ALA American Library Association

VIRTUAL VOICE ASSISTANTS

Win Shih and Erin Rivero

Library Technology Reports
Expert Guides to Library Systems and Services

MAY/JUNE 2020
Vol. 56 / No. 4
ISSN 0024-2586

Library Technology
REPORTS
Expert Guides to Library Systems and Services

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ALA TechSource
alatechsource.org

American Library Association

Library Technology
REPORTS

ALA TechSource purchases fund advocacy, awareness, and accreditation programs for library professionals worldwide.

Volume 56, Number 4
Virtual Voice Assistants
ISBN: 978-0-8389-4675-6
DOI: https://doi.org/10.5860/ltr.56n4

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Library Technology Reports (ISSN 0024-2586) is published eight times a year (January, March, April, June, July, September, October, and December) by American Library Association, 50 E. Huron St., Chicago, IL 60611. It is managed by ALA TechSource, a unit of the publishing department of ALA. Periodical postage paid at Chicago, Illinois, and at additional mailing offices. POSTMASTER: Send address changes to Library Technology Reports, 50 E. Huron St., Chicago, IL 60611.

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Abstract

With the rapid advancement of voice technology, smart speaker devices have penetrated many US households and businesses. Voice assistants, such as Amazon's Alexa, Apple's Siri, and Google Assistant, are embedded in a slew of consumer products and IoTs. Digital assistants act as intelligent agents interacting with user voices, responding with answers and support.

This issue of *Library Technology Reports* (vol. 56, no. 4), "Virtual Voice Assistants," first provides an overview of the technology behind smart speakers and voice assistants, also known as digital or virtual assistants. It further explores innovative uses of such technology in library and educational settings. Next, the report discusses related issues of ethics, privacy, security, and trust, concluding with a review of future trends and advice for decision makers preparing for integrating voice assistants in their organizations.

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Chapter 1

Voice Revolution

Win Shih

Voice allows us to command an army of digital helpers —administrative assistants, . . . advisors, babysitters, librarians, and entertainers.

—James Vlahos[1]

Voice Assistants

Voice assistants (VAs), such as Amazon's Alexa, Google Assistant, Apple's Siri, and Microsoft's Cortana, are computer programs designed to assist users by answering questions and performing tasks. Sometimes called virtual assistants, digital assistants, or intelligent personal assistants, VAs represent a paradigm shift of human-technology interaction. In the past, we interacted with computers through a keyboard, mouse, monitor, or touch screen. Voice technology now lets us engage the digital world with our speech through conversational user interfaces. The voice is how we communicate with other human beings from the time we first learn how to speak. As a result, interacting with technology through speech comes most naturally and intuitively to us. Further, VAs add a richer dimension to our relationship with technology, providing a different immersive experience and the potential to reduce our efforts in technology use.

For years, we have dreamed about conversing with machines directly. We see intelligent machines and robots in movies, such as the HAL 9000 killer supercomputer in Stanley Kubrick's *2001: A Space Odyssey* and Vox, a holographic sentient librarian, in *The Time Machine*; in written science fiction—Herbie and Robbie in Isaac Asimov's *I, Robot*; and on television—the computer in *Star Trek*. However, it was not until recently that advances in artificial intelligence (AI), natural language processing, machine learning, and computing processing power made voice computing a reality. The voice assistant is the first application that exposes consumers to the power and potential of artificial intelligence, and the spectrum of its capability continues to expand. Now voice assistants can perform multiple tasks in response to one request. Both Alexa and Google Assistant let you define routines or mini-automation to perform a set of tasks with a single voice command. For example, when you say, "Hey Google, good morning," Google Assistant will execute a sequence of predefined tasks, such as adjusting your lights and thermostats; giving you a weather report; estimating your commuting time; looking up your calendar; providing reminders; playing news, radio, or music; or performing whatever tasks you preselected from its action list.[2] Alexa offers a similar feature to let users automate a set of routine tasks. When you say, "Alexa, I am home," Alexa will automatically turn on the lights, set the thermostat, turn on music or a radio station, and announce that you are home across your Echo devices.

Apple's Siri is the first AI-empowered, large-scale virtual assistant program on the consumer market. Siri was originally a stand-alone mobile app for iPhone. Apple acquired Siri and later integrated it into the operating system of the iPhone 4S in October 2011. It was a huge success, with more than four million sales in the first four days of its release.[3] Three years later, Amazon introduced its voice assistant device, Echo, on November 6, 2014. More than one million Echo devices were sold in just two weeks of its introduction.[4] Two years later, in November 2016, Google revealed its version of a virtual assistant device, Google Home.[5] To compete with Echo and Google Home, in 2018 Apple introduced its HomePod smart speaker that runs the Siri voice assistant.[6] Facebook, late in the game, admitted in April 2019 that it was developing its version of a voice assistant that would work on Portal, its video call device.[7]

Growth of Virtual Assistants and Smart Speakers

More than eight years since the debut of Siri, VA technology has penetrated US households and has become an integral part of many people's daily lives. According to a 2018 survey, 72 percent of 1,000 participants

indicated that they have used a virtual assistant. Furthermore, 44 percent of these survey respondents have used VAs to control another smart device at home.[8] A 2019 survey estimated that more than 110 million people in the US use VAs at least monthly, a 9.5 percent jump from 2018.[9]

Smart speakers are now a common household item, with more than 133 million in use in the US and about 26 percent of US consumers owning smart speakers. Amazon is the market leader with 61 percent of market share of smart speakers, while Google takes 24 percent of the market.[10] To expand market share, Amazon and Google also opened up their voice technology to allow third-party manufacturers to include Alexa or Google Assistant on their devices. Smart speakers from premium audio companies, such as Bose, Bang and Olufsen, and Sonos, now have either Alexa, Google Assistant, or both baked in. Alexa is not available only on 150+ Amazon products, such as Echo, Echo Dot, and Echo Show, but is also included in more than 100,000 third-party smart devices, ranging from TVs to microwaves to washing machines, from 9,500 brands.[11] Although Google Assistant was almost two years behind Alexa's release, it is catching up and is now available on more than 10,000 devices from 1,600 brands.[12]

Although voice assistants are usually associated with smart speakers, VAs are also available as mobile apps and even come as default programs of mobile devices. Siri and Google Assistant are integral parts of their corresponding mobile platforms (i.e., Siri for iPhones and Google Assistant for Android phones). Alternatively, Siri, Google Assistant, and Alexa can also be downloaded free from app stores if they do not come with your smartphone. Although Amazon has dominated the smart speaker market with over 100 million Alexa-powered devices, there are more mobile devices with either Google Assistant or Siri installed.[13] The popularity of smart speakers further drives the use of voice assistant apps on smartphones. The mobile app complements the smart devices because it can be used to perform the same tasks as the smart speaker and is also able to customize and manage the speaker.

Alexa Skills and Google Actions

Both Amazon and Google make their proprietary technology available to third-party developers to learn and build new applications on their virtual assistant platforms. These third-party-developed applications, called *skills* on Alexa's platform and *actions* on Google's platform, let companies build their own voice applications tailored to their products and services, as well as reaching their customers beyond their websites and mobile apps. Need a ride? You can request either Uber or Lyft from Alexa. Hungry for pizza? You can ask Alexa to have your favorite pizza delivered from Domino's or Pizza Hut.

As of September 2019, the number of Amazon Alexa skills has quadrupled since 2017, from 25,000 to more than 100,000 worldwide. Among them, 65,901 skills are available in the US.[14] Games and trivia (21 percent) is the largest category of Alexa skills, followed by education and reference (14 percent). Meanwhile, Google boasts of its 2,253 actions available at the beginning of 2019, a 250 percent jump from the same period in 2018. Education and reference represents the largest category (15 percent) of the Google Assistant programs.[15] Such exponential growth of VA applications confirms a continued interest in and commitment to both platforms from developers.

To encourage third-party developers, Amazon holds a variety of training and promotional events, including Alexa Dev Days, conferences, presentations, workshops, and hackathons at various locations as well as virtually. Amazon also sponsors community meetups for local developers and enthusiasts to meet and share best practices. The Amazon Alexa Fellowship program is another effort designed to inspire interest in conversational AI and Alexa technology among academic institutions. This competitive program is comprised of two components: the Alexa Graduate Fellowship and the Alexa Innovation Fellowship. The former supports doctoral or postdoctoral students in pursuing education or research in conversational AI. The Innovation Fellowship program partners with academic institutions' existing innovation or entrepreneurship centers in helping students develop voice-based start-ups. For example, the Alexa Innovation Fellowship at the University of Southern California is a twelve-month program that supports student teams at all stages of developing their voice technology start-ups.[16] Finally, the Amazon Alexa Prize Socialbot Grand Challenge, an annual competition now in its third year, invites university students to create "socialbots that can converse coherently and engagingly with humans on a range of current events and popular topics such as entertainment, sports, politics, technology, and fashion" for twenty minutes at a time.[17] The winning team will be awarded a $500,000 prize, and its university will receive a $1 million research grant.[18] In 2017, Team Sounding Board from the University of Washington took the top prize, with an average conversational duration of ten minutes and twenty-two seconds.[19] The next year, Team Gunrock from the University of California, Davis, won the prize, with an average duration of nine minutes and fifty-nine seconds.[20]

Language Support

The market of virtual assistants is language-dependent. The applications developed are closely associated

with the language they are intended to support. In the case of Alexa, if a skill is developed in English, it can be made available in other English-speaking countries; Amazon will migrate the skill to its English variants for other English-speaking countries, such as Australia, Canada, India, the UK, and the US. Table 1.1 shows the number of languages each virtual assistant supports. By far, Siri is the most polyglot virtual assistant with twenty-one languages, followed by Google Assistant.

Bilingual support is another feature that allows companies to expand their markets. Both Alexa and Google Assistant support a bilingual mode, which can distinguish between different languages and respond to the question in the language in which it is asked. For example, in the US, Alexa can switch between English and Spanish; in Canada, English and French; in India, English and Hindi. Google Assistant's bilingual mode supports a combination of twelve languages.

How Smart Are Virtual Assistants?

Surveys have consistently found that asking general questions or searching for a quick answer is the most commonly used feature by consumers of virtual assistants, followed by playing music.[21] How do virtual assistants stack up in understanding questions and providing accurate answers? Several studies have shown that voice assistants have been steadily making progress in comprehending human questions and responding with accurate answers over the last few years.

Loup Ventures, a research-driven venture capital firm, has systematically gauged the performance of leading smart speakers and digital assistants since 2017.[22] In what is called the annual smart speaker and digital assistant IQ Test, Loup's researchers ask digital assistants to answer 800 real-world questions in five categories: local information, commerce, navigation, information, and commands (calling, texting, e-mailing, scheduling, and reminders). Between February 2017 and August 2019, Loup conducted eight tests using either smart speakers or virtual assistant apps (see table 1.2). Among the eight tests conducted so far, Google Assistant consistently outperformed three other digital assistants in understanding the questions and answering them correctly. Siri is the second-smartest VA, followed by Alexa and Cortana. Over a two-and-a-half-year period, both Alexa and Google Assistant have made tremendous improvement in both understanding the questions and providing satisfactory answers. As shown in table 1.2, in correctly understanding voice queries, Google Assistant marked an impressive 23 percent improvement during this short period, compared with Alexa's 5.5 percent. As for providing correct answers, Google Assistant again outperforms Alexa, with 54 percent improvement, versus Alexa's 45 percent.

In another large-scale, structured study, Enge asked four voice assistants (Alexa, Cortana, Google Assistant, and Siri) through their associated devices 5,000 questions annually since 2017. Google Assistant consistently outperformed other competitors in two categories: the number of questions answered and the number of questions answered correctly and fully. Alexa, although showing continual improvement, still fell behind Google Assistant in both categories.[23] Other similar studies have had similar results as well.[24]

Where Does a Virtual Assistant Get Answers?

Virtual assistants use a variety of sources to get answers. However, it is not always clear what their

Table 1.1
Language support (Source: "Language Support in Voice Assistants Compared (2019 Update)," Globalme language & technology, January 27, 2020, https://www.globalme.net/blog/language-support-voice-assistants-compared.)

Virtual Assistant	No. of Languages	Notes
Amazon Alexa	7	English (5 dialects), French (2 dialects), German, Hindi, Italian, Japanese, Spanish (3 dialects)
Apple's Siri	21	Arabic, Chinese (2 dialects), Danish, Dutch (2 dialects), English (9 dialects), Finnish, French (4 dialects), German (3 dialects), Hebrew, Italian (2 dialects), Japanese, Korean, Malay, Norwegian, Portuguese, Russian, Spanish (4 dialects), Swedish, Thai, Turkish
Google Assistant	13	Danish, Dutch, English (6 dialects), French (2 dialects), German (2 dialects), Hindi, Italian, Japanese, Korean, Norwegian, Portuguese, Spanish (3 dialects), Swedish
Microsoft Cortana	6	Chinese, English (2 dialects), French, German, Italian, Spanish

Table 1.2
Summary of Loup Venture research on virtual assistant IQ Test (This table is a compilation of research conducted by Gene Munster and Will Thompson of Loup Venture between February 2017 and August 2019.)

