

# 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

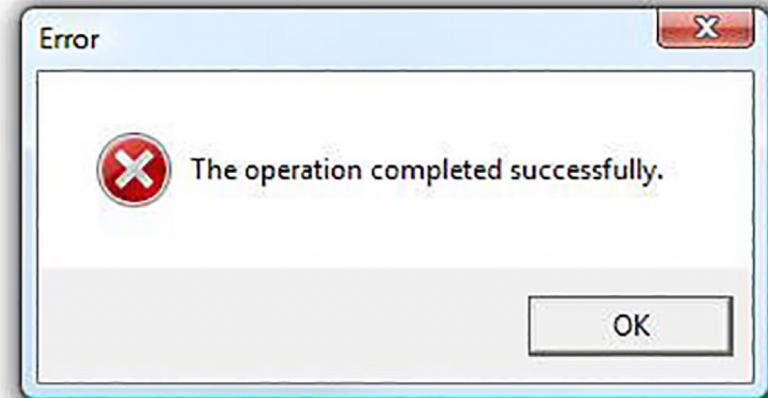
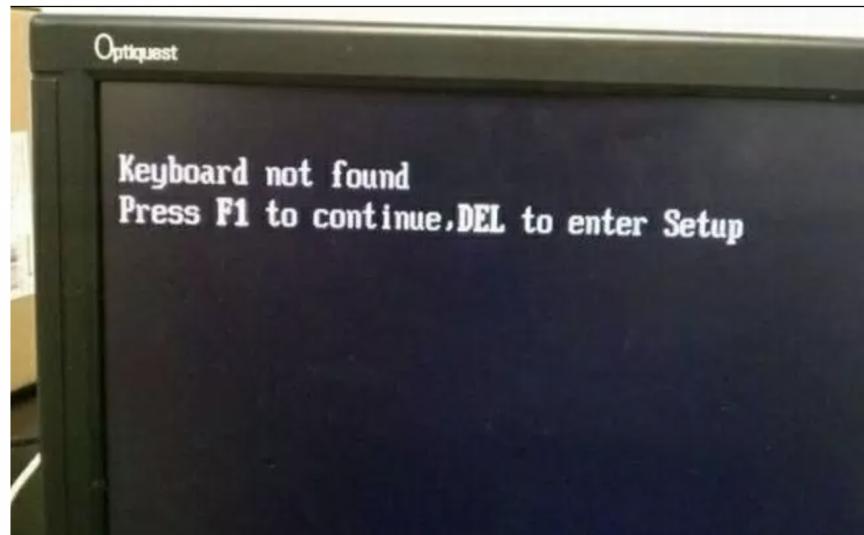
Transparency  
and trust

