

# 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

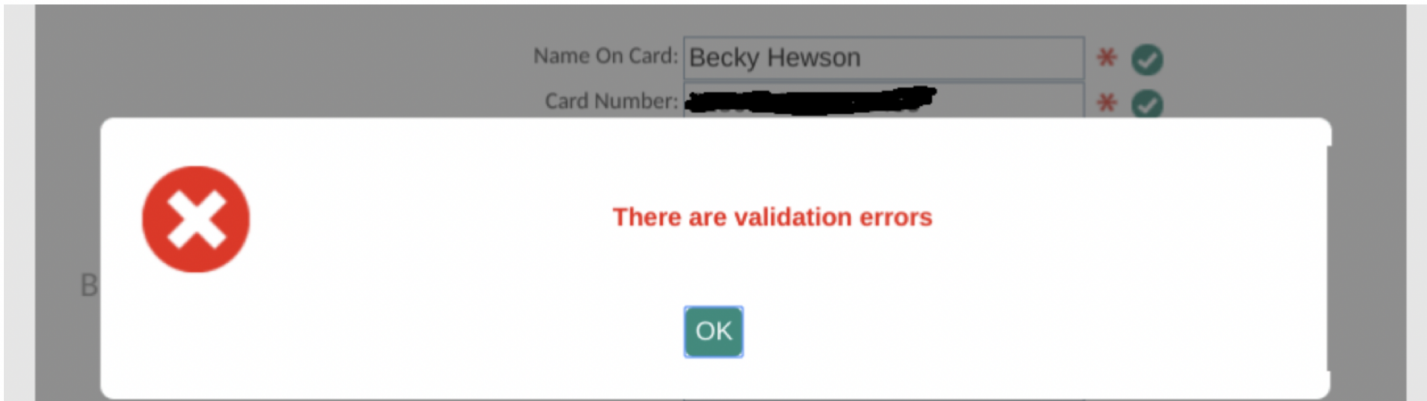
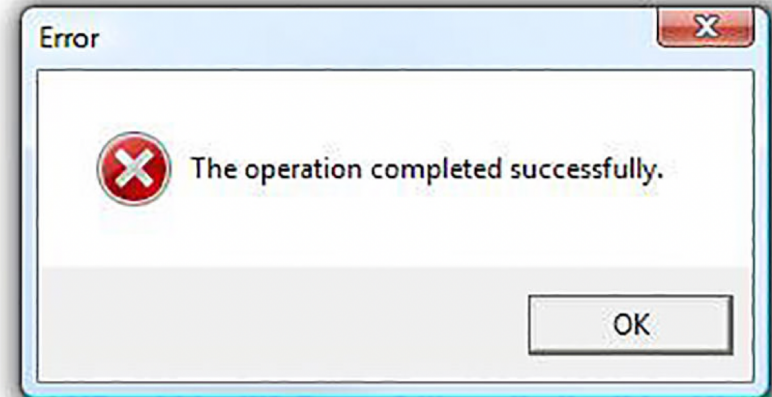
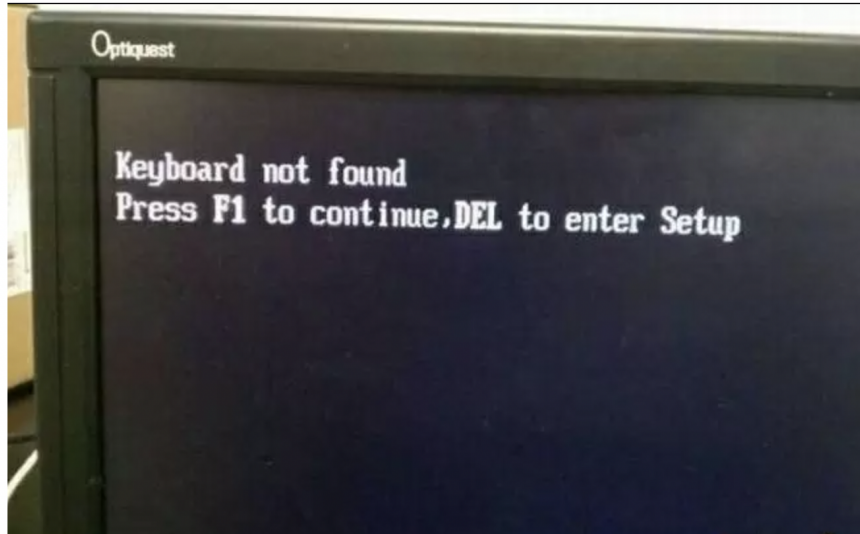
Ethics, governance, regulation, compliance, organizational culture