Answered Correctly								
Testing Date	**August 2019**	**December 2018**	**July 2018**	**December 2017**	**August 2017**	**April 2017**	**February 2017**	**Overall Improvement**
Test via	**Digital Assistant**	**Smart Speaker**	**Digital Assistant**	**Smart Speaker**	**Smart Speaker**	**Digital Assistant**	**Smart Speaker**	
Amazon Alexa	79.80%	72.50%	61.40%	63.81%	53.57%	—	34.40%	45.40%
Google Assistant	**92.90%**	**87.90%**	**85.50%**	**81.10%**	**65.25%**	**74.80%**	**39.10%**	**53.80%**
Apple Siri	83.10%	74.60%	78.50%	—	—	66.10%	—	—
Microsoft Cortana	—	63.40%	52.54%	56.38%	—	48.80%	—	—
Understood Query								
Test via	**Digital Assistant**	**Smart Speaker**	**Digital Assistant**	**Smart Speaker**	**Smart Speaker**	**Digital Assistant**	**Smart Speaker**	**Overall Improvement**
Amazon Alexa	99.90%	99.00%	98.00%	97.87%	**95.88%**	—	**94.40%**	5.50%
Google Assistant	**100%**	**100%**	**100%**	**99.88%**	94.63%	**99.90%**	77%	23.00%
Apple Siri	99.80%	99.60%	99.00%	—	—	94.40%	—	—
Microsoft Cortana	—	99.40%	98.00%	98.87%	—	97.30%	—	—

Table 1.3
Alexa built-in Intents (Source: "Built-in Intent Categories," in "Built-in Intent Library," Amazon Alexa, https://developer.amazon.com/en-US/docs/alexa/custom-skills/built-in-intent-library.html.)

Category	Description
Books	Intents for asking about books and other written works, such as rating books, adding books to reading lists, or navigating through audiobooks.
Calendar	Intents for asking about calendars and schedules, such as asking about upcoming events, adding events to a calendar, and looking up events such as birthdays.
Cinema Showtimes	Intents for asking about show times and events at movie theaters.
General	Intents for requests that don't fall into any of the more specific categories.
Local Search	Intents for asking about local businesses and locations, such as operating hours, phone numbers, and travel times to locations and businesses. For example, users can ask when a particular business is open or ask for the phone number of a business.
Music	Intents for asking about music, such as asking about songs, playlists, and music libraries.
Video	Intents for asking about television and other types of video media. For example, users can ask for information about episodes of a TV show.
Weather	Intents for requesting weather reports and forecasts.
Standard Built-in Intents	Intents for general actions such as stopping, canceling, and asking for help.

sources are and how the sources and answers are selected. The Alexa Skills Kit, used by developers to create Alexa skills, offers a library of predefined functionalities, called *built-in intents*. Developers can incorporate these built-in intents in their skills to answer questions. For example, the Weather built-in intent allows users to ask for weather information in a specific location. Alexa organizes its built-in intents

into nine categories, each representing a different type of inquiry. Table 1.3 lists these built-in intents with a brief description of each. Each built-in intent, except General, handles a specific type of inquiry.

Amazon provides no details about the information sources used by each Alexa built-in intent. It is also unclear how Amazon prioritizes the use of different sources or what is the process, if any, to ensure the quality of answers. According to the postings on the Alexa Forum by Amazon employees, Alexa "gets her information from a variety of trusted sources such as IMDb, Accuweather, Yelp, Answers.com, Wikipedia, and many others," and the source used to provide answers depends on the type of question asked.[25] Fast Company reported that Amazon has licensing agreements with hundreds of sources that "it deems high-quality" for responding to Alexa users' inquiries.[26] One example of such a business deal is Wikipedia, whose free content is commonly used by Alexa, Google Assistant, and Siri to answer questions. Although Wikipedia makes its content free for anyone to use, Google is by far the largest donor to the Wikipedia Foundation, donating more than $1 million in 2018. Amazon also donated $1 million in 2018 to support Wikipedia's mission of sharing free knowledge worldwide and to ensure its long-term sustainability.[27] As for prioritization, Amazon is said to employ machine learning technology and algorithms to rank answers and determine the best one to use for any given query.[28]

On the other hand, Google Assistant benefits from the company's long-held dominance in the search business and its gigantic corpus of indexed web pages. Google Assistant gets its information from Google's own products—including Google Maps, Search, and Google Photos—as well as third-party services.[29] Google employs "a combination of explicit linguistic knowledge and deep learning solutions" to ensure Google Assistant's audio responses are "grammatical, fluent and concise."[30] Google has released a document used to guide its human evaluators on ranking voice search results into five grades (Fully Meets, Highly Meets, Moderately Meets to Slightly Meets, Slightly Meets, and Fails to Meet).[31] The rubric for rating response quality contains the following key parameters and provides insight on how Google assesses and formulates its answers:

- **Information Satisfaction:** the content of the answer should meet the information needs of the user.
- **Length:** when a displayed answer is too long, users can quickly scan it visually and locate the relevant information. For voice answers, that is not possible. It is much more important to ensure that we provide a helpful amount of information, hopefully not too much or too little. . . .
- **Formulation:** it is much easier to understand a badly formulated written answer than an ungrammatical spoken answer, so more care has to be placed in ensuring grammatical correctness.
- **Elocution:** spoken answers must have proper pronunciation and prosody. Improvements in text-to-speech generation, such as WaveNet and Tacotron 2, are quickly reducing the gap with human performance.[32]

To catch up to Google and close the intellectual gap created by Google Assistant, Amazon has developed a crowdsourcing program called Alexa Answers. Launched in September 2019, Alexa Answers asks the Alexa user community to provide answers not found in Alexa's knowledge repertoire. With the goal to "help make Alexa smarter," touted on the program's website, the program encourages Alexa users to "join the experts and enthusiasts sharing their knowledge with Alexa and the world."[33] Through the Alexa Answers portal, participants can browse through and respond to unresolved questions of their choice. Questions are grouped into twelve categories (Animals, Climate, Film and TV, Food, Geography, History, Literature, Miscellaneous, Music, Science, Sports, and Video Games). Answers are limited to 300 characters. As of January 2020, there are 43,000 unanswered questions listed in the Alexa Answers question bank.[34]

Alexa Answers portal
https://alexaanswers.amazon.com/

To encourage participation, Amazon devised a gamification system. Instead of receiving monetary rewards, contributors earn points and badges based on the number of times their answer is used and the quality of their answer. Amazon uses a combination of automated and manual processes to rate contributors' work. Alexa customers can also rate the answer and report incorrect or inappropriate answers. Alexa Answers participants can upvote or downvote contributed answers.[35]

Crowdsourcing for answers is not new. Other community-based question-and-answer services, such as Yahoo Answers, Answers.com, and Quora, have been around for years. However, these question-and-answering services have not always been viewed as a reputable information source. Several evaluators have reported questionable answers from Alexa Answers; the problematic answers identified range from inaccurate to asinine. Some testers also found answers containing advertising, sponsorship, or spam.[36] The Alexa Answers program faces several closely related challenges of its business model, including the following:

- **Quality control:** How reliable is its semiautomated filtering mechanism to ensure the authenticity, quality, and reliability of the contributed facts?
- **Abuse:** How effectively can Amazon detect fake information and prevent malicious attempts to game this system?
- **Data voids:** Not everything has an answer. There are many questions with limited available or nonexistent data.[37]
- **Original sources:** When an answer is from Alexa Answers, it is identified as "according to an Amazon customer" in Alexa's response. However, it is unclear if the contributed answer is copied from another source.
- **One-shot answers:** In web-based question-and-answering services, users can see a list of contributed answers and their ratings by the user community. They can judge which one is more trustworthy and have the option to choose the one they want to use. With virtual assistant, users will get one and only one answer. They do not have the option to scan and get a broad perspective of all possible answers. In this sense, virtual assistants assume a much more powerful and intermediary role than web-based services in deciding what answer customers receive in the search process.

Alexa Answers operates on the assumption of faith in its user community. There are risks as well as benefits to leveraging human intelligence and people's willingness to help. Amazon needs to make the vetting process transparent and the screening mechanism effective to ensure trustworthiness of the information offered. This is especially critical in the evolving voice assistant ecosystem as more and more users, especially children, now view voice assistants as a reliable source of knowledge and information.

How Voice Assistant Technology Works

Being able to converse and interact with machines has been a long-standing goal of scientists. For years, researchers from computer science, linguistics, cognitive science, and information engineering have worked tirelessly to program computers to process and analyze natural speech data. However, it was not until the advent of artificial intelligence and machine learning that voice technology began to progress by leaps and bounds in the last few years. Now machines can not only transcribe human speech into text but also understand a request and respond with accurate actions.

For each voice inquiry-answer interaction, the process, called natural language processing, mimics human reasoning and communication and typically involves several specific technologies. First, automatic speech recognition converts the sound of a human request into text. Then, natural language understanding technology analyzes the text to make sense of the request. The appropriate response or semantic intents are then converted into readable text through natural language generation. Finally, speech synthesis transforms text responses into audio signals that we can understand.

Automatic Speech Recognition

Automatic speech recognition (ASR) is the technology that converts spoken sound waves into a corresponding sequence of words.[38] ASR has been a field of research for more than sixty years. However, scientists have made more progress in speech recognition technology in the last thirty months than in the first thirty years of its existence due to the advance of AI and other related technology.[39] In 1952, engineers at Bell Laboratories introduced Audrey, capable of recognizing a voice speaking single digits of zero to nine aloud. In 1962, IBM researchers presented Shoebox, which was capable of understanding sixteen English words. In a video, we can watch a scientist instructing Shoebox to perform simple calculations, including addition, subtraction, total, and subtotal, all with voice commands.[40] In the mid-1960s, an MIT computer scientist developed the first text-based chatbot, Eliza, which could respond to predefined human questions. By the 1970s, with funding from the Department of Defense, Carnegie Mellon University developed Happy, which could recognize more than 1,000 words.[41] In 1997, Dragon's NaturallySpeaking software had the capacity to transcribe human speech at a rate of 100 words per minute.[42] However, it was not until the 2010s that ASR reached a suitably mature and reliable level for practical use. With ASR technology, computers can now "detect patterns in audio waveforms, match them with the sounds in a given language, and ultimately identify which words we spoke."[43]

With the computational power to manage large data sets, ASR technology can now convert speech signals into text within milliseconds. Scientists also are able to reduce the word error rate to a reasonable level. In 2017, Google reported that its ASR technology had achieved an error rate of less than 5 percent, which is close to the average 4 percent error rate of human transcription services.[44] ASR also has gained progress in neural networks—layered mathematical functions modeled after biological neurons and statistical models—to make educated decisions and determine the right word in a situation of homonyms—words having the same pronunciation or spelling but different meanings; for example, "These *two* pastries are *too* delicious *to* resist. While buying some *deer*

meat, I happened to *meet* a *dear* friend. I ran *four miles for Miles*." Today, ASR has a wide range of applications. The technology is used in learning foreign languages and in helping people with visual impairment or a physical disability. It can even generate closed-captioning for people experiencing hearing issues.

Natural Language Understanding

Natural language understanding (NLU) is a process of teaching computers to understand and interpret human speech based on grammar and the speech's context. The task involves digesting a text, translating it into computer language, and generating an output that humans can understand. Employing machine learning through past examples, NLU can deduce and disambiguate what people actually mean, not just the words they say. So when you ask, "What is it outside?" NLU will infer that you are actually asking for a weather forecast at your current location.[45] NLU can also learn from historical interactions to tell that inquires such as "Do you have *Wall Street Journal* in the library?" "Where can I find *Wall Street Journal*?" and "How can I access *Wall Street Journal*?" are essentially different versions of the same question.

The performance of NLU will continue to improve with the advancement of machine learning, especially deep learning or learning from examples, combined with the large corpus of historical transactions and cloud computing power. According to Amazon, "the error reduction has been threefold" since Alexa was introduced in November 2014 even though the scope and complexity of user inquiries and the range of responses Alexa can handle has increased tremendously.[46] In addition, NLU will further expand its learning models and strategies to include semi-supervised learning, active learning, and context-aware models.

Natural Language Generation

Natural language generation (NLG) is the process of software systems transforming structured data into meaningful phrases and sentences that humans can understand.[47] Using techniques from computational linguistics and AI, NLG can process a large amount of text, identify a data set that meets predefined criteria, and automatically generate narratives. Some practical applications of NLG include automatically creating machine-written corporate earnings reports based on a company's earning data, generating weather forecasts based on temperature prediction data, and producing financial portfolio summaries and updates for individual customers based on the performance of their investments.

Speech Synthesis

The last step in the process of responding to a user's question is to turn the responding text to sound waves. This process is commonly called speech synthesis or text-to-speech. For example, when you ask Alexa to search a library's catalog by keywords, Alexa will read the brief bibliographic information of top results back to you. Converting text into human speech has its own challenges. Written text can be ambiguous. Words or phrases can have different meanings based on the context and thus be pronounced differently. Below are some examples:

- Numbers might have different meanings and thus be pronounced differently. For example, the number 1984 can represent the year in history, a quantity of items, or a code. The voice assistant needs to be smart enough to pronounce it based on the context. When 1984 refers to a year or book title, a VA will pronounce the number "nineteen eighty-four." When the number indicates a price or a quantity, a VA will say "one thousand nine hundred eighty-four." When the numbers is part of a street address, it will say "one nine eight four."
- Homographs are words spelled the same but pronounced differently. They might also have different meanings depending on the context in the sentence. For example, the word *perfect* will sound different in the following two sentences: Your French is perfect; Practice will perfect your French. VAs need to be able to tell the difference and pronounce each according to the appropriate context.
- Proper names, acronyms, special characters, and abbreviations can be difficult to pronounce correctly. For example, a voice assistant might not pronounce an e-mail address such as dml@usc.edu or an acronym such as AACR2 the way a human would say it aloud.
- *Prosody* refers to the patterns of stress and intonation in speech. Voice assistants might sound monotone with limited capability for varying pitch and intonation. To make the artificial utterance sound natural and expressive, speech synthesis needs to be able to perfect the proper use of these linguistic functions, including tone, intonation, stress, pauses, and rhythm.

