

Designing for Vision Impairments

Input, Interaction, and Accessibility
Spring 2019



This week

- **Monday**
 - Catchup on inclusive design perspective
 - Exploring vision accessibility
 - Time for project 1 (20 minutes)
- **Wednesday**
 - Test driving screen readers

An inclusive design perspective

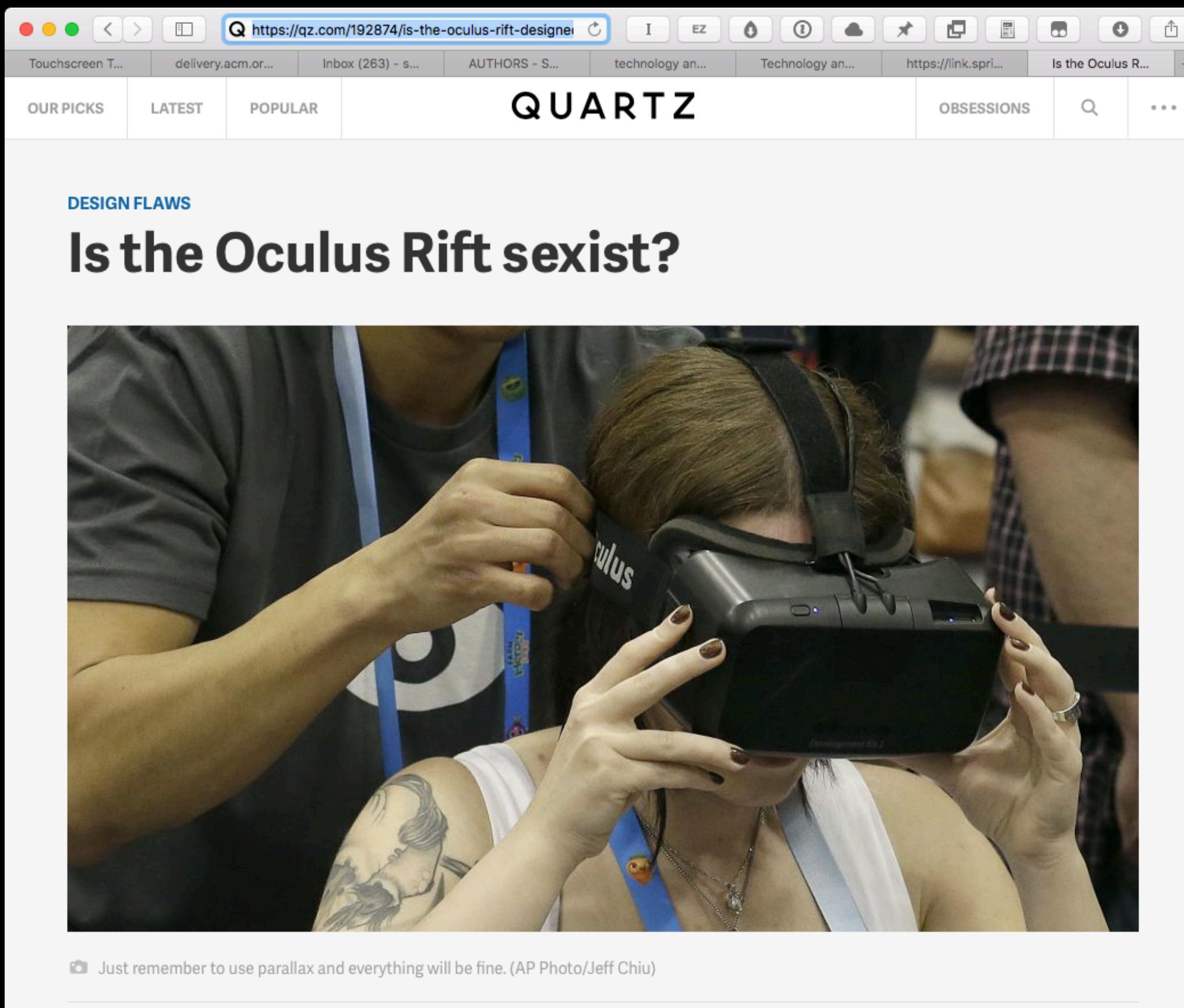
Considering diverse users

- How do we think about the individual?
- How do we think about the design process?

Disability & inclusion

- We'll spend much of our time talking about access for people with disabilities. Why?
 - There are many well-known but remaining accessibility problems
 - Addressing these problems can significantly impact people's lives

Inclusion beyond disability



Quartz news article titled "Is the Oculus Rift sexist?" featuring a woman wearing an Oculus Rift headset. The article is categorized under "DESIGN FLAWS". A caption at the bottom reads: "Just remember to use parallax and everything will be fine. (AP Photo/Jeff Chiu)"



PCWorld news article titled "Is Microsoft's Kinect Racist?" featuring a group of children holding Kinect accessories. The article is categorized under "NEWS" and "GAMES". A caption at the bottom reads: "Will all these kids be able to use the facial recognition features of Microsoft's Xbox 360 Kinect accessory? Photo courtesy of Microsoft."

Accessibility can affect lots of groups

- Future technologies, but also issues of affordability, resources, etc.
- We should keep this in mind throughout what we do here
- For now, we'll talk more about disability

Some terminology re: disability

- PWD - people with disabilities
- Accessibility - the practice of designing artifacts that are usable (usually focusing on PWD)
- a11y - “cool” abbreviation for accessibility; [a+11 letters+y]. Inspired by internationalization
→ i18n

More on PWD terminology

- Class follows the **reasonable person principle**: assume everyone is reasonable, acting in good faith
- Disability isn't a bad word
- Some terms have gone out of fashion (e.g., wheelchair bound, mental retardation)
- Some terms raise questions: what does it mean to call something **normal**?

What, even, is disability?

- Who is included? Excluded?
- How to think and talk about it?

Models of disability

- **Medical model:** people with disabilities (PWD) are patients; our goal is to restore or replace function
- **Social model:** What counts as “disability” is defined socially; people are naturally different, but society sets the bounds for what is considered normal and what is abnormal. Maybe we don't need to fix people.

The social model in action

- [The Shared Sign Language of Martha's Vineyard](#)
- In the 18th century, deafness was common on the island of Martha's Vineyard
- Sign language was commonly used by everyone



By the early 18th century, it was not uncommon for people in Martha's Vineyard to be deaf from birth. This had a profound effect on the culture of Martha's Vineyard - and one that went on to influence Deaf culture in the United States as a whole.

Definitions change over time

- Being nearsighted was not a significant disability until literacy became common
- Changing norms around texting may benefit some (e.g., deaf people) and impair others (e.g., people with dyslexia)

WHO model of disability (2012)

- **Body functions** and **body structures** describes how a person's body functions
- **Impairments** refer to functional limitations of a person's body
- **Activity limitations** refer to difficulties performing specific activities
- **Participation restrictions** refer to difficulties participating in activities of daily life
- (and all of this is affected by environmental factors)

Is impairment situational?



Situational vs. lifelong impairments

- Must consider
 - Compensatory skills
 - Assistive technologies
 - Ability to change the impairing context
(e.g. by changing activity)

Perspectives and solutions

“What should we do about it?”

- **Rehabilitation technology** - enable people to restore natural function (usually temporary)
- **Assistive technology** - provide technology to solve an accessibility problem (usually permanent)
- **Special education** - focus on access to education and empowerment
- **Legal perspective** - focus on rights and societal supports
 - Whose responsibility is this problem?

Design approaches

- **Assistive technology** - developing technology to “repair” a disability or address an activity limitation
- **Universal design** - build it from the ground up to accommodate the widest user group
- **Inclusive design** - often more pragmatic than universal design (include more, but not everyone), emphasizes participation by excluded users in the design process

Universal design in action



“Born accessible”
vs. bolt-on

Benefits for
everyone

More design approaches

- **Ability-based design** - develop systems that model and adapt to a user's ability
- **Design for empowerment** - emphasize empowering and increasing representation from marginalized groups
- **Value Sensitive Design** - consider other values in design other than usability (e.g., independence, self-determination)
 - Example: if we could, should we replace ASL interpreters with ASL-translating smart gloves? Why or why not?

