

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

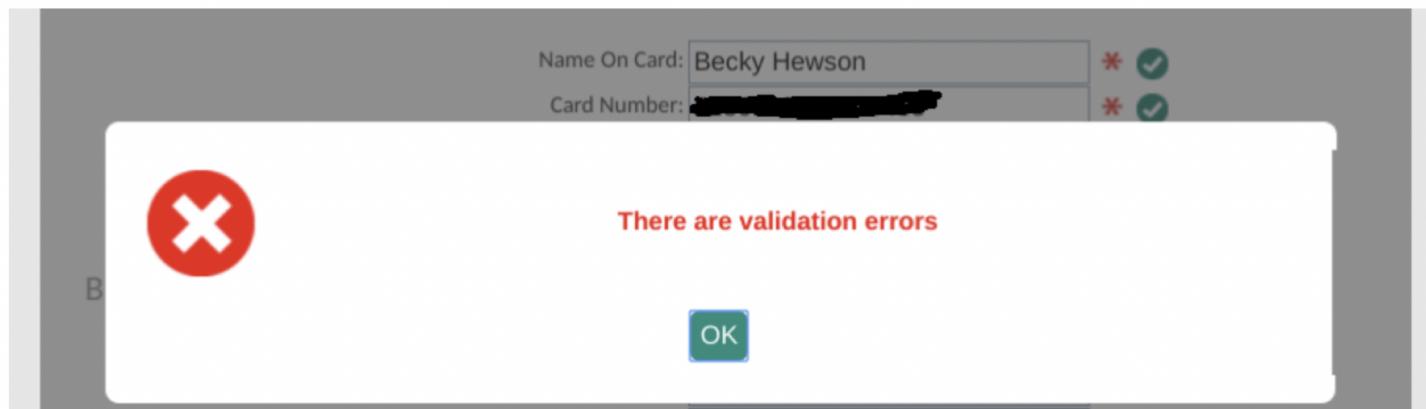
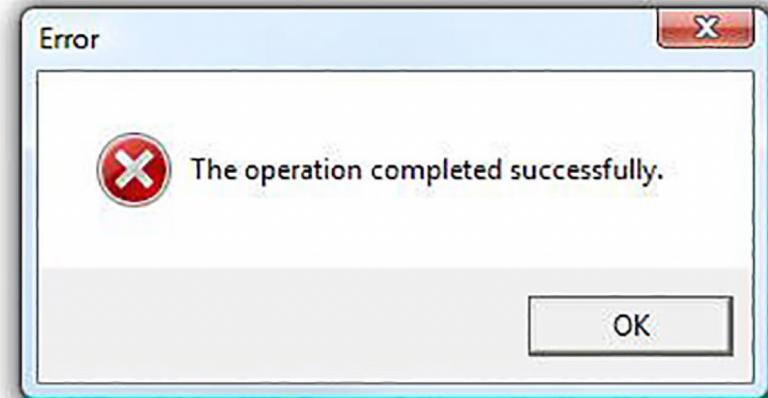
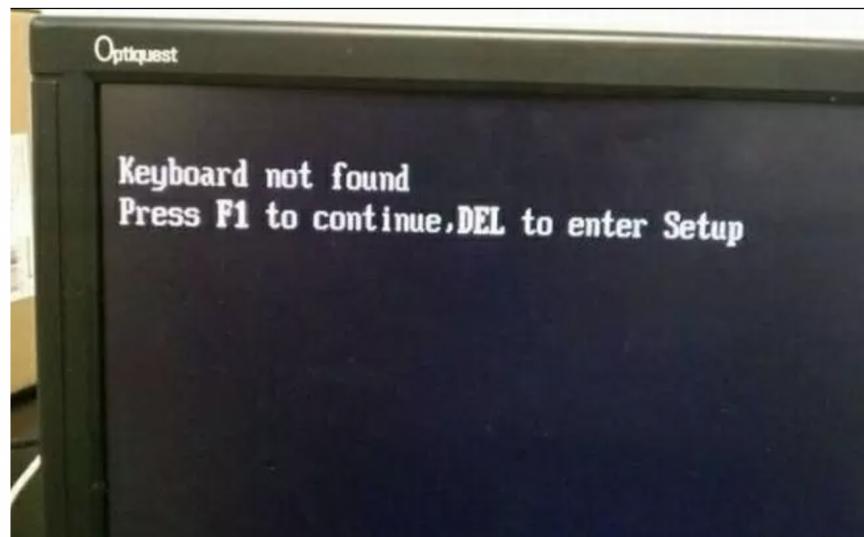
Interpretability
and explainability