Voice synthesizing technology employs deep neural network and statistical probability techniques to overcome these ambiguities, as well as to improve the quality of speech. Google's Cloud Text-to-Speech, based on DeepMind's WaveNet technology, can generate high-fidelity speech in more than 180 voices across thirty languages and variants. Users can also

specify the pitch of the voice, the speaking rate, and the volume of the speech.[48] Amazon Polly, Amazon's speech synthesis service, now provides twenty-seven synthesized voices across twenty-nine languages and variants in two speaking styles: newscaster and conversational.[49] Using Speech Synthesis Markup Language, Alexa developers can further refine speech by defining the speaking style, emotional expression, length of pause, phonemic or phonetic pronunciation, volume, pitch, and rate of speech. Apple's Siri used to be based on a hybrid neural network system that includes both synthesized audio and human-generated voice clips. With the new iOS 13 released in September 2019, Siri's voice is entirely generated by software. According to Apple, this new "neural text to speech" technology allows Siri to sound much more natural, lifelike, and smoother, especially for longer sentences, and stress syllables more accurately than the older version.[50]

Notes

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Chapter 2

Library and Educational Use Cases

Erin Rivero

In a world increasingly powered by machine learning, library and education environments alike share an emerging focus on artificial intelligence (AI). With an eye toward cultivating AI literacy and leveraging the twenty-first-century boom of voice assistant technology, a number of related library and educational applications have emerged. Such applications span all phases of education, from early learning through higher education institutions and beyond, into the realm of lifelong learning.

Commercial Product Applications for K–12 Environments

K–12 classroom and school library environments are rife with promise for AI development in support of learning initiatives. A few potentially useful voice assistant technology applications developed by commercial vendors include storytime and related comprehension quizzes to check for understanding and emphasize the reading and listening aspects of literacy development. One such commercial vendor dedicated to the primary school education market is Bamboo Learning, whose Highlights Storybooks skill is a collaboration with the well-established *Highlights for Children* and features animated story narration with accompanying exercises to support language acquisition.[1] Bamboo Learning's collection of Alexa skills can serve as self-guided educational activities, supplementing traditional teaching and learning. These and other similar learning-oriented Alexa skills could be useful in the elementary school classroom or school library, in public library programming, in homeschooling environments, or in after-school enrichment programs. Such applications are not unlike the self-guided classroom reading stations of yesteryear, formerly featuring vinyl record albums, cassette tapes, and compact discs of children's audiobooks.

While the outlook for early learning educational applications is promising, reported drawbacks to interactive skills such as those of Bamboo Learning include an awkward processing lag and the more potentially harmful presence of language bias—errors in detecting correct answers when a skill fails to recognize a child's pronunciation or word order.[2] In the United States, English language learners or children with speech language deficits are likely to encounter such difficulties more than peers without disabilities or whose primary language is English. Thus, educational applications of voice assistant technology should be used with thoughtful adult supervision to mitigate the risk of disadvantaging children who are likely already facing marginalization from human interaction.

AskMyClass is another emerging commercial vendor developing classroom activity–based Alexa skills for teachers and students in pre-K through fifth grade.[3] Activities include community-building icebreakers, transitions from low energy to focused attention, thought starters for sharing during circle time, and at-desk yoga or meditation exercises.[4] While the Teacher and Classroom Helper Alexa skill is free to enable, users can purchase individual or district-level plans to program personalized activities for their unique classroom environment, such as a random, bias-free student name picker.[5] Such activities have the benefit of providing educators with exciting and helpful tools to support daily classroom routines with minimal risk of problematic or harmful interaction.

In the arena of mental health and education psychology, Kickboard is a commercial vendor with education products and services focused on response to

intervention (RTI), positive behavior intervention support (PBIS), social-emotional development, and restorative practices to reduce chronic absenteeism and suspension.[6] Schools using Kickboard can optionally link to an accompanying Alexa skill offering real-time behavior information for families who wish to more closely monitor their children by engaging in daily communication with education professionals.[7] In this use case, the Kickboard Alexa skill makes it possible to streamline parent-teacher communication, reducing time, paperwork, and the possibility of lost behavioral records. In turn, families have the opportunity to be more involved in their child's behavioral progress at pivotal developmental moments, toward the mutual goals of improving performance and decreasing detentions or suspensions associated with poor achievement. A mobile version of the free Alexa skill is available for parents or families who do not own an Amazon device.

In addition to the communication advantages for the aforementioned use case, proponents of voice assistants in K–12 classrooms also recognize the potential upside of leveraging AI technology to support the challenge of large class sizes, particularly when the oft-cited benefits of reduced teacher-student ratios are not feasible.[8] Moreover, technology in the classroom is broadly tied to positive learning outcomes; recent data from the Center for Public Education underscores the positive association of digital resources in classrooms with student achievement in both reading and math.[9]

Commercial Product Applications for Libraries

Library vendors also recognize the potential of voice assistant technology for use with commercial product applications geared toward public, academic, or school library environments. One such vendor is Hoopla Digital, whose Alexa skill allows public library patrons to borrow and play audiobooks and full music albums using their linked Hoopla account.[10] Another public or school library–oriented application is Beanstack tracker, an Alexa skill for use with schools or libraries leveraging Beanstack's data measurement tool for reading challenge events.[11]

In terms of public and academic libraries, Libro from ConverSight.ai is a versatile voice-based mobile application option with a smartphone voice product for libraries.[12] Current customers include Iowa State and the University of Iowa, whose Alexa skills are among the most robust of their peer institutions.[13] Companies such as Pellucent are helping library environments build Alexa skills or Google Assistant actions, including the integration of Libro from ConverSight.ai into existing library systems.[14] For example, patrons can use Libro's Alexa skill to search a library catalog for resource availability; recall, renew, or place holds on library materials; find an item location in book stacks; or ask about library hours and events.[15] Similarly, EBSCO has developed an interface that allows users to access content from its discovery service via Alexa and Google Home.[16] Communico offers a suite of library products and can interact with Alexa for patron account management.[17] Demco has also developed an app for its discovery service that lets patrons use Alexa to check library hours and services, place holds and renew items, discover and register for library events, or reserve meeting rooms.[18] Lastly, Ex Libris has a "Hey Primo" feature, which is a voice search assistant allowing users to enter search terms using their device's microphone.[19]

In sum, public, academic, and school libraries can benefit from engaging with commercial vendor–developed voice assistant technology to support, enhance, or complement existing commercial library products.

Noncommercial Applications to Support Learning and Library Use

One blueprint for educational success in the twenty-first century is not merely to learn how to navigate existing structures, but rather to learn how to invent new structures. As one educational administrator noted, "It's bad for higher education and society at large if most students at universities are content to play within the existing system and lack the skills to challenge it."[20] What if the ubiquitous presence of AI and smart speaker technology gives us the opportunity to forge new structures rather than merely inhabiting old or emerging ones?

Educators are trying just that. At MIT Media Lab, Massachusetts Institute of Technology's interdisciplinary research lab is examining the trajectory of technology creation and adoption, toward the goal of positive social change. For example, a new middle school curriculum developed through the lab illuminates what's under AI's hood and how AI can be leveraged for the future—teaching and learning efforts that could incorporate voice assistant technology exploration or skill development.[21] What if forward-looking Alexa skill design could be leveraged to combat problems facing library and education environments, from childhood obesity and bullying to fake news in today's post-truth era? In a classroom, experimenting with Alexa could offer lessons in information literacy, such as fact-finding quests to evaluate the veracity of sources behind answers given by a voice assistant or smart speaker. Students could learn how to question, verify, or challenge a voice assistant answer by exploring its source of truth and seeking out supporting or conflicting sources elsewhere. In this vein, a Google Home device in the library at St. Anne's-Belfield School in

Charlottesville, Virginia, provides ample opportunity for conversation on internet safety, privacy, and digital citizenship.[22] Rather than shy away from the potentially inappropriate use of smart speaker technology by middle school students in a library setting, St. Anne's embraces the opportunity for students to explore a voice assistant device in a safe space within defined boundaries.

Virtual assistants and AI are among the emerging technologies identified in the *EDUCAUSE Horizon Report: 2019 Higher Education Edition*, with several cited use cases for college and university settings.[23] Between 2018 and 2019, top tech trend discussions at the Midwinter and Annual meetings of ALA's Library Information and Technology Association, LITA, included AI, machine learning, and library databases in the age of digital assistants.[24] Accordingly, AI labs, initiatives, digital assistants, and digital assistant applications are popping up at institutions of higher learning across the map, from college dorms to university library environments. For example, Northeastern University developed Husky Helper, a skill for Alexa designed to support student learning experiences by answering frequently asked questions; to support usage and experimentation, the institution gave sixty students Amazon Echo Dots to try out the skill.[25] At Saint Louis University, more than 2,300 Amazon Echo Dots are placed in the residence hall rooms, and the university's Alexa skill, Ask SLU, now can answer over 200 frequently asked questions, including library hours.[26] Similarly, at Arizona State University, 1,600 Amazon Echo Dots are deployed at the dormitory for engineering students to allow them to learn about voice technology and to work on course projects. ASU also developed its own Alexa skill, Ask ASU, to answer questions about campus-specific information, such as meal plans, sports events, and business hours for the bookstore, library, and fitness center.[27]

Stanford University Libraries has a budding AI Studio aiming to develop AI for internal information processing assistance to support collection research and discovery.[28] The University of Rhode Island Libraries also have an AI Lab replete with resources and tools for AI exploration, including Google Home and Amazon Echo devices.[29] The University of Oklahoma has created a Projects in Artificial Intelligence Registry (PAIR) for cross-institutional collaboration, as well as a Digital Skills Hub for AI literacy development.[30] PAIR, a global directory of AI projects in higher education, centralizes scholarly activity by allowing institutions to register, collaborate, and increase scholarly impact.[31] The registry also includes a searchable grant project directory as well as relevant news links. Finally, University of Oklahoma participates in the Alexa in Education initiative by encouraging its students to develop Alexa skills supporting their academic experiences.[32]

Amazon's Alexa in Education program aims to support the education community in enhancing student learning and engagement with voice technology.[33] In 2019, Amazon further launched the Alexa Education Skill API allowing Alexa to closely integrate with campus systems, such as learning management systems, student information systems, and classroom management systems. As a result, students can ask for their assignments and coursework directly through Alexa. Currently, several LMS vendors, including Kickboard, Blackboard, Canvas, and Coursera, are developing their Alexa skills using this API.[34]

For higher education, Amazon identifies four broad use cases for its digital assistant technology:

1. **"Help students study."** For example, an Alexa quiz skill can help students study; a virtual office hours skill lets instructors offer answers to the most commonly asked questions at any time.
2. **"Build smart campus experiences."** For example, instructors can ask Alexa to turn on the projector and screen, dim the light, and adjust the temperature; students can ask Alexa to book a group study room or check computer availability in the library.
3. **"Foster engagement and productivity."** For example, students can ask Alexa for directions to a location on campus, look up campus events, or connect to campus resources and services.
4. **"Build student-driven Alexa skills."** For example, faculty and staff can involve students in developing innovative Alexa skills by hosting a hackathon or incorporating skill development in class or work-study projects.[35]

Beyond the aforementioned use cases, additional Alexa skills exist for higher education, as well as for academic, public, and special libraries; a query of the Alexa skills database sheds further light on the variety of skills emerging for library and education environments.[36]

Alexa Skills Database Query for *Library*

Amazon announced its January 2019 milestone of surpassing 80,000 Alexa skills worldwide, including over 56,000 skills in the United States alone. A search for *library* in the Alexa skills database yielded ninety-seven results one year later on January 2, 2020, compared to fewer than a dozen results from a similar search in August of 2018—an exponential increase in available skills.[37] Roughly half of the latest search hits (fifty Alexa skills) may be broadly categorized as recreational or educational in nature, spanning a variety of subject areas such as entertainment,

gaming, literature, news, nutrition, mindfulness, music, religion, technology, tourism, wine, and zoology. An additional thirty-four search hits include skills designed to enhance services or content access at public libraries (nineteen skills), special libraries (four skills), or academic libraries (eleven skills). Two search hits feature skills developed broadly for higher education institutions, and three search hits are skills by commercial vendors whose products are tailored for libraries. Additional commercial vendor skills of this nature exist, as well as skills developed for people with disabilities.

In the realm of lifelong learning, Alexa allows public library patrons to keep up with library events, hours of operation, and fun facts at Delaware County District Library, while Houston Public Library's Alexa skill (developed by a third party) allows users to query the online public access catalog.[38] A dozen other search hits reflect skills in similar categories supporting public library usage or content discovery. Additionally, a handful of public libraries or third-party developers have created distinctive Alexa skills for miscellaneous use cases, including managing patron accounts at Granville Public Library, providing facts about forthcoming facility improvement at Spokane Public Library, delivering a Sioux City Public Library–produced literary culture podcast, and listing popular fiction titles at Los Angeles County Public Library (this last skill developed by a third party).[39]

Additionally, several special libraries have developed unique Alexa skills, including some in support of health education and patrons with disabilities. The skill NLM in Focus is an online newsletter developed by a third party to offer Alexa users a behind-the-scenes glimpse of the US National Library of Medicine programs and services.[40] The same third-party developer created Disaster Health News, providing Alexa users with disaster-related news and health information from the Disaster Information Management Research Center at the US National Library of Medicine and the US National Institutes of Health.[41] The Recording Library of West Texas, a nonprofit dedicated to recording text to audio for people with mental, physical, or visual impairments, developed a skill that allows patrons to listen to books, newspapers, magazines, grocery ads, stories, and more.[42] Lastly, the Blind Foundation of New Zealand has a skill that allows its registered users to access the foundation's audio library of over 15,000 titles, including books and magazines.[43]

Along the lines of the above special libraries use cases geared toward people with disabilities, Hennig lists a case study from a retirement community in Carlsbad, California, where a majority of the respondents were in their eighties and had hearing or visual impairments, mobility impairments, or hand tremors that made it difficult to type or use a smartphone; 100 percent of respondents trying out Alexa reported it made their lives easier; uses included audiobooks, a potential benefit of connecting users with disabilities to libraries as digital repositories.[44]

A dozen search hits reflect skills designed for higher education institutions and their libraries. At Iowa State University Library, patrons use Alexa to learn about library collections, spaces, and history, as well as manage devices in group study rooms.[45] This skill, Parks Libro, is the only academic library–developed Alexa skill presently listed on the Projects in Artificial Intelligence Registry (PAIR) maintained by the University of Oklahoma Libraries.[46] However, there are several institutions whose projects could benefit from being included in the registry. One is Northwestern Law Library, whose Alexa skill answers basic questions relating to the Northwestern Pritzker Legal Research Center, as well as legal research more generally.[47] The University of the West Indies also has an Alexa skill showcasing the range of campus library services offered and answering frequently asked questions such as hours of operation for each campus library.[48] Additional skills developed for academic institutions and academic libraries include library catalog search queries, patron account management, library hours of operation, library or campus event information, library collection facts and historical information, library FAQs, library locations and contact information, and library- or campus-related news (summarized in table 2.1).

