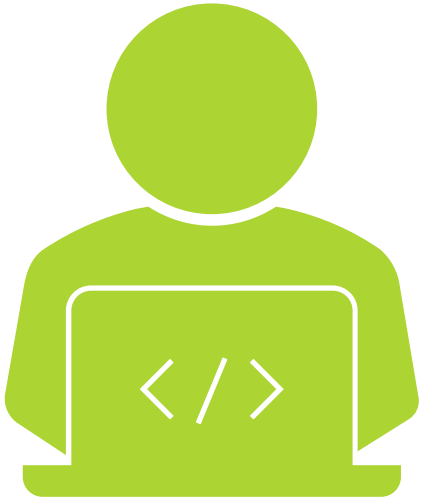
Human-Computer Interaction



Introduction

- **Imagine this scenario**:
  - You're the CEO of a promising fintech startup. Your development team has built what they consider a revolutionary mobile banking app with cutting-edge security features and comprehensive financial tools. However, three months after launch, user adoption is sluggish, customer support is overwhelmed with complaints, and your app store ratings are plummeting. The technology works perfectly, but users are abandoning the app in droves.

- What went wrong?

Lecture Roadmap

Understanding HCI - The foundation

HCI History about Ergonomics and Human Factors - Learning from the past

Problems and Challenges - Current battlegrounds

Recurrent HCI Themes - Timeless principles

Wrap-up and Q&A - Integration and next steps

Understanding HCI

- **Formal Definition**: HCI is the study of how people interact with computers and the design of computer systems for effective, efficient, and satisfying human use.
- **Business Translation**: HCI is about creating technology that people want to use, can use successfully, and will continue using—ultimately driving business value through superior user experience.
- **(ACM SIGCHI, 2021):**
  - "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."

Three fundamental components

1: The Human

Cognitive Abilities and Limitations

- *Working Memory:* Humans can only hold 7±2 items in working memory at once.

Physical Capabilities:

- **Fitts' Law**: The time to reach a target depends on the distance to and size of the target
- **Visual Processing**: Humans read left-to-right (in Western cultures), process images faster than text
- **Motor Skills**: Finger dexterity varies, especially with age and physical conditions

Cont’d

Emotional Responses:

- **Frustration Threshold**: Users will typically abandon a task after 3-4 failed attempts
- **Delight Factors**: Unexpected positive experiences create strong emotional connections
- **Trust Building**: Consistency and reliability in interactions build user confidence

Cultural Backgrounds:

- **Color Meanings**: Red means "stop" in Western cultures, but prosperity in Chinese culture
- **Reading Patterns**: Arabic and Hebrew users scan right-to-left
- **Social Norms**: Privacy expectations vary dramatically across cultures

2: The Computer

- Processing Power and Speed:
  - Modern computers can perform billions of calculations per second, but humans perceive delays over 100 milliseconds as sluggish.
- Input/Output Capabilities:
  - Visual: Screens, displays, indicators
  - Auditory: Speakers, alerts, voice feedback
  - Tactile: Keyboards, touchscreens, haptic feedback
  - Gestural: Motion sensors, cameras
- Software Applications:
  - Each application has its own interface conventions, learning curves, and interaction patterns.
- Network Connectivity:
  - Response times, offline capabilities, and data synchronization affect user experience.

3: The Interaction

- **User Interfaces Evolution:**
  - **Command Line Interface (CLI):**
    - Text-based, high learning curve, powerful for experts
  - **Graphical User Interface (GUI):**
    - Visual metaphors, intuitive for beginners
  - **Touch Interfaces:**
    - Direct manipulation, natural gestures
  - **Voice User Interface (VUI):**
    - Conversational, hands-free interaction
  - **Brain-Computer Interface (BCI):**
    - Direct neural control (emerging)

