COMP 3647
Human-AI Interaction Design

Topic 2:
Mental Models

Prof. Effie L-C Law

What is a mental model?

Why is it relevant to design?

What is a Mental Model?

A. A thing you make in your head as an imaginary exercise.

B. A scientific theory.

C. A way of thinking about the world (but not life)

D. A way of thinking about life, the world, or any concept.

E. None of the above.

An Example…

In 2016, Fiat Chrysler Automobiles recalled over 1 million vehicles due to a new shifter design known as the "Rocker Switch Gearshift"
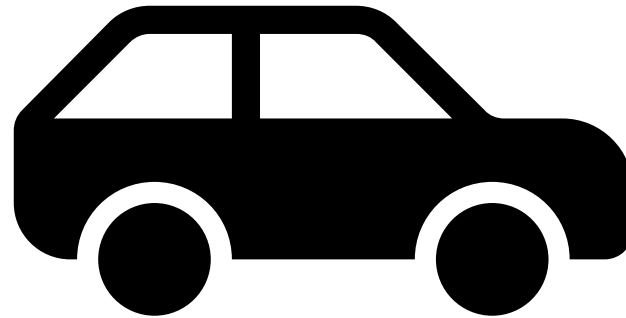
Button

It ratchets through the traditional PRND layout but always returns to its centre position.

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Mental Models and Design

People were getting out of their cars, thinking the shifter was in park, but then have the car drive off without them.

100 Crashes   **40 Injuries**

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What's Wrong: Designer's Perspective!

"Gear-selection is conveyed to the driver by multiple sets of indicator lights, not gear-selector position, and unless due care is taken, drivers may draw erroneous conclusions about the status of their vehicles."

Chrysler official statement

Driver Error (Stupid User!)

Fix it: Designer's Perspective!

Implement additional warnings

Encourage users to read their manuals

What's Wrong: User's Perspective!

People are used to **positional feedback** when changing gears!

Mental Model: Definition

- **A mental model is a person's internal representation of external reality, based on their learning and experience**.

- A mental model is how you think something will work, enabling you to make sense of the world through analogical reasoning (A works like B).
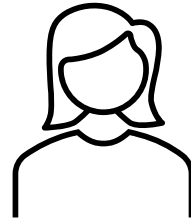
- Mental models can evolve over time!

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System Model (how something works) vs. Interaction Model (how to use something)

Engineer
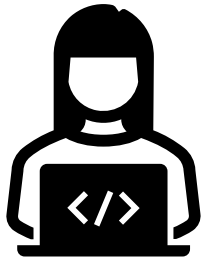
"I know how a drivetrain works, but not how people drive their cars"

UX Designer

"I can understand both sides and fill the gap"

Driver

"I am a great driver, but have no idea how my car works."

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Revising *User Model* → Calibrating Trustworthiness

Intermediate Feedback
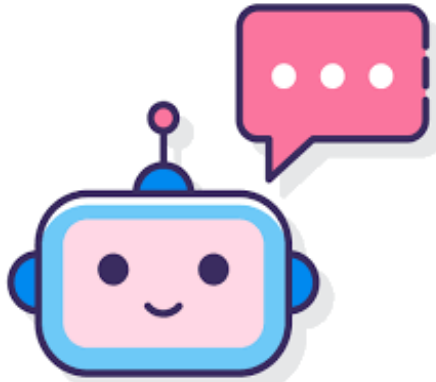*"How satisfied are you with me, so far?"*

Chatbot
Sub-system

Chatbot as
Interactive Tool

Human
in the Loop

Interaction & Curation
"It is ok. But how about this?"

Revising *Mental Model* → Calibrating Trust

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Evolving Paradigm

If you're creating something unfamiliar, base it in the familiar.

You can then evolve the paradigm

Mental Model: Basic Concepts

- If a mental model closely matches the actual behaviour of the device or interface, then people make accurate predictions/ expectations, and correct decisions, and choose appropriate actions.

- Users develop an understanding of a system through learning about and using it.

- Knowledge is sometimes described as a mental model:

  o How to use the system?

  o What to do with unfamiliar systems or unexpected situations?

- People make inferences using mental models of how to carry out tasks

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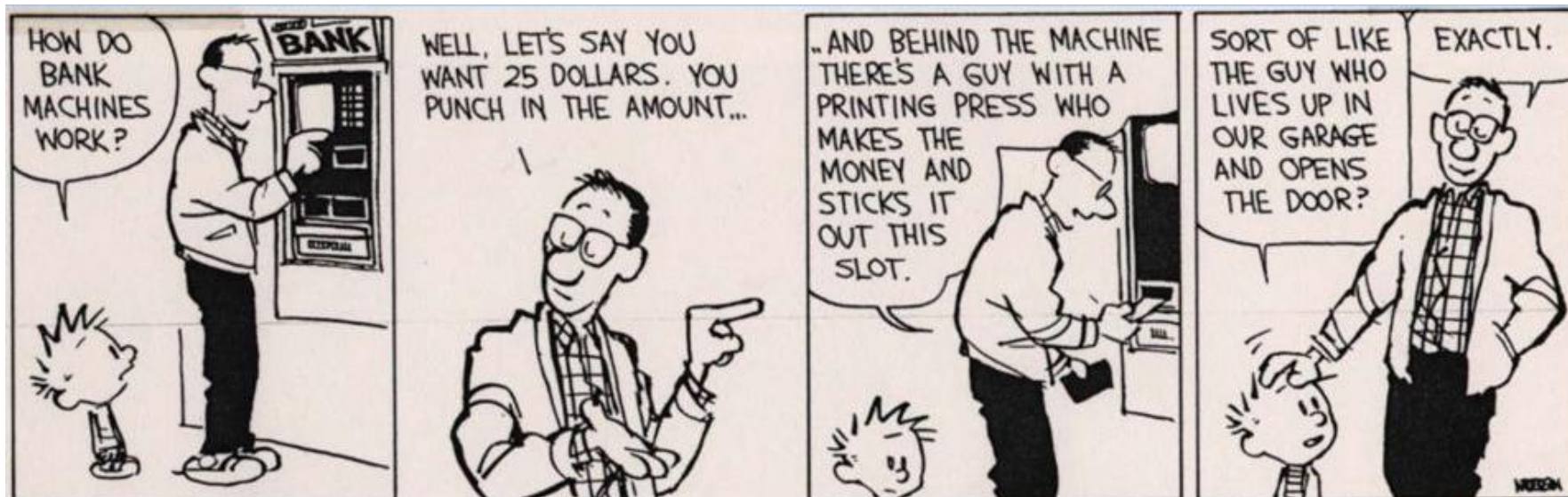University

