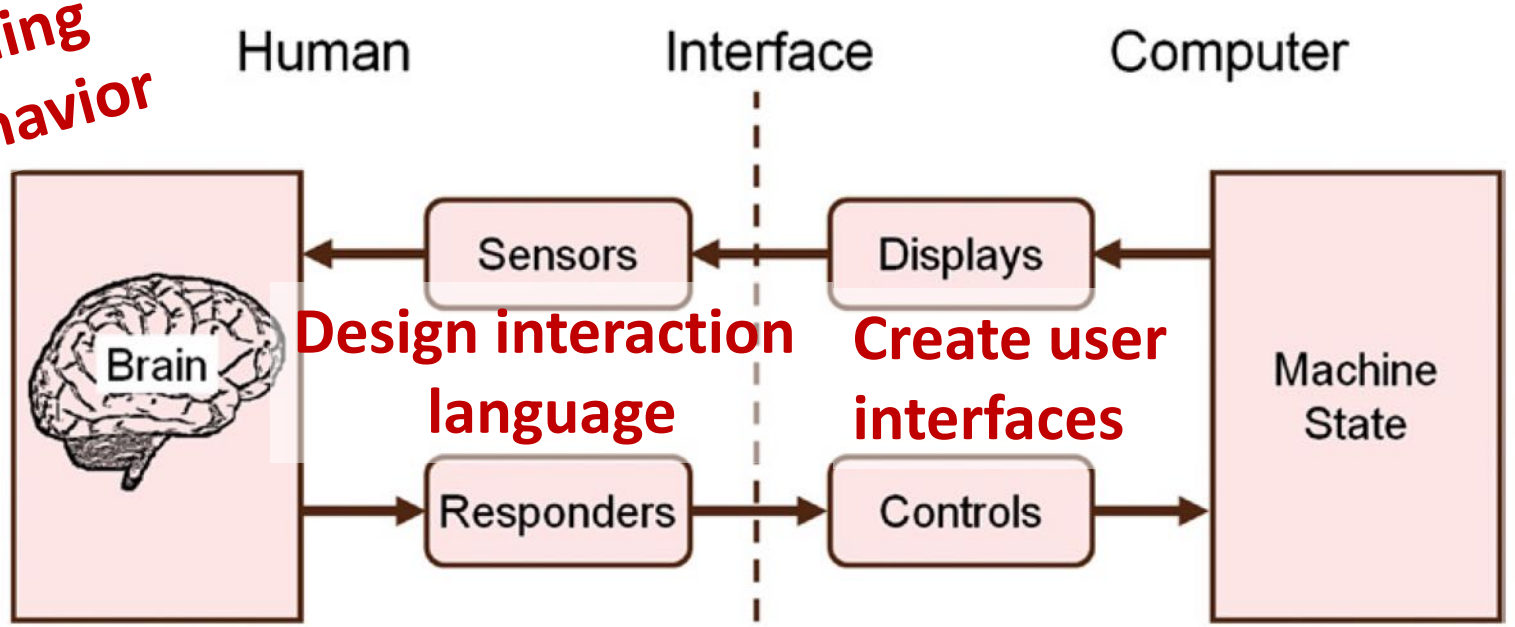
This week, I talked with Dan Russell, a search anthropologist at Google, about the time he spends with random people studying how they search for stuff. One statistic blew my mind. 90 percent of people in their studies don't know how to use CTRL/Command + F to find a word in a document or web page! I probably use that trick 20 times per day and yet the vast majority of people don't use it at all.

"90 percent of the US Internet population does not know that. This is on a sample size of thousands," Russell said. "I do these field studies and I can't tell you how many hours I've sat in somebody's house as they've read through a long document trying to find the result they're looking for. At the end I'll say to them, 'Let me show one little trick here,' and very often people will say, 'I can't believe I've been wasting my life!'"

