Leibniz Universität Hannover

Mensch-Computer-Interaktion 2

Introduction

Human-Computer Interaction Group

Prof. Dr. Michael Rohs
michael.rohs@hci.uni-hannover.de

Personen

- Vorlesung
  - Michael Rohs

- Übungsleitung
  - Henning Pohl

Ort, Zeit, Zuordnung

- Vorlesung (2 SWS, 4 LP)
  - LFI-Hörsaal (Raum 031), Gebäude 3702, Schneiderberg 32
  - Mittwoch 14:45-16:15
- Übung (1 SWS)
  - LFI-Hörsaal (Raum 031), Gebäude 3702, Schneiderberg 32
  - Appelstraße 11a
  - Mittwoch 16:15-17:00
- Zuordnung
  - Master INF und TI
  - Kernkompetenzbereiche MMK und SE

Webseite und Stud.IP

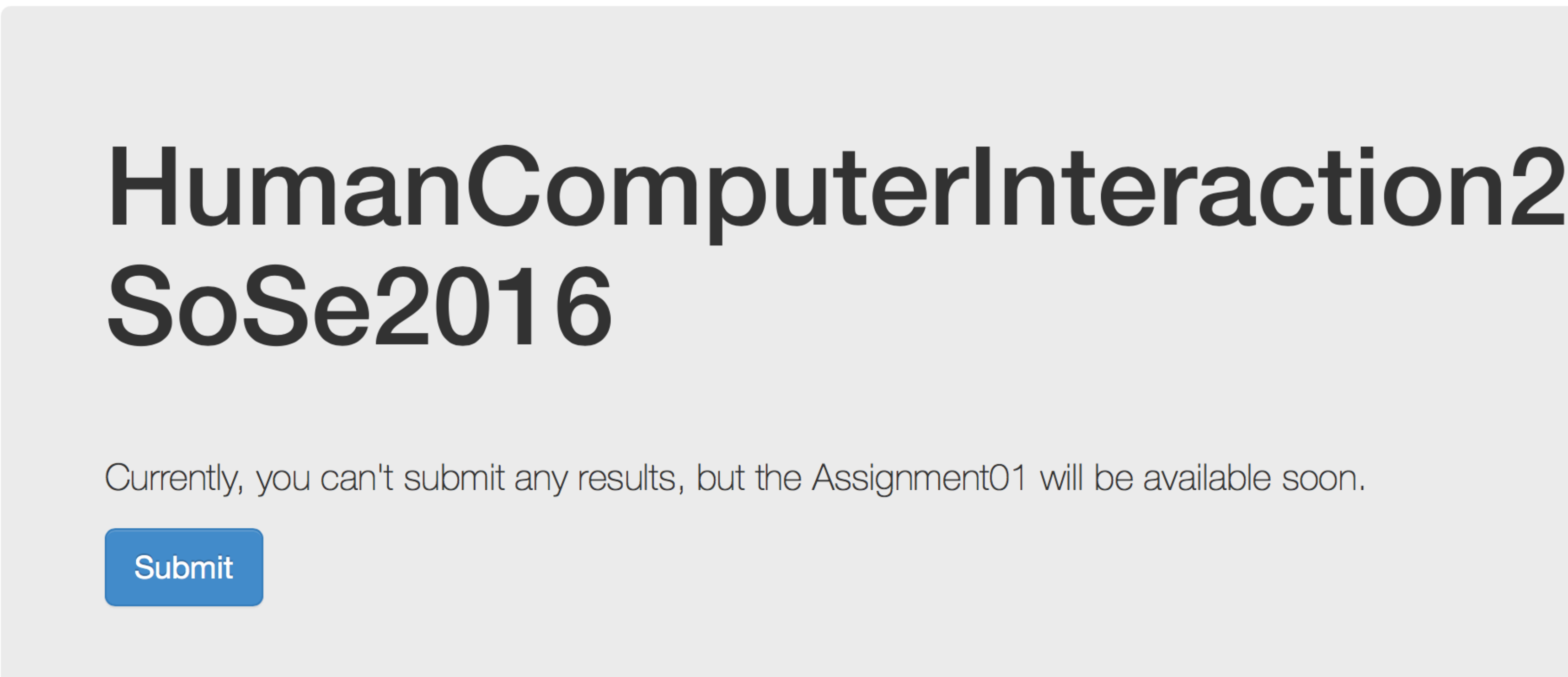
- Webseite
  - http://hci.uni-hannover.de/teaching/summer16-HCI2
- Stud.IP
  - https://elearning.uni-hannover.de/index.php
  - Tragen Sie sich bitte zur Vorlesung und zur Übung in Stud.IP ein.
  - Folien
  - Übungsblätter
  - Forum

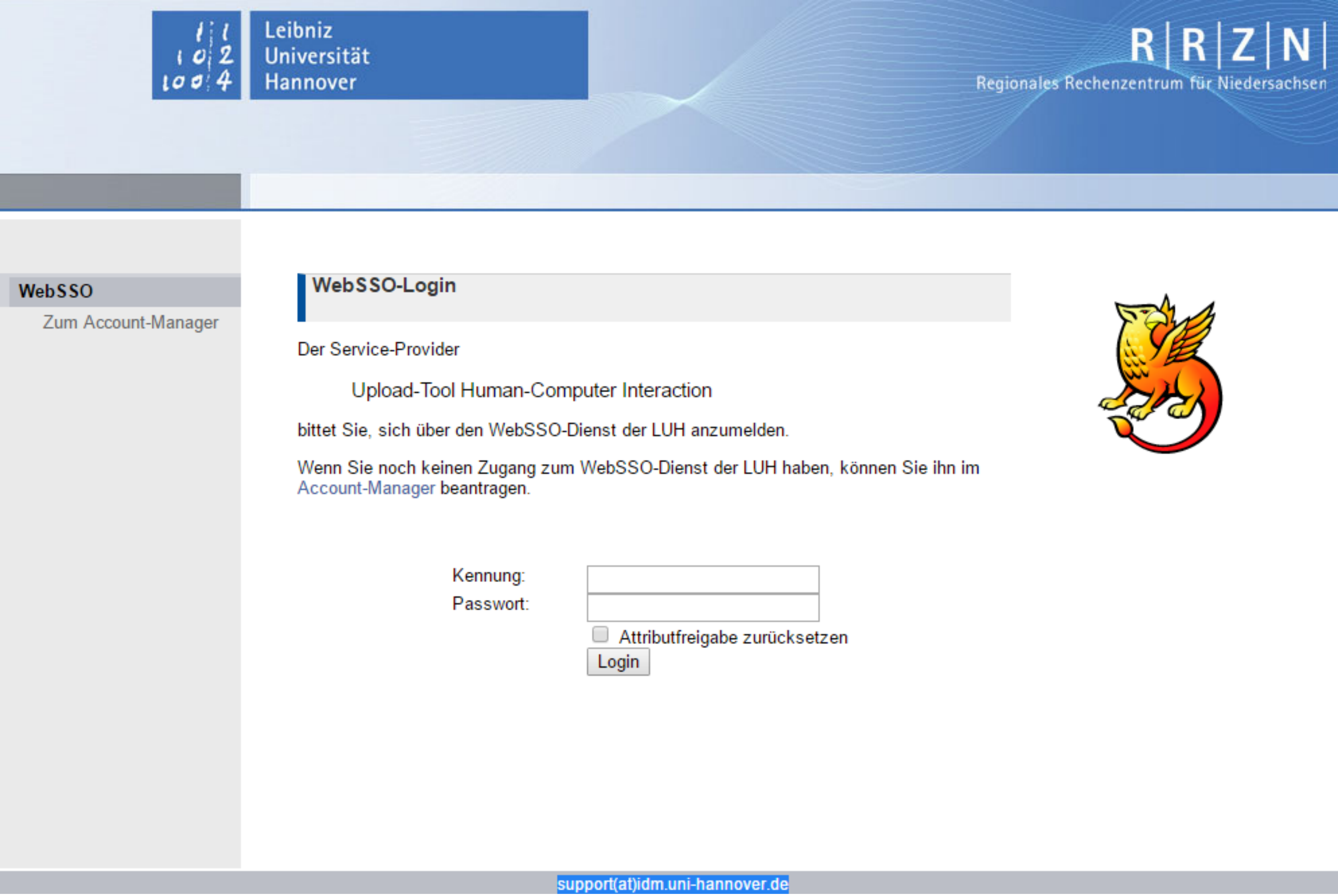
Präsenzübung (Mittwoch 16:15–17:00 Uhr)

- Vertiefung der Vorlesungsinhalte
- Beispiele
- Praktische Übungen
- Nachbesprechung Hausübungen

Assignment Submission System

https://assignments.hci.uni-hannover.de




Leibniz Universität Hannover
RRZN
Regionales Rechenzentrum für Niedersachsen
WebSSO
Zum Account-Manager
WebSSO-Login
Der Service-Provider
Upload-Tool Human-Computer Interaction
bittet Sie, sich über den WebSSO-Dienst der LUH anzumelden.
Wenn Sie noch keinen Zugang zum WebSSO-Dienst der LUH haben, können Sie ihn im Account-Manager beantragen.
Kennung:
Passwort:
Attributfreigabe zurücksetzen
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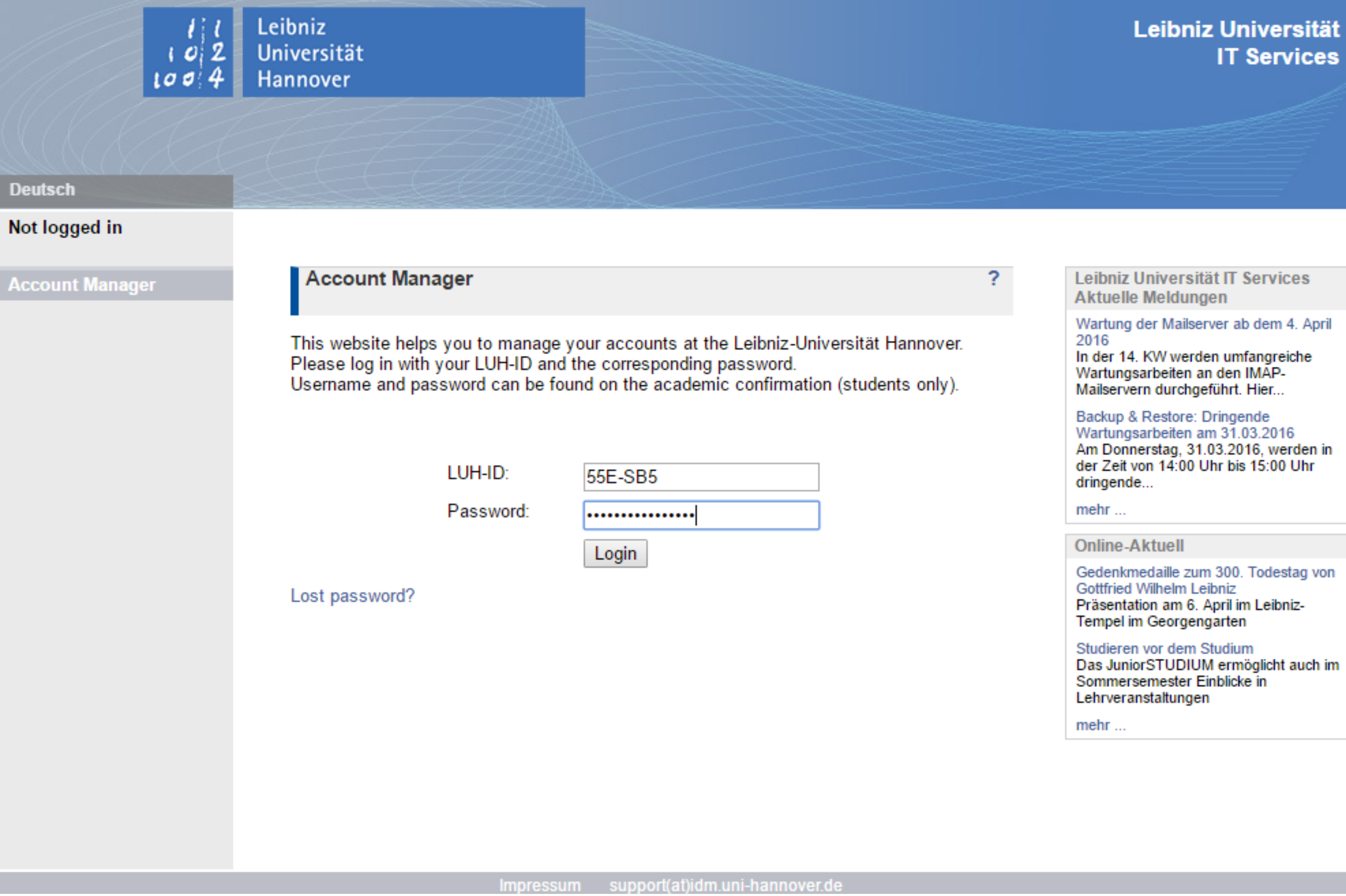
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Please log in with your LUH-ID and the corresponding password.
Username and password can be found on the academic confirmation (students only).
LUH-ID:
55E-SB5
Password:
Login
Lost password?
Leibniz Universität IT Services Aktuelle Meldungen
Wartung der Mailserver ab dem 4. April 2016
In der 14. KW werden umfangreiche Wartungsarbeiten an den IMAP-Mailservern durchgeführt. Hier...
Backup & Restore: Dringende Wartungsarbeiten am 31.03.2016
Am Donnerstag, 31.03.2016, werden in der Zeit von 14:00 Uhr bis 15:00 Uhr dringende...
mehr ...
Online-Aktuell
Gedenkmedaille zum 300. Todestag von Gottfried Wilhelm Leibniz
Präsentation am 6. April im Leibniz-Tempel im Georgengarten
Studieren vor dem Studium
Das JuniorSTUDIUM ermöglicht auch im Sommersemester Einblicke in Lehrveranstaltungen
mehr ...
Impressum
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Die folgenden Zugänge sind bereits für Sie eingerichtet:

Dienst	Benutzername	Status	Aktionen
IdM / HIS	55E-SB5 (Details)	aktiv	Passwort ändern
WLAN / VPN	55E-SB5-W1 (Details)	aktiv	Passwort ändern inaktivieren
Stud.IP	55E-SB5 (Details)	aktiv	
DreamSpark (ehem. MSDN-AA)	susan.miller@email.com (Details)	aktiv	
WebSSO / OpenID	55E-SB5 (Details)	aktiv	Passwort ändern inaktivieren
E-Mail	susan.miller@stud.uni-hannover.de (Details)	aktiv	Passwort ändern inaktivieren
Campus-PC	55E-SB5 (Details)	inaktiv	Passwort ändern aktivieren

Submission System

MobileInteraction SoSe2016: MI-assignment-01

Firstname: Susan

Lastname: Miller

E-Mail: susan.miller@email.com

File: Add Zip-File

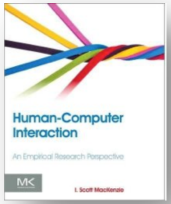
Submit

Übungen und Scheinbedingungen

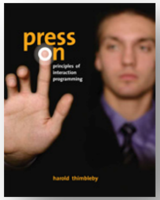
- Übungen
  - (meist) wöchentlich, Aufgaben lösen
  - Abgabe per Submission System
  - Bonuspunkte für Klausur (max. 15%)
- Klausur
  - Zeit: Donnerstag 28.7.2016, 8-11 Uhr, 90 Minuten
  - Ort: HG E214
- Scheinbedingungen
  - Bestehen der Klausur
  - Schein ist benotet

Bücher

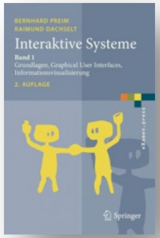
- I. Scott MacKenzie: Human-Computer Interaction - An Empirical Research Perspective. Morgan Kaufmann, 2013



- Harold Thimbleby: Press On - Principles of Interaction Programming. MIT Press, 2007.



