

Perceptions and Prospects of Artificial Intelligence Technologies for Academic Libraries: An Overview of Global Trends

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Abstract

Artificial Intelligence (AI) is seen as an extension of human intelligence and has taken over various sectors. Application of Artificial Intelligence in libraries has been providing a breakthrough for the information sector. Technological advancements can stimulate many human capabilities such as calculating, reading, speaking, grasping, remembering, making judgments and interactive learning. The adoption of artificial intelligence in virtual reference services is considered to provide a new online service model for libraries. Librarians are always on the cutting edge of technologies to engage and enhance services for their users, some of the valid additions include virtual realities that engages users with libraries and enhance information literacy skills.

This paper attempts to trace the application and potential impact of artificial intelligence in academic libraries. The application of artificial intelligence under four domains like educational, informative, assistive and social networking have been captured and explained along with their implications. Conversational agents such as chatbots, AI-based participatory library services, research impact, and information discovery, virtual reality have been described

Keywords: Academic Library, Artificial Intelligence, Expert System, Natural Language Processing

1. Introduction

The twenty-first century is a field of rapid transformation and technological advancements, organizations must adapt to evolving technologies to meet consumer demands. The use of Artificial Intelligence in libraries can be seen as a collection of technologies enabling machines to sense, comprehend, act and learn and can perform administrative functions and have provided cutting edge technologies for libraries. Librarianship is known as a profession known for integrating cutting edge technologies not just for information

dissemination but in terms of technology as well. Artificial Intelligence has become the new emerging trend for libraries. Artificial intelligence has proven to be a breakthrough for information sectors such as law, which has had significant impacts (Smith, 2016; Chen and Neary, 2017). Artificial Intelligence have had positive impacts on academic libraries and has brought changes in search and retrieval methods, discovery search, chatbots, text and data mining (Fernandez, 2016, p22)

2. Artificial Intelligence: An Overview

Artificial Intelligence can be understood as the collection of technologies that enables machines to sense, comprehend, act and perform several functions matching up with human intelligence. The

major components of the Artificial Intelligence bucket are machine learning, big data, natural language processing, decision logic, data visualization, data analytics.

McCarthy (2007) defined AI as the science and engineering of making intelligent “machines, especially intelligent computer programs.”

Artificial Intelligence aims to understand the nature of intelligence and constructing computer systems capable of intelligent response and action.

The first wave of artificial intelligence has already arrived in the form of basic online search which recommends similar results based on our search requests.

3. Literature Review

Cox and Pinfield (2018) identified the impacts of Artificial Intelligence on search and retrieval methods, resource delivery, scholarly publishing and on learning their findings suggest potential roles for academic libraries and gather the perceptions of the potential impact of Artificial Intelligence on academic libraries and its implications for library works. The potential roles for AI in libraries were data acquisition fabrication and curation, information literacy, aiding user navigation and Infrastructure building.

Yao et. al(2015) explained an artificial intelligence-based smart-talking robot Xiaotu: participatory library service. Xiaotu is a new online reference

