Lecture 24:

Toolkit support for Assistive and Accessible Interfaces; Web Accessibility

05-431/631 Software Structures for User Interfaces (SSUI)

Fall, 2021


HAPPY
thanksgiving

Logistics

- Happy Thanksgiving!
  - No class Thursday
  - No office hour tomorrow (Wednesday)

- 1 page project proposals due yesterday
- Meetings with me and Clara for next week (after Thanksgiving)
- Can everyone come to the last lecture for the presentations?

Disabilities

- Worldwide, more than 1 billion people experience some form of disability [World Health Organization, 2011]
- 19% of the U.S. population is disabled [U.S. Census Bureau, 2012]

Slide courtesy of Merrie Morris (Microsoft Research)

People With Disabilities

- People with Disabilities may have trouble with conventional interaction techniques
- Motor difficulties – difficulty with controlling mouse and keyboard
- Blind / low vision – difficulty with graphical interfaces
- Cognitive impairments and learning disabilities
  - Less focus on this area
  - Significant autism research, but mainly using computers in education or monitoring
- Deaf, etc. less of an issue
  - Still may benefit from computerized assistance, but usually can use conventional interaction techniques
  - Captioning on videos, etc.

"Assistive Technology"

- Wikipedia:
  - "Any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities"
- Includes fatter spoon handles, hearing aides, and screen readers
- "Accessibility software"
  - "Accessibility of a computer system to all people, regardless of disability or severity of impairment"

"Universal Design"

- One design works for everybody
  - Typical example: curb cuts
- "Situational Impairments"
  - Trying to type on Smartphone while walking
  - Trying to enter numbers without looking at a screen (e.g., while driving)
- Elderly
  - Less accuracy, lower vision, cognitive difficulties

Kinds of Physical Disabilities

- Cerebral Palsy
  - Result of brain damage to motor control parts of brain, often prenatally or as an infant
  - Doesn't get worse
  - Limited physical control
    - 58% have difficulties with communication
    - Often cannot talk or control their hands
  - Often, no affect on intelligence
    - 42% have problems with their vision
    - 23–56% have learning disabilities
  - 2.1 per 1,000 live births
  - Wide range of abilities

Kinds of Physical Disabilities, cont.

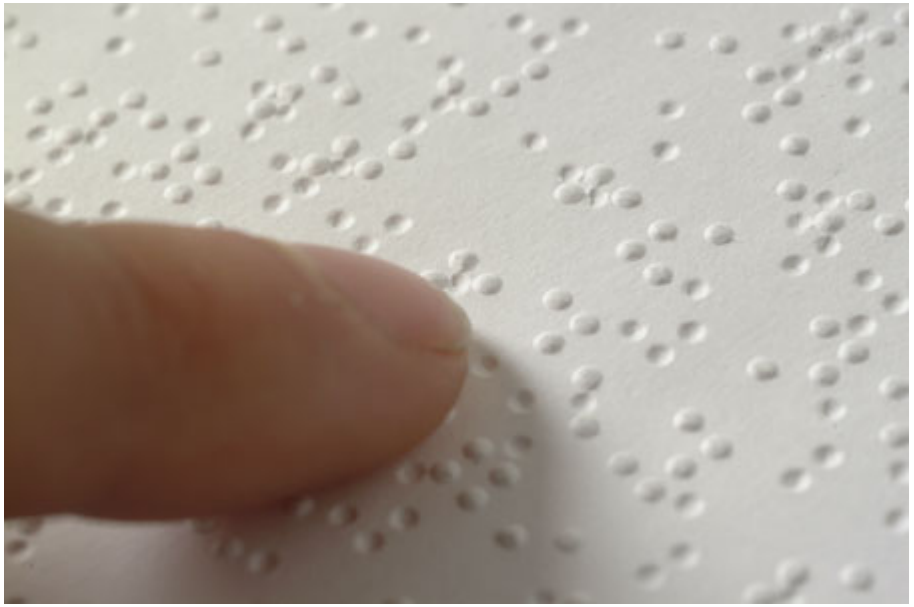
- Amyotrophic lateral sclerosis (ALS), Lou Gehrig's disease
- Affects about 30,000 Americans
  - 1.2-4.0 per 100,000 individuals in Caucasian populations
- Muscle weakness and atrophy throughout the body due to the degeneration of the upper and lower motor neurons
- Degenerative (gets worse)
- Lose ability to speak and move
- Eventually, may lose ability to eat and even breath
- Stephen Hawking, 1942-2018 (76)

Kinds of Physical Disabilities, cont.

- Parkinson's disease
  - Degenerative disorder of the central nervous system
  - Usually affects older people, usually after age 60
  - Shaking, rigidity, slowness of movement
  - About one million people in the United States
- Muscular Dystrophy (MD)
  - About one in every 4,000 newborn boys
  - Lose gross motor control while retaining fine motor control
  - Lose strength
- Many other physical disabilities and diseases
- Just being elderly
  - Reduced physical dexterity, eyesight, cognitive abilities, etc.

