

# 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:

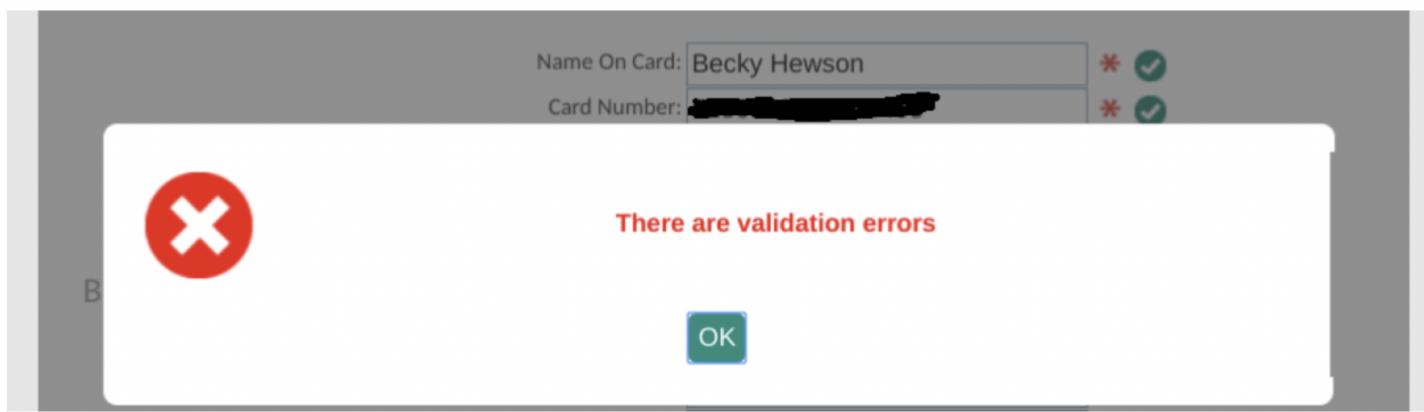
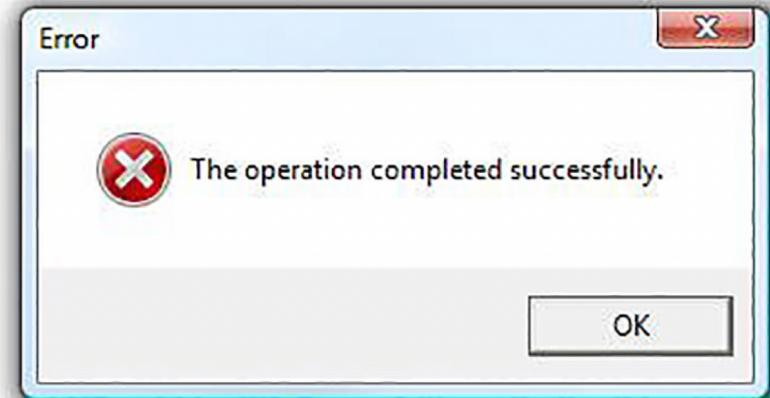
*Will You Accept an Imperfect AI? Exploring Designs for Adjusting End-user Expectations of AI Systems.* Kocielnik, et al., in CHI 2019

# 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 recovery & prevention
  - Feedback and control: Align user feedback with AI improvement