But who is right?

- _ツ)
- All of these perspectives may be useful at certain times
- Not necessarily mutually exclusive
- Useful to be aware of any implicit assumptions we are carrying with us

Considering impact

- Often we are considering trade-offs between the size of the group we are including and the magnitude of the impact
- Consider:
 - Helping 1 million people do their jobs 1% faster
 - Helping 100k people gain access to education
 - Helping 500 people live independently
- In reality, we are often dealing with external constraints. But it's worth taking a moment to consider this in the abstract case.

Why make things accessible?

- Laws or regulations
- Because we want to do the right thing
- Because accessible design is good design

Laws and regulations in the US

- Section 508 of Rehabilitation Act - guidelines for access to electronic resources
- Americans with Disabilities Act - guidelines for “reasonable accommodations” to work, education, public life
- Individuals with Disabilities Education Act (IDEA) - guidelines for access to education

How to know what to do?

- In the old days, sometimes it was difficult or impossible to create accessible versions of our programs
- Fortunately, we now have better tools on our side:
 - Programming frameworks that support accessibility (if you do the right thing)
 - Guidelines for accessible design (and sometimes automated testing tools)

HTML is great for this

- Well defined standards for creating accessible content
- Web Content Accessibility Guidelines (WCAG)
- By design, the web separates content (HTML) from presentation (CSS)
- Everything is rendered as HTML, can be scraped or altered by user's own device

Remixing the Web

https://userstyles.org/styles/browse/twitter

technology | Technology... | Is the Oculus... | www.who.int... | americans wi... | Americans w... | Section508.... | WebAIM: Uni... | Twitter The... | +

stylish Search for a style Create New Style FORUM LOG IN or SIGN UP

Home Editor's Choice Most Popular Newest Styles Recently Updated

Twitter Themes & Skins

Ice Cold Coca Cola - twitte... by Stylish Updated: 3/29/17 0 38

Twitter Champions Leagu... by Stylish Updated: 3/8/17 0 23

Twitter Flat Dark & Clean by Martinius Ulberg Updated: 1/14/18 1 630

Twitter Dark Mode (2017) by dubstrike Updated: 10/10/17 0 473

New Twitter dark mode by... by Dear_VooDoo Updated: 12/16/17 0 318

Twitter - Dark n Simple by Gibbu Updated: 2/4/18 0 237

Go to "https://userstyles.org/styles/155039/a-better-twitter"

The image shows a screenshot of the Stylish browser extension interface. The top navigation bar includes tabs for 'technology', 'Technology...', 'Is the Oculus...', 'www.who.int...', 'americans wi...', 'Americans w...', 'Section508...', 'WebAIM: Uni...', 'Twitter The...', and a '+' button. The main header features the 'stylish' logo, a search bar, and a 'Create New Style' button. Below the header is a sidebar with links to 'Home', 'Editor's Choice', 'Most Popular', 'Newest Styles', and 'Recently Updated'. A section titled 'Top Styled Sites' lists links to Google, Facebook, YouTube, Yahoo, Amazon, Wikipedia, Twitter, Netflix, eBay, and Reddit. The main content area is titled 'Twitter Themes & Skins' and displays eight different Twitter theme styles as cards, each with a preview image, title, author, update date, and download statistics. The themes include 'Ice Cold Coca Cola', 'Twitter Champions League', 'Twitter Flat Dark & Clean', 'Twitter Dark Mode (2017)', 'New Twitter dark mode', 'Twitter - Dark n Simple', and two other partially visible themes.

Ways to think about accessibility

- Following standards - this helps our design work on a variety of current and future devices
- Presenting content in multiple ways - since people may consume media in different ways, have we included the appropriate content for doing so?
- Supporting various input methods - including mouse, touch, keyboard

More ways to think about accessibility

- Using appropriate accessibility features of HTML (e.g., alt tags for images, ARIA labels for dynamic user interfaces)
- Semantic UI code - should represent the logical structure of the interface, not just visual
- Support end-user customization - e.g. font size, color contrast

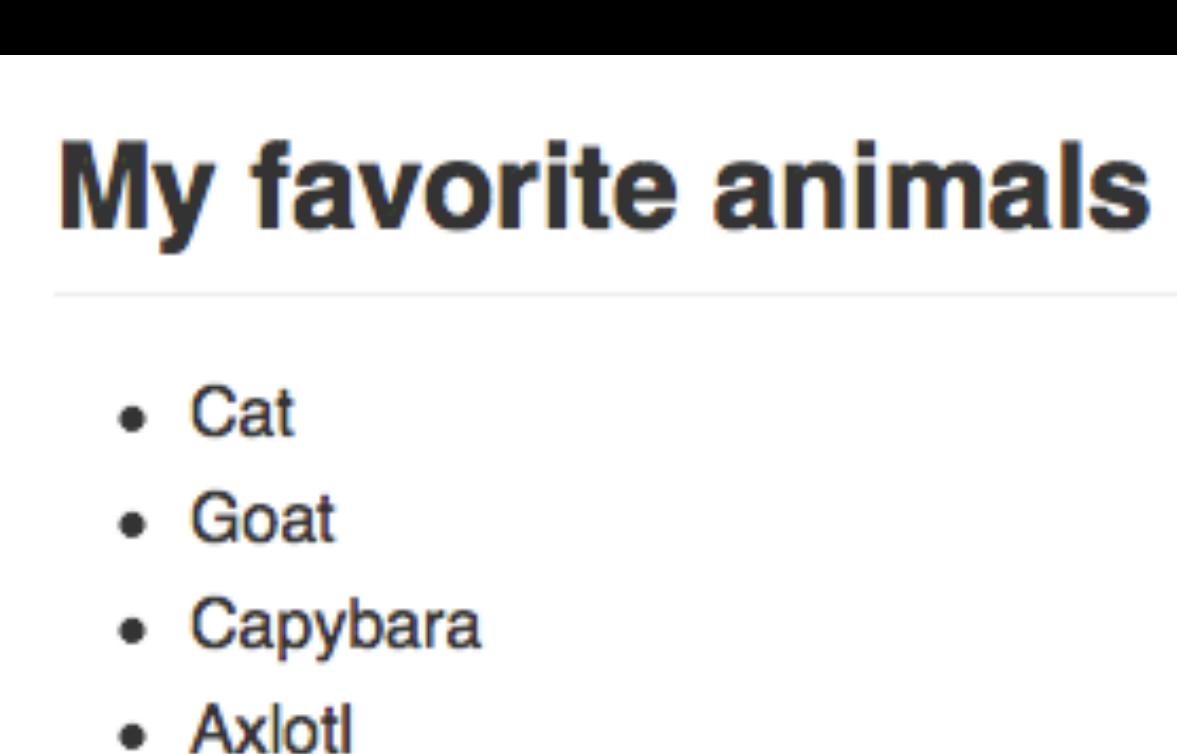
Where we go wrong

- Writing buggy UI code
- Neglecting to include alternative representations (image descriptions, video captions) - or including lousy versions of these
- Getting the visual presentation right but messing up the semantic representation (no **semantic UI**)

Semantic UI?

```
<h1>My favorite animals</h1>
<ul>
<li>Cat</li>
<li>Goat</li>
<li>Capybara</li>
<li>Axlotl</li>
</ul>
```

```
<p><strong>My favorite animals
</strong></p>
<p>• Cat</p>
<p>• Goat</p>
<p>• Capybara</p>
<p>• Axlotl</p>
```



Blindness & accessibility

Technology for vision impairments

- What people tend to use now
- History and research
- Key research challenges
- **This week we will consider technologies for individuals with very limited or no vision; next week we will look at other levels of visual ability**