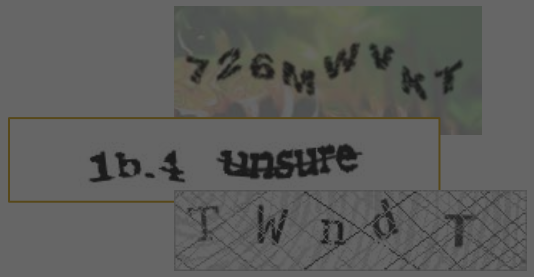
Blindness and Visual Disabilities

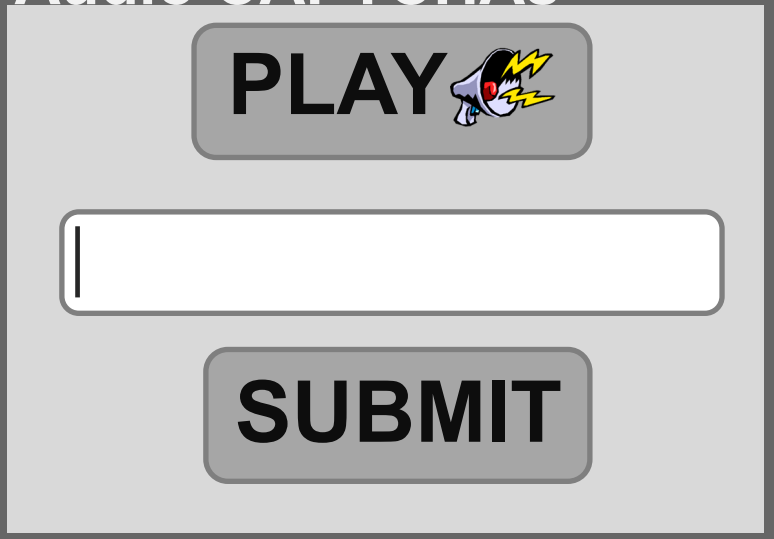
- Estimate that globally the number of people of all ages visually impaired is 285 million, of whom 39 million are blind.
  - (cite)
- Many levels
  - No vision from birth
  - Need magnification
  - Color blindness



Example: CAPTCHAs

- Hard for Computers/Easy for Humans
- Require vision





CAPTCHAs

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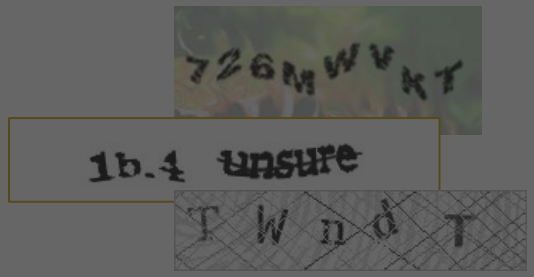
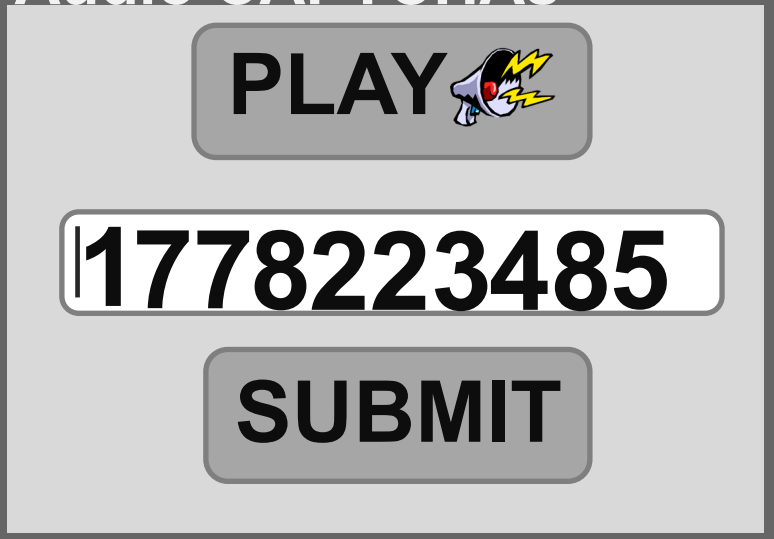
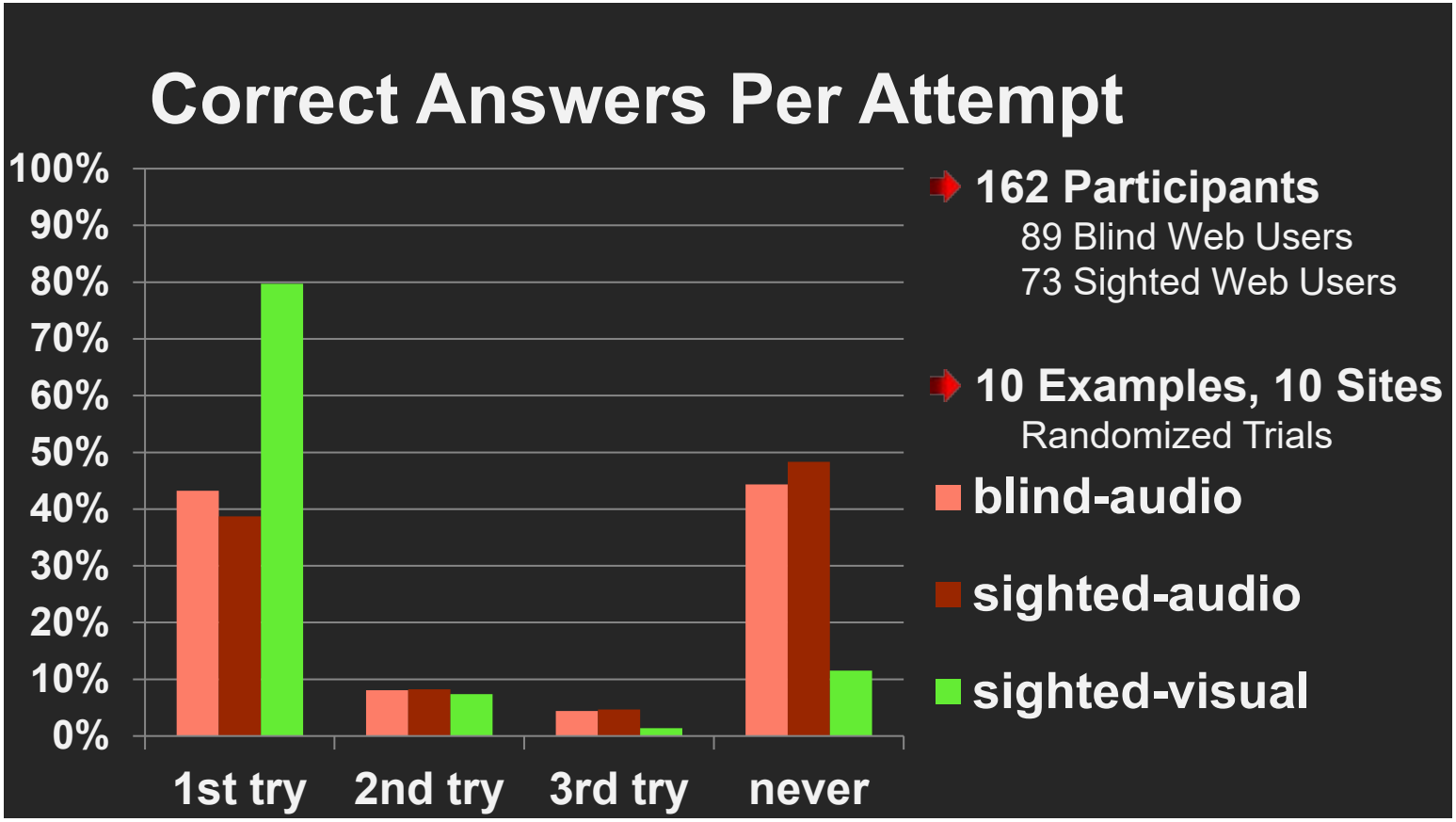