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

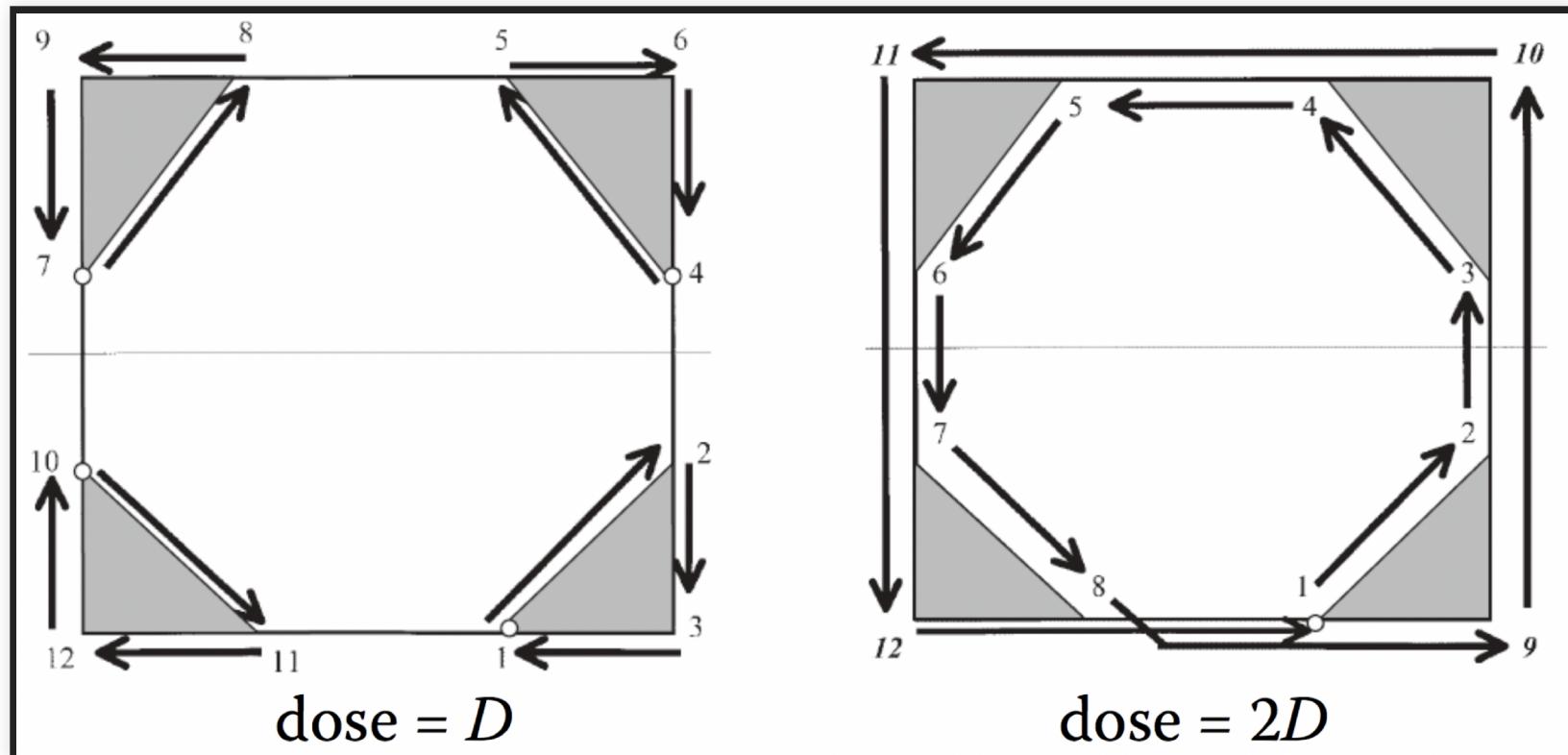


# POOR INTERACTION DESIGN CAUSES HARM



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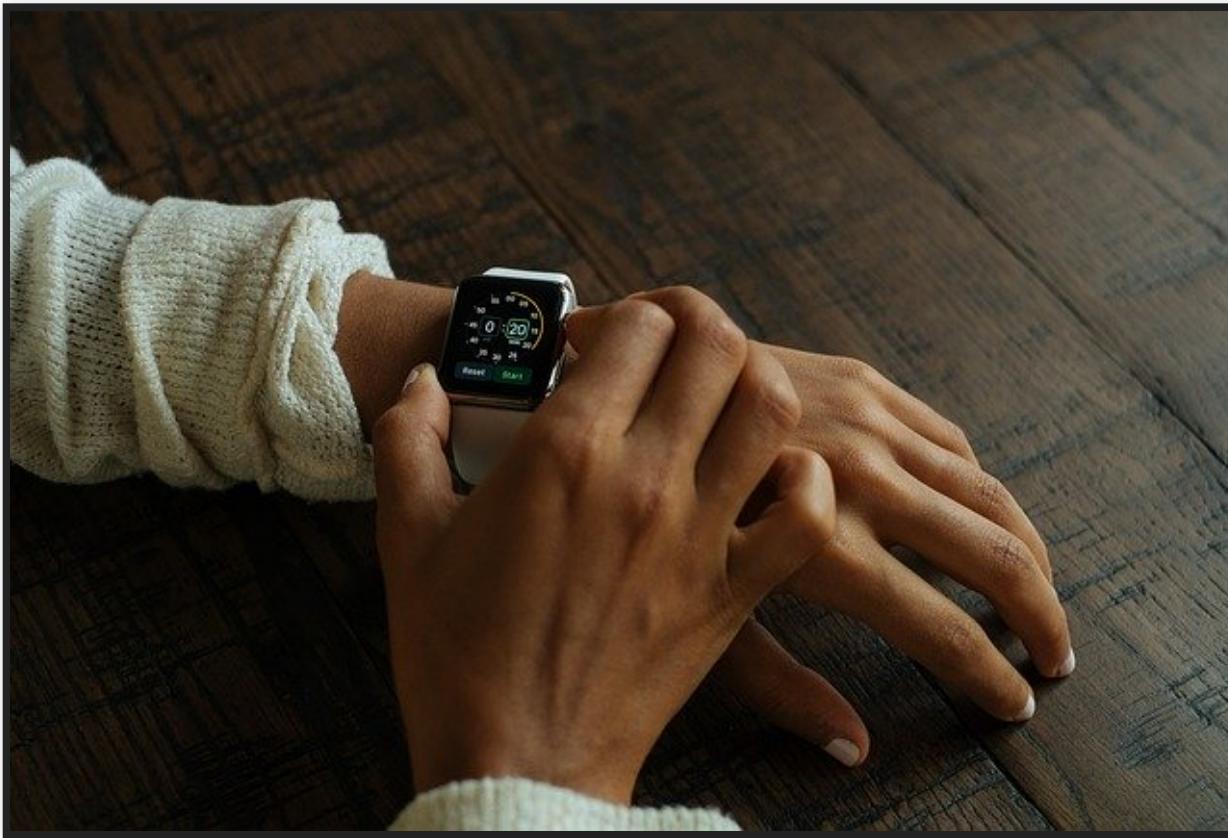
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- Cost: What is the effect of a wrong prediction?
  - If cost is too high, consider augmenting rather than automating
  - If possible, provide a way to undo the action of AI