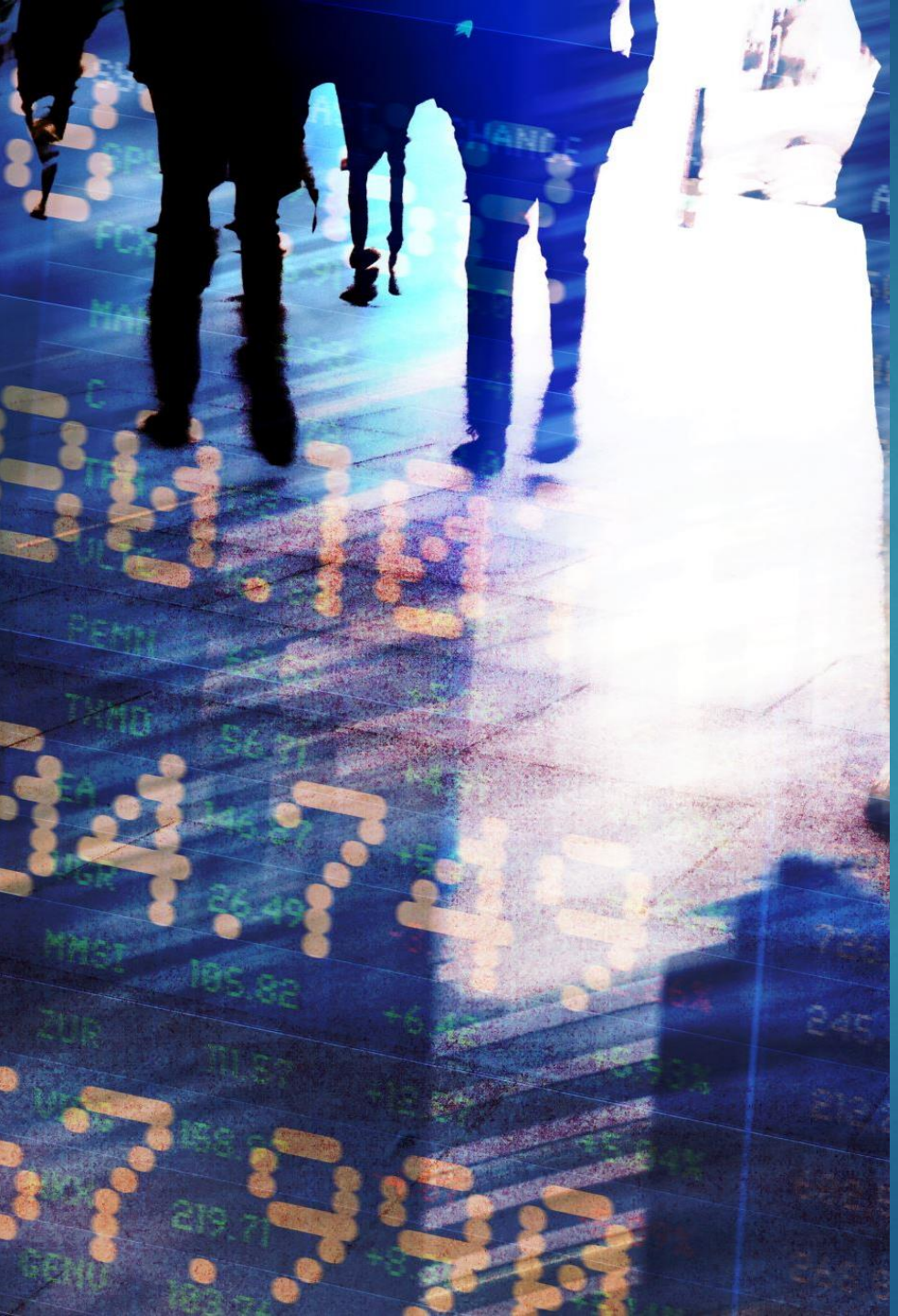
Why HCI Matters in Business

Revenue Impact:

- **Conversion Rates**: Good UX design can increase conversion rates by 200-400%
- **Customer Lifetime Value**: Satisfied users spend 140% more than frustrated users
- **Referral Rates**: Users of well-designed products are 6x more likely to recommend them

Cost Reduction:

- **Support Calls**: Good design can reduce support tickets by 50-80%
- **Training Costs**: Intuitive interfaces require less user training
- **Error Correction**: Well-designed systems prevent costly user errors



WHY?