- Bernhard Preim, Raimund Dachselt: Interaktive Systeme. Band 1, Springer, 2010.



Lectures

Session	Date	Topic	
1	6.4.	Introduction	
2	13.4.	Interaction elements	GUI toolkits, interaction techniques
3	20.4.	Event handling	
4	27.4.	Scene graphs	
5	4.5.	Interaction techniques	
	11.5.	no class (CHI)	
	18.5.	no class (spring break)	
6	25.5.	Experiments	design and analysis of experiments
7	1.6.	Data Analysis	
8	8.6.	Data Analysis	
9	15.6.	Visualization	
10	22.6.	Visualization	current topics beyond-desktop UIs
11	29.6.	Modeling interaction	
12	6.7.	Computer vision for interaction	
13	13.7.	Computer vision for interaction	

Klausur:
28.7.2016
8-11 Uhr
HG E214

Lectures (Details)

Date	Topic	Details
6.4.	Introduction	human performance, empirical research
13.4.	Interaction elements	widgets, widget states, JavaFX scene graph, layout
20.4.	Event handling	event handling, bindings, reactive programming, constraints
27.4.	Scene graphs	event filters/handlers, coordinate systems, scene graph nodes
4.5.	Interaction techniques	animation, alignment techniques
11.5.	no class (CHI)	
18.5.	no class (spring break)	
25.5.	Experiments	designing experiments
1.6.	Data Analysis	hypothesis testing, parametric and non-parametric tests
8.6.	Data Analysis	analysis of variance, confidence intervals, correlation
15.6.	Visualization	visualizing experiment data
22.6.	Visualization	information visualization
29.6.	Modeling interaction	descriptive and predictive models
6.7.	Computer vision for interaction	processing image data
13.7.	Computer vision for interaction	processing image data

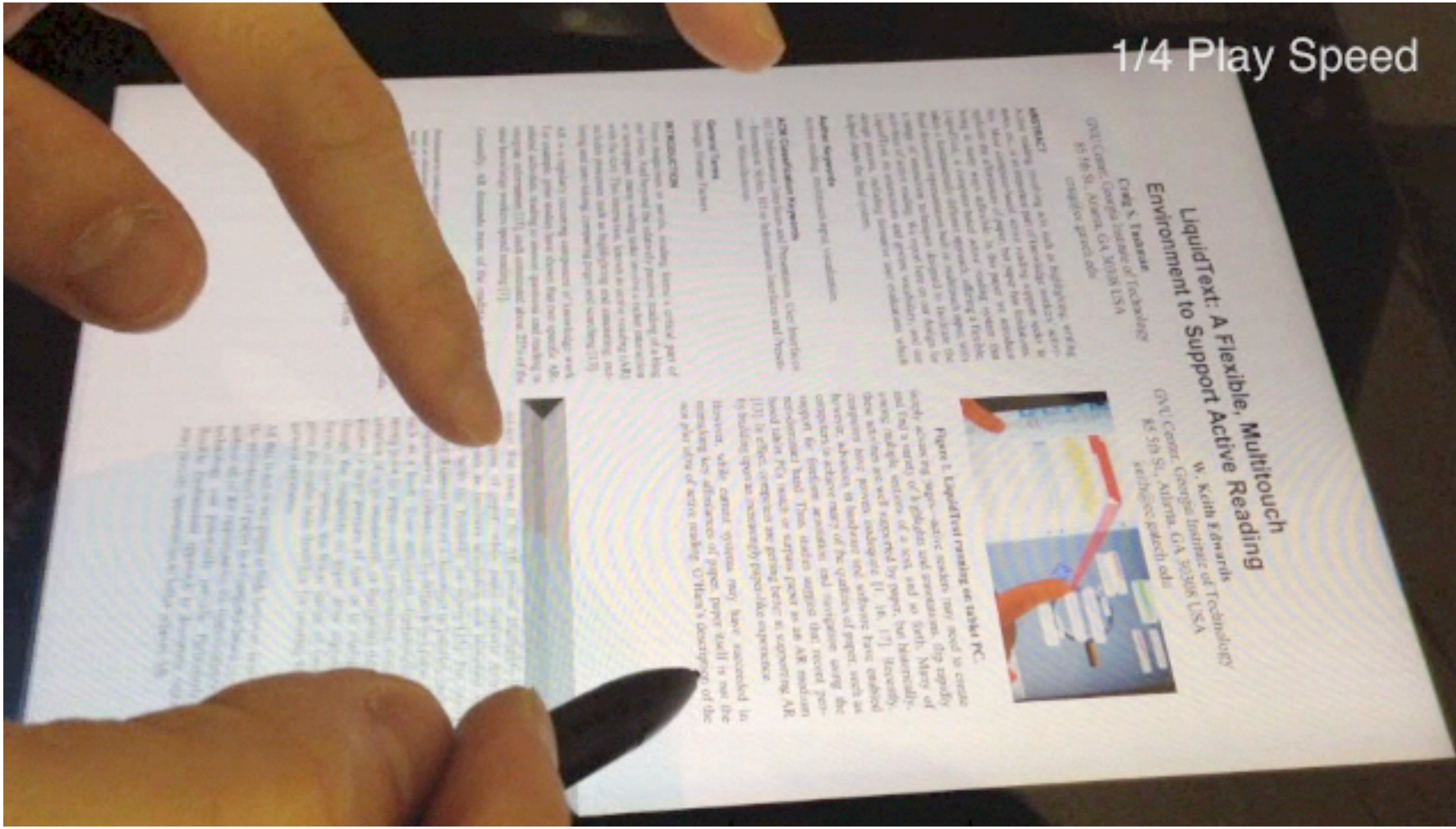
Exercises (Details)

Date	Topic	Details
6.4.	Introduction	reaction time, visual search
13.4.	Interaction elements	instrumental interaction, layout panes
20.4.	Event handling	listeners, properties, bindings, reactive programming
27.4.	Scene graphs	events, coordinate systems
4.5.	Interaction techniques	snapping techniques, improved snap-and-go
11.5.	no class (CHI)	
18.5.	no class (spring break)	
25.5.	Experiments	within- and between-subjects designs
1.6.	Data Analysis	ANOVA for reaction times, chi-squared test
8.6.	Data Analysis	design an experiment
15.6.	Visualization	develop the test prototype
22.6.	Visualization	conduct the experiment
29.6.	Modeling interaction	analyze and visualize the results
6.7.	Computer vision for interaction	processing image data
13.7.	Computer vision for interaction	processing image data

Goals, Scope

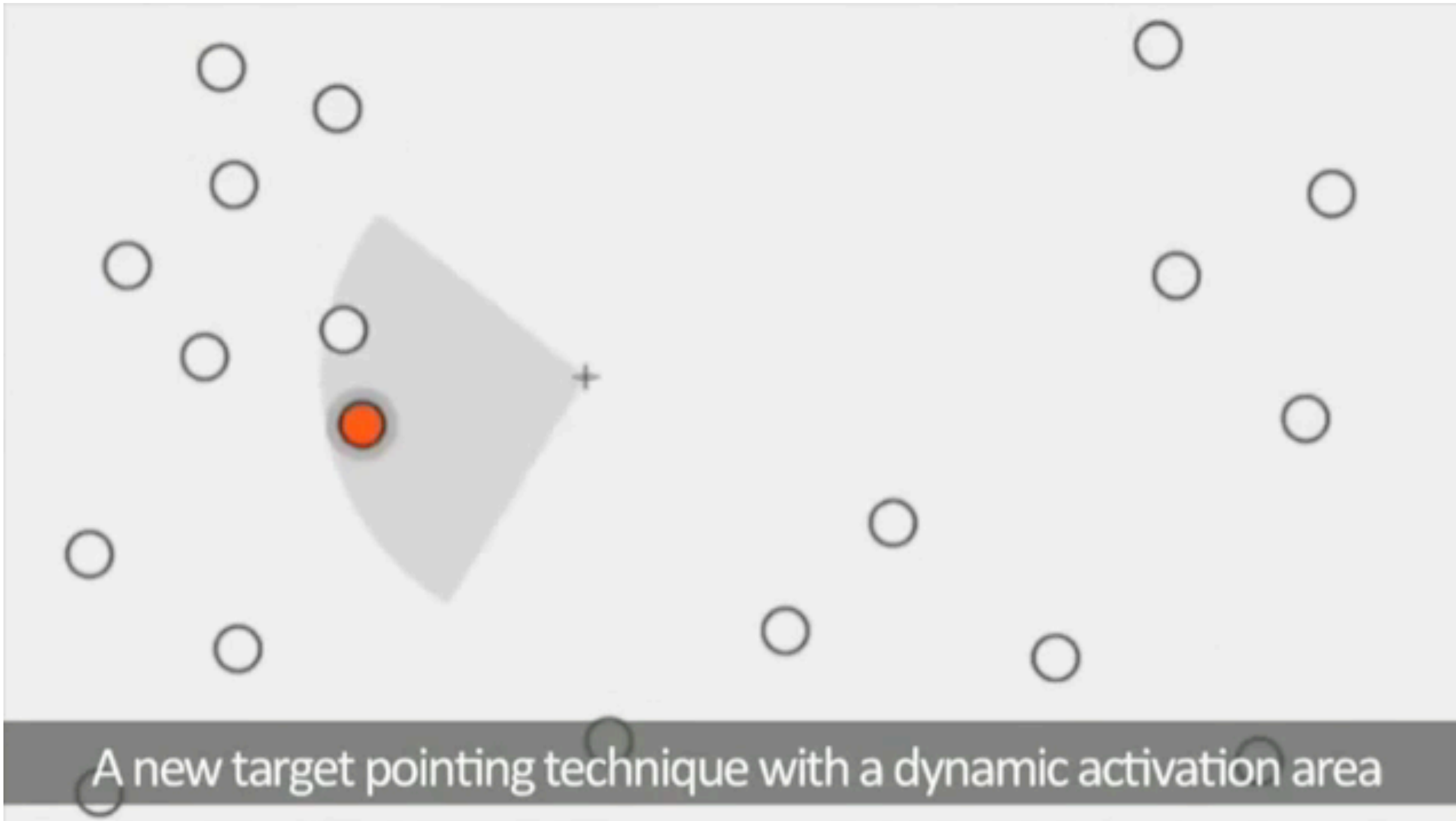
- Builds on MCI 1
- Fewer topics, but more in-depth
- Architecture of GUI toolkits
- Designing interaction techniques given a set of requirements
- Implementing interaction techniques with appropriate tools
- Evaluating interaction techniques for performance and usability
- Beyond-desktop user interfaces
- Individual assignments

Text Tearing: Opening Space for Digital Ink Annotation



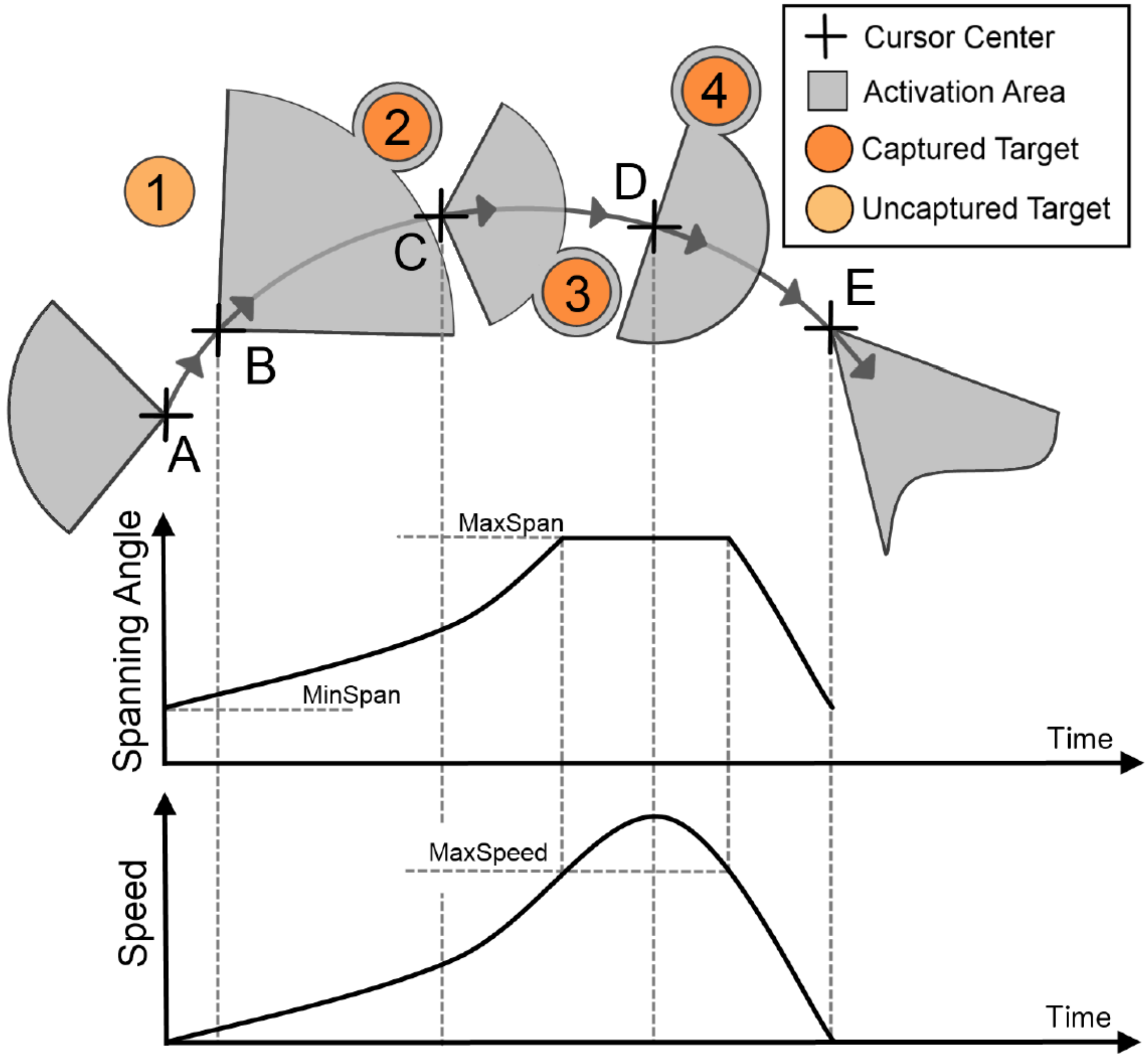
Yoon, Chen, Guimbretière. TextTearing: Opening white space for digital ink annotation. UIST 2013.