# EXAMPLE: DESIGN SUGGESTIONS IN POWERPOINT



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

# EXAMPLE: FALL DETECTION



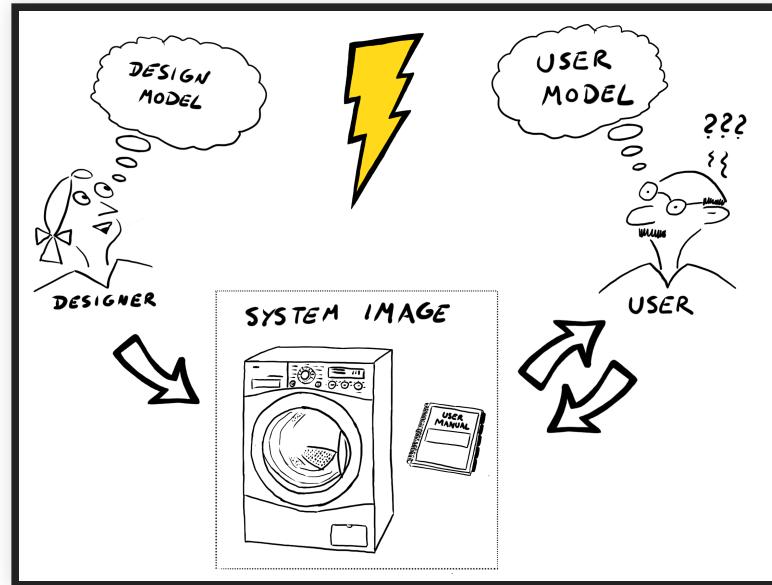
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  - "How does the system work? How does it respond to my actions?"
  - User plans actions and reacts to system based on this mental model
- Challenge: Aligning system with the user's mental model
  - Inherent mismatch between user's & designer's models
  - 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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- User: "What is AI doing, and how do I use it?"
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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

