

# HUMAN-AI INTERACTION

Eunsuk Kang

Required reading:

Building Intelligent Systems by Geoff Hulten (2018), Chapter 8.

*Guidelines for Human-AI Interaction.* Saleema Amershi, et al., in CHI 2019.

Optional reading:

*Will You Accept an Imperfect AI? Exploring Designs for Adjusting End-user Expectations of AI Systems.* Kocielnik, et al., in CHI 2019

# LEARNING GOALS

- Understand the risks of poor interaction design
- Understand the challenges behind designing human-AI interactions
- Understand the basic elements of user interaction design
- Consider design considerations for AI-based systems
  - Modes of interaction: Automate or augment?
  - Mental model: User understanding of what AI is doing
  - Dealing with errors: Guide user towards prevention & recovery
  - Feedback and control: Align user feedback with AI improvement

# WHAT'S COMING NEXT

## Fundamentals of Engineering AI-Enabled Systems

**Holistic system view:** AI and non-AI components, pipelines, stakeholders, environment interactions, feedback loops

### Requirements:

- System and model goals
- User requirements
- Environment assumptions
- Quality beyond accuracy
- Measurement
- Risk analysis
- Planning for mistakes

### Architecture + design:

- Modeling tradeoffs
- Deployment architecture
- Data science pipelines
- Telemetry, monitoring
- Anticipating evolution
- Big data processing
- Human-AI design

### Quality assurance:

- Model testing
- Data quality
- QA automation
- Testing in production
- Infrastructure quality
- Debugging

### Operations:

- Continuous deployment
- Contin. experimentation
- Configuration mgmt.
- Monitoring
- Versioning
- Big data
- DevOps, MLOps

**Teams and process:** Data science vs software eng. workflows, interdisciplinary teams, collaboration points, technical debt

## Responsible AI Engineering

Provenance,  
versioning,  
reproducibility

Safety

Security and  
privacy

Fairness

Interpretability  
and explainability

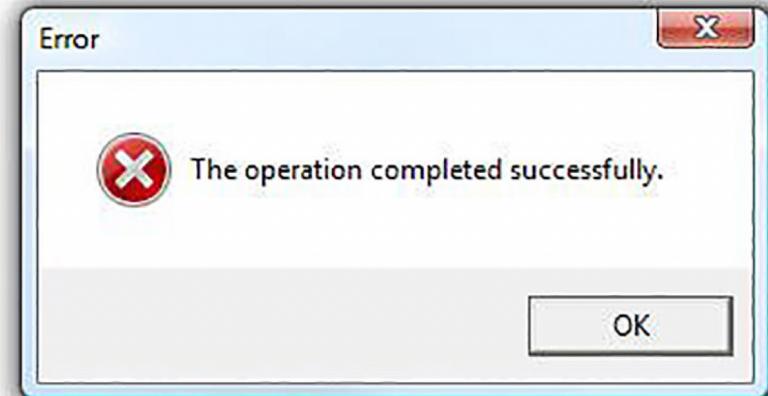
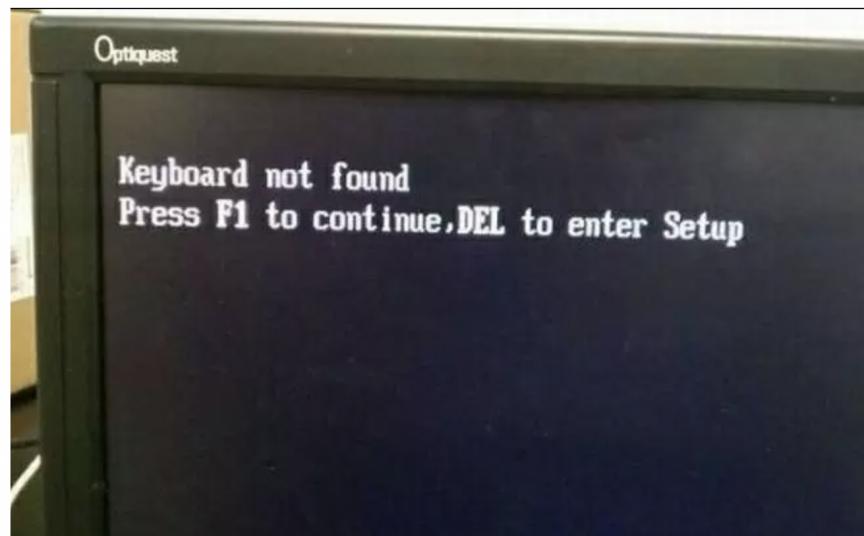
Transparency  
and trust