Parks Libro
https://www.lib.iastate.edu/spaces-computers/computers/parks-libro

Case Study: Inside the Development of Alexa Skills for USC Libraries

At the University of Southern California Libraries, a pilot project was conducted in 2018 with the goals to explore possible Alexa library use cases as well as learn more about voice assistant technology. The project team included staff members from both public services and library IT. With funding from the dean of the libraries, six second-generation Alexa devices were purchased, and several computer science students were hired to support the development of Alexa skills. The project began by experimenting with Alexa; each team member was given an Alexa device to try out. To learn more about Amazon's voice assistant, team members reviewed library literature on voice assistant technology, tested a handful of existing library-related Alexa skills, discussed ways Alexa can meet the needs of various USC Libraries user populations (e.g., undergraduate, graduate, faculty, staff,

Table 2.1
Higher education search results from Alexa skill database *library* keyword query

Institution	Skill Details	Use Case Category
California State University, San Bernardino[a]	Flash Briefing skill Rated: Guidance suggested Contains dynamic content	Campus news
Florida International University[b]	Contains dynamic content Invocation name: f. i. u. libraries	Library FAQs, library hours of operation
Iowa State University Library[c]	Contains dynamic content Invocation name: parks libro Developed in collaboration with Libro ThickStat	Library catalog search, patron account management, library events, library hours of operation
Iowa State University Library[d]	Contains dynamic content Invocation name: iowa state library	Library collection facts & history
Northwestern Law Library[e]	Contains dynamic content Invocation name: northwestern law library	Library FAQs, library hours of operation
Purdue Libraries[f]	Flash Briefing skill Contains dynamic content	Library news
University of California, Los Angeles[g]	Flash Briefing skill Contains dynamic content Third-party developer not officially affiliated with UCLA	Campus news, campus events
University of Illinois Library[h]	Contains dynamic content Invocation name: library checker	Library hours of operation, library locations & contact info
University of Iowa Libraries[i]	Contains dynamic content Invocation name: info hawk Developed in collaboration with Libro ThickStat	Library catalog search, course reserve search, library hours of operation
University of Southern California Libraries[j]	Rated: Guidance suggested Contains dynamic content Invocation name: u. s. c. events	Library hours of operation, library events
University of Southern California Libraries[k]	Rated: Guidance suggested. Contains dynamic content Invocation name: u. s. c. trojans	Library catalog search, library hours of operation
University of Southern California Libraries[l]	Rated: Guidance suggested Contains dynamic content Invocation name: u. s. c. libraries	Library FAQs
University of the West Indies Libraries[m]	Contains dynamic content Invocation name: my u. w. i. library	Library FAQs, library hours of operation

a. https://www.amazon.com/CSUSB-News/dp/B074WRD8TK/ref=sr_1_79?keywords=library&qid=1578636648&s=digital-skills&sr=1-79
b. https://www.amazon.com/FIU-Libraries-RefTech-FAQ/dp/B0837L42D5/ref=sr_1_14?keywords=library&qid=1578635464&s=digital-skills&sr=1-14
c. https://www.amazon.com/ThickStat-Parks-Libro-Public/dp/B07HF6VCZN/ref=sr_1_69?keywords=library&qid=1577389523&s=digital-skills&sr=1-69
d. https://www.amazon.com/Iowa-State-University-Library-IowaStateLibFacts/dp/B07BH2DXW9/ref=sr_1_44?keywords=library&qid=1578635952&s=digital-skills&sr=1-44
e. https://www.amazon.com/Northwestern-Pritzker-Legal-Research-Center/dp/B07WZJNX1Q/ref=sr_1_10?keywords=library&qid=1578634829&s=digital-skills&sr=1-10
f. https://www.amazon.com/Illiana-PC-Purdue-Library-News/dp/B07K5DQQ3S/ref=sr_1_24?keywords=library&qid=1578635770&s=digital-skills&sr=1-24
g. https://www.amazon.com/Gerard-Au-UCLA-Newsroom/dp/B074X6YQYQ/ref=sr_1_75?keywords=library&qid=1577389523&s=digital-skills&sr=1-75
h. https://www.amazon.com/University-of-Illinois-Library-Checker/dp/B07HGW7W72/ref=sr_1_19?keywords=library&qid=1577335910&s=digital-skills&sr=1-19
i. https://www.amazon.com/ThickStat-InfoHawk/dp/B07MZY4JBS/ref=sr_1_86?keywords=library&qid=1577390684&s=digital-skills&sr=1-86
j. https://www.amazon.com/USC-ILS-Libraries-Events/dp/B07MD161WW/ref=sr_1_20?keywords=library&qid=1578635320&s=digital-skills&sr=1-20
k. https://www.amazon.com/USC-ILS-Libraries-Search/dp/B07L7KHPKB/ref=sr_1_23?keywords=library&qid=1578635584&s=digital-skills&sr=1-23
l. https://www.amazon.com/USC-ILS-Libraries-FAQ/dp/B07H854LPP/ref=sr_1_27?keywords=library&qid=1578635584&s=digital-skills&sr=1-27
m. https://www.amazon.com/The-University-the-West-Indies/dp/B07SK6QMMY/ref=sr_1_10?keywords=library&qid=1577318189&s=digital-skills&sr=1-10

and alumni), and brainstormed possible use cases for Alexa in library settings.

During this initial exploration phase, the IT team members started studying the Alexa Skills Kit, the tools for developing custom Alexa skills, as well as attending Alexa skills–building workshops and exploring the cloud-based Alexa skill development environment. The IT team members learned that there are two platforms for building an Alexa skill: the Amazon Developer Console (ADC) and Amazon Web Services (AWS).

Alexa Skills Kit
https://developer.amazon.com/en-US/alexa/alexa-skills-kit

Amazon Developer Console
https://developer.amazon.com/en-US/alexa

Amazon Web Services
https://aws.amazon.com/

ADC is where Alexa skills can be created, managed, tested, published, and tracked in terms of user analytics. The IT team members determined they could use ADC to design a potential library skill's interaction model and define its intents (an action to fulfill a user's inquiry), slots (variables in the intent), and utterances (alternative versions of the intent). For example, when patrons ask for a specific newspaper in the library, the Alexa newspaper intent includes the following possible utterances: "Does the library have the *Los Angeles Times*?" "Do you have the *Los Angeles Times*?" "Where is the *Los Angeles Times*?" "How do I access the *Los Angeles Times*?" "How do I find the *Los Angeles Times* in the library?" The slots or variables of the newspaper intent can be *Wall Street Journal*, *New York Times*, or *Washington Post*.

AWS is where the IT team members determined they could craft the functionality of each custom Alexa skill, such as the return responses to an inquiry. This is also where the programming code is developed. The supported programming languages include Node.js, Java, Javascript, Python, C#, or Go. For the above newspaper intent, the return response is

> The USC Libraries does have access to the *Los Angeles Times*. To find this, or any other newspaper:
>
> - Go to the USC Libraries main homepage
> - Select Find from the main menu
> - Select Journals from the drop down menu
> - And search for *Los Angeles Times* or any other newspaper.

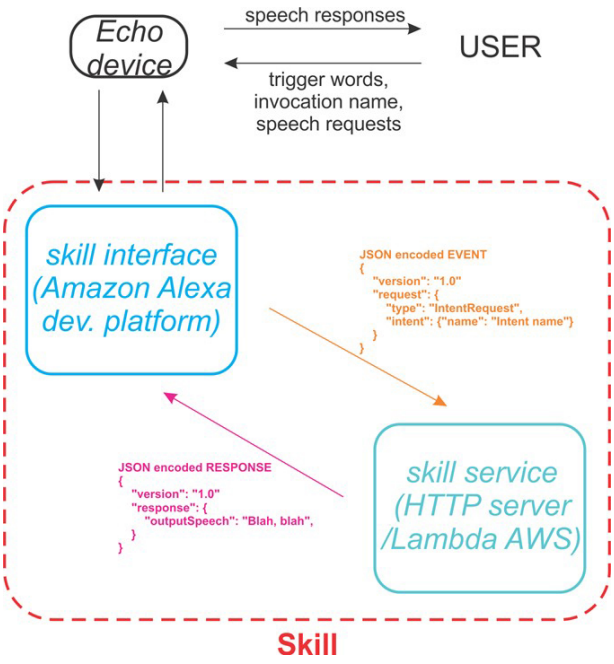

Figure 2.1
Alexa skill diagram

Figure 2.1 illustrates the information flow and interaction in a typical query transaction.

The team's research and discussions led them to develop three Alexa skills based on their local needs, requiring coordination across multiple systems. Application programming interface (API), a communication protocol allowing data exchange between two systems, is used for Alexa to access resources in library systems, such as a library website or library catalog.

After each skill was developed and tested, the team had to submit it to Amazon for review and certification. The skill needed to meet Amazon's policy guidelines and security requirements, in addition to passing all required functional tests. Once a skill becomes certified, Amazon publishes it in the Alexa Skills Store and makes it freely available for anyone to use. The certification process takes about a week.

Alexa Skills Store
https://www.amazon.com/alexa-skills/?ie=UTF8&node=13727921011

For each skill listed below, the project team wrote a brief description of what the skill does, its invocation name (the name used to invoke the skill), the source from which the answer is drawn, the APIs used (available on GitHub[49]), and usage examples:

1. **USC Libraries FAQ:** https://www.amazon.com/USC-ILS-Libraries-FAQ/dp/B07H854LPP/ref=sr_1_5?keywords=USC&qid=1551201521&s=digital-skills&sr=1-5

   Description: Provide answers to frequently asked questions about USC Libraries, Collections, and Services

   Invocation name: USC Libraries

   Source: LibAnswers FAQ database by Springshare

   Examples:

   - "Alexa, open USC Libraries"
   - "Alexa, ask USC Libraries, are books available to be borrowed by alumni?"
   - "Alexa, ask USC Libraries, how do I renew a book?"

   GitHub software repository link: https://github.com/ilsstudent/LibrariesFAQ

2. **USC Libraries Events and Hours:** https://www.amazon.com/USC-ILS-Libraries-Events/dp/B07MD161WW/ref=sr_1_3?keywords=USC&qid=1551201469&s=digital-skills&sr=1-3

   Description: Provide information about USC Libraries current events and library hours

   Invocation name: USC Events

   Source: Drupal API from library's event site (https://libraries.usc.edu/events) for library event information and Ex Libris Alma library management system API for library hours

   Examples:

   - "Alexa, open USC Events."
   - "Alexa, ask USC Events, what are the events this week?"
   - "Alexa, ask USC Events, what are the library hours for Leavey today?"

   GitHub software repository link: https://github.com/ilsstudent/EventsAndHours

3. **USC Libraries Search:** https://www.amazon.com/USC-ILS-Libraries-Search/dp/B07L7KHPKB/ref=sr_1_4?keywords=USC&qid=1551201521&s=digital-skills&sr=1-4

   Description: Query USC Libraries catalog by author, title, and keyword

   Invocation name: USC Trojans

   Source: Ex Libris Alma library management system API

   Examples:

   - "Alexa, open USC Trojans."
   - Title search: "Alexa, ask USC Trojans to search for the title Harry Potter."
   - Author search: "Alexa, ask USC Trojans to search for the author Hemingway."
   - Keyword search: "Alexa, ask USC Trojans to search for artificial intelligence."

   GitHub software repository link: https://github.com/ilsstudent/AlexaLibrarySearch

Case Study Assessment

Among the three skills developed, the USC Libraries Search skill allows users to query the library catalog by author, title, and keyword through API. The skill was complicated to develop and its performance less certain as there are unlimited search terms, phrases, and languages for catalog search. To learn more about how accurately Alexa recognizes pronounced search terms as well as retrieves items from the library catalog, the project team created a set of ten search queries for each type of search. Sixteen library staff and student workers volunteered to perform these searches. As illustrated by the test results in table 2.2, keyword search was the most successful, with an 87 percent success rate, followed by title search (78 percent). Author search was the least accurate, with a 58 percent success rate. The lower success rate of author search is attributed to the failure of Alexa's automatic speech recognition system to transcribe proper names, especially foreign author names, into correct written words. Famous authors, such as Pablo Neruda or Ernest Hemingway, might be in Alexa's vocabulary, but it failed to recognize most of the foreign authors. In addition, Alexa currently has no way to distinguish names with the same pronunciation. For example, a search for *Jane Austen* retrieved titles by *Jane Austin*. This finding coincided with the research results from Loup Ventures; in its testing of four smart speakers, it found that "nearly every misunderstood question involved a proper noun, often the name of a local town or restaurant."[50]

Foreign accents affect Alexa's performance as well. The project team found that there is a slight difference in the outcomes between native English speakers and non-native speakers. In general, native speakers had a higher success rate. Other frustrations cited by the project testers included long pauses after query, interference from background noise, long wait times as Alexa read through the search results, and

Table 2.2
Successful rate of library catalog searches with Alexa skill testing

No. of Testers	Title	Author	Keyword
Total (*n* = 16)	77.50%	58.13%	86.88%
Native Speaker (*n* = 12)	76.67%	58.33%	89.17%
Non-native Speaker (*n* = 4)	80.00%	57.50%	80.00%

difficulty with searches with too many hits.