The big idea

- Interacting using audio (and other non-visual media) is very different than interacting with visual representations
- It's worth getting practice to understand these differences

Accessibility challenges

- Talk with your neighbor
- What have you done so far today?
- What accessibility barriers would have come up if you found yourself unable to see?
- menti.com, 69 75 86

Some takeaways

- It's easy to overlook accessibility challenges if you don't experience them yourself
- At the same time, sighted people lack compensatory skills, familiarity with tools

Common access technologies

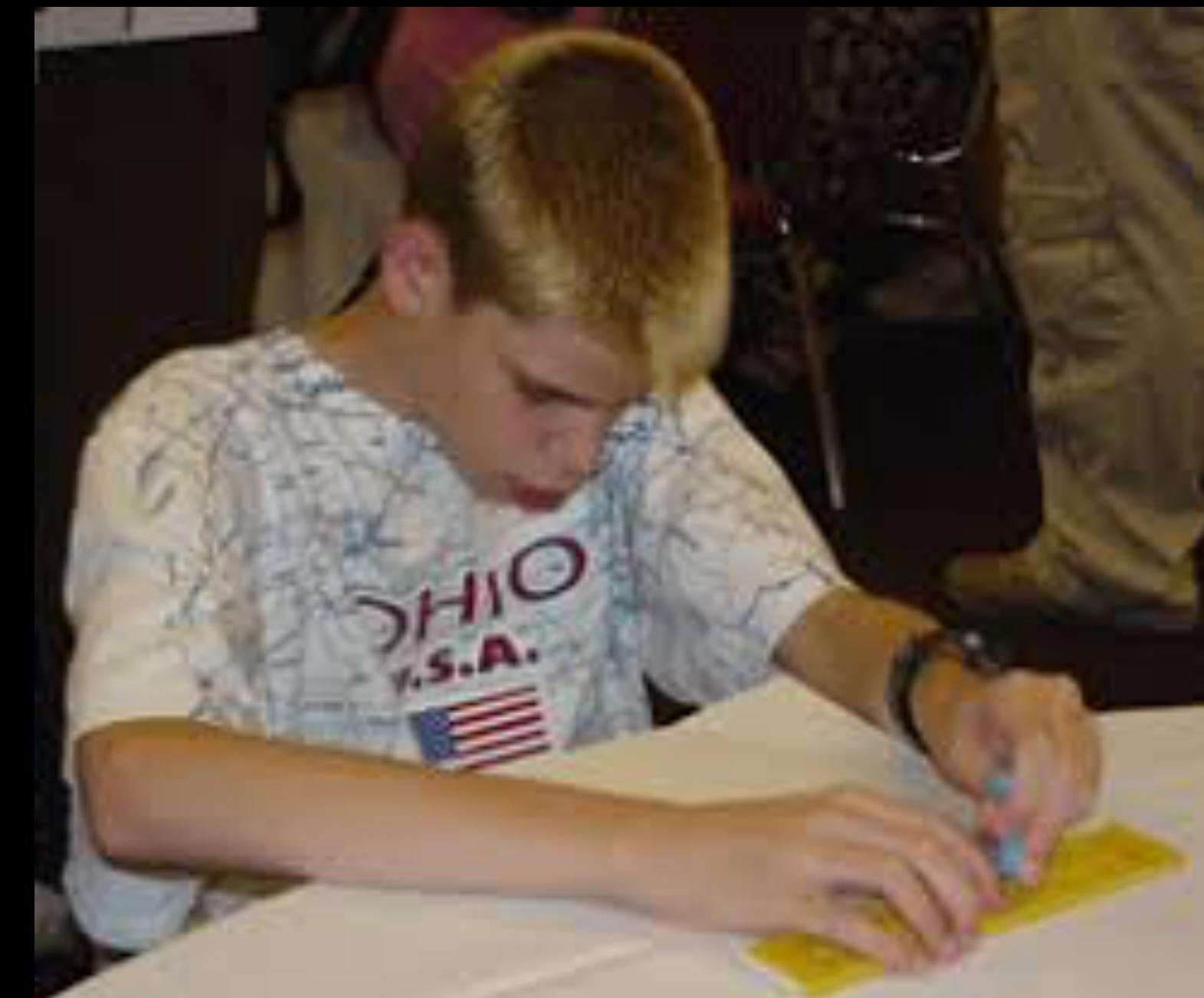
Computer access



Navigation



Specialized technology



From specialized to general

- Smartphones offer many capabilities that can be used for access
- Camera, GPS, Bluetooth for Braille or audio
- Apps enable new features to be easily added

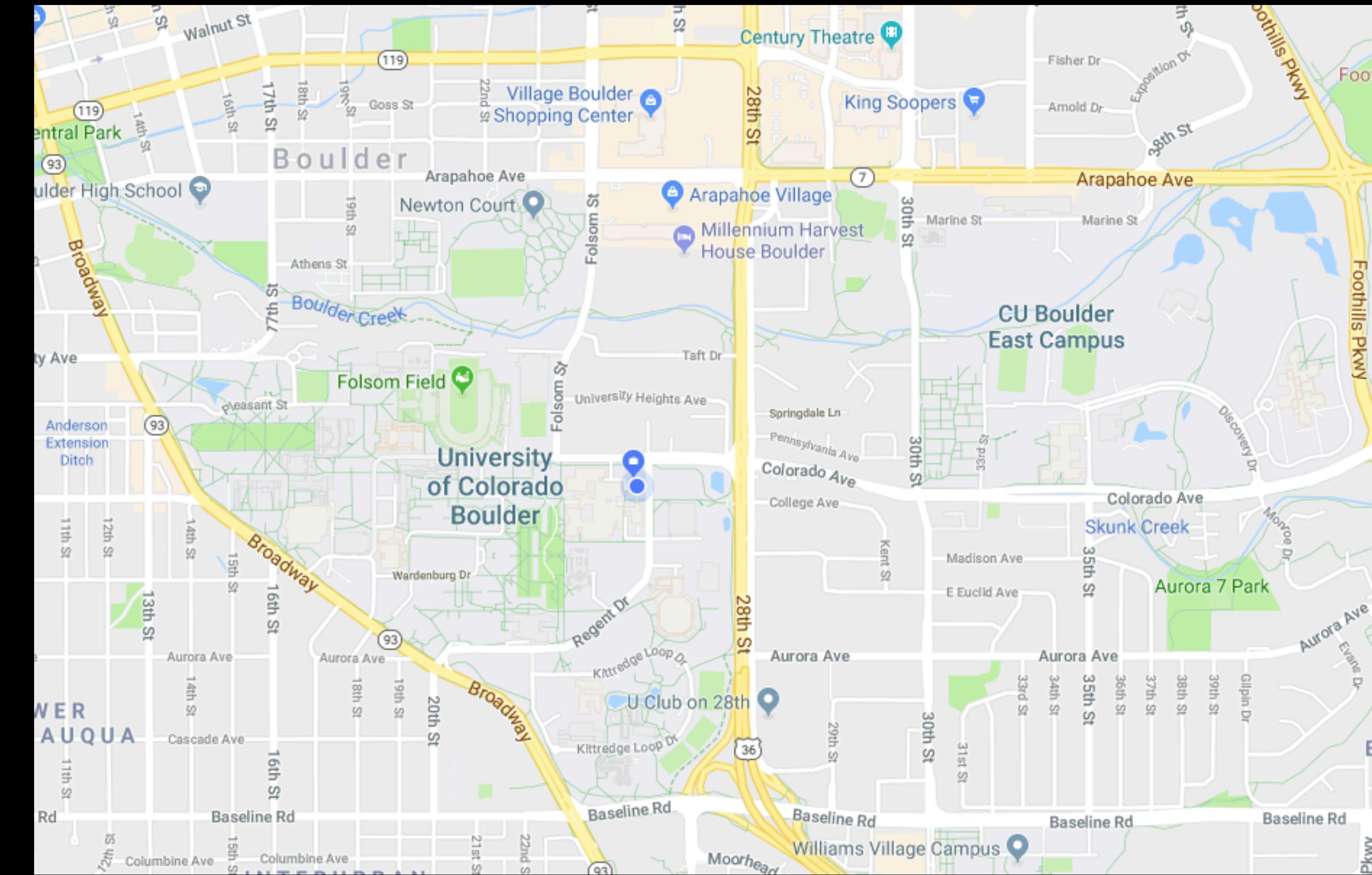


General strategies

- Represent visual information in an alternative format
- Audio or tactile
- But these are very different than the visual sense in terms of transmission rate, simultaneous interaction, saliency