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

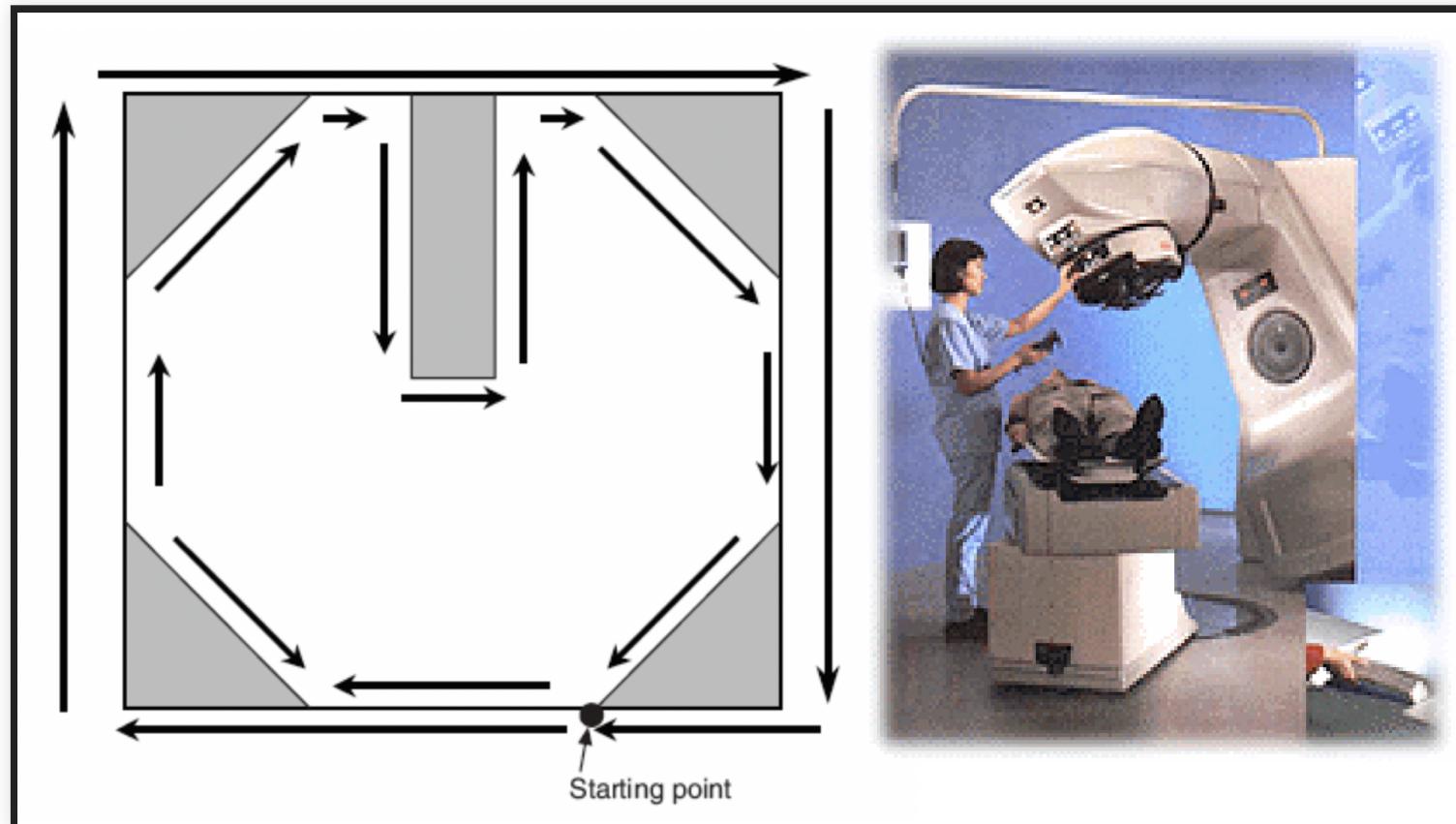
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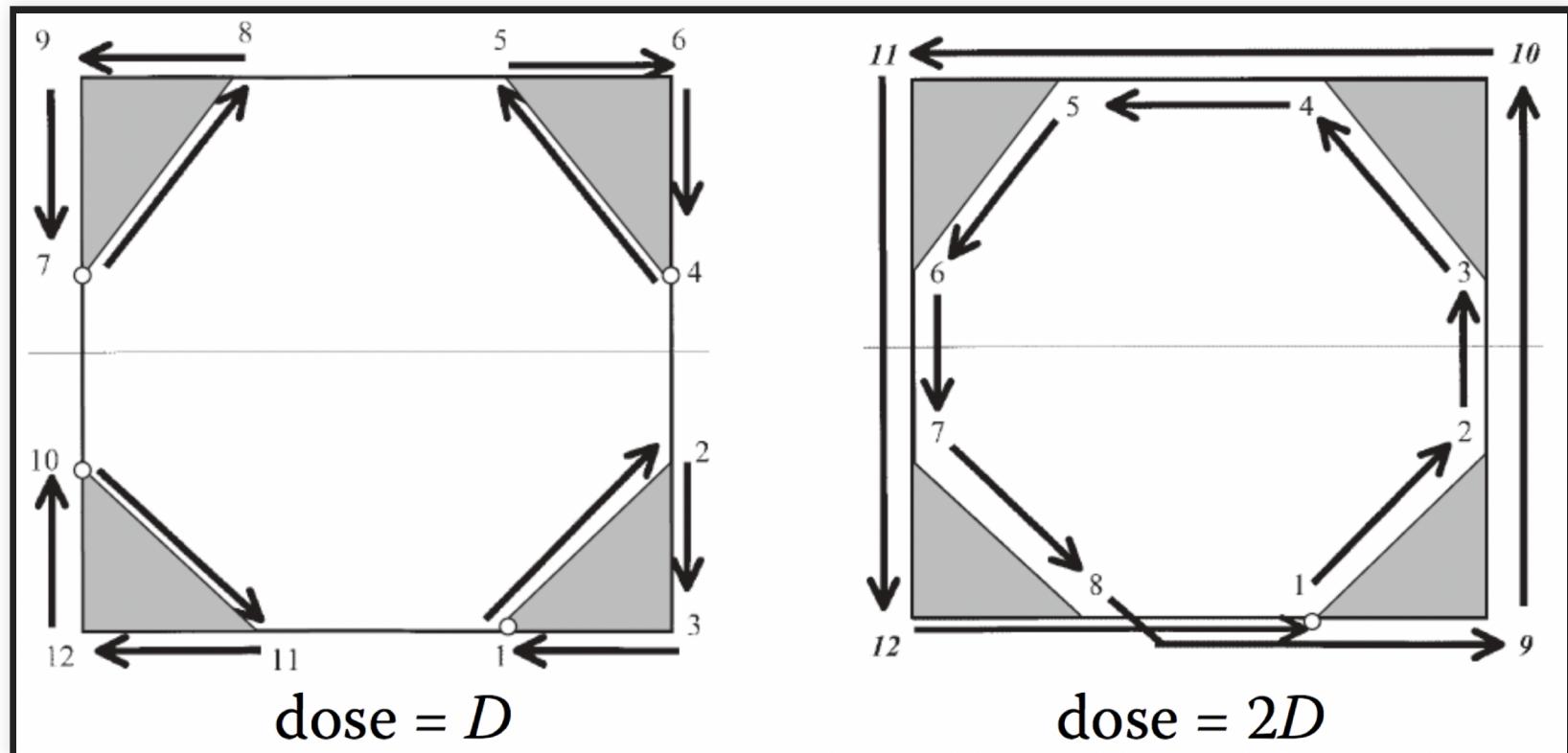


POOR INTERACTION DESIGN CAUSES HARM



- 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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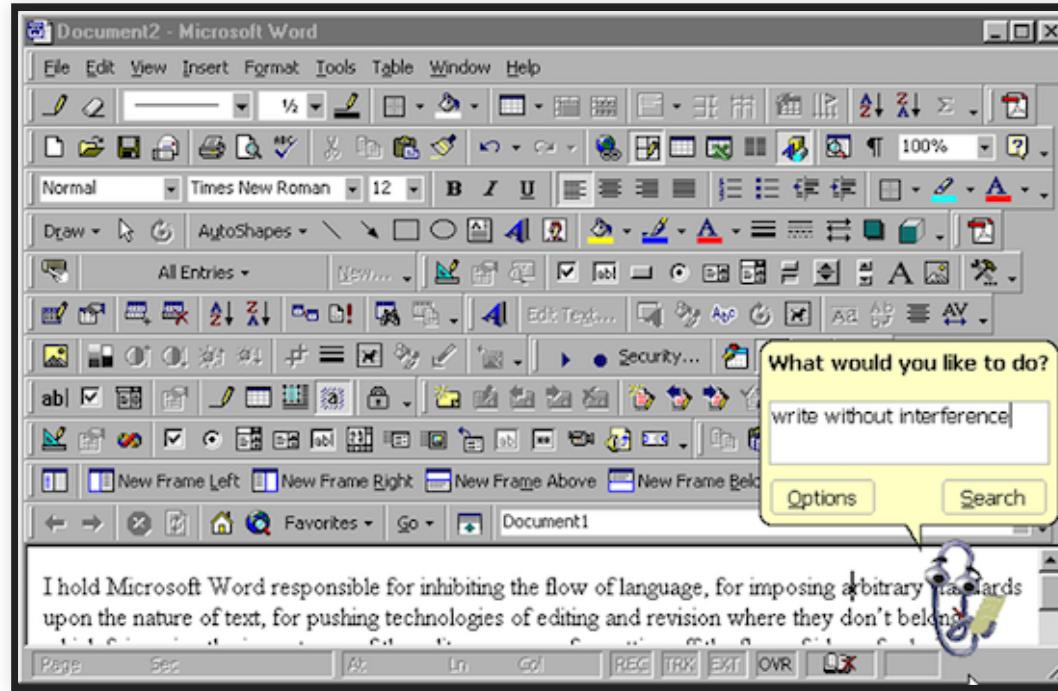
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- Errors: How often do users make errors, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

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

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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 - Difficult to communicate the user's need to AI
 - User enjoys performing the task (e.g., driving)

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- Forcefulness: How strongly to encourage taking an action?
 - Active: Automate action or interrupt user and ask for confirmation
 - Passive: Suggest action, but do not require immediate answer