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



# 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

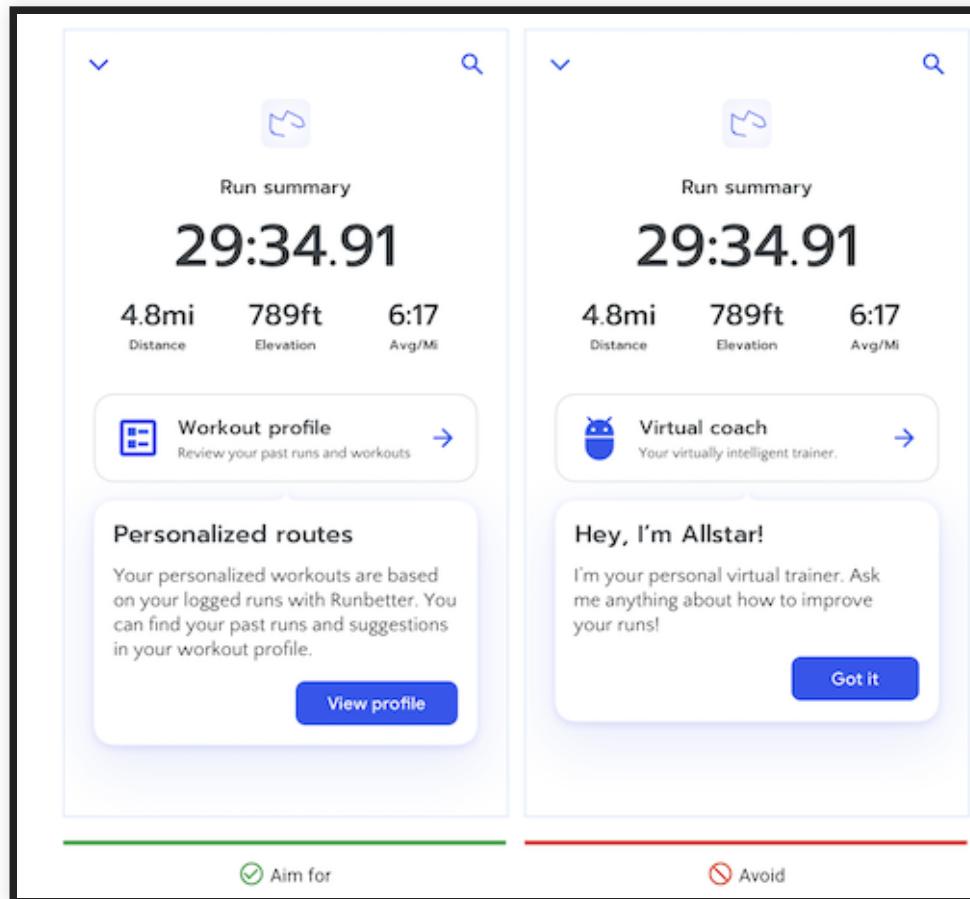
The image displays two screenshots of a document editing application interface, illustrating the onboarding process for setting user mental models.

**Screenshot 1:** The top screenshot 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:** The bottom screenshot shows the same document after interacting with the hotspots. A tooltip has appeared over the first underlined error ("eight year old"). The tooltip title is "In-line corrections" and the content is "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!" and "Ok, what's next? Let me close...".