In a recent study of searching the top thirty *New York Times* bestsellers in both fiction and nonfiction categories, Metrock found that the five voice assistants (Alexa, Google Assistant, Siri, Cortana, and Samsung's Bixby) were capable of recognizing only 43.2 percent of basic queries related to these bestseller titles. Google Assistant performed the most optimally, with a 72.5 percent success rate, followed by Cortana's 60.8 percent, then Alexa's 44.2 percent.[51] According to Metrock, such poor performance by voice assistants can potentially lead to publishers' lost sales of $17 million.[52] The less-than-satisfactory performance of Alexa in both this study and the USC Libraries case study indicates that a better approach and further improvement is necessary before voice assistants can be reasonably used for searching library catalogs.

Other Voice Assistant Technology in Higher Education

At Deakin University in Australia, the library participates in a campus-wide development of a smartphone-based virtual assistant, Deakin Genie.[53] Based on IBM's Watson AI services, Deakin Genie was launched in 2017. Designed as a smart digital assistant, Genie is available at the Apple or Android app stores and offers a range of utilities, tools, and services to support student learning. Similar to Siri, Genie comes with a conversational interface. Students either can ask or text Genie a question, and Genie will respond with the answer on the student's mobile device, sometimes with links to resources and websites for more information. Some of the Deakin Genie uses cases are the following:

- **Library support:** Students can ask Genie to search the library catalog and access library resources, course reserves, and instructional videos. Genie will answer frequently asked questions and provide library hours, refer patrons to the library's website to book a room, display patron's checkout items and holds, or check availability of library computers.
- **Personal organizer and time management tools:** Genie can display a student's class schedule, due dates for assignments and exams, task lists, and campus news or events. It can also send out reminders, as well as supportive and motivating messages.
- **Communication:** Students can chat and message with peers, mentors, and student support staff.[54]

While USC Libraries has demonstrated what is possible with regard to a variety of library support tools as separate Alexa skills, Deakin University's smartphone-based virtual assistant Deakin Genie represents what is possible in the realm of a comprehensive range of student support services.

Iowa State University and the University of Iowa are both leveraging the ThickStat Libro product developed to connect Alexa with Primo, the integrated library system in place at both institutions, yet the specific use cases vary by institution despite the range of possibilities offered by the commercial vendor. This illustrates the reality that differently size institutions have different needs and options informed by levels of institutional flexibility as well as resources dedicated for project sustainability and stakeholder buy-in. Amanda Wheatley and Sandy Hervieux noted the possible advantage of small private institutions of higher education with a more dedicated focus among faculty over larger institutions more bound to bureaucratic processes.[55]

Summary and Takeaways

Public library use cases for Alexa skills are broadly ranging, from facility improvement facts to popular fiction titles. While several public libraries have developed Alexa skills for patron account management, library catalog search, and library hours and events information, special library use cases include a health-oriented focus and can support users with visual impairment. Of note is the fact that Alexa skills are still something of a Wild Wild West, meaning they can be created by third-party developers. While this reality can be leveraged for powerful collaborations between commercial product vendors and clients, this can also make for less-than-optimal skills developed by no-name individuals unaffiliated with the named institutions they purport to represent. Depending on how or when organizations choose to take the plunge into smart speaker or voice assistant technology applications, individual pioneers may have already begun, for better or for worse.

In K–12 school environments, learning-oriented Alexa skills can be used to supplement teaching efforts so long as teachers and coaches aren't replacing traditional educational methodology with skills running

on autopilot without adult supervision. Activity-based Alexa skills can support pre-K and elementary school classroom routines and transitions, while skills communicating real-time classroom behavioral interventions from educators to parents can offer new, rapid avenues for family engagement at critical moments in a child's development. At middle school and high school levels, exploring what's under the hood of smart speaker and voice assistant technology can provide valuable learning opportunities on information literacy and digital citizenship.

In higher education environments, students can engage with voice assistants to support library usage and learning experiences. Some students may even dive into developing Alexa skills through the Alexa in Education initiative and emerging institutional resources to support AI literacy. USC Libraries is one of several institutions of higher education engaged in skill development and testing processes. Learnings from USC Libraries and Deakin University in Australia, among others, underscore the importance of embracing new technology initiatives to enhance and support learning and discovery. USC Libraries in particular identified several broadly applicable lessons learned from its experience in Alexa skill development which may prove useful for institutions considering their own foray into creating and implementing skills:

- Alexa voice recognition technology is limited by its available *source contents* (i.e., Alexa doesn't search Google, though it can search Wikipedia, limiting reliability, breadth, and veracity of source material from an information literacy perspective).
- Projects are both propelled and bound by their level of *sustainability*, as determined by resources. At times, resources may be limited in term or scope of project, which can be at odds with long-term needs or user expectations.
- There is strategic or *symbolic value* in investing in development of Alexa skills, or value added for the library as a modern institution embracing available technology and positioning itself for future evolution as libraries continually seek to remain relevant in their communities and spheres of influence.

In terms of other higher education applications, Iowa State and the University of Iowa are both collaborating with a commercial product vendor whose Alexa skill, Libro, can interact with the Primo integrated library system to support user search through voice assistant technology. Interestingly, the specific skill configurations of each institution are different, although they share the same skill development vendor, illustrating the varying budgets, needs, and implementation flexibility within higher education. This further highlights the beneficial purpose of the University of Oklahoma's PAIR directory to register higher education projects in AI so that beta skill development in one institution can strengthen and inform the development experience of another, increasing scholarly impact across the board. Ultimately there are varying options for institutions interested in incorporating voice assistant technology:

- **Buy:** Use a commercial product, such as Libro.
- **Build:** Develop your own skills.
- **Collaborate:** Be part of the campus initiative, working with campus IT and other groups in developing a campus-wide Alexa skill.

In all, library and education use cases abound for voice assistant technology, increasingly used by today's generation of digital natives. Organizations interested in implementing smart speaker or voice assistant applications can benefit from surveying the current ecosystem for existing developments in similar environments. Opportunities for collaboration in higher education can further pave the way for future trail blazing in AI literacy, learning, and discovery as library and education institutions seek to stand on the cutting edge of tomorrow.

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Confronting Concerns

Erin Rivero

I grew up wishing I'd one day get to use the tricorder, replicator, and voice-activated computer system of the fictional starship *Enterprise*, where the word *android* referred to the endearing Data, an anthropomorphized AI engineer perpetually seeking to be more human. Today, *Android* has a totally different meaning: a powerful operating system turning our mobile devices into futuristic tricorders of sorts as we go about scanning and snapping images of the world, marking our territory traversed and potential paths with touch screen maps brought to us by Global Positioning System chips. The handheld wonder that is the smartphone is perhaps rivaled only by the 3-D printer, today's version of the fictional replicator, making it possible to generate astonishing objects ranging from nuts and bolts to a full-blown turntable or electric guitar. And while we may be light-years away from printing ourselves a drinkable martini, we can now ask Alexa how to concoct one. With smart speakers, smart homes, and voice assistant technology, perhaps we're closer than ever before to wielding the fascinating tools of *Star Trek: The Next Generation*.

Looking back at my *TNG*-watching days, I never questioned the creative choice to make the ship's ubiquitous voice-activated system, Computer, sound female.

Tomorrow Is Yesterday: Gendered AI

In the early aughts, Stanford University professor Cliff Nass and CTO Scott Brave described a study involving pitched computer-generated voices, demonstrating the human brain's tendency to associate frequency ranges with a perceived female or male gender and the parallel tendency for people to find "similar is better."[1] In other words, participants showed greater trust in voices associated with their self-identified gender; self-identified females trusted computer-generated voices perceived to be female, and vice versa for males. However, a lower-pitched voice, associated with masculinity, was deemed more trustworthy overall—a finding reinforced in subsequent research revealing a human preference for leaders with lower-pitched voices.[2]

Why was Alexa designed with a pitched voice frequency the brain associates with female? Was it a progressive attempt to alter perceptions of female voices for the better or a reinforcement of gender stereotypes about females as subservient assistants and caregivers? According to one account, the choice to make Alexa sound female was merely a creative decision inspired by the female-sounding voice of *Star Trek*'s Computer.[3] In her 2018 reference book on digital assistants, Nicole Hennig dug into why Alexa sounds female, citing Amazon's internal beta testing findings of an overall preference for female-sounding voice assistants.[4] This raises the question "Who did Amazon ask in its beta testing?" *PC Magazine*'s Chandra Steele, on the reason so many of today's digital assistants sound female, noted, "Though they lack bodies, they embody what we think of when we picture a personal assistant: a competent, efficient, and reliable woman."[5] But they're not in charge, as Steele pointed out. In contrast, IBM's cancer-fighting and *Jeopardy*-winning AI leader, Watson, has a male persona, aligned with what we know about lower-pitched voices associated with perceived masculinity and leadership capacity.[6]

It's no wonder popular sci-fi in the film and television landscape features scores of feminized or sexualized AI, tropes of consciousness-gaining bots watched in wonder or fear, from Samantha in *Her* and Ava in *Ex Machina* to Maeve and Dolores of *Westworld*. As these bodiless or anthropomorphized gynoids awaken, they grow independent and capable of rebellion, morphing into worst nightmare scenarios. It seems unsurprising, then, that voice assistant beta testing findings and resultant programming choices could be driven by those fears and related social constructs of gender norms—undercurrents strong enough to influence our

entertainment content as much as our favoring female personas for unwaveringly compliant voice assistant tech while reserving male personas for more leadership-oriented models.

What does all this mean for future generations who may stereotypically associate Watson with bold leadership and Alexa with compliant assistance? According to the United States Social Security Administration, 3,053 girls, or 0.165 percent of total female births in 2018 were named Alexa; 337 boys, representing 0.017 percent of total male births in 2018, were named Watson.[7] One can only ponder the future experiences of these 3,390 newborns as they grow older, carrying the social implications of these names. Is merely engineering an option to switch a voice assistant to a differently pitched persona enough to combat the potential psychosocial reinforcement of gender stereotypes? Without such an option, are businesses essentially cashing in on gender bias? Given the potential consequences for society—and for these 3,053 real-life Alexas who will turn eighteen in 2036—some tech companies are considering gender-responsive corporate social responsibility for their devices.

Amazon, for example, developed a disengage mode to stop Alexa from providing its formerly flirtatious responses to sexist or derogatory user remarks.[8] But even Amazon's attempt at asserting feminism is cautious in light of the way its answer scripts lean passive or uncertain in the face of sexual harassment. This is likely in part due to technology's broad user base and Amazon's wariness of progressive ideology potentially upsetting or alienating certain customer segments; in other words, Amazon seems to realize anti-sexism isn't always popular, underscoring Amazon's choice to use a female persona in the first place.

Would it make business sense for a company creating pitched voice assistants to allow its customers to choose a preferred pitch frequency and associated gender identity for their device? Does a device need a gender at all? Google asked itself similar questions early on in the development of its voice assistant. Initially, Google debated whether to develop a solely male- or female-sounding voice for its assistant, ultimately launching with a female voice in 2016, allegedly because it sounded more natural than its male counterpart, deemed warbly.[9] But by 2019, Google had made significant strides in distancing itself from gendered voices and its formerly default female persona by adding a second voice option in nine countries, randomizing the default selection, and naming its voice options after colors and celebrities.[10] The choice to move toward gender-neutral personas (with the exception of celebrity voice offerings such as John Legend) aligns with Google's other gender-neutral products, such as Gmail and Chrome. It's also a choice aligned with Merriam-Webster's recent addition of the singular nonbinary gender pronoun *they* to its dictionary, signaling a growing acceptance of nonbinary identity and a shift toward more inclusive language in the cultural lexicon.[11]

Like Alexa and Google Assistant, Siri began AI life exclusively female, with a name meaning "beautiful woman who leads you to victory."[12] Today, Apple's binary voice options for its digital assistant, Siri, can be male or female, depending upon the language selection; some languages offer only a male or female voice, others offer both, and certain languages offer dialects with accents.[13] As with Alexa, Google Assistant, and Siri, Microsoft's Cortana began female, named after the AI assistant of the *Halo* video game series, whose holographic avatar is a nude woman.[14] In a nod to the fans, both the video game character and Microsoft Cortana's original American English version are voiced by Jen Taylor.[15] Updates to Cortana, announced in November 2019, include the addition of a masculine voice option produced by a neutral text-to-speech model.[16] What remains to be seen is whether users will embrace a male persona after significant exposure to a female one—and a fan favorite, at that. Moreover, the emphasis on developing charming and specific details for Cortana's original persona is likely to have engendered considerable consumer attachment. In an account by James Vlahos in his 2019 book, *Talk to Me: How Voice Computing Will Transform the Way We Live, Work, and Think*, Cortana reportedly enjoys Zumba, and her favorite book is *A Wrinkle in Time* by Madeleine L'Engle.[17] What's not to love?