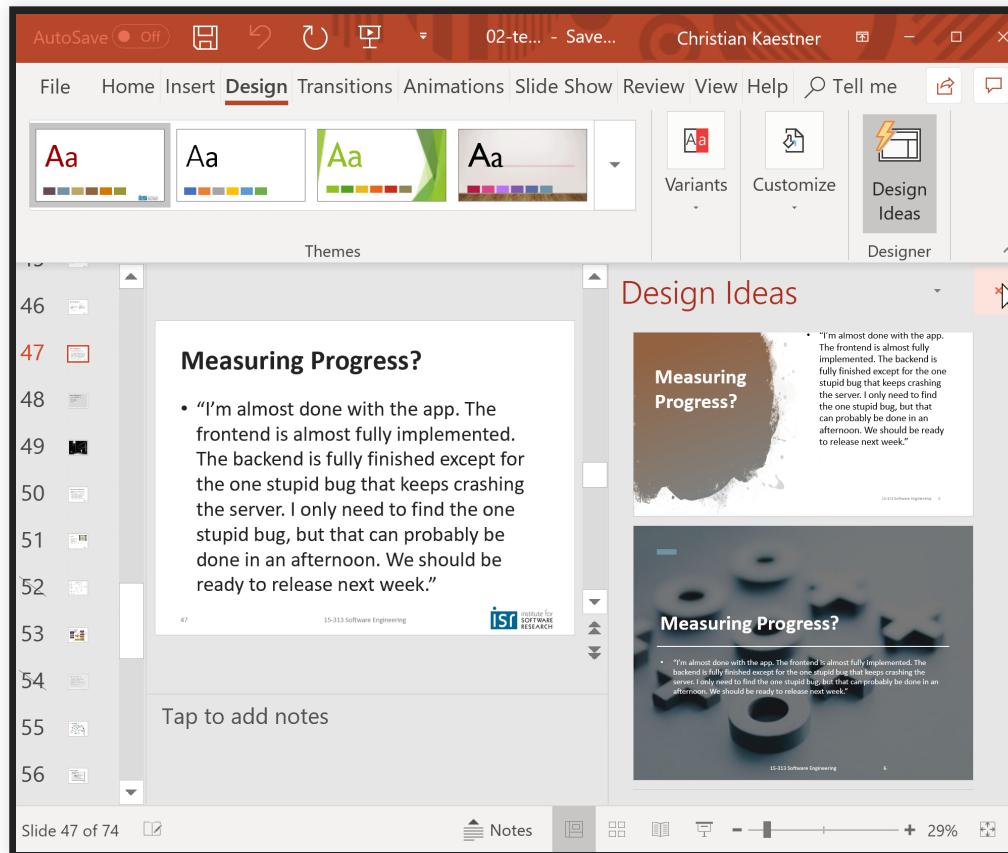
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- Cost: What is the effect of a wrong prediction?
 - If cost is too high, consider augmenting rather than automating
 - If possible, provide a way to undo the action of AI

EXAMPLE: DESIGN SUGGESTIONS IN POWERPOINT



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

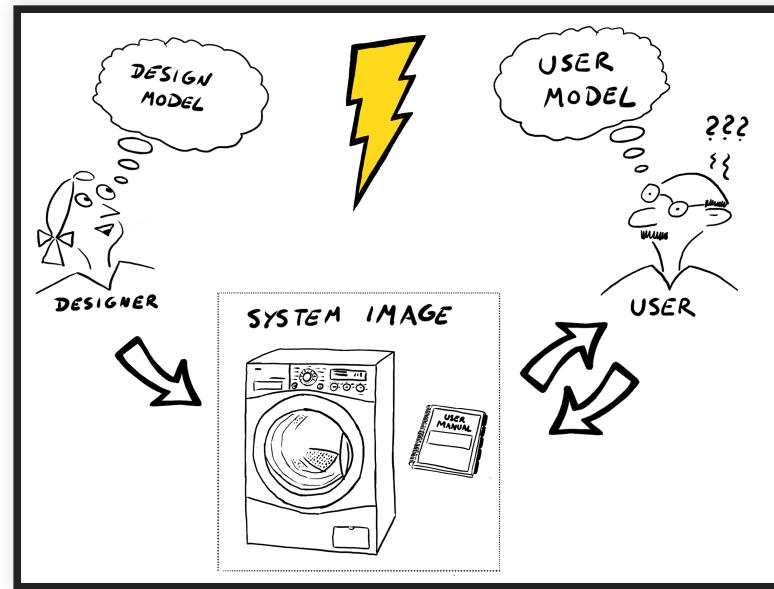
EXAMPLE: FALL DETECTION



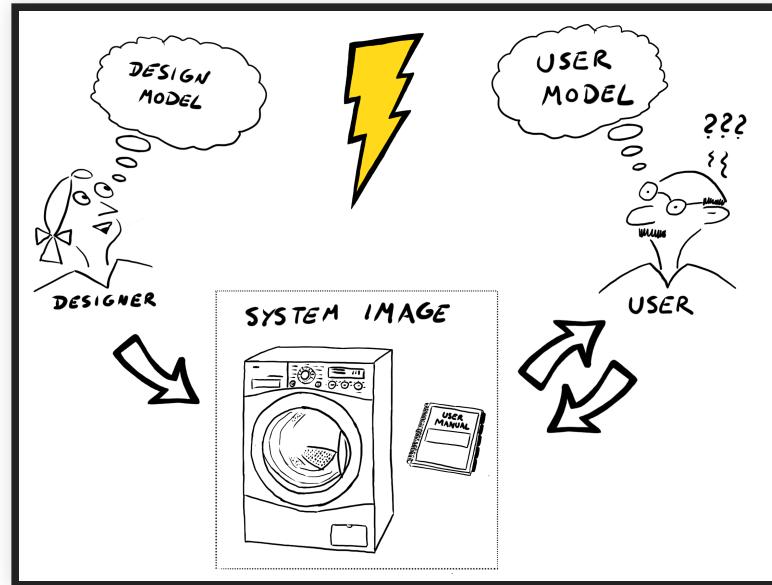
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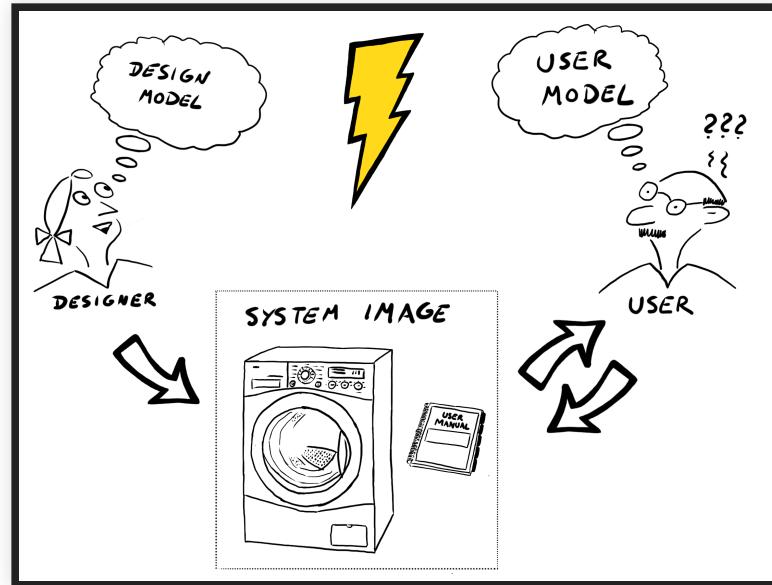