- **Brand Impact:**
  - **First Impressions**: Users form opinions about websites in 50 milliseconds
  - **Trust Building**: Professional, consistent interfaces build credibility
  - **Competitive Differentiation**: Superior UX becomes a sustainable competitive

HCI History about Ergonomics and Human Factors

- **The Birth of Human Factors: World War II Era (1940s-1950s)**
- **Historical Context**: During WWII, military leaders noticed that well-trained pilots made fatal errors with aircraft controls. The problem wasn't incompetence—it was poor design.
- **Key Insight**: The B-25 bomber's engine and landing gear controls were identically shaped and positioned next to each other. Stressed pilots would accidentally retract the landing gear instead of adjusting engine power, causing crashes.
- **Solution**: Redesign controls with different shapes and positions—round knobs for engines, wedge-shaped handles for landing gear.
- **The Fundamental Realization**: Technology should adapt to humans, not the other way around.

Ergonomics Principles Established

Anthropometric Data: Design for human body dimensions and capabilities

Biomechanics: Reduce physical strain and fatigue

Environmental Factors: Consider lighting, noise, and temperature effects

Safety First: Prevent human error through design

Research

- **The Computing Evolution Timeline**

Brief History & Evolution

Timeline:

- **1940s–50s:** Early computers – no direct interaction (punch cards, batch processing).
- **1960s–70s:** Terminals & command-line interfaces; HCI rooted in **human factors engineering**.
- **1980s:** Graphical User Interfaces (GUI) – Xerox PARC, Apple Macintosh revolutionized interaction.
- **1990s–2000s:** Web usability, mobile computing, early accessibility focus.
- **2010s–present:** Ubiquitous computing, smartphones, AR/VR, AI-driven interfaces, brain–computer interaction.

Key HCI Innovations

- **Hyperlinks**:
  - Non-linear navigation through information
- **Mosaic Browser (1993)**:
  - First graphical web browser with inline images
- **Search Engines**:
- AltaVista, Yahoo, organized the growing web
- **2000s: Mobile and Touch - Computing Goes Portable**
- **Smartphone Evolution**:

Problems and Challenges

The Fundamental Design Gulfs

Gulf of Execution - "How do I do this?"

- This represents the difference between what users want to accomplish and what actions the system allows.
- Users know what they want but don't know how to achieve it
- Interface complexity vs. functionality trade-offs

Real-World Example: Video Conferencing During COVID-19

- **User Goal**: "I want to share my presentation screen"
- **System Reality**: Multiple buttons labeled "Share Screen," "Present," "Share Content"
- **User Confusion**: Which button do I press? Will it share my whole screen or just the application?
- **Business Impact**: Productivity loss, meeting delays, user frustration

Design Solutions:

Clear Labeling: Use action-oriented language ("Share Your Presentation")