Ethics, governance, regulation, compliance, organizational culture



# RISKS OF POOR INTERACTION DESIGN

# POOR INTERACTION DESIGN CONFUSES USERS



# POOR INTERACTION DESIGN ANNOYS USERS



# POOR INTERACTION DESIGN CAUSES HARM

## Alexa recorded a woman's private conversation and sent it to a random contact

Kyle Wiggers

@Kyle\_L\_Wiggers

May 24, 2018 7:38 AM

f t in



# POOR INTERACTION DESIGN CAUSES HARM

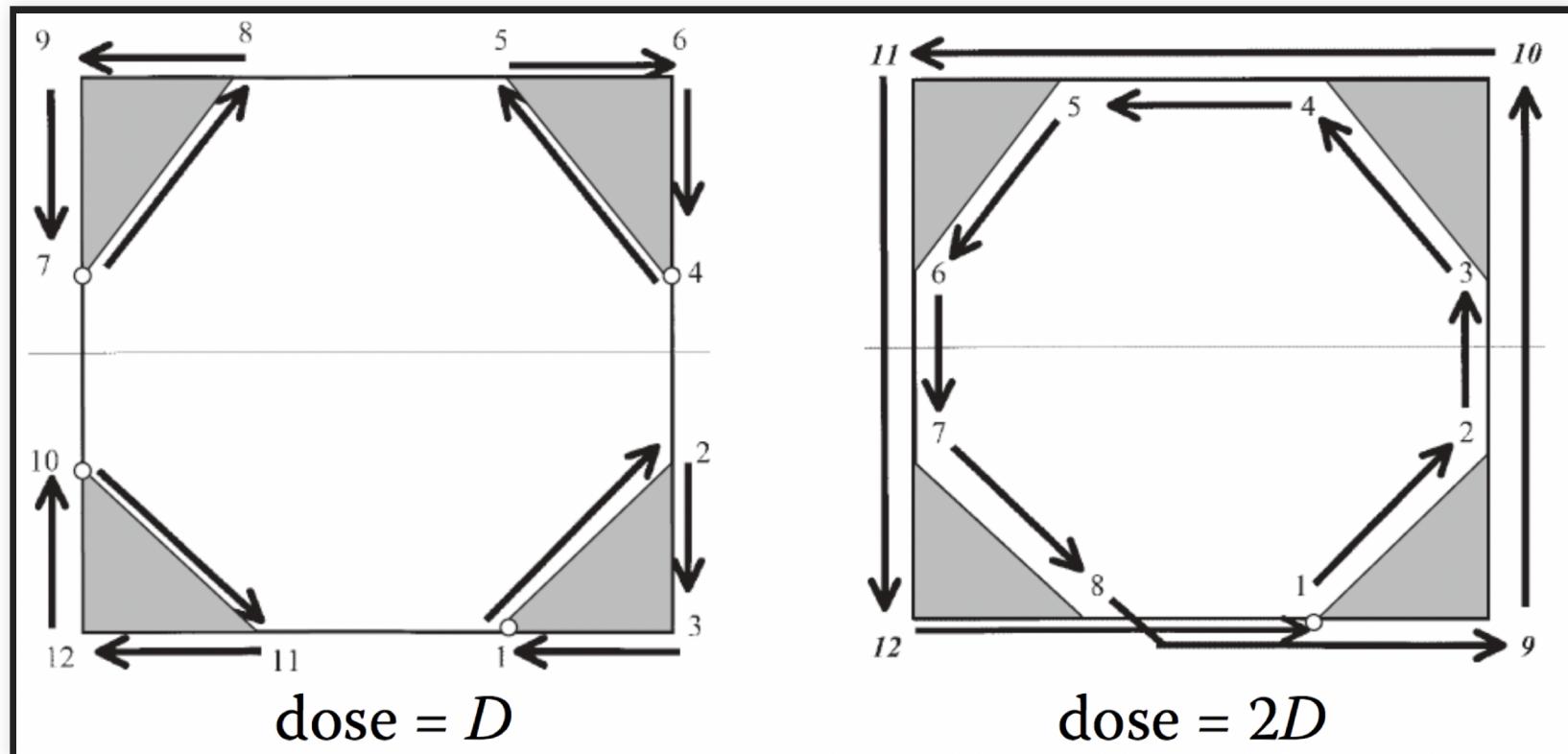


# POOR INTERACTION DESIGN CAUSES HARM



- Radiation therapy system at Panama City public hospital (2001)
  - Therapist draws block shapes to determine treatment area
  - Software computes final radiation settings

# POOR INTERACTION DESIGN CAUSES HARM



- Same shape drawn in different order, double the radiation dose
- 28 patients overdosed; 8 dead
  - Therapists charged with 2nd degree murder (but are they really to blame?)

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  - Contribute to security or privacy issues
  - Cause physical (injuries, deaths) and societal harms (bias, misrepresentation)

# USABILITY CONCEPTS

(This will be a brief tour to a complex subject. If you are interested, consider taking [05-318/618: Human-AI Interaction](#))

# DIMENSIONS OF USABILITY

<https://www.nngroup.com/articles/usability-101-introduction-to-usability/>

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- Satisfaction: How pleasant is it to use the design?

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# INTERACTION COST



- Mental and physical effort needed to perform a desired task
  - Task memorization & recall, context switch, track system state
  - Reading, scrolling, clicking, typing, waiting for UI changes
- **Goal of usable design:** Minimize interaction cost while allowing users to perform their tasks

# USABILITY & AI



- AI has potential to greatly reduce interaction costs
  - Automate tasks through personalization & predictions
- But also introduces new usability challenges
  - Q. What's new or hard about AI-based systems?

# USABILITY & AI



- AI has potential to greatly reduce interaction costs
  - Automate tasks through personalization & predictions
- But also introduces new usability challenges
  - **Unpredictability:** AI makes mistakes, sometimes unexpectedly
  - **Opaqueness:** User has difficulty understanding how system works
  - **Evolution:** AI behavior changes over time, surprising users

# DESIGN CONSIDERATIONS FOR AI

- **Modes of interaction:** Automate or augment?
- **Mental model:** User understanding of what AI is doing
- **Dealing with errors:** Guide user towards prevention & recovery
- **Feedback and control:** Align user feedback with AI improvement

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  - User enjoys performing the task (e.g., driving)

