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Intelligent Libraries: New horizons with Artificial Intelligence

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ABSTRACT

This study throws light on the definition, the historical development of Artificial intelligence (AI) and its application in different streams of study. This paper mainly deals with the implementation of AI in the library environment and also discussed the issues and challenges in deploying AI in libraries. It gives some insights on Competencies and skills required for Librarians in the AI era and the role of librarians in this artificially intelligent society.

Key Words – Smart libraries, Intelligent libraries, Artificial intelligence, Modern libraries

1. INTRODUCTION

The exponential growth and development of modern technologies in recent decades have impacted each and sector in many ways. Technology has provided new skills, opportunities, and new challenges for humankind. This trend is changing traditional roles. There are two revolutionary technologies catching fire nowadays, i.e., Genome editing and Artificial Intelligence. Genome editing is popularly known as gene editing. Genome editing is a collection of techniques that enables scientists to change an organism's DNA. Scientists all over the world have developed different approaches for gene editing. The recent and popular among those approaches is CRISPR-Cas9. And the other technology which is changing the world is Artificial Intelligence (AI). AI has already touched many of our daily computing activities, from surfing the web to spam email applications. AI triggers speech recognition, which makes Apple's Siri, Microsoft's Cortona, Google Assistant, and Amazon's Alexa to process and respond to the user's queries. The advent of AI helps self-driving cars and robots to navigate the streets and sidewalks. The people around the globe might experience Artificial Intelligence Presence in almost all the areas of their life, i.e., working places, libraries, and homes, etc. This transformation has a tremendous impact on libraries, its services, and its role. Big data analysis

and intelligent machine learning are reshaping the way libraries gather, access, and distribute the information. From the digitization of information to the Internet of Things (IoT), modern intelligent technologies are changing the library professional's ability to process the data, digging the meaning out of it, and make decisions based on the drawn definition.

The future of the library and information system in the digital era has been a highly discussed topic in recent years. Libraries are still considered as the traditional information providers to the society they serve. Libraries are the fore frontiers in adopting the latest technologies that can be integrated into the services and management systems. With selected technologies, libraries are trying to find a new marketplace where unlimited information is available at a click. Learning and teaching techniques are dramatically changing; in this regard, it's the duty of library professionals to reach the present generation of patrons to serve their needs effectively and efficiently. (Vijayakumar, S and Sheshadri, K.N., 2019)

In the hyper-connected ear, Artificial Intelligence enables libraries to provide valuable experiences to their users. AI plays a pivotal role in updating and expanding the value proposition of the library system. This paper explores how advanced technologies, and Artificial Intelligence, in particular, can help modern libraries to reach their potential in the digital age.

2. ARTIFICIAL INTELLIGENCE: DEFINITION, HISTORY, AND DEVELOPMENT

Artificial Intelligence (AI) is considered as an extension of human intelligence. AI has already taken over in various sectors. AI is simply known as the bundle of technologies that allows machines to sense, comprehend, act, and perform multiple activities like humans. The major areas of AI are machine learning, big data analytics, natural language processing, data visualization, analytics, and many more, which matches human intelligence. AI adopts non-algorithmic methods to solve day to day problems of any systems.

Artificial Intelligence intends to create machines which work intelligently and act like a human in nature. Artificial intelligence enables any device to achieve given responsibilities by processing enormous quantities of data, and recognize outlines, predict the data inputs, which allows users to provide feedback for improving accuracy over time.

2.1. Definition of Artificial Intelligence

In general – "AI is the science of getting machines, or computer systems, to perform tasks that require intelligence if done by humans, or perhaps animals."

John McCarthy, the one who coined the term Artificial Intelligence defines "AI as the science and engineering of making intelligent machines, especially intelligent computer programs."

The Encyclopaedia Britannica states, "artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings."

The English Oxford Living Dictionary states AI as - "The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."

2.2. Brief History of Artificial Intelligence (AI)

AI is not a different technology for researchers. This technology emerged decades ago. Its history can be drawn back to the year 1943 When Warren, McCullouch, and Walter Pitts

projected a model of artificial neurons. Their initial work renowned as Artificial Intelligence (AI) worldwide. The following paragraphs concisely define the milestones of Artificial Intelligence.