Audio CAPTCHAs



Study of Existing CAPTCHAs



Jeffrey P. Bigham and Anna C. Cavender. 2009. Evaluating existing audio CAPTCHAs and an interface optimized for non-visual use. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09). Association for Computing Machinery, New York, NY, USA, 1829–1838. DOI:https://doi.org/10.1145/1518701.1518983

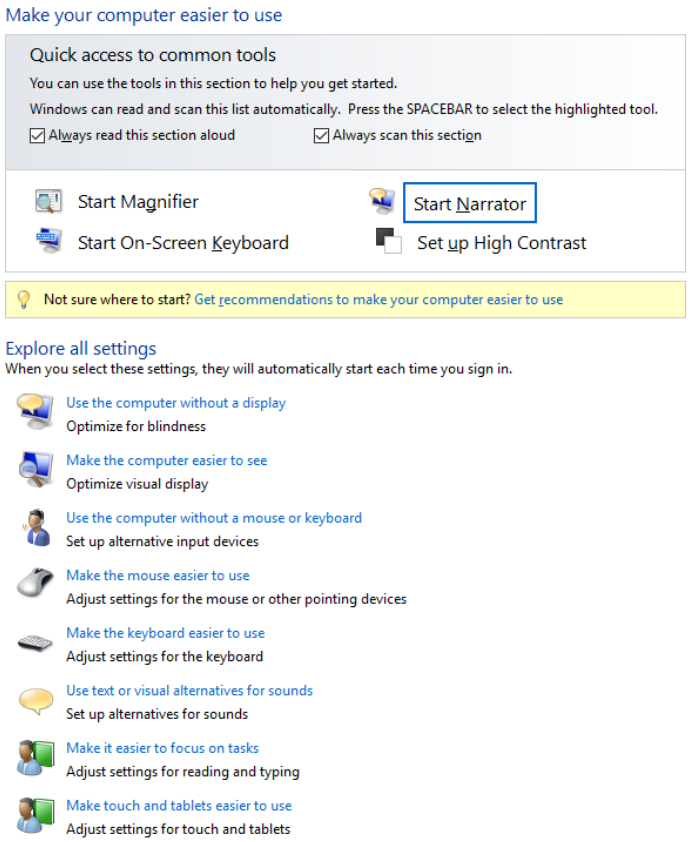
Recommendations and Laws

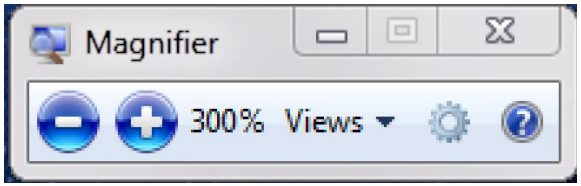
- Section 508 of the Rehabilitation Act mandates all federal agencies to purchase only accessible products and to provide information on the Web in a barrier-free manner
- Accessibility guidelines exist for the major operating systems and platforms

[Zimmermann & Vanderheiden 2008]

Assistive Technologies Built into OSs

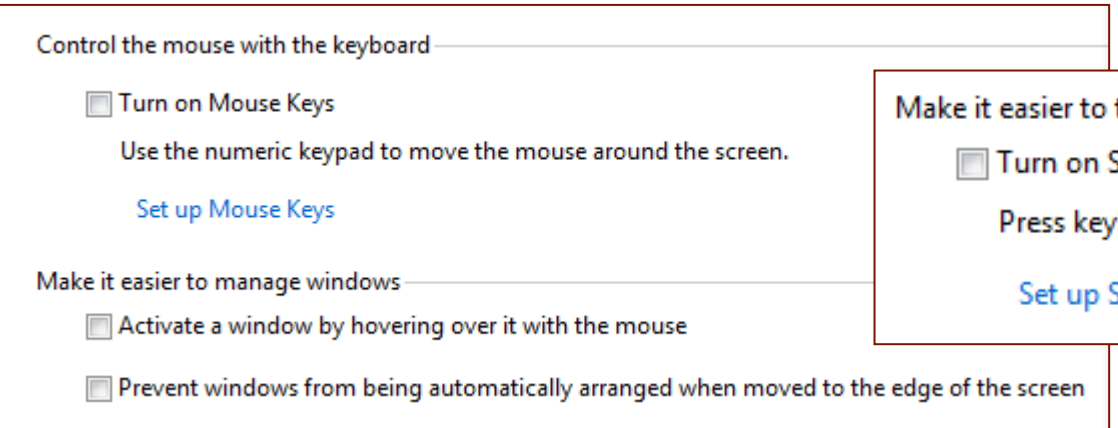
- Windows has a whole collection of adaptations
  - Accessories/Ease of Access
  - Magnifier – make whole screen or a portion bigger
    - Can also just use larger fonts, lower resolution
    - Change colors and contrast
  - Narrator – read words on screen
  - On-Screen keyboard
    - Can be scanned
  - Built-in speech recognition

