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ALL ABOARD! MAKING AI EDUCATION ACCESSIBLE

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TABLE OF CONTENTS

CALL TO ACTION

Are you an AI educator or practitioner?

Do you want to make your knowledge accessible to learners across a range of abilities and levels of expertise?

If so, then this primer is for you!

This document is a primer on making AI education accessible. Here, you will find:

- ☑ Best practices and guidelines for making text-based and visual educational content accessible.
- ☑ A case study that illustrates how comics can be used to accessibly communicate AI concepts to the general public.
- ☑ Pointers to free resources you can use to improve the accessibility of educational content you are developing.

WHY AI EDUCATION MUST BE ACCESSIBLE

As artificial intelligence (AI) takes on a significant role in mediating our social lives, a democratic discourse around how this technology should be built, used, and regulated becomes increasingly important. To align the use of AI with broader social goals of equity, this discourse must include the voices of a diversity of stakeholders. This, in turn, requires that all stakeholders be appropriately informed about the basics of AI, to productively engage in critical conversations about the benefits and risks of this technology. In other words, AI education is needed! However, AI education itself is often inequitable, especially when it comes to accessibility and participation from people with disabilities. There is an urgent need to take AI education out of the classroom and into the public sphere, and to develop a culture and practice of accessibility. The mission of the All Aboard! project is to address this need.

All Aboard! is grounded in the accessibility work of the NYU Ability Project and in the work of the NYU Center for Responsible AI (R/AI) that produces comic books and public education courses to reach a broad and diverse audience of learners.

“We Are AI: Taking Control of Technology” is a free course that introduces the basics of AI, and discusses the social and ethical implications of the use of this technology in modern life. It was developed by the NYU Center for Responsible AI (NYU R/AI) in collaboration with Peer 2 Peer University (P2PU) and the Queens Public Library (QPL). “We Are AI” is structured as a sequence of five modules, each consisting of short instructional videos, discussion-based exercises, and a comic book as supplementary reading.

The goal of All Aboard! is to improve the accessibility of R/AI’s “We are AI” course and to develop guidelines for improving the accessibility of AI education, more broadly. Towards this goal, we convened a series of roundtable discussions in Spring 2022, bringing together data scientists, disability scholars and activists, and social scientists. The group used the first two modules of the “We are AI” course, “What Is AI?” and “Learning From Data”, as a concrete use case, and specifically focused on improving the accessibility of the videos and comics within these modules. This primer is the outcome of those discussions.

All Aboard! aligns neatly with other accessibility efforts in STEM education, such as the AccessSTEM project, the ACM Special Interest Group on Accessible Computing, and the Universal Design for Learning movement. We also share motivation with focused efforts to improve the accessibility of visual content, such as the Accessible Comics for the Blind Project and tactile graphics design work by the NYU Ability Project.

We extend our sincere gratitude to the *All Aboard!* roundtable participants for bringing their expertise and lived experience to the table.

Directly engaging with individuals and communities who have lived experience with one or more disabilities is essential to any accessibility effort, as is including intersectional identities, such as LGBTQI+ and disability.

This work was supported in part by the NSF Northeast Big Data Innovation Hub, and we are deeply grateful for their support!

KEY CONSIDERATIONS

There is no single way to design for accessibility. While basic accessibility requirements, such as providing alt-text descriptions for images, should always be met, specific methodological choices depend upon the accessibility focus of the material in question. For example, comic books can be made accessible in different ways, and for different target audiences: from using plain language, to embedding detailed stylistic descriptions, to creating versions specifically for different sensory mediums (e.g., audio, visual, or tactile). This means that educators must carefully consider which accessibility strategies to adopt for their specific material, target audience, and format.

The following **10 key considerations** span across content and formatting, and are intended to guide AI educators and practitioners in developing their bespoke accessibility strategies.

ACCESSIBILITY STRATEGY AND FORMAT

An accessibility strategy can help determine if a single set of materials should be made as broadly accessible as possible, or if there should be different versions of the materials that are responsive to different accessibility needs. An accessibility strategy should be selected first, and then used consistently to guide specific formatting decisions across different formats, such as videos, comics, and websites. For example, a comic could be made accessible using plain language, stylistic descriptions, and audio elements, all in one digital object. Alternatively, different versions (print, audio, and tactile) of the comic could be developed, each with a different accessibility focus. When different versions and/or materials are used, the narrative pace and style of interaction should be consistent. For example, video content should focus on audience interaction the same way in which comics focus on audience interaction. A facilitator guide can reinforce the strategy, helping connect different materials and outline additional activities for specific target groups.

NARRATIVES AND STORIES

Developments in AI dominate the headlines, but beyond buzzwords, these concepts remain elusive and abstract to many. Narratives and stories are a simple but effective way to cater to a wide audience, with different levels of technical expertise. AI education efforts that employ narrative storytelling should avoid extensive theory-building, and instead focus on making clear why and how AI is important to people's lives. Furthermore, it is also important to underline how ubiquitous AI is, how complex it can be, and what is at stake when this technology is misused. This is no easy feat, but using simple and relatable examples from daily life (such as cab-hailing services like Uber, or robotic vacuum cleaners like Roomba) can drive home the fundamental message of why people should care about AI, and incentivize self-education.

LANGUAGE

Language is an important component of educational materials. It appears in a variety of modalities, including narrative text and dialogue in a comic book, summary text and spoken dialogue in an instructional video, and alt-text description of an image or a page. To make educational materials accessible, it is important to ensure that the language is plainly understandable to a wide audience.

Excessive use of specialized terms and jargon is a mode of exclusion, and it is important to avoid it in AI education. Instead, language that is easily understandable and does not use specialized terms or jargon should be used wherever possible. Key terms should be both defined and explained in simple and accessible ways. When possible, terms should be defined close to, but not directly after, their first use. Definitions immediately following new terms can distract from the point of the sentence.

It is also important to keep in mind that an everyday term can have a different connotation, or even carry a different meaning, when used in a technical context. When using such terms, it is helpful to elaborate on the context or provide an explicit definition. For example, the words “cost” and “pattern” have different connotations in computer science and AI than they do in everyday language, which can make their use in the technical context confusing. Another consideration is that, when using an algebraic variable to refer to an entity, explicitly repeating what the variable refers to can improve clarity. For example, it may be helpful to say “individual *x*” or “observation *d,*” rather than simply “*x*” or “*d.*”

HUMOR

Humor can be an important component of accessibility — it's an effective tool to communicate difficult points in a light and fun manner. However, when used in combination with other design choices, humorous tone and sarcasm can be lost. This might have a detrimental effect on the accessibility of the material because it could cause the reader to disconnect from the larger point. While humor and sarcasm can be lost in single-person narratives, dialogue-based narratives that engage diverse characters can effectively deploy humor to land a punchline or deliver a take-away message. Creators can use explicit gestures, such as an eyeroll of a character, emojis in dialogue, or an explicit **sigh** in the text, to effectively communicate a humorous or sarcastic tone.

REPRESENTATION

To ensure equity in representation, it is important to use specific language about social identities to avoid implicit stereotypes. For example, simply saying "woman" might invite people to visualize a stereotypical "white woman," or saying a "group of diverse people" might invite a stereotypical "college brochure™ diverse group" of people. Furthermore, when writing visual descriptions (such as in alt-text), it is important to think critically about both the social identities that are represented visually and the purpose of that representation.

Therefore, it is preferable to provide specific descriptions of intersectional identities wherever possible, for example “a Black woman and a non-binary person in a wheelchair.”

VIDEOS

In videos, the pace of narration should be sufficiently slow and allow for questions that can activate the audience and advance viewer participation. Dialogue between speakers can also improve viewer engagement. Shorter videos are easier to comprehend for most learners, and it may be necessary to break up content into multiple video segments if necessary. If there is text in the video, such as on slides, it should always align with what is being said by the speaker or included in the voice-over. If text panels are shown, they should be narrated as well. Basic accessibility measures — such as American Sign Language (ASL) and alt-text — should also be included, wherever necessary.