# What is HCI, and what is HCI Research?

*Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.*

**Understanding human behavior**




**Design interaction language**

**Create user interfaces**

**Create new technology**

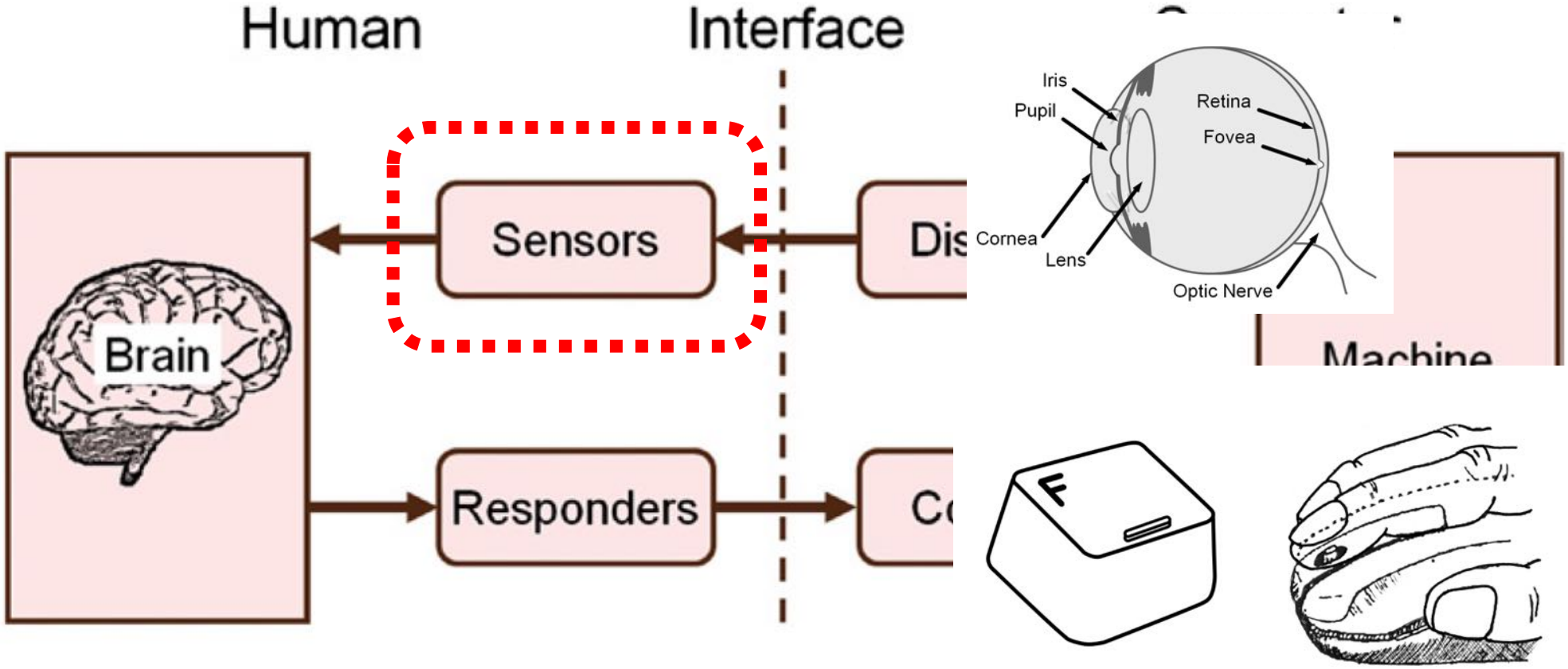
**Develop evaluation methods**

Kantowitz, B. H., & Sorkin, R. D. (1983). *Human factors: Understanding People-System Relationships*

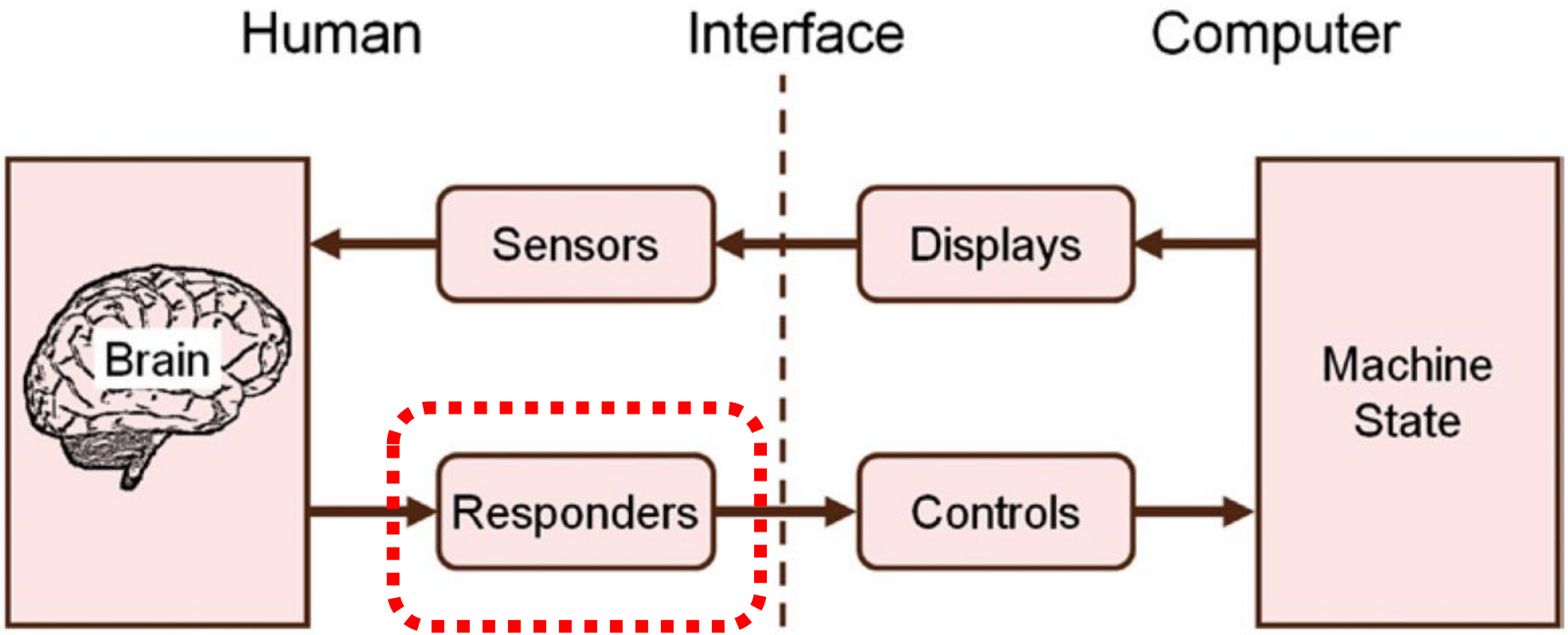
# What is HCI, and what is HCI Research?

- Empirical Research Contributions
- Artifact Contributions
- Methodological Contributions
- Theoretical Contributions
- Dataset Contributions
- Survey Contributions
- Opinion Contributions