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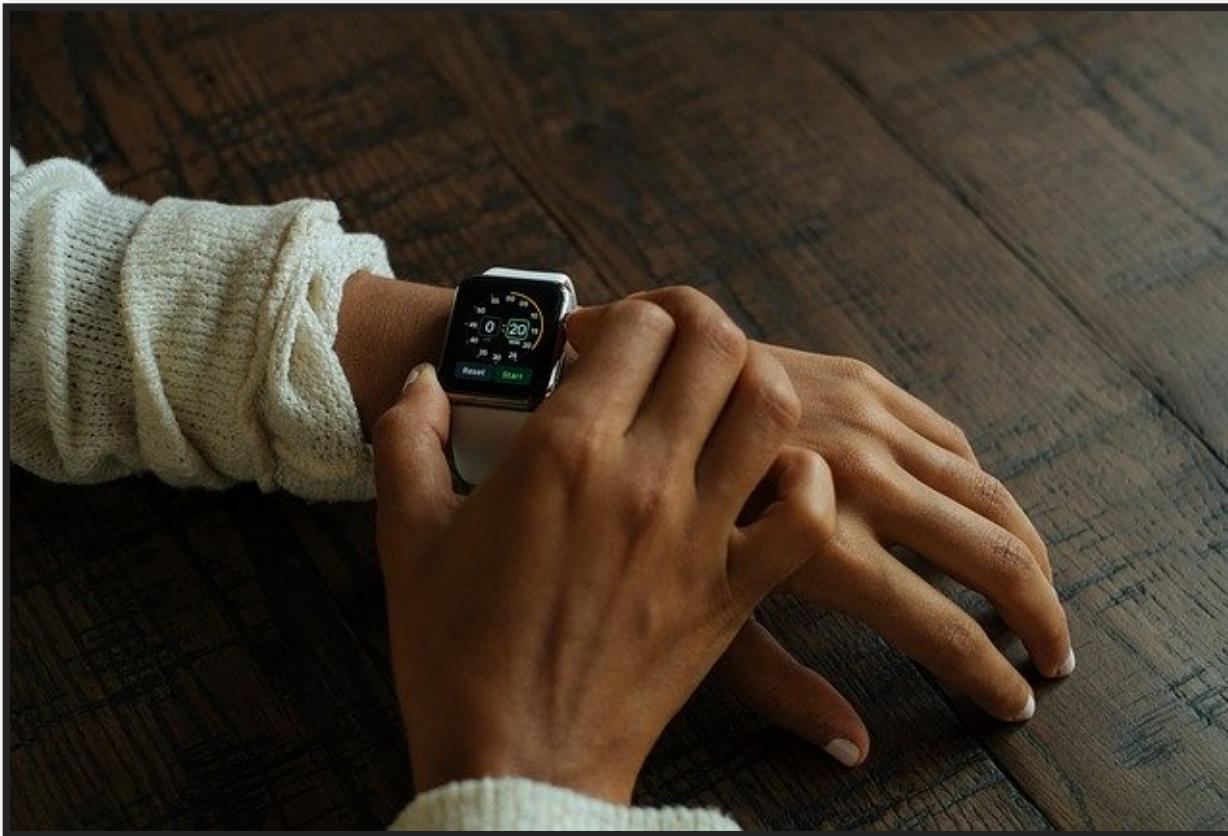
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- Cost: What is the effect of a wrong prediction?
  - If cost is too high, consider augmenting rather than automating
  - If possible, provide a way to undo the action of AI

# EXAMPLE: DESIGN SUGGESTIONS IN POWERPOINT



- Automate or Augment? Why?
- Forcefulness? (active vs. passive)
- Frequency?

# EXAMPLE: FALL DETECTION



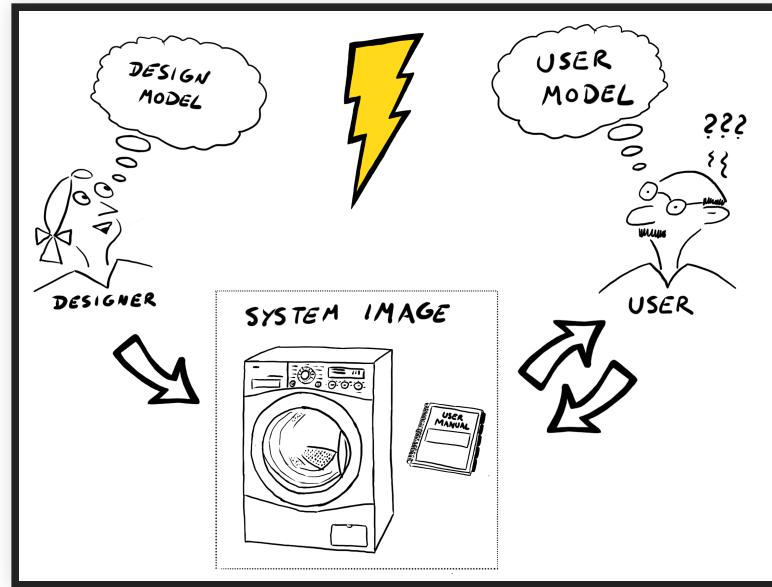
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  - "How does the system work? How does it respond to my actions?"
  - User plans actions and reacts to system based on this mental model
- Challenge: Aligning system with the user's mental model
  - Inherent mismatch between user's & designer's models
  - User's model may be preconceived based on prior experience
  - User's model and/or system evolves over time

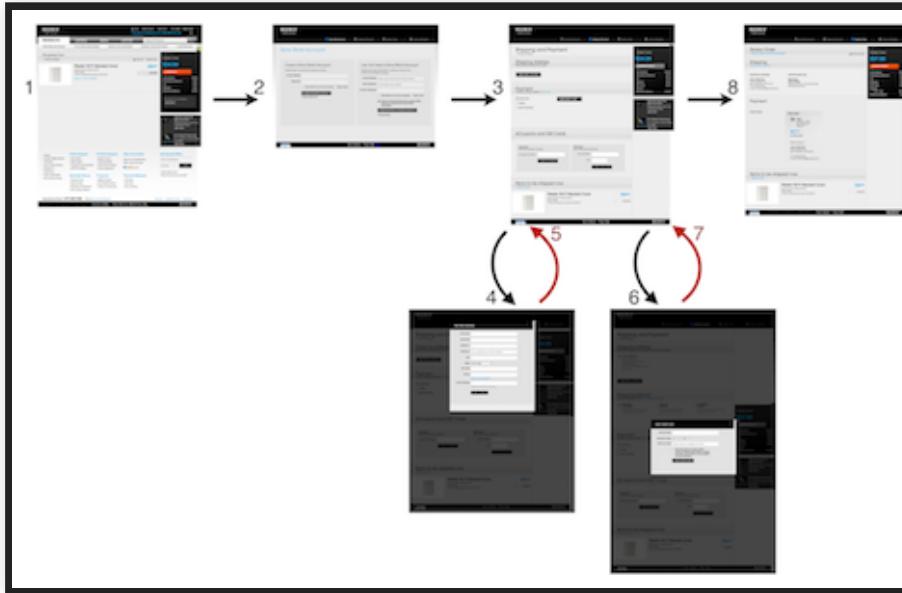
# EXAMPLE: SHOPPING CART CHECKOUT



Mental model for shopping cart = A linear sequence of familiar steps

1. Browse for items
2. Add items to cart
3. Choose checkout
4. Enter shipping & billing data
5. Press Order
6. Get confirmation