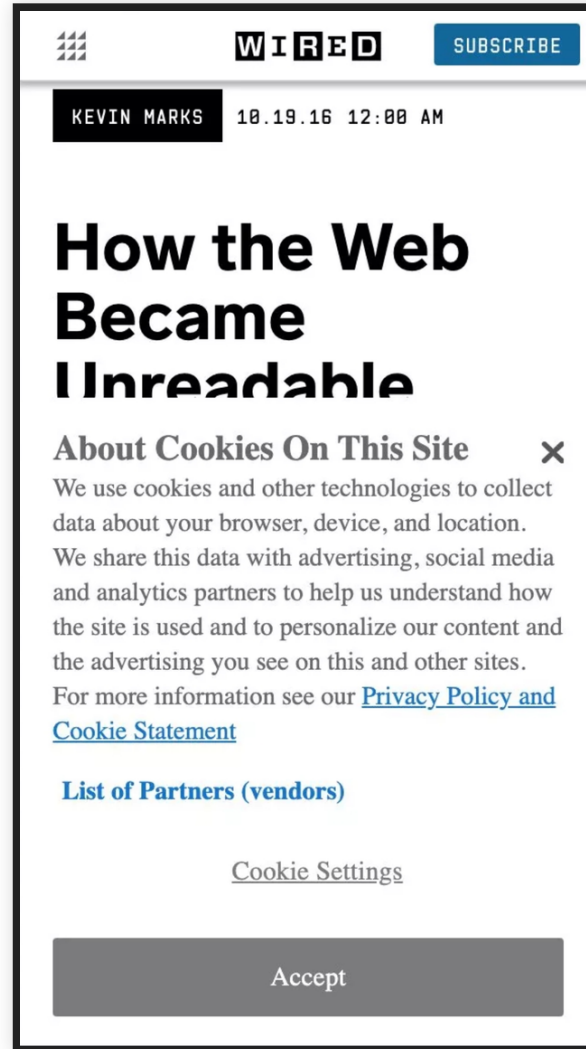


# **RISKS OF POOR INTERACTION DESIGN**

# 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

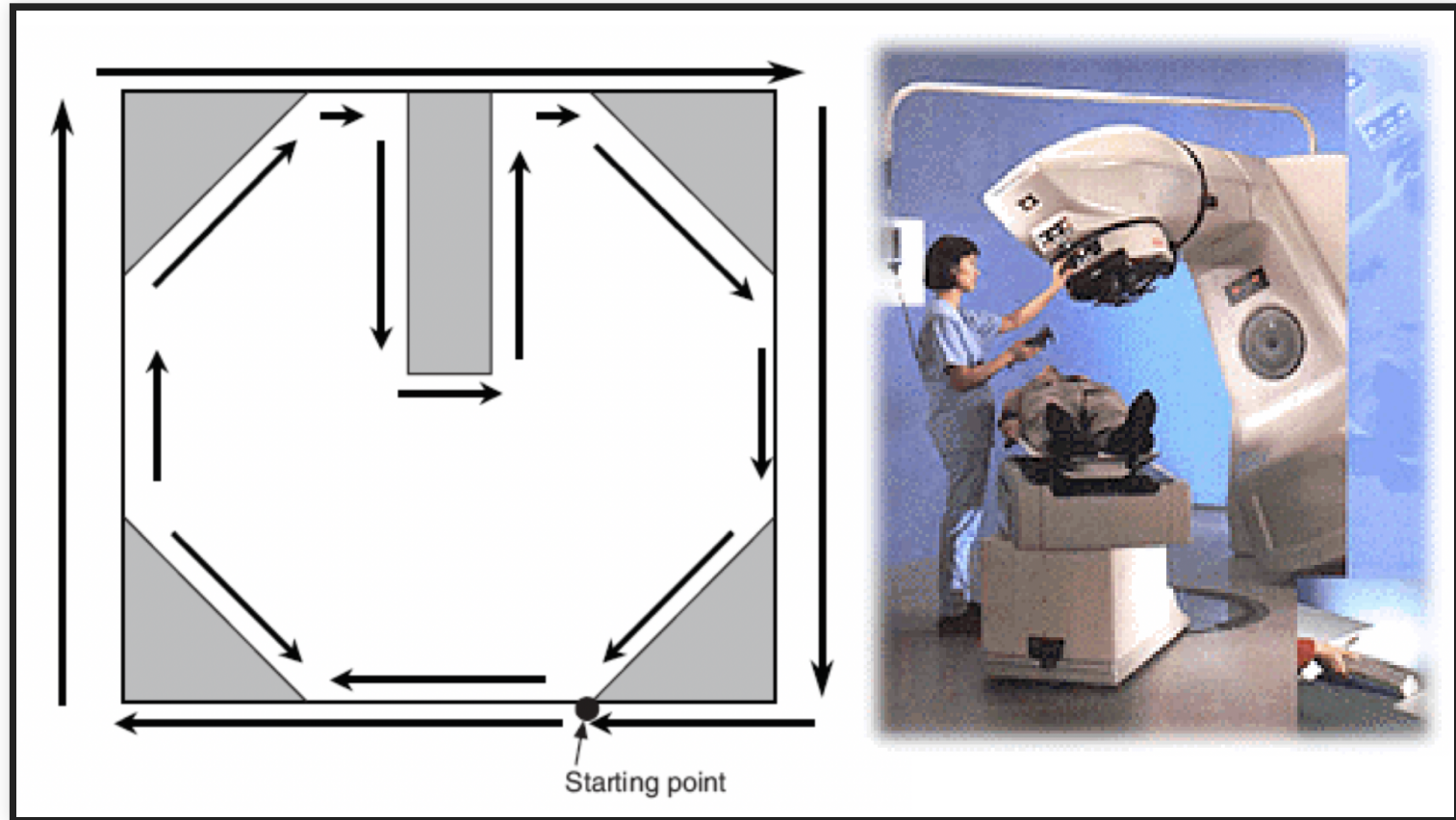


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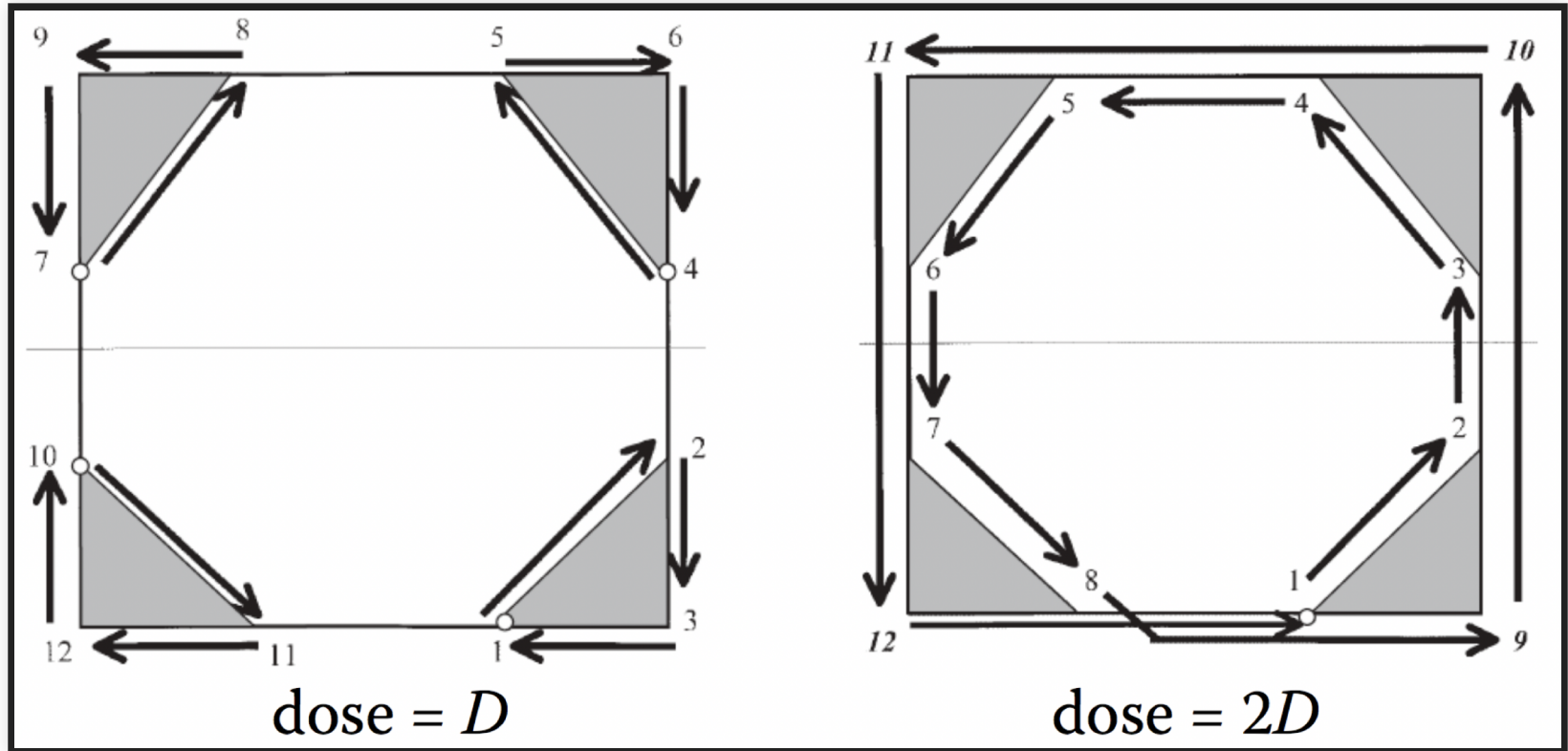


# POOR INTERACTION DESIGN CAUSES HARM



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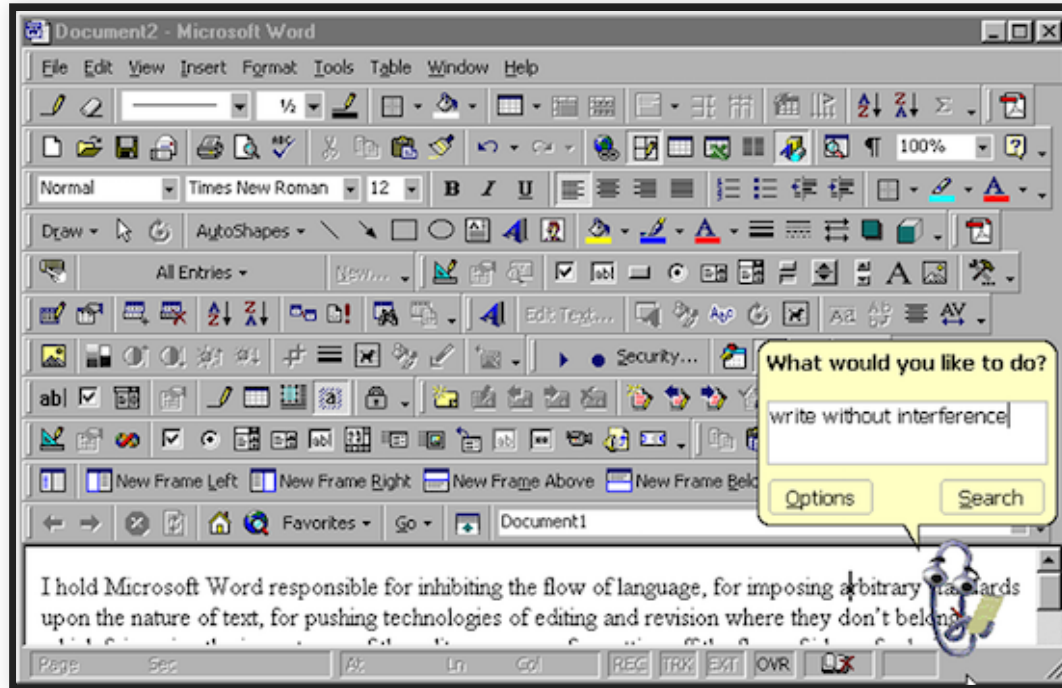
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- Satisfaction: How pleasant is it to use the design?