# RISKS OF POOR INTERACTION DESIGN

# POOR INTERACTION DESIGN CONFUSES USERS



# POOR INTERACTION DESIGN ANNOYS USERS



# POOR INTERACTION DESIGN HINDERS USERS

APPLE \ MOBILE \ TECH \

## What happened to Apple design?

*Unapologetically bad*



# 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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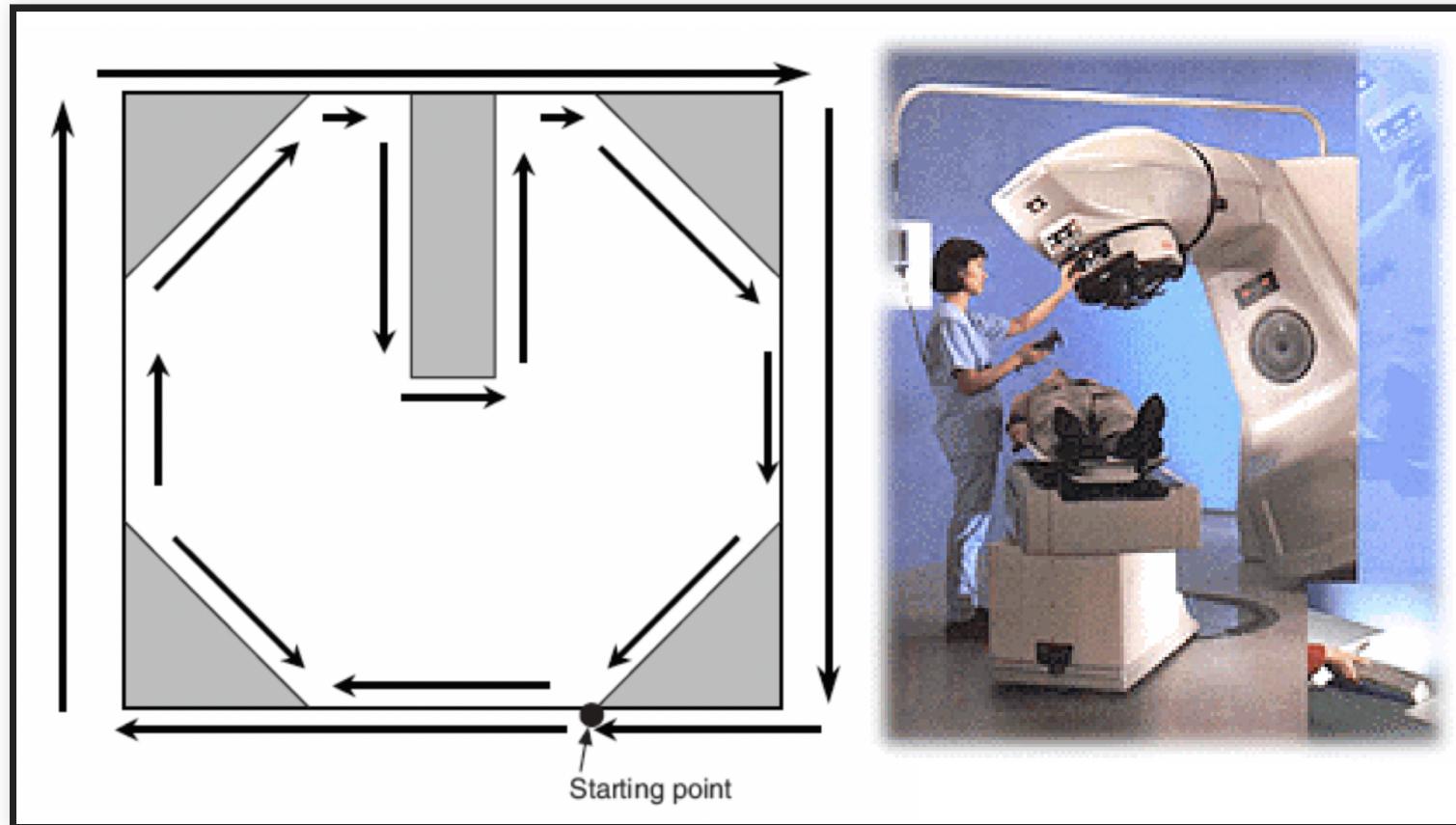
# POOR INTERACTION DESIGN CAUSES HARM