Naïve Mental Models

Journal of Experimental Child Psychology
Volume 104, Issue 1, September 2009, Pages 52-67

ELSEVIER

Mental models and other misconceptions in children's understanding of the earth

Georgia Panagiotaki [a], Gavin Nobes [b], Anita Potton [c]
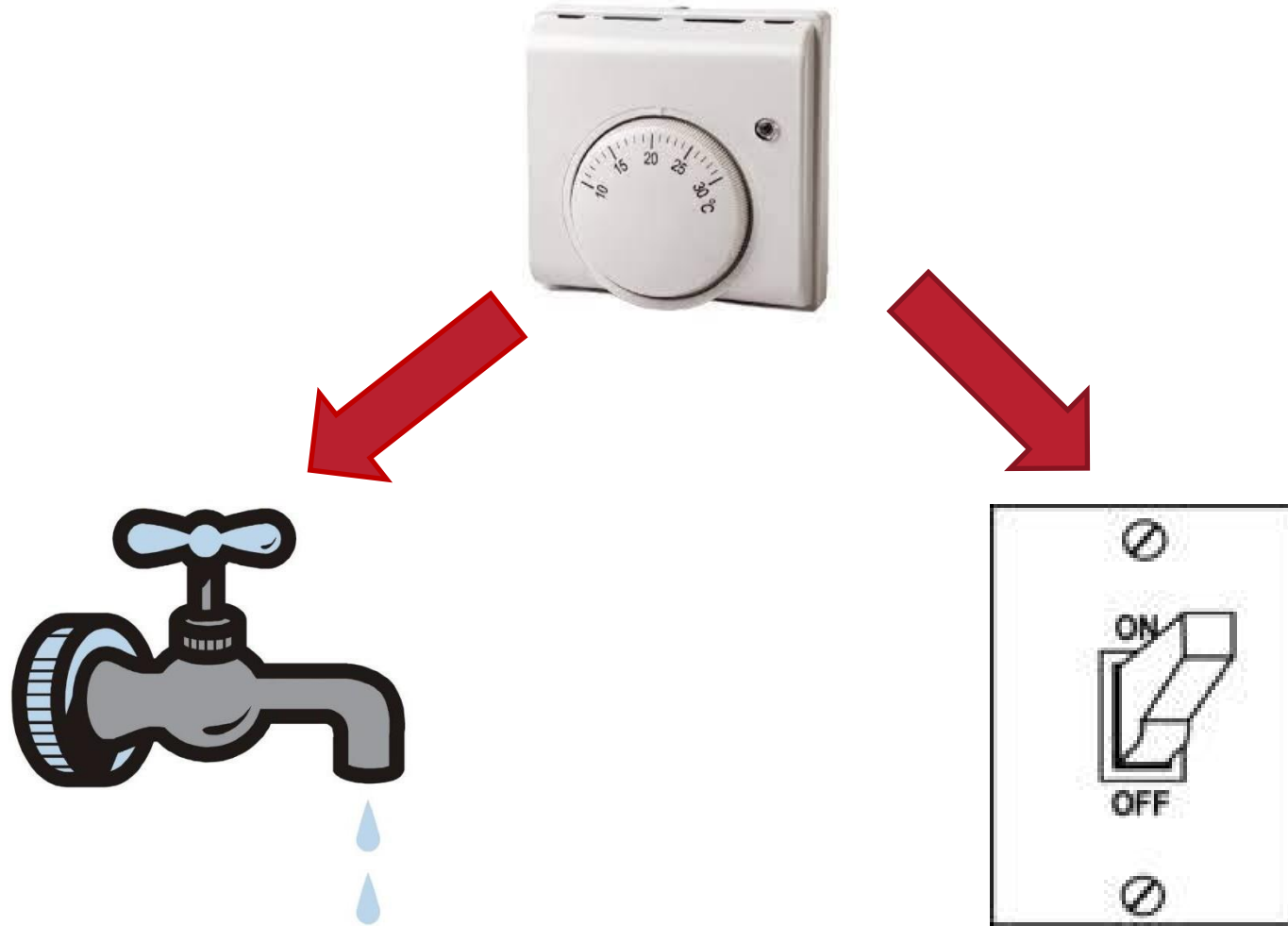
⊞ Show more

Everyday Reasoning and Mental Models

You arrive home on a cold winter's night to a cold house. How do you get the house to warm up as quickly as possible?

(A) Set the thermostat to be at its highest

(B) Set it to the desired temperature?

Do room thermostats work like taps or switches?

Heating up a Thermostat-controlled Room

- Many people have erroneous mental models (Kempton, 1996)