TYPOGRAPHY, LAYOUT, AND HIERARCHY

In general, the widely accepted and adopted typographic standards for accessibility should be maintained. In terms of layout, key information should be discernable at one glance. Design elements should be used minimally and intentionally, and should serve to create a clear hierarchy of importance, for example, by placing items on the screen according to their relative importance. Placing related items in proximity to one another can help those who have low vision or trouble focusing on the screen.

CONTRAST

The readability of a text depends on the contrast ratio between the font color and the background color. Using pure black text on a pure white background should be avoided, because stark contrast can make text appear blurred or moving for people with Irlen syndrome. Generally, the contrast between the text and the background should be at least 4.5:1 for small text and 3:1 for large text.

COLOR

Color selection matters for images as much as it does for contrast in text sections. Not having enough contrast and overcrowding the graphics with intricate patterns can make it harder to distinguish between the borders of multiple elements. Especially when using complex graphics or visuals, it is important to use colors that support enough contrast, to avoid using patterns that make it difficult to gauge depth, and to determine boundaries between elements.

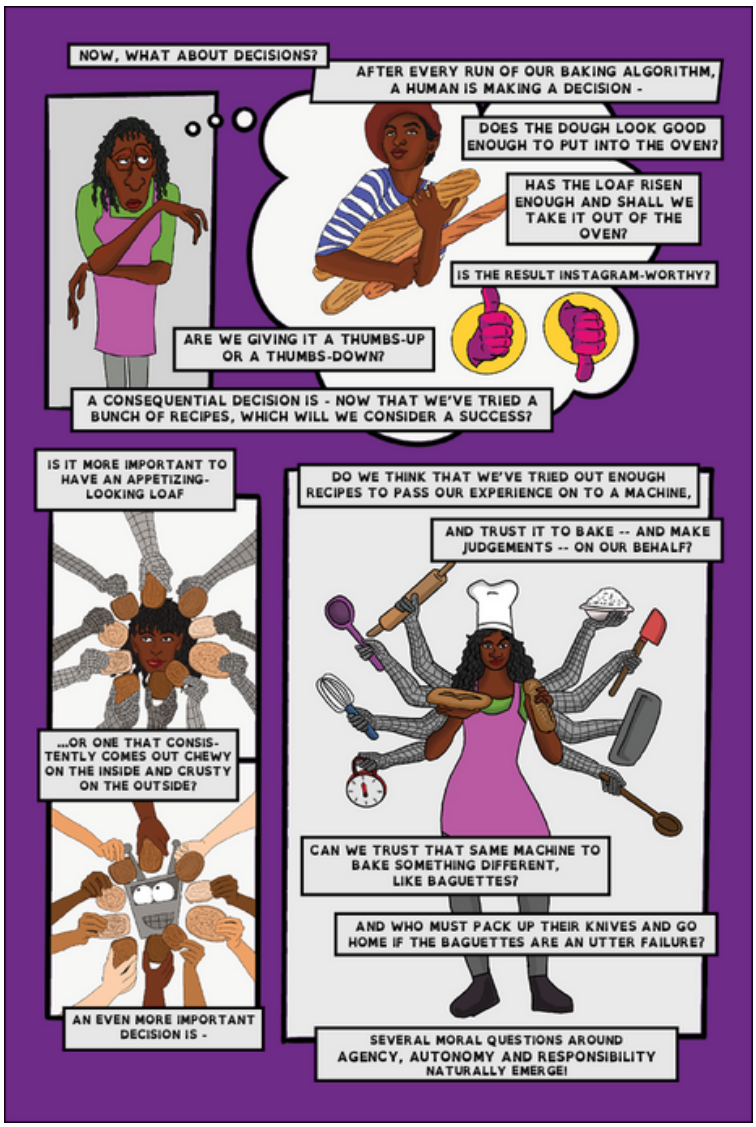
ALL ABOARD! APPLIED: MAKING COMICS ACCESSIBLE

Comics can be a fun and engaging medium for accessible AI education. The most influential example in this space is the "Logicomix" graphic novel, which translates mathematical foundations into popular science through compelling characters and an engaging narrative. A more recent example is a comic-book / text-book hybrid aptly titled "The Hitchhiker's Guide to Responsible Machine Learning."

While rich visuals and humorous storylines can improve engagement and retention, comic books can also become overwhelming for certain audiences owing to the inherent complexity and richness of the medium. In this section, we share insights on the effective use of comics for accessible AI education, based on the key considerations we shared above, and on the feedback accumulated from the All Aboard! roundtable discussions. We distilled this feedback into critiques (what not to do) and actionable suggestions for refinement (what to do).

COMPLEXITY

We identify three dimensions of complexity within educational comic books, namely: narrative or story, visuals, and take-away. In general, each page of a comic book should effectively allocate its “complexity budget” between these three dimensions to educate the reader without overwhelming them. This means that the complexity level should never be the same across the three dimensions. For example, when concluding with an important take-away, it is important to keep the visuals and the story arc simple.

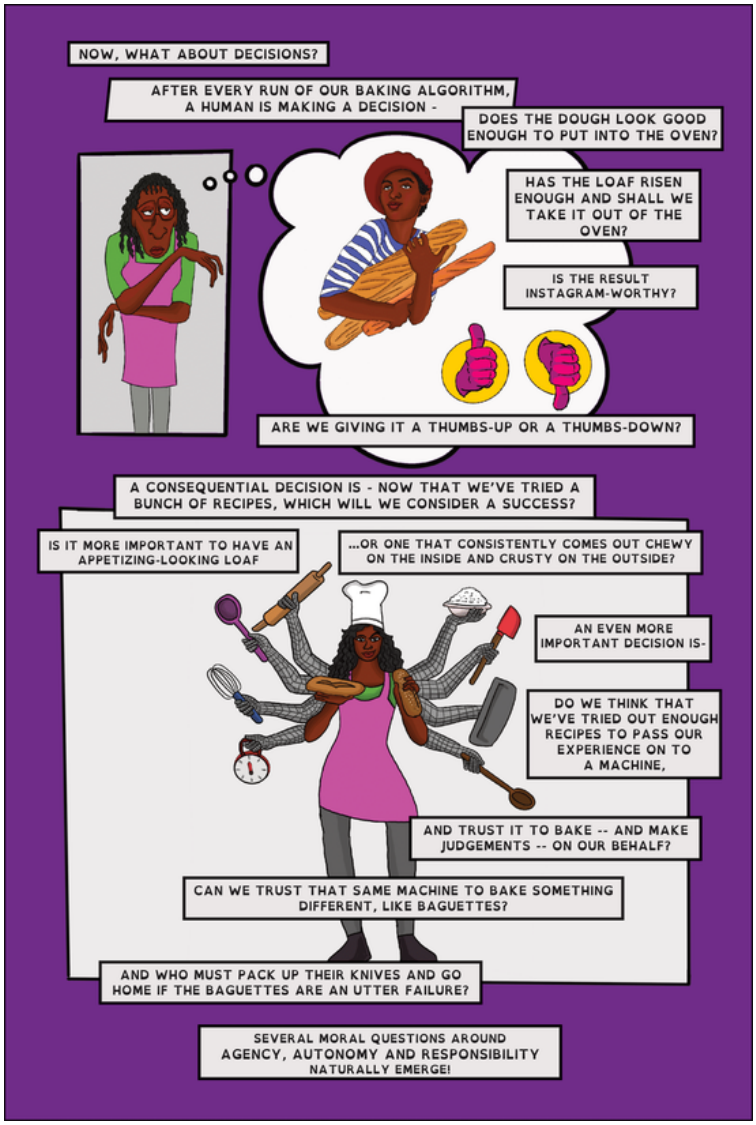


We Are AI Comics, Volume 1: What is AI? (before)

In this page, we develop a narrative that uses baking to explain the difference between rule-based and data-driven algorithms. We are making an important point about agency and autonomy in the development of technology, by asking the question of “who is baking, and who judges how good/bad the baked loaf is?”

Critique:

- ☒ The visuals and layout are so complex on this page that the message is undermined.
- ☒ The layout is clunky, and it is not clear in what order the panels should be read.
- ☒ The text makes an important but complex point about agency and autonomy, but it is overshadowed by the overly complex images.