**Chukwuemeka Afigbo**  
@nke\_ise

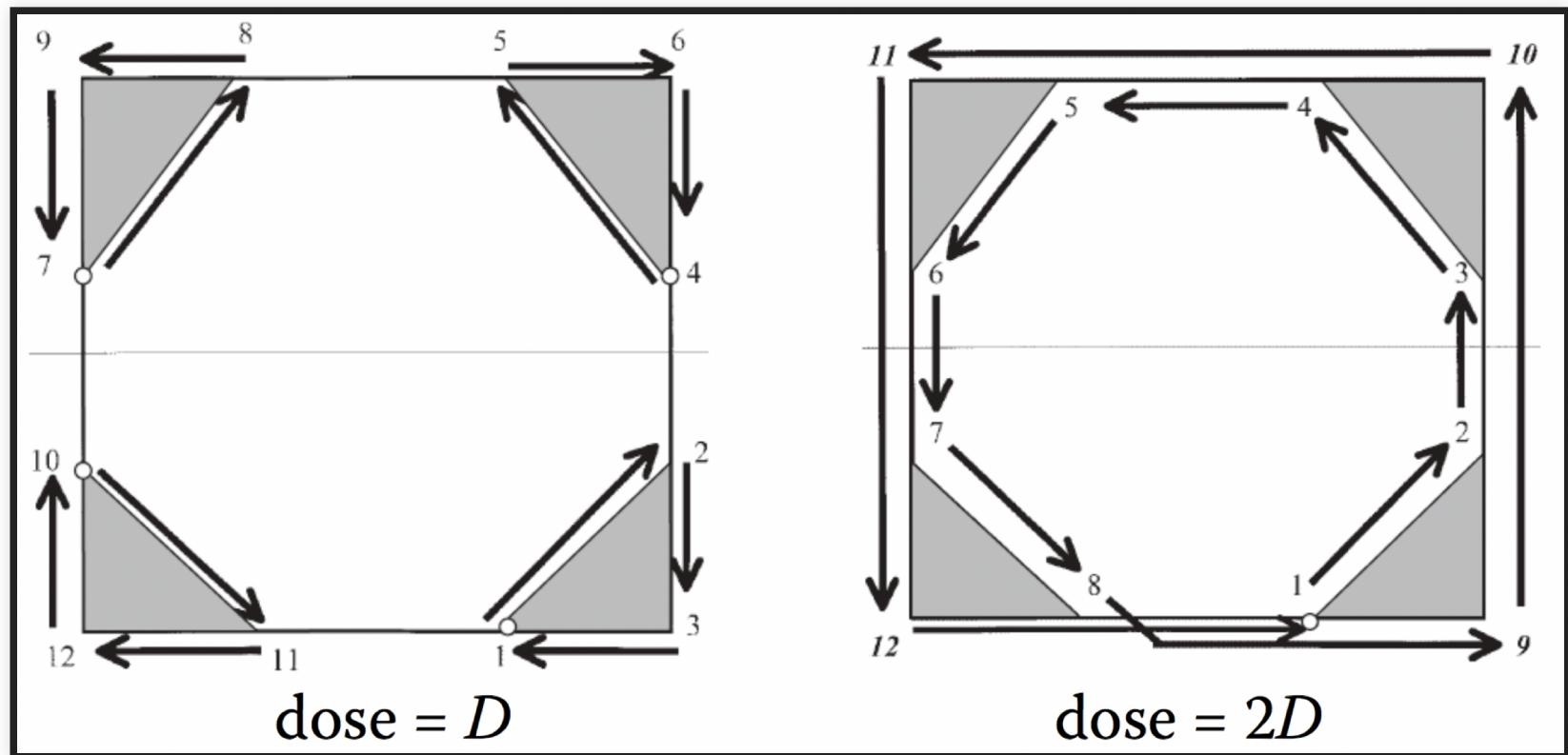
If you have ever had a problem grasping the importance of diversity in tech and its impact on society, watch this video

# 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?)

# RISKS OF POOR INTERACTION DESIGN

- Interaction design is not just about visual presentation!
- Poor interaction design can:
  - Cause confusion or misunderstanding
  - Prevent the user from effectively performing their task
  - Increase mental and physical burden
  - Drive users away from the product
  - Contribute to security or privacy issues
  - Cause physical (injuries, deaths) and societal harms (bias, misrepresentation)

# USABILITY CONCEPTS

# 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 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 recovery & prevention
- **Feedback and control:** Align user feedback with AI improvement

# MODES OF INTERACTION

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- Automate: Take action on user's behalf
- Augment: Provide options or additional information
  - Prompt: Ask the user if an action should be taken
  - Organize: Display a set of items in an order
  - Annotate: Add information to a display
- Hybrid of above

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

# AUTOMATE OR AUGMENT? WHY?

The screenshot shows a Microsoft PowerPoint slide titled "Measuring Progress?" with slide number 47. The slide contains a bulleted list about app development progress. The "Design" tab is selected in the ribbon, and the "Design Ideas" feature is open, displaying two generated designs for the slide content.

**Design Ideas**

- "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."