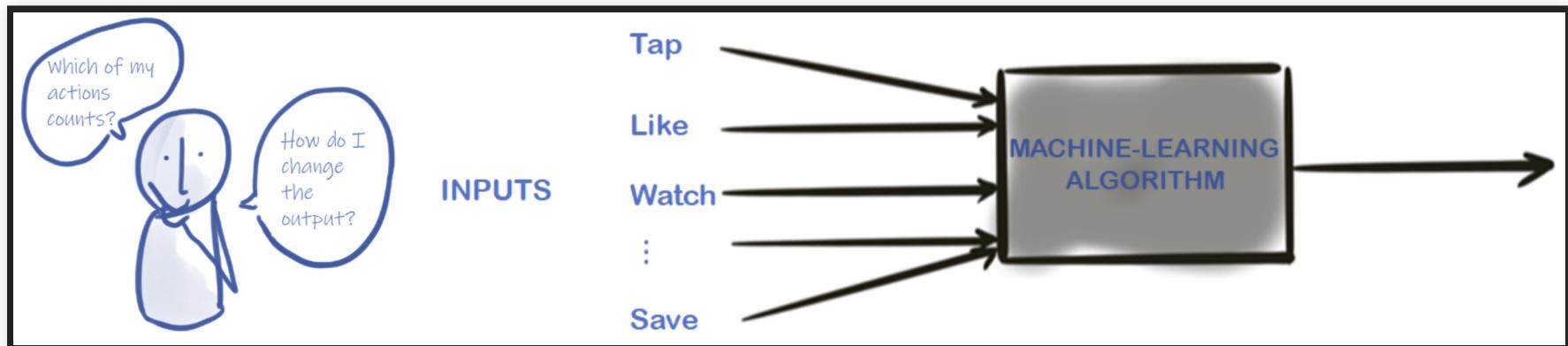
# BREAKING MENTAL MODEL



- Anti-pattern: Interrupt linear flow & bring user back to a previous step
  - Create an account, open a new dialog to enter preferred address...
  - Breaks user's mental model => failure to convert into sales
- ~60% of customers abandon their shopping cart

<https://baymard.com/blog/checkout-process-should-be-linear>

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- Lack of trust over output: How do I know the output is correct?



# MENTAL MODEL FOR VOICE ASSISTANTS?



Q. Can you describe what it does? What it cannot do?

# MENTAL MODEL FOR VOICE ASSISTANTS?



- Unclear, inconsistent mental model
  - An interface for other services?
  - "Handy helper"?
  - Knowledge repository? Fact-finding tool?

<https://www.nngroup.com/articles/mental-model-ai-assistants/>



# MISALIGNMENT IN VOICE ASSISTANTS



- AI often fails to meet user expectations
  - (1) User doesn't know how to get AI to do X
  - (2) User says X, but AI can't do X well
- Users settle on simple tasks over time; small but limited improvements



# MISALIGNMENT IN MENTAL MODELS

*“So, this week, I realized that I don't use my IA nearly as much as I thought I did. I do use it often. However it's very much normally the same like five things over and over again.”*

- User settles on a suboptimal mental model & fails to benefit from the full capabilities of AI

<https://www.nngroup.com/articles/mental-model-ai-assistants/>

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- Improve/adjust the user's mental model
  - Set the user's expectations through onboarding
  - Increase transparency and explain decisions made by AI
  - Allow user to adjust system behavior to match their expectations

# ONBOARDING: SET USER'S MENTAL MODEL

The image displays two screenshots of a document editing application interface, illustrating the onboarding process for setting user mental models.

**Screenshot 1:** A blue callout box on the left says: "This is presumably what a document you've loaded into the app would look like. It seems like a really nice and simple interface!" A blue callout box on the right says: "Ooh! A pulsing hotspot! appears on the first highlighted grammatical error! Let me click..." A blue callout box at the bottom right says: "Clicking the hotspot, I get a little tooltip explaining how this all works!"

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**Demo document**

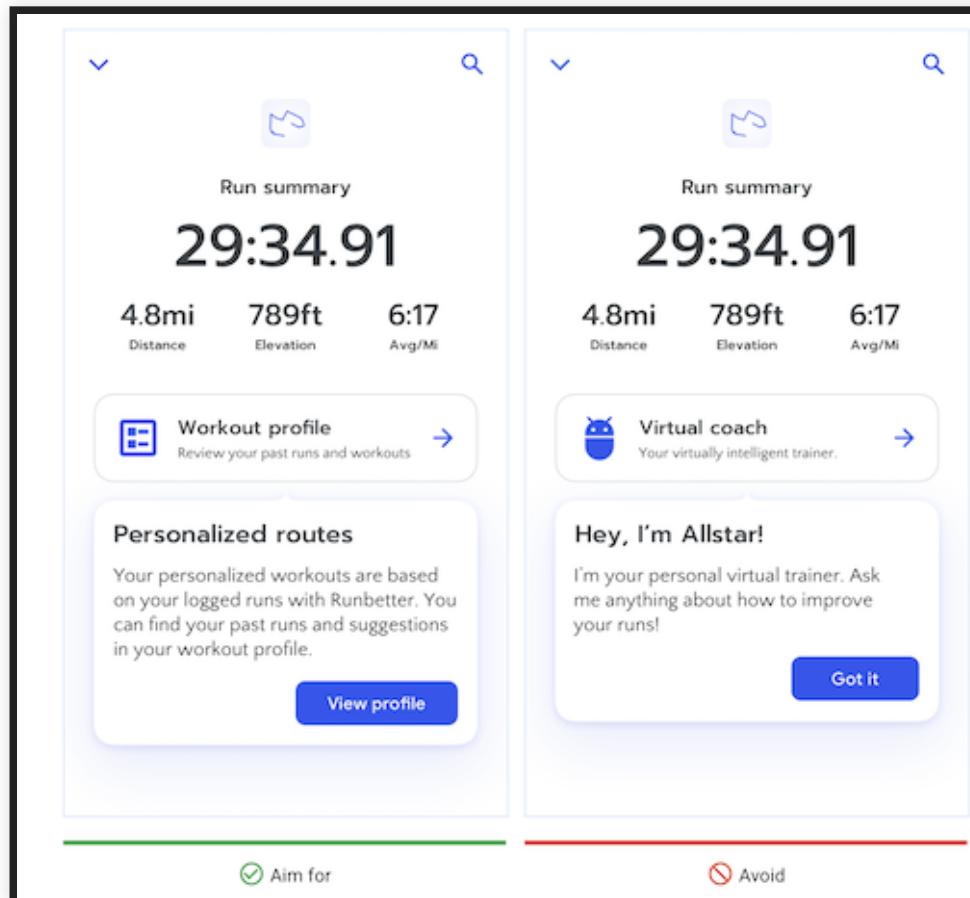
Remember when you were a careless eight year old kid riding a bike with your friends, racing each other around the neighborhood? Remember that feeling of absolute freedom as you felt the wind in your hair and the smile it put on your face? I never thought I would feel that way as a grown up, until my friends presented me a red brand-new bike. At first, I was a bit skeptical about the total idea of commuting by bike. One morning a couple of days later, I changed completely my mind. I was stuck at a traffic jam and saw in my rear mirror a man in a suit riding a classy bike with his laptop case in one hand and a handlebar in the other. I figured out it would take him about 15 minutes to get to the office while I was still sitting in my car and waiting for the cars in line ahead to move, even if just for a inch. I was always very afraid of being late for my business.