- Provide examples of how the system works

# ONBOARDING: SET USER'S MENTAL MODEL

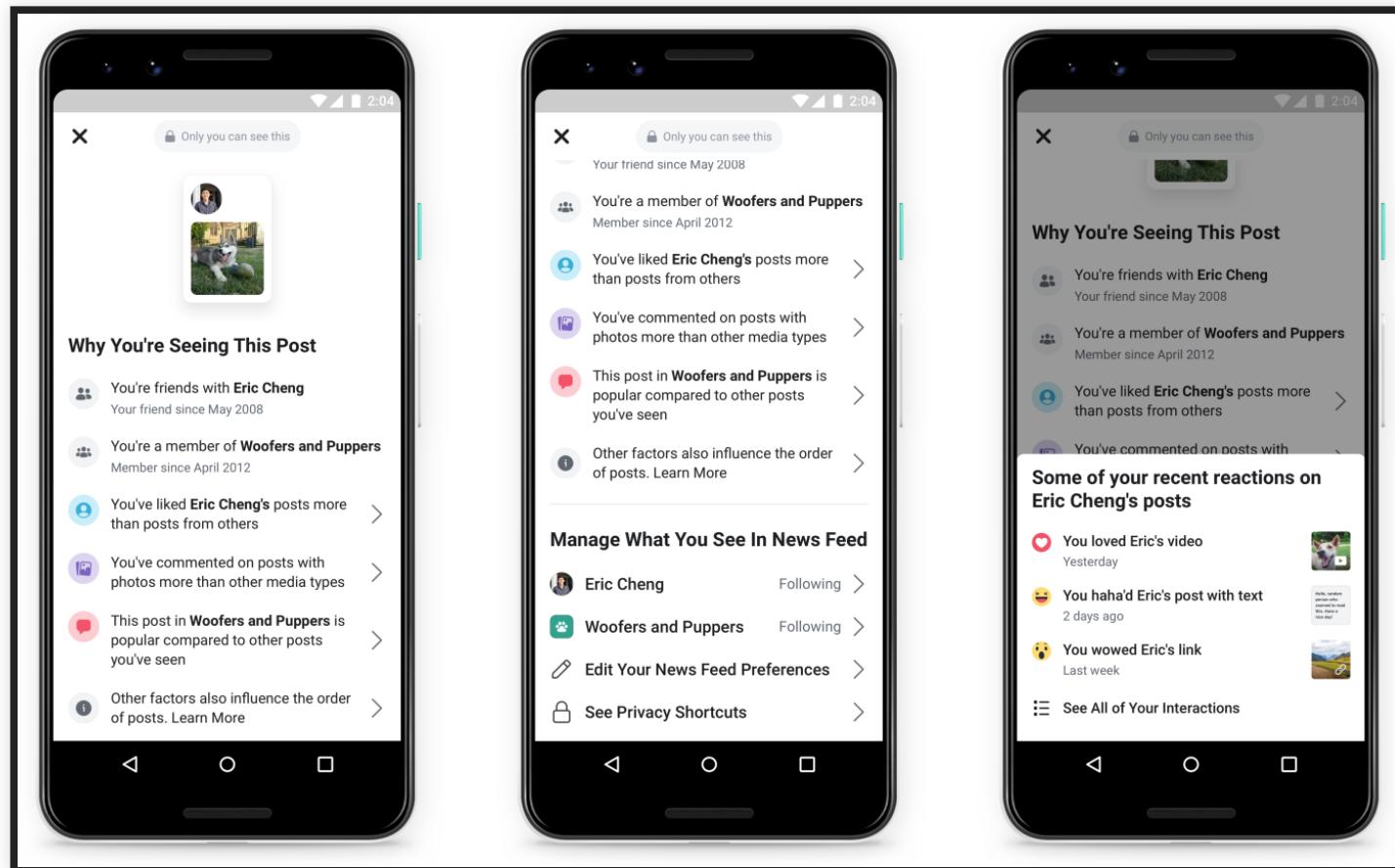


- Be explicit about what system can and cannot do

<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 proposed appointment is shown for 'Saturday December 29' (labeled B). It includes a contact photo of 'JB' (John Bass), his name, the date and time (Wed Aug 22 2018 10:57 AM), and a message from 'Eric Ramiro'. A red callout box (labeled C) highlights 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 proposed appointment details are: Date: Sat Aug 25 2018 and Time: 01:00 pm. At the bottom are buttons for 'Create Appointment', 'Cancel', and 'Edit details' (labeled D).

- 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)

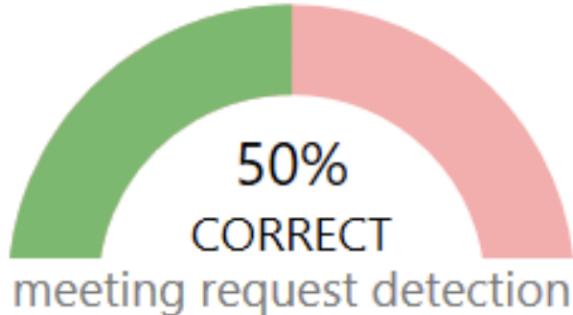
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  - Suggest actions to fix the error (e.g., "Edit details" option)
- Give user controls to recover from and mitigate the effect of an error
  - e.g., delete or modify incorrect meeting schedule