**Design Ideas 2**

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Design transformations in PowerPoint

# AUTOMATE OR AUGMENT? WHY?



Fall detection in a smartwatch

# FACTORS TO CONSIDER

- 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
- Frequency: How often does interaction occur?
  - When a new prediction is available or model changes
  - Periodically (e.g., suggest action every hour)
  - Only when explicitly initiated by user
- Cost: What is the effect of a wrong prediction?
  - If possible, provide a way to undo the action of AI

# FACTORS TO CONSIDER

Slide design transformations:

AutoSave (Off) 02-te... - Save... Christian Kaestner File Home Insert Design Transitions Animations Slide Show Review View Help Tell me Aa Aa Aa Themes Variants Customize Design Ideas Designer

46  
47 Measuring Progress?  
48 • "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."  
49  
50  
51  
52  
53 15-313 Software Engineering ISR INSTITUTE FOR SOFTWARE RESEARCH  
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55 Tap to add notes  
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Slide 47 of 74 Notes 29%

Fall detection:



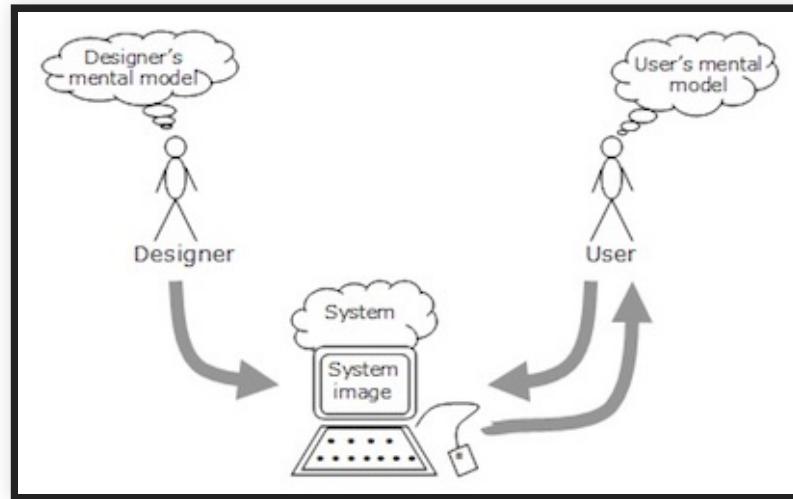
Q. Forcefulness, frequency, cost?

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  - "How does the system work? How does it respond to my actions?"
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  - 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 submit
6. Get confirmation

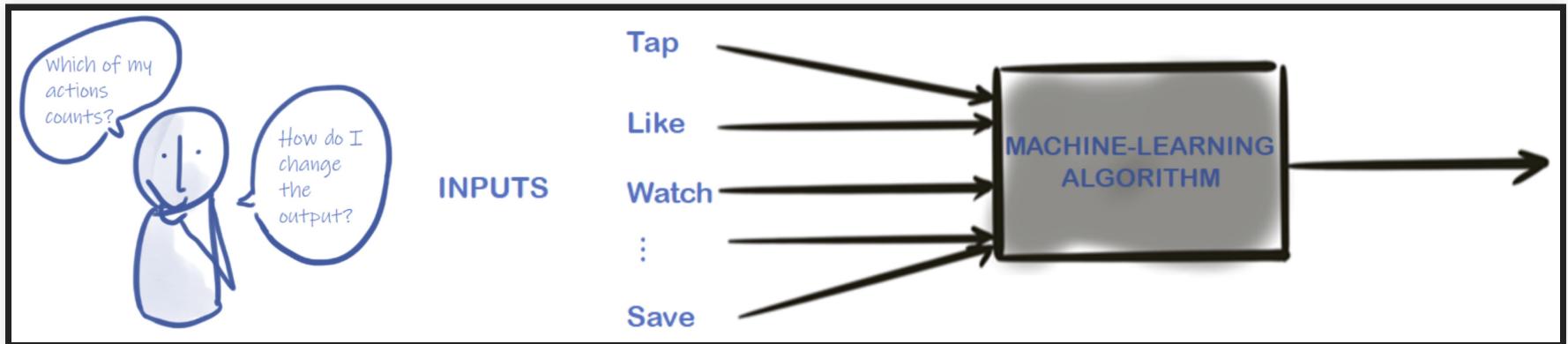
# BREAKING MENTAL MODEL



- 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?"
  - Typically less transparent than traditional applications
  - AI will make mistakes, often unpredictably