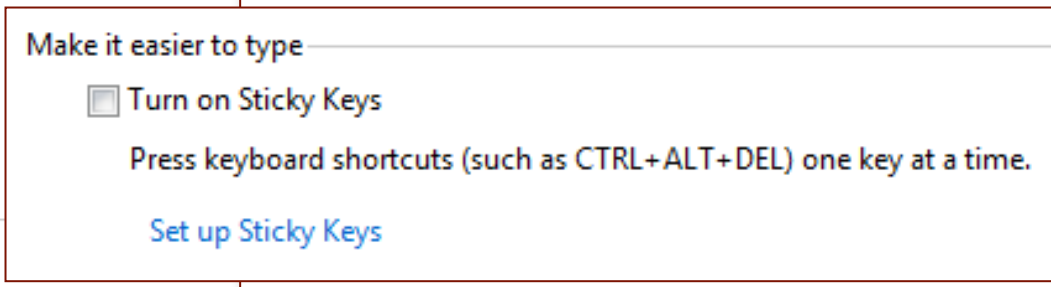




Assistive Technologies Built into OSs, cont

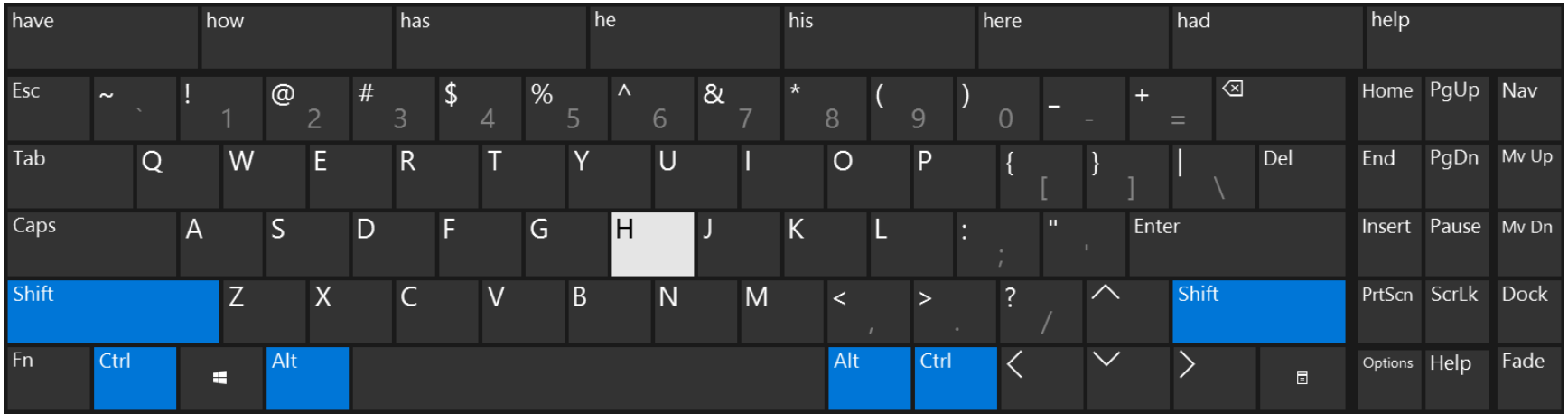
- Adaptations for mouse
  - Make mouse easier to see
  - Move mouse with the keyboard
- Adaptations for keyboard
  - Sticky Keys – so no need for chords
    - Work like on Smartphones





On Screen Keyboards

- Built-in or add-on
  - Usually add auto-complete and auto-predict
    - Auto-predict: Predict next word based on previous words with no letters typed
- Can point to on-screen keyboards with various mechanisms
  - Example: head tracking (*video 3:05*)
- Or use scanning keyboards
  - Sip and puff to select *(video 3:55)*