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



# OTHER FACTORS TO CONSIDER

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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

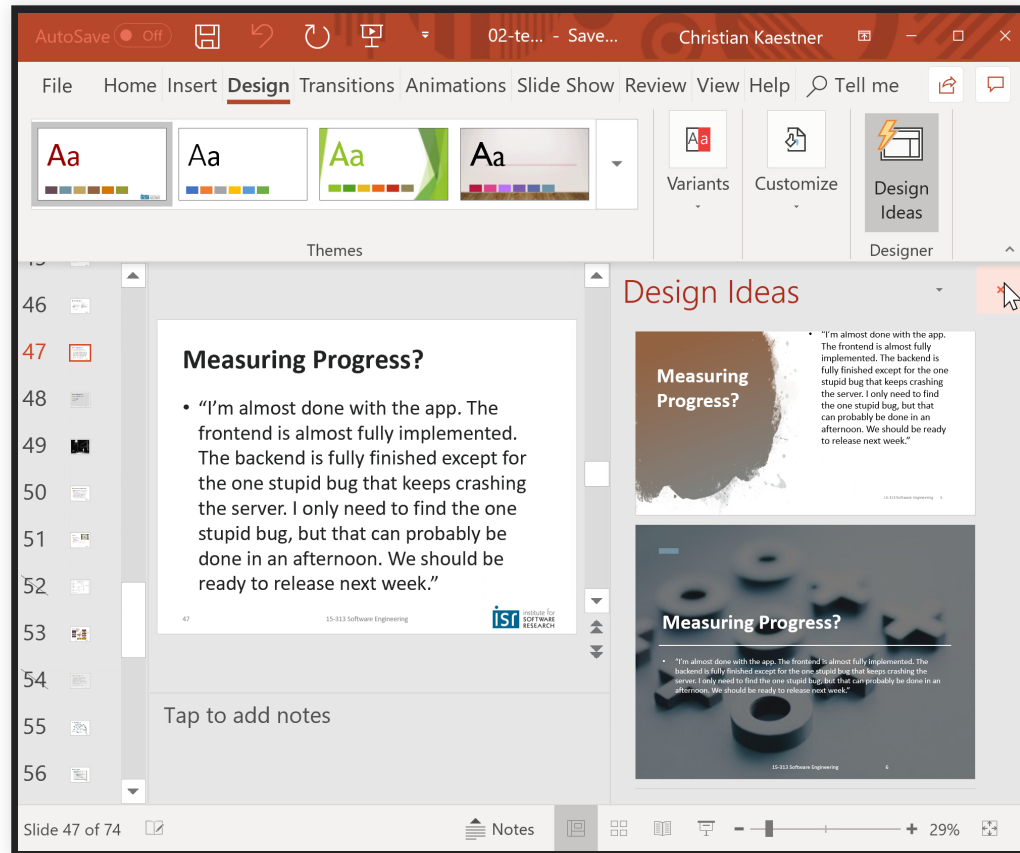
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  - Only when explicitly initiated by user
- Cost: What is the effect of a wrong prediction?
  - If cost is too high, consider augmenting rather than automating
  - If possible, provide a way to undo the action of AI

# EXAMPLE: DESIGN SUGGESTIONS IN POWERPOINT



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

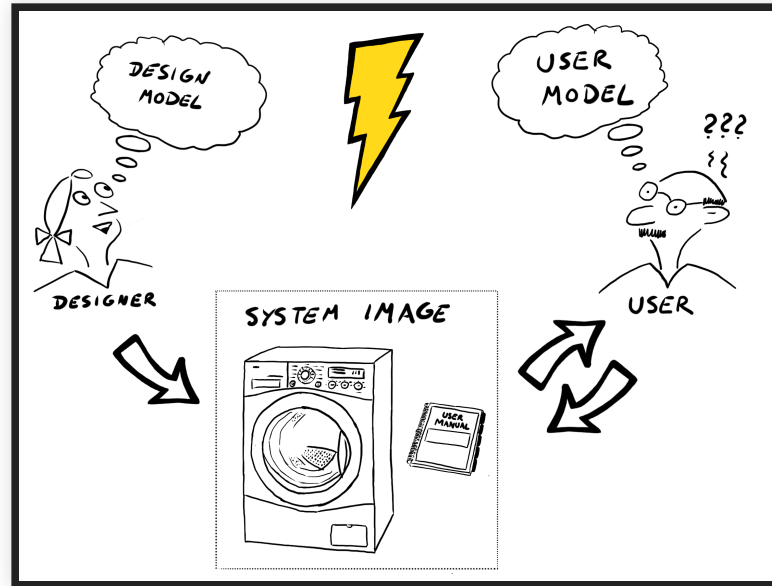
# EXAMPLE: FALL DETECTION



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

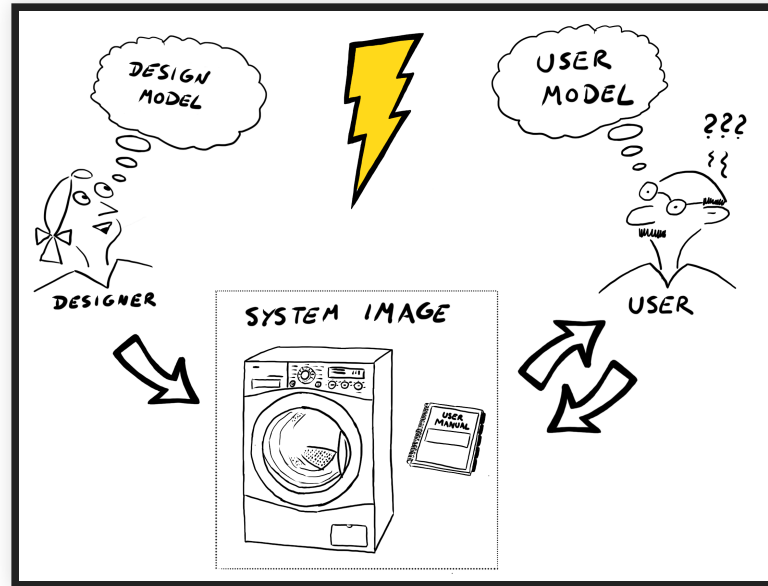
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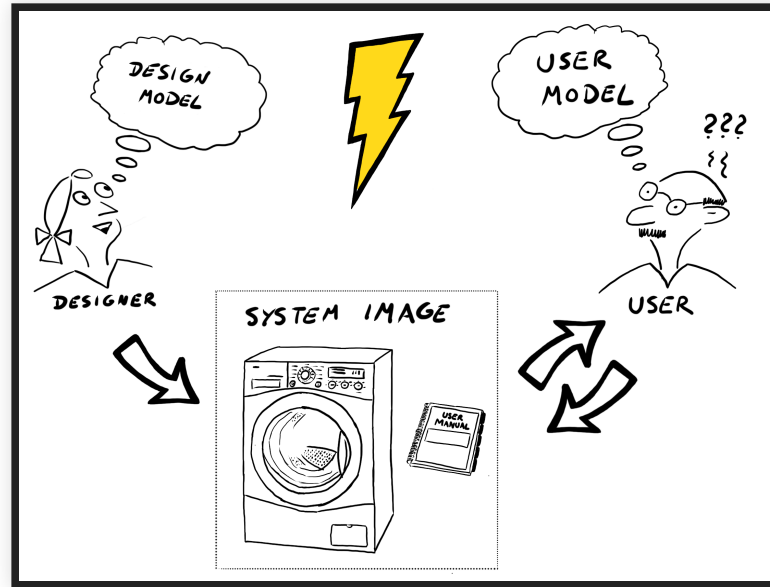


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- What the user believes about the system
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  - "How does the system work? How does it respond to my actions?"
  - User plans actions and reacts to system based on this mental model
- Challenge: Aligning 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

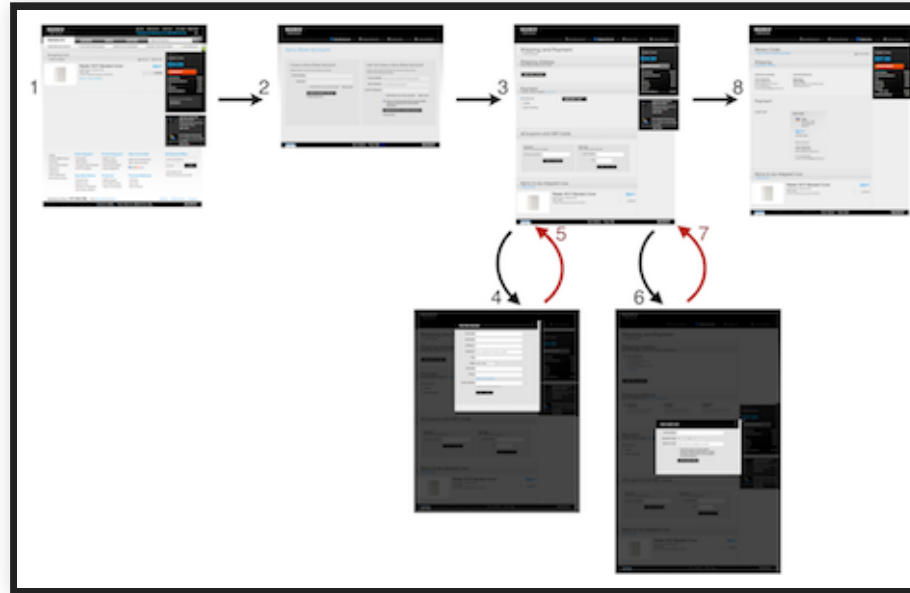
# EXAMPLE: SHOPPING CART CHECKOUT

The screenshot shows the J.Crew checkout page. At the top, there's a navigation bar with links like 'Gifts', 'New', 'Women', 'Men', 'Kids', 'Home', 'Brands We Love', 'SALE', and 'Factory'. Below this is a promotional banner for 'THE GET TOGETHER EVENT: 45% OFF YOUR PURCHASE.\*'. The main content area is titled 'CHECKOUT' and features a progress bar with four steps: 'SHIPPING ADDRESS', 'SHIPPING OPTIONS', 'BILLING', and 'REVIEW'. A red box highlights the first three steps, and a red arrow points to the 'BILLING' step. Below the progress bar, there's a section for 'YOUR SHIPPING INFORMATION' with fields for 'First Name', 'Surname', 'Company / Care Of (optional)', 'Address', and 'Postal Code'. To the right, there's a 'SUMMARY' section showing 'SUBTOTAL', 'Shipping', 'Tax', and 'TOTAL' amounts. At the bottom right, there's a 'CONTINUE' button and links for 'HAVE A PROMO CODE?' and 'HAVE A QUESTION?'.