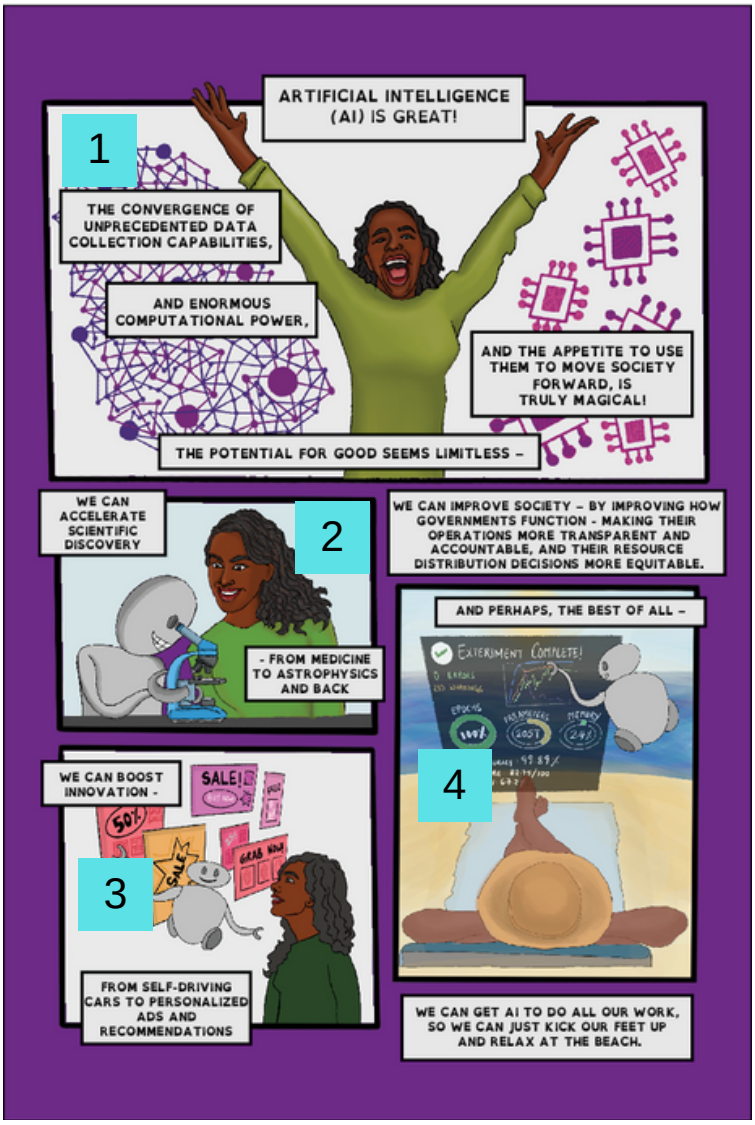
We Are AI Comics, Volume 1: What is AI? (after)

Refinement:

- ☑ Each panel within the layout should be clean and simple; visual content should be used sparingly.
- ☑ The size of each panel should be determined based on the number of elements within it, as well as on the complexity of the visual artwork itself and the body of text it needs to support.
- ☑ Creators should not force too much reading content into one panel, by limiting the number of text boxes per panel.

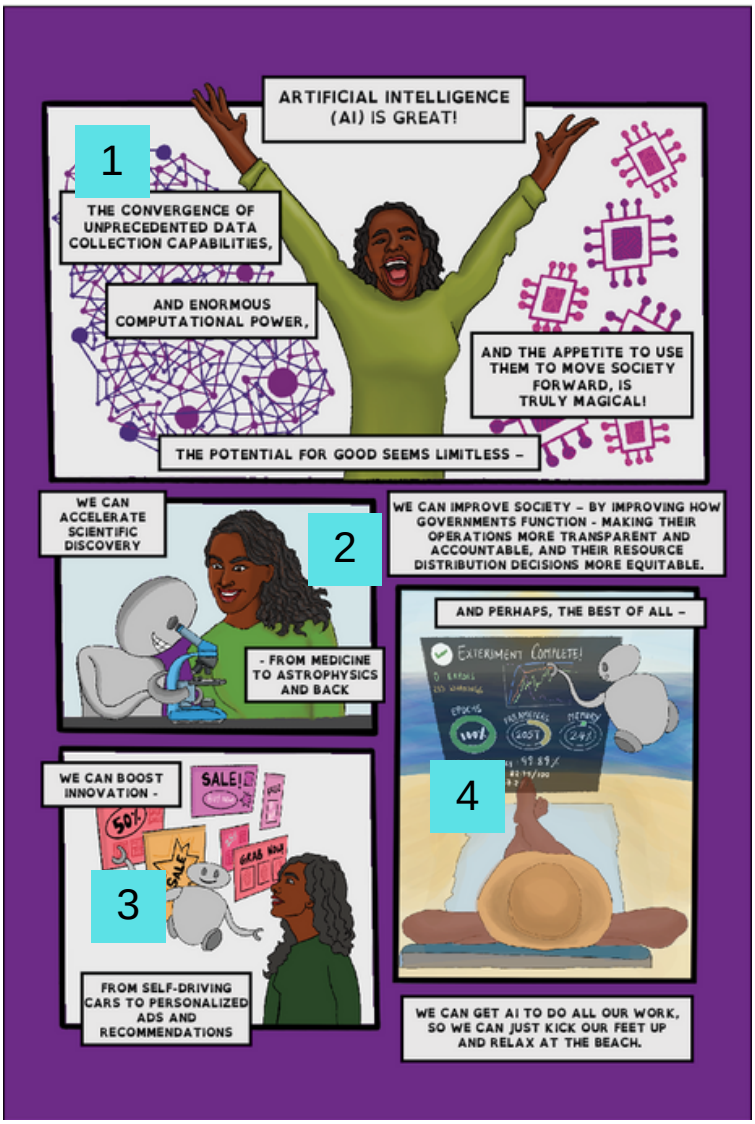
OVERALL READING EXPERIENCE

It is important not only to think about the complexity of individual elements, but also about how components come together on a page, and how this shapes the overall reading experience. Layouts can determine reading and visual order, and poorly chosen layouts can confuse the reader.



We Are AI Comics, Volume 1: What is AI? (before)

In this page, we are showing various scenarios that illustrate the potential of AI and the positive impact this technology can have on our everyday life. We are using differently-sized panels. The intended order in which panels are to be read is 1→2→3→4.

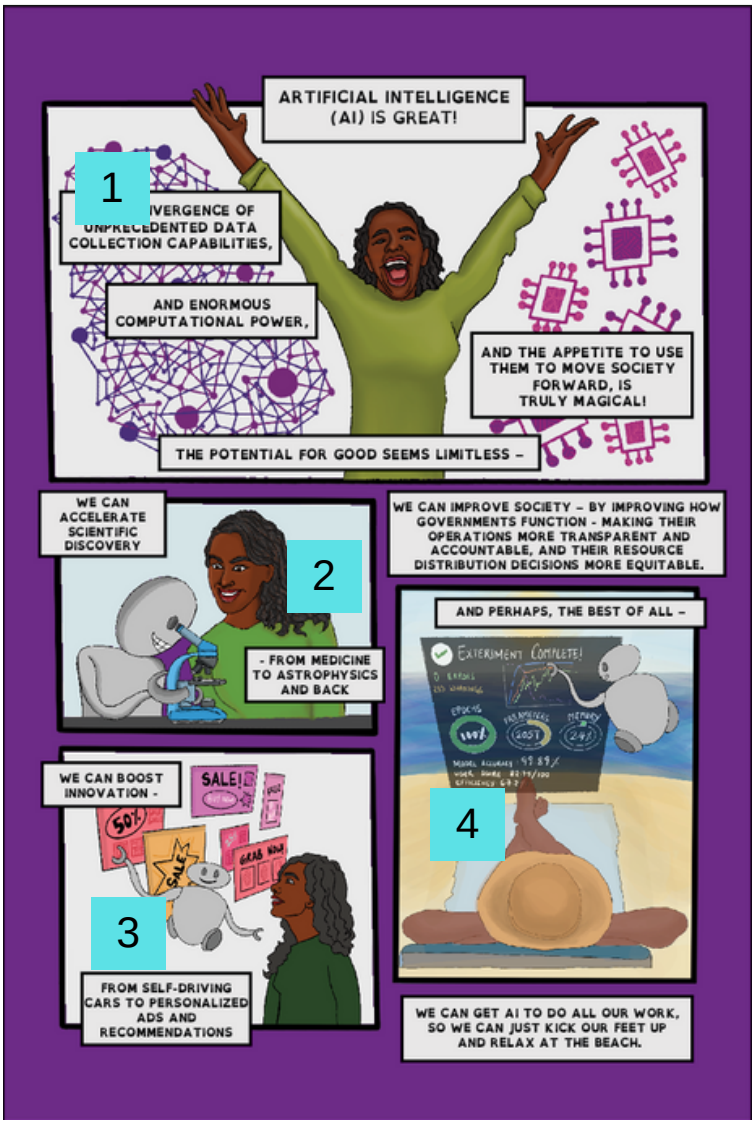


We Are AI Comics, Volume 1: What is AI? (before)