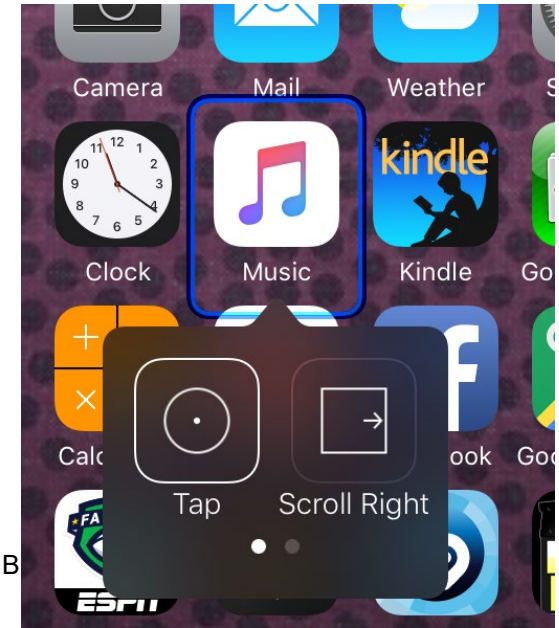


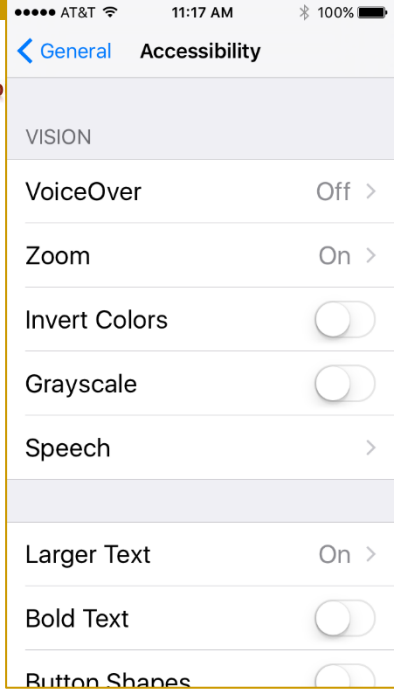
Screen Readers for the Blind

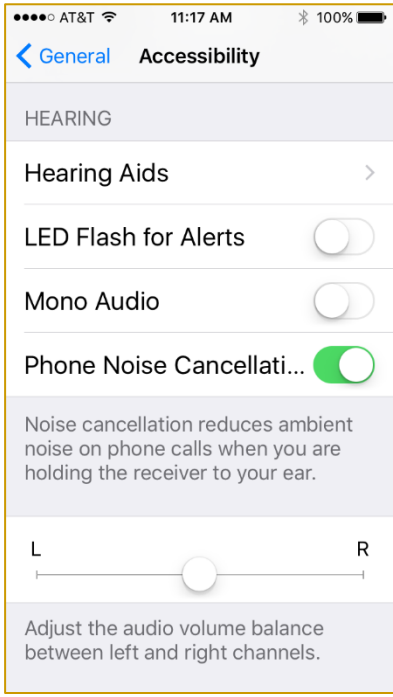
- Reads the words on the screen
- Keystroke to move to next area
- Blind people can operate them amazingly quickly
- JAWS – job access with speech
  - Example: *video 7:23*
- IBM Home Page Reader – by Chieko Asakawa from IBM Japan, visiting CMU

Assistive Technologies in iPhone

- Many pages of accessibility settings
- VoiceOver – reads what is on screen
- Zoom – screen magnifier – 3 finger tap
- Speech recognition for controlling device
- Closed captions on videos
- AssistiveTouch – so don't need multiple fingers, don't need to press Home button, etc.
- Switch Control
  – Scanning through items with optional connection to external switch
  - How to set it up with BlueTooth (video 7:14)
  - Can use head movement with built in camera (video 3:25)







Augmentative and Alternative Communication (AAC) devices

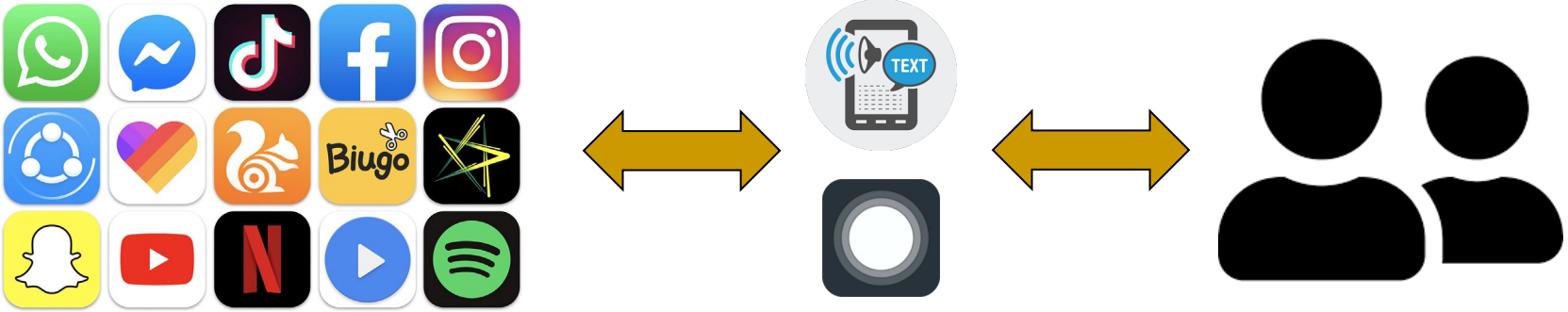
- Talk for people
- Originally were cardboard pictures that would point at
- Now computerized
- Custom devices or tablet applications
  - DynaVox *(Example in use - video 3:41)*
  - MinSpeak by Semantic Compaction
    - Both Pittsburgh companies!
- Usually pictures since faster than typing
- Pointing – head or eye tracking or scanning with switch (like keyboards)

Web Accessibility

- http://www.w3.org/WAI/intro/accessibility.php
- Original web was a real boon to handicapped
  - All text, easily navigated, provided access to: “education, employment, government, commerce, health care, recreation, and more”
- Then it got more complicated and inaccessible
- Standards and requirements emerged to help
- Includes:
  - Using appropriate html standards, e.g., <h3>, not <b>
  - “Alt” labels for pictures
  - Easy distinguishing between content and navigation
    - Link at top that goes directly to content for screen readers
  - Clearly marked links to multi-media content, etc.
  - … *many more*
- *But most web sites still have accessibility problems*

Accessibility in Mobile UI

Assistive technology: assuming an immutable environment. “non-standard” users use assistive technology to access the system (e.g., stair lifts)



Regular Mobile Apps

Accessibility Tools
(e.g., screen readers,
assistive touch tools)

Thanks to
Toby Li for
these slides!