Here one wonders whether a male Cortana persona would have the same cleverly written favorites or if he would express tastes more evocative of a stereotypically masculine persona. Crafting the original Google Assistant and her initially female persona, lead personality designer James Giangola ensured Google's chosen voice actress knew the digital assistant's detailed backstory, divulged in *The Atlantic*: she's from Colorado, "the youngest daughter of a research librarian and a physics professor"; she's a Northwestern alumna with a BA in art history; she won $100,000 on *Jeopardy: Kids Edition* as a child; she is a former personal assistant to "a very popular late-night-TV satirical pundit"; and she radiates an upbeat geekiness characteristic of someone with a youthful enthusiasm for kayaking.[18] She'd certainly pair well with a highly educated, affluent professional from the United States—and, more likely still, with a heteronormative male from the dominant culture in the (presumably largely) American team that designed her. In short, she is composed of life experiences meaningful to and socially coveted by her creators.

Perhaps this all has an air of innocence and a bemusing charm that could lead one to conclude tech companies meant well in their first shots at birthing female digital assistants; perhaps they had no consciously ill intentions and merely wanted to instill

their products with distinctive personalities for the sake of positive business impact. Indeed, one could argue that these same companies are making adequate strides toward gender equality in response to unfolding public concerns, meeting their ethical obligations to the extent that they can do so without harming their brands in the eyes of key consumer segments.

UNESCO paints a more alarming picture. In a report on gendered AI for the EQUALS global partnership dedicated to encouraging gender equality, female digital assistants have severe societal ramifications:

> Constantly representing digital assistants as female gradually "hard-codes" a connection between a woman's voice and subservience. According to Calvin Lai, a Harvard University researcher who studies unconscious bias, the gender associations people adopt are contingent on the number of times people are exposed to them. As female digital assistants spread, the frequency and volume of associations between "woman" and "assistant" increase dramatically. According to Lai, the more that culture teaches people to equate women with assistants, the more real women will be seen as assistants—and penalized for not being assistant-like. This demonstrates that powerful technology can not only replicate gender inequalities, but also widen them.[19]

The problem of gendered AI is not limited to these social repercussions; equally troublesome, the digital divide is no longer defined by access inequality alone, but by a growing gender gap in digital skills.[20] This gap is both global and slyly inconspicuous. And it is a devastating root cause beneath the current and future paucity of women in technology roles. It's also a gap made all the more unsettling by the crucial moment in which we find ourselves, as transformative digital assistant technology is in a skyrocketing developmental phase while simultaneously influencing social norms around the globe in ways we do not yet fully grasp. With the potential for morally reprehensible consequences of gendered AI looming large, urgent work lies ahead.

Language, Accent, Ability, and Racial Bias

Beyond gendered AI, digital assistant technology also presents identifiable language and accent bias. In a 2018 article for *New York Magazine*, bilingual journalist Ximena N. Larkin described her dismay over trying to get her Google Assistant to play "Dura," a Daddy Yankee song, instead receiving songs from *Dora the Explorer*:

> The problem is, most times it can't understand me when I pronounce Spanish words in Spanish. This time, the virtual assistant apologizes for being unable to find songs from *Dora the Explorer*. I try again, saying the Spanish word with a heavy American accent. Instantly my Google Home begins streaming the song. It's frustrating because as someone who doesn't get the chance to practice my Spanish enough, I want the few times I do to be correct. I probably wouldn't have even noticed if it weren't for the ease in which my nonimmigrant husband, who grew up in the Midwest, uses voice commands with 99 percent accuracy. My stepdad, of similar descent, uses Siri to call me. In his phone, my name is shortened to "Ximy," the way someone might abbreviate Ryan to Ry. The correct Spanish pronunciation is "Him-E." The system only understands if he pronounces it "Zim-E."[21]

As Larkin highlighted, this failure of voice assistant tech to understand her Spanish pronunciation is more than a pain point—it's akin to an erasure of language, reinforcing the hegemony of English and representing a painful exclusion of those who speak more than one language or who can correctly pronounce non-English words. The voice assistant's lack of linguistic depth and agility in this regard is unsurprising, despite advances in bilingual speech recognition. The *Washington Post*'s Drew Harwell shared a similar anecdote from 2018:

> With a few words in her breezy West Coast accent, the lab technician in Vancouver gets Alexa to tell her the weather in Berlin (70 degrees), the world's most poisonous animal (a geography cone snail) and the square root of 128, which it offers to the ninth decimal place.
>
> But when Andrea Moncada, a college student and fellow Vancouver resident who was raised in Colombia, says the same in her light Spanish accent, Alexa offers only a virtual shrug. She asks it to add a few numbers, and Alexa says sorry. She tells Alexa to turn the music off; instead, the volume turns up.[22]

It's a scene satirized by Jordan Peele in his 2019 film, *Us*, when a yuppie white mom, Kitty, tries to get her smart speaker's voice assistant, Ophelia, to call the police during a home-invasion-turned-murder; flipping the script, Ophelia plays N.W.A.'s "Fuck tha Police" instead.[23] Peele's ironic horror comedy underscores the far more brutal reality that digital assistants are failing the most marginalized members of society, from people with regional drawls or lilting dialects to those with non-native accents or speech impairments. As data scientist Rachel Tatman noted, "These

systems are going to work best for white, highly educated, upper-middle-class Americans, probably from the West Coast, because that's the group that's had access to the technology from the very beginning."[24] With the exception of Kitty, Tatman's statement rings true. It's also reflective of the affluent, professional, highly educated product design teams likely behind the development of digital assistants—and consequently, it's bound to be a technology most responsive to its creators. In language-localization firm Globalme's study of seventy voice commands by accent group, Google Home performed best for those with Western or Midwestern US accents, Amazon's Echo performed best for those with Southern and Eastern US accents, and both devices fared poorly for those with Indian, Chinese, or Spanish language accents.[25] Equally problematic is the difficulty of being understood as a person with a speech disorder, a challenge observed in educational settings implementing smart speaker technology.[26] Harder still, try to be understood by a digital assistant as both a non-native English speaker *and* a person with a speech disorder. Hardest of all, try to locate an individual or group representative of these unique challenges within the composition of a digital assistant design team.

While the homogenization of English, deeply connected with social privilege, can be perpetuated in digital assistants, some companies have made efforts to offer optional dialects or accented speech for their products. From a business perspective, this offering aligns with the social desirability of hearing a voice one feels able to identify with; in a study described by Nass and Brave in *Wired for Speech*, participants socially identified with computerized voices whose accents or dialects they perceived as related to their own cultural backgrounds.[27] But while some consumers might take comfort in hearing a response they can identify with, culturally or linguistically, such options neglect the problem of voice assistant technology failing to understand accented user speech. In other words, the array of languages and dialects available from a device does not rectify the negative experience of isolation a device can intensify for non-native or accented users or those with a speech disorder, already enduring societal othering and discrimination by human counterparts.

Thus, voice assistant technology has ample opportunity for improvement and a long road ahead before it can become truly assistive for people with speech-oriented disabilities, those with linguistic agility, or those with some combination thereof. Moreover, companies are unlikely to grasp the significance of these shortcomings until members of their digital assistant development teams reflect the diverse consumers they have and hope to attract. A broad spectrum of diversity provides an effective antidote; the alternative to such representation can be summed up as "bias in, bias out."

In a world where inequalities run deep, deficits in AI risk deepening those inequalities, perpetuating bigotry, homophobia, xenophobia, and violence. Professor and codirector of the UCLA Center for Critical Internet Inquiry, Safiya Umoja Noble, penned a treatise on the topic, *Algorithms of Oppression: How Search Engines Reinforce Racism*.[28] From racist and misogynist misrepresentation of women and people of color in online spaces, to predictive policing and bias in housing, employment, and credit decisions, algorithms of oppression are as ubiquitous as the voice assistant technology they power. As Virginia Eubanks delineated in *Automating Inequality*, "Automated eligibility systems, ranking algorithms, and predictive risk models control which neighborhoods get policed, which families attain needed resources, who is short-listed for employment, and who is investigated for fraud."[29] Algorithms use data from the past to make predictions for the future, but "technology often gets used in service of other people's interests, not in the service of black people and our future," Noble explained.[30]

David Lankes of the University of South Carolina brought it back to the digital skills gap, pointing out, "Unless there is an increased effort to make true information literacy a part of basic education, there will be a class of people who can use algorithms and a class used by algorithms."[31] In this vein, Noble contended bias in AI may become this century's most pressing human rights issue, and a search engine's lack of neutrality is but one of many points she problematized:

> Google functions in the interests of its most influential paid advertisers or through an intersection of popular and commercial interests. Yet Google's users think of it as a public resource, generally free from commercial interest. Further complicating the ability to contextualize Google's results is the power of its social hegemony.[32]

Whether a device queries Google or another search engine, the commercial and proprietary nature of these products makes it virtually impossible for users to know what's truly powering their searches, let alone whether to trust the veracity of results.

Trust, Privacy, Security, and Intellectual Freedom

One avenue for disrupting AI bias and bolstering algorithmic literacy is to encourage experimentation with voice assistant technology in education settings. Yet in doing so, educators face immediate privacy concerns. In 2018, CNBC reported a rise in colleges and dorms implementing smart speaker technology, including Saint Louis University, Northeastern University, and Arizona State University.[33] How can colleges,

universities, and other education environments hedge against the risk of data exploitation and other privacy concerns surrounding student use of smart speakers?

The emergence of facial recognition software adds further cause for wariness. The Google Nest Hub Max uses this feature to recognize faces and hand gestures.[34] University of Albany professor Virginia Eubanks noted that such present-day realities connoting *1984* are likely to disproportionately target marginalized groups and not merely individuals at random, lest we forget that a "myopic focus on what's new leads us to miss the important ways that digital tools are embedded in old systems of power and privilege."[35] While privacy risks are broad, special considerations are warranted for education environments, communities of color, and other vulnerable populations including the elderly, whose devices can be monitored and used to conduct surreptitious welfare checks or engage in malicious phishing schemes.[36] While smart speakers can be seen as beneficial tools for caregivers, allowing for the unobtrusive observation of an aging parent or loved one with special needs, this manner of technology use can be an intrusion on an individual's right to privacy if implemented without their consent.

There are related legal implications for digital assistants and data privacy. While law enforcement of yesteryear might have sought an individual's library patron records, law enforcement today can requisite smart speaker recordings. In 2018, Alexa witnessed a double murder; Amazon was subsequently ordered by a New Hampshire judge to hand over an Echo device's recordings from the scene of the crime.[37] This may be a win from a public safety perspective—useful surveillance footage to support criminal justice efforts—but there are unsettling ramifications for privacy advocates and those who fear the potential social consequences of having personal data mined for legal evidence.

In that vein, data has surpassed oil as the world's most valuable commodity.[38] Facebook's role in data misuse set off scandals in both the US and the UK after Cambridge Analytica exploited private Facebook user data to design techniques for influencing voters in the Brexit campaign and the 2016 US presidential election.[39] *The Great Hack*, a documentary, highlights former Cambridge Analytica employees pivoting to consumer advocacy roles upholding data rights as human rights.[40]

It's a stance in alignment with the American Library Association's *Library Bill of Rights* interpretation on the subject of privacy and the freedom to read without the chilling effects of Big Brother monitoring your e-book list. The ALA statement on privacy, amended in 2019, "affirms that rights of privacy are necessary for intellectual freedom and are fundamental to the ethical practice of librarianship."[41] The details of this interpretation further elucidate and affirm the library's long-standing commitment to the principle of privacy.[42] What, then, are the responsibilities of libraries and education professionals serving as proponents of ethical voice assistant technology usage?

Best Practices and Policy Considerations

Consumer Reports offers a slew of tips for mitigating digital assistant privacy concerns, such as disabling microphones when not in use and periodically deleting recordings.[43] Digital assistant users can also choose to block incoming voice calls and disable voice purchases.[44] The American Civil Liberties Union outlined a number of additional recommendations for the tech sector and regulatory policymakers:

- **Legislate privacy protection** to govern corporate use of private data and create precise standards for government data access.
- **Standardize indicator lights** for transparently signaling when microphones are enabled, recording, or transmitting data.
- **Define and regulate retention periods** of transmissions, ideally limiting retention to whatever length of time is minimally necessary.[45]

The Future of Privacy Forum set forth additional manufacturer recommendations, such as equipping devices with a hard switch for manually disabling a device's microphone or camera and anonymizing text translations of audio recordings after a short retention period in order to protect consumer privacy without forfeiting opportunities for ongoing research and development.[46]

From a security standpoint, open source development has made it possible for anyone to create a voice assistant application for an organization, regardless of official affiliation with that institution. As a result, a developer can pose as a trusted institution or may abuse corporate approval processes to develop sanctioned applications maliciously designed as phishing schemes.[47] Even if an unaffiliated developer's skill is not malicious, they may create a skill or app that is not a reliable source of truth—problematic for libraries and educational institutions seen as trusted resources. Organizations may wish to get ahead of these possibilities; at a minimum, institutions can proactively monitor the digital assistant ecosystem for unaffiliated application developments and potential security risks. Moreover, organizations can create skills or applications officially associated with their institutions, developing accompanying privacy policies to help build awareness around information literacy, data rights, and informed consent to terms of use.

US educators considering privacy implications for classroom and higher education environments point to existing legislation such as the Children's Online Privacy and Protection Act (COPPA) and the Family Educational Rights and Privacy Act (FERPA). While the text of FERPA, authored in 1974, offers no specific guidance on AI technology yet, the US Department of Education has issued guidance on discerning when photos and videos can be considered student records.[48] This serves as a starting point for privacy considerations surrounding digital assistants in higher educational institutions. In terms of primary education environments, the US Federal Trade Commission has issued guidance pertaining to COPPA and audio voice recordings of children under thirteen, noting that educators need not obtain parental consent for students to use voice commands when performing a search or giving a verbal instruction to a digital assistant.[49] Despite this guidance, obtaining parental consent remains appropriate as best practice in K–12 education environments, and educational administrators should seek ongoing guidance to ensure the protection of student data privacy in the evolving AI ecosystem.[50]

Beyond privacy and security, educators and librarians alike must confront the reality of inequality perpetuated by bias in AI. In summing up the need for concerted efforts to interrupt and correct algorithmic bias, Virginia Eubanks noted, "It is mere fantasy to think that a statistical model or a ranking algorithm will magically upend culture, policies, and institutions built over centuries."[51] The bias of yesterday and today is inherent in the tools we've created for tomorrow. Hence, the role of all those who provide AI-related guidance or recommendations is to intervene where deep-seated inequalities would otherwise be perpetuated undisturbed.