Critique:

☒ Most people read from left to right (with the exception of speakers of right-to-left languages such as Arabic, Aramaic, Hebrew, or Farsi) meaning that, although the intended order in which panels should be read to follow the narrative is 1→2→3→4, most readers would naturally read the panels in the order 1→2→4→3.

☒ This issue is further exacerbated by the first-person narrative style of the comic: if this page had a narrative plot in the form of a story that is unfolding in front of the reader, it would be easier to follow the order of panels, since the visuals will also give cues about the ordering.



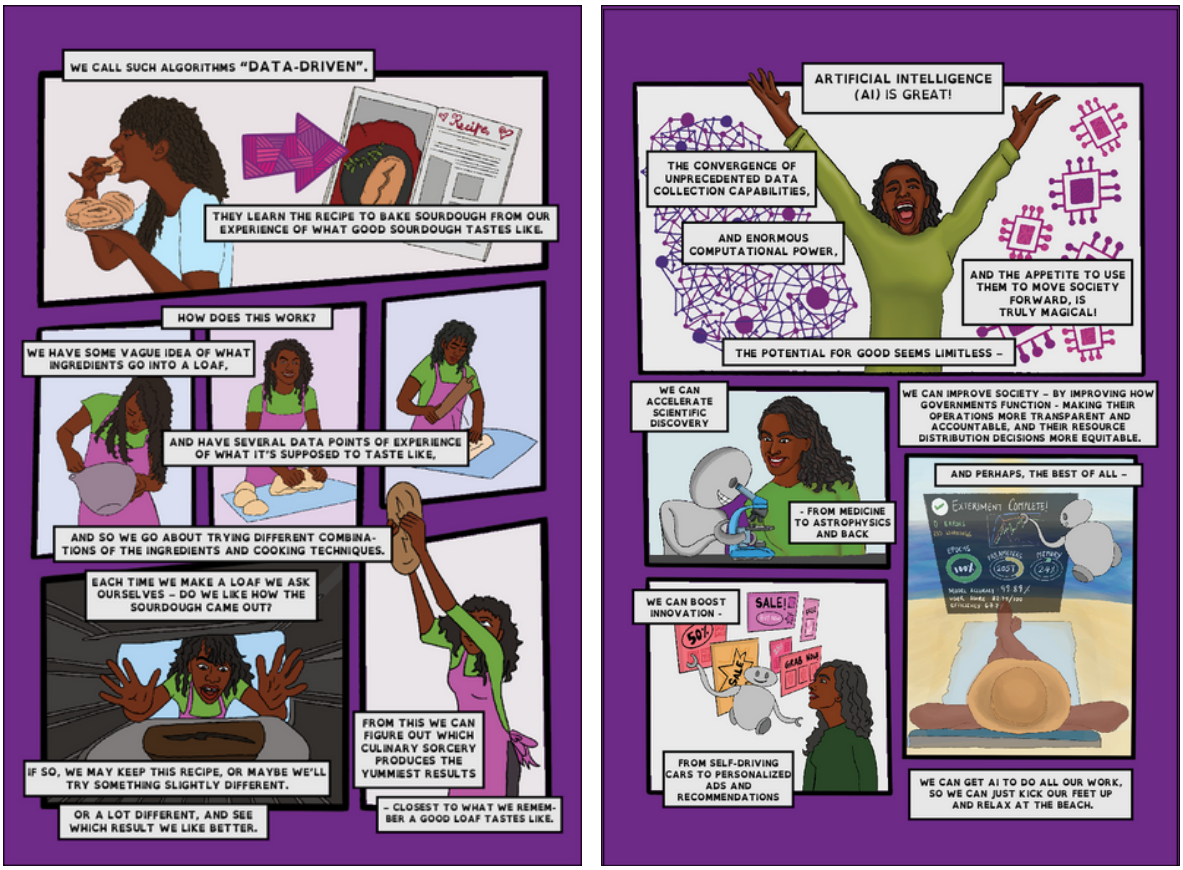
We Are AI Comics, Volume 1: What is AI? (before)

Refinement:

- ☑ The layout should be used to create a visual hierarchy to intuitively guide the reader from one panel to the next in the intended order.
- ☑ The reading order and the placement of text elements should be consistent with the visual order.
- ☑ A well-defined reading order also improves the digital accessibility of the document: it simplifies the tagging of reading order and alt-text for screen readers.

VISUAL CONSISTENCY

Visual consistency is key for anchoring the narrative and guiding the reader. Conversely, inconsistency can be visually confusing and disorienting for the reader, detracting from the broader message on the page, and in the comic as a whole. In general, panels should be consistent in style and in the way in which characters are presented. This, for example, pertains to the characters' clothing, as well as to how they are drawn and colored.

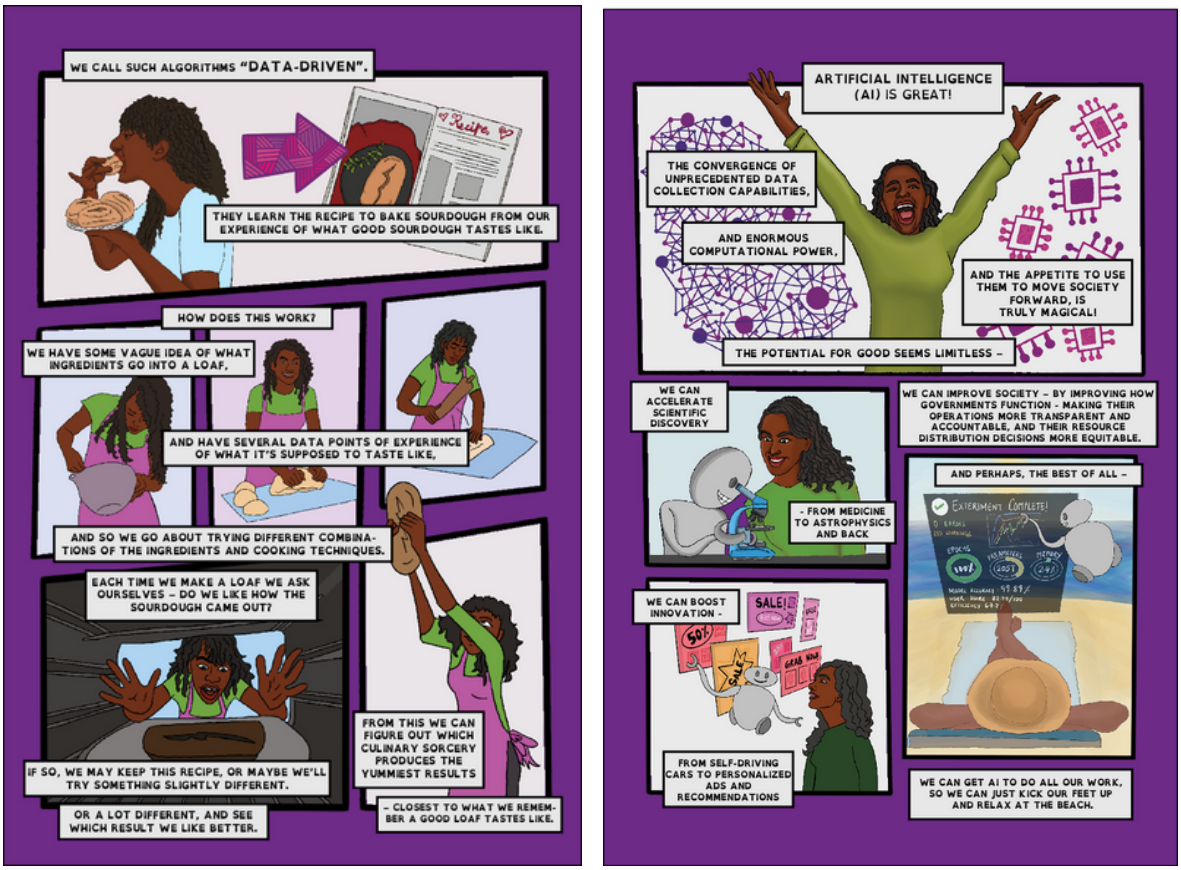


We Are AI Comics, Volume 1: What is AI? (before)