MENTAL MODEL



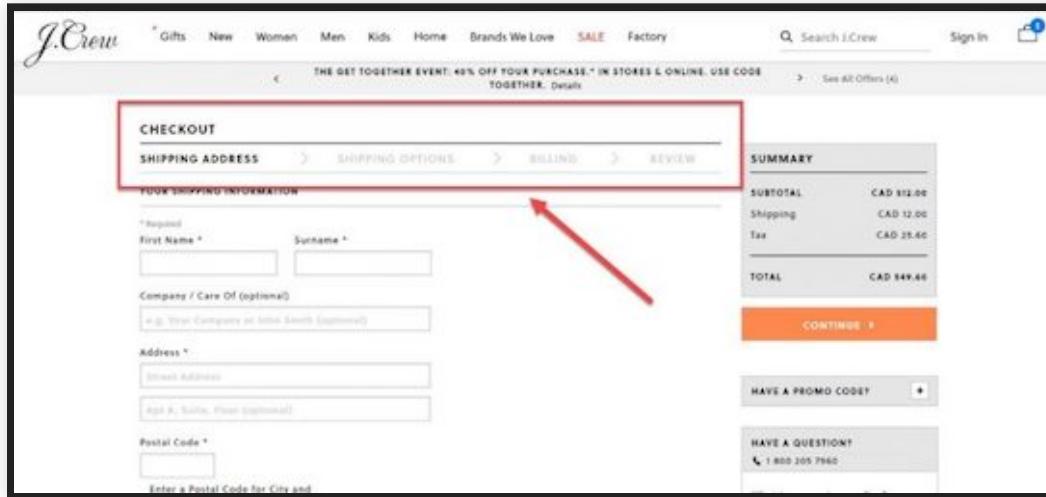
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 - "How does the system work? How does it respond to my actions?"
 - User plans actions and reacts to system based on this mental model

MENTAL MODEL



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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

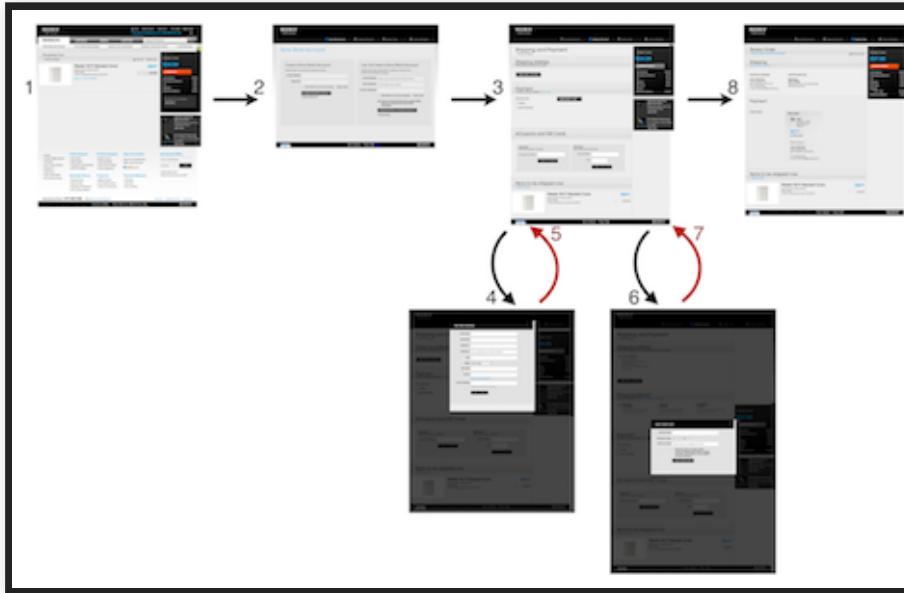
EXAMPLE: SHOPPING CART CHECKOUT



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

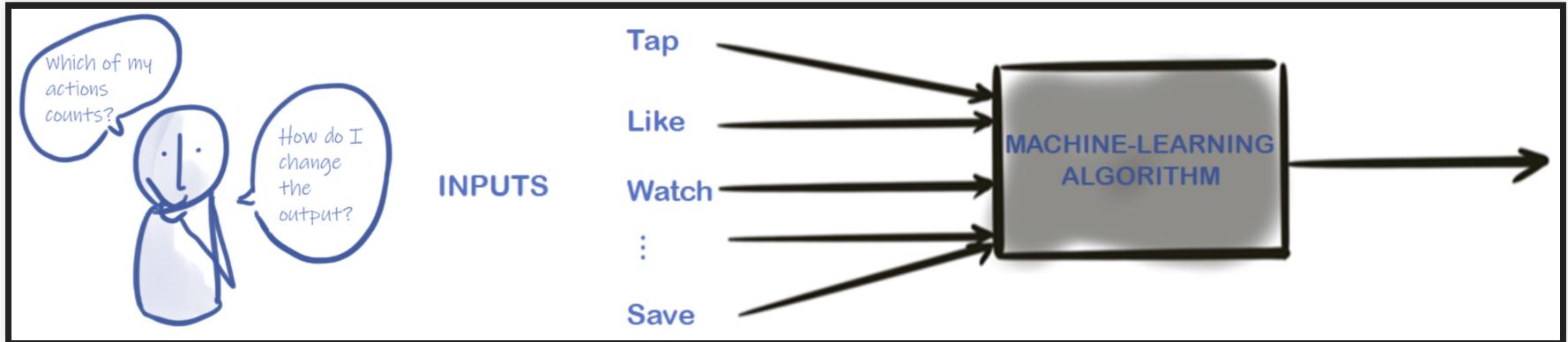
BREAKING MENTAL MODEL



- 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

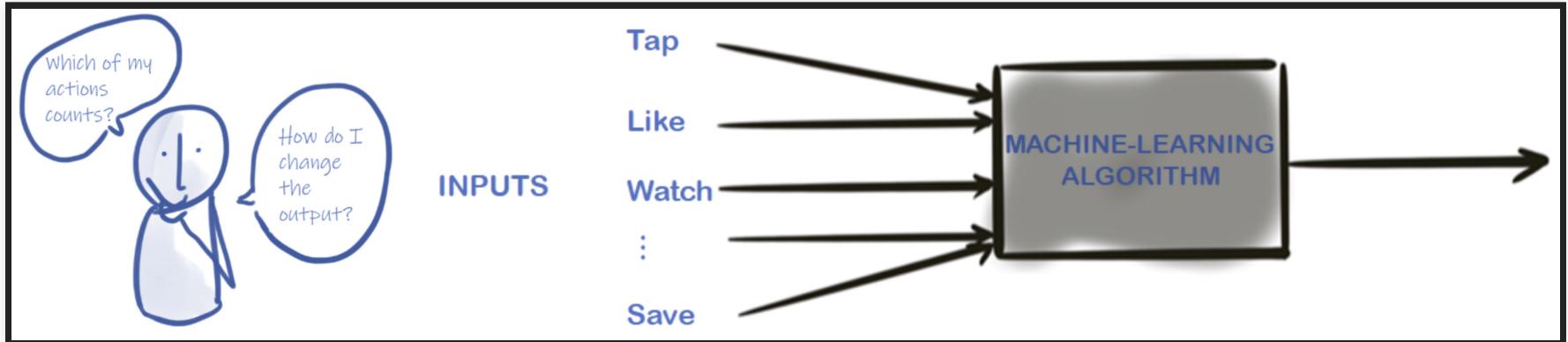
<https://baymard.com/blog/checkout-process-should-be-linear>