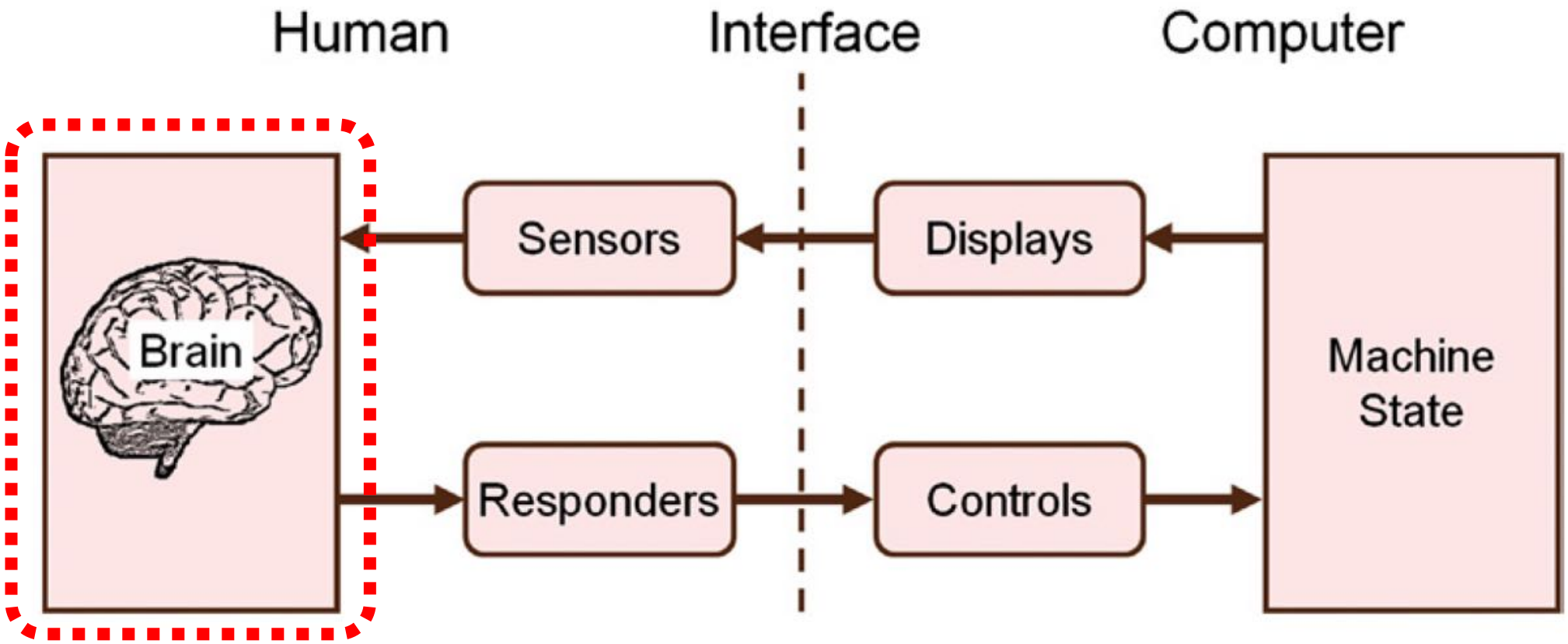
# How do humans perceive and control things?