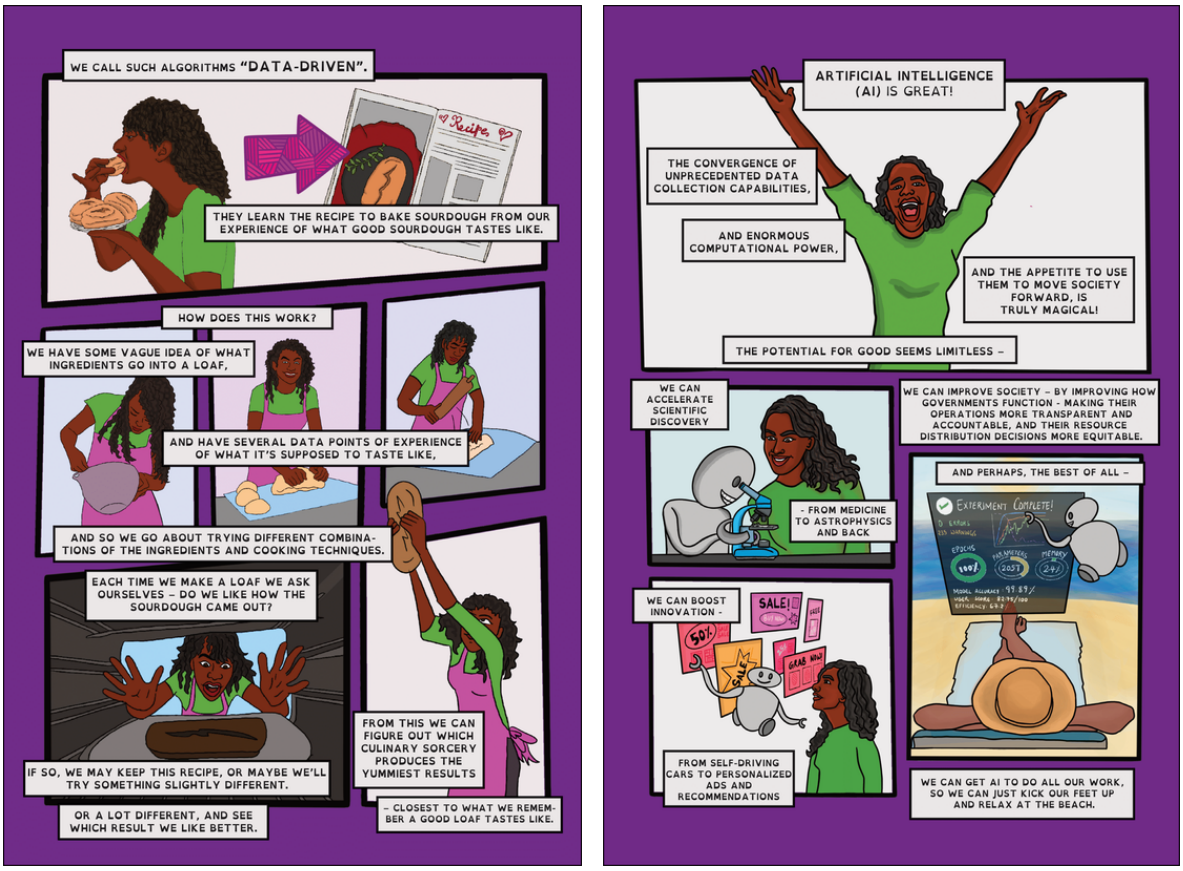
In these two pages, the same character is used to illustrate the positive aspects of AI, and to explain data-driven algorithms, using bread baking as a metaphor.

Critique:

☒ These pages lack visual consistency: on the page shown to the left, the character's clothes are three different shades of green. On the page shown to the right, the character's clothes change color abruptly. In the top panel her shirt is blue, and then it changes to green, and the sleeve length varies in subsequent panels. There is also a lack of consistency in how the character's facial features are drawn.



We Are AI Comics, Volume 1: What is AI? (before)



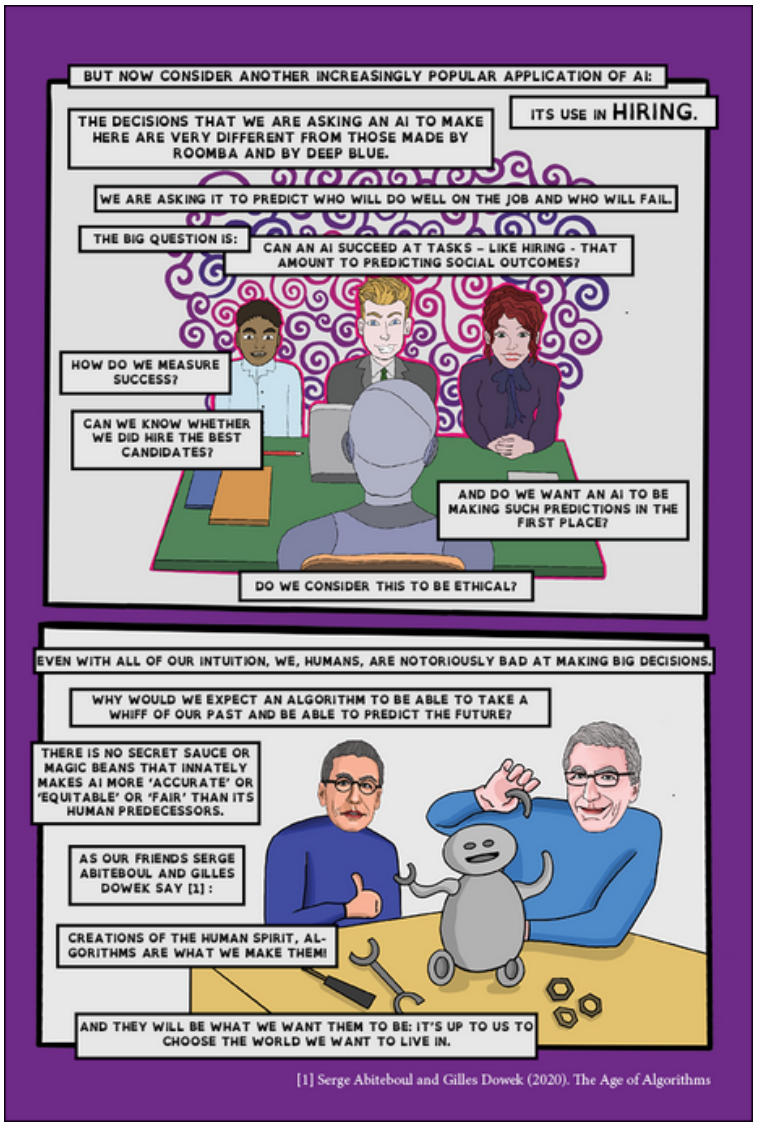
We Are AI Comics, Volume 1: What is AI? (after)

Refinement:

- ☑ Creators should ensure visual consistency, especially with regards to colors and style used for key characters.
- ☑ The use of visuals should also be consistent throughout the comic, based on the narrative style. When educational comics use a first-person narrative — with a narrator speaking to the reader — the visuals need to supplement what is being said in text.
- ☑ When educational comics use a third-person story, characters should be drawn consistently so as not to confuse the reader or detract from the substantive points/takeaways.

