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AI and Creating the First Multidisciplinary AI Lab

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Chapter 3

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Artificial intelligence (AI) has recently surfaced as a technology trend that is both highly innovative and disruptive. AI is a discipline that aims to create a machine that is as intelligent as a human. The idea of AI dates back to Alan Turing's classical 1950 paper titled "Computing Machinery and Intelligence."[1] The term *artificial intelligence* was coined as the topic of the Dartmouth Conference in 1956 by John McCarthy, Professor Emeritus of Computer Science at Stanford University.[2]

For a long time, the dominant paradigm in AI research was "symbolic AI."[3] Symbolic AI is an attempt to develop human-level AI by representing human knowledge based upon logic and a set of rules. An expert system is a good example for illustrating this symbolic AI approach, as it is a computer program that mimics a human expert's decision-making process. It follows explicit rules and instructions in the program that were fully understood and articulated by humans in advance. In the early 1970s, AI scientists built expert systems, such as MYCIN and DENDRAL, which performed medical diagnosis based upon the rules that model doctors' expertise in infectious diseases and conducted spectral analysis of molecules, respectively.

However, the approach that enabled the recent breakthroughs in AI is not symbolic AI. It is machine learning. Machine learning belongs to the nonsymbolic AI paradigm. While symbolic AI directly embeds rules and logic into an AI application, machine learning relies on a large amount of data and statistics to develop an AI application that acts intelligently. In this respect, machine learning is similar to data mining, the process of exploring large data sets to discover patterns and correlations. Machine learning, however, focuses more on prediction than discovery as a subfield of AI. The greatest difference between symbolic AI and machine learning is that machine learning allows an AI program to learn, that is, learn from data to generate and refine rules. By contrast, a symbolic AI program simply applies a set of rules crafted by programmers. It cannot generate or adapt the rules on its own.

Machine learning produced AI programs whose performance is close to or even surpasses that of humans. For example, AlphaGo, an AI program created by DeepMind, surprised many by winning four out of five Go matches with the eighteen-time world champion Sedol Lee in 2016.[4] Given the enormous complexity of Go, this victory of a machine against a human is an astonishing achievement.

The machine learning technique used to develop AlphaGo is called "deep learning." Deep learning utilizes an artificial neural network with multiple hidden layers between the input layer and the output layer in order to refine and produce the learning algorithm that best represents the result in the output. Once such an algorithm is produced from the data in the training set, it can be applied to a new set of data. Deep learning generated impressive results in many fields, such as computer vision, facial and speech recognition, natural language processing, machine translation, and customized recommendations.

Raw computing power and large data sets are key

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to the success of a deep learning application. The distributed version of AlphaGo that beat Sedol Lee ran on 1,202 CPUs and 176 GPUs.[5] A GPU (graphics processing unit) accelerates the training process of an artificial neural network by providing additional processing power suited for matrix computations.

Why Does Artificial Intelligence Matter?

AI is already being used in many products and services. Google Pixel Buds, released in 2017, provides real-time translation using the power of AI, and so does Google Translate. The face recognition feature in Facebook photo upload also relies on AI. In 2018, Google demoed Duplex, a new capability of Google Assistant, which placed a call to a restaurant and successfully made a reservation by carrying on a conversation with a restaurant staff member.[6] Self-driving technology is another front in which AI is making headway. Autonomous vehicles are already being tested on public roads in several countries on a large scale.[7] Both technology companies and traditional automobile manufacturers, such as Apple, Google, Tesla, Uber, General Motors, Mercedes-Benz, and Ford, are heavily investing in AI-driven self-driving technology.[8] Medical researchers are applying AI to MRI (magnetic resonance imaging) to make the process faster and less cumbersome.[9] New York University School of Medicine started a partnership with Facebook and the Facebook Artificial Intelligence Research group (FAIR) to drastically reduce the time required for MRI image reconstruction by using AI-based image tools.[10]

But the real significance of AI lies more in its far-reaching impact on our society than in its technological feats. One goal of AI is to automate human tasks. But until recently, not many people thought that machines would be able to perform tasks as complex as translation or driving. Now, however, more and more people are beginning to see the possibility of machines playing a larger role in our lives. With this, more questions arise. What would happen when AI can fully automate translation, driving, and even more complex tasks? If an intelligent machine makes a mistake, how will we be able to detect and correct the issue? Can we delegate important decision-making to an intelligent machine? How can we ensure that the algorithm that runs an intelligent machine does not replicate or magnify existing social biases and prejudices?[11] If intelligent machines drastically reduce the need for human labor, what would that mean to us and our society? Will machines eventually be able to do everything humans do? If that happens, does that mean that machines are as intelligent as humans? How should we interact with such intelligent machines and programs? Who or what will be held accountable when an intelligent machine causes injury or damage? It is clear from all these questions that AI is a trend that will affect our lives in a number of areas from economy to law at both the individual and the societal level.