Visual imagery is complicated

- Relatively easy to filter information / access superimposed information
- Non-linear access
- We know lots about how to use visual attention in design



Mini-activity

- Write a text description of this image
- Post it menti.com,
69 75 86



Considering context

- How would the description change for:
 - A book about animation
 - A Star Trek: TAS episode guide
 - A find-the-hidden object game

Creating alternative representations

- **Approach 1:** Have humans translate
 - How do we convince people to create alternative information?
 - How do we know what to translate?
- **Approach 2:** Have machines translate
 - New technology
 - What happens if the computer is wrong?

Text vs. nonspeech/tactile

- Often we provide access through text, either spoken or Braille
- Alternatives include tactile representations (such as tactile graphics) and sonification (representing data as sound)
- We'll focus on text for now, visit other approaches later

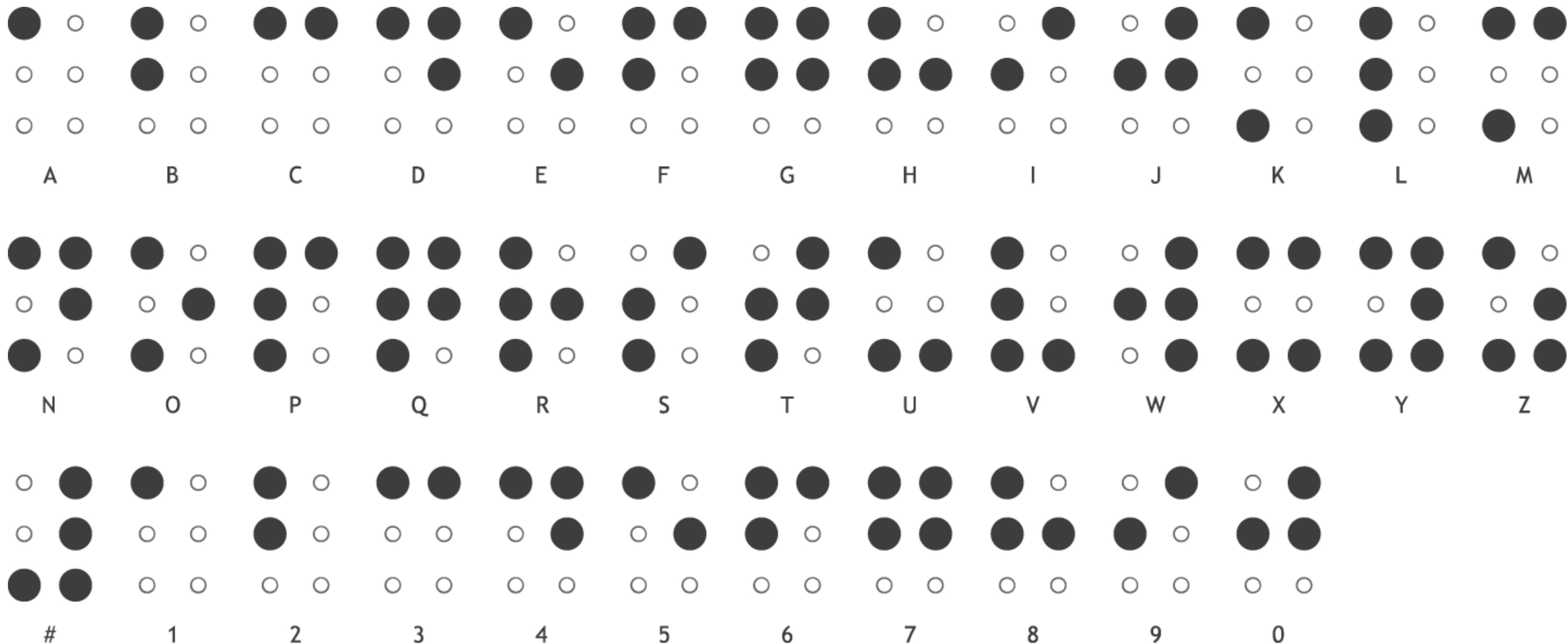
Computer access

- Typically use screen reader software
- Provides description of operating system and applications as **output**
 - May map to audio, Braille, or both
- Supports keyboard navigation as **input**
 - Must provide a mental model for navigating applications, responding to alerts, etc.

Braille vs. audio output

- With training, screen reader audio output can be up to 300+ WPM
- Braille reading speed can be 200-400 WPM
- Using Braille is silent, preserves aural attention
- Braille literacy is low; this could create problems in the future
- **We should not assume that a blind person has access to a Braille display, or even that they read Braille**

Braille alphabet

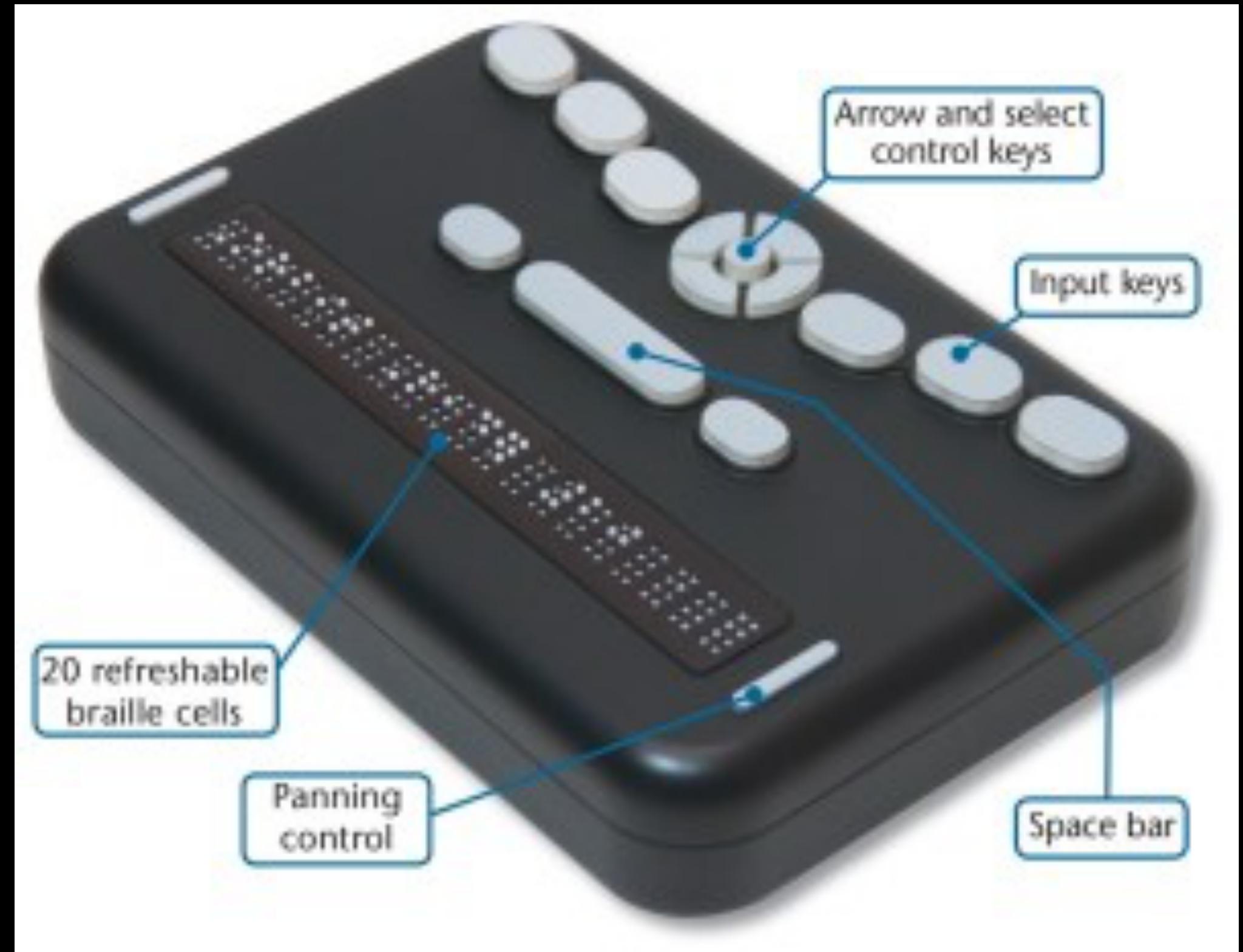


Specialized Braille (Nemeth code)