**In-line corrections**

Hover your mouse over underlined words to fix issues with one click.

- Provide examples of how the system works

# ONBOARDING: SET USER'S MENTAL MODEL

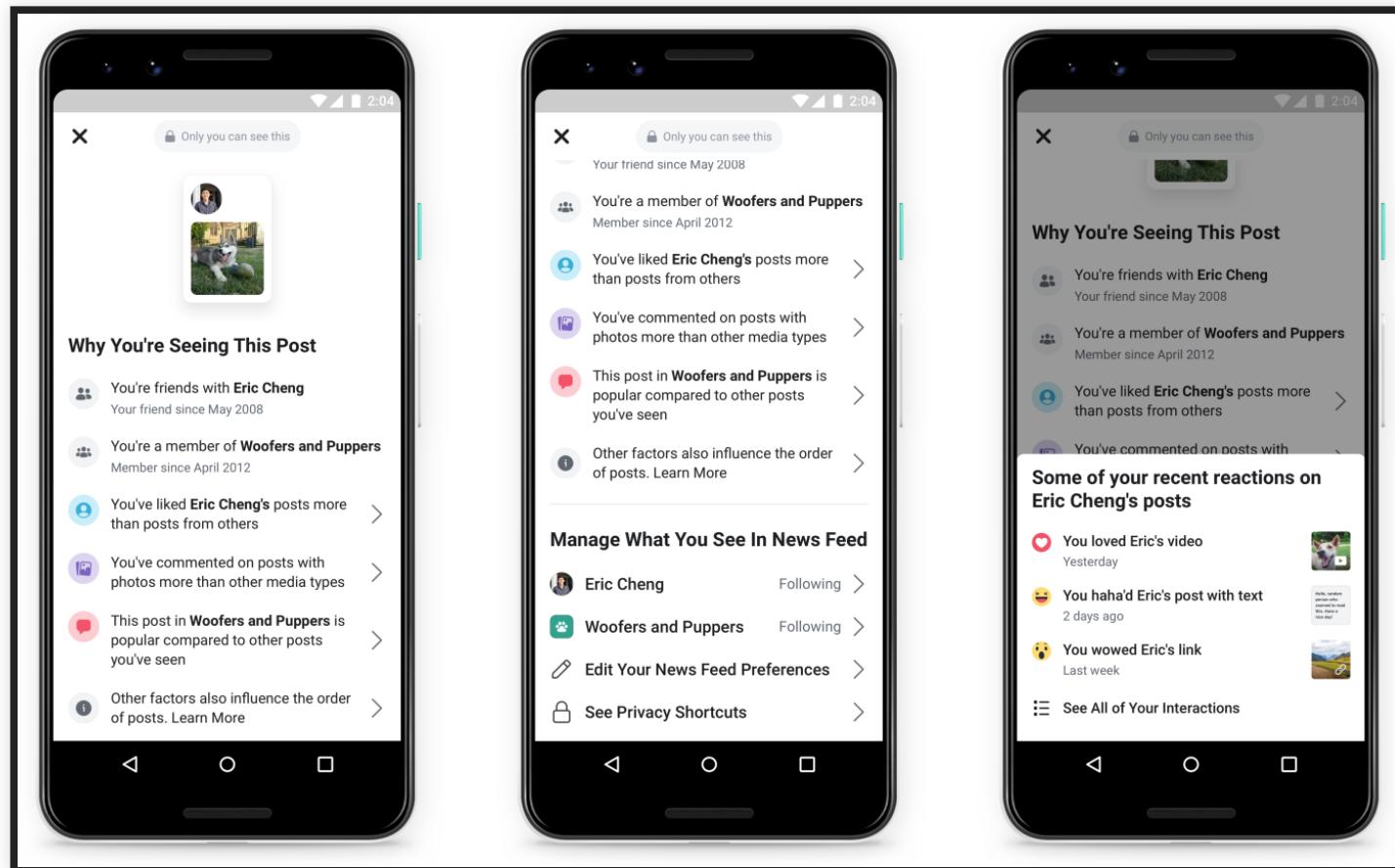


- Be explicit about what system can and cannot do

<https://pair.withgoogle.com/chapter/mental-models/>



# TRANSPARENCY: EXPLAIN HOW DECISIONS ARE MADE



- Explain how the user's input actions influence output

# DEALING WITH ERRORS

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- User errors: Mistakes made by users (e.g., click on a wrong button)
  - Lots of work in cognitive science & human factors
  - Error taxonomies, human performance modeling, task analysis, ergonomic analysis, etc.,
  - Often due to misalignment of mental models
- System errors: Failure to provide an outcome expected by the user
  - Due to mistakes made by an ML model
  - **Our focus in this lecture**

# EXAMPLE: SCHEDULING ASSISTANT

The screenshot illustrates a scheduling assistant interface. On the left, under 'Inbox' (labeled A), there are several email entries:

- John Bass: Saturday December 29, We will plan on Meeting at Al's Formal Wear at 1P...
- Kate Bush: keeping the lights on, John- ,Was lovely meeting you this weekend. ,Sorry...
- Daphne Co: Dinner, Hi Eric, ,Would you and Shanna like to meet us for...
- Sally Beck: Per Your Request, Sally, ,Please find attached the file that we discuss...