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

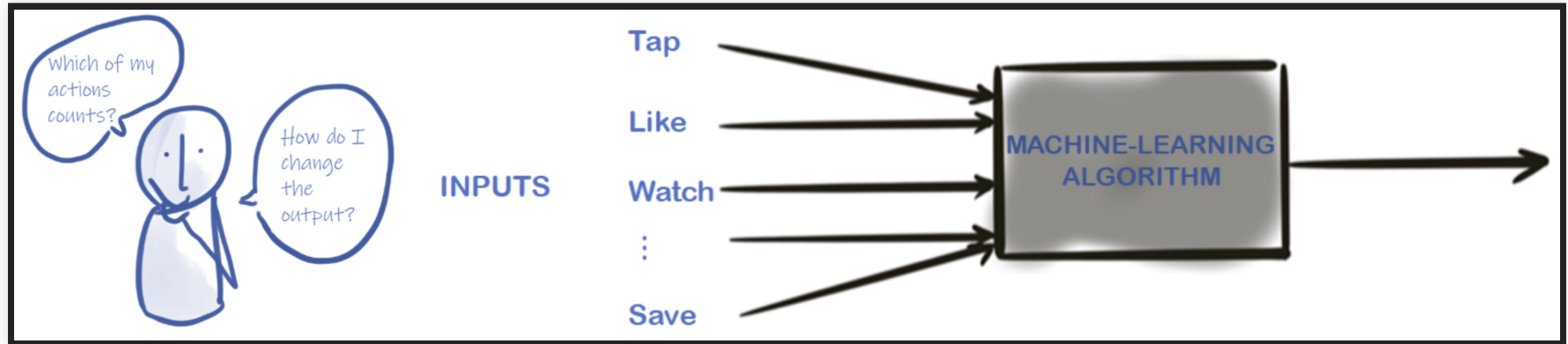
# BREAKING MENTAL MODEL



- 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>

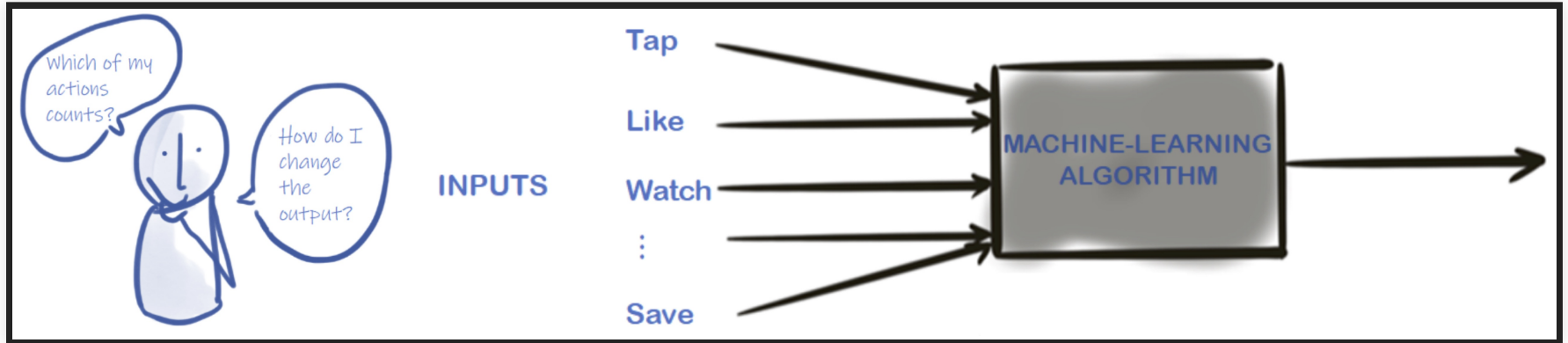
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  - Opaqueness: Typically less transparent than traditional apps
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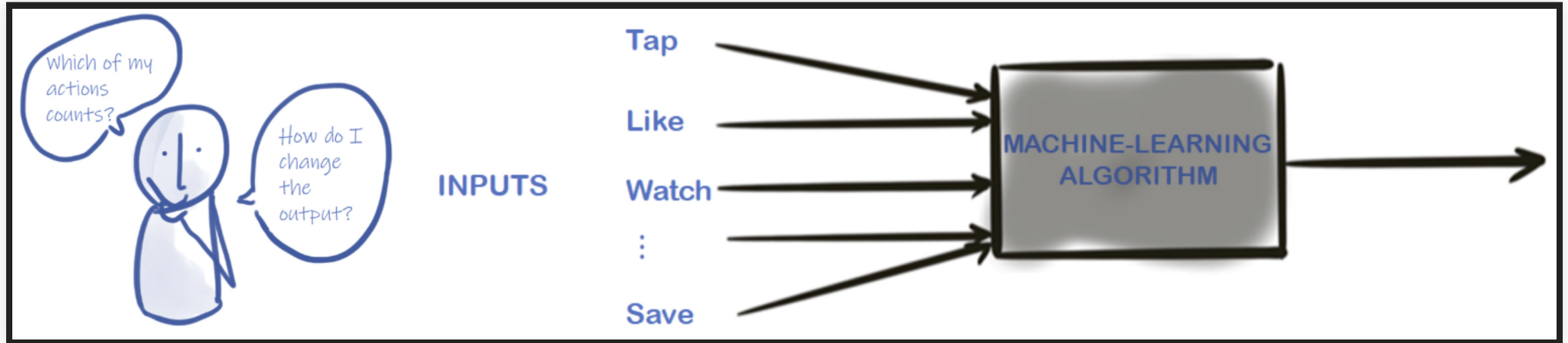


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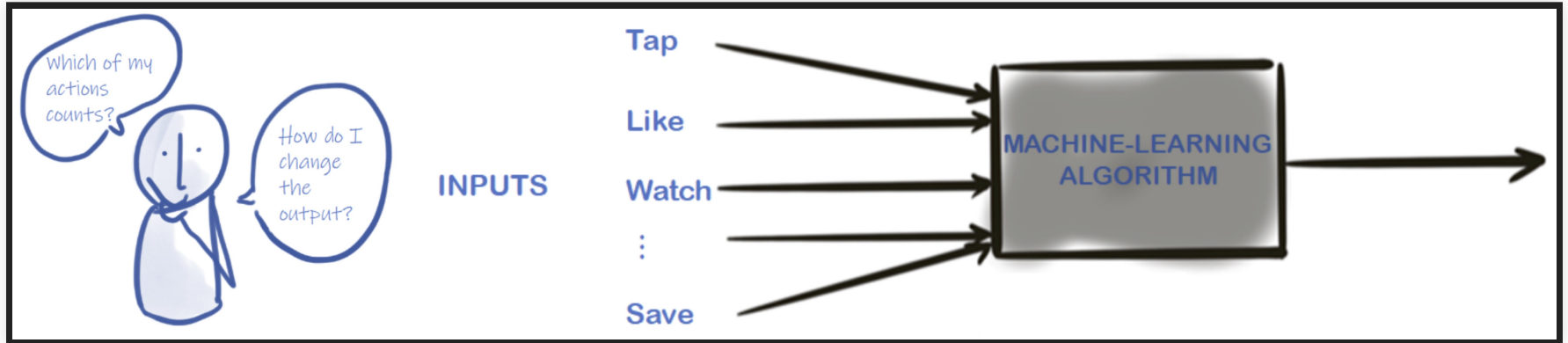
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- Lack of trust over output: How do I know the output is correct?