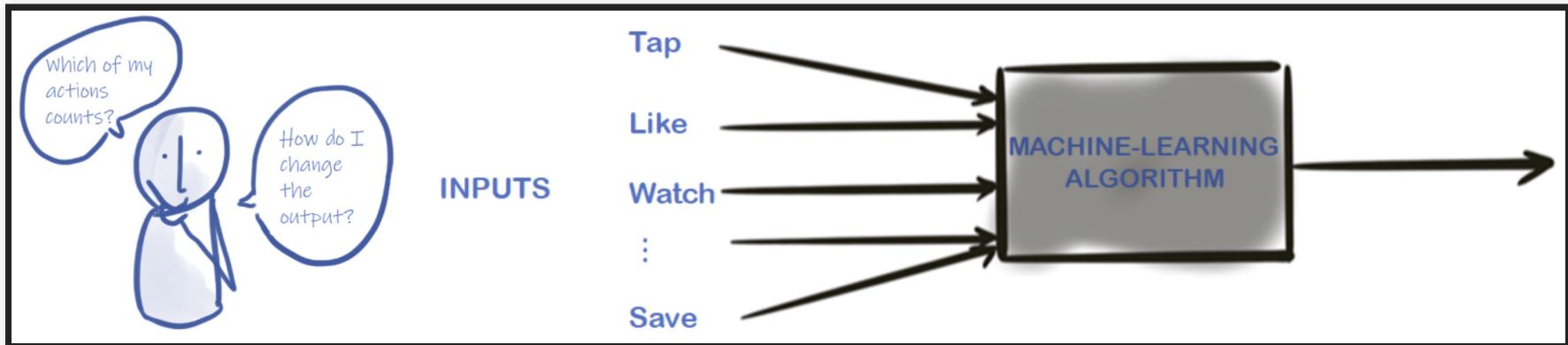
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- Lack of trust over output: How do I know the output is correct?

<https://www.nngroup.com/articles/machine-learning-ux/>



# MENTAL MODEL FOR VOICE ASSISTANTS?



Q. Can you describe what it does? What it can't 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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- 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 EXPECTATIONS

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

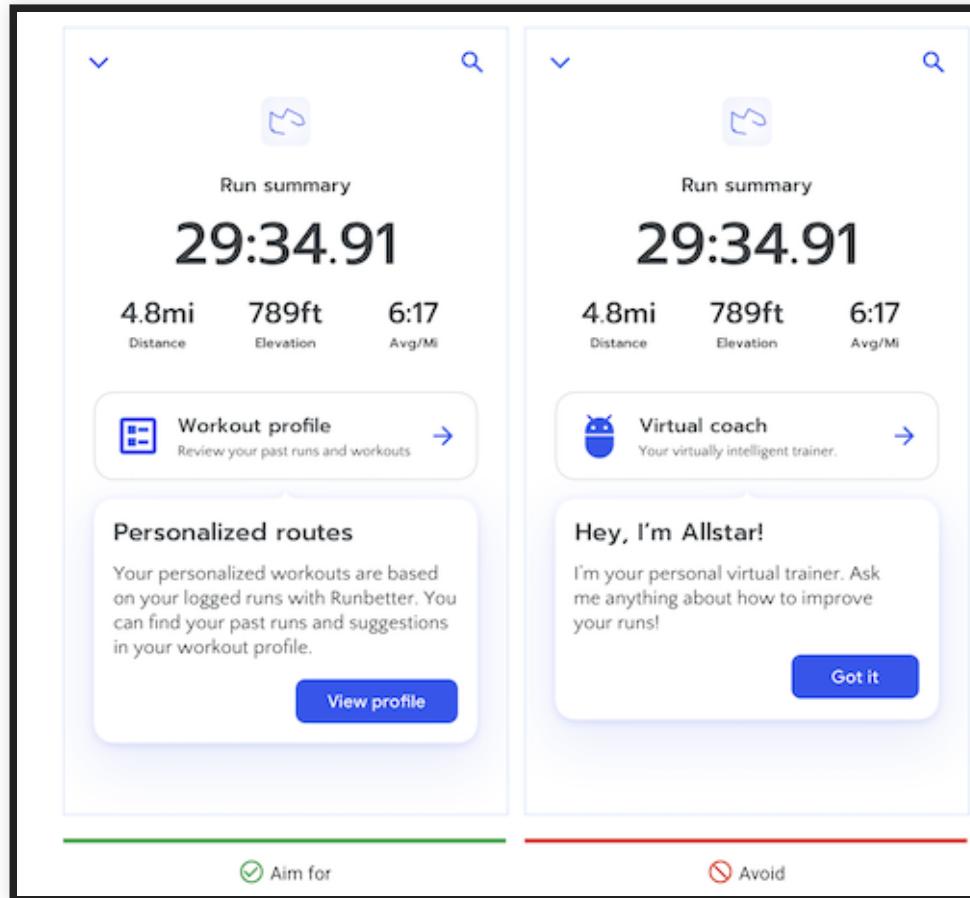
**Screenshot 1:** This screenshot shows a simple document interface with a sidebar containing file management icons (back, forward, upload, download) and a settings gear icon. The main area is titled "Demo document". A blue callout box on the left says: "This is presumably what a document you've loaded 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 reads:

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

**Screenshot 2:** This screenshot shows the same document after a word has been underlined. A tooltip appears over the underlined text "eight year old", titled "In-line corrections". The tooltip text says: "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! Ok, what's next? Let me close..." The document text remains the same as in Screenshot 1.

- Provide examples of how it works

# ONBOARDING: SET USER EXPECTATIONS



- Be clear about what system can(not) do

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



# TRANSPARENCY: EXPLAIN HOW DECISIONS ARE MADE



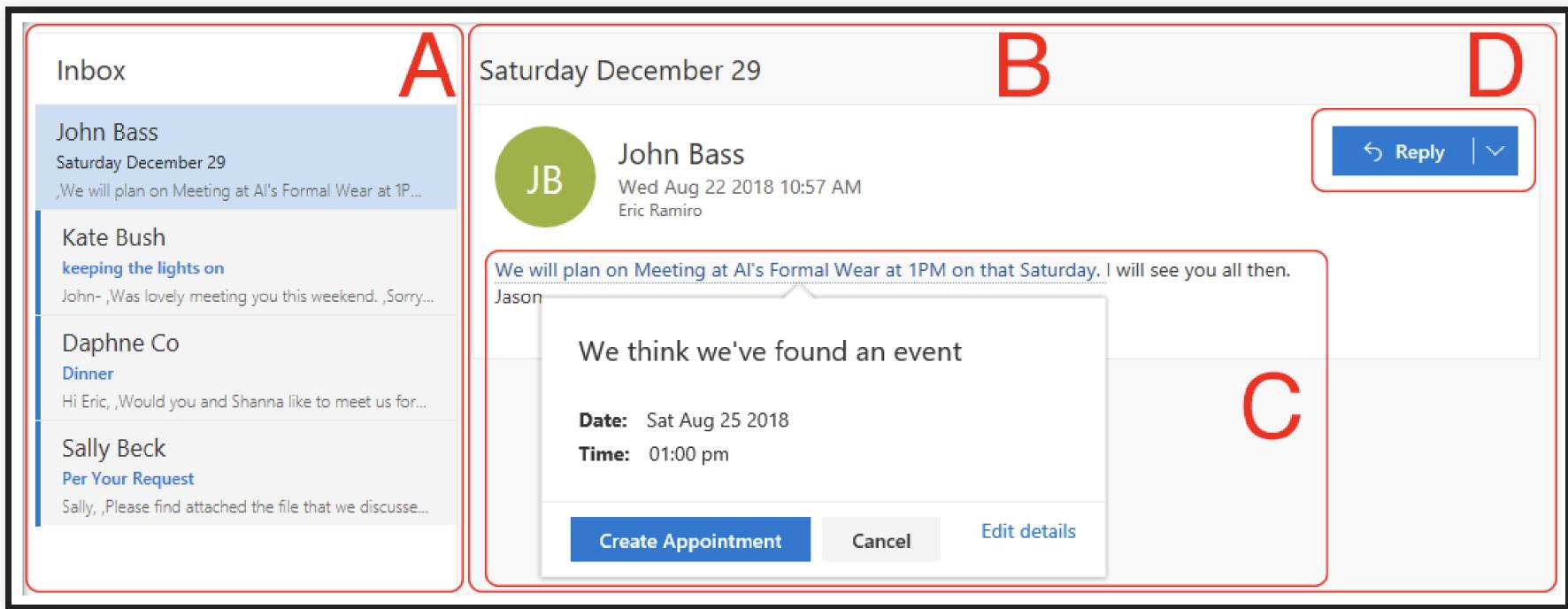
- Explain how the user's actions influence output