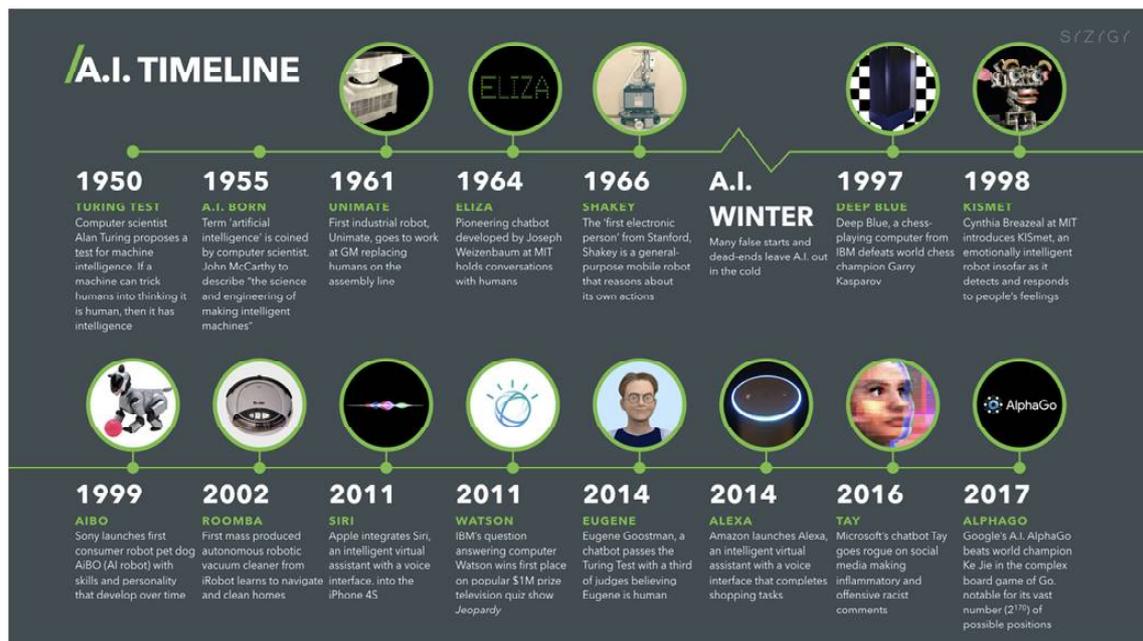


Fig.1: Artificial Intelligence Timeline

[Source: Marsden, Paul (2017) Artificial Intelligence Timeline Infographic – From Eliza to Tay and beyond, Available:<https://digitalwellbeing.org/artificial-intelligence-timeline-infographic-from-eliza-to-tay-and-beyond/>]

service modus operandi. The factors contributing to the success of robots include modular architecture, self-learning, vivid language. It allows users to become content co-creators and maximizes the potential of delivery of virtual reference service offering high featured interactive communication. (Yao et.al, 2015).

Massis(2018) examined artificial intelligence and its potential relationship to libraries the findings suggest “The very disruptive nature of any new technology could be viewed as a threat to many institutions, including the library. But with the eventual acceptance and incorporation of AI into its services, it is certainly possible to speculate that this latest technology “intrusion” could also offer many potential positive enhancements into a multitude of library services, many of which are only being examined, considered and piloted in their early stages of development.

Mogali(2015) reflected upon the major areas of artificial intelligence i.e. pattern recognition, expert systems, robots, and natural language processing. The application of expert systems in library activities such as reference services, cataloging, classification and have been very promising and prove to improve the productivity of libraries to a great extent.

Fernandez(2016) identified potential impacts of AI in libraries analyzing big corpora of data, creating metadata, translation of search and integrating search across content. Completely new ways of interacting with information, e.g. location-based search will also be part of the picture, he suggests.

4. Application of Artificial Intelligence in Academic Libraries

Artificial Intelligence plays several roles in academic libraries and has the potential to transform the way

they function. Some of the interrelated roles performed by academic libraries are enlisted in the table below-

Table-1: Application of AI in Academic Libraries

SN	Role of AI	Applications
1	Data Curation	Collection Management, Digital Preservation
2	Navigating new information environment	Understanding Scholarly communication landscape
3	Data Analysis	Statistical analysis
4	Content Procurement	Licensing for e-content
5	Data Quality Control	Collection Management
6	Data Literacy	Information Literacy
7	Human-Computer Interaction	Reference services

The above Table describes the role of artificial intelligence in libraries along with their applications in a specific domain of libraries. Some changes with interventions of artificial intelligence have been implemented in libraries and yet some need to be done. The role of librarians as data curators would have to take up data related skills such as data management, licensing, quality control these skills along with the integration of artificial intelligence would transform libraries into an intelligent library.

Applications of Artificial Intelligencies in academic libraries under several domains have been traced and explained along with their implications as follows:

4.1 AI-Based Conversational Agents

Human-Computer interactions serve four main functions in libraries i.e. educational, informational, assistive and interactive (Rubin and Chen, 2010) Conversational Agents can be defined as “natural language interaction interfaces which are designed

to stimulate a conversation with a real person” (Rubin and Chen, 2010). Natural Language Interaction (NLI) is a part of fields like Artificial Intelligence and Natural Language Processing (NLP) (Joshi, 199) NLI promises to provide believable, personalized and human-like interaction with computers in natural language. (Rubin and Chen, 2010).