# MENTAL MODEL FOR VOICE ASSISTANTS?



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

# MENTAL MODEL FOR VOICE ASSISTANTS?

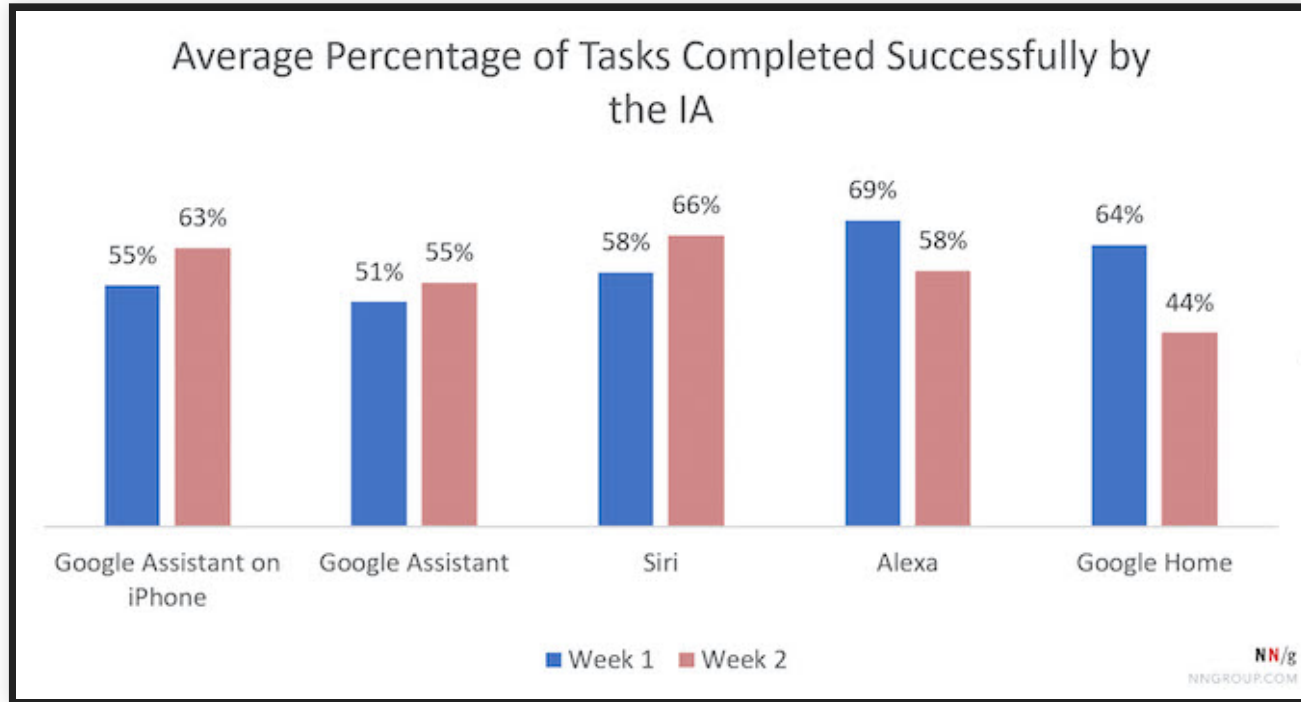


- Unclear, inconsistent mental model
  - An interface for other services?
  - "Handy helper"?
  - Knowledge repository? Fact-finding tool?

<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

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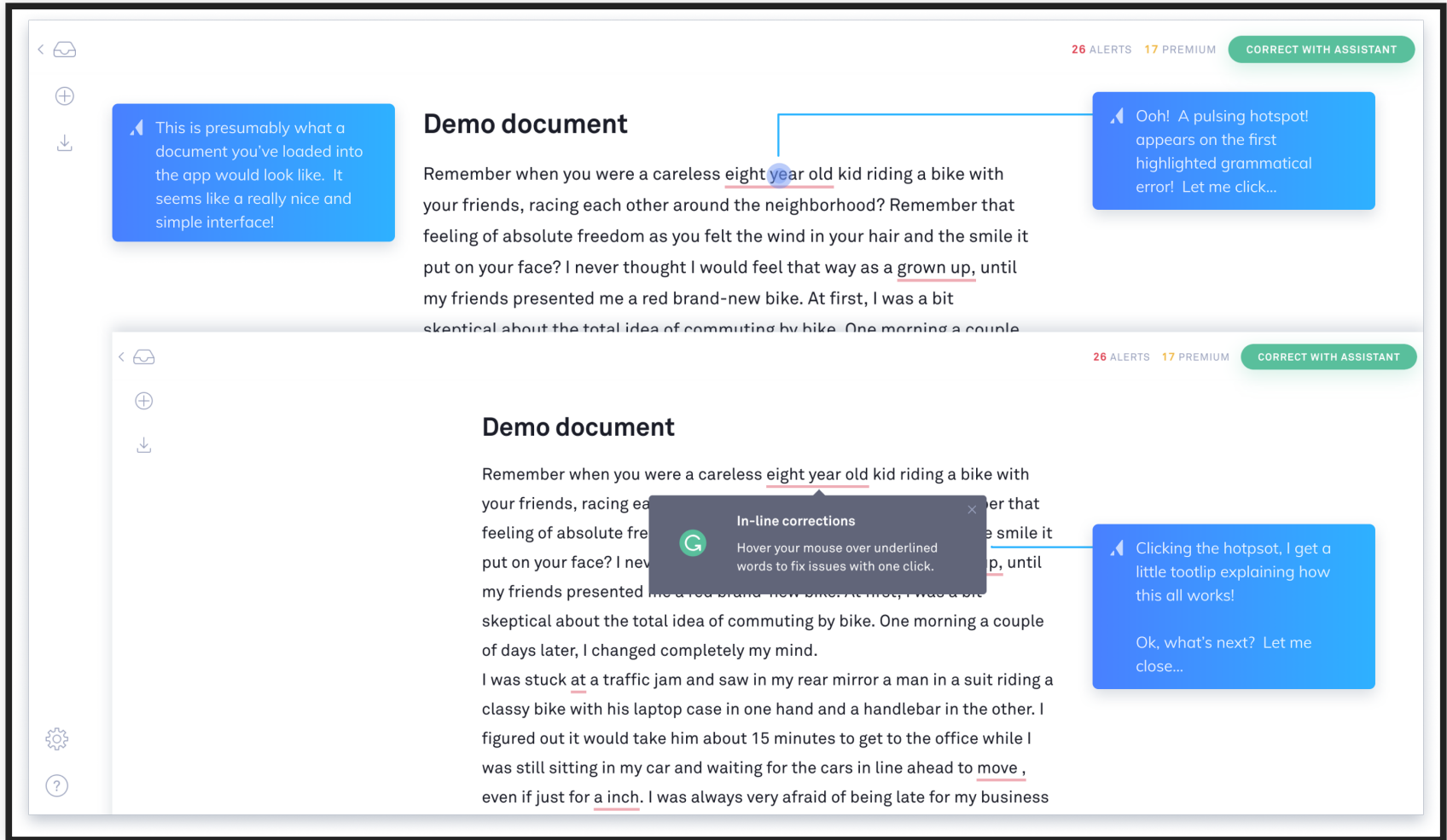
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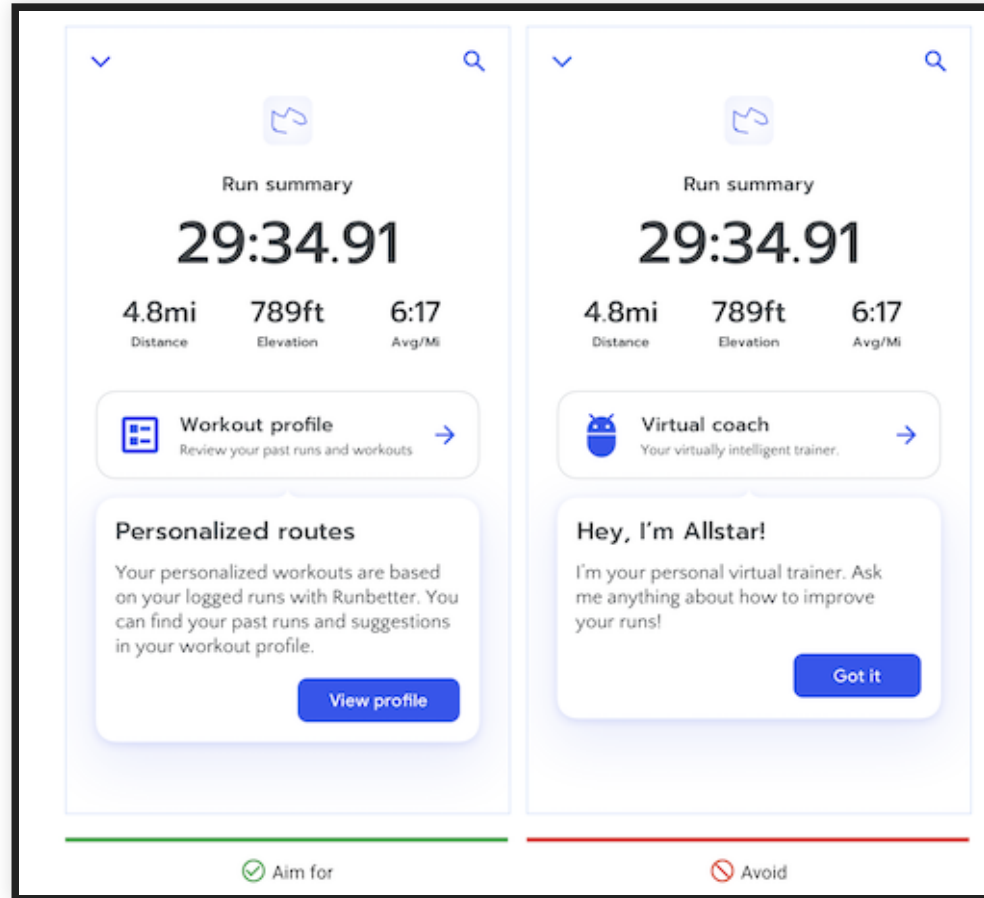
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- Improve/adjust the user's mental model
  - Set the user's expectations through onboarding
  - Increase transparency and explain decisions made by AI
  - Allow user to adjust system behavior to match their expectations