# 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.,
- System errors: Failure to provide an outcome expected by the user
  - We will focus on this

# EXAMPLE: SCHEDULING ASSISTANT



- 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 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



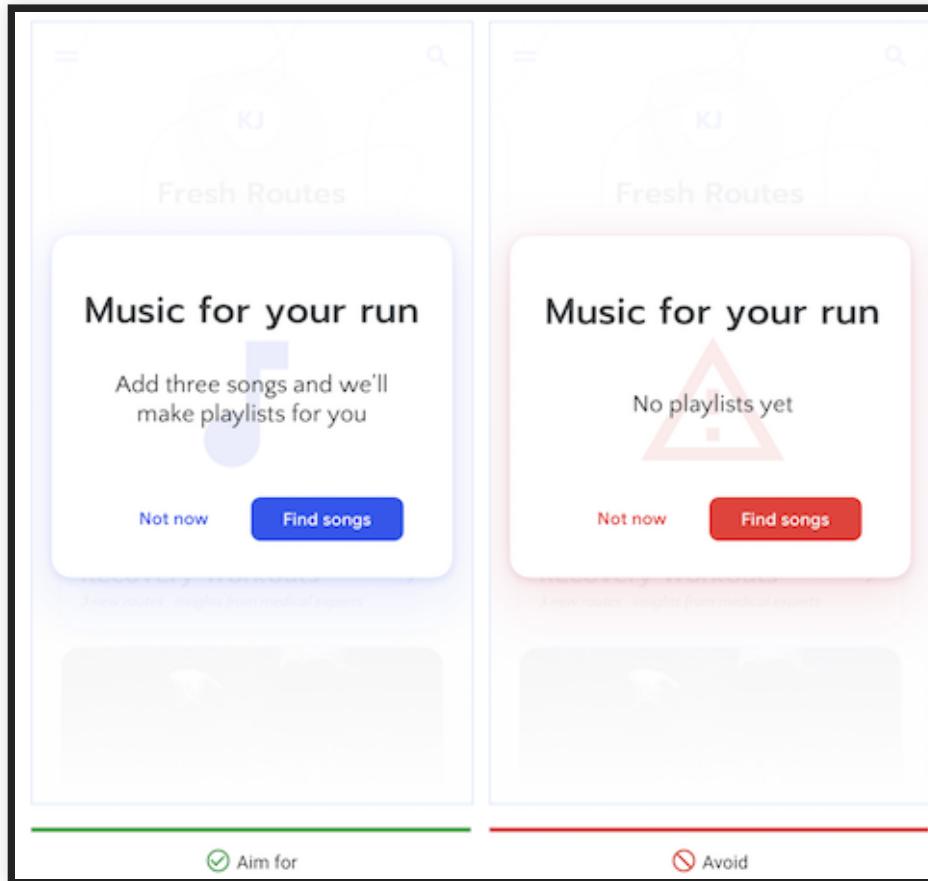
The Scheduling Assistant can correctly detect meeting requests about 50% of the time.



- 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/>

# ERRORS IN VOICE ASSISTANTS



*“...sometimes it says it does – like the reminders and the sending messages. It says it will do it. But then at the end we found that it didn’t really send the message.”*

- Q. How do we detect an error?
- Q. How can we notify/guide the user when an error occurs?