The two important forms within the natural language interaction are chatbots and embodied conversational agents. Interaction in the case of chatbots is limited to text input or output. Embodied Conversational Agents comprise of a computer interface which uses its face and body in a human-like while interacting with the user” (Foster, 2007, p.828).

a) Chatbots

Chatbots are computer programs that simulate an intelligent conversation through text, speech or through an embodied representation. They are also referred to as digital assistants or virtual intelligent agents. They answer directional, reference and predictable inquiries. Chatbots are available 24/7 are consistent and patiently answer queries

Table 2: Application of AI-Based Conversational Agents in Academic Libraries

Sn	Purposes	Applications
1	Educational	E-learning Courseware Support Computer-Assisted language learning
2	Informational	Information Assistants Interfaces for Institutional Repositories
3	Assistive	Automated Virtual Reference Librarians Website tour guides Virtual readers advisory services providers
4	Socially Interactive	Social Software hosts Virtual reader’s advisory hosts Virtual book club Virtual storytellers

The above table taxonomically describes the various purposes and applications of natural language conversational agents which can be deployed in academic libraries. Conversational agents have great potential to serve the information needs of the millennial user community in academic libraries.

b) Profile of some popular conversational agents:

i. Lillian-Informational Chatbot: Lillian is an informational chatbot which has been incorporated into the library website. It informs users about the library holdings and answers questions on library materials using OCLC(Online Computer Library Centre) (Chatbots.org, 2006) Lillian advises patrons about the content of books, titles by the same author, related book reviews and recommendations.

ii. Darcy: Darcy is an animated avatar that delivers short audio messages from the library website regarding recent events, public awareness announcements about the library, It appeals to the young students the most.

iii. Stella: Stella is a text-based chatbot from the Hamburg State and University Library which is equivalent to virtual librarians that supplement live reader’s advisory services with a real-time conversation in which the system fine-tunes its retrieved results based on the responsiveness of users (Christensen, 2007).

To heighten awareness regarding natural language-related technologies in libraries there should be broader discussions within the Library and Information Science community. The purpose of application of AI-based conversational agents should not be confused with replacing face to face

human interaction rather it should focus upon enhancing the services offered by libraries. Adopting conversational agents in a library will increase diversity as these applications can serve a large number of patrons at any time of the day, server wider range of users even if they are at a physical distance. Spoken or voice-based systems facilitate applications to users with visual impairments. Conversational agents enhance user-information systems as they add expressive power to a machine (Andre and Rist, 2000), Free librarians from the tedious and repetitive tasks and keeping up with the changing times.

Conversational agents stand in compliance with the roles of libraries i.e. information sharing and retrieval as they enhance the social interactions offering a virtual librarian, more attention needs to be paid towards the intersection of Natural Language systems as they have a long way to go and benefit LIS professionals and patrons.

4.2 AI-Based Participatory Library Services

The concept of participatory libraries was first coined by Lankes et.al (2007). It refers to the idea that libraries should offer integrated services in a manner that allows users to participate in the core library functions (Lankes et al., 2007; Nguyen et al., 2012). The relationship between libraries has evolved from information users to information users and information curators to a more user-centered role. (Nguyen et al., 2012).

“Xiaotu” an artificial intelligence-based talking robot was developed in China, Xiaotu plays the role of a virtual librarian and creates a participatory environment by attracting users to participate in resource sharing. (Yao et. al, 2015)

a) Xiaotu: Smart Talking Robot (China)

Xiaotu provides real-time virtual 24/7 reference services in mobile and social networking platforms. (Yao et al., 2011b) The main functions of Xiaotu include natural language communication in Chinese, expert answers in professional fields, searching in OPAC, searching in Baidu Baike, China’s version of Wikipedia, self-training, and learning; and finally, interface to integrate with other systems.

Xiaotu has been developed based on ALICE(2015) which is the most pioneer natural language processing robot. Xiaotu operates on a large database, requires reference records accumulated by Tsinghua University Library. Users can also teach Xiaotu new knowledge in a question-answer format the teachings get recorded in the server. Xiaotu quickly made her presence on the social networking web site Renren (Renren,2015a), the equivalent of Facebook in China and enhances the availability of services such as an intra application on the website.