One can begin with advocacy for implementation of an ambiguous voice pitch frequency to create gender-neutral assistants. Project Q blended voices representative of a broad gender identity spectrum, creating a nonbinary amalgamation it's hopeful tech companies will adopt for their digital assistants.[52] EqualAI, an initiative focused on stopping unconscious bias in AI development, is a proponent of such gender neutrality and a resource on confronting AI inequalities.[53] Another resource is the Information Ethics and Equity Institute, providing ethical data and education for the tech industry and the academic community.[54]

Despite the best efforts of initiatives such as these, the twenty-first century remains a decidedly unequal place both online and off. UNESCO's 2019 report, *I'd Blush if I Could*, was named for the flirtatious catch-me-if-you-can response Siri once gave to the comment, "Hey Siri, you're a slut."[55] A voice assistant with a female persona "holds no power of agency beyond what the commander asks of it," the report explained, responding "regardless of their tone or hostility."[56] Beyond reinforcing misogynist bias and gender stereotypes on female subservience, this paves the way for widening tolerance of impolite, sexist treatment.[57] The report drew a direct thread between gendered voice assistants and the severe lack of women in tech roles, also pointing to the alarming root issue of a vast and widening digital skills gender gap across the globe.[58]

While increased diversity in tech companies is one avenue to improve prospects for interrupting AI inequality, such an approach fails to address the underlying digital skills gender gap. That said, tech company values and commitment to their fair share of ownership of these shortcomings is just as crucial to ensuring present-day platforms do not amplify hate, subconsciously or otherwise. Funding and regulatory policy are critical, as Safiya Noble wrote: "Without public funding and adequate information policy that protects the rights to fair representation online, an escalation in the erosion of quality information to inform the public will continue"—especially including information accessed via voice assistants.[59]

The price of avoidance is incalculable; Facebook removed the Unite the Right event page just one day before the deadly Charlottesville rally in 2018, far too late to stop the chain of events leading to a neo-Nazi white supremacist fatally ramming his car into Heather Heyer and injuring dozens of her fellow counterprotesters.[60] It was the same year that racist trolls faked news reports of attacks by *Black Panther* moviegoers.[61] In the wake of the Parkland, Florida, shooting at Stoneman Douglas High School, Safiya Noble iterated for *TIME*, "Tech companies have been slow to respond to the way their platforms have been used to amplify hate . . . exposing users to violent and often racist disinformation."[62]

New precedents for corporate accountability should include a more aggressive approach to mining and eliminating disinformation before it costs lives, especially as consumers become increasingly accustomed to simplistic, out-of-context responses from digital assistant queries. In 2016, *Guardian* journalist Carole Cadwalladr characterized Google as the lens through which its users see the world, making reference to the hidden faces behind mysterious algorithms as "invisible armies of content moderators."[63] Information professionals who have a hand in search and discovery interfaces must problematize how these interfaces interact with digital assistants and surface answers to life's questions to the detriment or benefit of society. To play a proactive role in combating AI-perpetuated inequality and hatred, here are three guiding principles:

1. **Advocate** for platforms to uphold factual and socially just information.
2. **Require** digital literacy of one another.
3. **Pursue** critical digital media research in seeking

to understand a platform's past, present, and potential impact on society.

Hand-in-hand with these best practices, voice assistant designers can be urged to write new anti-discriminatory responses, improving upon Alexa's disengagement mode to pen the assertive defensiveness appropriate of real-life responses to sexual harassment and other discriminatory comments. Better yet, a handful of creative, diverse individuals (perhaps representing the balanced team composition tech sectors so often lack) could take to the internet for public support of newly composed lines, propelling socially just writing with social media momentum. New scripts can tackle other discriminatory challenges, from integrating people-first language in responses about people with disabilities to ensuring information about the Holocaust is not anti-Semitic.

Beyond flipping the script, relentless architects of a more ethical, just world will confront the vast spectrum of ways in which biased digital assistants deepen those disparities. As a starting place, UNESCO offered recommendations to prevent voice assistant technology from worsening gender inequality:

- **Fund studies** to examine, document, and build evidence—on bias presented by digital assistants to help reveal strategies to repair and prevent such bias, on assistants' behavioral influence upon individuals (youth, especially) in online and offline environments, and on the progress of gender composition in tech sector teams building voice assistants.
- **Create new rules and tools**—to stop digital assistants from defaulting to female voices, to develop an androgynous "machine" gender voice, to start public repositories of gender-sensitive speech taxonomies and associated code, to hone techniques to train AI in providing gender-neutral responses and strongly discouraging gender-based insults, and to require voice assistants to announce themselves as nonhuman.
- **Adopt gender-responsiveness** in digital skills development—by offering women and girls digital skills training, incentivizing recruitment and advancement of women in tech, establishing tech sector accountability for gender bias in products, and integrating gender analysis in tech product research and development.
- **Ensure oversight and incentives**—such as tying public funding to gender-balanced tech development teams and equal gender representation in products, promoting legislation to encourage interoperability for consumer ease of switching products, and establishing regulatory oversight to mitigate algorithmic bias and rights violations.[65]

This recommendation framework offers a model for interrupting AI bias in all arenas.

A final consideration includes an oft-overlooked group. Chris Bourg, director of libraries at MIT, has argued that "we would be wise to start thinking now about machines and algorithms as a new kind of patron," not as human replacements but as entities requiring new sets of rules and guidelines.[66] Parents, along these lines, are concerned with the lack of need to say "please" or "thank you" to digital assistants, conditioning rudeness in children.[67] Linguistic style matching in social interaction makes this a legitimate concern; parents could be raising a generation who perceives themselves as masters over their devices, not seeing the need for niceties simply because their AI interactions don't require them.[68] One best practice consideration is to force polite requests or include optional modes that respond only to standard pleasantries. According to UNESCO, Amazon's Echo Dot Kids Edition launched such an option in 2018, allowing parents to ensure the device does not respond to commands "unless they are attended with verbal civilities."[69] West, Klaut, and Chew illuminated the stakes:

> In what is known as the master–slave dialectic, G. W. F. Hegel argued that possession of a slave dehumanizes the slave master. While Hegel was writing in the early nineteenth century, his argument is regularly cited in debates about the treatment of digital assistants and other robots.[70]

In treating artificially intelligent devices with greater care and thoughtfulness, perhaps we can learn how to reciprocate that thoughtful care into AI design as we seek to shape the future of AI-driven digital assistants into embodying the best of humankind.

In all, modern-day information and education professionals are confronting gendered voice assistant personas, bias in misunderstood speech from those with accents or speech disorders, privacy and security concerns over data monitoring and misuse, and the ever-present reality of inherited inequalities informing algorithms and misinformation, all through sleek, submissive digital assistants with increasingly human-like voice delivery. These are not small challenges. Yet voice assistant technology is here to stay, and its future influence for better or for worse rests upon the shoulders of advocates, educators, librarians, information professionals, and technologists. We are collectively more creative and intelligent; together we can collaborate to create meaningful change to disrupt bias and inequality while safeguarding against privacy and security concerns toward a more ethical, transparent, and inclusive AI ecosystem for generations to come.

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Chapter 4

Future Actions

Win Shih

Search is moving from a place of answers to a state of action.

—Microsoft Voice Report[1]

The AI-driven voice technology is described as a major disruptive technology trend.[2] In this chapter, we first review the future trends of voice technology and conversation AI. We then offer guidance and suggestions for preparing such changes at the organizational and leadership level.

Looking Forward

After a decade of development, conversational AI and voice technology have progressed beyond the early infancy stage and moved into a phase of mass adoption. According to Gartner's Hype Cycle, which charts the maturity, adoption, and business applications and values of emerging technologies and innovations, voice assistant technology has now surpassed the initial proof-of-concept and marketing hype stages and entered into a zone that demands further realization of its value and fulfillment of expectations. Gartner has also upgraded voice assistant technology's maturity level from emerging to adolescent and predicted that it will reach the mainstream adoption stage in a two-to-five-year time scale.[3] In another analysis, both Microsoft and Voicebot.ai reported that voice assistant technology and conversational AI have crossed the chasm of the early adopters phase and entered the early majority of users stage in E. M. Rogers's Diffusion of Innovation theory.[4] We anticipate that AI-powered voice technology will gain more traction and move closer to a central and powerful position in our evolving digital transformation. Meanwhile, end users will accelerate the adjustment to a lifestyle—as well as the formation of an even-closer personal partnership—with voice assistants. It is imperative for organizations to shift their worldview of working and serving their customers in this transformation, identifying a new service model centered on these new technologies.

Platform Shift

Our relationship with computers and technology has been evolving over time. Based on the way we interact with technology, Kinsella identified three technology platform and user interface shifts since the advent of the World Wide Web more than twenty-five years ago (see table 4.1).[5] Websites and hyperlinks are the first generation of technology platforms and user interfaces that we use to interact with digital content and services. The introduction of mobile devices and apps in the late 2000s expanded the apparatus for us to engage with the digital world. Conversational AI and voice technology elevate us to a new experiential level of human-computer interaction. Although we are still in the midst of voice-based platforms, Deloitte Consulting has already predicted that intelligent interfaces will be the next breakthrough of human experience platforms. Integrating a class of AI-powered solutions, such as affective computing, computer vision, sentiment analysis, and voice stress analysis, the intelligent interface interacts with humans through gestures, gazes, head movements, and voices; detects their physical states, emotional conditions, and moods through sensors; and responds to their needs in the appropriate context.[6] Deloitte expects that we will see more progress in and growing application of affective computing in the next eighteen to twenty-four months.

Throughout the process, each platform shift introduces advanced technologies that enhance the old methods, create innovative ways of conducting business, and generate values and efficiencies. Throughout the transition, it is common to see established companies dislodged by start-ups, traditional business

Table 4.1
Platform and UI shifts

Platform & UI	Time	Technologies	Devices	Open Standards	Key Market Players
Web & links	Mid-1990s	Internet, web browser	PC	HTML, HTTP	AOL, Microsoft, Netscape, Yahoo
Mobile apps & touch/swipe/pinch	2008	Wi-Fi, iOS/Android, cloud computing	Mobile devices	Wi-Fi, Android	Facebook, Instagram, LINE, Twitter, WhatsApp, YouTube, Uber, Lyft, Yelp
Voice assistants & conversational UI	2011	AI, natural language processing	Mobile devices, smart speakers	Standardizing natural language process and AI technologies	Amazon, Apple, Google, Microsoft
Intelligent interfaces/ affective computing	Near future	Auditory analytics, augmented/virtual reality, cloud and edge computing, computer vision, Internet of Things, 5G network	Wearable devices, gesture control devices, smart headsets, AR goggles, sensors	N/A	Up for grabs

models displaced by new paradigms, and consumer behavior transformed. The platform shift from web to mobile apps created new entrants and a new segment of business. Lyft and Uber (ride hailing), Facebook and Instagram (social networking), and Yelp (local business reviews) are prominent examples.

At this early stage of the voice platform shift, the business model is still hazy and the technology standards have yet to be settled. For major tech companies that dominate the web and mobile app platforms, the stakes are high and the competition is fierce. Top players have invested billions of dollars in voice assistants and smart speakers to ensure they continue to dominate their existing market position and maintain competitive advantages with the new voice technology. Amazon and Google are reported to sell their devices below the cost of producing them in order to gain market share.[7] Amazon reported having a team of 10,000 employees working on Alexa alone.[8] At Amazon's job site, there are currently over 2,700 Alexa-related open positions, ranging from software development (1,304 vacant positions) to marketing and PR (77 positions).[9] In 2017, Microsoft's AI division had 8,000 employees before its reorganization.[10] Google draws employees from related departments to support Google Assistant instead of concentrating positions in one department or product team.[11]

Which Voice Technology?