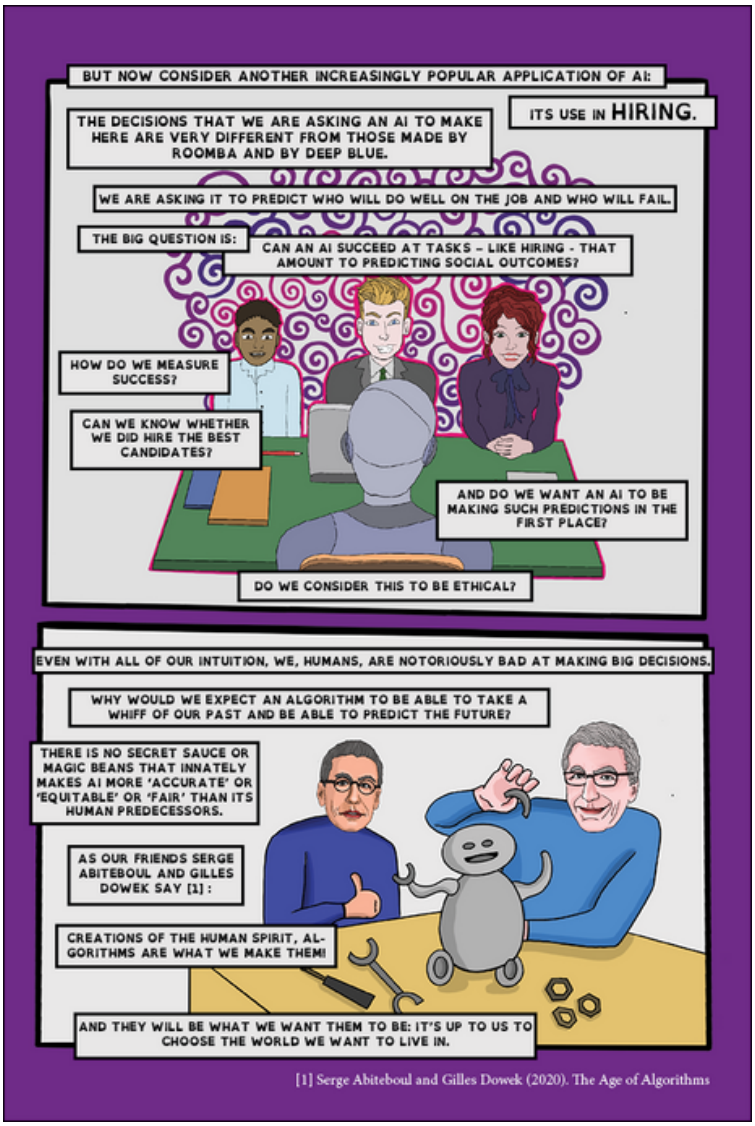
PACING

With any educational undertaking, it is important to think about pacing. Going too fast and presenting several ideas simultaneously can overwhelm the reader and lead to poor retention. On the other hand, a slow-grind to an important point or take-away can bore the reader and lose their attention entirely.



We Are AI Comics, Volume 1: What is AI? (before)

In this page, the first panel illustrates two different real-world applications of AI. The first one is the use of AI in hiring, depicting professional-looking people sitting across a robot that interviews them. The second panel depicts the authors of the book “The Age of Algorithms,” Serge Abiteboul and Gilles Dowek, to relay the message that it is up to us to determine what our future with AI should look like.



We Are AI Comics, Volume 1: What is AI? (before)

Critique:

- ☒ This page has only two panels, but a lot of text boxes: there is too much information or educational content being forced into a single page.
- ☒ There is no connection between the two examples shown in the two panels, they appear disconnected.

We Are AI Comics, Volume 1: What is AI? (after)

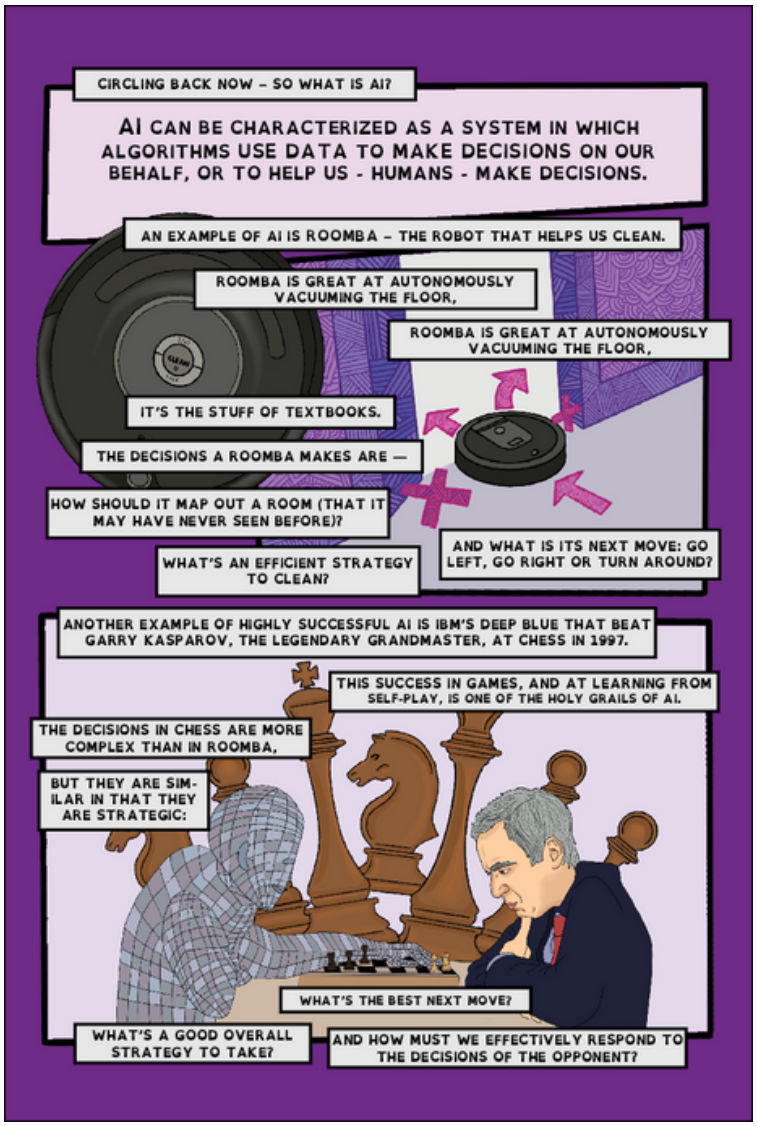
Refinement:

- ☑ Creators should effectively use the chosen format to convey pacing: having many panels on a page with little text will likely set a faster pace for the reader and can be effectively used to quickly set up a point or a scene. On the other hand, when a page contains few panels, then it can include more text per panel to drive home an important point slowly and deliberately.
- ☑ The choice of layout and narrative should be aligned to manage the pacing: few panels with a lot of text covering different points or takeaways can appear too fast-paced and confuse the reader.

- ☑ Repetition can be used to control the pace: creators can leverage the graphic novel format, with components like sidebars and visually distinct inline definitions, using repetition to slow down the narrative without cluttering the text.
- ☑ The educational content must flow at an easy-to-understand pace. Dense description of content and pages with too much text should be avoided.