- Why?
  - General valve theory, where 'more is more' principle is generalised to different settings (e.g., gas pedal, gas cooker, tap, radio volume)
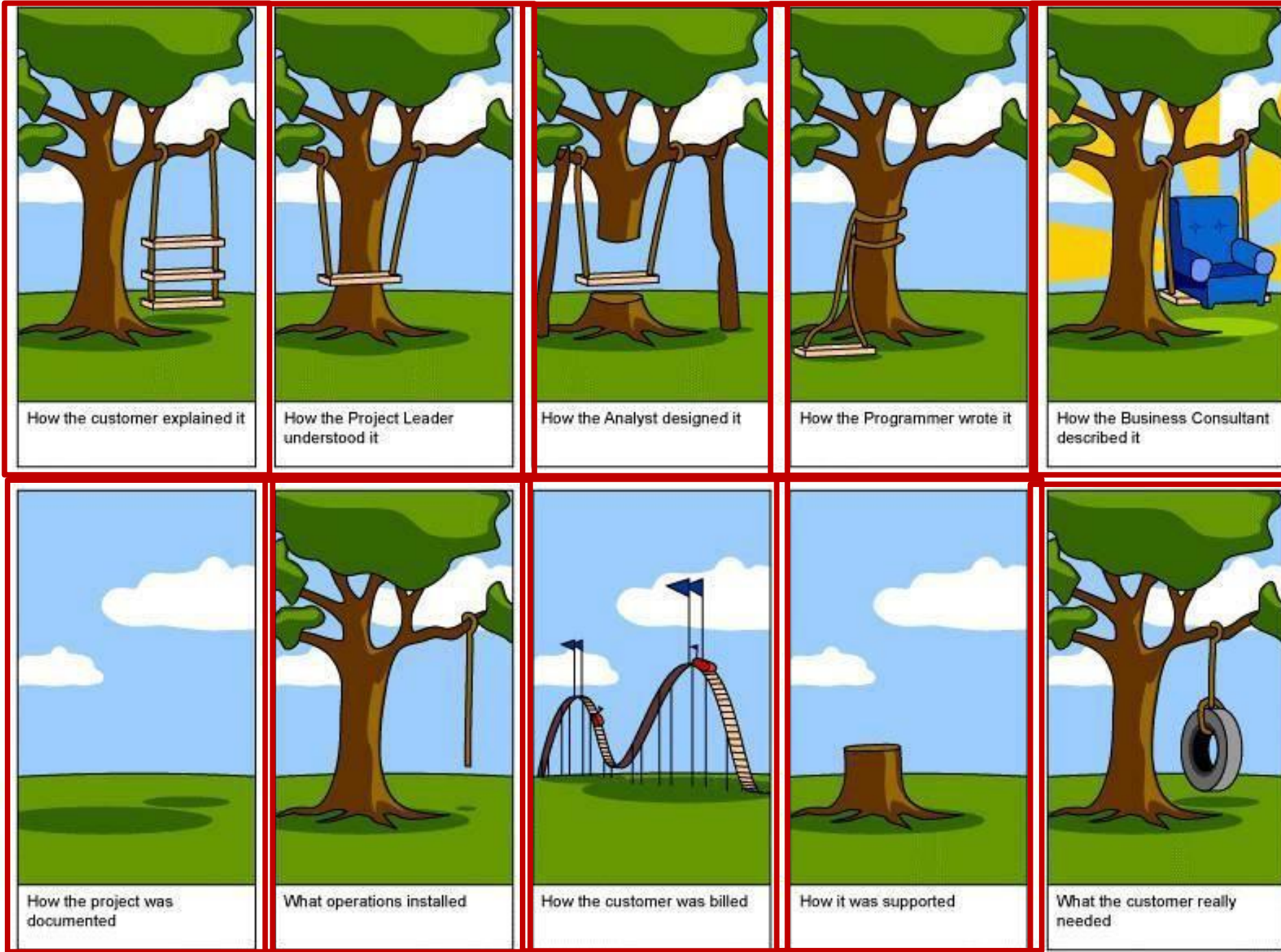 - Thermostats based on model of on-off switch model

Mental Models for Interactive Devices

Same is often true for understanding how interactive devices and computers work:

- poor, often incomplete, easily confusable, based on inappropriate analogies and superstition (Norman, 1983)

- elevators and pedestrian crossings - lot of people hit the button at least twice. Why? Think it will make the lights change faster or ensure the elevator arrives!

You can have as many mental models of a system as the number of different people involved in a project!

How the customer explained it

How the Project Leader understood it

How the Analyst designed it

How the Programmer wrote it

How the Business Consultant described it

How the project was documented

What operations installed

How the customer was billed

How it was supported

What the customer really needed

Source: https://pmac-agpc.ca/project-management-tree-swing-story

Good user interfaces help the user develop a good mental model of the system.

One way to help the user build a mental model is through <u>explanation</u> and <u>analogy</u> (A is like B).

What is Computer Virus?
(Folk Models)

...software that prevents, detects, and removes ...ke computer viruses, worms, trojan horses, ...nd other types of malware.

Tips to Stay Vigilant

When in doubt, always err on the side of caution. Be cautious when opening, downloading, or executing any files or email attachments.

Virus Detection Methods

...TURE BASED DETECTION
...rus works with a database of ...ruses. Each virus is identified ...iquely recognized coded ...s, called the virus fingerprint.

The term **"virus"** commonly refers to many different kinds of **malware**.

SUSPICIOUS BEHAVIO...
An antivirus can als... viruses based on he... from virus behaviou...

This method c... detecting new... yet stored in t...

...e database needs to be ...ated often so it knows ...t viruses to look for!

This method can be effective for detecting new viruses that are not yet stored in the database.

PREMISE PROTECTED
ANTIVIRUS ON WATCH

Maintain an updated antivirus.
To protect yourself from getting infected, keep your antivirus software up-to-date.

Myth: Multiple antivirus programs are beneficial.
Fact: Having ONE updated antivirus software is better than installing multiple incompatible programs.

Myth: Having an antivirus is enough.
Fact: Take a multi-layered approach to computer security that includes protection such as an antivirus program, and being cautious online.

Practice safe inte...
Download files from... avoid insecure file-s...

Myth: I don't use the inte...
Fact: Even if you don't use... infected external drives like... onto your computer.

Myth: I don't visit "shady"...
Fact: You could still get infected through legitimate websites that have been compromised, and through phishing sites, which are malicious clones of popular or trusted websites.

Install the latest system security updates.
Reduce the vulnerability of your OS by keeping it updated to the latest version.

Myth: Macs are far more secure than PCs.
Fact: The market share of Windows is higher than Apple's OS, making PCs bigger targets. As Macs become more popular, they are also becoming attractive targets for hackers.

Myth: Viruses damage your computer's hardware.
Fact: Viruses cannot physically damage hardware, but might indirectly affect how hardware behaves.

ANTIVIRUS SOFTWARE
Boosting Computers' Immune System

An **antivirus** is software that prevents, detects, and removes malicious software like computer viruses, worms, trojan horses, spyware, adware, and other types of malware.
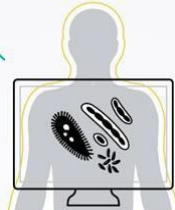
VIRUS DETECTION METHODS

SIGNATURE BASED DETECTION
An antivirus works with a ... se of known viruses. ... virus is identified by its ... ly recognized coded ... ces, called the virus ... rint.

The term **"virus"** commonly refers to many different kinds of **malware**.

SUSPICIOUS BEHAVIOUR BASED DETECTION
An antivirus can sometimes recognize new viruses based on heuristics derived from virus behaviours previously seen.