The Implicit Fan Cursor: A Velocity Dependent Area Cursor



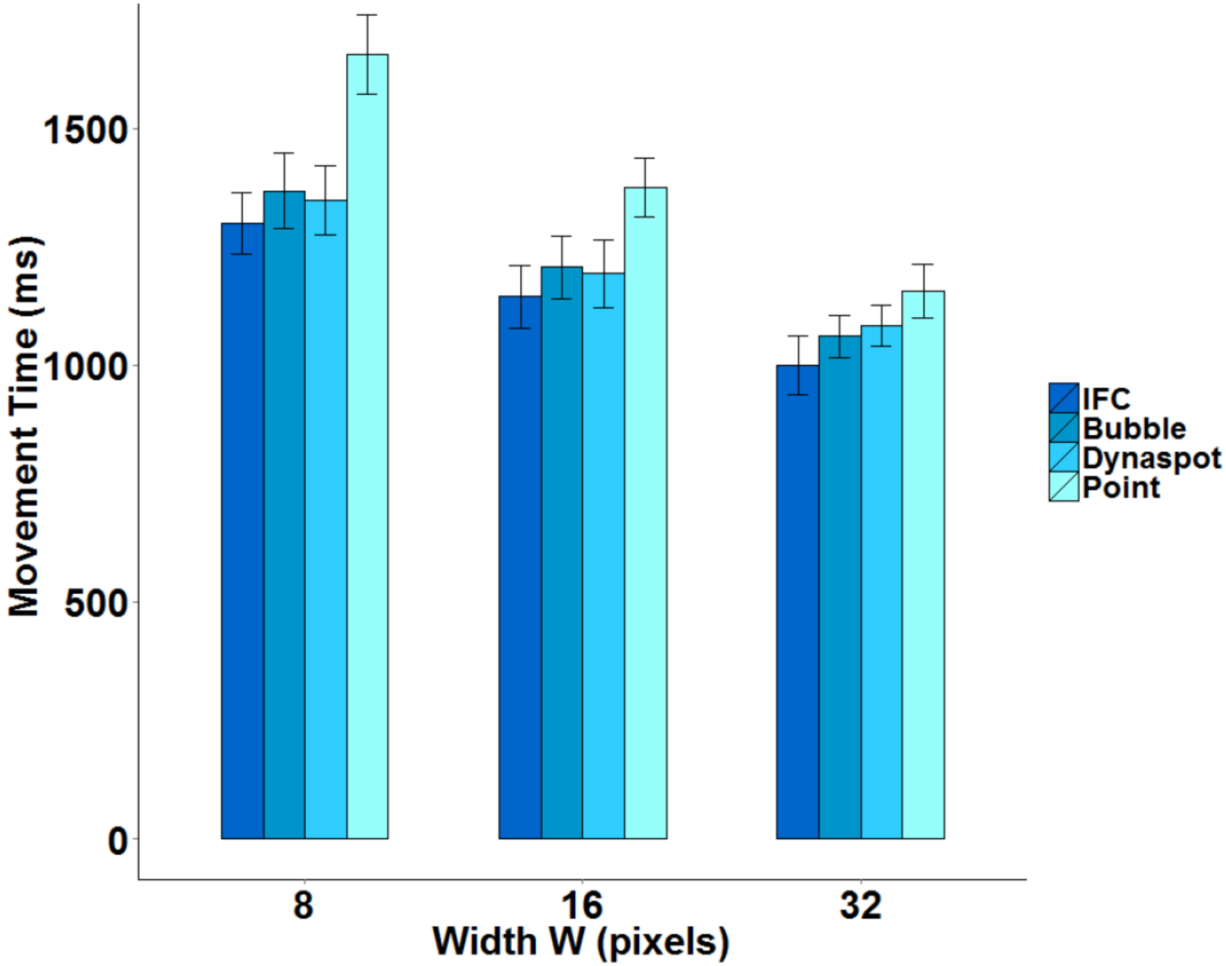
Su, Au, Lau. The Implicit Fan Cursor: A Velocity Dependent Area Cursor. CHI 2014.

The Implicit Fan Cursor: A Velocity Dependent Area Cursor



Su, Au, Lau. The Implicit Fan Cursor: A Velocity Dependent Area Cursor. CHI 2014.

The Implicit Fan Cursor: A Velocity Dependent Area Cursor



Su, Au, Lau. The Implicit Fan Cursor: A Velocity Dependent Area Cursor. CHI 2014.

Mini-Project: Improving an Interaction Technique

- Improve one interaction technique within a complex piece of software
  - Find an (small) aspect that could be done better
  - Evaluate status quo (user test and model)
  - Implement that aspect and improved version of it
  - Evaluate improved version
- Examples
  - PowerPoint, selecting one of a group of overlapping items
  - Adding annotations to text
  - Durations of notifications
  - Devise better pointing techniques

Mini-Project: Approach

- Brainstorm possible improvements
- Develop a functional prototype
  - Java8 and JavaFX
- Perform a usability test to measure performance and satisfaction
- Optionally: Use a model to predict performance
  - Fitts Law, Steering Law, Hick-Hyman Law
  - STNs, Statecharts
  - GOMS
  - etc.

Mini-Project: Alternatives

- Analyze an existing interaction technique
  - Document the interaction technique in detail
  - Replicate the technique in a test application
  - Take measurements to evaluate the performance of the technique
  - Write a report on the results
- Analyze an existing device
  - Identify the interaction techniques available in that device
  - Critique how the interaction techniques are realized given the particular constraints of that device
  - Analyze performance of one of the techniques in the context of device usage
- Create a novel interaction technique
  - Design, implement, and evaluate it

based on:
Newell: Unified Theories of Cognition. Harvard University Press. p. 122 after MacKenzie, p. 29

Time Scale of Human Action

Scale (s)	Time Units	System	World (Theory)
10^7	months		social band
10^6	weeks		
10^5	days		
10^4	hours	activity	rational band
10^3	10 minutes	task	
10^2	minute	task	
10^1	10 s	unit task	cognitive band
10^0	1 s	operations	
10^{-1}	100 ms	deliberate act	
10^{-2}	10 ms	neural circuit	biological band
10^{-3}	1 ms	neuron (nerve cell)	
10^{-4}	100 µs	organelle (structures within cells)	

based on:
Newell: Unified Theories of Cognition. Harvard University Press. p. 122 after MacKenzie, p. 29

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Time Scale of Human Action

Scale (s)	Time Units	System	World (Theory)	HCI Research Area
10^7	months		social band	groupware usage patterns, social networking, online dating, privacy, design theory
10^6	weeks			
10^5	days			
10^4	hours	activity	rational band	web navigation, search strategies, collaborative computing, user-centered design
10^3	10 minutes	task		
10^2	minute	task		
10^1	10 s	unit task	cognitive band	selection technique, menu design, force feedback, text entry, gestural input, etc.
10^0	1 s	operations		
10^{-1}	100 ms	deliberate act		
10^{-2}	10 ms	neural circuit	biological band	
10^{-3}	1 ms	neuron (nerve cell)		
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after MacKenzie, p. 29

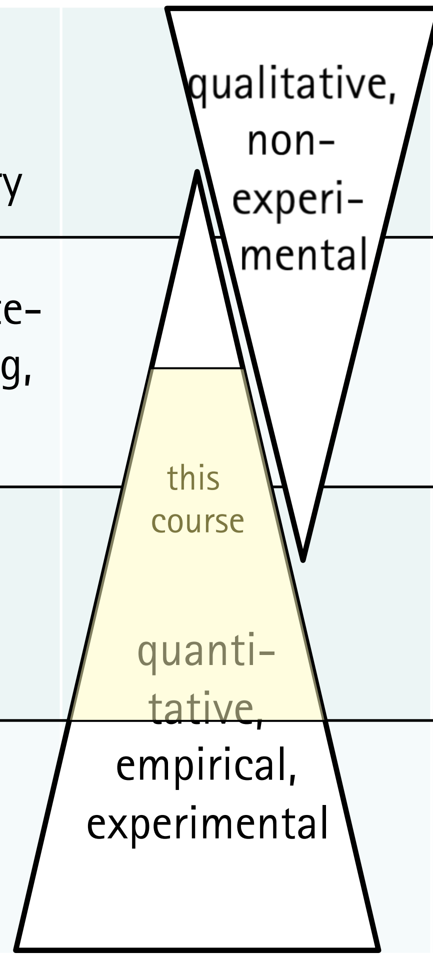
Time Scale of Human Action

Scale (s)	Time Units	System	World (Theory)	HCI Research Area	Research Approach
10^7	months		social band	groupware usage patterns, social networking, online dating, privacy, design theory	qualitative, non-experimental
10^6	weeks				
10^5	days				
10^4	hours	activity	rational band	web navigation, search strategies, collaborative computing, user-centered design	
10^3	10 minutes	task			
10^2	minute	task			
10^1	10 s	unit task	cognitive band	selection technique, menu design, force feedback, text entry, gestural input, etc.	
10^0	1 s	operations			
10^{-1}	100 ms	deliberate act			
10^{-2}	10 ms	neural circuit	biological band		quantitative, empirical, experimental
10^{-3}	1 ms	neuron (nerve cell)			
10^{-4}	100 µs	organelle (structures within cells)			

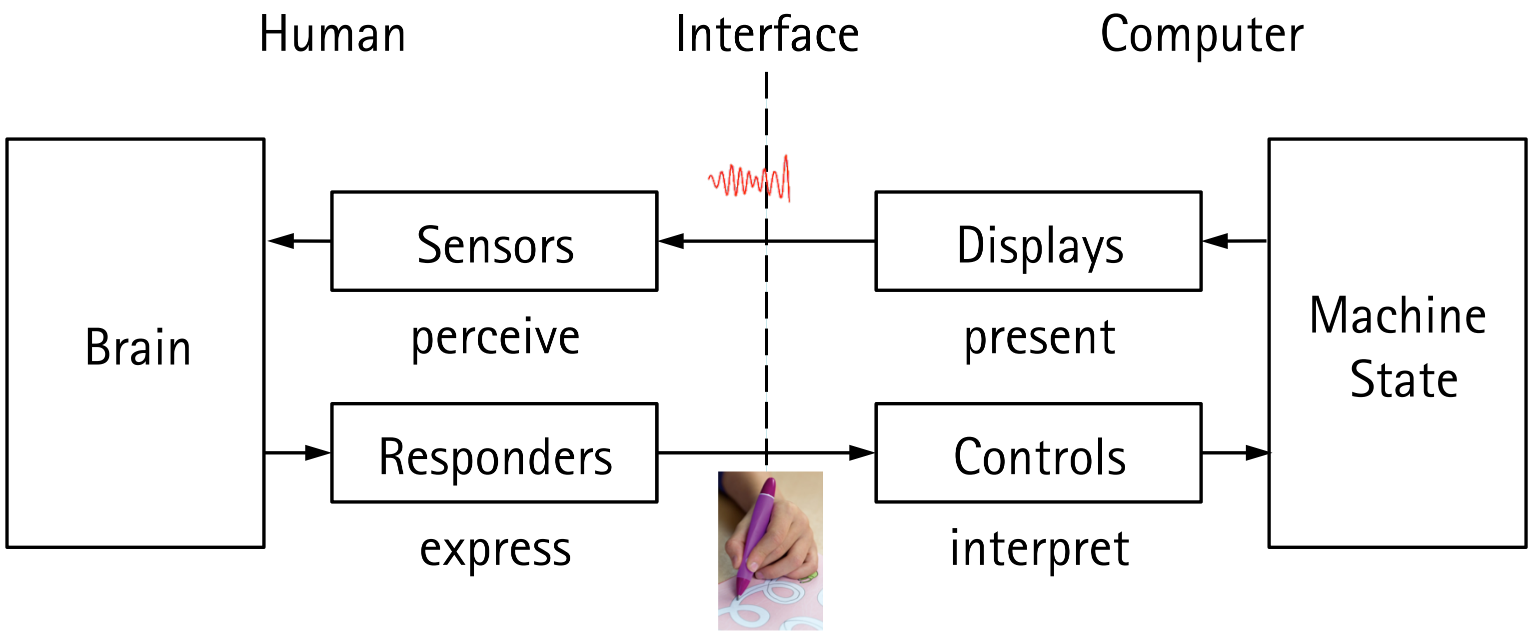
based on:
Newell: Unified Theories of Cognition. Harvard University Press. p. 122 after MacKenzie, p. 29

Time Scale of Human Action

Scale (s)	...	HCI Research Area	Research Approach	Research Methods
10^7 10^6 10^5		groupware usage patterns, social networking, online dating, privacy, design theory		interviews, observation, case studies, scenarios
10^4 10^3 10^2		web navigation, search strategies, collaborative computing, user-centered design		identification of patterns, strategies, analysis of interface structure, heuristic evaluation, think-aloud
10^1 10^0 10^{-1}		selection technique, menu design, force feedback, text entry, gestural input, etc.		measurements of completion time, error rate, workload, fatigue, feedback perception
10^{-2} 10^{-3} 10^{-4}				



Human – Interface – Computer



- Sensors: Vision, hearing, touch, taste, smell
  Signals at interface: Sound waves, electromagnetic waves, physical contact, etc.
- Responders: Fingers, hand, arm, eyelid, eyeball, eyebrows, tongue
  Signals at interface: Movement (motor control) through muscles