Preview: Show users what will happen before they commit

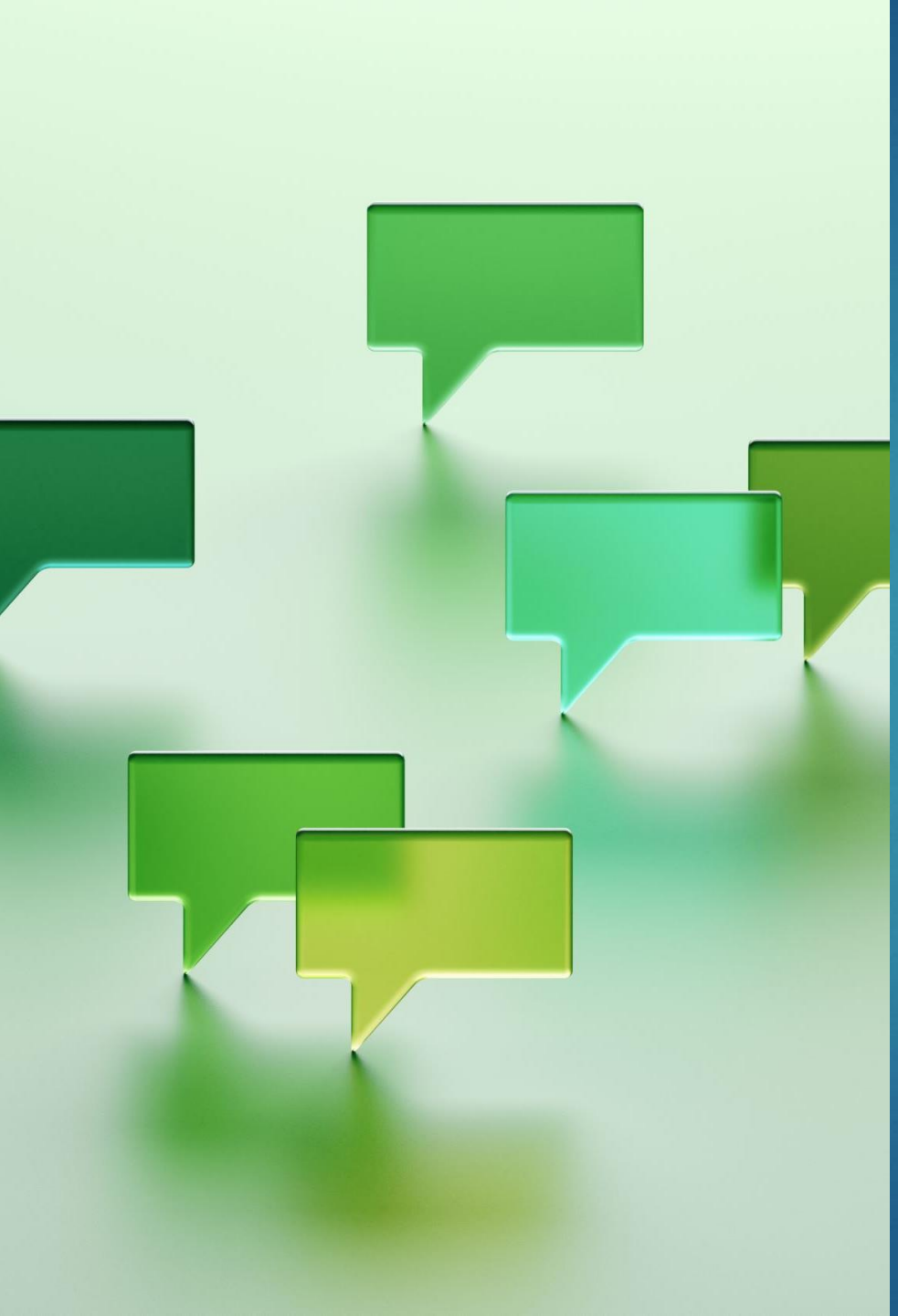
Undo: Allow users to easily reverse actions

Contextual Help: Provide assistance exactly when needed

Gulf of Evaluation/ Knowledge - "What happened? Did it work?"