...abase needs to ...ften so it knows ...to look for!

Suspicious behaviour based detection can be effective for detecting new viruses that are not yet stored in the database.

SUSPICIOUS BEHAVIOUR BASED DETECTION

An antivirus can sometimes recognize new viruses based on heuristics derived from virus behaviours previously seen.

Suspicious behaviour based detection can be effective for detecting new viruses that are not yet stored in the database.

TIPS TO STAY HEALTHY

Maintain an updated antivirus
To protect yourself from getting infected, keep your antivirus software up-to-date.

Myth: Multiple antivirus programs are beneficial.
Fact: Having ONE updated antivirus software is better than installing multiple incompatible programs.

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Fact: Take a multi-layered approach to computer security that includes protection such as an antivirus program, and being cautious online.

Practice safe internet habits
Download files from reliable sources, and avoid insecure file-sharing programs.

Myth: I don't use the internet so I can't get a virus.
Fact: Even if you don't use the internet, inserting infected external drives like USBs can transfer viruses onto your computer.

Myth: I don't visit "shady" sites so I can't get a virus.
Fact: You could still get infected through legitimate websites that have been compromised, and through phishing sites, which are malicious clones of popular or trusted websites.

Install the latest system security upda...
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When in doubt, always err on the side of caution. Be cautious when opening, downloading, or executing any files or email attachments.

Mental Models: What is new when working with AI?

Mental Models: Implications of AI

Prepare users for change and help them understand how to train the system.

- ✓ Which aspects of AI should we explain to our users?
- ✓ How should we introduce AI to the user initially - and thereafter?
- ✓ What are the pros and cons of introducing our AI as human-like?

Recap

A mental model: a person's understanding of how something works and how their actions affect it. People *form* mental models for everything they interact with, including products, places and people.

Mental models help set expectations for what a product can and can't do and what kind of value people can expect to get from it. Mental models can also serve as **bridges between experiences**.

Mental Models: User Expectations for AI

Mismatched mental models can lead to unmet expectations, frustrations, misuse, and product abandonment.

We need to set correct mental models for users by considering the early user experience with a product and fully explain how the product works.

Key considerations:

- Set expectations for adaptation
- Onboard in stages
- Plan for co-learning
- Account for user expectations of human-like interaction

Set expectations for adaptation

Mental models: Set expectations for adaptation

Static products e.g. we buy today will be same one tomorrow.

Responsive products e.g. adapt how they respond based on user input over time.
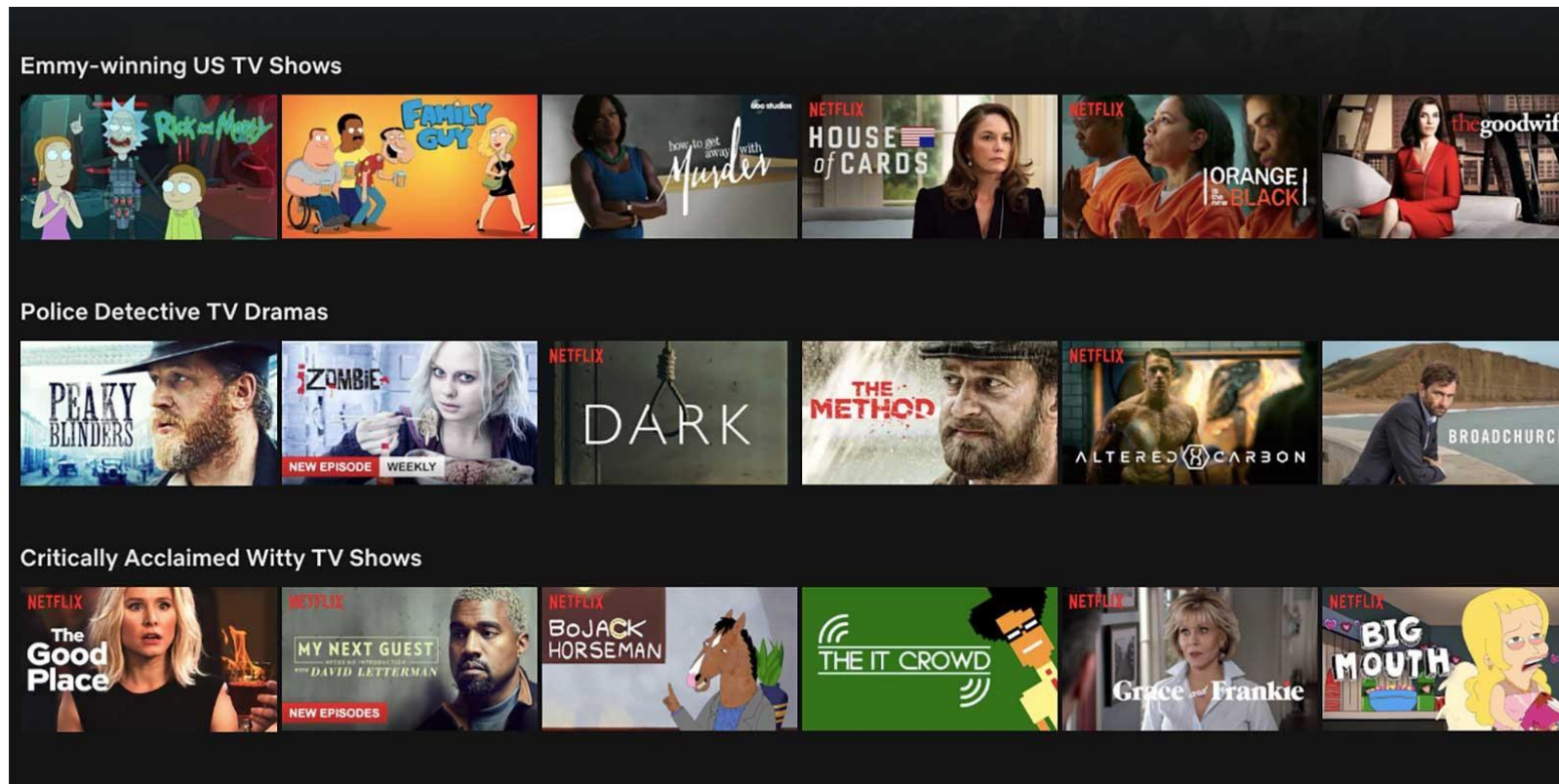
Mental Models: Set expectations for adaptation

Create effective mental models of AI products by building on existing models while teaching users the dynamic relationship between their input and product output.