Expression	Linear format	TeX	Nemeth ASCII braille	Nemeth
a^2	a^2	a^2	A^2	• ; ;
e^{-x^2}	e^-x^2	e^{-x^2}	E^-X^2	• ; .. ; .. ; ; ;
x_2^a	x_2^a	x_2^a	X;2^A	.. ; : ; ; .
x^{a_2}	x^(a_2)	x^{a_2}	X^A^;2	.. ; ; ; ; ; ;

Refreshable Braille

- Devices can be quite expensive (thousands of dollars)
- Braille input uses **chorded** typing
- Devices connect to computer via Bluetooth



Embossed Braille

- Produced via a Braille embosser (more or less a printer)
- Typically large, non-portable, expensive
- May be available at work or school



Best practices for Braille

- Helpful to have Braille version available
- Don't assume that everyone has access to Braille devices, or reads Braille
- Presenting content as well-structured text enables the end user to decide on the format

Screen readers

- Most common form of computer access
- Represents applications and their components in a hierarchical form
- “an infinite set of nested lists”
- Typically paired with keyboard input (and not mouse input)

Screen reader use

- At top level: navigate between system and applications
- Navigate between different parts of application, based on underlying UI code
- Often jump around between parts of a document: headings, links, etc.
- May be combined with screen magnification, for low vision users)



(a) Sighted

[IBM.]
[Skip to main content.]
United States [change]
Terms of use
(Start of form 1.)
[Search for:]
[Text.]
[Search: Image Button.]
(End of form 1.)
Home
Products
Services & solutions
Support & downloads
My account
(Start of map with 4 items.)
(End of Map.)
Learn about
Business consulting
Industry solutions
IT services
Software products
Servers & storage
Notebooks
Desktops
Other hardware products
Shop for
Special offers
IT services
Software
Servers & storage
Notebooks
Desktops
Workstations
Upgrades and accessories
Get started
Download
Troubleshooting
Product support
Training
Open source
Warranty
main

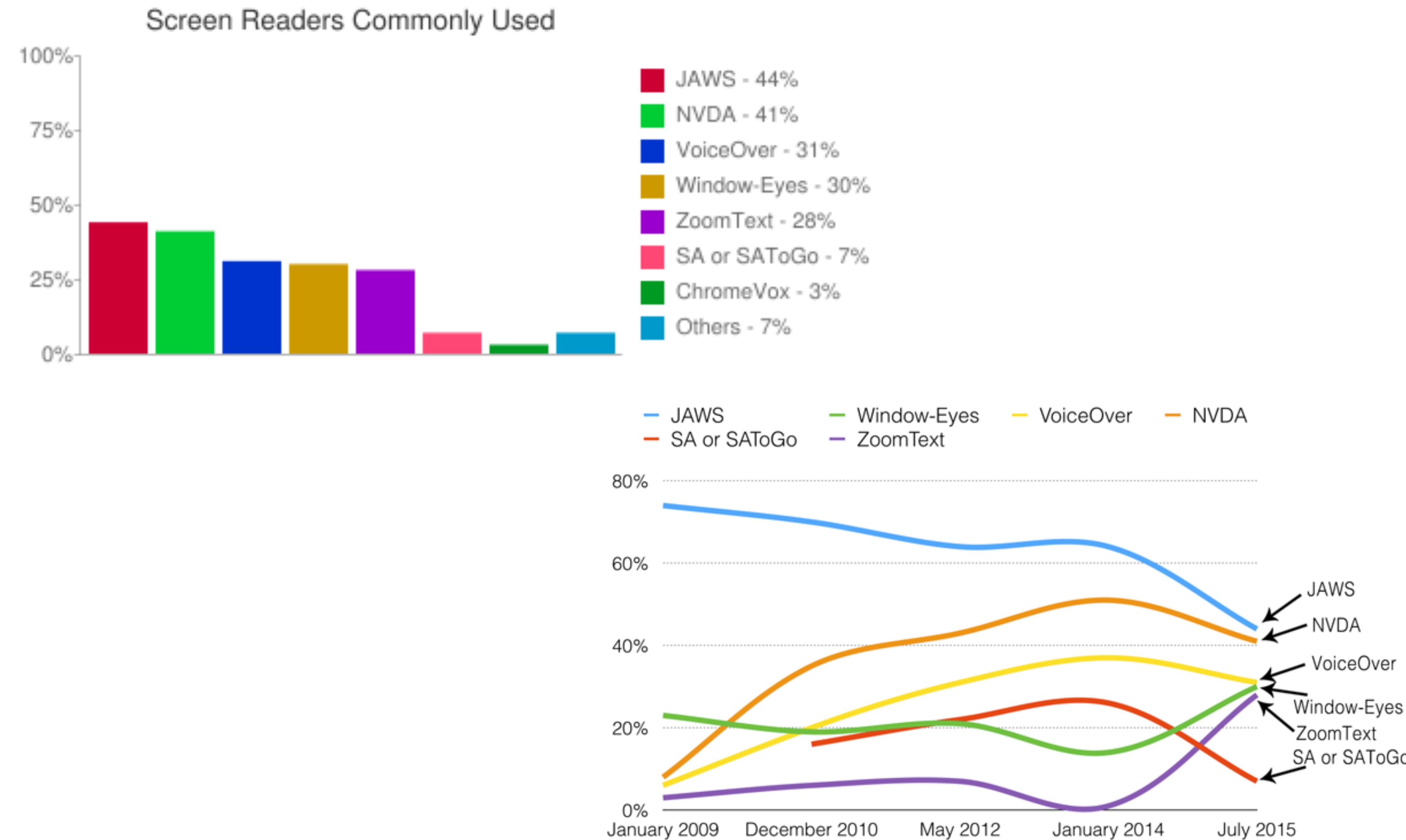
(b) Blind
(Home Page Reader v3.04)

Figure 2. Example of large difference between sighted and blind.