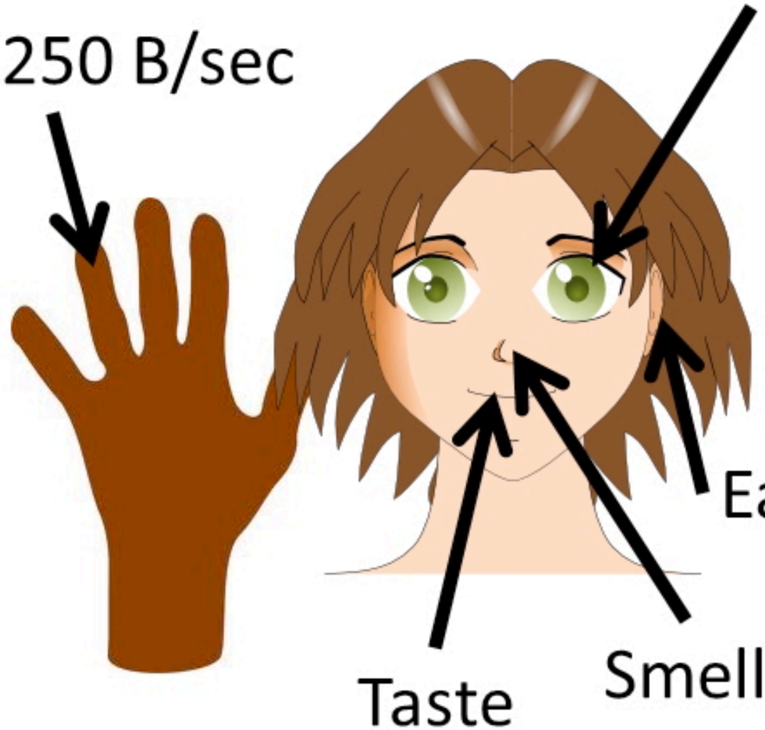
Human Input (Sensors)

Touch 250 B/sec

25 touches/sec
10 fingers

Eyes 180 MB/sec

2 eyes
1 Mpixel/eye
3 bytes/pixel
30 images/second



Ears 144 KB/sec

18 kHz
2 Nyquist sampling
2 bytes / sample
2 ears

Dan Olsen - http://icie.cs.byu.edu/CS256/Videos/HumanFactors/HumanInputOutput.wmv

Human Output (Responders)

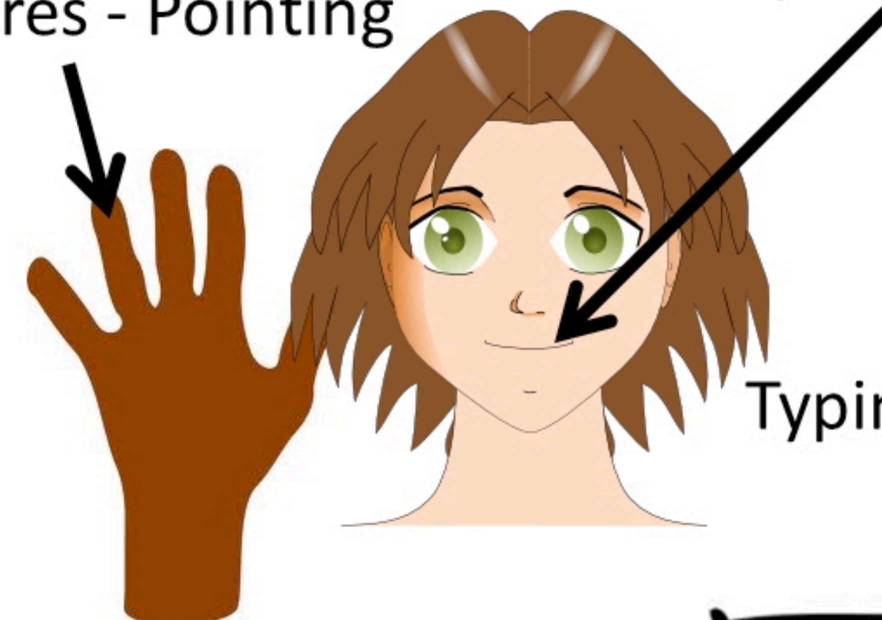
Gestures - Pointing

dexterity =
muscle size /
limb size

Speech 14 B/sec

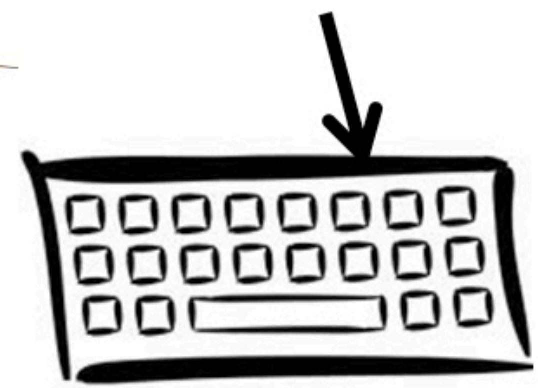
160 words/min
5 char/word

error rates!



90 words/min
5 char/word

Typing 7.5 B/sec



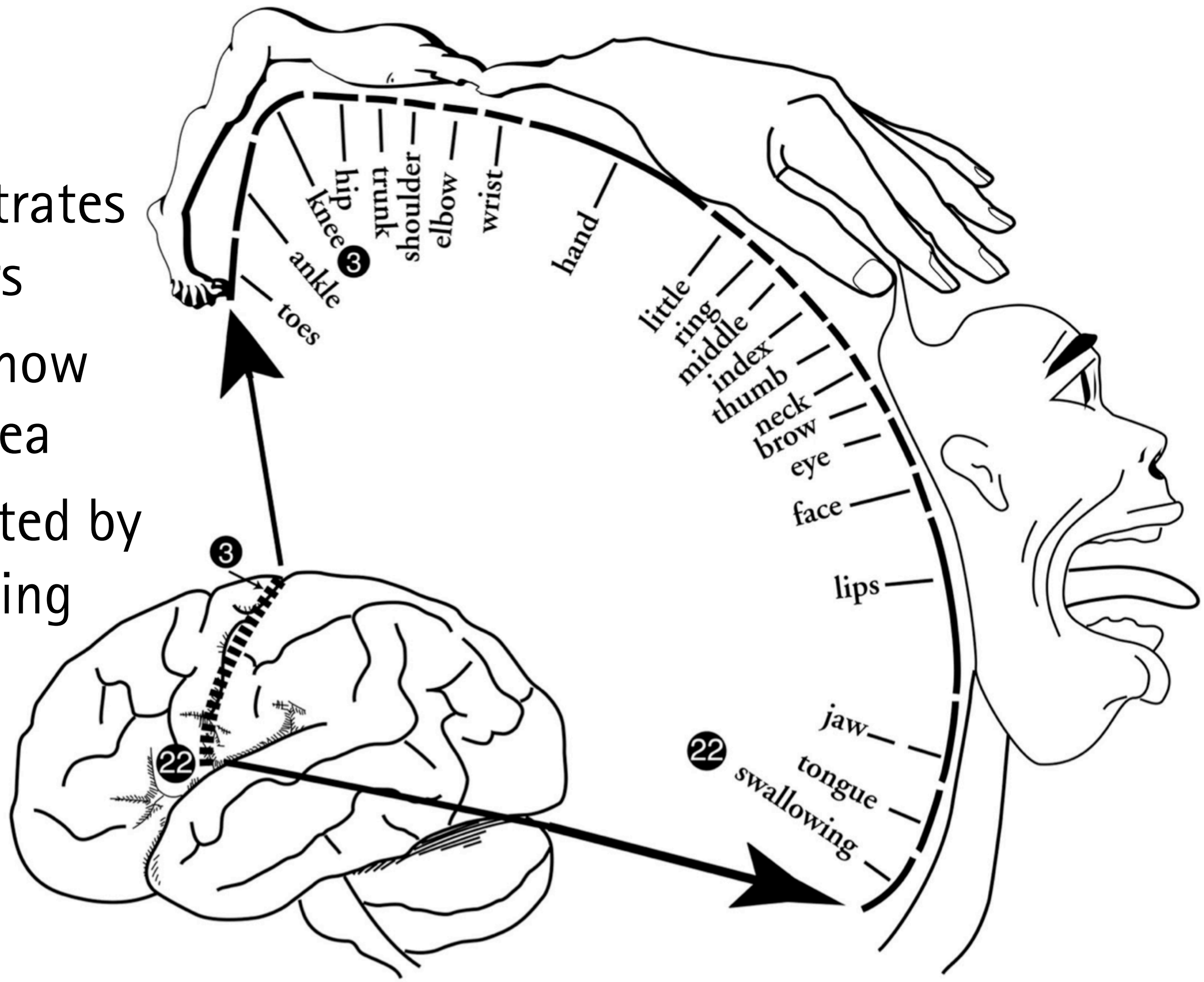
Dan Olsen - http://icie.cs.byu.edu/CS256/Videos/HumanFactors/HumanInputOutput.wmv

Dexterity

- How fine the manipulation be performed with a limb can be
  - “Dexterity = Muscle size / limb size”
- Tongue: Highest dexterity
- Fingers: Second highest dexterity
  - Muscle that actuates finger is on forearm
  - Muscle size is 2-3x size of finger
- Wrist: High dexterity
  - Muscle size same as muscle size for finger
  - But: Hand is larger (more mass)
- Forearm: Medium dexterity
  - Biceps, triceps
  - Muscle size is 1x size of arm

Motor Cortex and Motor Homunculus

- Penfield's motor homunculus illustrates human responders
- Lengths of bars show size of cortical area
- Muscles represented by large area promising for input devices

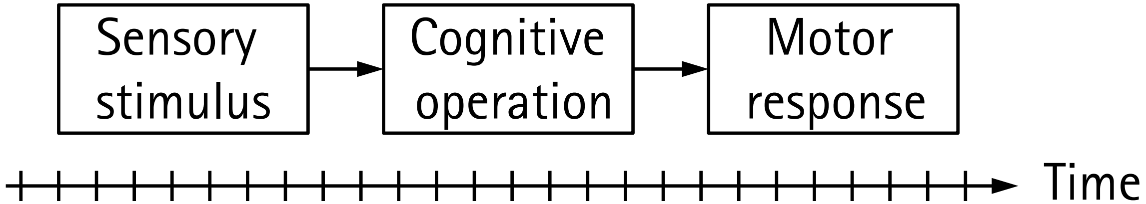


Source: http://www.intropsych.com/ch02_human_nervous_system/homunculus.html

Summary: Human Input and Output

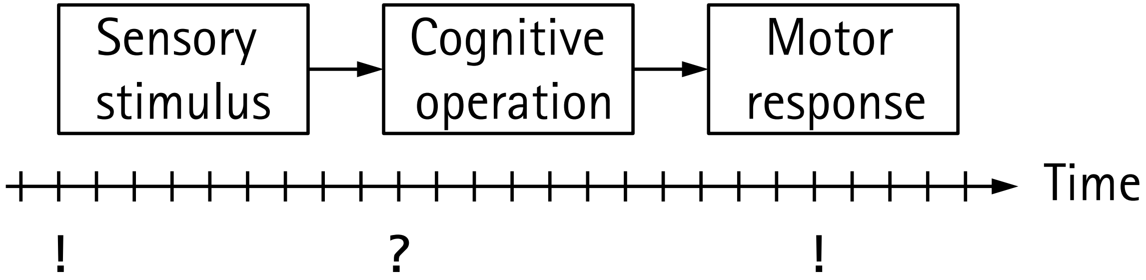
- Human Input
  - Eyes: 180 MB/s
  - Ears: 144 kB/s
  - Touch: 250 B/s
- Human Output
  - Speech: 14 B/s (inaccurate)
  - Typing: 7.5 B/s (accurate)
  - Gestures/pointing: depends on dexterity and representation in cortex

Cognitive Operation in a Reaction Time Task



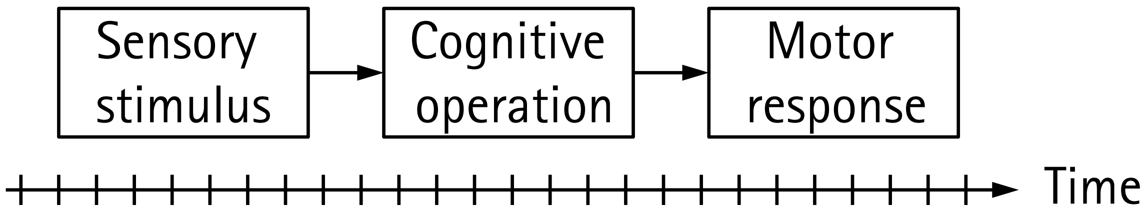
- Example: visual stimulus, button press as response
  - Retina converts light to nerve impulses
  - Transmitted to brain for perceptual processing
  - Neural activations in motor cortex
  - Nerve signals transmitted to hand
  - Muscle transforms nerve signal to physical movement
- Sensory stimuli and motor responses exist in outside world
  - Relatively easy to measure
- Cognitive operations within human brain
  - Difficult to measure

Cognitive Operation in a Reaction Time Task



Operation	Typical time (ms)
Sensory reception	1-38
Neural transmission to brain	2-100
Cognitive processing	70-300
Neural transmission to muscle	10-20
Muscle latency and activation	30-70
Total:	113-528 (!)