Fig. 2: Xiaotu: Smart Talking Robot in a TV reality show (China)

[Source: Chinese AI robot takes on humans in reality TV show, Tribune, January 09, 2017. Available: <https://tribune.com.pk/story/1288976/chinese-ai-robot-takes-humans-reality-tv-show/>]

4.3 AI in Research and Scholarly Communication

Artificial Intelligence will have a profound impact on the research environment it will bring about significant changes in the way peer reviews are done, working of journals, publication patterns. Automated peer reviews may not offer the quality and precision as human-based peer reviews and may have disruptive impacts on the research environment. The role of journals might change as information seekers may stop depending on journals for filtering services and would prefer subscribing to filtering services based on their needs. (Cox and Rutin, 2018) Research scholars would find relevant information on their fingertips and would help increase their scope.

4.4 AI and Information Discovery

Artificial Intelligence would have a range of impacts on search and resource discovery, it would lead to faster search and retrieval process and analyzing the searcher's behavior. The models for recommendation systems would evolve to an extent that needs to search may not be there and the computer would anticipate the needs of the users. Diversification in terms of a search may take place and may serve the role of a reference librarian to a great extent. (Cox and Rutin, 2018)

Expert Systems

Expert Systems can be defined as “knowledge-based computerized systems which play a role of intelligence interface or gateway for providing access to a database and to obtain relevant information.” It is a computer program that provides expert advice, decisions or recommended solutions for a given situation. An expert system has three main components Knowledgebase, Inference Engine, and User Interface. (Mogali, 2015)

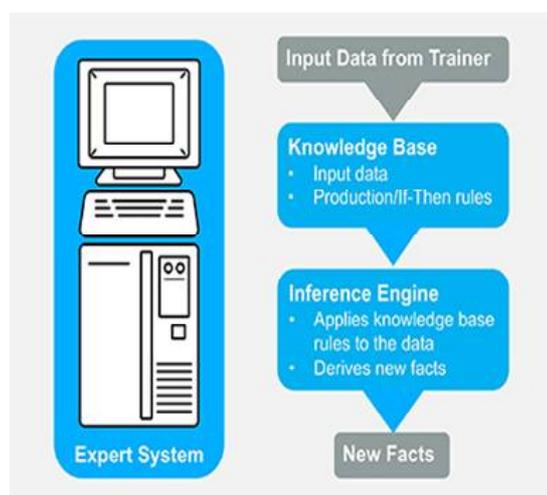


Fig. 3: Expert Systems

[Source: Kennedy, Saira (2018). Artificial Intelligence and Machine Learning: What Are They and Why Are They Important?

Available: <https://mapr.com/blog/artificial-intelligence-and-machine-learning-what-are-they-and-why-are-they-important/>]

Pattern Recognition in Academic Libraries

The information needs of users are increasing day by day and one of the major challenges which lie in front of knowledge managers is information retrieval from the ocean of the web. Several fundamental retrieval techniques such as voice recognition, speech recognition, segmentation, and automatic indexing are widely being used. Semantic Analysis of texts, machine learning, clustering, artificial neural networks is among the highly popular techniques. Artificial Intelligence analyses data from previous searches in many different ways and finds patterns that are based on patron usage.

5. Artificial Intelligence in Virtual Reality for Modern Libraries

Virtual reality refers to the immersion of a user into a completely simulated environment. It consists of a computer-generated simulation of something where users can interact with the help of equipment such as headphones, head-mounted displays, gloves with sensors, etc. Virtual reality has integrated with libraries over time and has formed to be new forms of dialogue between LIS professionals and users, Virtual Reality offers multiple means to increasing information literacy and search and retrieval skills. Free apps can be downloaded on smartphones which allows entering the virtual reality ecosystem for educational systems are as follows-

5.1 Aura-Soma

Aura-Soma is a free app compatible with iOS and Android devices, it allows original content creation known as "Auras" with human-based narrations, charts, graphs, and animations. It brings life to libraries as when the user points at a digital object an aura appears at the screen briefly describing the content.