How to think about screen reader use

- Text is linear and takes time to hear
 - Little success in simultaneous speech
 - Users may adjust verbosity in some applications
- Providing landmarks to navigate content is key
- Don't count on mouse input

Screen reader popularity



Gesture-based screen readers

- Available in most off the shelf devices (Talkback on Android, VoiceOver on iOS)
- Uses a **cursor** to select active content
- Midas Touch problem: if I need to touch to know what's there, won't I touch things by mistake?
- Separate navigation (directional swipes) from selection (double tap or two-finger tap)

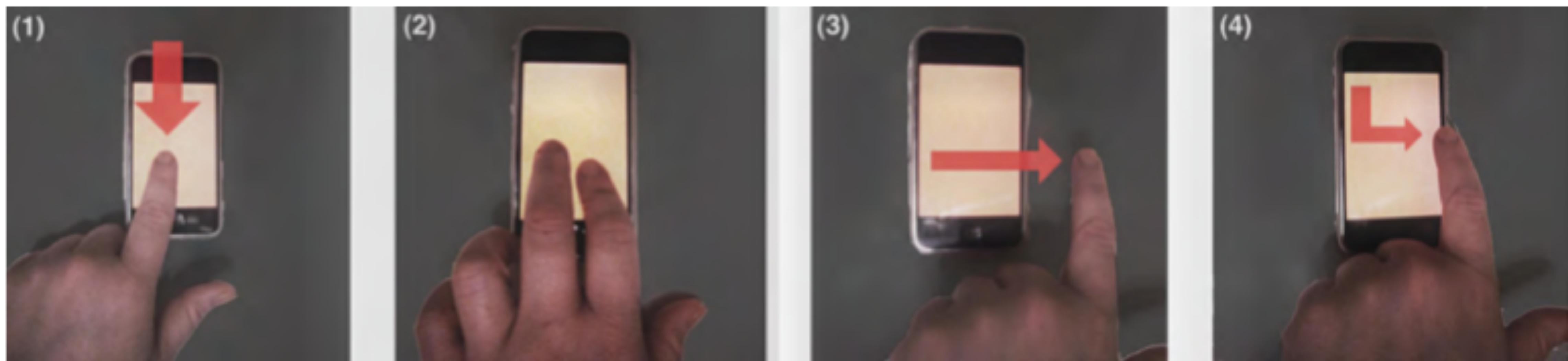


Figure 3. Slide Rule uses multi-touch gestures to interact with applications. (1) A *one-finger scan* is used to browse lists; (2) A *second-finger tap* is used to select items; (3) A *flick* gesture is used to flip between pages of items or a currently playing song; (4) An *L-select* gesture is used to browse the hierarchy of artists and songs in the music player.

Specifying voice characteristics

- You can do this in CSS!
- But it's rare
- In general, it's preferred to defer to user's screen reader, rather than self-voicing

```
h1, h2, h3, h4 {  
  voice-family: male;  
  richness: 80;  
  cue-before: url("beep.au")  
}
```

Exciting research problems

How do we help?

- Proposed project: powered skates for a blind person
- Say the destination and it takes you there
- What are the strengths and weaknesses of this approach?



Why not rocket skates?

- **Control:** Are we giving the user more control or less control?
- **Dependence:** Are we creating a dependency on a technology? What if the technology fails?
- **Empowerment:** Does this technology improve the user's condition? Can they learn and improve themselves?

Open research problems

- Independent navigation (pedestrian, public transit, cars)
 - Outdoor navigation supported by GPS
 - Indoor navigation often requires infrastructure that we don't have
 - Navigation styles may differ based on location, existing navigation skills or technology

The Blind Driver Challenge



https://www.youtube.com/watch?v=cTHa_5Y5IA4

Research problem 2

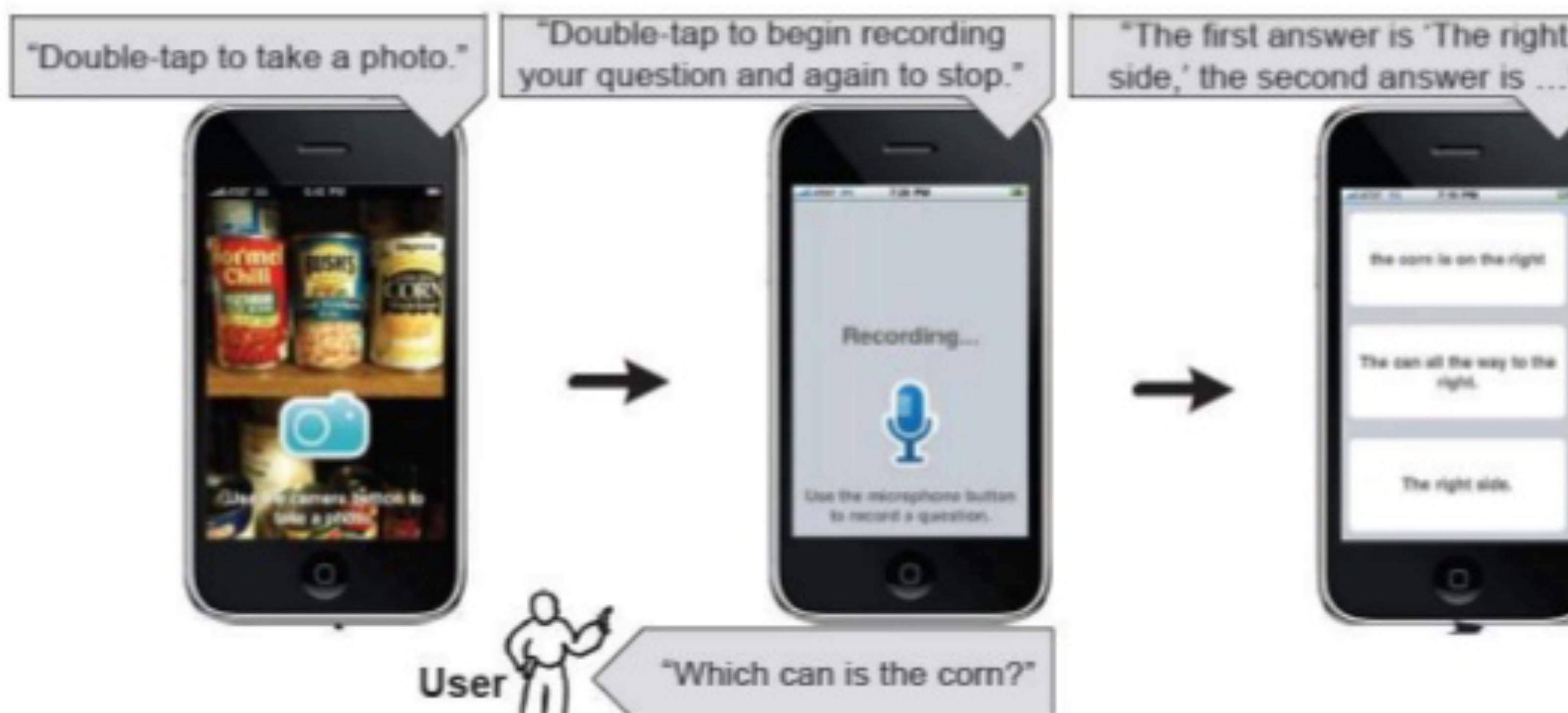
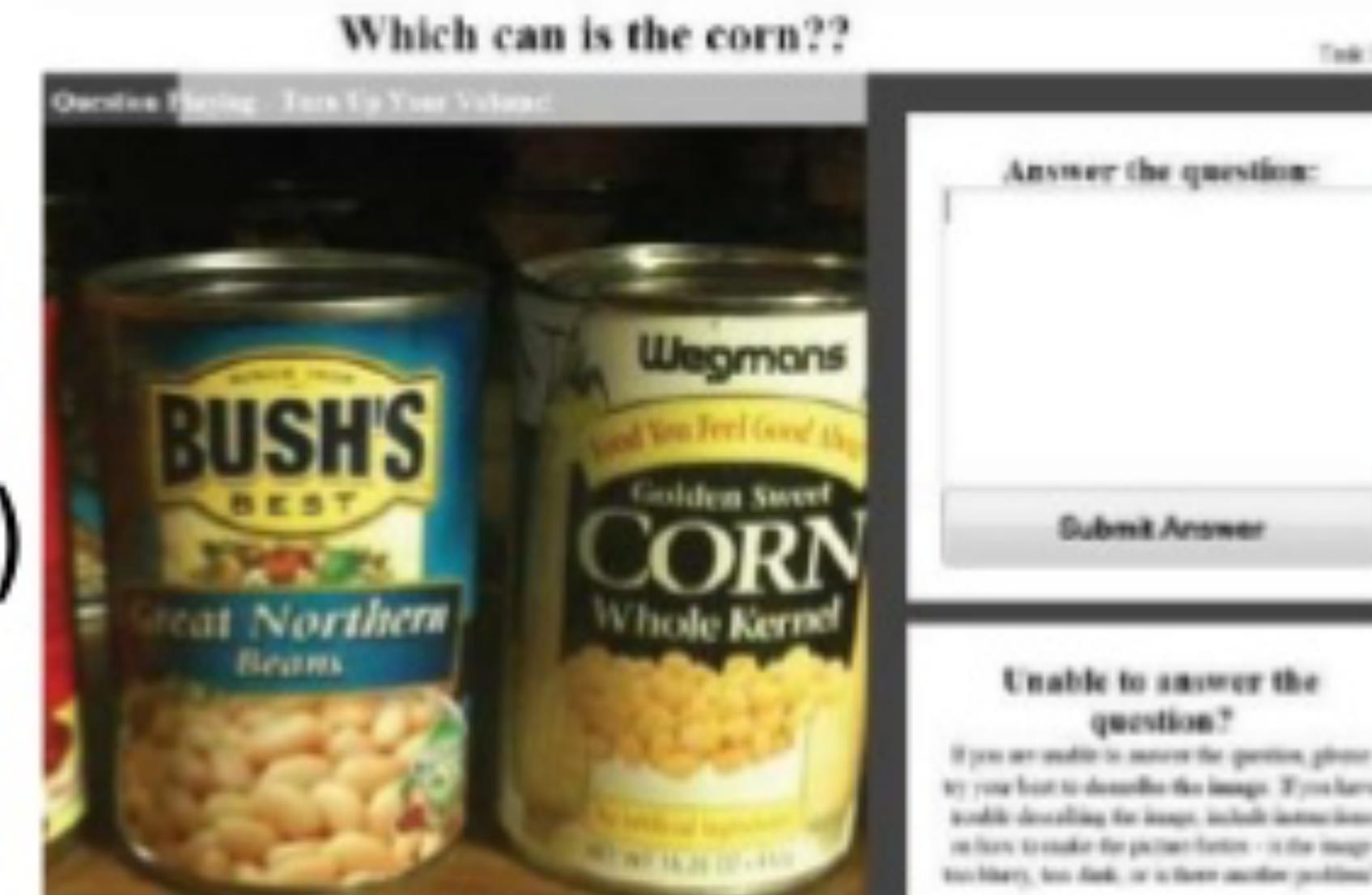
- Access to visual information
 - Many approaches: speech, non-speech, tactile
 - What should be represented?
 - How do we generate good descriptions?