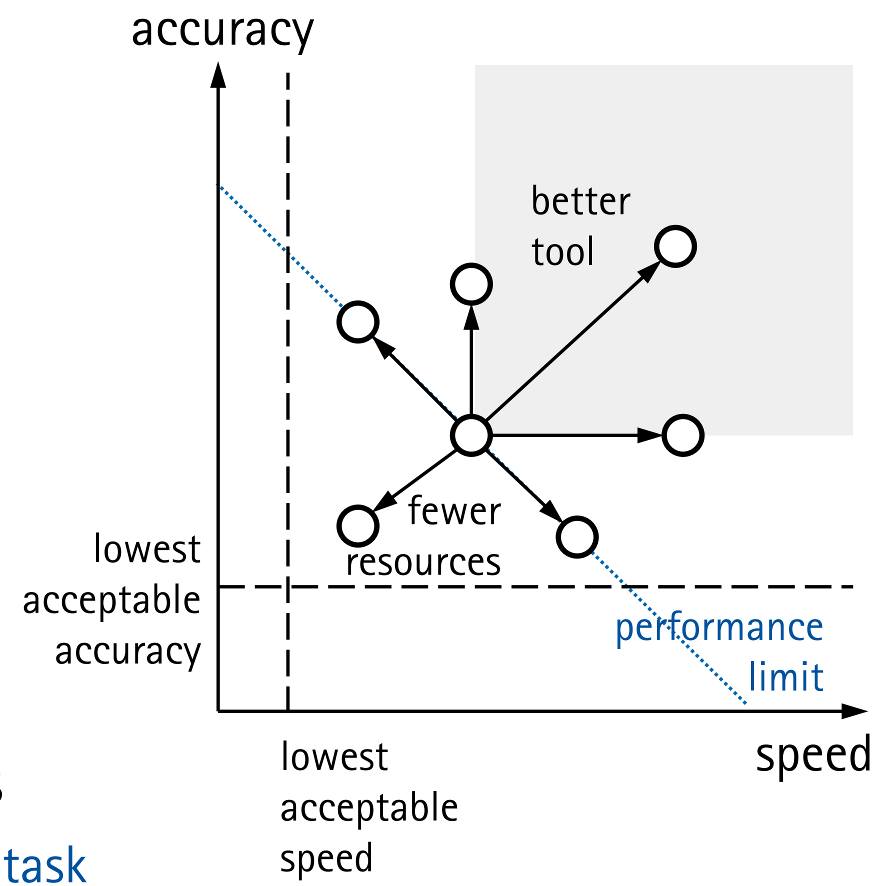
Cognitive Operation in a Reaction Time Task



- Tasks that fit this scheme
  - Car driving: Pressing brake pedal in response to changing signal light
  - Mobile phone: Accepting a phone call
  - Web: Click the close button on a popup ad
  - PC: Switching to email app on audio notification

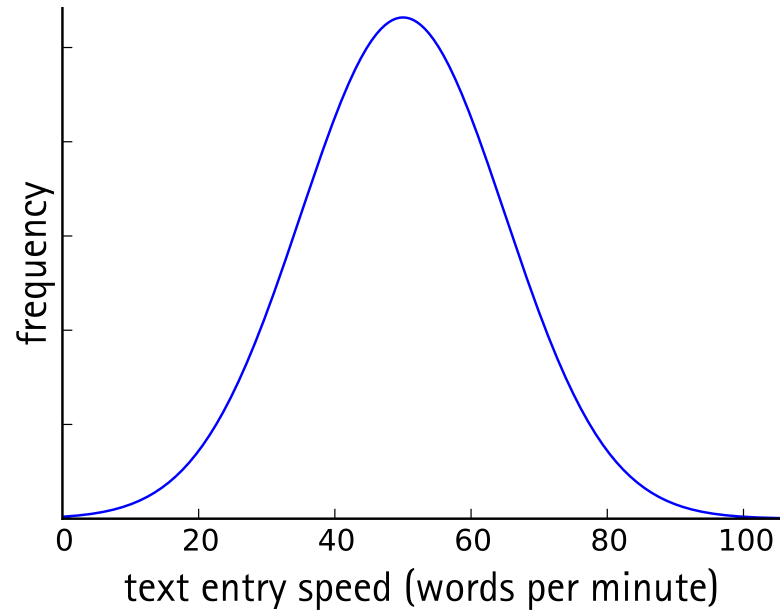
Human Performance

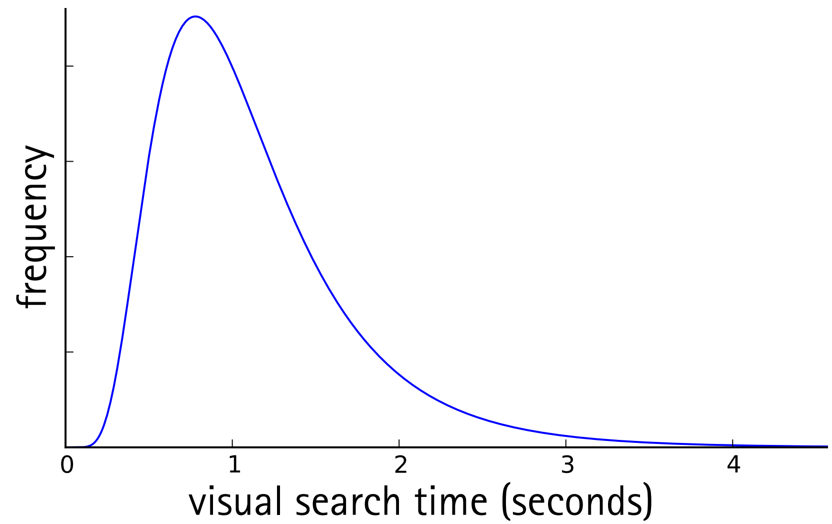
- Speed and accuracy when performing a goal-directed task
- Speed-accuracy tradeoff
  - Faster → errors increase
  - Slower → accuracy improves
  - Relative importance depends on task and context
- HCI typically requires high speed and low error rate
- Speed and accuracy might also be traded for cognitive resources
  - "Sloppy" execution of a task, other task



Human Performance

- Performance varies even if task is constant
  - For repeated measurements of one person
  - For one person in different states (relaxed, stressed, excited, tired)
  - For different people
  - For different contexts
- Distributions of performance
  - Symmetric around a center
  - Or "skewed" in one direction



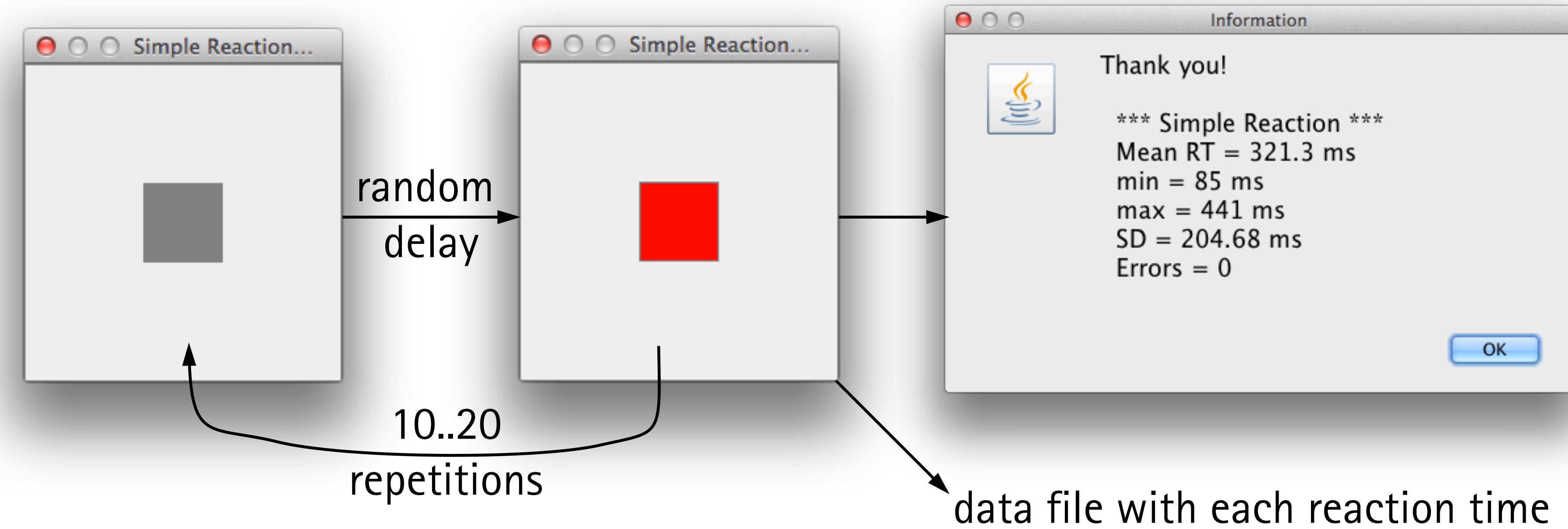


Simple Reaction Time

- Delay between stimulus and user's response
  - Example: Pressing a button in response to a light
- Stimulus modalities
  - Auditory stimulus: Phone rings
  - Visual stimulus: Traffic light
- Reaction times depend on stimulus modality
  - Auditory stimulus (e.g., phone rings): 150 ms
  - Visual stimulus (e.g., traffic light): 200 ms
  - Pain: 700 ms
- Reaction time in sports
  - 100 m dash: False start if reaction time < 100 ms

Simple Reaction Time

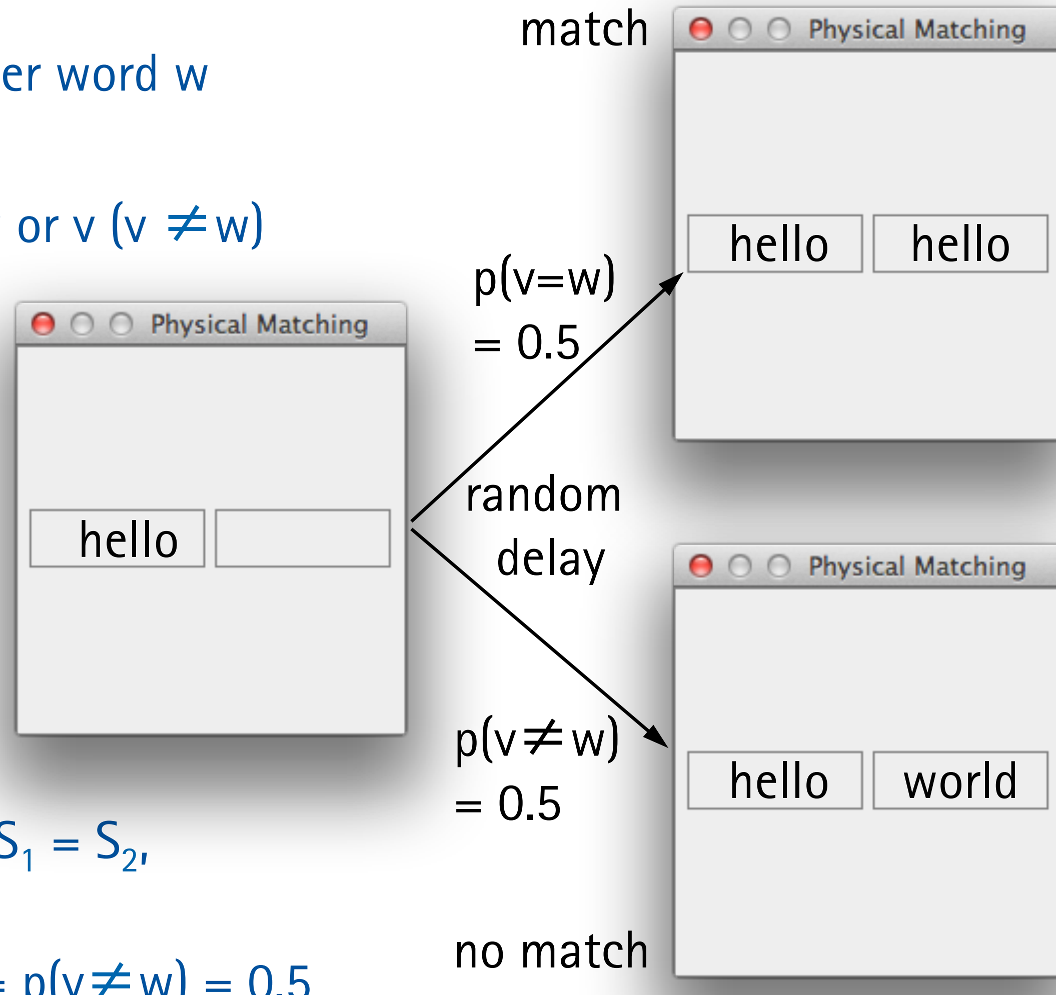
- Java test application (Stud.IP, modified from MacKenzie, http://www.yorku.ca/mack/HCIbook/)
  - java ReactionTimeExperiment



- Press key as quickly as possible after red box appears

Physical Matching

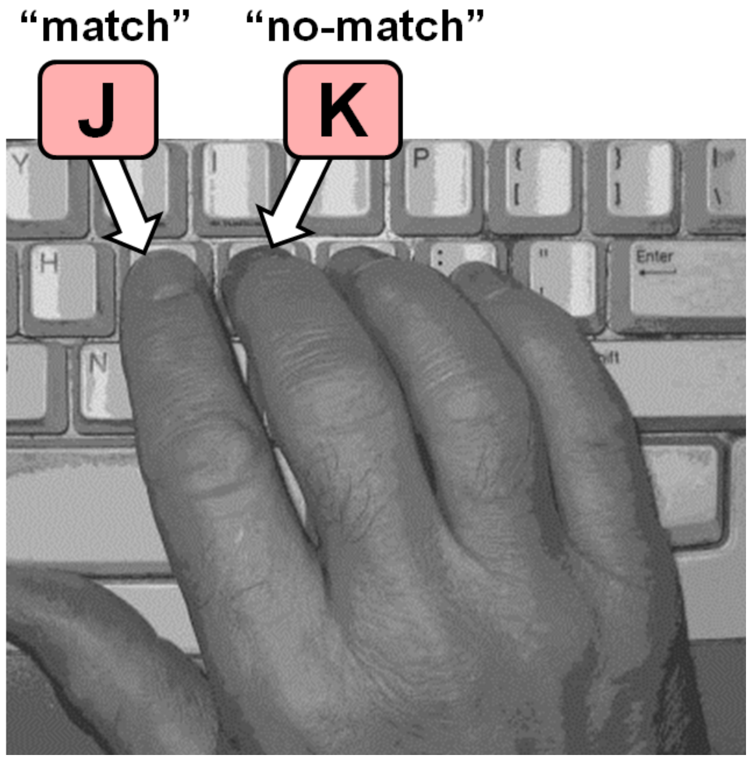
- Stimulus 1: five-letter word w
- Random delay
- Stimulus 2: either w or v ($v \neq w$)



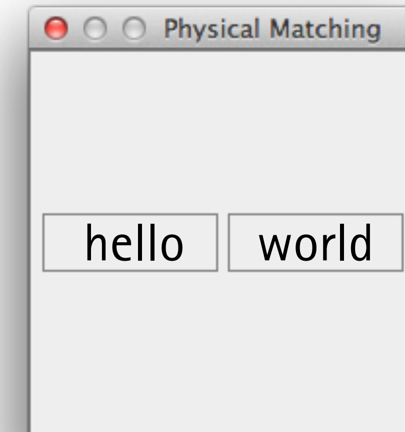
- User presses key_1 if $S_1 = S_2$, else presses key_2
- Probability $p(v=w) = p(v \neq w) = 0.5$

Physical Matching Experiment

match



no match



Physical Matching

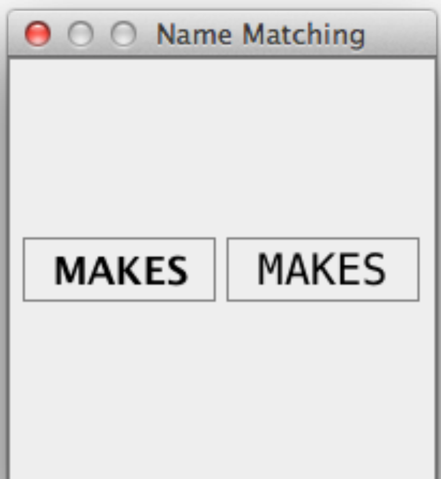
- Example for physical matching in HCI
  - T9 text input:
    compare suggested word to intended word,
    press '0' to accept,
    press '*' to see next suggestion