MENTAL MODEL FOR AI-BASED SYSTEMS



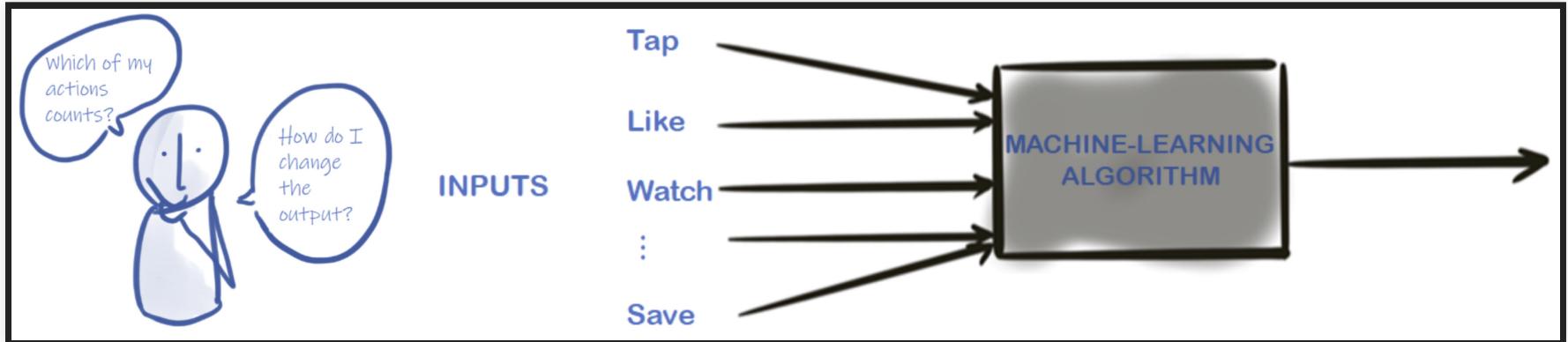
- User: "What is AI doing, and how do I use it?"
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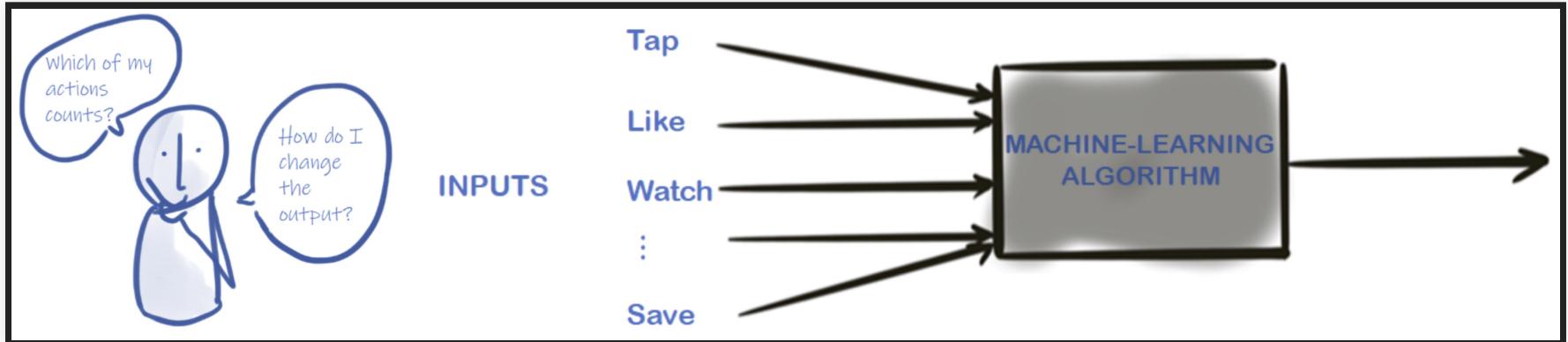
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- Lack of control over output: Why am I being given these recommendations? Why is the output displayed in this order?
- Lack of trust over output: How do I know the output is correct?

MENTAL MODEL FOR VOICE ASSISTANTS?



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

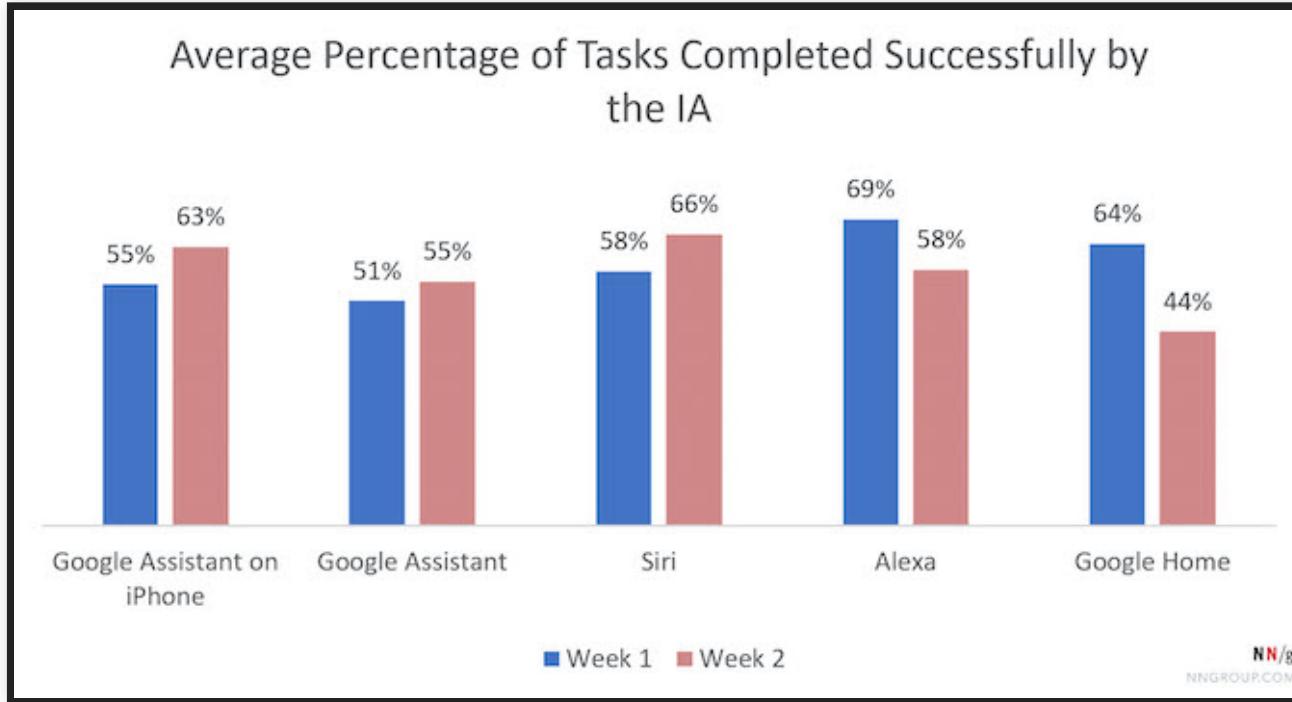
MENTAL MODEL FOR VOICE ASSISTANTS?