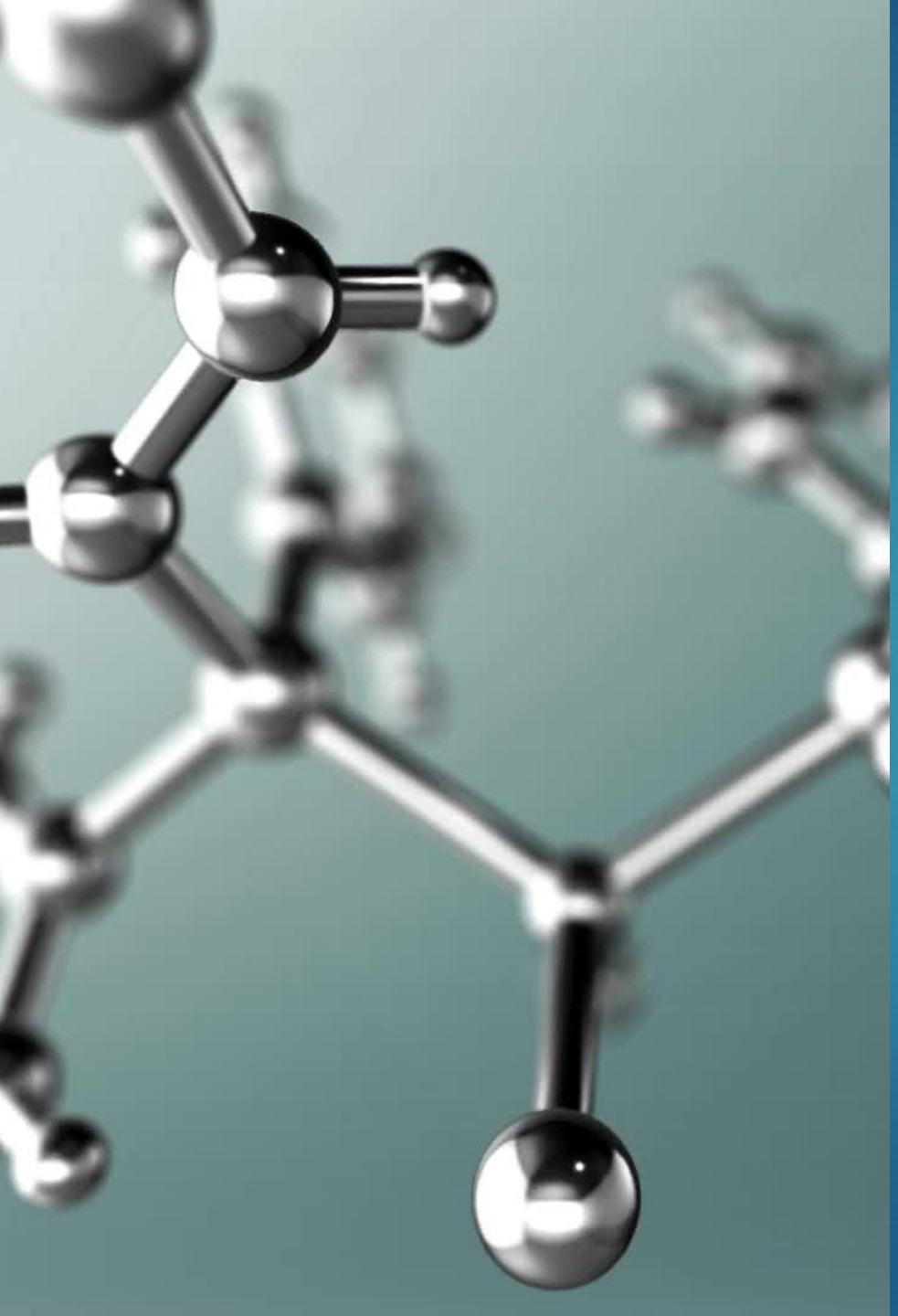
- This represents the difficulty users have in understanding system responses.
- Users don't know what the system can do
- Systems don't know what users want
- Bridging this gap requires careful design

- **Real-World Example**: Online Banking Transfers
  - **User Action**: Clicks "Transfer Money"
  - **System Response**: Page refreshes with no clear indication
  - **User Confusion**: Did the transfer happen? Is it processing? Should I try again?
  - **Risk**: Users might submit duplicate transactions or abandon the process



Design Solutions:

- **Immediate Feedback**:
  - "Transfer initiated. Processing..."
- **Progress Indicators**:
  - Show steps in multi-part processes
- **Confirmation**:
  - Clear success messages with transaction details
- **Status Transparency**:
  - Let users know what's happening behind the scenes