One may think that these questions are premature. But AI applications are advancing at a rapid pace. For example, AlphaGo was defeated by another AI program, AlphaGo Zero, only a year later in 2017. AlphaGo Zero was developed using a machine learning technique called "reinforcement learning" and defeated the original Alpha Go program by 100 games to none. Unlike AlphaGo, which learned from over 100,000 games played by human Go experts, AlphaGo Zero learned by playing millions of Go games against itself.[12]

AI will also transform many areas of the library services and operation.[13] (1) We can easily imagine the AI-powered digital assistant mediating a library user's information search, discovery, and retrieval process,[14] directly interacting with library systems and applications. (2) Many tasks in cataloging, abstracting, and indexing that are currently performed by skilled professionals may be automated by AI applications as they become more sophisticated. (3) A chatbot may take up part of the library's reference or readers' advisory service.[15] (4) AI applications may be used to extract key information from a large number of documents or even information-rich visual materials such as maps and generate a summary to facilitate research.[16] Libraries will need to keep a close eye on the developments in AI and carefully follow how it may affect the way people's information-seeking, learning, and teaching activities, as well as the library's traditional services and operation, are currently conducted.

AI Lab at the University of Rhode Island

Background

With the rise of big data and data analytics, and the rapid advancement in AI, the demand for data scientists, software developers, and statisticians has been quickly growing. In response, more and more colleges and universities have started new degree or certificate programs in data science in recent years.

Libraries, particularly college and university libraries, will no doubt be asked to support these new programs. For this reason, academic libraries will need to develop services and programs that facilitate educational activities and skill building in areas of data science and AI.

University of Rhode Island (URI) launched the Big Data Collaborative in 2016, which identified over fifty

scholars across the URI campuses whose research activities share the common characteristics of collecting, analyzing, and interpreting large amounts of data. The goal of the Big Data Collaborative is to generate synergy among Big Data researchers and to position URI at the forefront of data-intensive discovery.[17] In 2017, URI acquired DataSpark, a nonprofit organization specializing in data analytics, which is now housed at the URI Libraries.[18] URI also started a new bachelor's degree program in data science in 2018 to respond to students' increasing interests in and desire for data science education.

Unique Vision and Mission

The new AI Lab at URI was designed to support these initiatives and programs. It was also inspired by the results of a freshman survey.[19] The survey asked the URI freshmen what topics they wished to see in the college curriculum. A large number of first-year URI students mentioned AI as the topic of their interests. Invigorated by this survey result, several faculty members at the URI Libraries; Department of Electrical, Computer, and Biomedical Engineering; Department of Computer Science and Statistics, which includes Big Data Initiative and Data Science Programs; and Department of Philosophy wrote and submitted a joint grant proposal proposing to create an AI Lab. In the fall of 2017, the Champlin Foundation awarded approximately $143,000 for the AI Lab to be located at the URI Libraries. Additional funding was also provided by participating colleges and the URI Provost's Office. The AI Lab opened in the fall of 2018.

AI Lab at URI
https://web.uri.edu/ai

Traditionally, AI labs were created as facilities for AI researchers who are interested in purely the technical aspect of the new technology. Access to those labs was restricted, and they were not designed to facilitate interdisciplinary discussion or raise awareness about the social impact of the technology. By contrast, the AI Lab at URI focuses on facilitating student learning on AI and places a strong emphasis on a multidisciplinary collaborative approach to foster interdisciplinary thinking. It considers (1) educating students and faculty about AI's rapidly developing capabilities, (2) facilitating interdisciplinary collaboration in AI research, and (3) promoting active discussion about AI's social implications as its core mission. For this, the library is an excellent central location that functions as the important hub of all intellectual activities on campus. The library serves all disciplines, is open to everyone, and is frequented by students and faculty all year round. It is the logical place for anyone seeking to learn about new technology trends such as AI to come and expect to find other like-minded people. The AI Lab at URI is the first in the nation to be located in a library and a pioneer in its unique vision and mission not found in traditional AI labs.

Student Learning

The AI Lab at URI is designed to be closely integrated with the existing URI courses in many different disciplines ranging from oceanography to philosophy. For example, students in ELE 491/591: Wearable Internet of Things will apply deep learning algorithms to enhance designed wearables that collect data on health. The course BME 468/ELE 568: Neural Engineering will utilize the AI Lab's processing power to gain a deeper understanding of using brain electrical activity to control robots and other technology. The course PHL 103: Philosophy will engage students in discussions related to relationships between human and machine. Other courses that will benefit from the AI Lab include computer vision, oceanographic data systems, Bayesian statistics, and philosophy of science. Furthermore, the AI Lab is expected to serve as a generator of new courses exploring AI from fields outside of computing, engineering, and mathematics.

In student learning, the AI lab will encourage a hands-on approach through self-directed learning and peer-to-peer learning among students. Those who will be using the AI lab as part of a course will have the course instructor as their primary guide. In addition, an educational and computational consultant who has a strong computer science background and is familiar with machine learning will create a training curriculum, tutorials, and instructional materials and provide consultation at the AI Lab.