Identify existing mental models

- How people currently solve the problem that the product will use AI to address.
- That existing solution will very likely inform their initial mental model.

Example: labelling email messages - read, think about the meaning, context, importance, label..., time of day the message was sent or the length?
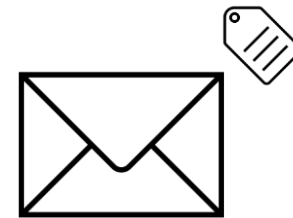
Mental Models: Set expectations for adaptation

Key concepts

To understand the context for the user's relationship to AI product, work through some of the questions below:

- What is the user trying to do?

- What mental models might they carry over to the product?

- What is the step-by-step process that novice users currently use to accomplish the task?

- How uniform is this process between different users?

Onboard in stages

Mental Models: Onboarding in Stages

Onboarding: the process of helping a new user or customer get to know a product/service.

The onboarding experience begins before users purchase or download our product or even visit our website and continues indefinitely.

It's important to consider the different stages of introducing our AI and how mental models form and change along the way.

1. Introduce and set expectations for AI
2. Explain the benefit, not the technology
3. Only introduce new features when needed
4. Design for experimentation

Mental Models: Onboarding Stage 1 - Information

1. **Introduce and set expectations for AI**

   After identifying users' existing mental models

   - How information our user received before their first interaction with the product has shaped their expectations.

   - Collaborate closely with the marketing team to develop appropriate and consistent messaging.

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Mental Models: Onboarding Stage 1 - Trust

1. **Introduce and set expectations for AI**

   Don't over promise that "AI magic" will help users accomplish their tasks.

   - this may lead to mental models that overestimate what the product can actually do.
   - if fail to meet expectations, severe damage on trust!

   "AI magic"?

   Shielding users from a product's complexity

   - hiding how it works can set users up for confusion and broken trust.
   - explaining specific product capabilities can become overly technical, intimidating and boring.
   - striking for the right balance

Aim for

Emphasise how the app will benefit users.

RUN

4.5 ★★★★⯪ (1,348,231)

RUN is a running app that adapts to your fitness levels and designs personalized workouts to help you improve your running.

RUN | **Download**

Avoid

Don't emphasise the underlying technology.

RUN

2.1 ★★☆☆☆ (4,651)

RUN is the only intelligent running app that uses sophisticated deep neural net machine learning to make your run smarter because we believe in ML driven workouts.

RUN | **Download**

Mental Models: Onboarding Stage 1 - Disclosure

1. **Introduce and set expectations for AI**

   Messaging guidelines for setting the right expectations for your product:
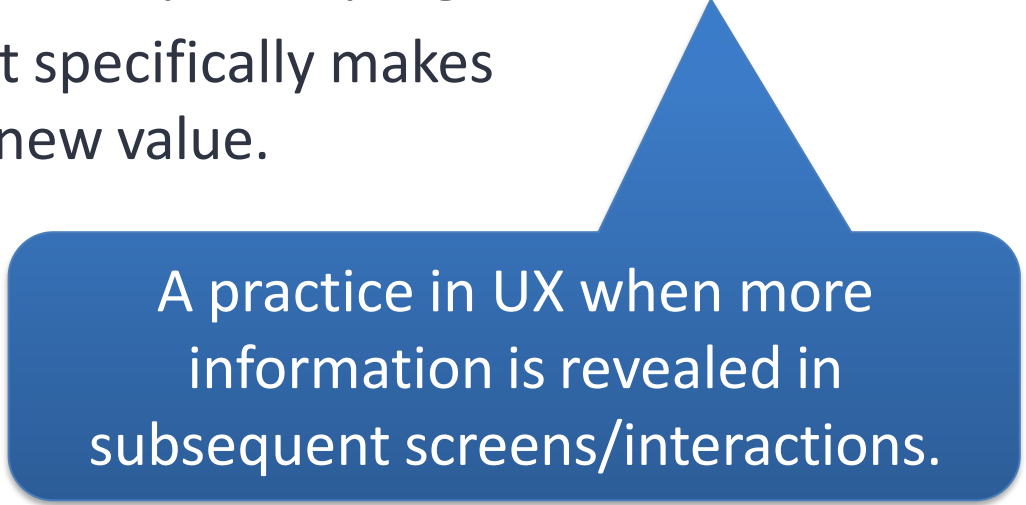
   - Be up-front about what the product <u>can</u> and <u>can't do</u> the first time the user interacts with it, ideally in marketing messages.

   - Offer examples of how it works that clarify the <u>value</u> of the product.

   - Let people know up-front that it may need their <u>feedback</u> to improve over time.

   - Communicate why people should continue to provide feedback, focusing on the value to them.

Mental Models: Onboarding Stage 2

2. **Explain the benefit, not the technology**

Make sure to evaluate which details users need to build a good mental model.

- If they're interested in understanding the underlying technology of the product, we can provide more detail with <u>tooltips</u> and <u>progressive disclosure</u>.

- If we do talk about the AI, focus on how it specifically makes part of the experience better or delivers new value.

> A practice in UX when more information is revealed in subsequent screens/interactions.

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Mental Models: Onboarding Stage 3

3. **Only introduce new features when needed**

   As users explore the product, use relevant and actionable "inboarding" messages to help them along.

   Avoid introducing **new features** when users are busy doing something unrelated. This is especially important if we're updating an existing product with new AI features that change the function or user experience.

   > People learn better when short, explicit information appears right when they need it!

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Aim for

Introduce an AI-driven feature at the moment it is relevant to the user.

Need a training partner?

We can suggest runners with shared goals and similar paces

Avoid

Don't introduce AI-driven features as part of a long introductory list of product features.

Mental Models: Onboarding Stage 4 - Start

4. **Design for experimentation**

   Many people learn best by tinkering with a new experience. People sometimes skip onboarding steps because they are eager to start using the system, and reading even a few screens feels like it's in the way.

   - Keep onboarding short

   - Suggest a low-risk or reversible action users can try right away

   Encourage with a <u>small</u>, <u>contained</u> initial experimentation experience.