On the right, a card labeled B shows a message from John Bass on Saturday December 29. It includes a profile picture of John Bass (JB) and the text: "We will plan on Meeting at Al's Formal Wear at 1PM on that Saturday. I will see you all then." Below this, a message from Jason states: "We think we've found an event". The card also displays inferred information: Date: Sat Aug 25 2018 and Time: 01:00 pm. At the bottom are buttons for Create Appointment, Cancel, and Edit details. A red box labeled C encloses the inferred event information. A red box labeled D encloses the reply and cancel buttons.

- Analyze e-mail content for possible meeting scheduling
- Suggest creating a new meeting based on inferred information

*Will You Accept an Imperfect AI? Exploring Designs for Adjusting End-user Expectations of AI Systems. Kocielnik, et al. (CHI 2019)*

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- Provide meaningful error messages to the user
  - Provide an explanation for the error
  - Suggest actions to fix the error (e.g., "Edit details" option)

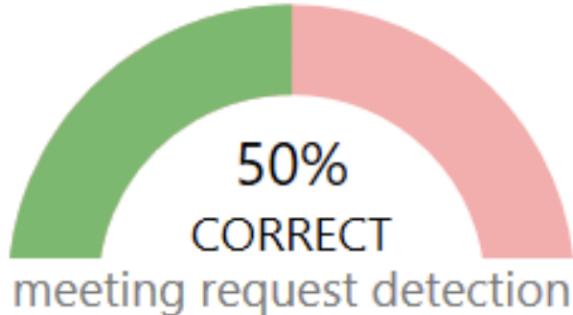
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- Give user controls to recover from and mitigate the effect of an error
  - e.g., delete or modify incorrect meeting schedule

# SETTING USER EXPECTATIONS FOR ML ERRORS



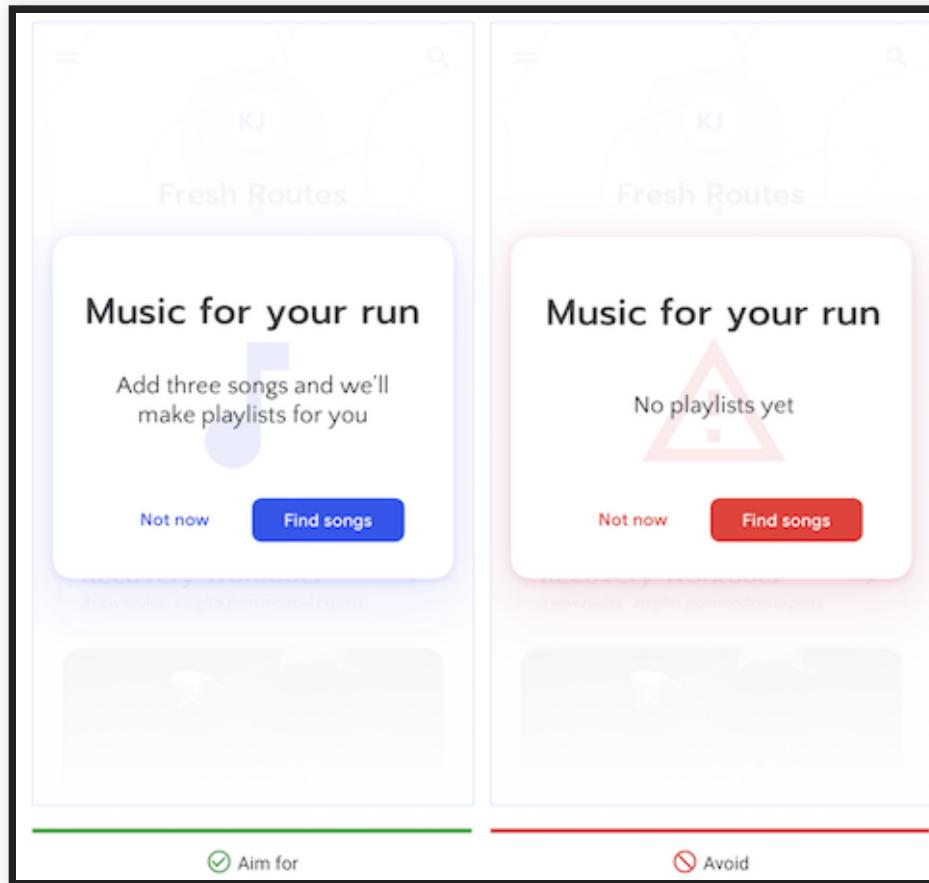
The Scheduling Assistant can correctly detect meeting requests about 50% of the time.



- Be upfront about how well the system performs (e.g., model accuracy)
- Temper the user's expectations and avoid surprises

*Will You Accept an Imperfect AI? Exploring Designs for Adjusting End-user Expectations of AI Systems.* Kocielnik, et. al. (CHI 2019)