Educational Outreach

Educating people and raising awareness about rapid advancement in AI is an important mission of the AI Lab at URI. Many events are to be hosted to identify and bring together faculty, staff, and the greater community with an active interest in AI from diverse vantage points. Even before the opening, the AI Lab planning team had already organized a few events. The first AI meet-up group in Rhode Island was formed and met in February 2018. At this meet-up, people from various fields had an opportunity to learn about developments in AI and share ideas about how the AI Lab at URI may become a useful resource not only for URI students and faculty but also for those outside of URI. In April 2018, a panel discussion program, "People of Color in AI: A Discussion on Ethical Implications and Impacts," was held at the URI Libraries.

With Karim Boughida, the dean of URI Libraries, as the moderator, two invited speakers, Timnit Gebru, the cofounder of Black in AI, and Ahmed Bouzid, cofounder and CEO at Witlingo, explored the topic of algorithmic biases and the representation of minority groups in AI.[20]

In addition to this type of discussion meetings and talks, the AI Lab team is also considering an AI hackathon open to students from URI and beyond. The AI Lab will also offer opportunities to integrate AI-focused learning experience into existing K–12 initiatives, such as SMILE (Science and Math Investigative Learning Experience), a precollege STEM (science, technology, engineering, and math)–based afterschool program that includes fourth though twelfth grade students across Rhode Island, and the Rhode Island STE(A)M Center, the state's primary education hub that promotes K–12 STEAM literacy.[21] URI has strong outreach initiatives and programs that engage local students, and the AI Lab will be a great addition to those existing efforts.

Planning, Space, and Equipment

During the planning phase, the AI Lab team made conscious efforts to engage the URI community in thinking about the topic of AI. In addition to the two aforementioned events, the AI Lab team also held a brainstorming session to solicit suggestions and feedback. In this brainstorming session, participants rotated through four different tables, discussing their ideas about the upcoming AI Lab's potential offerings and activities. Each of the four tables was given one of these four topics: events, instruction and courses, technology equipment, and AI ethics. Many great ideas were shared and collected from the brainstorming session, and they will inform and shape future AI lab offerings. For promotion, news about the upcoming AI Lab was widely disseminated through a variety of communication channels on campus and beyond.[22] AI was also one of the discussion topics at the URI annual faculty retreat, where the faculty members were encouraged to visit and utilize the soon-to-open AI Lab for their courses and research.

The AI Lab has three learning zones: one area for individual learning with AI workstations, another called "the hands-on projects bench," and the third named "the AI Hub" for collaborative thinking. Different learning zones allow both self-directed and team learning and accommodate various skills levels and interests. To keep the space flexible, all furniture items are easily moveable. The AI Lab also has separate meeting room space, which makes it easy for people to have impromptu discussions away from the AI workstations. Some of the projects that would be pursued in the AI Lab are (1) programming deep learning robots fitted with cameras, radars, sensors, and actuators, (2) building AI algorithms for those robots to navigate known and unknown environments, and (3) accessing and analyzing a variety of big data sets.

In purchasing equipment, we looked for computing equipment specially optimized for machine learning and deep learning tasks. The AI Lab will provide access to Nvidia DGX-1 for the use of students and faculty. Nvidia DGX-1 is a high-performance GPU server.[23] A GPU server is useful in developing deep learning applications.[24] URI students and faculty will be able to use this server from the lab to develop and run deep learning AI applications that require much computing power. For AI workstations, we selected Lambda TensorBook. TensorBooks have popular AI development frameworks, such as TensorFlow, Keras, PyTorch, Caffe, and Theano, already installed.[25] In addition, Nvidia Jetson TX2 Development Kit, Amazon Echo, Google Home Mini, and several robots will be available for the AI Lab users. These items will be used to further facilitate learning and development activities by URI students and faculty. In selecting our computing equipment, our greatest consideration was to pick turnkey solutions if available due to the shortage of IT staff and expertise.

Looking Ahead

The AI Lab at URI is unique in that it is a student-learning-oriented multidisciplinary AI Lab located in a library setting. As the first of its kind, it has no example to follow. For this reason, its programs and activities will be developed and evolve over time through continuous brainstorming and experimentation.

What makes a learning space successful is not its technology but people.[26] Building a strong community of creative people around new space, however, takes time. Only when the library and the campus community have patience and perseverance to continuously support and invest in it will the AI Lab be fully adopted by students and faculty. In return, the library and the campus community will get to discover and benefit from many unanticipated but thrilling outputs from students and faculty, who will make use of the AI Lab for their own fascinating purposes.

Embedded in many courses, the AI Lab plans to be a well-known resource among URI students. As a generator for new courses, the AI Lab aims to be a source of new ideas and inspiration for URI faculty in all disciplines. A variety of educational programs and events will be organized to further encourage more faculty and students to visit and utilize the AI Lab, explore the new technology, and deepen their understanding about how this new technology will affect us, society, and the world.

Notes

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14. Currently, Yewno (https://www.yewno.com/), Quartolio (https://quartolio.com/), and Iris.ai (https://iris.ai/) are some of the AI-powered products for information discovery and retrieval in the market.
15. University of Oklahoma Libraries are building an Alexa application that will provide some basic reference service to their students.
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