Early Developments

Donald Hebb formulated a rule for modifying the connection strength between neurons in the year 1949. His state is now recognized as 'Hebbian Learning.' Later in the year 1950, Alan Turing, an English mathematician and a pioneer in machine learning, published a work called "Computing Machinery and Intelligence." In this work, he proposed the Turing Test, which can calculate the machine's capability to unveil intelligent behaviour equivalent to human behaviour.

The birth of Artificial Intelligence

Allen Newell and Herbert A Simon developed the first artificial intelligence program in the year 1955. This development is now known as "Logic Theorist." Their program solved several mathematical theorems and also found shreds of evidence for some theories. The year 1956, termed as the birth year of AI when an American Computer scientist John McCarthy introduced the term "Artificial Intelligence" at the Dartmouth Conference. The passion for AI was in elevation, and several high-level languages like FORTRAN, LIPS, and COBOL were invented.

Golden Years

In the late 1960s, computer scientists emphasized to develop algorithms to resolve mathematical hitches and theorems. Joseph Weizenbaum developed the earliest Chatbot named ELIZA in 1966. Later in the year 1972, the Japanese invented the first humanoid intelligent robot WABOT-1.

AI Winter

During the period 1974-1980, despite reasonable efforts, Computer scientists had to face shortage funding from governments for AI research. During this time, publicity of interest in AI research was decreased; as a result, this period was called 'Winter Period of AI.'

A boom of AI

Artificial Intelligence came back with the 'Expert System' in the year 1980. Expert Systems are programmed to show the decision making capability of a human expert. In the same year, the first national conference was organized by the American Association of Artificial Intelligence at Stanford University.

The second AI Winter

Between 1987 and 1993, the government again stopped funding AI research as there was a lot of investment but no outcome. The expert system like XCON was expensive. Hence this period was called 'Second AI Winter.'

New opportunities with intelligent agents (1993-2011)

During this period, AI research received success in computational power, got a greater emphasis on solving problems. The considerable success recommended AI to be used in logistics, data mining, medical diagnosis, and other areas. IBM's Deep Blue turns out to be the first computer-

enabled chess-player to beat the world champion, Garry Kasparov. AI developed a vacuum cleaner called 'Roomba' and entered homes in the year 2002. In the year 2006, AI came into the business. Companies like Facebook, Twitter, and Netflix started using AI systems.

Deep Learning and Big Data (2011 to present)

In 2011, Artificial Intelligence got much attention as it achieved some milestones. IBM developed – Watson is the first question answering system in the world. In a quiz exhibition match called a Jeopardy!, Watson, defeated the two great champions, Brad Rutter and Ken Jennings. Deep learning methods started accuracy benchmarks in the year 2012. Google giant introduced its Android App facility called 'Google Now,' which was able to predict the information needs of the users based on the search history. A Chatbot 'Eugene Goostman' won a competition in 'Turing Test' in the year 2014. The year 2015 was considered as landmark year of Artificial Intelligence. Several software industries showed interest in adopting AI technology in their projects. In the year 2018, IBM's 'Project debator' debated on different issues with experts and performed awfully.

Today, Artificial Intelligence has reached a remarkable level. The perception of deep learning, big data, and data science are on-trend. Companies like Google, Facebook, Amazon, and IBM are employed with AI and developing amazing gadgets like Amazon's Echo. (Javapoint, 2020)