# SETTING USER EXPECTATIONS FOR ML ERRORS



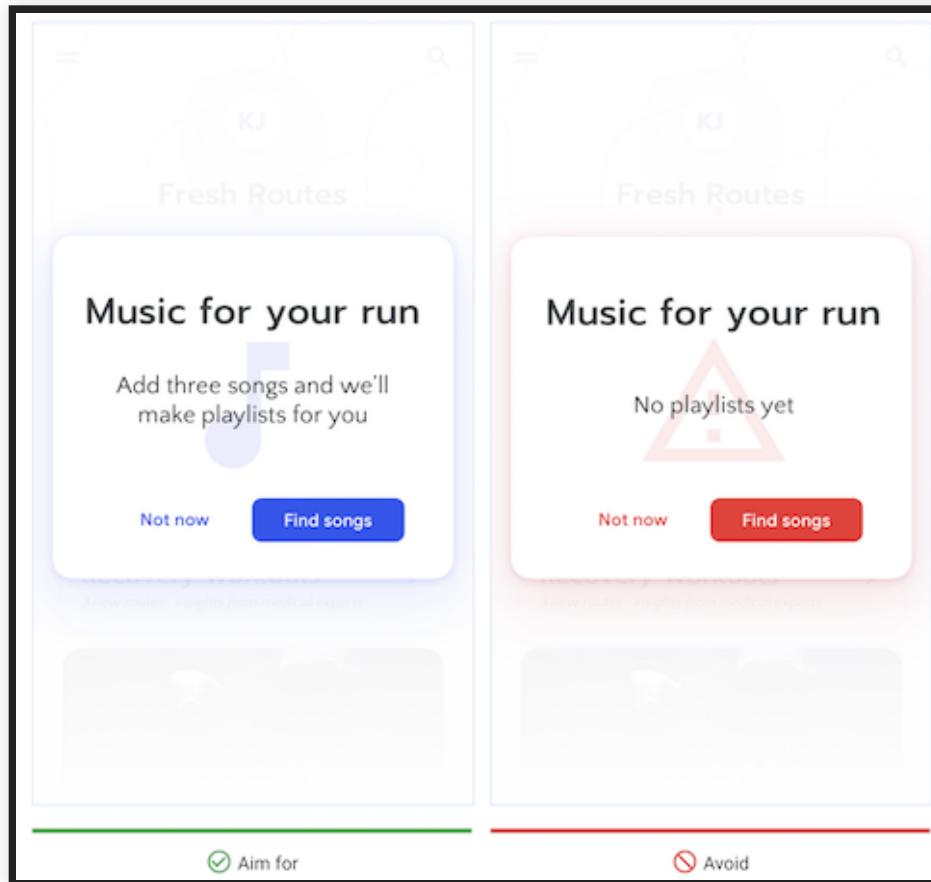
The Scheduling Assistant can correctly detect meeting requests about 50% of the time.



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

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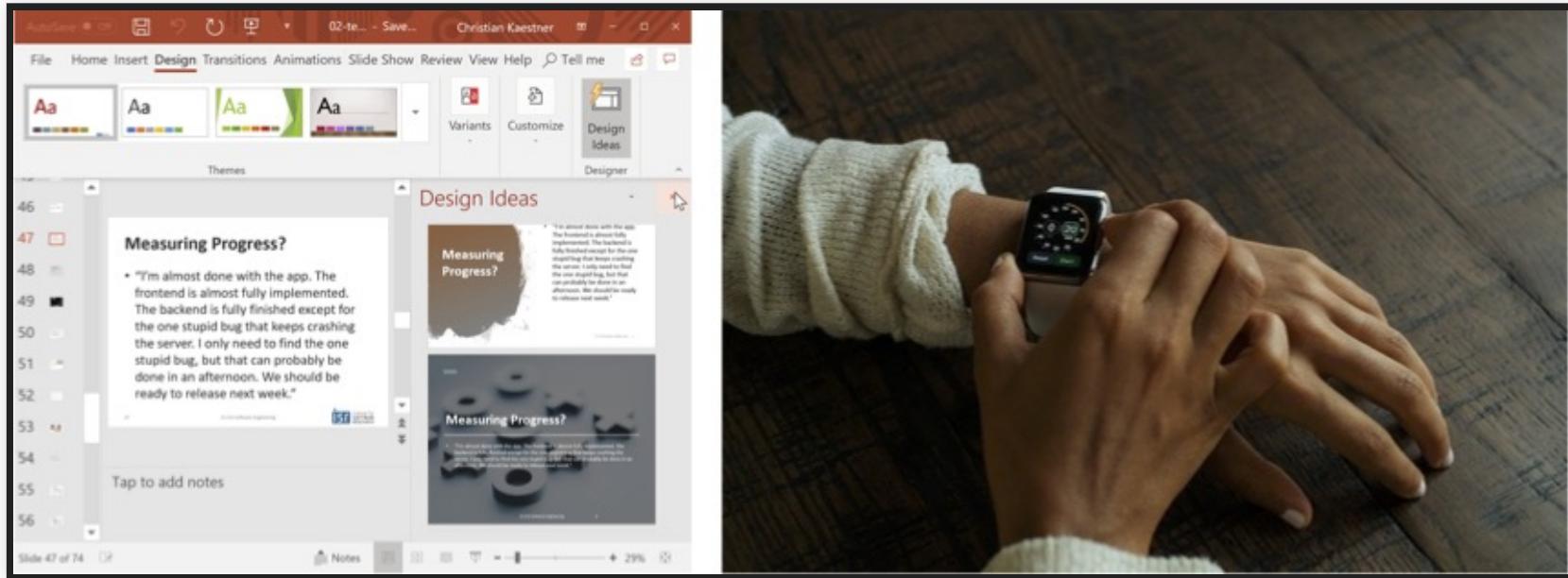
# ERROR MESSAGES: SUGGEST USER ACTIONS