VizWiz

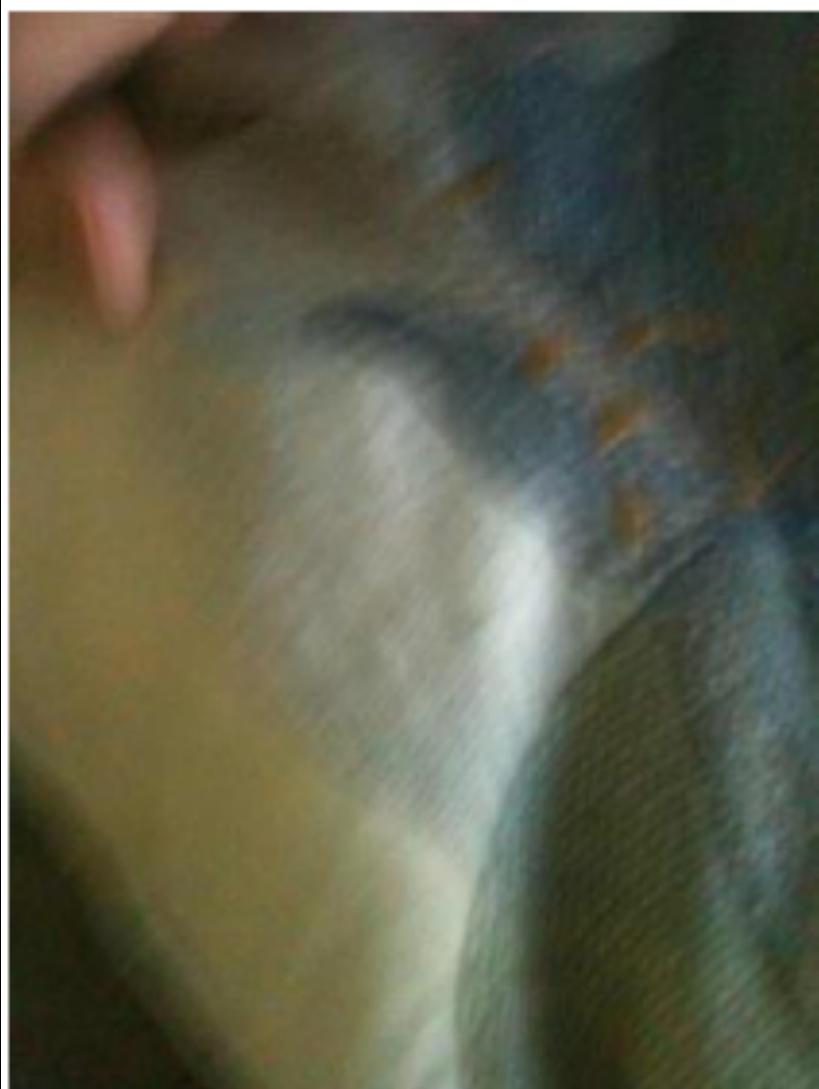
- Use crowd workers to answer visual questions
- User takes a photo and records a question
- People on Mechanical Turk answer questions for a few cents

VizWiz

Bingham et al. ([UIST 2010](#))



What color is this pillow?



What denomination is this bill?



Do you see picnic tables across the parking lot?



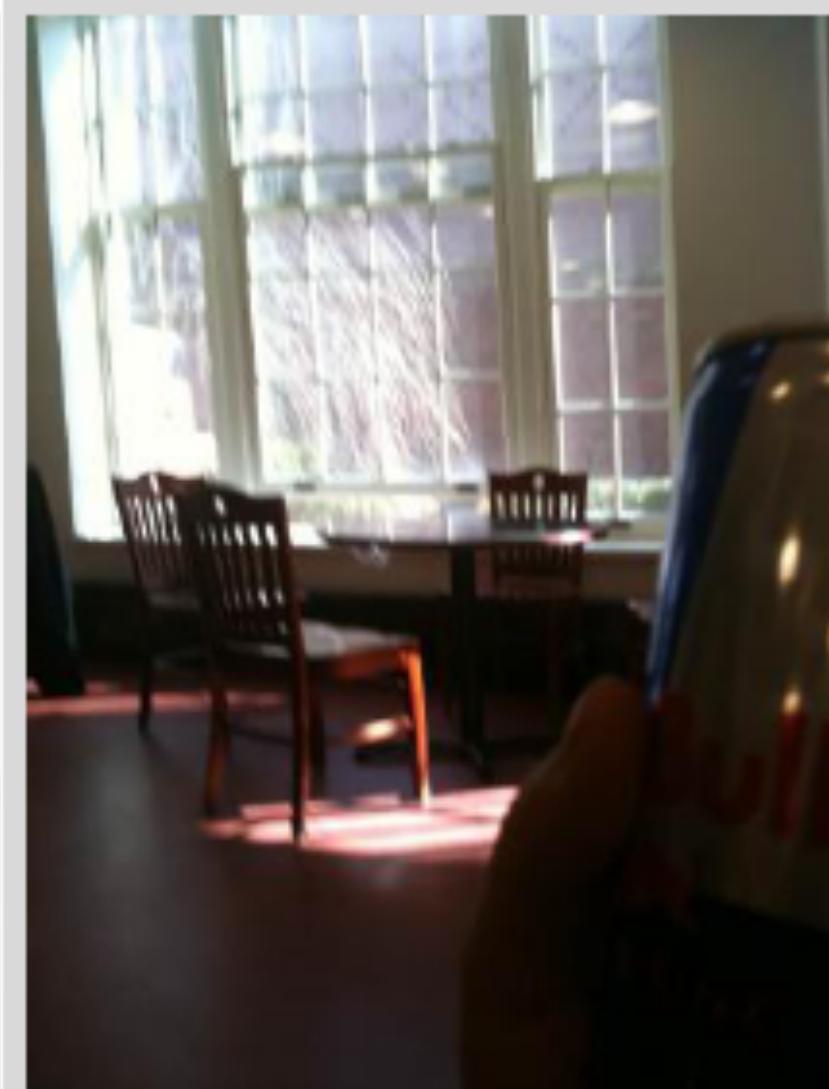
What temperature is my oven set to?