# How do humans perceive and control things?

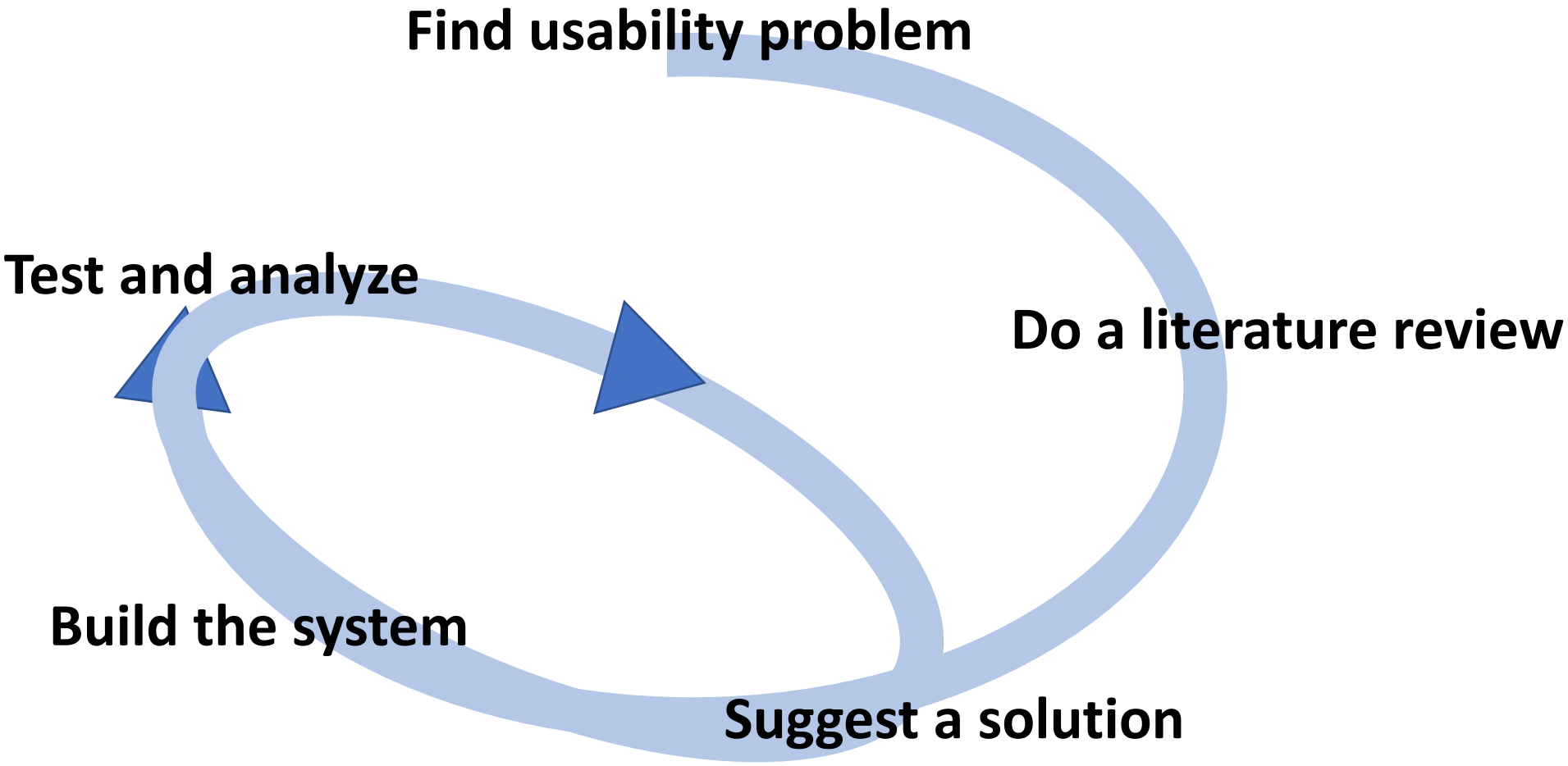


# How do humans perceive and control things?



# Conducting HCI Research

# How to conduct HCI Research?

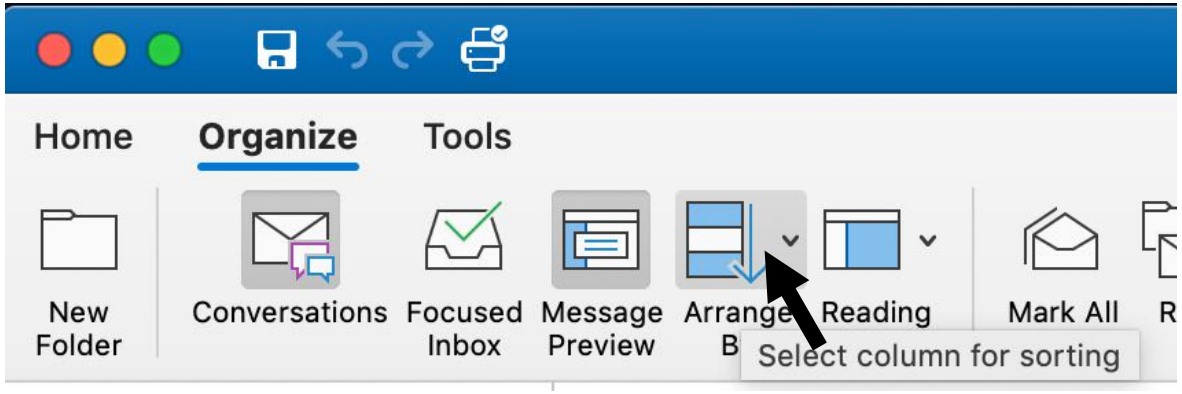


# Research Methods

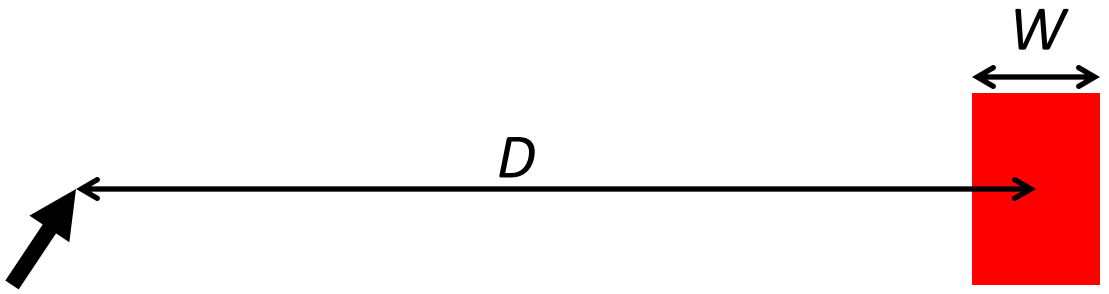
- Experimental Method
  - Acquire knowledge through controlled lab experiments.
  - Tests if changes to a manipulated variable result in changes to a response variable.
  - High precision, low relevance.
- Observational Method
  - Observe humans interacting with computers in a natural setting.
  - Using interviews, field investigations, case studies, focus groups, etc.
  - Tends to be qualitative.
  - High relevance, but sacrifices precision.

# Example: Pointing Device Evaluation

- Real task: interacting with GUI's
  - Pointing is fundamental




- Experimental task: target acquisition
  - Abstract, elementary, essential



# What Variables to Manipulate/Measure?

- Independent variables
  - Factors that are manipulated in the experiment
- Dependent variables
  - Factors which are measured
- Control variable
  - Variables with constant value
    - e.g. Screen background color in pointing task

# Within vs. Between Subjects Design

## Within-subjects design:

- All subjects do all conditions
- Fewer participants needed
- Prone to learning transfer effects

| Condition 1 | Condition 2 |
|---|---|
| Subject 1 | Subject 1 |
| Subject 2 | Subject 2 |
| . | . |
| Subject 10 | Subject 10 |

---

## Between-subjects design:

- Subjects only do one condition
- More participants needed
- No learning transfer effects
- Can train to high skill

| Condition 1 | Condition 2 |
|---|---|
| Subject 1 | Subject 11 |
| Subject 2 | Subject 12 |
| . | . |
| Subject 10 | Subject 20 |