- Perception, cognition, and motor response more complicated than for simple response experiment
  - Perception: red box vs. two words
  - Cognition: recognize red box vs. compare words and decide
  - Motor response: move either index or middle finger
- Increased difficulty measurable as longer response time

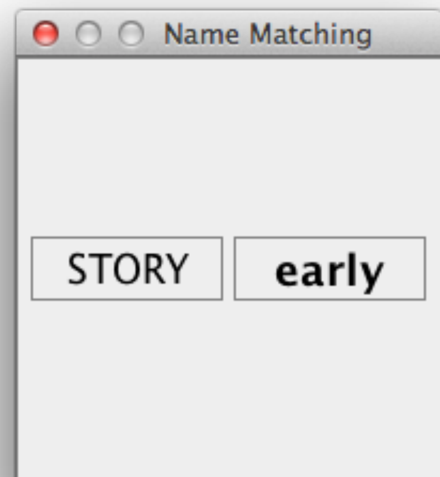
Name Matching

- Same as physical matching (match iff v = w),
  except that appearance of second stimulus is different
  - UPPERCASE or lowercase, plain or **bold**, 18 or 20 point, etc.
- Cognitive demand is higher, because of appearance differences need to be decoded before symbolic comparison

match



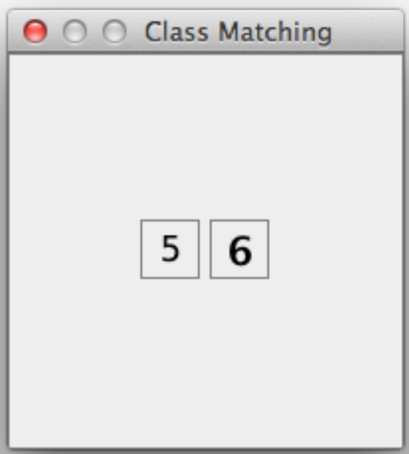
no match



Class Matching

- Stimulus 1: letter or digit (exclude ‘O’, ‘0’, ‘I’, ‘1’)
- Stimulus 2: letter or digit (exclude ‘O’, ‘0’, ‘I’, ‘1’)
- As in name matching there may be appearance differences
- Match if both stimuli are letters or if both are digits (same class)
- Cognitive demand is higher than for name matching, because consultations of long-term memory required

match



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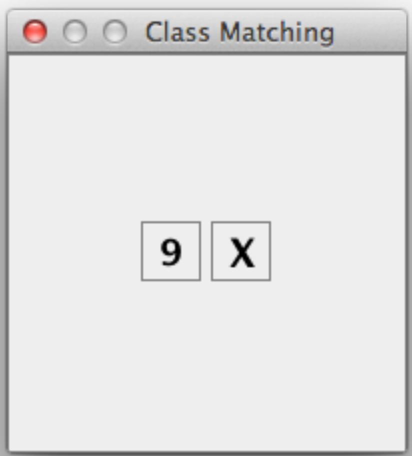
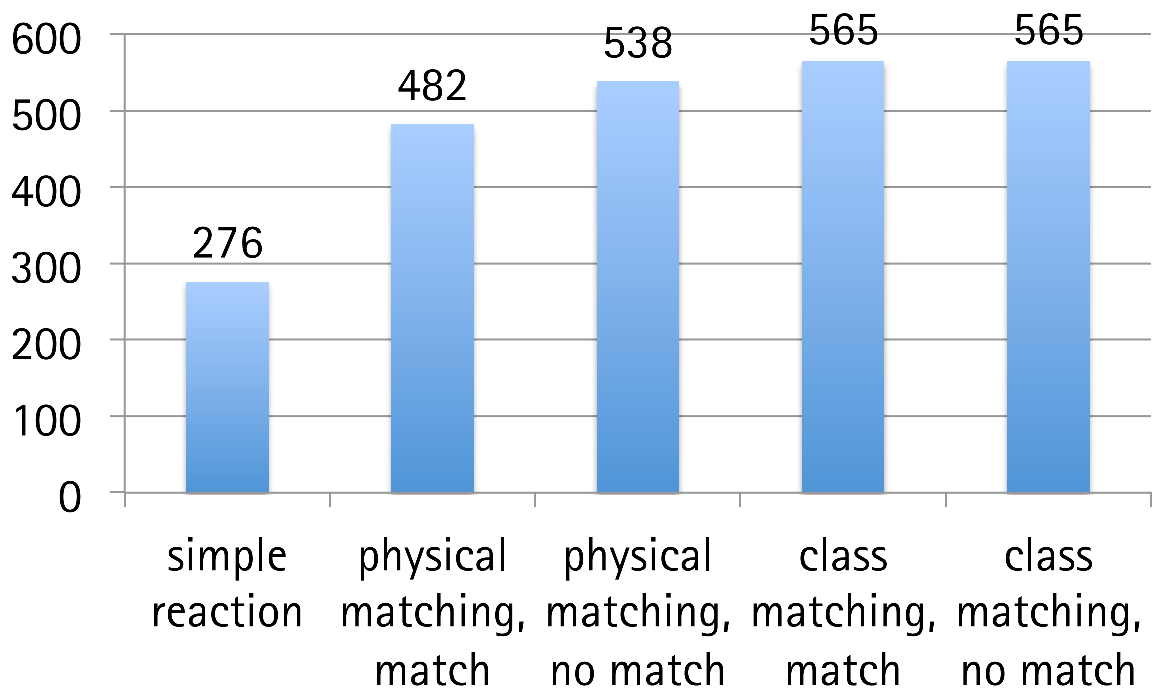


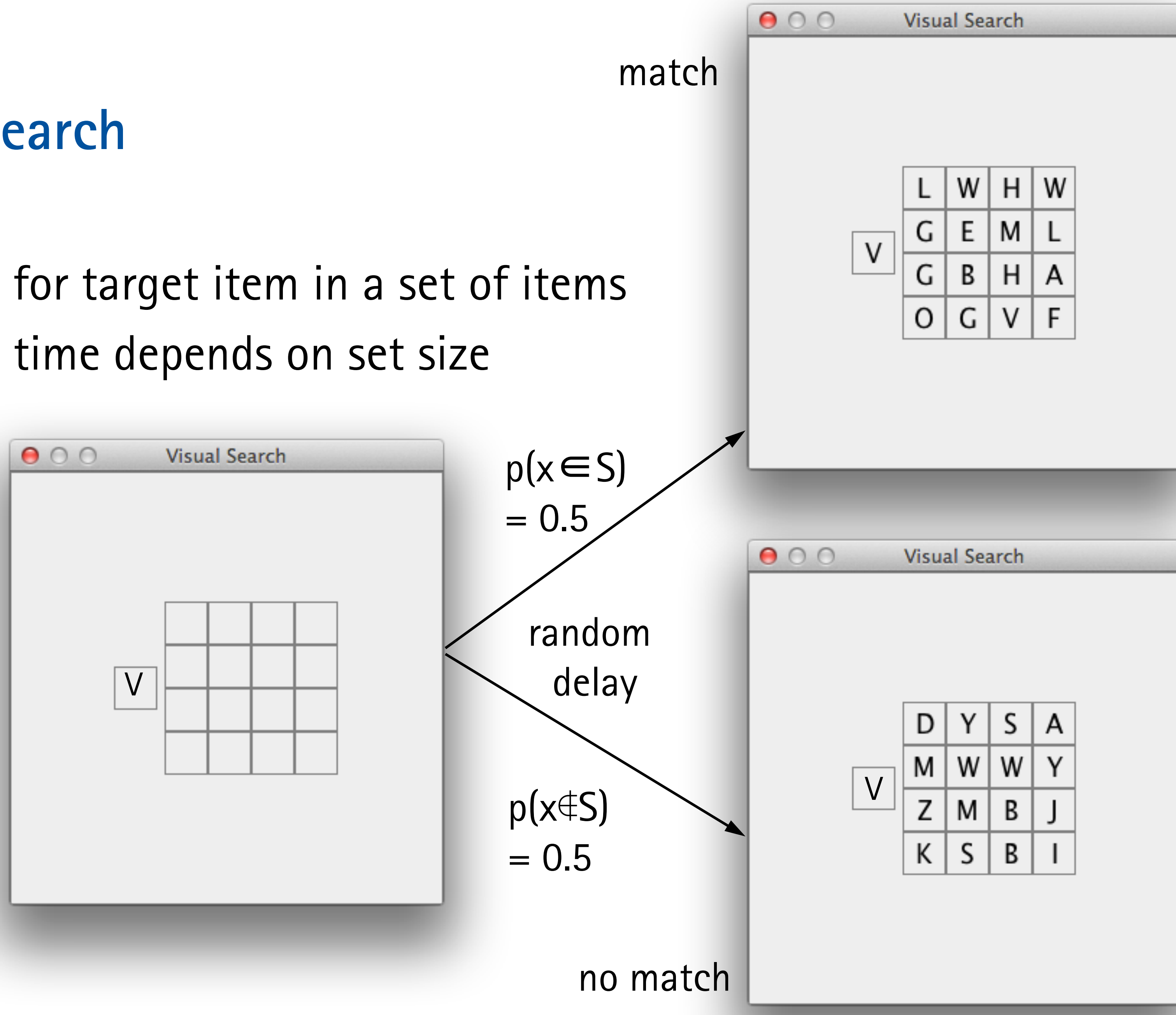
Results of Experiment on Reaction Tasks (MacKenzie)

- 14 students
- 3 blocks of 10 trials each (1st block practice)
- 2 orders (simple, physical, name, class)
- Mean times
  - Simple reaction: 276 ms
  - Physical matching: 482 ms (match) 538 ms (no match)
  - Class matching: 565 ms (mach) 565 ms (no match)



Visual Search

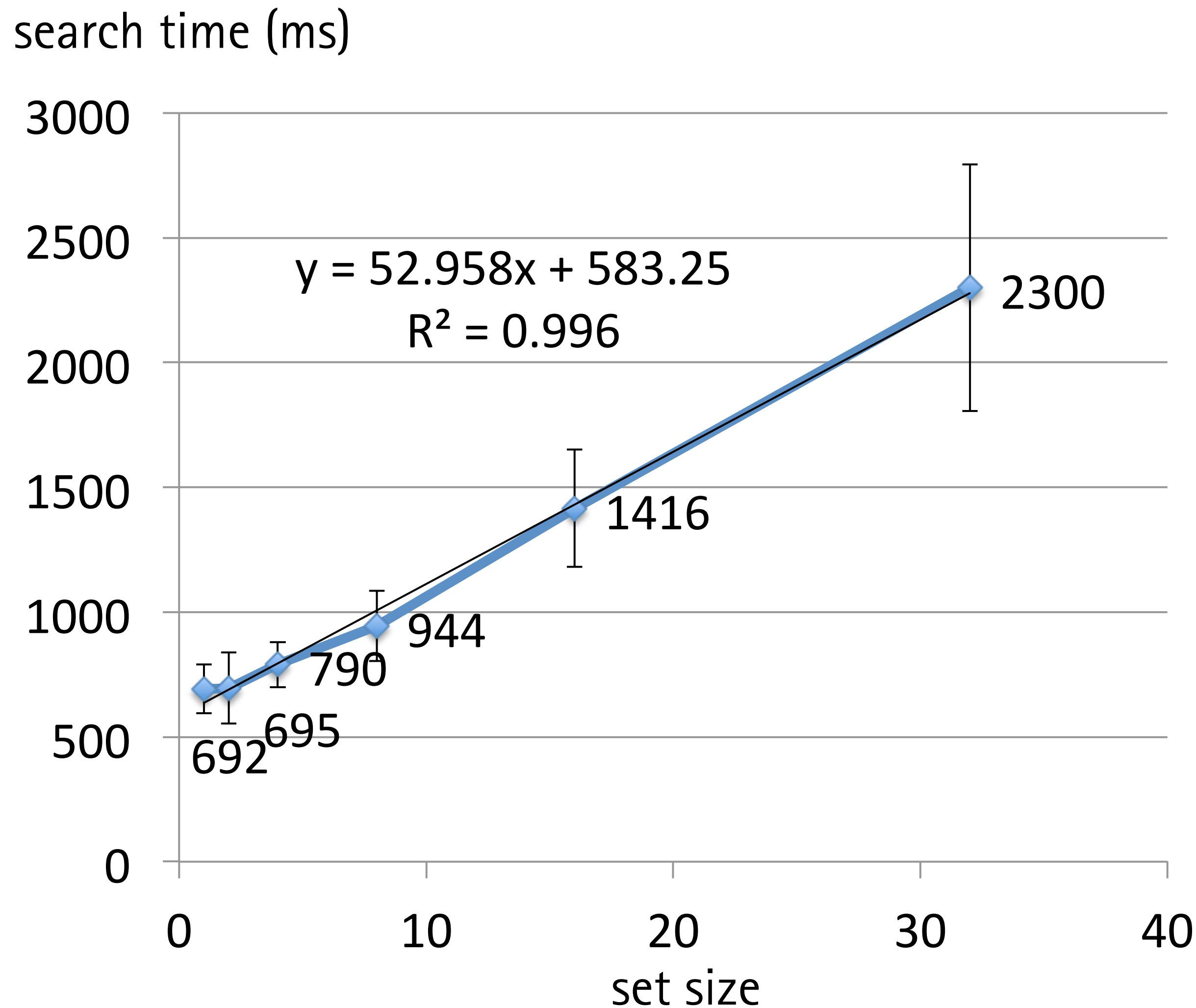
- Search for target item in a set of items
- Search time depends on set size



Visual Search

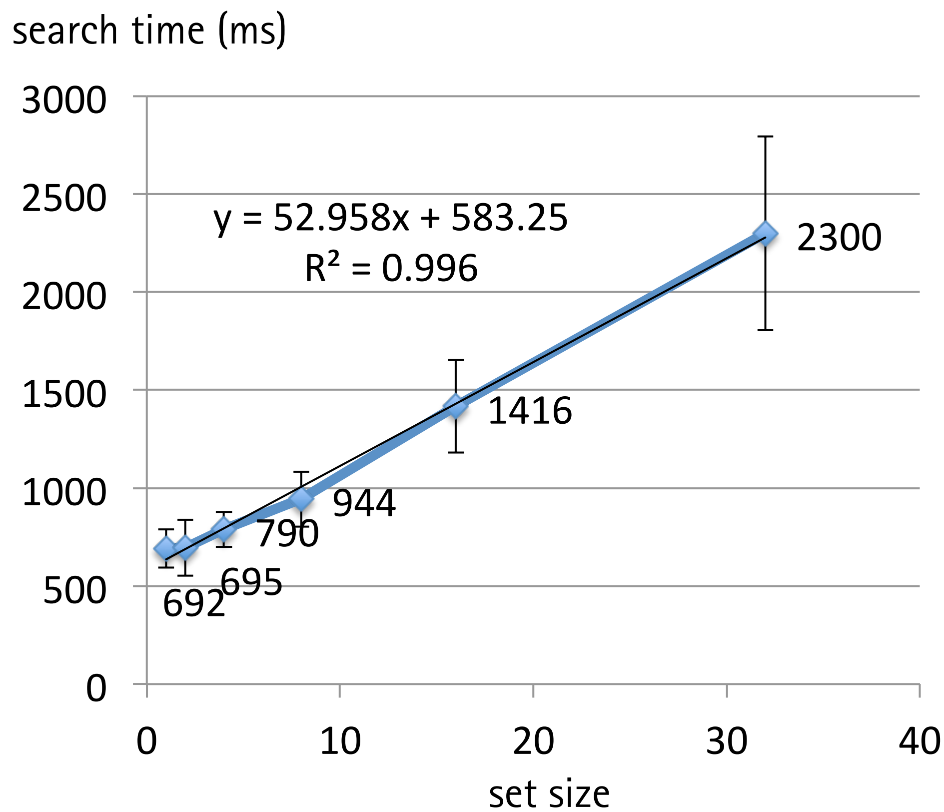
- 1 person
- 20 repetitions
- Set sizes
  1, 2, 4, 8, 16, 32

- Vertical bars are 95% confidence intervals



Visual Search

- Linear relationship between number of items and search time
  - $t = 52.958\ n + 583.25$ (ms)
  - $R^2 = 0.996$ means that the fit is very good
- Relevance to HCI
  - Menu selection
  - POIs on a map
  - Icons in a folder
  - etc.