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Mental Models: Onboarding Stage 4 - Time

4. **Design for experimentation**

   A user's willingness or ability to spend time experimenting depends on their goal in using our product.

   Example: an average consumer who purchases a new smart speaker might enjoy spending time experimenting with different commands and questions. In contrast, a busy enterprise user might regard testing commands and functions as just one more chore in a busy day.

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Mental Models: Onboarding Stage 4 – Trial & Error

4. **Design for experimentation**

   Point users towards where they can quickly understand and benefit from our product.

   Otherwise, they may find the boundaries of the system by experimenting in ways it **isn't prepared** to respond to. This can lead to errors, failure states, and potentially erosion of trust in a product.

   Helping users get back on track.

Your first run

We'll average your first few runs together before we start making recommendations

Learn more   **Let's go**

✅ Aim for

Encourage experimentation and reassure users that experimenting won't dictate their future experiences.

Welcome

To get started, lace up and head out on your first intelligent run

Learn more   **Let's go**

🚫 Avoid

Don't assume users want the AI to start learning from the first use.

Mental Models: Onboarding - Messaging

Key concept

Onboarding is all about setting up the interaction relationship between the user and our product. Here's a simple messaging framework to get you started:

This is *{ our product or feature },*
and it'll help you by *{ core benefits }.*
Right now, it's not able to *{ primary limitations of AI }.*
Over time, it'll change to become more relevant to you.
You can help it get better by *{ user actions to teach the system }.*

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Plan for co-learning

Mental Models: Plan for co-learning

AI-powered products can adapt and get better over time, so the user experience can change. Users need to be prepared for that and adjust their mental model when necessary.

1. Connect feedback with personalisation
2. Fail gracefully
3. Remind, reinforce, and adjust

Mental Models: Plan for co-learning

1. **Connect feedback with personalisation**

   In onboarding, let users know how the feedback they provide helps the AI personalise their experience.

   Tie this to the user benefit with phrasing like

   "you can improve your experience by giving feedback on the suggestions you receive."

   then, let them now where and how to do so.

   Two ways to collect feedback:
   - Implicit feedback
   - Explicit feedback

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Mental Models: Plan for co-learning

1. **Connect feedback with personalisation**

    Two ways to collect feedback:

    *   **Implicit feedback**: when people's actions while using the product help improve the AI over time. There should be a place in a product where users can see <u>which signals</u> are being used <u>to what end</u>.

    *   **Explicit feedback** : when people intentionally give feedback to improve an AI model, like picking categories of music they're interested in. This kind of feedback can help the user feel more in <u>control of</u> the product. If we can, explain precisely what impact the feedback will have on the AI, and when it will take effect.

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Mental Models: Plan for co-learning

1. **Connect feedback with personalisation**

    When the system collects feedback, explain how continually teaching the system benefits the user. Be clear about what information will help the AI learn and how it will improve the product output.

Mental Models: Plan for co-learning

2. **Fail gracefully**

   The first time the system fails to meet expectations, the user will likely be disappointed. However, if the mental model includes the idea that the system learns over time, and learns better with the right input, then failure, especially the first failure the user encounters, becomes an opportunity to establish the **feedback relationship**.

   Once this relationship is set, users will see each failure not only as more forgivable, but also something that they can help fix. This buy-in can help cement the **mental model of co-learning**.

Mental Models: Plan for co-learning

2. **Fail gracefully**

   What if a system isn't certain, or can't complete a request?
   ➢ Make sure there's a default user experience that doesn't rely on AI. That way, the burden of educating the AI doesn't stop users from getting things done.

   When a product fails gracefully?
   ➢ It doesn't get in the user's way, and they see feedback as a way to make their objectives even easier over time, while still being able to use the system now.

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Mental Models: Plan for co-learning

3. **Remind, reinforce, and adjust**

   Products as part of a user's **everyday routine**.

   Mental models get formed and reinforced by ongoing use.

   Products meant to be **used occasionally**.

   Mental models might erode over time, so it's helpful to consider ways to reinforce them, or to remind users of the basics.

Mental Models: Plan for co-learning

3. **Remind, reinforce, and adjust**

   Strengthen mental models across AI products by maintaining **consistent messaging** about the user **benefits** of improving AI with **feedback**.

   Over time, users may adopt a common mental model that recognises AI solutions and their strengths and weaknesses, becoming more comfortable with what they'll get and how they can shape their experience.

   To increase the odds of that happening:

   - Keep track of user needs
   - Adapt to the evolving user journey

Mental Models: Plan for co-learning

3.   **Remind, reinforce, and adjust**

   • **Keep track of user needs**
     Monitor how the product is being used. Reviewing **product logs** can show behaviour or use trends that point to user confusion or frustration.
     For product meant to be used for a short time or to achieve a specific goal, this determines how frequently mental models should be reinforced/updated.

   • **Adapt to the evolving user journey**
     What if how a feature works changes/improves significantly?
     ➤ Consider if users need "re-boarding" to the new experience.

     What if the system is simple and the mental model is clear and memorable?
     ➤ Maybe only a little reinforcement is required.
     A quick user study with people who have used the product previously, but not in the last month or so, could reveal what kind of nudge would be needed.

Account for user expectations of human-like interaction

Mental Models: Human-like Interaction

AI products launched to be anthropomorphic or human-like

Siri	Celia	Cortana	Alexa

This choice has advantages and disadvantages that should be weighed carefully.

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Mental Models: Human-like Interaction

Advantages

People tend to reflexively infer human characteristics from voice interfaces, and some interactions, such as conversational interfaces, are inherently human-like.

Disadvantages

Algorithmic nature and limits of these products are not explicitly communicated, they can set expectations that are unrealistic and eventually lead to user disappointment, or even unintended deception.

Hey! I am not a human.

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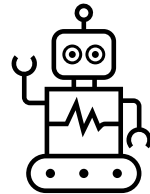
Mental Models: Human-like Interaction

When users confuse an AI with a human being, they can sometimes disclose more info than they would otherwise, or rely on the system more than they should.

Disclosing the algorithm-powered nature of these kinds of interfaces is a critical onboarding step.