# 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?

# 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?

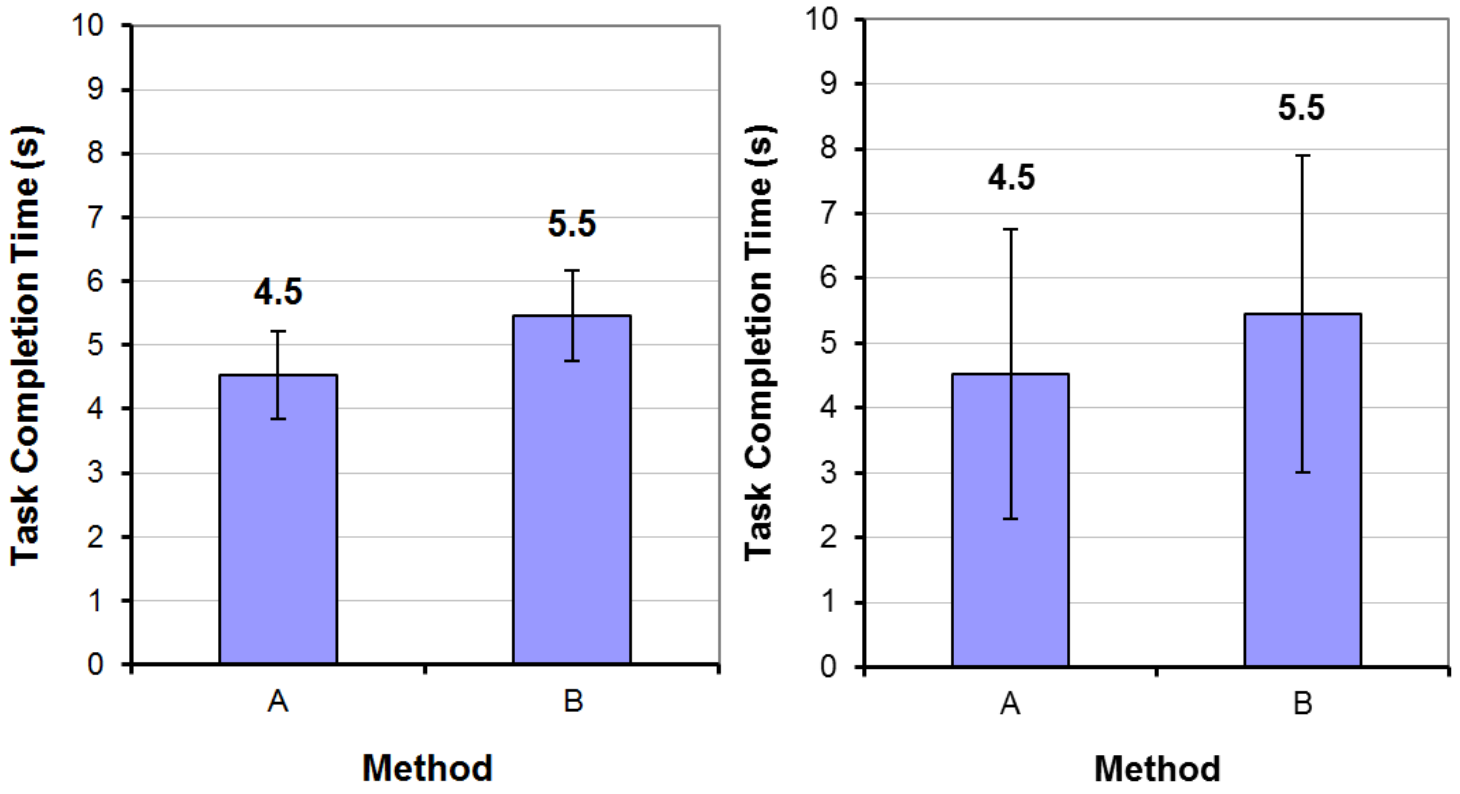
- For hypothesis testing, we instead use a statement:

> 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

# Descriptive Statistics

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



# Statistical Significance

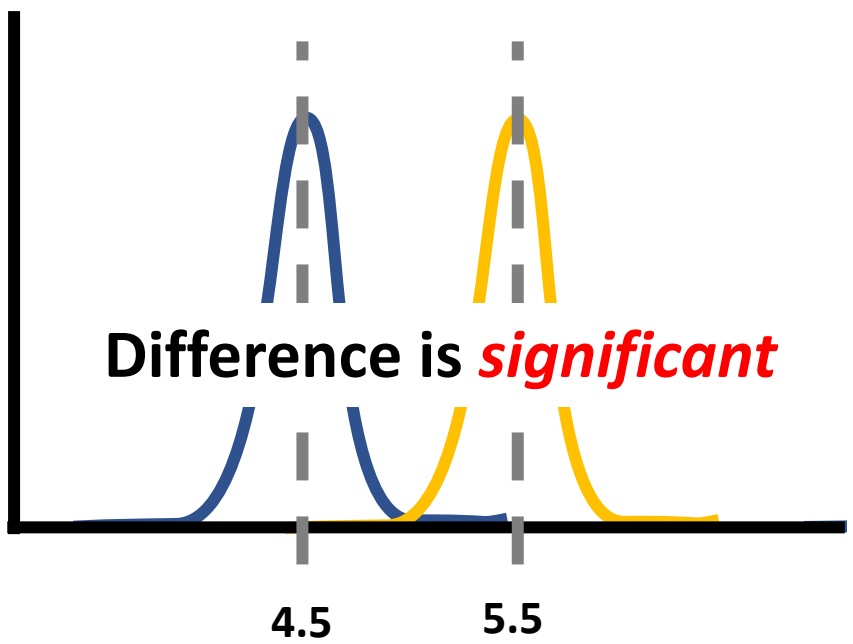
- Null Hypothesis:
  - IV x has no effect on DV y
- “P-Value”:
  - Probability of obtaining your results, assuming the null hypothesis is true
- When $p < .05$
  - Reject the null hypothesis
  - IV x does have an effect on DV y

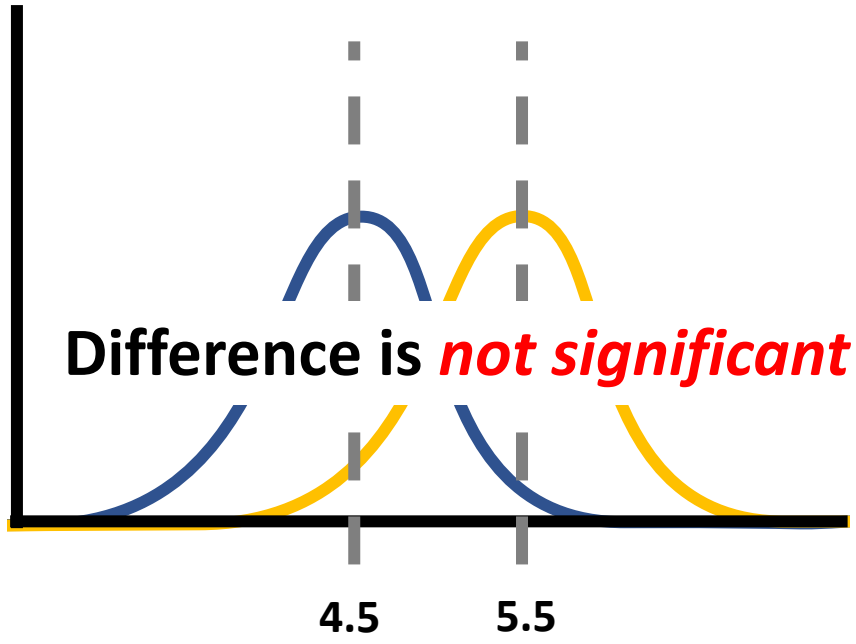
# Analysis of Variance

- 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 Analyze the Variance?