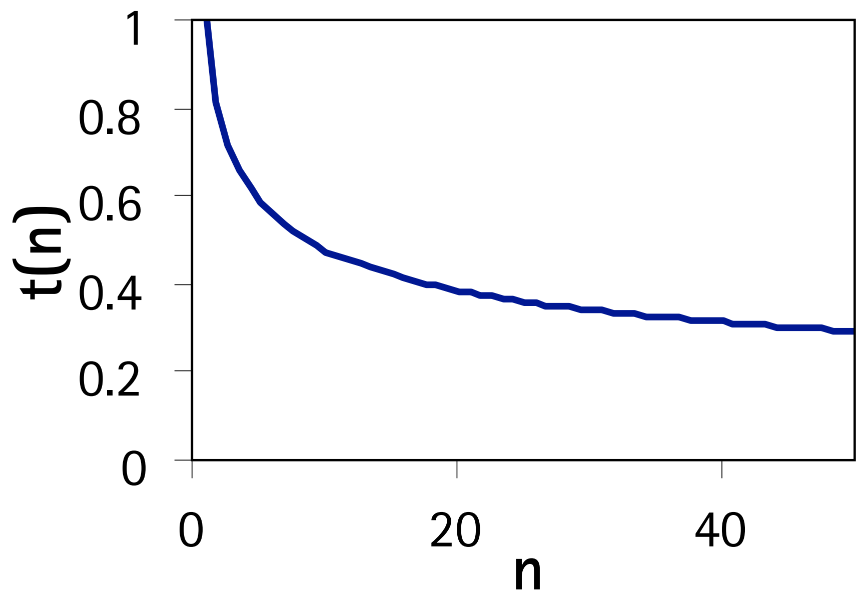


Skilled Behavior

- Reaction experiments: Stimulus-response behavior, simple cognitive operation, simple motor response
- Complex activities improve with practice → learning
  - Examples: Playing computer games, programming
- Skilled behavior
  - Sensory-motor skills
  - Mental skill
  - Often combination of these, example: surgery
- Evaluate skilled behavior through measurement
  - Reduction of task completion times with repetitions
  - Time unit: trial, block, session; minutes, hours, days, months, years
  - Longitudinal studies in HCI

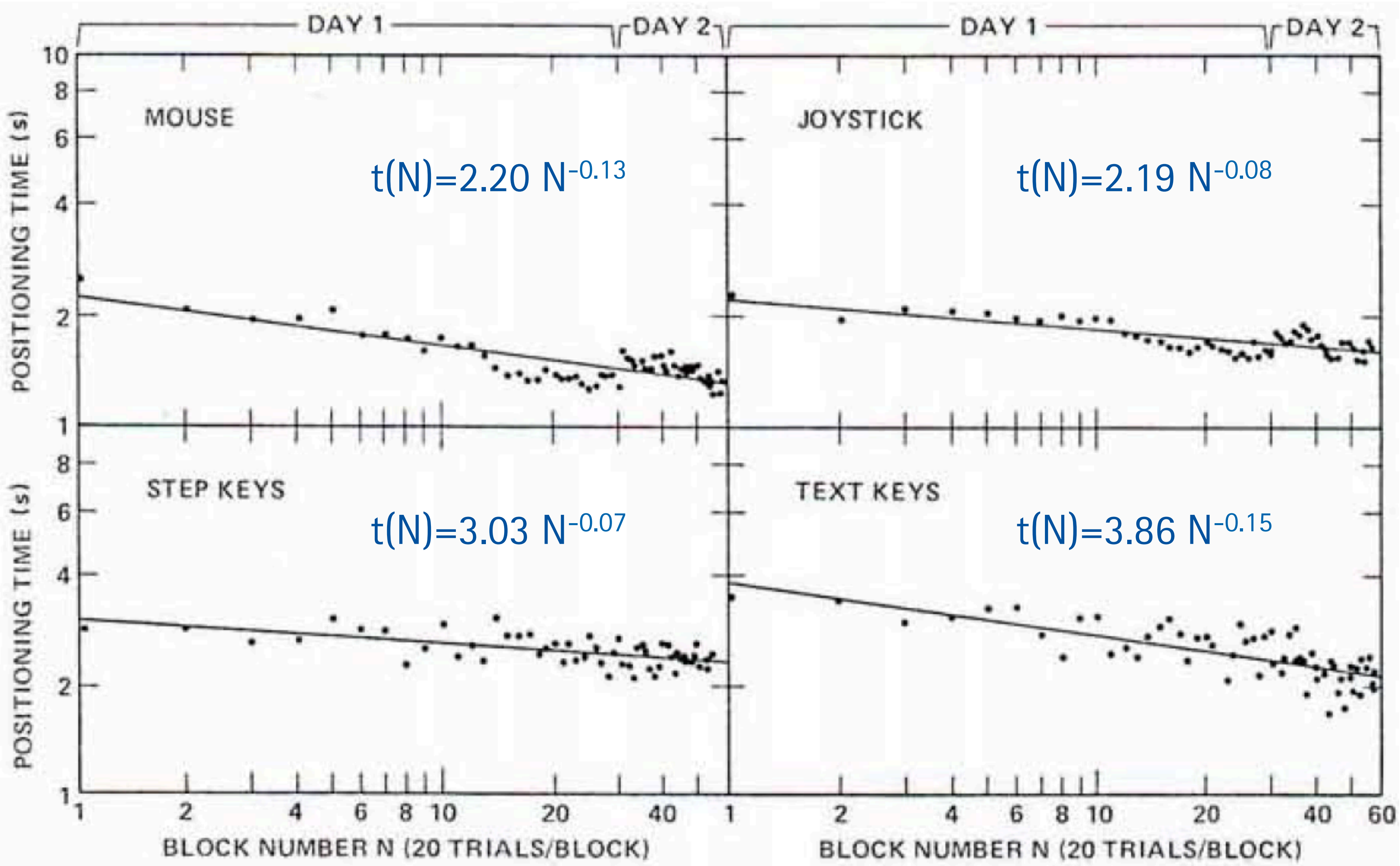
Power Law of Practice

- Relationship between experience and efficiency
- $t(n) = A + B\, n^{-a}$
  - t(n): expected time after n trials
  - A: theoretical lower bound
  - B: initial time
  - a: learning parameter
    typically $a \in [0.1, 0.6]$
- Does not consider effects of
  - Motivation
  - Fatigue (distribute practicing)
  - Pauses (1-2 minutes effective)



Skill	B	a
Visual search (1 target letter)	0.68	0.51
Visual search (10 target letters)	0.61	0.81
Cursor position with keys	3.03	0.07
Cursor position with mouse	2.20	0.13
Edit sentences	30.27	0.08

Learning Curves for Pointing Devices (Card et al., 1967)



Attention

- Performing multiple tasks simultaneously
  - Impossible if they both require conscious control
    - Example: Texting while driving
  - Possible if they are automatic cognitive processes
    - Example: Talking while walking
- Short-term memory as place of cognitive processes
  - Conscious control of cognitive processes
    - Serial → "Tunnel of consciousness"
    - Examples: Multiply, read
  - Automatic cognitive processes
    - Parallel
    - Example: Automatic visual searching
- Study performance for tasks separately, then simultaneously

Divided Attention, Selected Attention

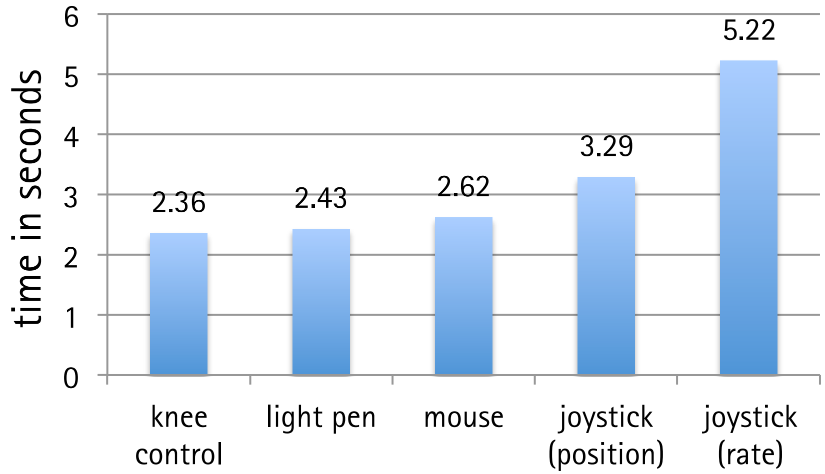
- Divided attention
  - Performing multiple tasks simultaneously
  - Example: Walking while talking
- Selected attention (aka focused attention)
  - Focus on one task while excluding others
  - Ignore extraneous events, focus on primary task
  - Example: Talk to someone in a noisy room
- Attention in HCI
  - Office environments, interruptions, task switching, decreased productivity
  - Very brief tasks in mobile interactions

Human Error

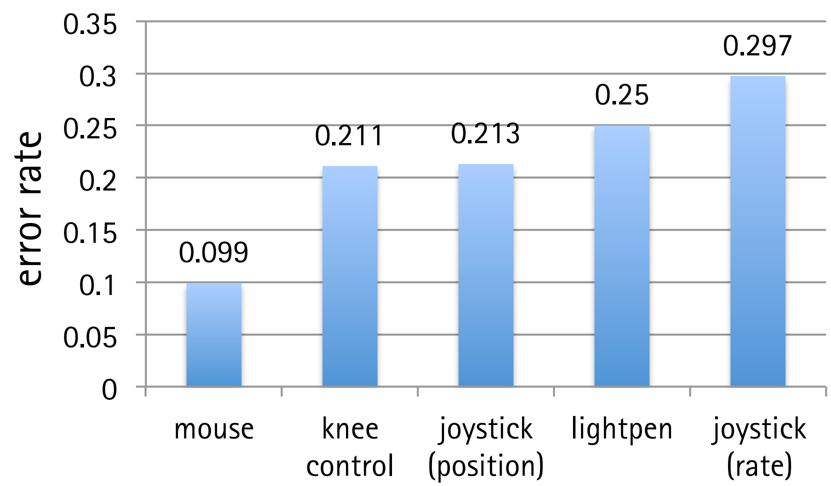
- Empirical view: Errors as a metric of performance
- Error: Incorrect trial, result deviates from desired outcome
  - Example: Target selection occurs outside the target
  - Example: Entered text contains spelling errors
- Error rate as ratio of incorrectly completed trials to all trials
- Analysis of why errors occur
  - Example: Input device? Gain setting? In final movement phase?
  - Example: Keys adjacent to correct keys? Keys too small?
  - External factors? Distractions? Readability?
- Insight often leads to improvement
  of input device or interaction technique

Empirical Research in Input Devices

- Task completion time
  - seconds



- Error rate
  - ratio of missed selections to all selections

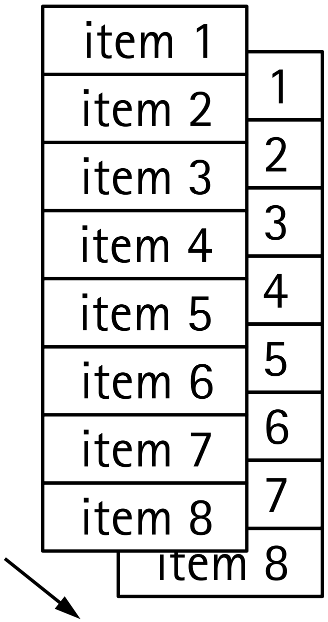


Data is from the first study on input devices: English, Engelbart, Berman. Display selection techniques for Text Manipulation. IEEE Trans. on Human Factors in Electronics. 1967.