# ONBOARDING: SET USER'S MENTAL MODEL



- Provide examples of how the system works

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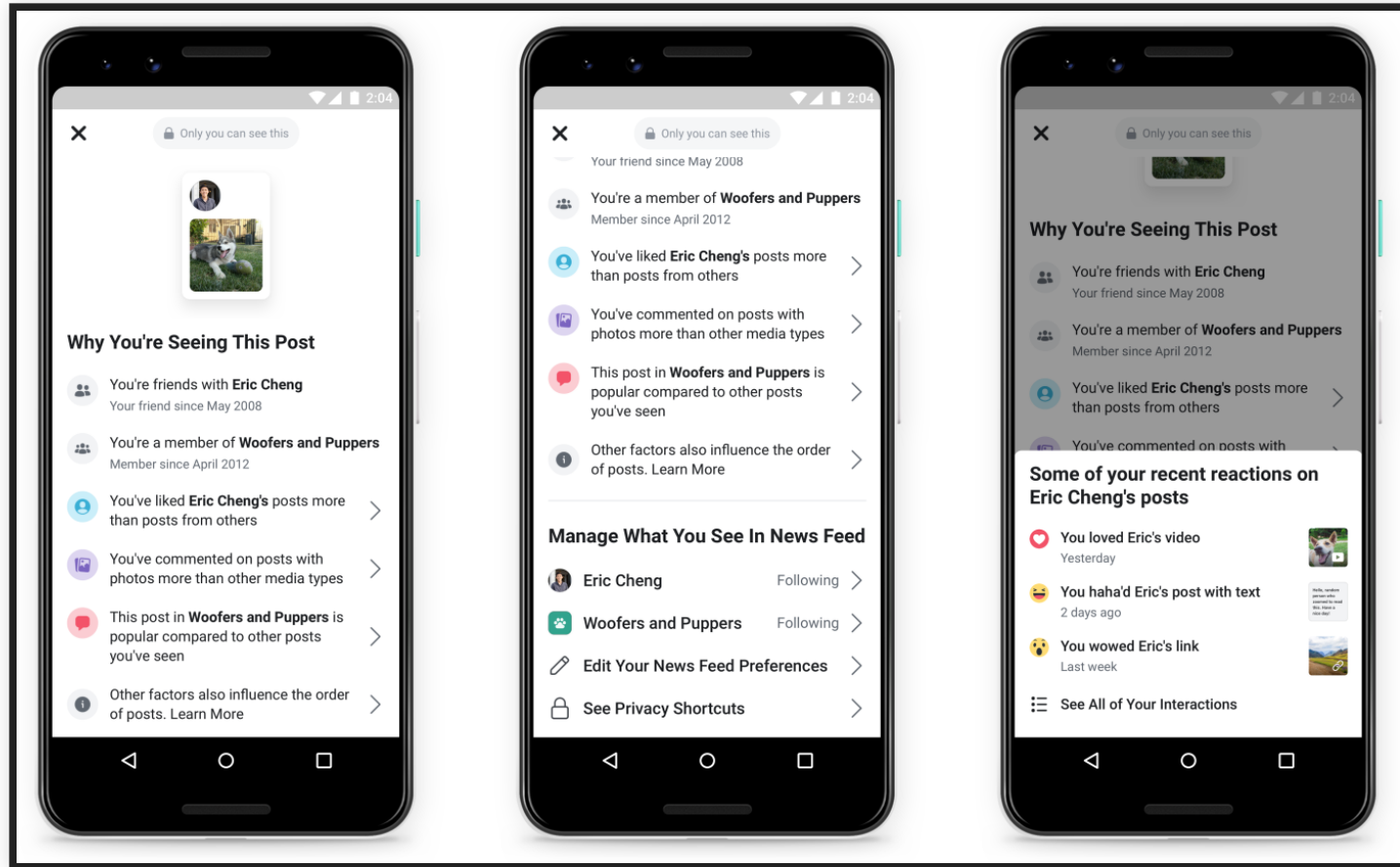
- Be explicit about what system can and cannot do

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





# TRANSPARENCY: EXPLAIN HOW DECISIONS ARE MADE



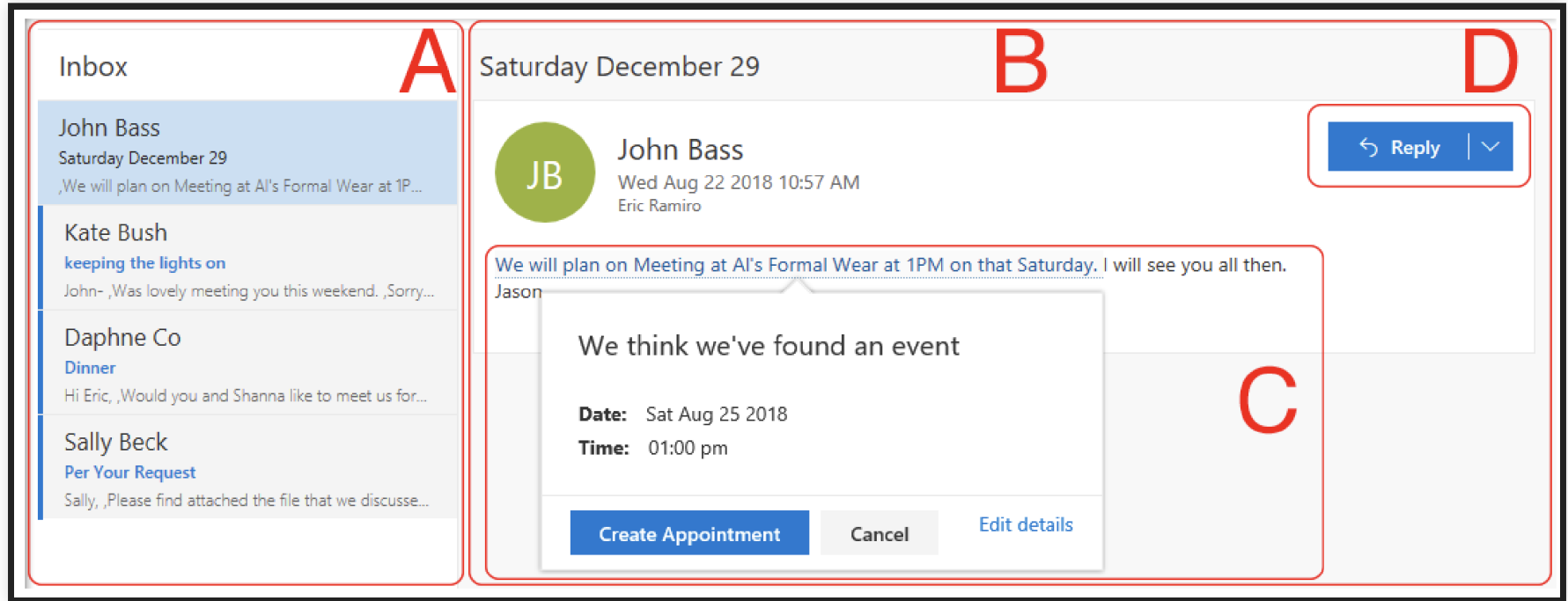
- Explain how the user's input actions influence output