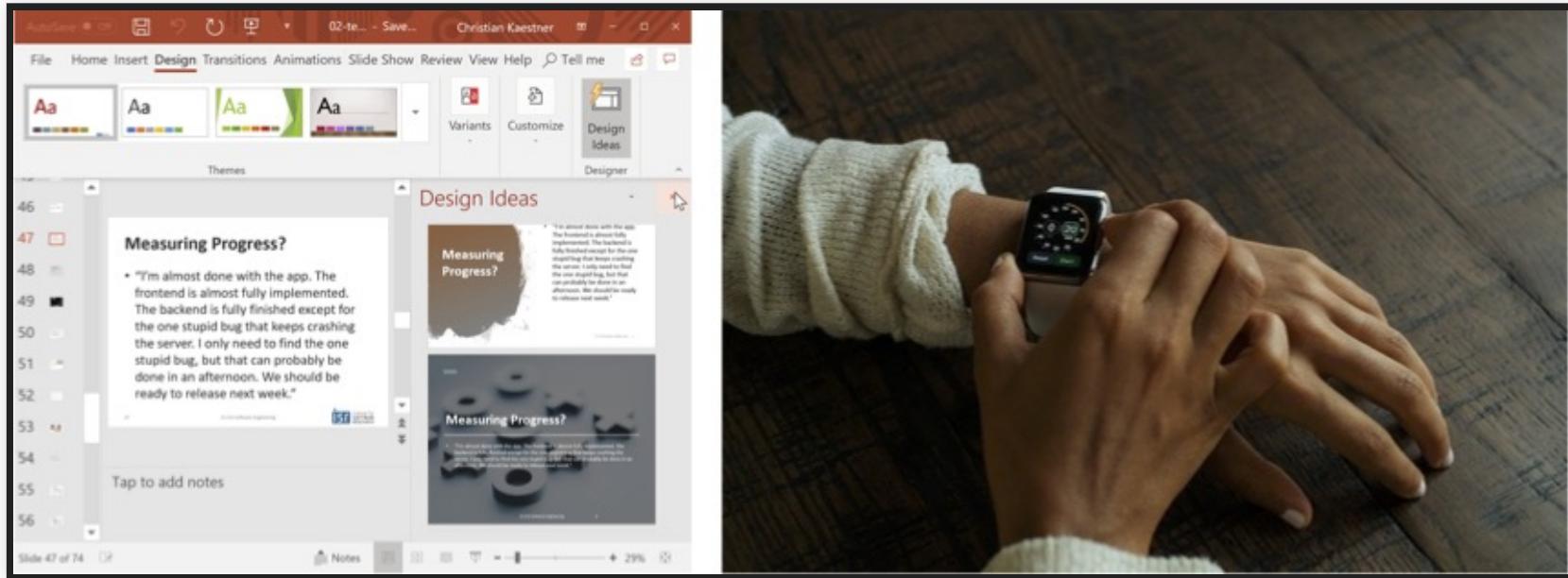
# ERROR MESSAGES: SUGGEST USER ACTIONS



- Tell the user what the AI needs in order to behave as intended
- Guide the user towards ways to recover from/prevent further errors

<https://pair.withgoogle.com/chapter/errors-failing/>

# BREAKOUT: DEALING WITH ERRORS



The image is a composite of two parts. On the left, a screenshot of a Microsoft PowerPoint slide titled "Measuring Progress?" is shown. The slide contains a bulleted list: "I'm almost done with the app. The frontend is almost fully implemented. The backend is fully finished except for the one stupid bug that keeps crashing the server. I only need to find the one stupid bug, but that can probably be done in an afternoon. We should be ready to release next week." On the right, a photograph shows a person's hands resting on a dark wooden surface. One hand is wearing a black Apple Watch, which is displaying a digital clock interface.

Design suggestions/fall detection

- In #lecture, type:
  - Possible error(s):
  - How to detect the error:
  - How to allow the user to recover from error:
  - What additional data to collect (from user) to reduce future errors:

# FEEDBACK AND CONTROL

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  - Surveys, ratings, thumbs up, feedback forms, etc.,

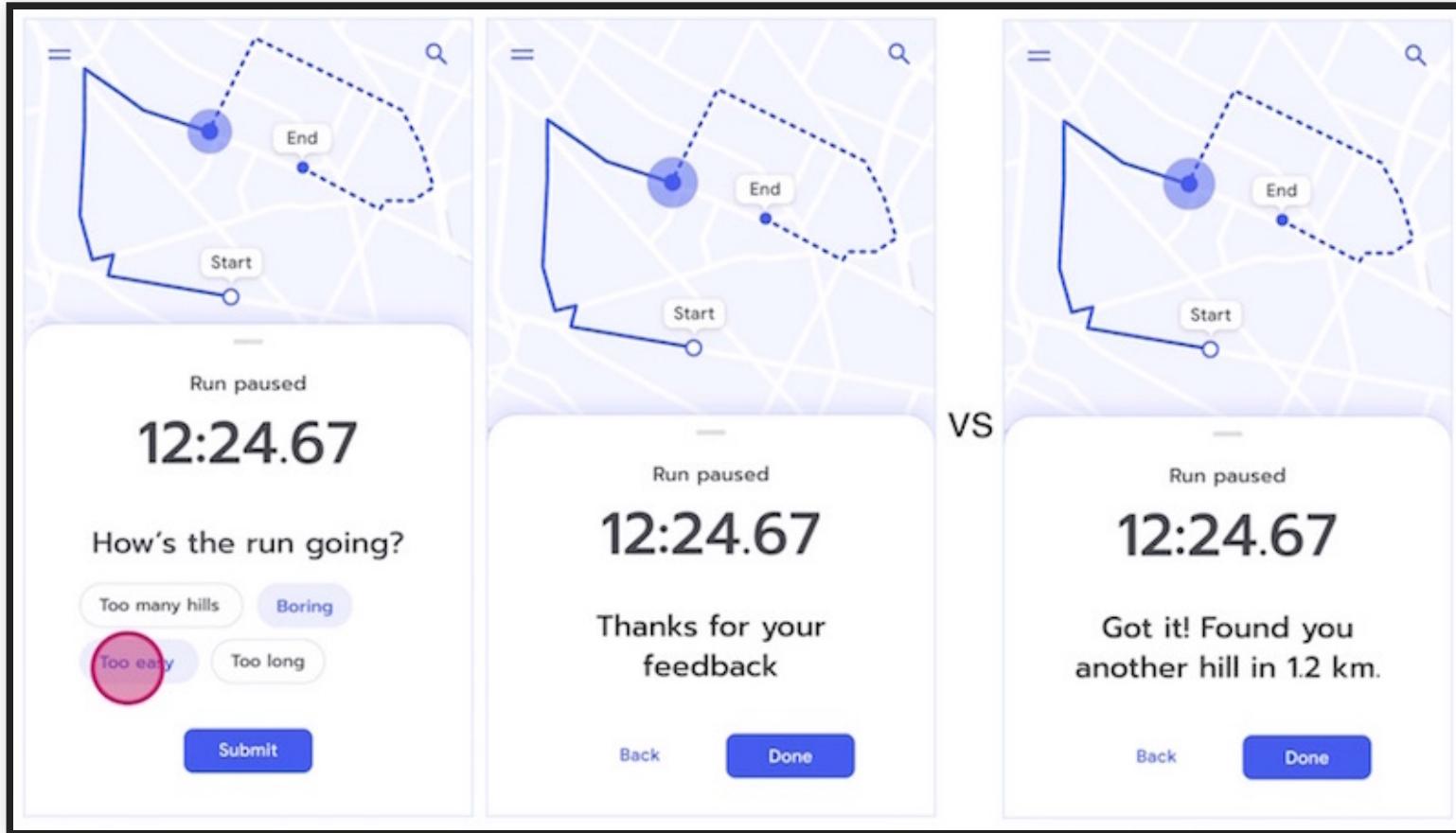
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- Implicit feedback: Data about user behaviors collected by system
  - e.g., times of day, duration of usage, recommendations accepted/rejected, click patterns, etc.,
- Explicit feedback: Prompted or deliberately provided by user
  - Surveys, ratings, thumbs up, feedback forms, etc.,
- Design considerations for feedback
  - Align feedback with improving interactions (and AI)
  - Acknowledge user feedback & respond immediately