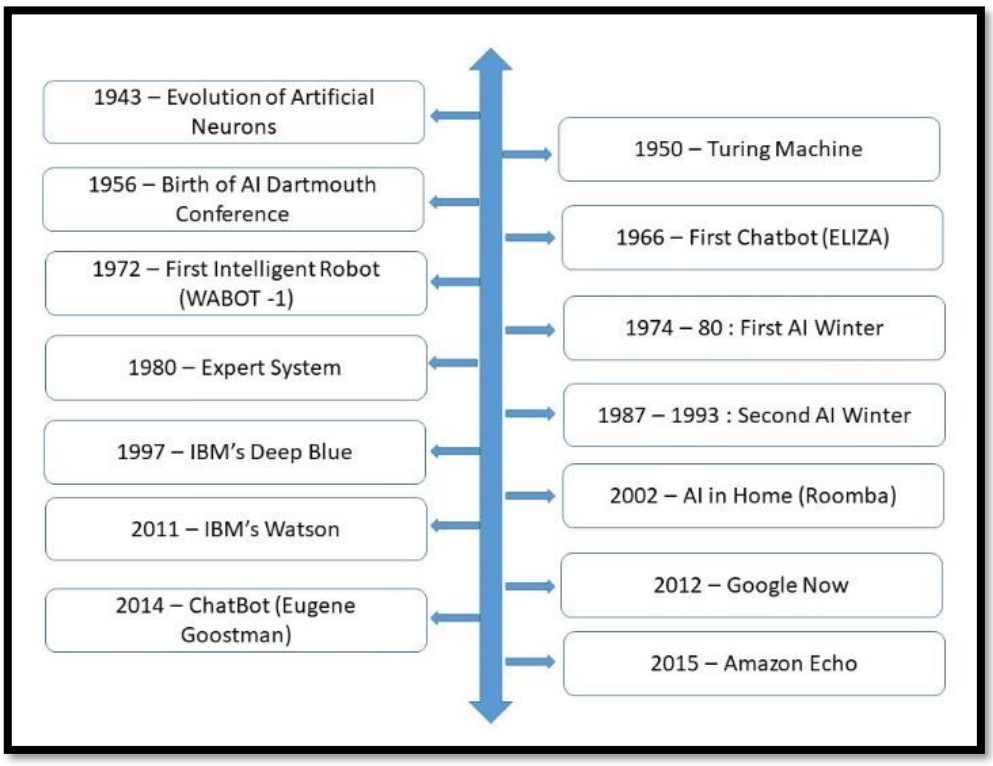

Figure 1: Artificial Intelligence Milestones

3. APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) can be applied to any logical task. Modern AI skills are ubiquitous and are too numerous. Generally, when technology touches the mainstream, it is merely considered as artificial intelligence; instead, it will be labelled as the 'AI Effect.' Most useful models of AI include drones, self-driving cars, medical tools, art designs, evidencing mathematical theories, gaming, surfing webs, online assistance, image recognition, riddling junk emails, prophesying flight delays, judicial decisions and targeting online advertisements, etc.

In today's world, information is at our fingertips. With mushrooming growth in technology, one can assume that social media sites have overtaken television as a source of the latest news. Especially the younger generation is increasingly reliant on social media platforms. Significant publishers use AI technology to post their products and create a higher volume of publicity.

The objective of Artificial Intelligence in different areas, i.e.Expert System (ES), Natural Language Processing (NLP), Pattern Recognition (PR), and robotics, is to simulate human intelligence with supercomputers. Modern computational techniques that are applied in developing Artificial Intelligence are discussed below;

a) Expert System (ES)

Expert System (ES)is the knowledge-based computer-enabled system that acts as a protagonist of intelligence interface or gateway to provide access to the storehouse of information. They range in scale from simple rule-based systems to an enormous scale integrated developments. An expert system is a program that provides expert advice, recommended solutions for a given situation. The diverse mechanisms of expert systems are Knowledgebase, Inference Engine, and User Interface. (Chemulwo M.J., 2020)

b) Natural Language Processing (NLP)

Developing machines or computers which can understand the human language is the long-standing goal of computer science. The definitive generation of computer language is the Natural language. AI experts were able to develop the Natural Language interface using partial vocabulary and syntax. NLP enables a machine to know the primary linguistic concepts within a question or solution. Its goal is to design and develop a tool that can analyze, understand, and create human language. The various mechanisms of natural language processing are speech synthesis, speech recognition, machine translation, linguistic approaches, information retrieval, and data extraction. (Chemulwo M.J., 2020)

c) Pattern Recognition

Pattern Recognition (PR) is a process of developing a close connection between the new stimulus and previously-stored stimulus. PR is studied in various areas, which include Psychology, cognitive Science, Ethnology, and Computer Science. It is based on either prior knowledge of extracted information from the patters. The patterns to be classified are usually groups of measurements or observations. The components of PR are data acquisition, pre-processing, feature extraction, model selection and training, and evaluation. (Afolayan, J. O., 2020)

d) Robotics

The robotics is a subfield of Artificial Intelligence, which is concerned with machine performances. A Robot is a machine that performs automated tasks on human supervision or

programmed set of instructions or guidelines developed based on Artificial Intelligence Techniques (Shohana, Nowrin., 2018).