- 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

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 - Identify potential mismatch vs. user's mental model
- 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

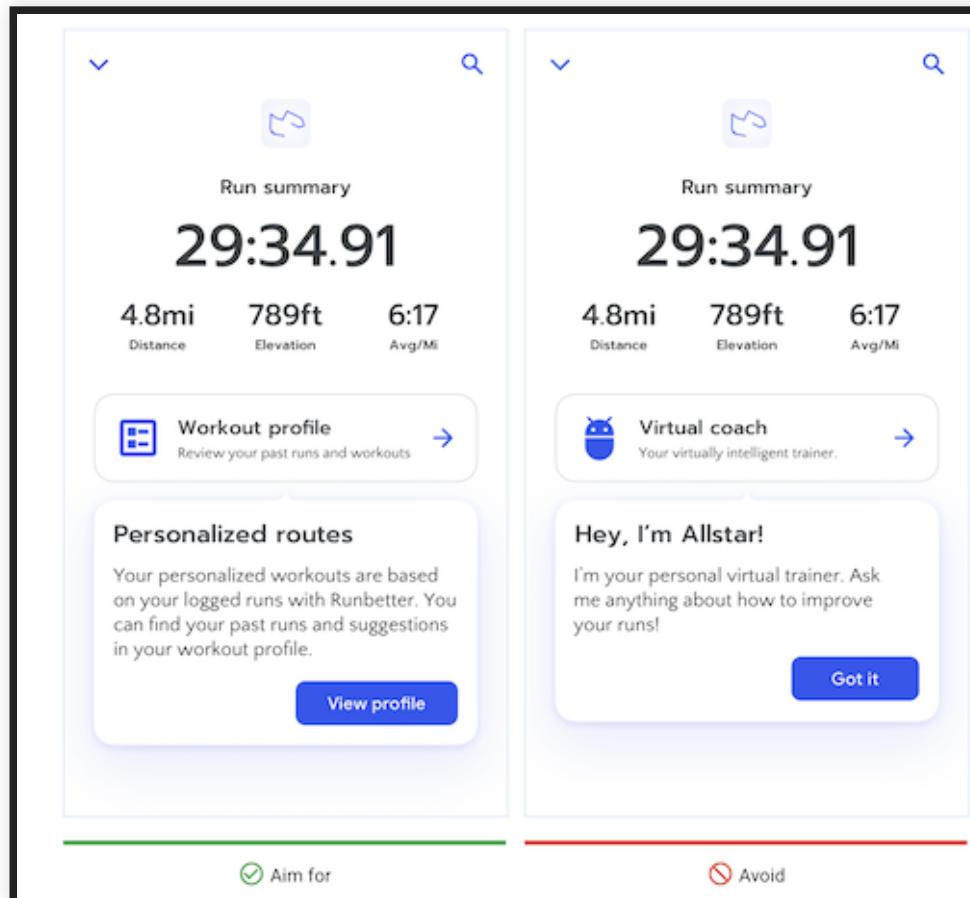
The image displays two screenshots of a document editing application interface, illustrating the onboarding process for setting user mental models.

Screenshot 1: Shows a document titled "Demo document". 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...". The document text includes several underlined errors: "eight year old", "grown up", and "a inch".

Screenshot 2: Shows the same document after interacting with the hotspots. A tooltip appears over the first underlined error ("eight year old") with the title "In-line corrections" and the instruction: "Hover your mouse over underlined words to fix issues with one click.". A blue callout box on the right says: "Clicking the hotspot, I get a little tooltip explaining how this all works!". Another blue callout box below it says: "Ok, what's next? Let me close...".

- Provide examples of how the system works

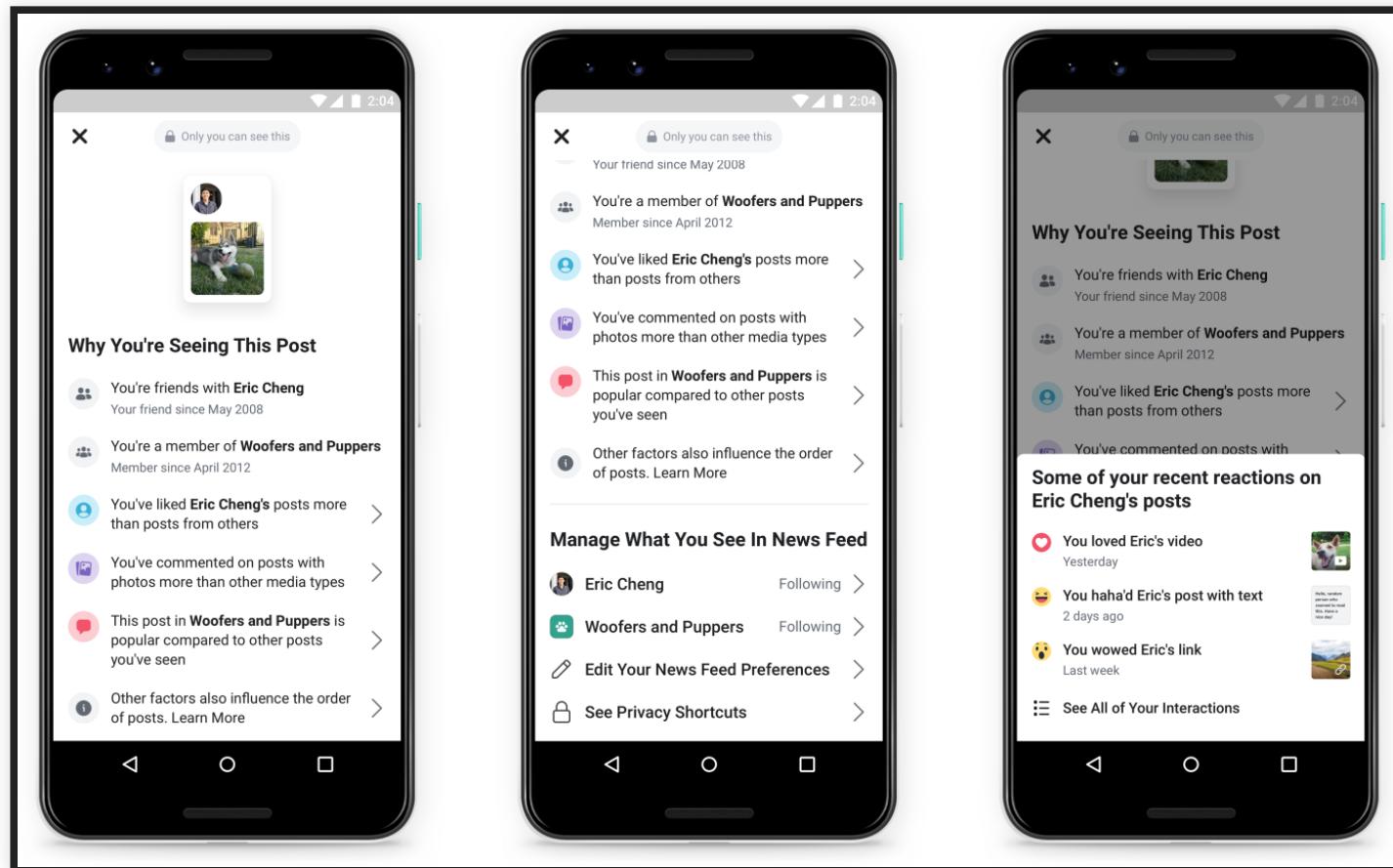
ONBOARDING: SET USER'S MENTAL MODEL



- 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 scheduled event for Saturday December 29 with John Bass. A message from Jason (labeled C) suggests creating a new appointment for Saturday, August 25, 2018, at 01:00 pm. The card has a 'Reply' button (labeled D).