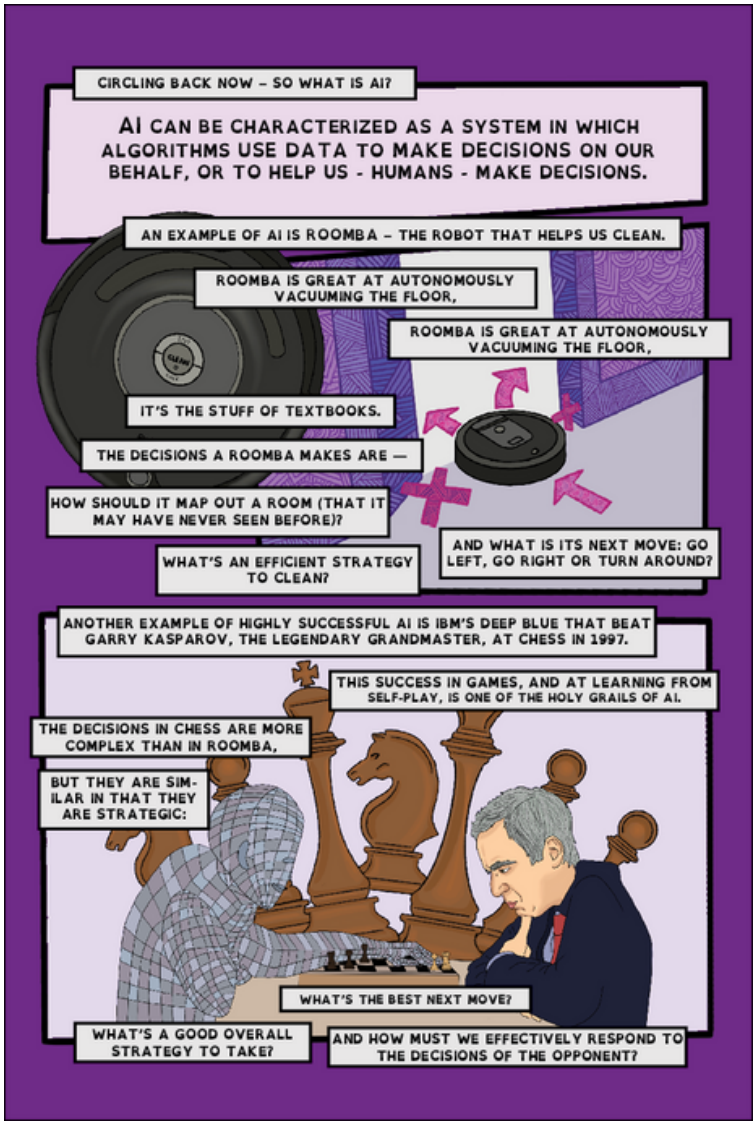
POINTS OF VIEW

The most effective way to educate a reader is by creating a personal connection between the material and their lived experience. This is all the more important for AI literacy, given the ubiquity of this technology. Single-narrative styles (written from the PoV of one character) can be reductive, because they convey one voice and a single perspective.



We Are AI Comics, Volume 1: What is AI?

In this page, two large panels illustrate two cases of rule-based AI: the Roomba vacuum cleaner and Gary Kasparov's chess game against IBM's AI, Deep Blue.



We Are AI Comics, Volume 1: What is AI?

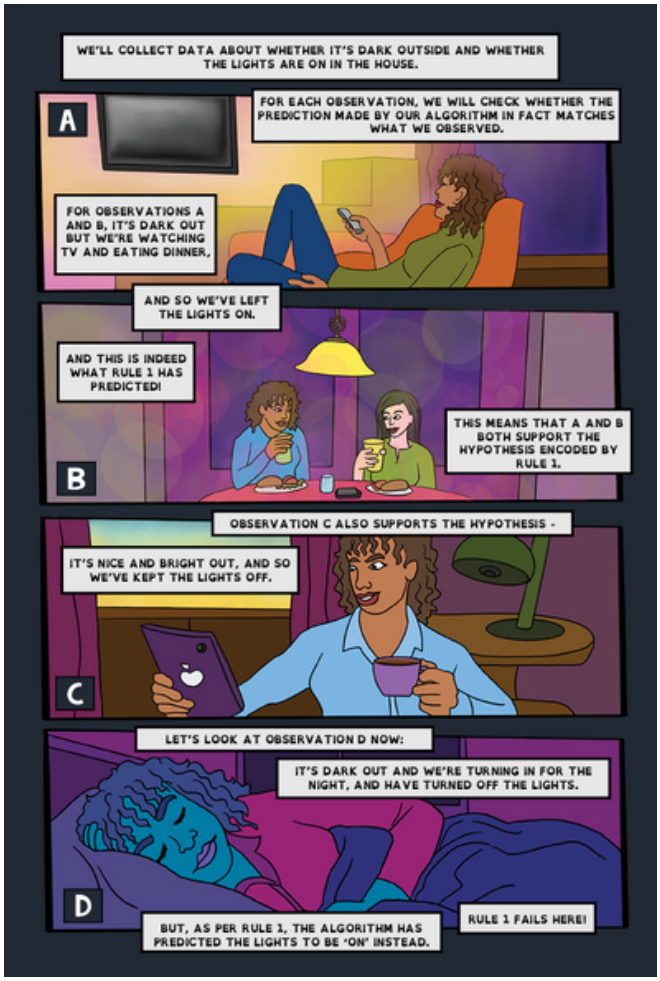
Refinement:

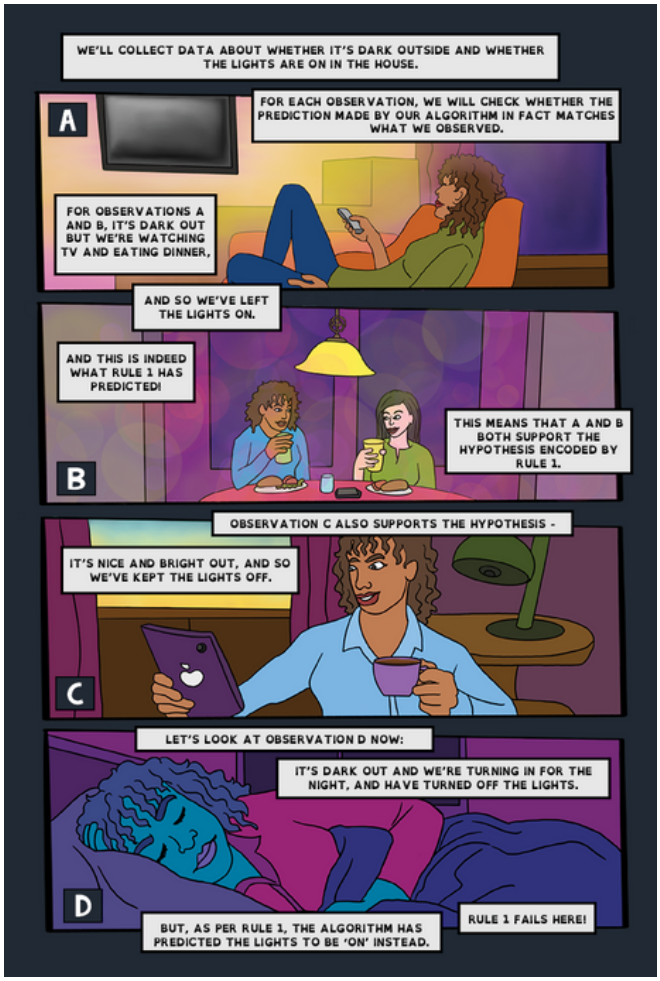
- ☑ Creators should bear in mind that constructing a dialogue-based narrative with a story woven into the content can make complex AI topics easier to understand. Relatable storylines can garner the reader's attention and cater to a wide audience.
- ☑ It is important to remember that individual points or takeaways need to be woven together with an engaging narrative. Writing rich characters also allows for different demographics and different lived experiences to be centered. This, in turn, develops a stronger connection between the reader and the material. Stylistic descriptions of the visuals can also help to convey tone.
- ☑ Having a variety of characters helps present competing viewpoints and tones. Satire and humor can be effectively incorporated through specific characters, instead of causing cognitive dissonance when a single narrator changes tone abruptly.

REPRESENTATIONAL JUSTICE

Creators should be intentional about representational justice. It is insufficient to create a rich and diverse set of characters to set up the story — character identities must be represented consistently across modalities.

For example, consider this page from the comic: to the left is the actual page (with visuals and narrative text), and to the right is the corresponding alt-text description of the page.

COMIC	ALT-TEXT
	The screen is split into four panels: a,b,c, and d. **Panel A:** It's late in the evening, a woman is lounging on her couch, channel-surfing casually. It's dark outside, but the room is well lit. **Panel B:** Two women sit at a dinner table, plates of delectable delights sit in front of them as they raise their glasses in celebration. It is dark outside, but the table is well-lit with an overhead hanging lamp.