4. APPLICATION OF ARTIFICIAL INTELLIGENCE IN LIBRARIES

4.1. Expert System in Library Services

Resources, users, and staff are the three main aspects of any type of library. All the library activities revolve around these three aspects. The use of the expert system is promising to establish a good relationship between staff and users, users, and databases. The expert system can help library professionals to understand the user requirements and the need for improvement in productivity. The adoption of the expert system in the library will also help to improve the excellence of the facility.

a) Reference service is the most sought activity of the library. The expert system will act as an auxiliary for reference librarians. Reference librarians can make use of methods like Research, Pointer, Online reference Assistance, AMSWERMAN, PLEXUS to locate reference resources.
b) Cataloguing is considered as one of the oldest technique of the library. Many attempts have been made to automate the cataloguing through the expert system. These attempts have dedicated to descriptive cataloguing as it was based on AACR2. One can find two ways to apply AI technique in cataloguing i) Human-machine interfaces, where intellectual work is distributed to the arbitrator and the support system. ii) An expert system with cataloguing capabilities associated with online publishing.
c) Classification is the primary function of the library. Classification helps to organize knowledge or resources. Hence, it is advised to take the utmost care while holding collections in the library and information centres. Coal SORT, EP-X, and BIOSIS are examples of an Expert System, which can be adopted in library classification activity.
d) Serial Indexing is another section of the library where expert systems can be adopted. Indexing periodicals involve identification of notions to transform the ideas into verbal metaphors and to select and assign controlled vocabulary terms which are comparable to verbal explanations. The main intention to automate the intellectual characteristics of indexing is to strengthen indexing uniformity and superiority. Based on the provided data by the indexer, the systems can reach appropriate terms. The systems can come to a conclusion based on the assumptions and can take necessary action. The 'Med Index' is an excellent model of the library indexing system.
e) There is a lack of exposure among users on AI-oriented services in many libraries. Very less number of users have interacted with knowledge-based expert systems. Besides, most of these expert systems-oriented services are undergoing many improvements to reach the user's requirements.
f) Library users have a significant role in the collection development of any library. The suggestions made by library users may help librarians to develop library resources, especially online resources. Many systems have been adopted by the library to acquire the resources

4.2. Natural Language Processing in Library Services

The first thing when we think of the term 'Natural Language Processing,' the ability it speaks or writes a sentence, and a mechanical process of requesting and expressing comes first. We can apply NLP to many disciplines, including libraries. One can use NLP in libraries to search the OPAC and get accurate information. Indexing is the foundation of information retrieval. The

purpose of the index is to improve the precision of retrieving parts of the relevant documents and to reduce the proportion of recalls and related files recovered.

4.3. Machine Learning in Library Services

Libraries procure, acquire, and process thousands of resources. Library professionals create thousands of pieces of metadata to make it easy for users to search for acquired resources through the library database. For electronic books, if the metadata is not available, librarians will develop it manually. In recent years every piece of information is born digital. Machine learning offers an array of potential mechanisms to assist libraries in creating metadata for digital resources. Machine learning allows cataloguing not only to increase the speed of metadata generation but also to expand the depth and breadth of subject terms.

4.4. Robotics in the Library Services

A robot is a multipurpose machine that is reprogrammable, automatically controlled, can be fixed on any location for the use in automation applications. In the digital libraries still procure a considerable number of printed documents, and also they provide a variety of services and resources for digital libraries. This has created combined pressure on libraries to offer printed and online resources to their patrons. Modern technology has given many challenges and opportunities for libraries. To deliver a variety of services, libraries need to build a personalized robotic scanning system which allows the browsing collection through the web interface.

4.5. Intelligent Interfaces to Online Databases

Many users still find it difficult to access online databases. Such users must know the different communication protocols. The users should try to understand the language control, search techniques, file structures, and a variety of terminologies. Artificial Intelligence may help libraries to overcome these issues. The intelligent interface system's primary purpose is to enable access to the construction of some required knowledge for the front end software used in the online search system. The Interface which gives access to the existing online search system may succeed by adopting Artificial Intelligence. The Interface does not solve the problem of restructuring the database but instead allows the search system itself to make the approach more intelligent.