Can you please tell me what this can is?



What kind of drink does this can hold?



(89s) I can't tell.
(105s) multiple shades of soft green, blue and gold

(24s) 20
(29s) 20

(13s) no
(46s) no

(69s) it looks like 425 degrees but the image is difficult to see.
(84s) 400
(122s) 450

(183s) chickpeas.
(514s) beans
(552s) Goya Beans

(91s) Energy
(99s) no can in the picture
(247s) energy drink

VizWiz

- Benefits: Humans are good at answering questions
- Challenges: ??

Some challenges of VizWiz

- Privacy
- Domain expertise (for example, fashion)
- How to take accurate photos?
- Latency (but VizWiz is optimized for answers in 3-5 minutes)

Research problem 3

- Supporting automated description
 - How to gain representative data?
 - How to convey uncertainty?
 - How to deal with errors?

Automated description at Facebook



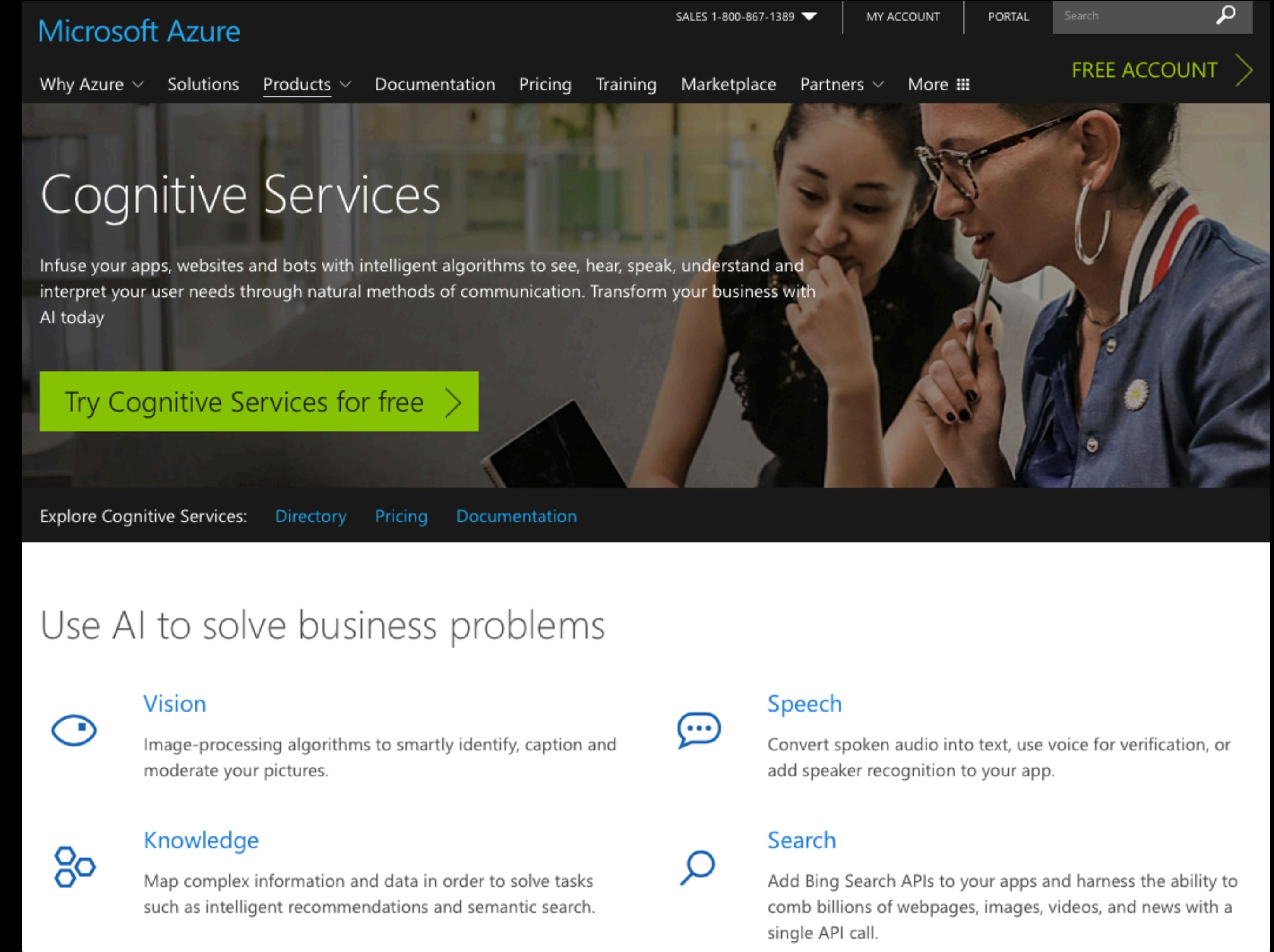
Facebook automatic alt text



Image may contain: two people, smiling, sunglasses, sky, outdoor, water

Use automated image descriptions

- APIs available via Google and Microsoft



The screenshot shows the Microsoft Azure Cognitive Services homepage. At the top, there's a navigation bar with links for SALES 1-800-867-1389, MY ACCOUNT, PORTAL, and a search bar. A "FREE ACCOUNT" button is also visible. The main heading is "Cognitive Services" with a subtext: "Infuse your apps, websites and bots with intelligent algorithms to see, hear, speak, understand and interpret your user needs through natural methods of communication. Transform your business with AI today". A prominent green button says "Try Cognitive Services for free >". Below this, there's a section titled "Use AI to solve business problems" with four categories: Vision, Speech, Knowledge, and Search. Each category has an icon and a brief description.

Microsoft Azure

SALES 1-800-867-1389 ▾ | MY ACCOUNT | PORTAL | Search | FREE ACCOUNT >

Why Azure ▾ | Solutions | Products ▾ | Documentation | Pricing | Training | Marketplace | Partners ▾ | More ▾

Cognitive Services

Infuse your apps, websites and bots with intelligent algorithms to see, hear, speak, understand and interpret your user needs through natural methods of communication. Transform your business with AI today

Try Cognitive Services for free >

Explore Cognitive Services: [Directory](#) [Pricing](#) [Documentation](#)

Use AI to solve business problems

Vision
Image-processing algorithms to smartly identify, caption and moderate your pictures.

Speech
Convert spoken audio into text, use voice for verification, or add speaker recognition to your app.

Knowledge
Map complex information and data in order to solve tasks such as intelligent recommendations and semantic search.

Search
Add Bing Search APIs to your apps and harness the ability to comb billions of webpages, images, videos, and news with a single API call.

Research problem 4

- Supporting activities of daily living (ADLs)
 - Not just work, what about games, sports, TV, art?
 - If non-disabled people do it, it should be accessible

Research problem 5

- Providing equal access to collaborative work
 - Shared notes (e.g. whiteboards)
 - Visual attention
 - Incompatible user interfaces (“hey, can you proofread that text in the top right?”)

Non-visual UIs for everyone

- Non-visual UIs becoming more popular
- Home agents (e.g., Alexa, Siri)
- Complex multimodal tasks (e.g., air traffic control, military or police operations)
- Understanding the differences between user groups is an ongoing problem

Let's work on Project 1

- Finalize a team if you haven't already
- Work on UI sketches