Accessibility in Mobile UI

Assistive technology: assuming an immutable environment. “non-standard” users use assistive technology to access the system (e.g., stair lifts)

Universal design/Design for all (Shneiderman 2000): “one size fit all” solution – the same system design should be usable by everyone (e.g., ramps instead of stairs)

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Universal design/Design for all (Shneiderman 2000): “one size fit all” solution – the same system design should be usable by everyone (e.g., ramps instead of stairs)

Ability based design (Wobbrock 2011): the system identifies the user’s abilities and automatically adapt to them (e.g., soft keyboard that automatically corrects errors based on the perceived user motor impairments (Kane 2008), Android driving mode)

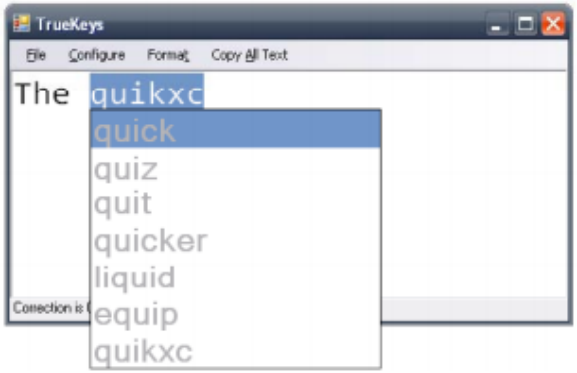
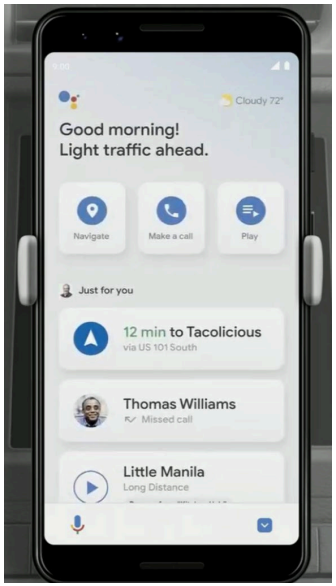
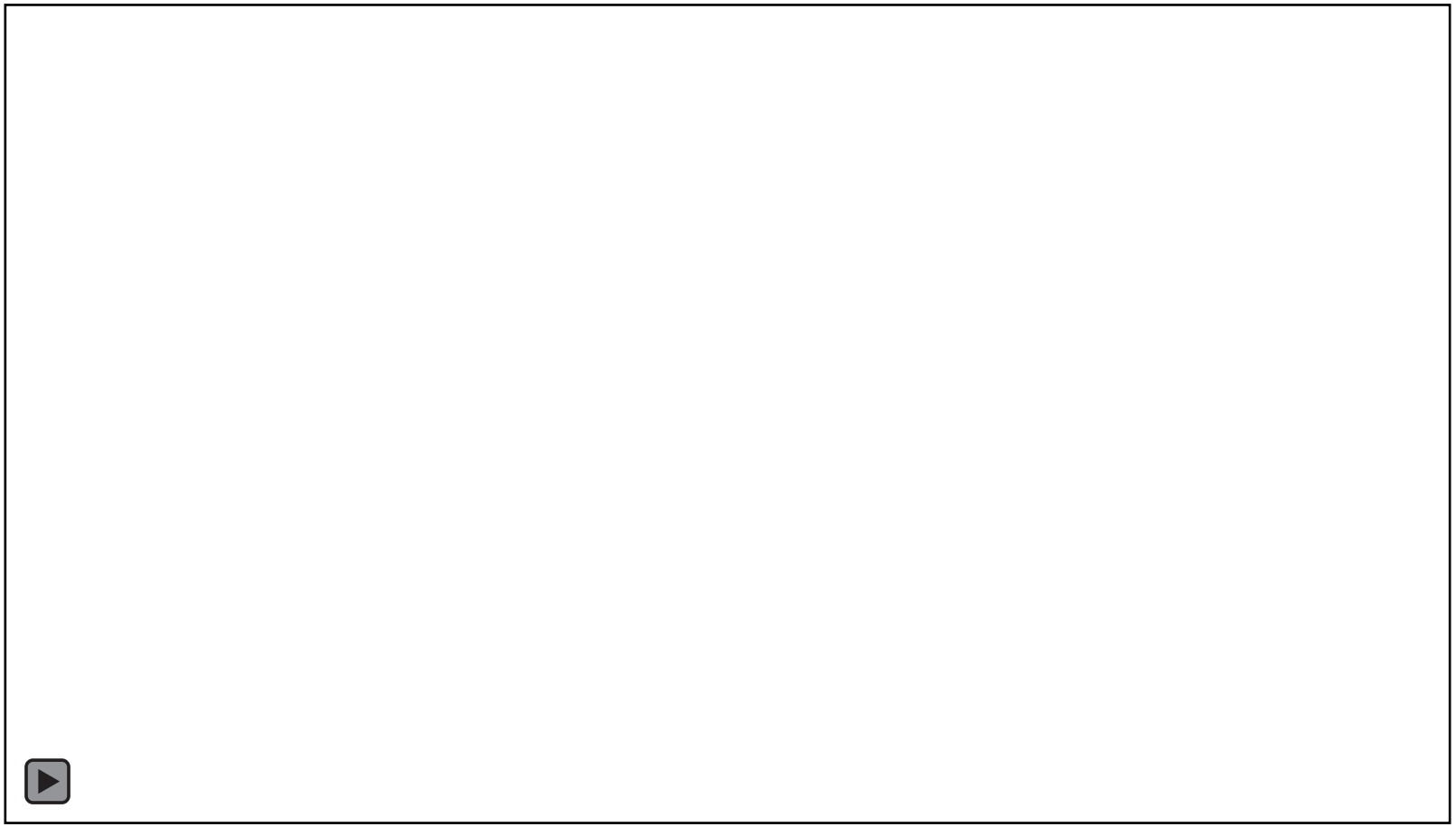


Figure 1. The TrueKeys user interface performing a correction from “quicxc” to “quick”.