- Two examples:




$$F = \frac{\text{between-group variability}}{\text{within-group variability}}$$

# Example #1: ANOVA Analysis

**ANOVA Table for Task Completion Time (s)**

| | DF | Sum of Squares | Mean Square | F-Value | P-Value | Lambda | Power |
|---|---|---|---|---|---|---|---|
| Subject | 9 | 5.080 | .564 | | | | |
| Method | 1 | 4.232 | 4.232 | 9.796 | .0121 | 9.796 | .804 |
| Method * Subject | 9 | 3.888 | .432 | | | | |

**Probability of obtaining the observed data if the null hypothesis is true**

The mean task completion time for Method A was 4.5s. This was 20.1% less than the mean of 5.5s observed for Method B. The difference was statistically significant ($F_{1,9} = 9.80$, $p < 0.05$)

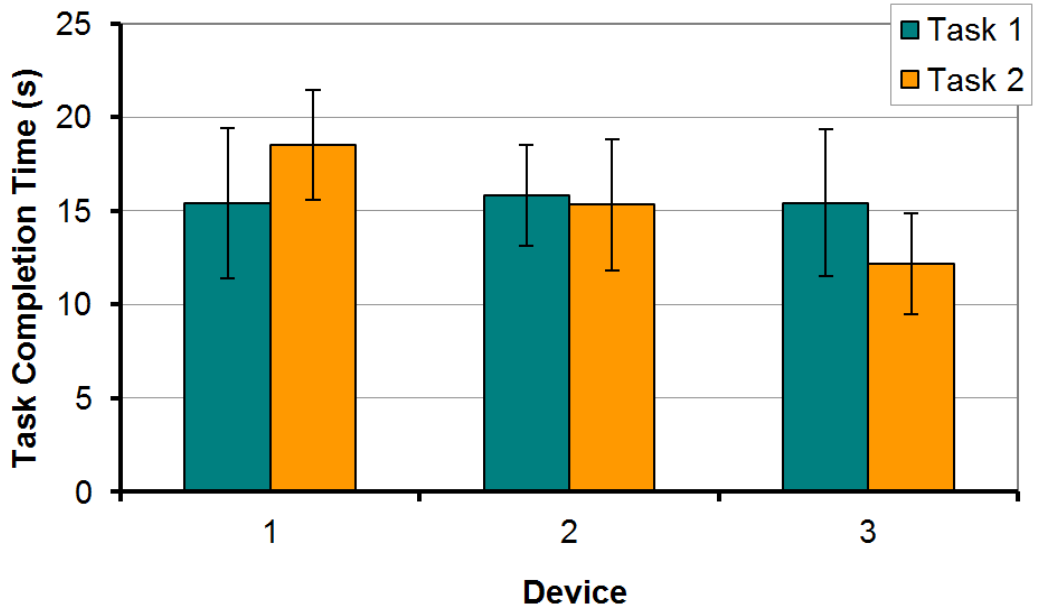
# Two-way ANOVA

- An experiment with two independent variables is a *two-way design*
- ANOVA tests for
  - Two main effects + one interaction effect
- Example
  - Independent variables
    - Device → D1, D2, D3 (e.g., mouse, stylus, touchpad)
    - Task → T1, T2 (e.g., point-select, drag-select)
  - Dependent variable
    - Task completion time
  - Both IVs assigned within-subjects
  - Participants: 12

# Two-way ANOVA Example

| Participant | Device 1 | | Device 2 | | Device 3 | |
|---|---|---|---|---|---|---|
| | Task 1 | Task 2 | Task 1 | Task 2 | Task 1 | Task 2 |
| 1 | 11 | 18 | 15 | 13 | 20 | 14 |
| 2 | 10 | 14 | 17 | 15 | 11 | 13 |
| 3 | 10 | 23 | 13 | 20 | 20 | 16 |
| 4 | 18 | 18 | 11 | 12 | 11 | 10 |
| 5 | 20 | 21 | 19 | 14 | 19 | 8 |
| 6 | 14 | 21 | 20 | 11 | 17 | 13 |
| 7 | 14 | 16 | 15 | 20 | 16 | 12 |
| 8 | 20 | 21 | 18 | 20 | 14 | 12 |
| 9 | 14 | 15 | 13 | 17 | 16 | 14 |
| 10 | 20 | 15 | 18 | 10 | 11 | 16 |
| 11 | 14 | 20 | 15 | 16 | 10 | 9 |
| 12 | 20 | 20 | 16 | 16 | 20 | 9 |
| *Mean* | 15.4 | 18.5 | 15.8 | 15.3 | 15.4 | 12.2 |
| *SD* | 4.01 | 2.94 | 2.69 | 3.50 | 3.92 | 2.69 |

| | Task 1 | Task 2 | *Mean* |
|---|---|---|---|
| Device 1 | 15.4 | 18.5 | 17.0 |
| Device 2 | 15.8 | 15.3 | 15.6 |
| Device 3 | 15.4 | 12.2 | 13.8 |
| *Mean* | 15.6 | 15.3 | 15.4 |