# 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



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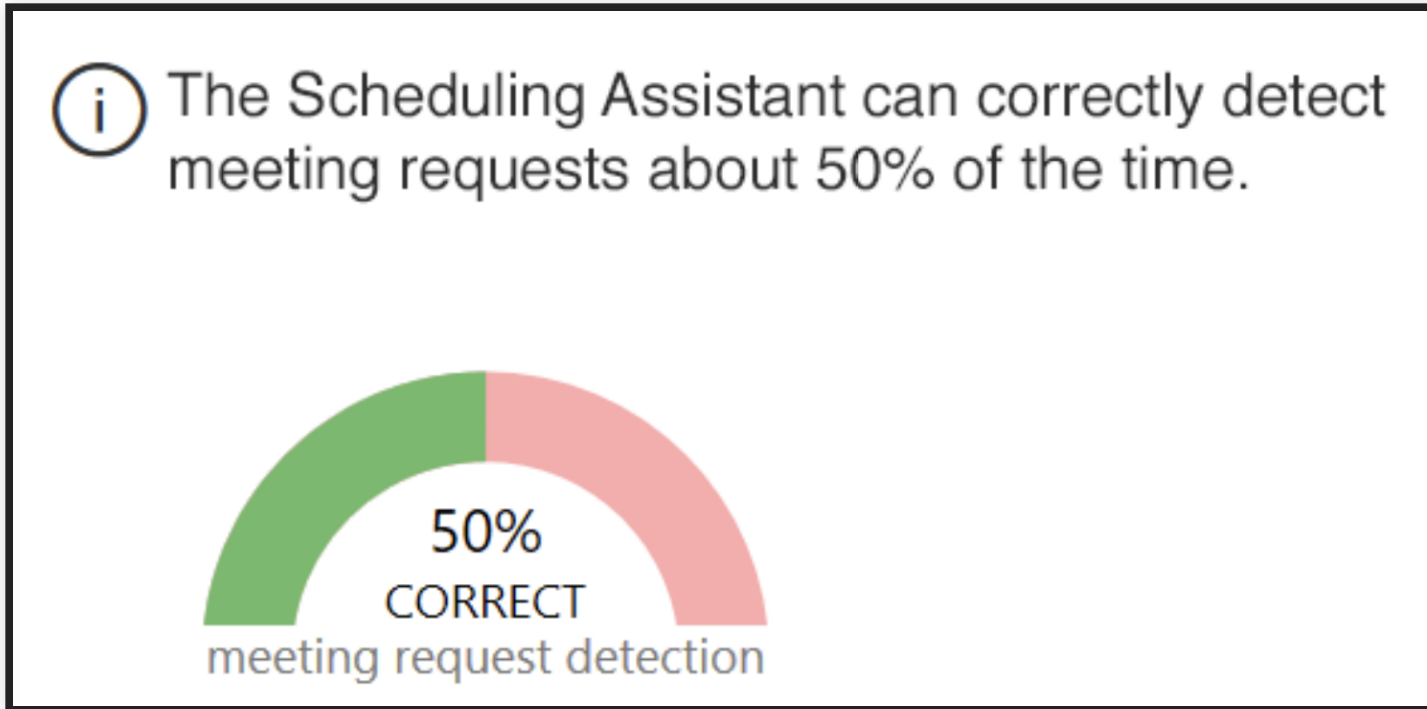
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- Give user controls to recover from and mitigate the effect of an error
  - e.g., delete or modify incorrect meeting schedule

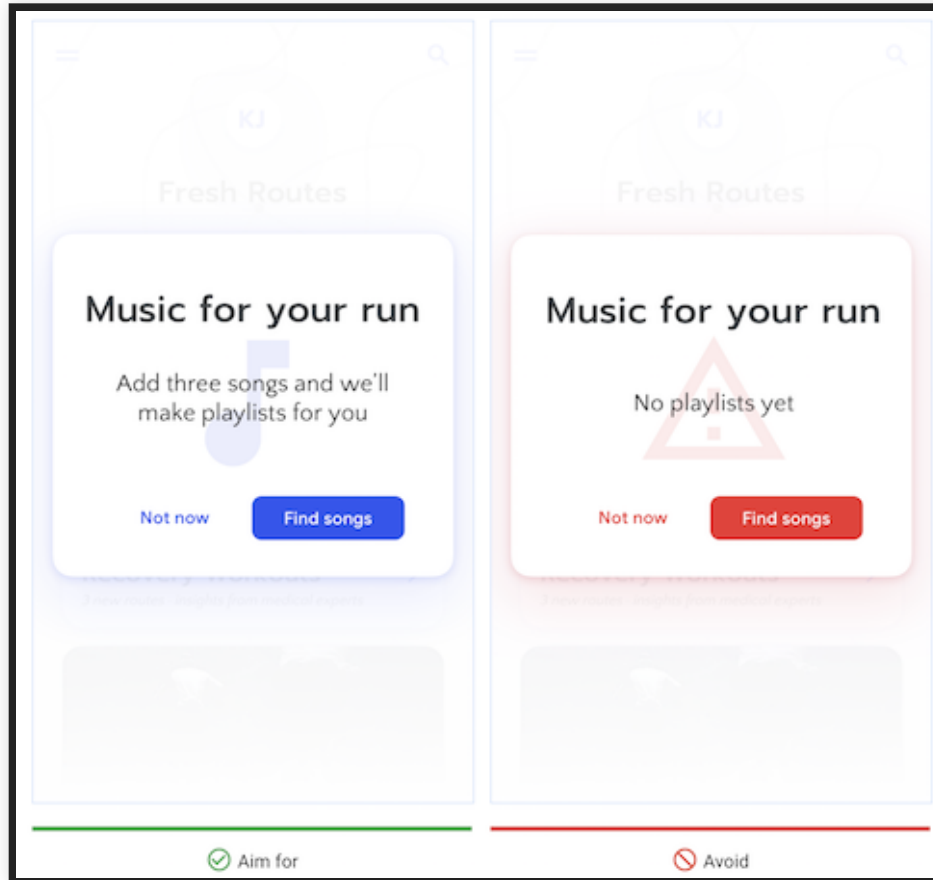
# SETTING USER EXPECTATIONS FOR ML ERRORS



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

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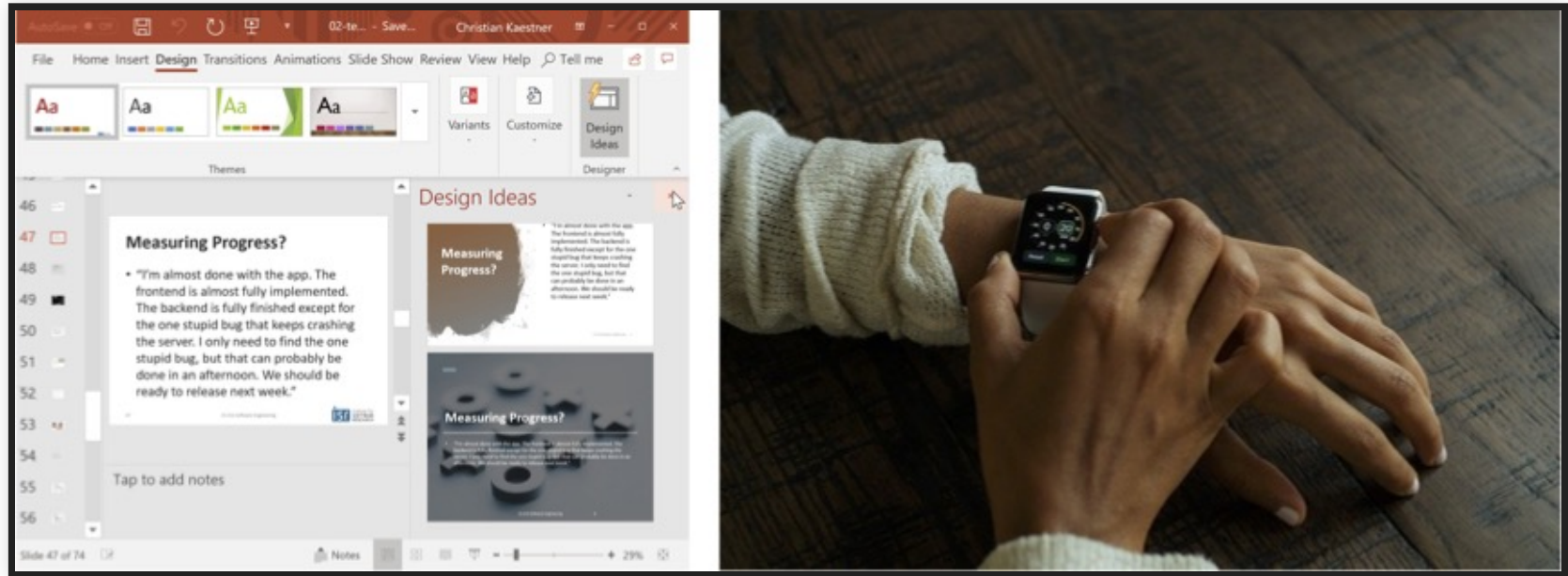
# ERROR MESSAGES: SUGGEST USER ACTIONS