The intelligent Interface to online database searching can help in the following ways:

- select the appropriate hosts and databases;
- allow the patrons to state the required information in proper terminology;
- determine the level and access to the information requested;
- adapt the extent of the information to be retrieved;
- formulate the vocabulary query used in the selected databases;
- express a search query in the format required; and
- Present search results in a helpful way, e.g., ranking in the order of probability of relevance.

5. ISSUES AND CHALLENGES IN DEPLOYING ARTIFICIAL INTELLIGENCE

Recent research shows that the library and information professionals are keen to adopt the advanced technologies in the library and information centres they serve. Intelligent librarians can predict that Artificial Intelligence makes a significant part of the library system. It is evident

from the recently conducted surveys, many researchers that a very less number of libraries run AI-related operations in their libraries. Despite sufficient awareness among library professionals about AI, many libraries are facing internal issues for adopting AI technology. Overcoming this resistance might lead to a better understanding of the challenges in implementing AI in libraries.

The lack of awareness and sufficient knowledge on the benefits and cost-saving opportunities of Artificial Intelligence can bring difficulties for the library in implementing AI technology into the library system. Budget is not the only constraint which is stopping the libraries from adopting AI, along with other modern techniques. Few library staff often shows resistance to cope with new technologies. Many libraries are explaining the motivation for taking new workflows and technologies, but still learning interest among library staff not up to the mark. Skill gaps in digital fluency are proving to be a hindrance to adopting AI technologies and other modern technologies.

Some of the significant 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 designed to learn specific data sets with the help of machine learning technology. Personal data may become a commodity and has a high risk of getting misused for illicit purposes. Hence, Librarians need to secure privacy by providing new ways of interacting with AI.
b) *Intellectual freedom:* Artificial Intelligence might lead to intelligent freedom threats while seeking and receiving information from an AI system. This is because the personal data will be explored through machine learning. Users' queries and search activities will be saved by the AI system, which can be later used to get persons' private data.
c) *Quality of Intelligence:* The level of quality of an AI system can be determined by two main factors, i.e., logical algorithms and corpus capacity. Consistent algorithms are technically related, whereas corpus capacity is relevant to data. With the rapid technological advancements, more and more algorithms are being formulated and optimized. To cope up with the technological trend, a sufficient number of crawlers would be necessary to obtain the network and improve the quality of intelligence.
d) *Cost:* Budget is one of the primary barriers to adopting Artificial Intelligence in the information sector. Most of the Artificial Intelligence systems are commercial. Investing in AI technologies has not yet got much importance in the library and information centres. Hence it requires more clarity among library professionals.
e) *Linguistic Styles:* Chatbots have limited memory, and its processing power does not support extensive vocabulary. In this regard, programmers need to predict and develop suitable responses to the Chatbots. This task is challenging for a country like India as the language and dialect vary in every state. Prescribed communication styles may not be ideal for all types of interactions.
f) *Bias:* The experts have always questioned the transparency and accountability of the AI system. The algorithms of AI systems function based on the developer's preference.

6. COMPETENCIES AND SKILLS REQUIRED FOR LIBRARIANS IN THE AI ERA

Some experts of library and Information Science suggest that the librarians working in Tech-Savvy environments face a situation where traditional capabilities turn out to be less prominent. And experts claim that there will be a great emphasis on individual skills than the practical skills. In the future, there will be an increased interest in ICT skills, which covers the

active practice of Artificial Intelligence. Although most libraries might apply AI technology, librarians should not be wholly dependent on technology. Librarians should carry on making their efforts to offer services to their users with the human touch.

Along with personal and interpersonal skills, an intelligent librarian should have the technical skills. The technology abilities include electronic communication, knowledge of hardware and software, core operating systems, Internet applications, content creation and development, computing and networking, security and server management, project preparation and management, framing policies, and technological training. (Cox et al., 2018)

Shortly, Artificial Intelligence will influence the way information can be accessed and analyzed. AI has already given insights for the library and information professionals that how the library users may search for the required information. Librarians can come up with the points at which data could be transformed or delivered entirely in new ways. Following are the areas where library professionals should focus on in the AI era :

- Providing content
- Procuring content for AI
- Data quality control
- Obtaining AI tools
- Data curation
- Designing data infrastructure
- Explaining how to navigate the infrastructure
- Teaching critical data literacy
- Designing AI mechanisms
- Data analysis and designing algorithms

7. ROLE OF LIBRARIES IN ARTIFICIALLY INTELLIGENT SOCIETY

Increasing pressure on libraries to deliver information in the stipulated time is tempting the libraries to turn to Artificial Intelligence. With AI libraries can maximize efficiency in services. However, libraries need to be aware of the probable ethical concerns of some AI use cases. This makes choices to protect the public trust.