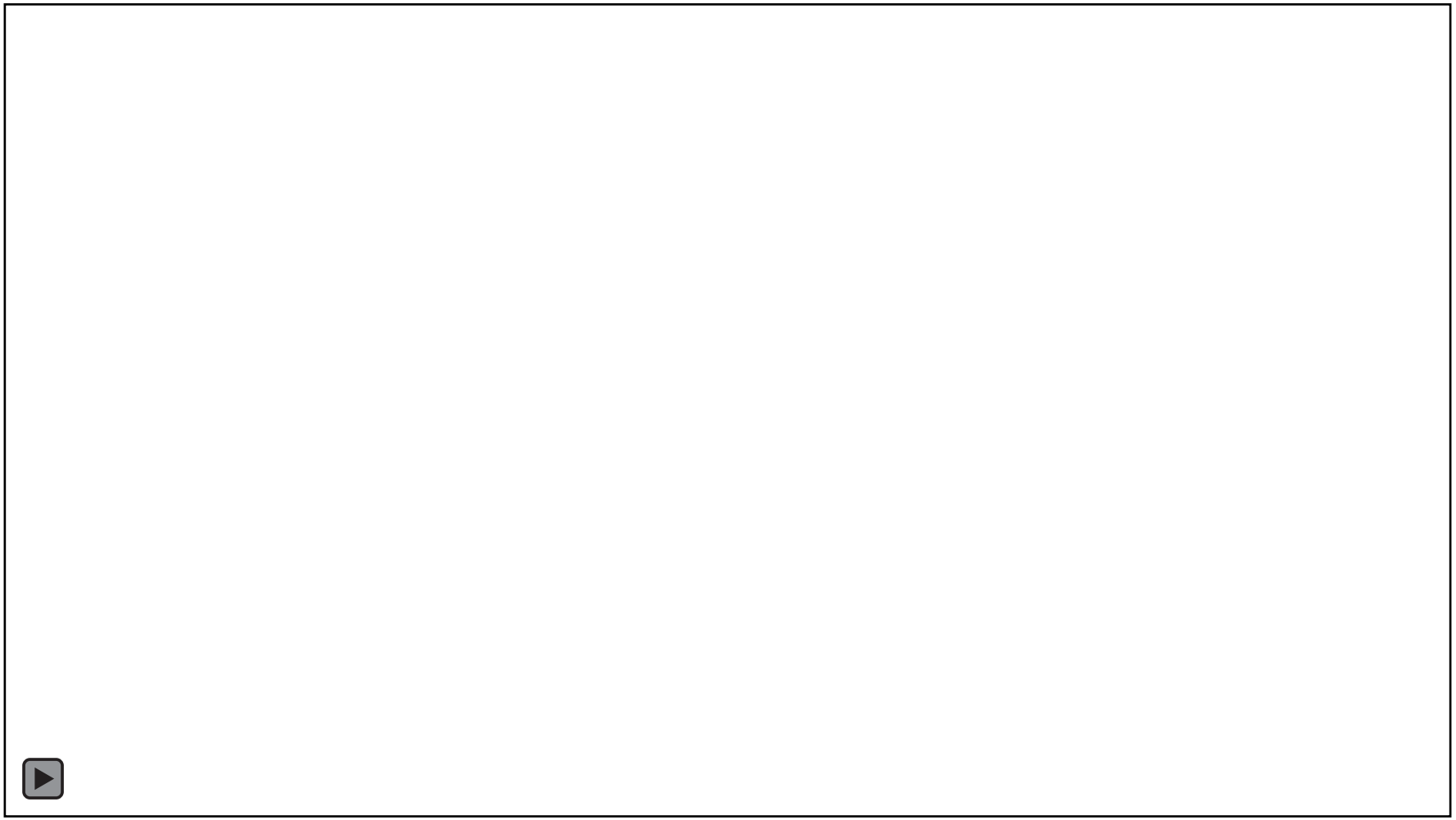


Accessibility in Mobile UI



Android Talkback + Touch Exploration

Accessibility in Mobile UI



Linear navigation – explore the screen one item at a time

Developing Accessible Apps - Android

That is, building your apps in a way that's friendly to assistive tools and providing necessary meta-data of your GUI.

- **Alt-text:** add content descriptions to all graphical widgets, the screen reader reads out the `contentDescription` field of all views. Set `contentDescription` to `null` for decorative elements so they are omitted by screen readers
- **Hierarchy:** organize your widgets in clear hierarchy so it's easier to navigate using assistive tools.
- **Set `focus order` for your widgets:** so important ones are read out first in linear navigation.
- Use **built-in** widgets (e.g., Button, Spinner) and event handler (e.g., onClick) instead of custom ones (e.g, onTouchDown + onTouchUp) whenever possible.
- If you use gestures/voice input/sensory input (such as tilting the phone) in your interface, the **same functionalities should also be available without using these modalities** for users who can't do them.

Developing Assistive Tools - Android

Android allows developers to build assistive tools by implementing an `AccessibilityService`

- Listening to events: can listen to events in the foreground UI such as VIEW_CLICKED, TEXT_CHANGED, WINDOW_CHANGED, WINDOW_CONTENT_CHANGED etc.
- For each event, the service can retrieve a hierarchical representation (similar to DOM tree) for all UI elements on the screen as well as their meta data (e.g., contentDescription, isClickable, isEditable, className)
- For each event, the service can also interact with UI elements on the screen on the user's behalf (e.g., CLICK, LONG_CLICK, SELECT, SET_TEXT).
- Usually, for each event, an assistive tool represents the event and the current state of the UI in an alternative way (e.g., read out, show a simplified interface) so the user can understand, solicit the user's intent on what to do in the current state in a way that corresponds to the user's ability (e.g., voice, gaze, trackball), and perform the action on the original UI on the user's behalf.
- Android accessibility guide: https://developer.android.com/guide/topics/ui/accessibility

Research

- *Lots* of current work on accessibility
- Annual 3-day conference: ASSETS'21
  - The 23rd International ACM SIGACCESS Conference on Computers and Accessibility
- But most not about tools / toolkit support