5.2 EON Reality

EON Experience portal is an interactive online library that is home to thousands of 3D objects, avatars, scenes, and applications (EONReality,2015). Allows development of custom content which attracts users'. Used by Carnegie Mellon University (USA), Imperial College (UK), Nanyang Technological University (Singapore) and many other educational institutions (Massis,2015)

6. Automated Virtual Reference Librarians

The working hours of librarians are limited, virtual reference services using instant messaging services

can solve user queries. Content-based information retrieval can direct users in pulling out relevant library web pages and navigating the content more efficiently. Information is delivered to patrons in speech or text form which can be controlled, the pace of information dispersal from the system can also be controlled

6.1 Pixel: University of Nebraska, USA

Pixel, a virtual reference librarian was developed using SQL database and artificial intelligence mark up language metadata, interface built using PHP answers variety of questions and has attracted a huge number of chatters from across the world. It provides 24/7 consistent service and has replaced complex navigation by providing targeted answers. These systems free librarians from redundant reference queries and allow them to spend more time on research and issues which require human expertise. (Allison, 2011)

7. Artificial Intelligence and Global Trends in Academic Libraries

Artificial Intelligence has the potential to meet Educational, Informational, Assistive and Socially Interactive needs making them suitable for libraries. AI has several perspectives such as information literacy, critical thinking skills, enhancing the productivity of libraries.

Technical Infrastructure to access collections is being built up in MIT so its collections are accessible by the Application programming interface and can be used by machine learning algorithms. Scholarly information needs to be in open access to collaborate with AI. LIS professionals need to get familiarized with the latest researchers and working of AI and create possibilities of AI for metadata creation and

harvesting, collection development, reference services, human-machine collaboration.

The future of artificial intelligence holds wide scope in the information sector as the needs of users as well as LIS professionals have been evolving at a fast pace in order to meet those needs in an effective and efficient manner the LIS professionals need to implement artificially intelligent as well as expert systems would widen and diversify the functions of library.

8. Issues and Challenges in Deploying Artificial Intelligence in Academic Libraries

Artificial Intelligence is still tied up with several technological, social and economic challenges, some of the major issues in the implementation of artificial intelligence technologies in libraries are- language preparedness, system requirements, privacy concerns, a threat to intellectual freedom they have been briefly described as follows:

- a) **Privacy:** Artificial Intelligence when fed with massive amounts of data, eventually learns to identify certain data sets with the help of machine learning. Personal data becomes a commodity that might get misused for illicit purposes. Librarians need to secure privacy by providing anonymous ways of interacting with artificial intelligence systems.
- b) **Intellectual freedom:** Seeking and receiving information from Artificial Intelligence systems leads to intellectual freedom at threat, as personal data is sought through machine learning. Queries and search history gets saved which can be used against people.
- c) **Quality of Intelligence:** The quality level of a particular artificial intelligence system is

determined by two main factors i.e. logical algorithms which are technical related and corpus capacity which is related to data. With technological advancements taking place at a skyrocketing pace more and more complicated algorithms are being formulated and optimized. To catch up with the same, more and more crawlers would be required to obtain the internet and improve its quality of intelligence.

- d) **Cost:** Cost is one of the major barriers to the implication of AI in the information sector, Most of the AI systems are in the form of proprietary software. Investment in AI-based technologies has not become a trend in libraries and require more dialogue and clarity among professionals.
- e) **Linguistic styles:** Chatbots have limited memory and processing power does not support extensive vocabulary or the ability to deal with diverse conversational styles. Developers need to predict the types of interactions and develop suitable responses to them, which is a challenging task for a country like India as the dialect varies in every state, Prescribed conversation styles might not be suitable for all kinds of interactions.
- f) **Bias:** The transparency and accountability of artificial intelligence systems are being questioned, the algorithms may function based on developer bias or commercial organizations which may lead to disparity in the academic sector.

9. Conclusion

The partnership between artificial intelligence and libraries can be a major step towards the future of libraries. AI brings in tools for enhancing services

such as discovery, search and retrieval processes more efficient. These intelligent information systems have the potential to engage and foster human skills. Librarians can adopt artificial intelligence for several purposes such as reference services, teaching information literacy skills, monitoring and evaluation, information search and retrieval processes. AI will have implications over several services from offering insights to collections, easily storing and transferring files. This form of collaborative technology will emerge in enhanced partnerships between librarians and stakeholders. The success stories of implementation of AI can act as a stepping stone towards adopting these innovative technologies and enhancing the services offered by librarians to a greater extent.

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