- 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



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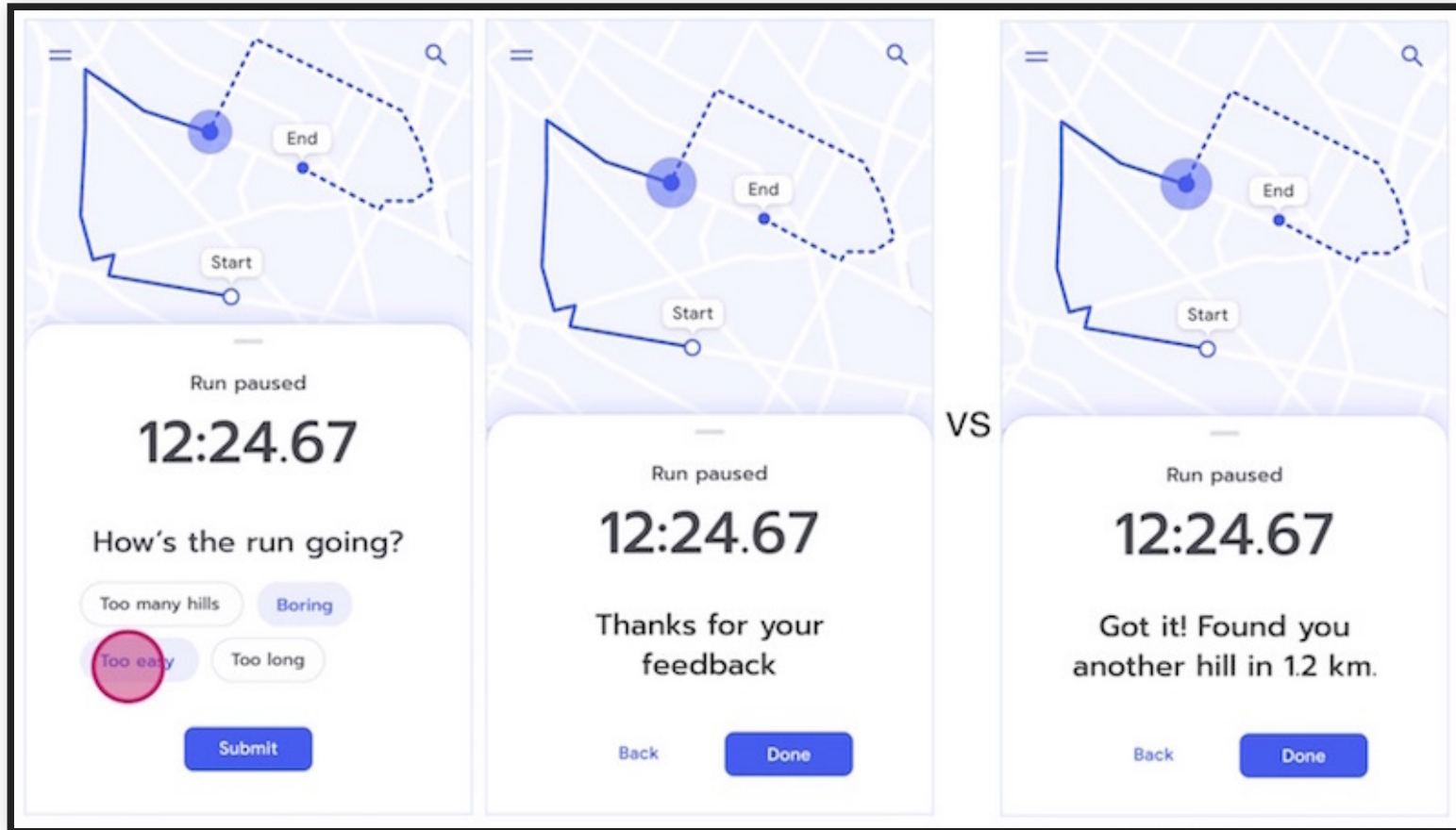
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  - Align feedback with improving interactions (and AI)
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  - Align feedback with improving interactions (and AI)
  - Acknowledge user feedback & respond immediately
- In addition to feedback, provide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

# RESPONDING TO FEEDBACK

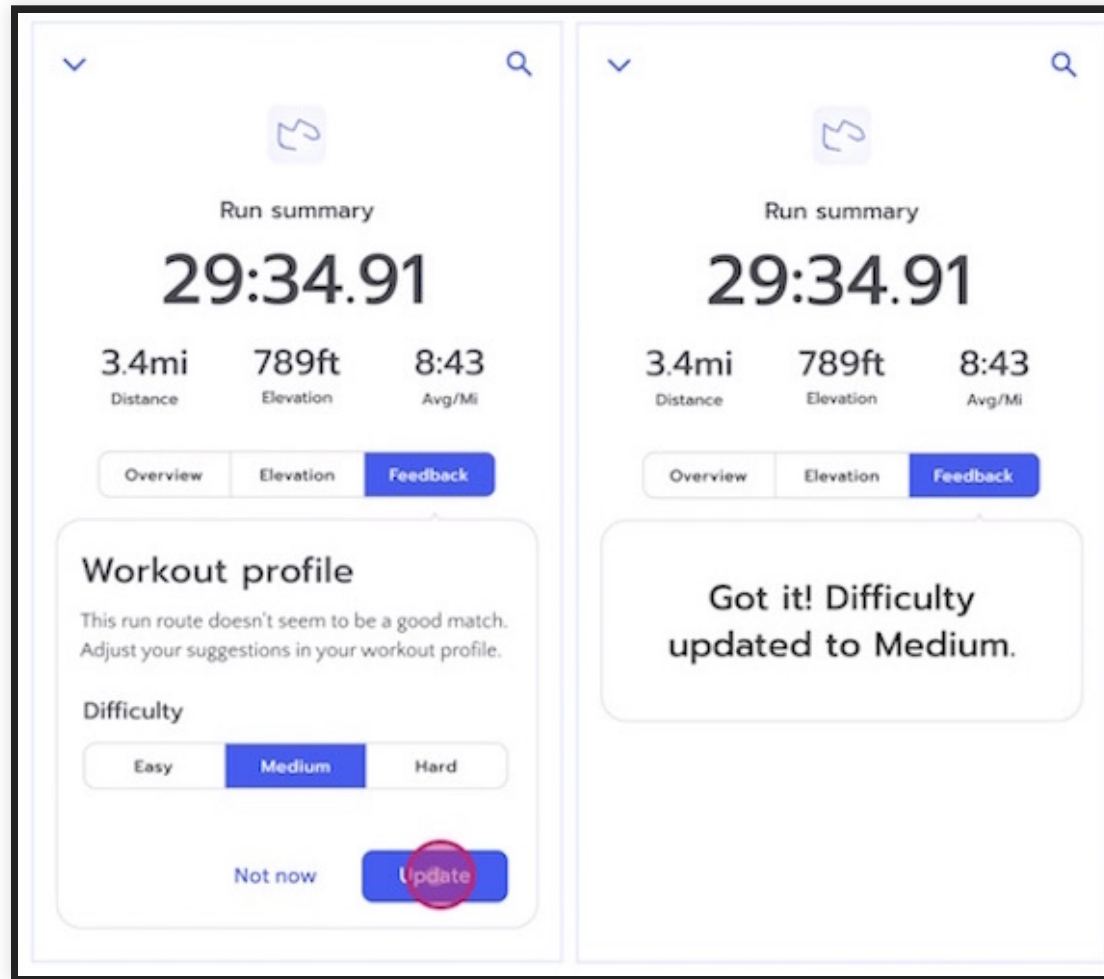


- When possible, respond to feedback with an adjustment to AI behavior

<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

## INITIALLY

1

INITIALLY

Make clear what the system can do.

Help the users understand what the AI system is capable of doing.

2

INITIALLY

Make clear how well the system can do what it can do.

Help the user understand how often the AI system may make mistakes.

## DURING INTERACTION

3

DURING INTERACTION

Time services based on context.

Time when to act or interrupt based on the user's current task and environment.

4

DURING INTERACTION

Show contextually relevant information.

Display information relevant to the user's current task and environment.

5

DURING INTERACTION

Match relevant social norms.

Ensure the experience is delivered in a way that users would expect, given their social and cultural context.

6

DURING INTERACTION

Mitigate social biases.

Ensure the AI system's language and behaviors do not reinforce undesirable and unfair stereotypes and biases.

## WHEN WRONG

7

WHEN WRONG

Support efficient invocation.

Make it easy to invoke or request the AI system's services when needed.

8

WHEN WRONG

Support efficient dismissal.

Make it easy to dismiss or ignore undesired system services.

9

WHEN WRONG

Support efficient correction.

Make it easy to edit, refine, or recover when the AI system is wrong.

10

WHEN WRONG

Scope services when in doubt.

Engage in disambiguation or gracefully degrade the AI system's services when uncertain about a user's goals.

11

WHEN WRONG

Make clear why the system did what it did.

Enable the user to access an explanation of why the AI system behaved as it did.

## OVER TIME

12

OVER TIME

Remember recent interactions.

Maintain short-term memory and allow the user to make efficient references to that memory.

13

OVER TIME

Learn from user behavior.

Personalize the user's experience by learning from their actions over time.

14

OVER TIME

Update and adapt cautiously.

Limit disruptive changes when updating and adapting the AI system's behaviors.

15

OVER TIME

Encourage granular feedback.

Enable the user to provide feedback indicating their preferences during regular interaction with the AI system.

16

OVER TIME

Convey the consequences of user actions.

Immediately update or convey how user actions will impact future behaviors of the AI system.

17

OVER TIME

Provide global controls.

Allow the user to globally customize what the AI system monitors and how it behaves.

18

OVER TIME

Notify users about changes.

Inform the user when the AI system adds or updates its capabilities.

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/aiguideelines>.



# 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