Inbox (A):

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Scheduled Event (B):

Saturday December 29

JB John Bass
Wed Aug 22 2018 10:57 AM
Eric Ramiro

We will plan on Meeting at Al's Formal Wear at 1PM on that Saturday. I will see you all then.
Jason

We think we've found an event

Date: Sat Aug 25 2018
Time: 01:00 pm

Buttons (C):

Create Appointment Cancel Edit details

Reply Button (D):

Reply | v

- 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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- Define types of errors & their costs
 - False positives vs. false negatives
 - Optimize for one with lower costs
 - Q. For meeting scheduling, which are more acceptable?

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 - Poor/bias training data, noise in data, data drifts

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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)

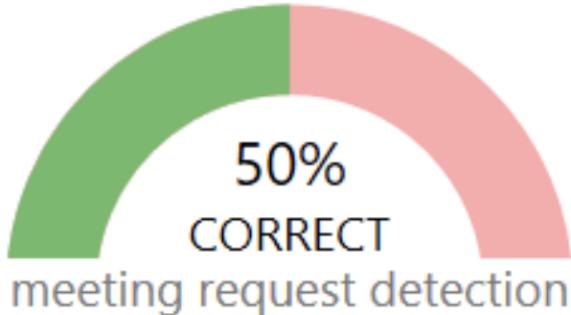
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- Give user controls to recover from and mitigate the effect of an error
 - e.g., delete or modify incorrect meeting schedule

SETTING USER EXPECTATIONS FOR ML ERRORS



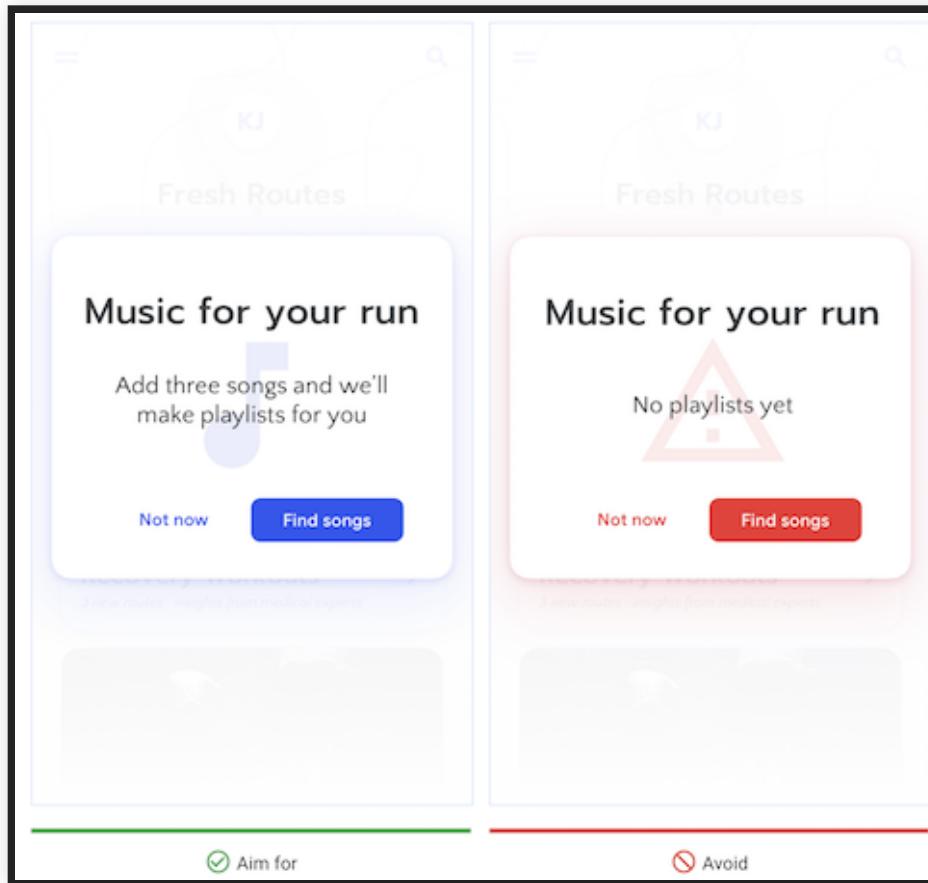
The Scheduling Assistant can correctly detect meeting requests about 50% of the time.



- 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)