**ANOVA Table for Task Completion Time (s)**

| | DF | Sum of Squares | Mean Square | F-Value | P-Value | Lambda | Power |
|---|---|---|---|---|---|---|---|
| Subject | 11 | 134.778 | 12.253 | | | | |
| Device | 2 | 121.028 | 60.514 | 5.865 | .0091 | 11.731 | .831 |
| Device * Subject | 22 | 226.972 | 10.317 | | | | |
| Task | 1 | .889 | .889 | .076 | .7875 | .076 | .057 |
| Task * Subject | 11 | 128.111 | 11.646 | | | | |
| Device * Task | 2 | 121.028 | 60.514 | 5.435 | .0121 | 10.869 | .798 |
| Device * Task * Subject | 22 | 244.972 | 11.135 | | | | |

The grand mean for task completion time was 15.4 seconds. Device 3 was the fastest at 13.8 seconds, while device 1 was the slowest at 17.0 seconds. The main effect of device on task completion time was statistically significant ($F_{2,22} = 5.865$, $p < .01$). The task effect was modest, however. Task completion time was 15.6 seconds for task 1. Task 2 was slightly faster at 15.3 seconds; however, the difference was not statistically significant ($F_{1,11} = 0.076$, ns). The results by device and task are shown in Figure x. There was a significant Device × Task interaction effect ($F_{2,22} = 5.435$, $p < .05$), which was due solely to the difference between device 1 task 2 and device 3 task 2, as determined by a Scheffé post hoc analysis.

CS6501: Human-Computer Interaction, Fall 2020

# Assignment #1: Quantitative Evaluation

## Why do I do this?

There is a big difference between learning to run an experiment and actually running an experiment. This assignment is designed to give you an experience of preparing an experiment, (virtually) meeting participants and interacting with them, and collecting and analyzing results from the experiment. This will be helpful for you to plan the course project and hopefully, your other research projects.

## What do I do?

**You will conduct an experiment** that tests pointing performances of **two input devices of your choice** using GoFitts (http://www.yorku.ca/mack/FittsLawSoftware/doc/index.html?GoFitts.html). The input devices can be anything you can test, such as a mouse, a touchpad, a touchscreen, or a stylus. But given the experiment being conducted online, it may be easier for you to choose the input devices that others may already have (e.g., Mouse and Touchpad). In case you or your participants don't have two input devices, you may test dominant and non-dominant hand performances instead of using two input devices.

# Qualitative Research Methods

- A form of research in which the **researcher collects and interprets data**, making the researcher as much a part of the research process as the participants and the data they provide.
- **Utilizes an open and flexible design** and in doing so stands at odds with the notion of rigor so important when doing quantitative research.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, SAGE

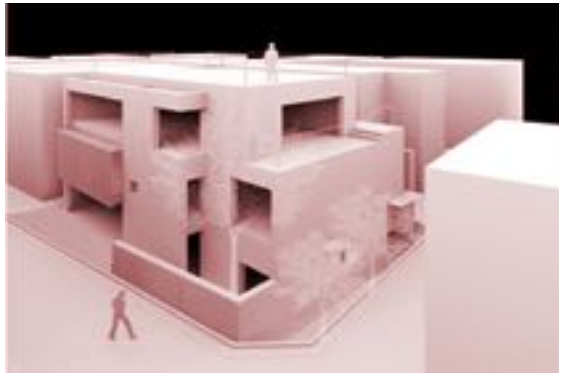
# Qualitative Research Methods

- Query and Critique
  - Ask people to provide judgements or feedback on a design
  - Excellent for getting initial and continued feedback on a design
  - May not identify all problems that will actually occur
  - Some methods are time consuming
- Observe Users
  - Observe users actually using the system or prototype
  - Typically quick and easy to do
  - Some methods can reveal what a person is thinking

# Modeling Interaction

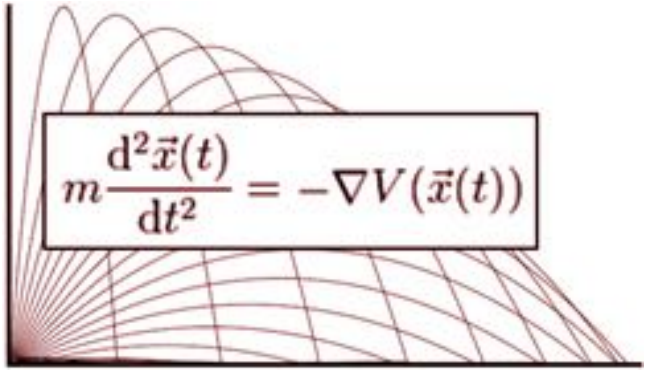
- A *model* is a simplification of reality

Architect's scale
model of a building



***description***
→ provides insight into space usage, movement of people, light, etc.

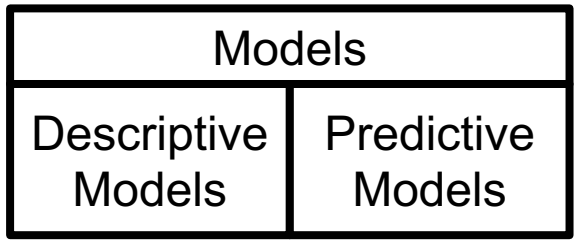
Physicist's model for the trajectory of a tossed ball




***prediction***
→ gives the ball's position as a function of time

# Descriptive Models

- Descriptive modeling is at times so simple, the process barely seems like modeling
- Any reduction or partitioning of a problem space qualifies as a descriptive model




- Other names:
  - *Design space*, *framework*, *taxonomy*, *classification*, and often without a name given
- As a partitioned domain, we are empowered to think differently – and critically – about the problem