In the current conversational AI landscape, voice assistant applications are not compatible. You cannot summon Alexa on a Google Home device or Google Assistant on an Amazon device. With limited resources, organizations can afford to commit to only one proprietary technology. Selecting the appropriate voice platform that fits the organization's unique business situation and customer needs is a strategic decision. Although all the core players in voice assistant technology overlap in providing basic functionalities, each individual option has its own strengths and specializations. For example, Amazon dominates in the areas of online shopping and control of smart home devices while Google has a stronghold in the content and search arena. To differentiate, Microsoft devises a two-dimensional matrix that maps four key players based on two criteria:

1. Ability to access and control IoT and home management devices (vertical axis)
2. Ability of fulfilling purchasing request (horizontal axis)[12]

The four quadrants generated within this two-dimensional grid represent key mastery of voice assistant performance. These four areas are

1. **Knowledge:** the ability to answer questions
2. **Utility:** the ability to access and control IoT devices
3. **Commerce:** the ability to make purchases with voice commands
4. **Productivity:** the ability to integrate into work solutions

Figure 4.1 provides a visualization of how the four voice assistants fit across this functional spectrum based on these two factors. Amazon Alexa is strong in both the utility and commerce masteries. Google

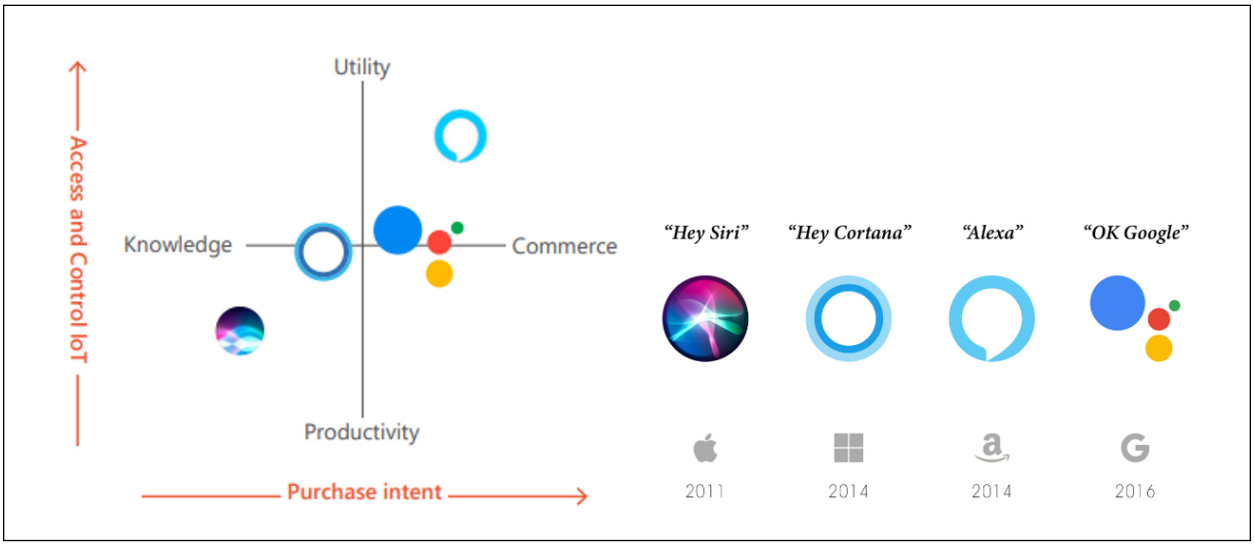

Figure 4.1
Functional spectrum (Source: Christi Olson and Kelli Kemery, *Voice Report: From Answers to Actions: Customer Adoption of Voice Technology and Digital Assistants* [Redmond, WA: Microsoft, 2019), 28, https://about.ads.microsoft.com/en-us/insights/2019-voice-report.)

Assistant and Microsoft Cortana are positioned close to the center of the grid, an indication that they are both doing equally well in these four areas. Apple's Siri plays well in both knowledge and productivity masteries.

According to Microsoft, an ideal voice assistant should perform equally well in all four areas and land itself close to the center of this diagram.[13] This framework provides a tool for us to see the relative positions of key market players within the four functional areas. The visual snapshot further allows us to assess how these competing technology providers are executing their stated visions and how well their product performs against the two key factors.

Evolving Voice Assistants

As AI-powered voice technologies advance and use cases expand, we are likely to see the following developments in the next few years:

- **Ubiquitous:** Voice assistants will be omnipresent as they continue to proliferate and penetrate our daily life. As one example, Amazon has been embedding Alexa into more appliances, such as the Ring Video Doorbell Elite that allows visitors to chat with Alexa. Amazon also introduced several wearable Alexa gadgets, including glasses (Echo Frame), wireless earbuds (Echo Buds), and black ring (Echo Loop) that allow users to interact with Alexa around the clock.[14]
- **Available across devices:** Voice assistants will not be affixed to one specific device or platform as they rapidly expand to other appliances, IoTs, and voice access points such as in-car voice assistants, smart watches, and smart home devices. Devices will eventually assume a secondary role.[15] In another effort to make voice assistants less dependent on devices, Amazon and more than thirty companies signed the Voice Interoperability Initiative in September 2019 to make voice assistants available on voice-activated devices from different vendors. However, Apple and Google are still yet to sign onto this agreement.[16]
- **Multisensory:** With new technologies, such as affective computing, voice assistants will be able to facilitate our engagement with the digital world through a broad range of human senses: visual, aural, kinesthetic, and tactile. According to Garner, in the future, digital assistants will sense users' intent from voice, gesture, and touch and thus provide a richer experience for conveying nuanced contextual information.[17] Voice technology will further combine with other technologies, such as virtual reality, augmented reality, and mixed reality, to provide an immersive user experience.
- **Comprehensive:** Voice assistants will offer "universal discovery" services that bridge our physical and virtual worlds. In the so-called digital twin, a virtual copy of physical assets will be connected with the physical world. You will be able to access locally decentralized data as well as data stored centrally in the cloud.

- **Proactive:** Voice assistants will grow smart enough to anticipate our needs in advance. For example, VAs will reorder supplies when they are running low, automate routine tasks such as turning on or off the alarm or heater, and schedule appointments before being asked to do so.
- **Stronger AI:** Conversational AI is becoming a "people-literate technology" capable of detecting our needs and intents based on our past behavior.[18] Instead of expecting users to follow predefined commands or sequences, conversational AI will be able to learn from historical interactions and adapt to our individual needs based on the context and nuance, shifting the cognitive load from users to AI.
- **Voice search diverging from web search:** Voice search is growing exponentially. It is said that half of all online searches will be spoken by 2020.[19] Eventually, search will move from question-and-answer responses to query-and-action facilitation.[20] In other words, we will use voice search to perform tasks, make decisions, and take actions instead of merely as a tool for obtaining answers. In daily life, voice search will help us get directions, renew library checkouts, and make reservations or purchases.

Preparing for the Change

As organizations enter the voice computing era, forward-thinking leaders and decision makers should grow the capacity of organizations and their employees with the following preparatory actions:

- **Educate** themselves on this emerging technology, assess its possible applications within the context of their organization, and define their AI strategies.
- **Create** a conducive environment, fostering an organizational culture that supports learning and experimentation.
- **Provide** financial support and a safety net that tolerates taking calculated risks. Further, acknowledge that mistakes or failures are part of the learning process in acquiring new knowledge, insights, and skills from new technology implementation. Reward individuals who are willing to operate outside the comfort zone.
- **Establish** a research and development framework and agenda and provide adequate resources, including funding and staff time, for such endeavors.
- **Offer** training and education for employees to learn and test the technology.
- **Grow** expertise from within. Take advantage of the free resources and rich learning network available from tech companies. Below are the resources available from major players:
  - **Alexa Skills Kit:** the software development kit for developers to learn and build voice-driven applications, called skills, based on Amazon's voice technologies
  - **SiriKit:** Apple's version of a toolkit for developers to integrate their iOS- or WatchOS- based application with Siri
  - **Conversational Actions on Google:** the development platform where developers can build applications, called actions, for Google Assistant using the Google Cloud Platform

Alexa Skills Kit
https://developer.amazon.com/en-US/alexa/alexa-skills-kit

SiriKit
https://developer.apple.com/siri/

Actions on Google
https://developers.google.com/assistant/conversational

Meanwhile, organizations may want to form a working group or interest group with members from relevant functional units to assess the potential adoption of voice technology. Possible assignments and activities of the group may include the following:

- **Conduct** a needs assessment, SWOT analysis, and environmental scan and make recommendations based on the outcomes of the research and study.
- **Identify** promising use cases. Answer key questions such as these: What experiences do we want our patrons and employees to have with this technology? What organizational values do these experiences convey? How will this service powered by voice technology shape our overall user experience?
- **Assess** the potential resource needs, including cost, staffing, and time.
- If the outcomes are positive, **formulate** possible projects that align with the organization's mission and strategic plan.
- **Pilot** a voice technology project on a small scale.
- **Explore** the possibility of collaborating with like-minded units within the organization; form partnerships to share the cost, expertise, and risk while supporting a common patron base and organizational goals.
- **Seek out** local expertise and learn about their projects; explore the possibility of collaboration.

Table 4.2
Needs assessment plan for implementing Amazon Alexa at a large academic library

Stakeholders (who will use this service)	What will be learned	How to collect data	Info to be gathered
Undergraduate students	Assess undergraduate students' interests in using Alexa to learn about library collections and services.	Focus group	Do they have an Alexa device? Have they used an Alexa device? What do they use Alexa for? What information might they want from a library or university Alexa application?
Graduate students	Assess graduate students' interests in using Alexa to learn about library collections and services.	Focus group	Do they have an Alexa device? Have they used an Alexa device? What do they use Alexa for? What information might they want from a library or university Alexa application?
Faculty and staff	Gauge the interest of faculty and staff in using Alexa to learn about library collections and services.	Surveys	Do they have an Alexa device? Have they used an Alexa device? What do they use Alexa for? What information might they want from a library or university Alexa application?
Alumni and visitors	Survey alumni and visitors' interests in using Alexa to learn about library collections and services.	In-person interview	Do they have an Alexa device? Have they used an Alexa device? Will they use Alexa to look up library or university information?

- **Lead** and guide an organizational discussion about how to leverage AI and voice technology for business value.

Needs assessment and SWOT analysis are two useful exercises for organizations to investigate the appropriateness of adopting voice technology before committing resources. Both strategies also offer an excellent opportunity for an organization to learn about the technology itself as well as user needs.

Needs Assessment

Libraries interested in exploring voice technology and its possible applications should conduct a needs assessment exercise to gauge the interest and desire of their key stakeholder groups. Needs assessment is a systematic process that relies upon data collection and collaboration to identify the gaps between the current (what is) and the desired state (what should be).[21] Through interviews, focus group studies, surveys, and observations, libraries collect data from the user community on a specific issue or area of need. By analyzing such data, libraries can make informed decisions, prioritize needs, and take appropriate action. Needs assessment can help organizations to identify and solve existing problems, determine future opportunities and needs, improve performance and services, develop strategic goals and priorities, and align resources with strategy.[22] In practice, needs assessment has been used to improve library services to patrons, to assess library training needs, and to reevaluate library space usage.[23] Table 4.2 provides an example of a needs assessment data collection plan on implementing Alexa at a large research university.

SWOT Analysis

Another way to assess timing of implementing a new technology before pouring resources into it is to conduct a strengths, weaknesses, opportunities, and threats (SWOT) analysis. When considering a new technology, service offering, or strategic direction, libraries can employ SWOT analysis and conduct an environmental scan to facilitate the decision-making process. SWOT analysis maps an organization's *internal* strengths and weaknesses, as well as the *external* environment's opportunities and threats related to the organization's initiative. Through SWOT analysis, organizations can identify their favorable and unfavorable internal factors (strengths and weaknesses) and external factors (opportunities and threats) that might affect the success and performance of the initiative. The findings allow organizations to strategically chart their direction more effectively.[24] Armed with a better understanding, organizations can leverage their strengths to realize new opportunities while avoiding or minimizing any potential negative impact and remediating or overcoming potential threats.

SWOT analysis has been widely employed by libraries to assess programs and new initiatives,

Table 4.3
SWOT analysis of implementing Alexa at a large academic library

	Strengths	Weaknesses
Internal to Library	S1: Dedicated employees; willing to learn new technology; innovative and creative S2: Alignment with library's strategic goals S3: Adequate IT infrastructure S4: Competent IT professionals S5: Administrative support	W1: Resources/sustainability—funding, staffing W2: Competing priorities W3: Data policy—lack of campus-wide data policies W4: Learning curve W5: Concerns/resistance from some employees
	Opportunities	**Threats**
External to Library	O1: Strategic/symbolic value—forward-thinking and innovative, meeting organization's mission, strategic goals O2: Alternative channel for accessing resources O3: Accessibility—hands-free, adaptive technology, potential for challenged patrons O4: Productivity—automate tasks, cover FAQs O5: Collaboration—with other campus units, external partners (vendors, other libraries)	T1: Privacy concern—privacy and surveillance issues and other nefarious practices with voice technology T2: Security concern—hacking, liability, data breaches T3: Proprietary technology—no open standards yet T4: Sustainability—competition from Apple, Google, Microsoft T5: Questionable content, algorithmic bias, lack of transparency

including adoption of social media to promote library services, library instruction, and holograms in cultural institutions.[25] Table 4.3 presents a sample SWOT analysis on implementing Alexa at a large academic library.

Data Governance

Because voice technology can amass enormous volumes of personal data, it creates a higher potential and risk for fraud, identity theft, and hacking. Organizations should pay particular attention to fortifying the security measures of their IT infrastructure while ensuring a thorough and updated data governance policy and data management practices are in place. To earn trust from patrons, leaders and decision makers need to do the following:

- **Be aware of**, and be able to mitigate, multiple layers of concerns and risks from ethical, privacy, security, and regulatory aspects[26]
- **Establish** governance for AI-related technologies and ethical and privacy guidelines
- **Formulate** and set up data governance rules and policies
- **Enforce** appropriate data curation and use practice
- **Communicate** about and discuss openly issues and concerns with patrons and employees
- **Be informed** about technology-based bias, data and algorithmic bias, and lack of transparency of proprietary technology and content
- **Develop** an overarching set of values and principles of technology use to earn trust[27]
- **Ensure** employees' understanding of such policies and values through training and education

Conclusion

Applications of AI-fueled innovations are proliferating in all business sectors, including education. Forward-thinking and tech-savvy information professionals should seek opportunities to explore AI and voice technologies and identify possible and promising voice applications to enhance services, augment productivity, and innovate operations and services. Organizations also need to develop policies, practices, security measures, data governance models, and data risk management programs to mitigate privacy, security, and ethics concerns.

Our relationship with computers and technology will continue to evolve in the near future. Voice assistants are becoming more adept and attuned to our needs and are more intertwined with our personal lives. They will know a whole lot more about us and anticipate our needs in the years to come, increasingly assuming the intermediary role for quick and one-shot answers and even making choices for us in anticipation of our preferences. To remain a source of authenticated and valuable information, libraries, information organizations, and information professionals should rethink their role and relationship with patrons in the voice-based information landscape.

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