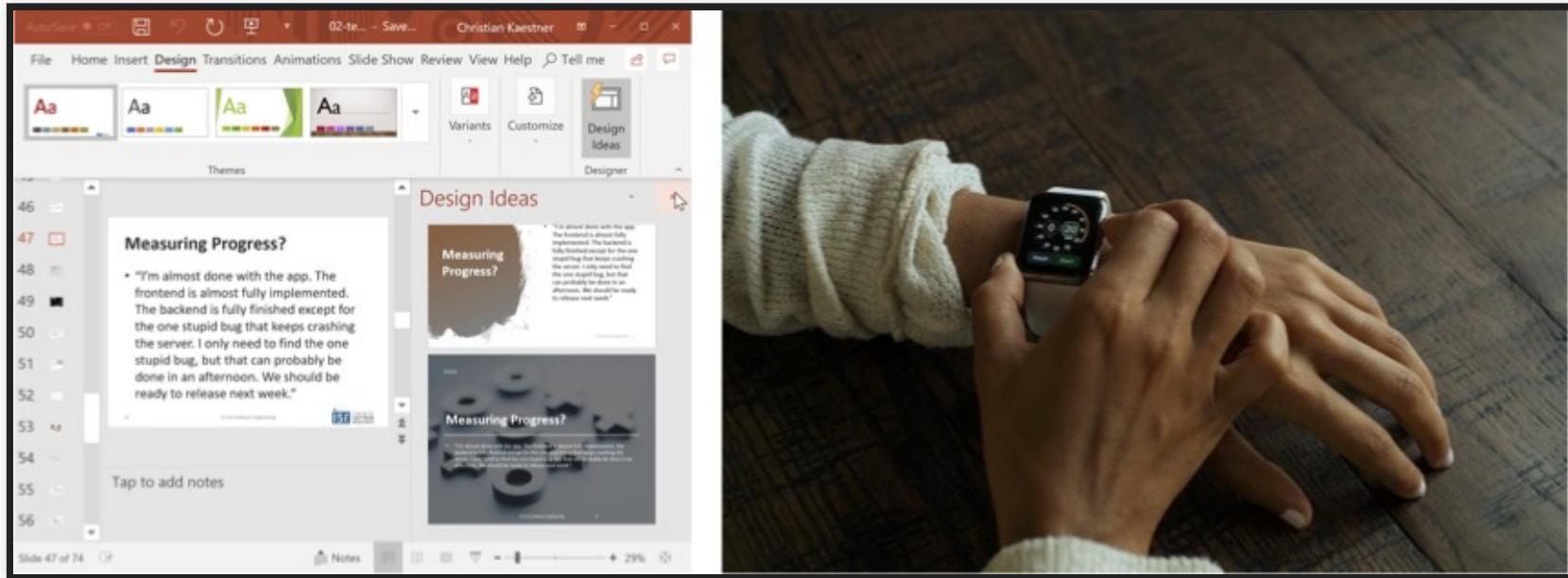
ERROR MESSAGES: SUGGEST USER ACTIONS



- 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



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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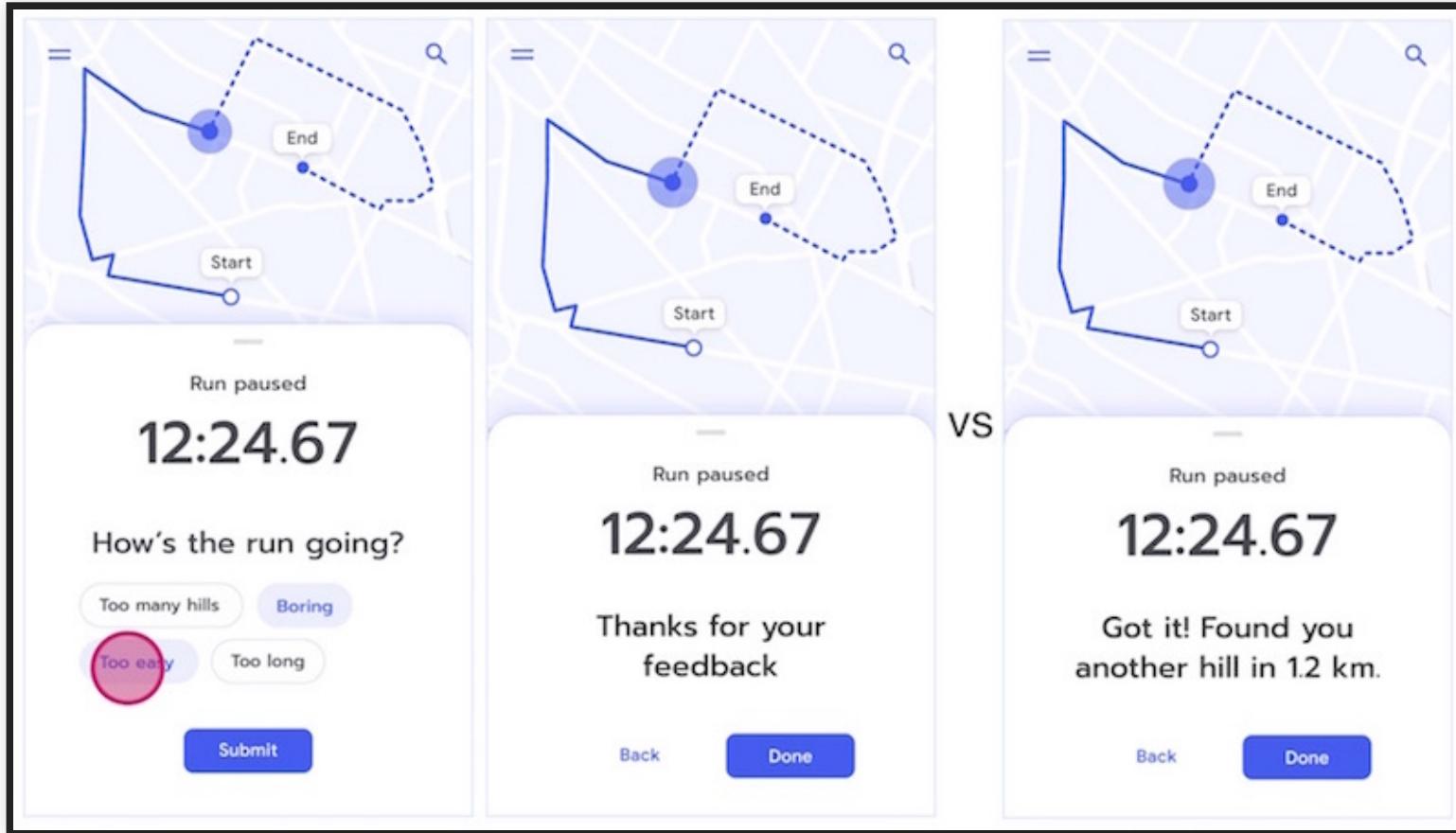
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 - Acknowledge user feedback & respond immediately
- In addition to feedback, provide a way for user to adjust AI behavior

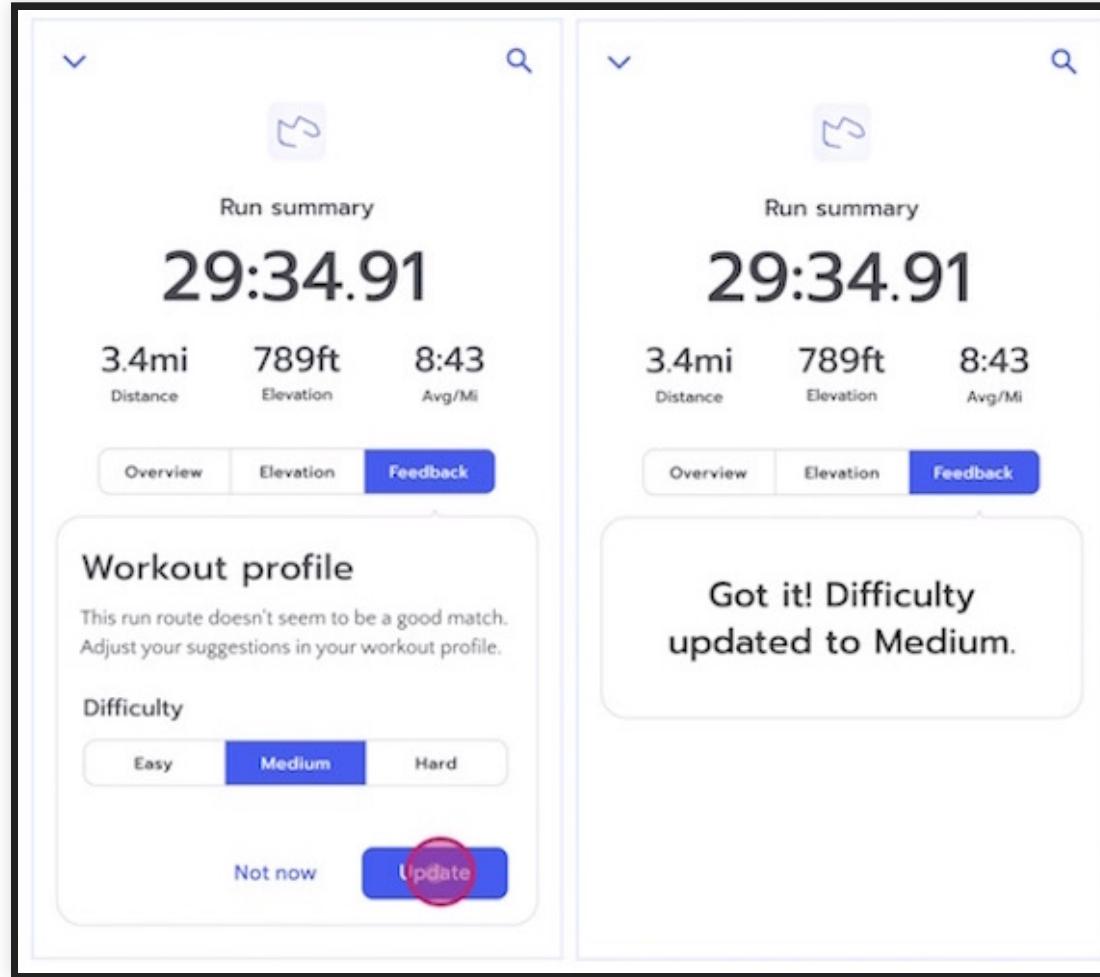
RESPONDING TO FEEDBACK



- 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

INITIALLY							
	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>					
DURING INTERACTION	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>			
WHEN WRONG							
	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>		
OVER TIME	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 surprises that 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