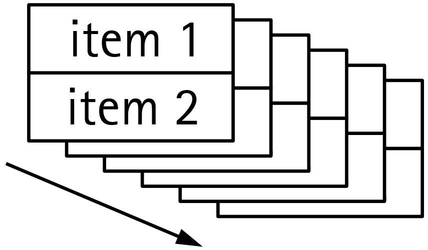
Empirical Research on Menu Design

- Breadth versus depth
- Example: 64 menu items

    - 8 items on each menu, 2 levels deep



    - 2 items on each menu, 6 levels deep



Empirical Research

- Discovering facts, theories, or laws by observation
- Raise and answer questions
  - About a new or existing UI design or interaction method
  - Statement of prediction (hypothesis) about expected outcome
- Observe and measure
  - Empirical evidence analyzed quantitatively (numbers) and qualitatively (categories)
  - Observations are gathered manually (human observers) automatically (computers, software, sensors, etc.)
- User studies, experiments
  - Artificial situations that seek to isolate the phenomena to be observed

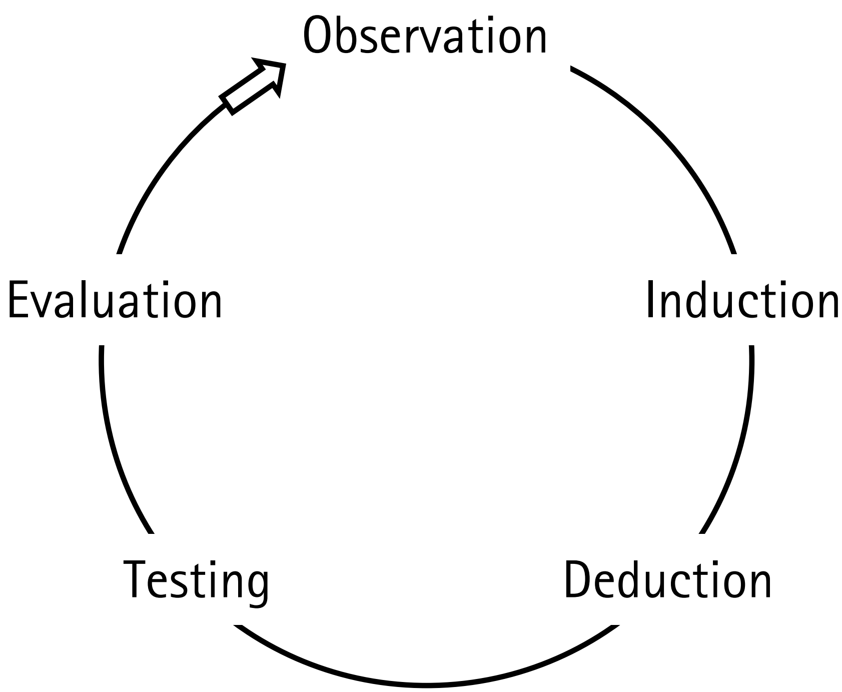
Research Questions

- Empirical research helps answering questions
  - About a new or existing UI design or interaction technique
- Example questions
  - Is it viable?
  - Is it as good as or better than current practice?
  - Which of several design alternatives is best?
  - What are its performance limits and capabilities?
  - What are its strengths and weaknesses?
  - Does it work well for novices, for experts?
  - How much practice is required to become proficient?

adapted from MacKenzie: Empirical Research in HCI: What? Why? How?

Empirical Cycle (de Groot)

- Observation
  - Gather and organize data
- Induction
  - Formulate hypothesis
- Deduction
  - Infer logical consequences and predictions from hypothesis
- Testing
  - Generate new data to check validity of predictions
- Evaluation
  - Evaluate and interpret the outcome of testing



(A. D. de Groot, Dutch chess master and psychologist)

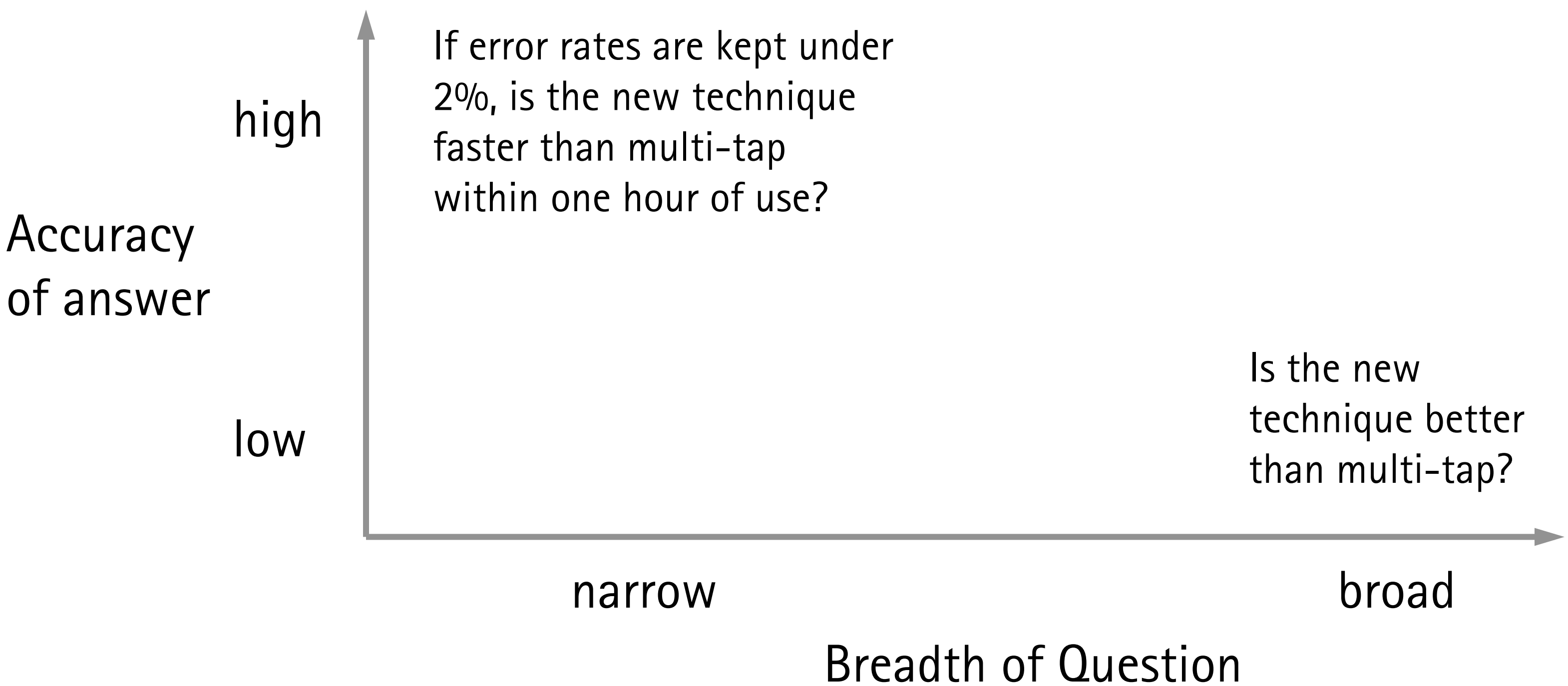
Deductive Reasoning

- Infer logical consequences from a set of premises
- Apply rules to facts to generate new facts
- If the premises of a rule are true and the rule is true, then the consequences are true
- Laws of deductive reasoning
  - Modus ponens: $P \Rightarrow Q$, P, therefore Q
  - Syllogism: $P \Rightarrow Q$, $Q \Rightarrow R$, therefore $P \Rightarrow R$
  - Modus tollens: $P \Rightarrow Q$, $\sim Q$, therefore $\sim P$
- Example
  - If John understood this book, he will get a good mark
  - John has understood this book
  - Therefore John will get a good mark

Inductive Reasoning

- Generalizing from a initial set of facts (examples, instances)
- Formulate probable consequences from the given evidence
- Result is plausible, but not proven, might be false
- Very common in everyday life
  - Many things are not absolutely sure, but only highly probable
  - We need to simplify by generalizing from limited experience
  - We can deal with exceptions
- Types of inductive reasoning
  - Generalization: Q% of sample has attribute A ⇒ Population has attribute A
  - Syllogism: Q% of population P has A, X is a member of P ⇒
    X has attribute A with probability Q%
  - Analogy: Shared properties of A and B ⇒ other properties of A also apply to B

Breadth-Accuracy Tradeoff



adapted from MacKenzie: Empirical Research in HCI: What? Why? How?

Scientific Method (classical view)

hypothesis = research question

phenomenon = an interaction between a human and a computer

1. Observe and describe a phenomenon
2. Formulate a hypothesis to explain it
3. Use the hypothesis to predict or describe other phenomena
4. Perform experiment to test the hypothesis

predict = predictive model
describe = descriptive model

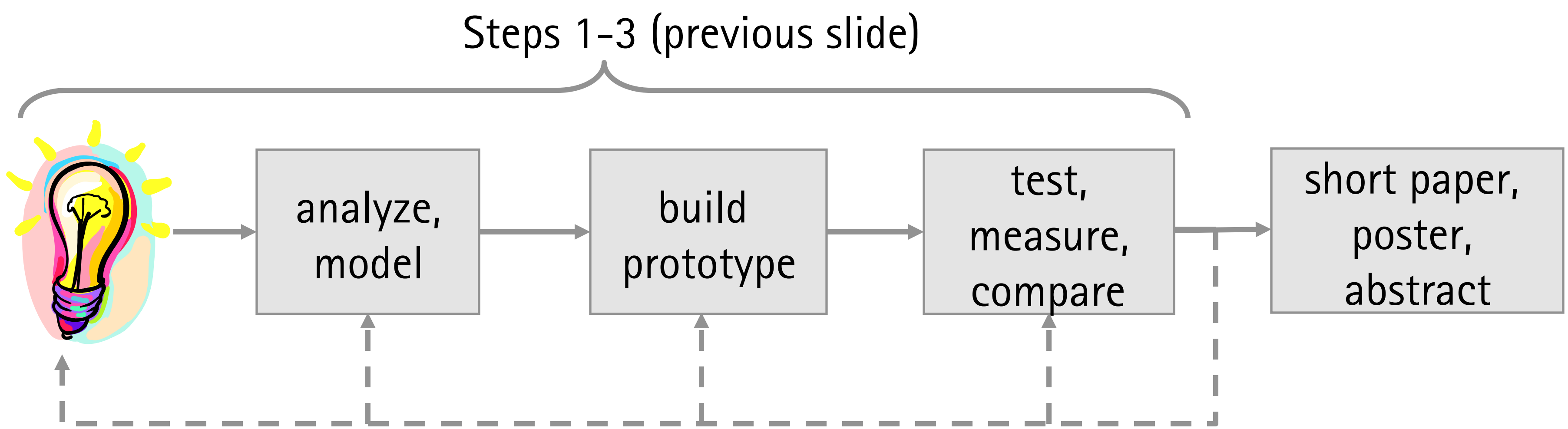
experiment = user study

Very nice, but what to researchers actually do?

adapted from MacKenzie: Empirical Research in HCI: What? Why? How?

Steps in Empirical Research

Phase I – The Prototype



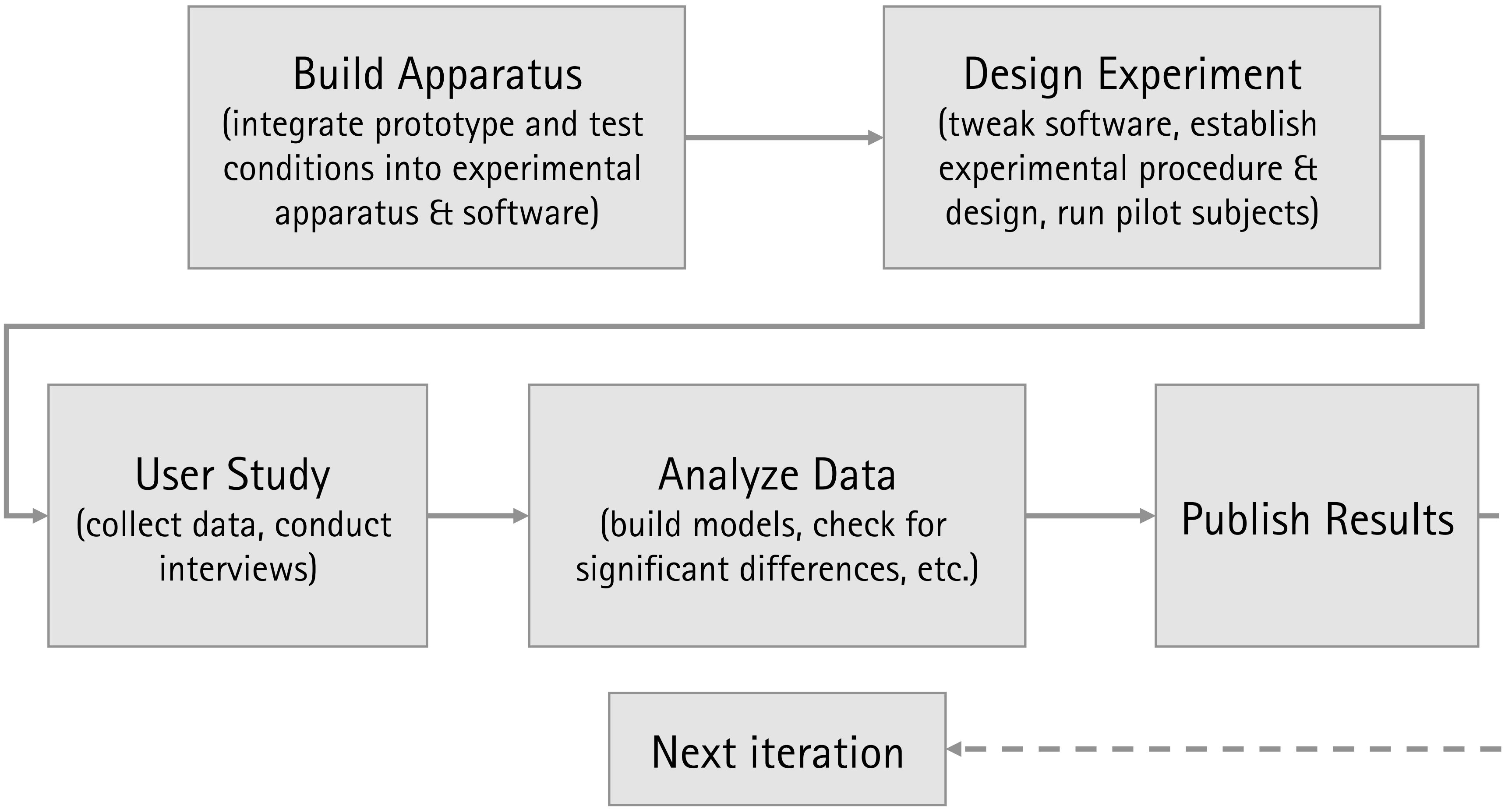
iterations are frequent, unstructured, intuitive, informed, ...

Research questions “take shape”, i.e., certain measurable aspects of the interaction suggest “test conditions” and “tasks” for empirical inquiry.

adapted from MacKenzie: Empirical Research in HCI: What? Why? How?

Steps in Empirical Research (2)

Phase II – The User Study



adapted from MacKenzie: Empirical Research in HCI: What? Why? How?

Summary

- Wide time scale of human action (focus on tasks of 0.1-10 sec)
- Interaction cycle (present - perceive - express - interpret)
- Human performance
  - Human input (eyes 180 MB/s, ears 144 kB/s, touch 250 B/s)
  - Human output (speech 14 B/s, 7.5 B/s, gestures/pointing)
  - Basic tasks (reactions, matching, visual search)
  - Practice and automation effects
  - Attention (divided, selected)
  - Performance metrics: time, error
- Empirical research
  - Optimize interfaces for human performance
  - Empirical cycle (observation, induction, deduction, testing, evaluation)