- 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 Word document titled "Measuring Progress?". 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 of a person's hands resting on a 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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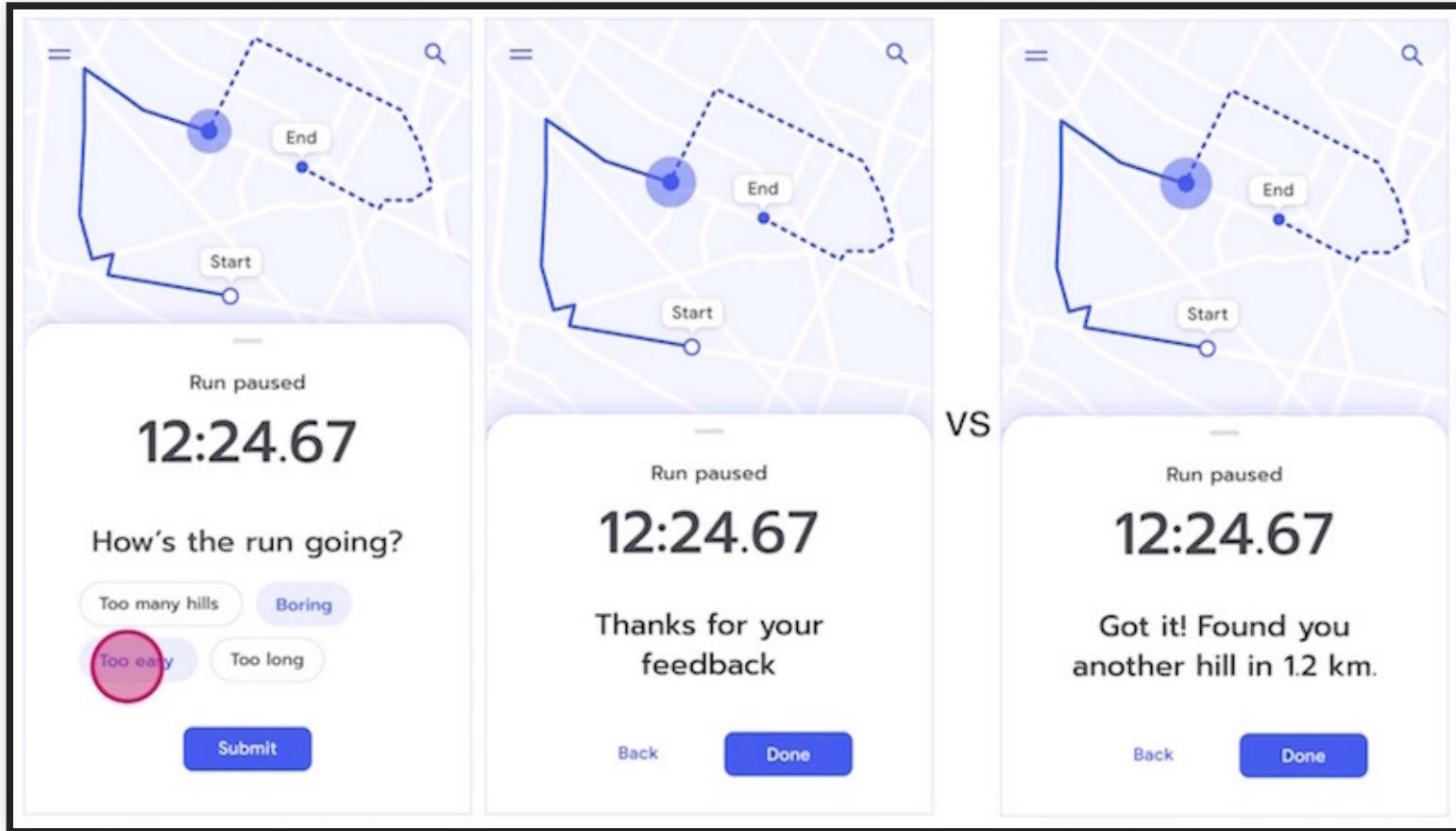
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  - Align feedback with improving interactions (and AI)
  - Acknowledge user feedback & respond immediately

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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

<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 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