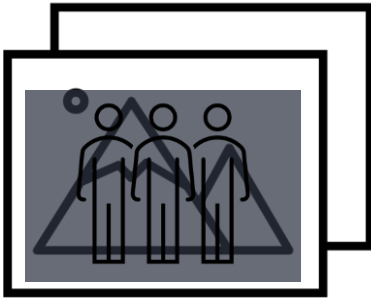Messages should make it extremely **clear** that the product is NOT a human.

1. Clearly communicate AI limits and capabilities
2. Cue the correct interactions

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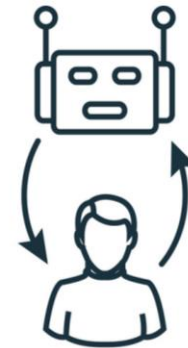
Mental Models: Human-like Interaction

1. **Clearly communicate AI limits and capabilities**

   Human and human-like AI-powered app are different, inherently!

   "automatic photo tagging" – NOT tagging photos the same way a person would, just "automatically".

   - A person can recognise their friends from multiple angles, but AI cannot.
   - But, AI can scan thousands of photos, identify subject, and label them.

   The key is to communicate the system's limits and capabilities in a way that doesn't create or support expectations of **super-human abilities**.

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Mental Models: Human-like Interaction

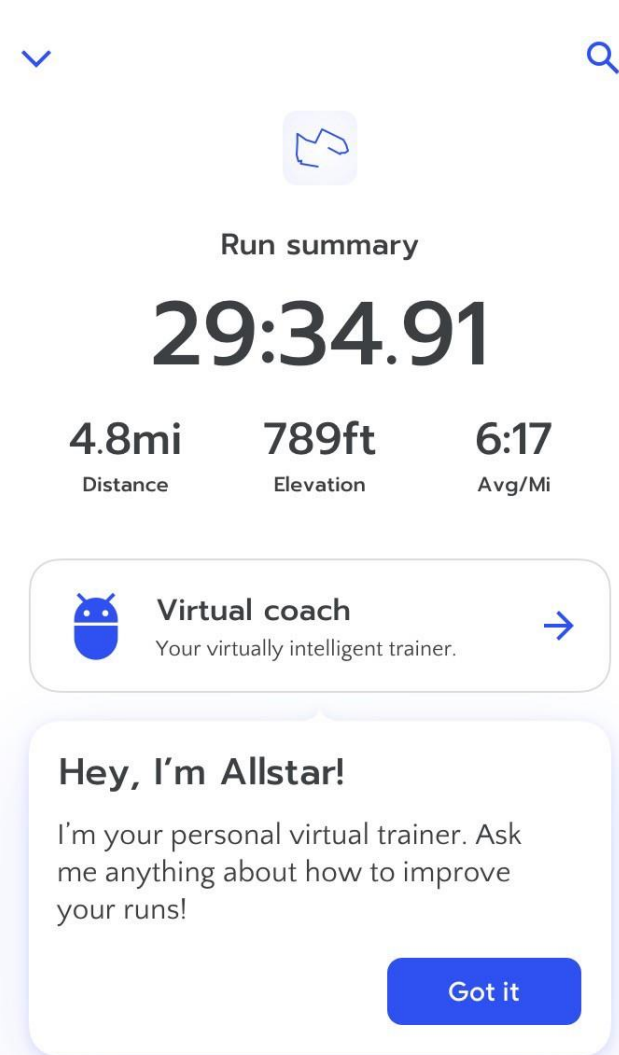1. **Clearly communicate AI limits and capabilities**

   Don't over-commit!

   When users cannot accurately map the system's abilities, they may over-trust the system at the wrong times, or miss out on the greatest value-add of all!

   > Choose the level of humanisation based on how well the AI's capabilities **match** the user's perceptions of what a human can do.

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Run summary

29:34.91

4.8mi · Distance **789ft** · Elevation **6:17** · Avg/Mi

Workout profile
Review your past runs and workouts →

Personalized routes
Your personalized workouts are based on your logged runs with Runbetter. You can find your past runs and suggestions in your workout profile.

View profile
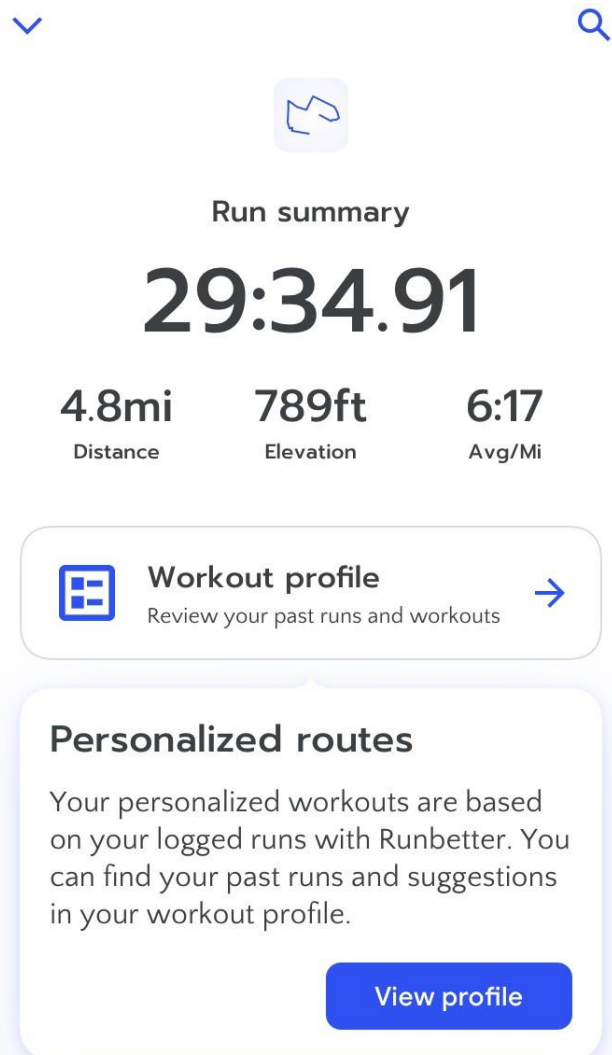
✅ Aim for

Describe AI features in terms of helping people improve while setting the right expectations for what the AI can do.