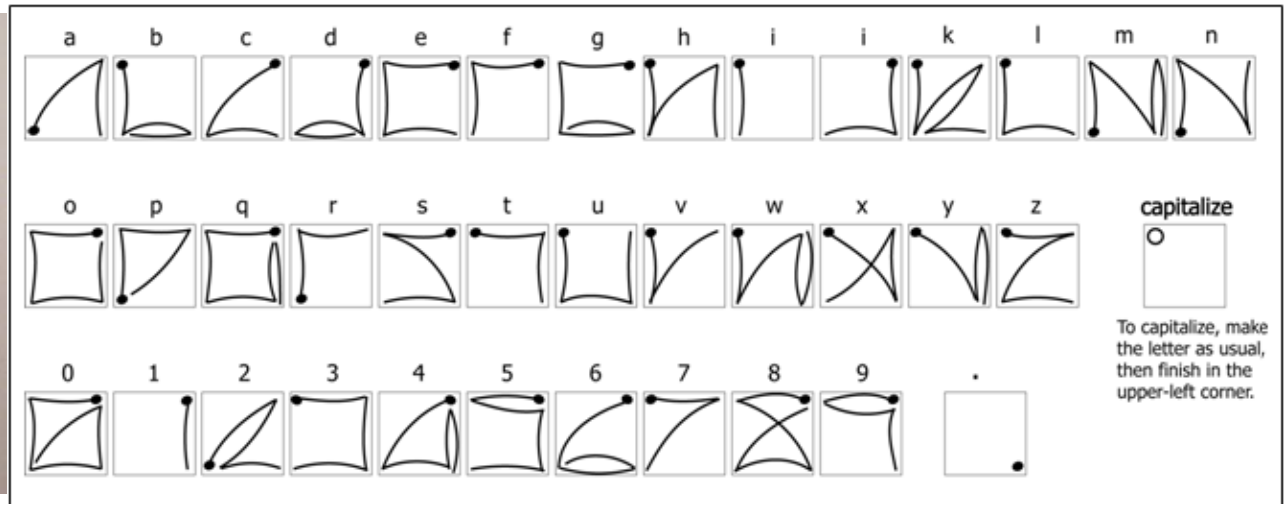
Research: RemoteCommander

- Brad A. Myers, Jacob O. Wobbrock, Sunny Yang, Brian Yeung, Jeffrey Nichols, and Robert Miller. "Using Handhelds to Help People with Motor Impairments", Fifth International ACM SIGCAPH Conference on Assistive Technologies; ASSETS 2002. July 8-10, 2002. Edinburgh, Scotland. pp. 89-96. http://www.cs.cmu.edu/~pebbles/papers/pebbleshandicapped.pdf

- We were researching using Palm Pilots to augment regular computers
- Pebbles Remote Commander allows the Palm to be mouse and keyboard for a PC
  - Found by a father of a 10-year old with Muscular Dystrophy (MD) and he wrote a testimonial
- Found some long cables & special long and lightweight stylus

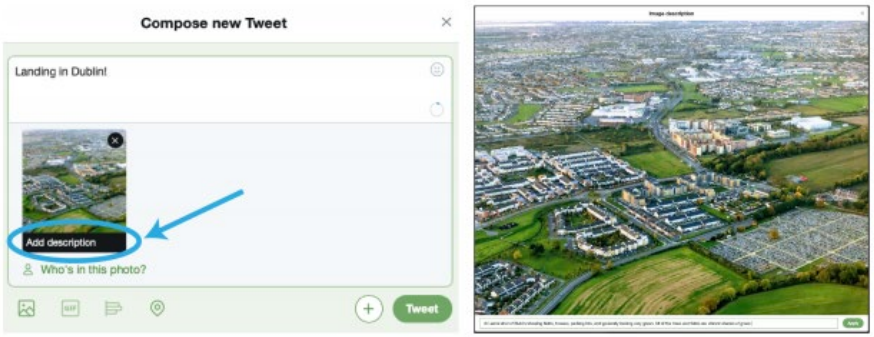
Research EdgeWrite

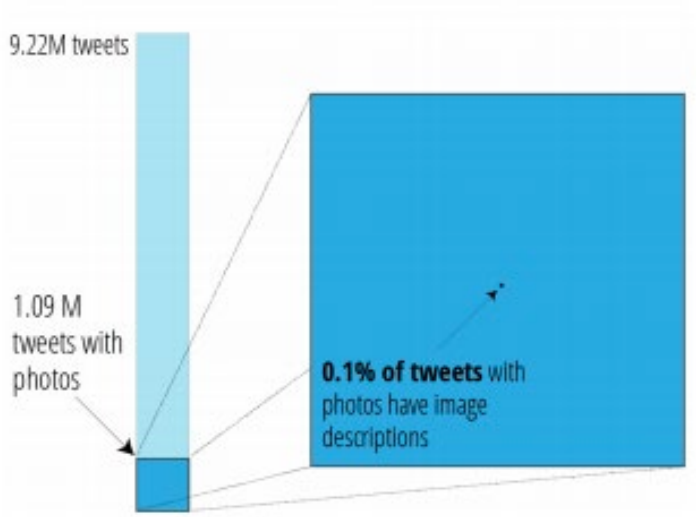
- Led to the EdgeWrite project for text entry
- Jacob O. Wobbrock, Brad A. Myers, and John A. Kembel. 2003. EdgeWrite: a stylus-based text entry method designed for high accuracy and stability of motion. In *Proceedings of the 16th annual ACM symposium on User interface software and technology* (UIST '03). ACM, pp. 61-70. http://dl.acm.org/citation.cfm?doid=964696.964703



"It's almost like they're trying to hide it": How User-Provided Image Descriptions Have Failed to Make Twitter Accessible

- Gleason, **Bigham**, et al. WWW 2019.





Other Resources

- CMU courses
  - Spring 2022: Patrick Carrington, 05-499B: "Accessibility"
  - Spring 2020: Divakaran Liginlal, 67-315 (IS): "A Web For Everyone"
  - Accessibility (S2015,F2017) by Jeff Bigham
- HCII Faculty
  - Jeff Bigham
    - E.g., crowdsourcing with iPhone for blind
  - Patrick Carrington
    - E.g., technology to help with wheelchairs
  - etc.