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

# FEEDBACK AND CONTROL

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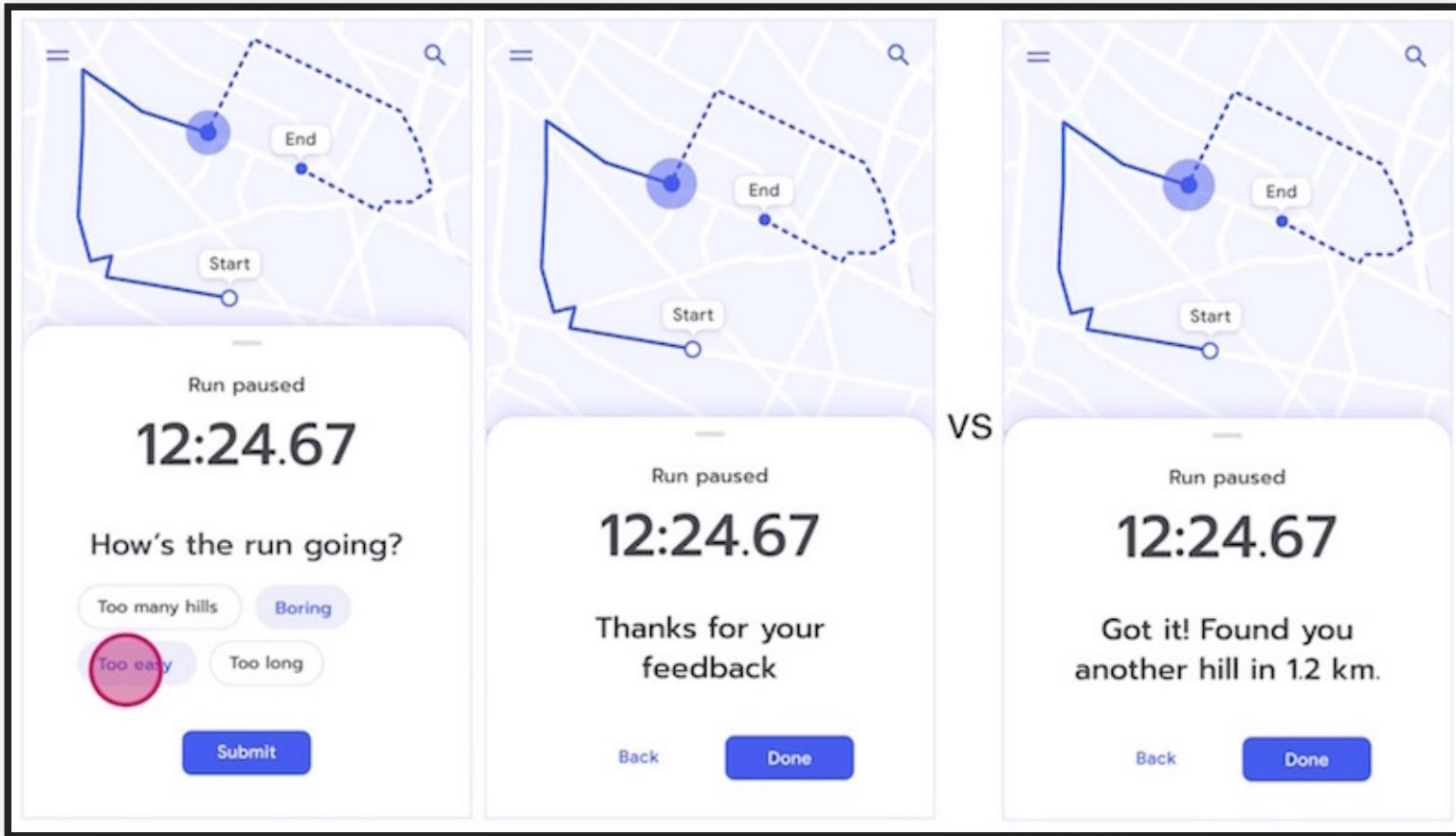
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  - Align feedback with improving interactions (and AI)
  - Acknowledge user feedback & respond immediately
- In addition to feedback, provide a way for user to adjust AI behavior

# 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

# USER FEEDBACK IN VOICE ASSISTANTS

*"All of the things that even Siri herself said she could do — for example 'I can send money via Venmo, just try and say this.' I tried and it didn't work, and maybe there are settings that I need to fix. But when those types of things happened, there was no button that said 'Hey, in order to make this work in the future, click this and we'll take you to the permissions or whatever'"*

- Q. How do we collect user feedback? Implicit? Explicit?
- Q. What kind of control do we provide to the user?

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

# GUIDELINES FOR HUMAN-AI INTERACTIONS

# Guidelines for Human-AI Interaction

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