Support ethical AI research: Governments and many private organizations are considering ethical data for Artificial Intelligence training and efficient information gathering models. This is because the use of AI is growing. Libraries can support AI research by supplying a treasure of high-quality resources for Machine Learning. Particularly academic libraries have archives of data coded with scientific standards. Intelligent librarians can contribute to ethical AI research by offering their literacy expertise. Library professionals can also promote ethical data handling.

For the past few decades, users have gained digital literacy training from libraries, and now it is time for algorithmic literacy training. Algorithmic literacy includes recognizing the interaction with AI, understanding how AI identifies information available online and how algorithms collect personal data. Libraries can use their skills in digital literacy programmes and can make arrangements for useful activities which help the users to develop algorithmic literacy skills.

Encourage public debate on Artificial Intelligence: Libraries are considered as community hubs. Libraries can encourage citizen participation in discussing the future of AI society. AI, with its mushrooming technology, can change society and its culture. Keeping this in mind, as social

hubs, libraries must act as a forum for the people to communicate their problems to the AI commons initiative. This initiative can bring together AI developers with society.

Educating people to live with Artificial Intelligence: The world is experiencing enormous transformation in the education system. Artificial Intelligence will impact labour markets. In this connection, the biggest priority of the library is creating awareness of lifelong learning and enlightening the social presence in educational activities. Libraries can play a vital role in achieving educational goals. Libraries can educate non-digital learners to update themselves with modern technology. On the other side, Artificial Intelligence helps the libraries to develop learning tools that would be of great use for non-digital learners. Public internet access and digital literacy programmes can help more people enjoy the benefits of AI. The knowledge and information that libraries offer can help people learn new techniques to traverse the altering labour market and improve their livelihoods. (IFLA Blog, 2020)

8. CONCLUSION

Artificial Intelligence and its functions will increase day by day business sectors, industrial sectors, military sectors, educational and scientific sectors, and academic and research organizations. The success in the areas of AI, such as Expert Systems, Natural Language Processing, Pattern Recognition, and Robotics, has triggered significant commercial movement. The feasibility of artificial intelligence in the sections like cataloguing, classification, documentation, collection development, etc., seems to be enlightening year after year. In the future, AI will occupy all spheres with more advanced models with high technologies. Library and Information Science will be greatly benefited by the development of efficient Artificial Intelligent systems for technical services as well as Information processing and management.

References:

1. Afolayan, J. O., Ogundokun, R. O., Afolabi, A. G., &Adegun, A. A. (2020). Artificial Intelligence, Cloud Librarianship, and Infopreneurship Initiatives for Inclusiveness. In A. Tella (Ed.), Handbook of Research on Digital Devices for Inclusivity and Engagement in Libraries (pp. 45-69). Hershey, PA: IGI Global. DOI:10.4018/978-1-5225-9034-7.ch003

2. Chemulwo, M. J., &Sirorei, E. C. (2020). Managing and Adapting Library Information Services for Future Users: Applying Artificial Intelligence in Libraries. In N. Osuigwe (Ed.), Managing and Adapting Library Information Services for Future Users (pp. 145-164). Hershey, PA: IGI Global. DOI:10.4018/978-1-7998-1116-9.ch009

3. Andrew M. Cox, Stephen Pinfield, Sophie Rutter, (2018) "The intelligent library: Thought leaders' views on the likely impact of artificial intelligence on academic libraries," Library Hi Tech, Vol. 37 No. 3, pp. 418-435.

4. Vijayakumar, S, and Sheshadri, K.N. (2019), Applications of Artificial Intelligence in Academic Libraries, International Journal of Computer Sciences and Engineering, Vol. 7, pp 2347 - 2693

5. Library Policy and Advocacy Blog (IFLA) - https://blogs.ifla.org/lpa/2019/07/01/the-robots-are-here-ai-libraries-and-the-internet/?cv=1 (accessed on 9.4.2020)

6. Javapoint, History of Artificial Intelligence - https://www.javatpoint.com/history-of-artificial-intelligence (accessed on 9.4.2020)