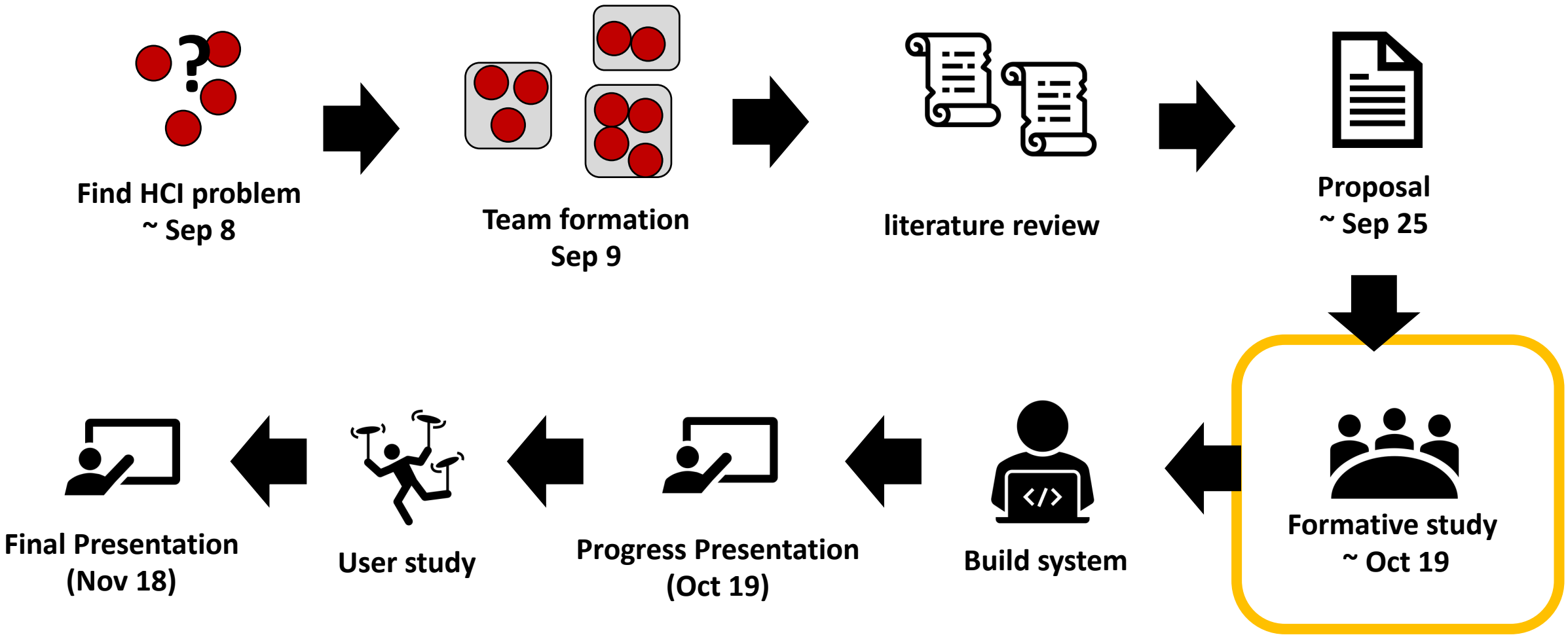
# Predictive Models

- A predictive model is an equation
- Predicts the outcome on a *criterion variable* (*DV*) based on the value of one or more *predictor variables* (*IV*)
- Note: the predictor variables must be ratio-scale attributes
- Predictive models, like descriptive models, allow a problem space to be explored
- However, predictive models deal with numbers, not concepts

# RIMES: Interactive Multimedia Exercises for Lecture Videos

Juho Kim (Microsoft Research, MIT CSAIL)
Elena L. Glassman (Microsoft Research, MIT CSAIL)
Andrés Monroy-Hernández (Microsoft Research)
Meredith Ringel Morris (Microsoft Research)

# Course Project: Timeline



# Assignment #2: Formative Study

- Conduct an Interview or a Focus Group
- Find an interview topic that's related to your project.
- Team effort, team report
- 2+ interview sessions or a focus group with 4+ participants.
- Report should include:
  - Interview design
  - Interview results (summary and insights)
  - Your reflections on the interview

**Due Oct 19 (Mon) 23:59 pm**

**Assignment instruction will be on the course webpage**

# Project Progress Report (Presentation + Document)

- Project Progress Report (Due Oct 23)
  - Similar to Method Section of a CHI paper
  - Three sections
    - Findings from Formative Study
    - Study Method
    - Research Plan

# Project Progress Report (Presentation + Document)

- You will share
  - What you found during your formative study
  - How you will conduct your study
  - Your detailed timeline

# Project Progress Report (Presentation + Document)

- Project Progress Report (Due Oct 23)
  - Similar to Method Section of a CHI paper
  - Three sections
    - Findings from Formative Study
    - Study Method
    - Research Plan

# Project Progress Report (Presentation + Document)

- Project Progress Presentation (On Oct 19, 21)
  - Each team will present for 15 minutes
  - Each team will have 5 minutes Q&A and feedback session
  - Presentation order will be randomized

# Topic Presentation – Preparation

- There are 12 topics to be presented (check the topic list on Collab)
  Topic sign-up is due today. You'll be randomly assigned to a topic if you don't do it.
- Each team will have two or three students.
- Each team will cover a topic, which has two papers.
- All team members should thoroughly read the papers.
- After reading the papers, team should discuss them.
  E.g., about the benefits/contributions, limitations, or future directions of the paper

# Topic Presentation – Presentation

- Each team will present for 30-35 minutes and discuss for 10-15 minutes
- Presentation will have three components
  - **Topic introduction:** a brief description about the topic
  - **Paper summary:** explain what these papers are about, including their contributions, design, and study design and results.
  - **Discussion:** share your discussion and also lead discussions in the class
- Every member of the team should present.

# Topic Presentation – Participation

- All students should read the papers before each class so that they can actively participate in the class
- You will choose a paper among the four papers to be presented in the class and write a reading response to it.
- You don’t need to write a reading response for the day you’re presenting
- Actively participate in the class, feel free to ask questions or talk about your thoughts – it will not be recorded.

# Topic Presentation – Grading

- Grade breakdown (15 points)
  - Topic Introduction (2 points)
  - Understanding Paper 1 (5 points)
  - Understanding Paper 2 (5 points)
  - Effective Talk Delivery (1 points)
  - Discussion  (2 points)
- First two teams will get 0.5 bonus points

Thank you!