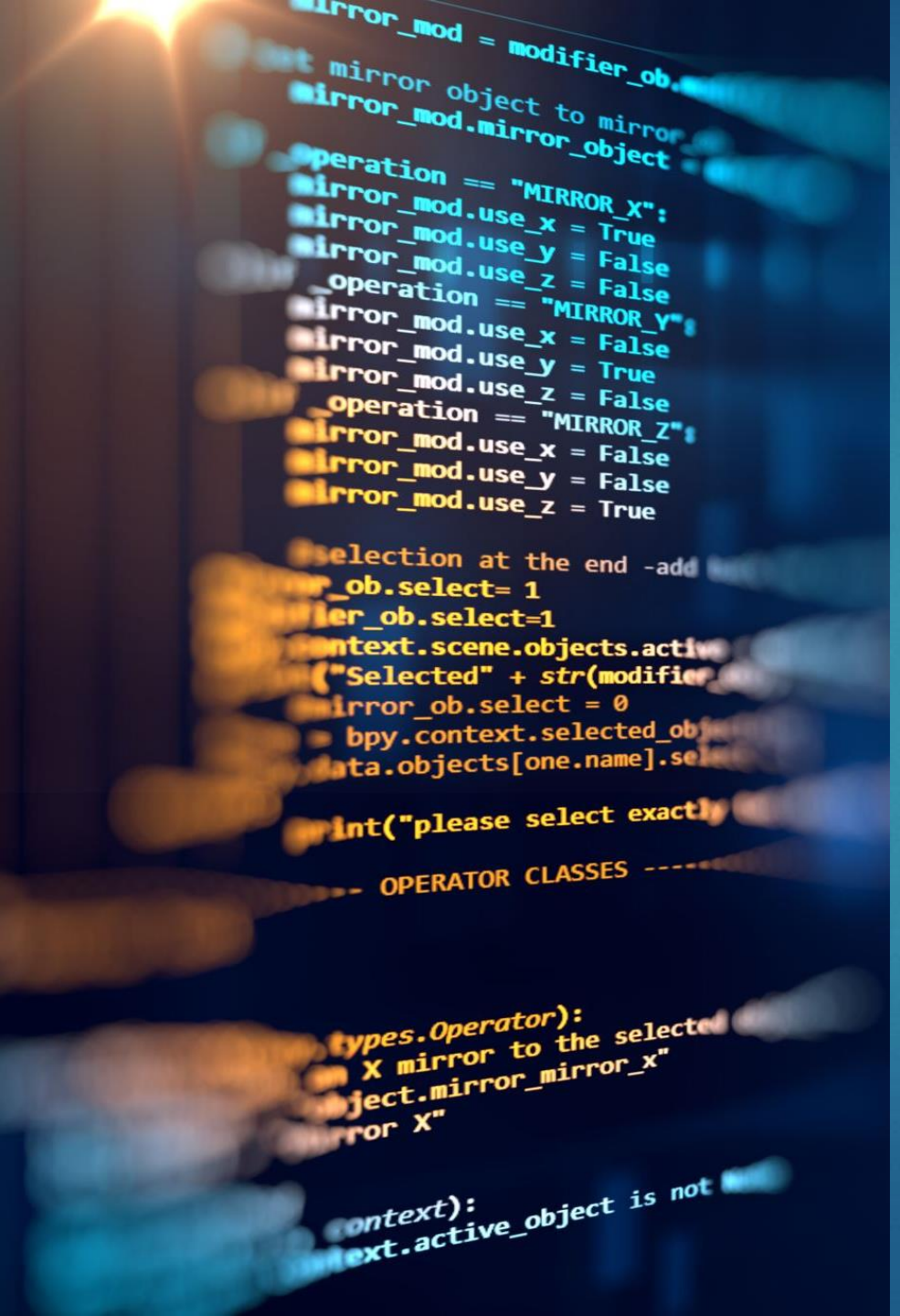


Human Limitations

Memory Constraints

- **Working Memory (7±2 Rule):**
  - George Miller's research shows humans can hold 7 (±2) items in working memory simultaneously.

- **Design Implications**:
  - **Navigation Menus**: Keep main navigation to 5-9 items
  - **Form Fields**: Group related information, use progressive disclosure
  - **Shopping Carts**: Show clear item counts and totals



Long-term Memory Challenges

- **Passwords**:
- Average user has 100+ online accounts but can only remember a few passwords
  - **Procedures**: Users forget infrequently-used software features
  - **Preferences**: Settings and customizations are often forgotten
- **Design Solutions**:
  - **Single Sign-On**: Reduce password burden
  - **Smart Defaults**: Remember user preferences automatically
  - **Progressive Disclosure**: Reveal advanced features as needed
  - **Contextual Reminders**: Help users recall previous actions

Attention Limitations

- **Selective Attention**:
  - Humans focus on one primary task while filtering out distractions.
- **Change Blindness**:
  - Users often don't notice changes that occur outside their focus area.
- **Attention Economy**:
  - With infinite digital content competing for limited human attention, businesses must fight for user focus.
- **Design Strategies**:
  - **Visual Hierarchy**: Use size, color, contrast to guide attention
  - **Motion**: Subtle animations can direct attention without being distracting
  - **Notification Management**: Respect user attention with meaningful, timely alerts
  - **Focus States**: Make it clear what element is currently active

Perception Limitations

- **Visual Processing Speed**:
  - Humans can process images in as little as 13 milliseconds, but reading requires sequential attention.
- **Color Vision**:
  - 8% of men and 0.5% of women have some form of color blindness.
- **Business Impact**:
  - Color-only information excludes significant user populations.
- **Principles in Interface Design**:
  - **Proximity**: Related items should be visually grouped
  - **Similarity**: Similar items should look alike

Research

- **Contemporary HCI Challenges**
- **Business-Specific HCI Challenges**