Run summary

29:34.91

4.8mi · Distance **789ft** · Elevation **6:17** · Avg/Mi

Virtual coach
Your virtually intelligent trainer. →

Hey, I'm Allstar!
I'm your personal virtual trainer. Ask me anything about how to improve your runs!
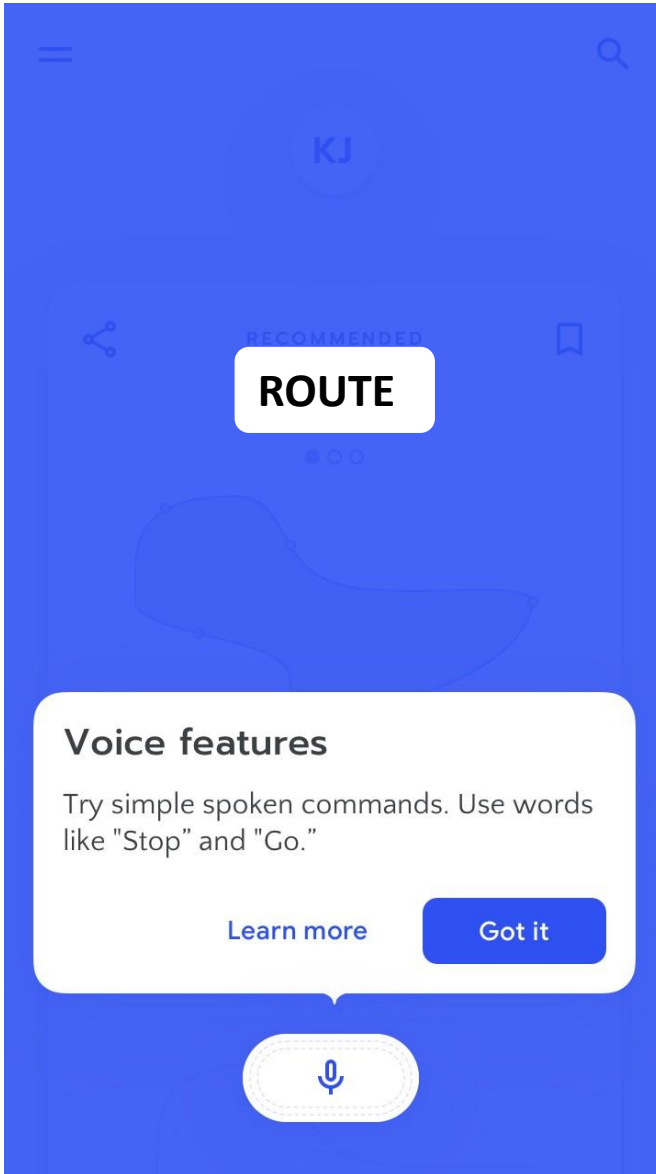
Got it

🚫 Avoid

Don't create unrealistic expectations by presenting the AI as human-like when it can actually do far less than a person.

Mental Models: Human-like Interaction
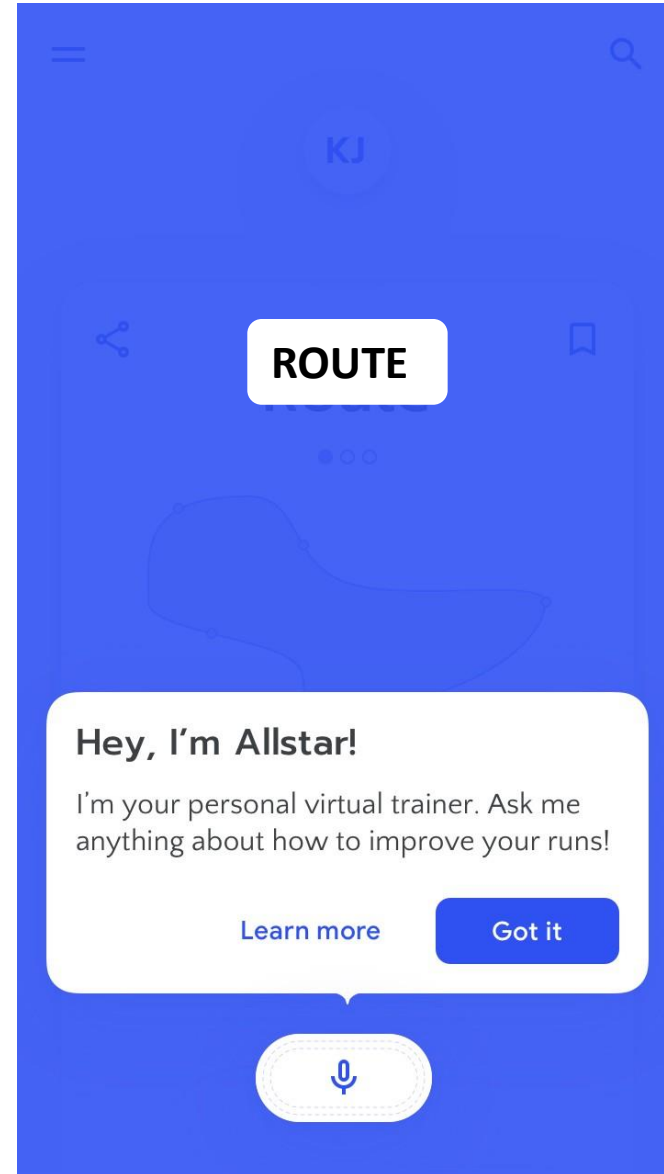
2. **Cue the correct interactions**

    Leveraging human characteristics to build mental model.

    - Useful if the product interactions rely on distinctly human behaviours
    - But, it could be risky… user model of near-perfect NLP… disappointment.

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ROUTE

Voice features

Try simple spoken commands. Use words like "Stop" and "Go."

Learn more   Got it

✅ Aim for

Set expectations for the kind of commands the AI can understand to reinforce the right mental models.

ROUTE

Hey, I'm Allstar!

I'm your personal virtual trainer. Ask me anything about how to improve your runs!

Learn more   Got it

🚫 Avoid

Don't set unrealistic expectations about what the AI can do, especially compared to humans.

References

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Exercise

Exercise

Identify an existing AI system which you think should be improved.
Try to answer the following questions with regard to mental models:

- Which aspects of AI should be explained to users?
- How to set expectations for adaptation and personalisation?
- How to help a new user get to know the app?
- How to consider different stages of introducing AI features?
- How to connect feedback to adaptation and personalisation to establish the relationship between user actions and AI output?

Questions?