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  - Align feedback with improving interactions (and AI)
  - Acknowledge user feedback & respond immediately
- In addition to feedback, provide a way for user to adjust AI behavior

# RESPONDING TO FEEDBACK



- When possible, respond to feedback with an adjustment to AI behavior

<https://pair.withgoogle.com/chapter/feedback-controls/>



# GIVING USER CONTROL



- Provide a mechanism for user to adjust system behavior

# GIVING USER CONTROL OVER ML BEHAVIOR



Adjust how aggressive you would want the Scheduling Assistant to be in detecting meetings in your emails:



**Fewer detections**  
some requests  
might be missed



**More detections**  
more non-requests  
might be suggested



- Provide a mechanism for the user to control the types of ML errors
- Scheduling assistant: Adjust thresholds to achieve trade-offs between precision vs recall

# GUIDELINES FOR HUMAN-AI INTERACTIONS

# Guidelines for Human-AI Interaction

<b>INITIALLY</b>							
	1 INITIALLY Make clear what the system can do. <small>Help the user understand what the AI system is capable of doing.</small>	2 INITIALLY Make clear how well the system can do what it can do. <small>Help the user understand how often the AI system may make mistakes.</small>					
<b>DURING INTERACTION</b>	3 DURING INTERACTION Time services based on context. <small>Time when to act or interrupt based on the user's current task and environment.</small>	4 DURING INTERACTION Show contextually relevant information. <small>Display information relevant to the user's current task and environment.</small>	5 DURING INTERACTION Match relevant social norms. <small>Ensure the experience is delivered in a way that users would expect, given their social and cultural contexts.</small>	6 DURING INTERACTION Mitigate social biases. <small>Ensure the AI system's language and behaviors do not reinforce undesirable and unfair stereotypes and biases.</small>			
<b>WHEN WRONG</b>							
	7 WHEN WRONG Support efficient invocation. <small>Make it easy to invoke or request the AI system's services when needed.</small>	8 WHEN WRONG Support efficient dismissal. <small>Make it easy to dismiss or ignore undesired system services.</small>	9 WHEN WRONG Support efficient correction. <small>Make it easy to edit, refine, or recover when the AI system is wrong.</small>	10 WHEN WRONG Scope services when in doubt. <small>Engage in disengagement or gracefully degrade the AI system's services when uncertain about a user's goals.</small>	11 WHEN WRONG Make clear why the system did what it did. <small>Enable the user to access an explanation of why the AI system behaved as it did.</small>		
<b>OVER TIME</b>	12 OVER TIME Remember recent interactions. <small>Maintain short-term memory and allow the user to make efficient references to that memory.</small>	13 OVER TIME Learn from user behavior. <small>Personalize the user's experience by learning from their actions over time.</small>	14 OVER TIME Update and adapt cautiously. <small>Limit sensitive changes when updating and adapting the AI system's behaviors.</small>	15 OVER TIME Encourage granular feedback. <small>Enable the user to provide feedback indicating their preferences during regular interaction with the AI system.</small>	16 OVER TIME Convey the consequences of user actions. <small>Immediately update, or convey how user actions will affect future behaviors of the AI system.</small>	17 OVER TIME Provide global controls. <small>Allow the user to globally customize what the AI system monitors and how it behaves.</small>	18 OVER TIME Notify users about changes. <small>Inform the user when the AI system adds or updates its capabilities.</small>

The Guidelines for Human-AI Interaction will help you create AI systems and features that are human-centered. We hope you use them throughout your design process – as you evaluate existing ideas, brainstorm new ones, and collaborate with the multiple perspectives involved in creating AI.

These guidelines synthesize more than 20 years of thinking and research in human-AI interaction. Learn more: <https://aka.ms/aiguidelines>.



# HUMAN-AI INTERACTIONS

Human-AI interactions must be considered throughout the entire ML lifecycle!

- Requirements & design
  - Understand user needs & their mental models
  - Explicitly design system to match the mental model
- During interaction
  - Consider factors for interaction (automate vs augment, forcefulness, frequency)
- When errors occur
  - Provide an explanation & actionable information
  - Provide ways for user to adjust AI behavior
- Maintenance and evolution
  - Collect user feedback and improve model
  - Adjust system design to reduce mental model mismatch

# SUMMARY

- Goal of usable design: Minimize interaction cost
  - Automation does not necessarily imply reduced cost!
- Interaction design considerations for AI
  - Modes of interaction: Automate or augment?
  - Mental model: User understanding of what AI is doing
  - Dealing with errors: Guide user towards prevention & recovery
  - Feedback and control: Align user feedback with AI improvement