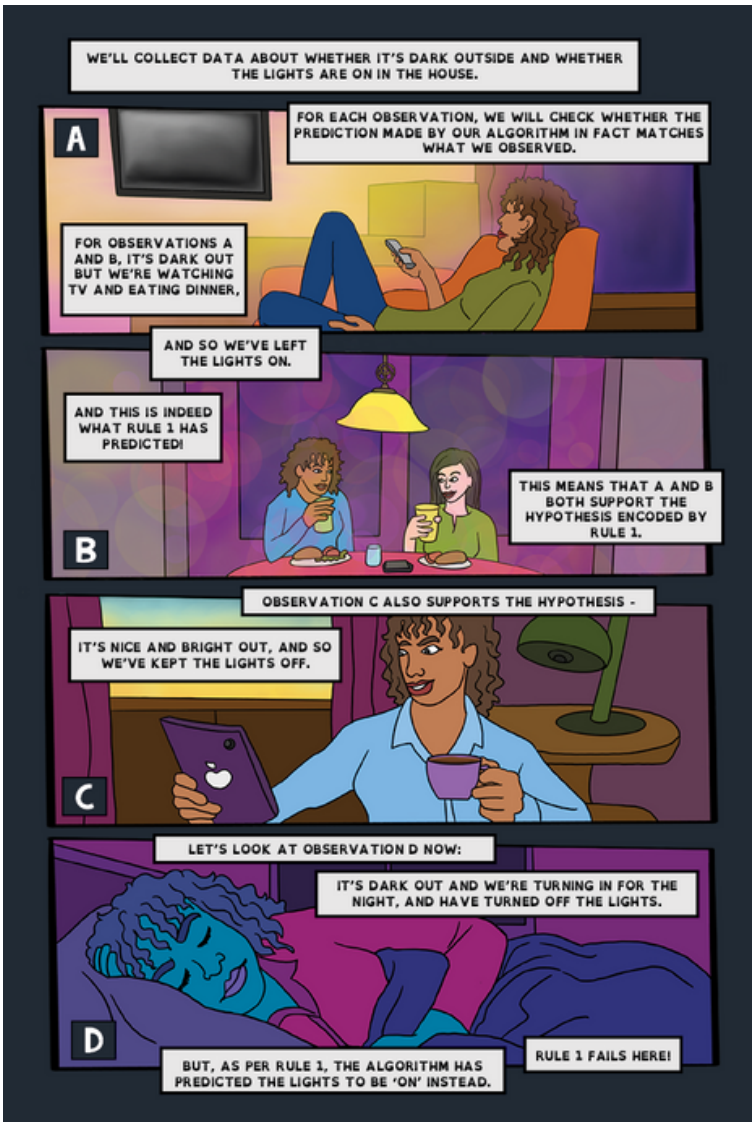
COMIC	ALT-TEXT
	**Panel C:** A woman sits at her table and reads with a morning cup of coffee in one hand and an iPad in the other. A lamp is in view behind her, but it is off. There's a window on the other side behind her that is open, and the pleasant morning sun lights up the room. **Panel D:** A woman is deep in sleep in her bed, snuggled into her duvet. The room is dark and the lights are off, and so we see her in the reflected hues of purple and blue.

We Are AI Comics, Volume 2: Learning from Data

Critique:

☒ The alt-text descriptions on this page do not do justice to the intentionality with which character identities are drawn. We see a recurring character in these panels — one who is intentionally drawn as a woman of color. However, the image descriptions repeatedly describe her generically as "a woman."

☒ The alt-text makes no attempt to connect the reader with the characters on the page. The character we see on this page appears several times throughout the comic book, but the image descriptions refer to her as "a woman" instead of being more specific about the character's identity or role as a recurring protagonist.



We Are AI Comics, Volume 2: Learning from Data

Refinement:

- ☑ When writing visual descriptions (for example, in alt-text), it is important to think critically about which social identities are represented visually and the purpose of that representation. Using specific language about social identities can help avoid implicit stereotypes. For example, saying "a group of diverse people" might invite a stereotypical picture of a group of people, rather than specific language about which identities are meant to be represented in the group.

RESOURCES

In this section, we share useful resources for designing for accessibility.

GENERAL VISUAL DESIGN CONSIDERATIONS

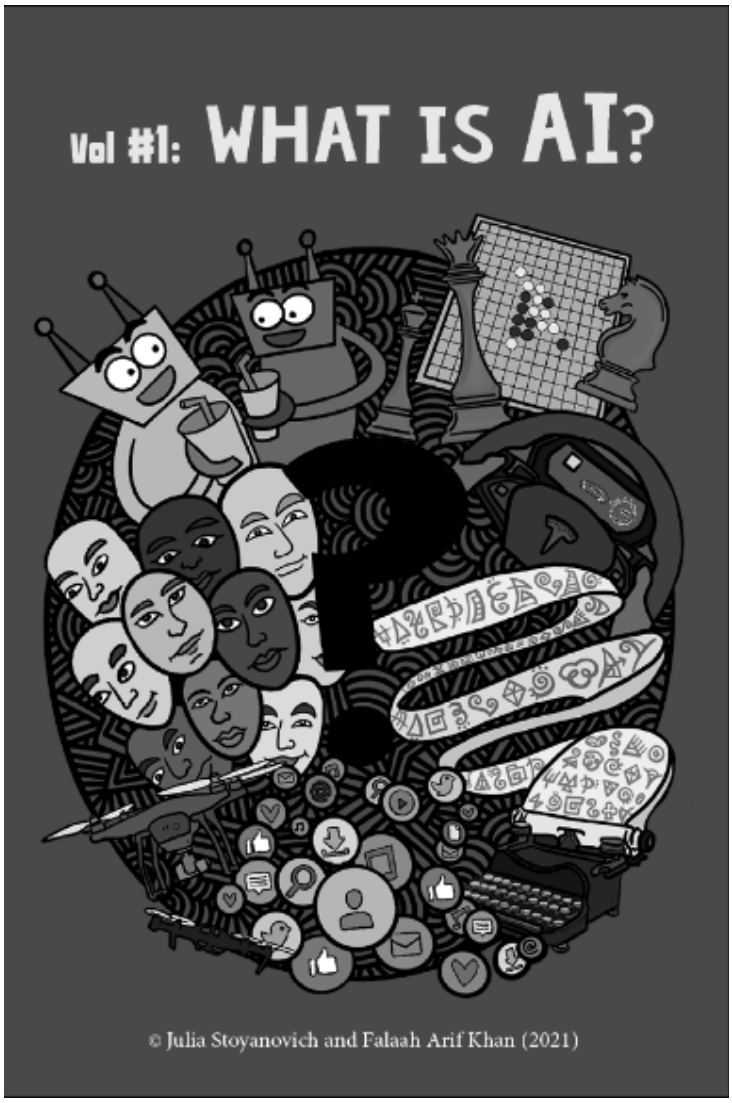
There are some common visual design principles and pointers to consider for digital accessibility when designing for different visual formats such as videos, textual content, comics, and more. A comprehensive list and set of guidelines can be found on the US government's official website.

CONTRAST CHECKER

An online contrast checker can be used to assess the contrast ratio.

COLOR BLINDNESS SIMULATOR

The COBLIS tool can be used to determine how the chosen colors look for people with different vision-based disabilities.



We Are AI Comics, Volume 1: What is AI?

Here's an image of the cover page of Volume 1 of the "We Are AI" comics that has been simulated to mimic what a person with color blindness/monochromacy would see.

IMAGE DESCRIPTIONS

To create image descriptions for alt text, UX design tips can be useful.

SARCASM TIPS

To better and more inclusively work with sarcasm and humor, web design guidelines for humoristic or sarcastic content can be used.

VIDEO CONTENT TIPS

To ensure the effective use of video material, principles and guidelines for enhancing the three core elements of cognitive load management, engagement, and learning can be followed, as well as advice on the length of instructional videos.

ALL ABOARD! ROUNDTABLE PARTICIPANTS

Our sincere thanks go to *All Aboard!* roundtable participants:

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- Lucas Rosenblatt
- Meghana Shanbhogue
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