
**Modern data science and its exploitation in university libraries:
identity of belonging and areas of application**

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Torchi hayet ¹¹University of Biskra, Algeria, Email: hayet.torchi@univ-biskra.dz**Abstract:**

The digital world continues to offer promising new developments for library and information institution in their scientific course and applied practices, as modern data science is considered one of the most fertile fields for this world, which is witnessing great and continuous developments, and its cross-fertilization with a number of sciences and fields of application of its technologies, especially at the level of university libraries, which will inevitably affect positively its administrative function, technical operations, and digital services, as well as the job specialization of its professionals in terms of scientific competencies and technical skills in organizing and processing data and information; If the latest developments in this science and the applications of artificial intelligence related to it are properly employed, according to strategic plans and alternative options that respond to avoiding the signs and overcoming the challenges that may prevent achieving the investment returns expected from this exploitation; this will be explained in the papers of this research.

Keywords: modern data science, artificial intelligence, data scientist skills, university libraries.

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1.METODOLOGICAL INTRODUCTION

It was predicted at the beginning of this millennium that traditional libraries would disappear to be replaced by modern forms such as electronic and other libraries, and information networks with limited or international scopes, However we are witnessing that these institutions especially university ones remain at the forefront of the priorities of the bodies that govern them and those responsible for managing them, and this is confirmed by the speed of their development and modernization with the introduction technological technologies on their physical entites and digital aspects and diversifying their documentary stocks between paper and digital and their information services to keep pace with the course of the era in which they are active and respond to the changing needs of their beneficiaries and their digital behaviors which imposed the continuous improvement of their experience in dealing with it to ensure their permanent loyalty.

In the 1960s automation was relied upon to streamline some operations in libraries especially lending and indexing by inventing punched cards and printing catalogs automatically leading to the(MARC) format and direct access catalogs (OPAC) then the matter expanded to the design of integrated automated systems to manage all administrative functions and technical operations, Procedures and services that exploit coding languages and standards for organizing and processing information in the world of the web, And other innovations that serve various types of libraries, facilitate search and retrieval operations, and raise the quality of the services they provide and the efficiency of their performance, as the user in these developments has been transferred from a mere recipient to an interactor and participant in creating content and modernizing digital information services, developing research tools available on the internet and social media.

Not long ago the digital world woke up to an unprecedented renaissance in modern data science techniques and artificial intelligence applications that serve segments of society in general and the academic community in particular, with professional methods and

models in dealing with raw, structured or unstructured data analyzing it engineering it and transforming it into accurate information that serves many purposes including, making immediate decisions, predicting behaviors, patterns of use and consumption...ect.

In a way that almost eliminates the role of humans and in a record time that is hardly counted and the best evidence of this currently is the uproar created by smart chatbots based on self –aware generative-learning as a model –ChatGPT- which made most business companies rush to invest in the data resulting from their activities their customers reactions and their competitive market data to control them and exploit opportunities for survival and excellence.

Likewise Algerian university libraries should not neglect to exploit modern data science in developing its various aspects as is the case in the libraries of the united states of American which were the first in this regard especially since library professionals were among the first to deal with data within the ancient concept of this science – datalogy- therefore it will not be difficult for them to understand its recent developments and exploit its new technologies to change and adapt the information services of these libraries and be unique in their reliability and updating .

In order to explain this what was stated in this research was divided into two:

The first aspect of it was concerned with: clarifying the concept of modern data science the identity of its affiliation and its relationship with library and information sciences between aspects of connection and functional overlap, the most important elements of the success of employing the techniques of this science and the areas of their application in university libraries and the benefits resulting from this application were also addressed.

The second aspect was devoted to : introducing artificial intelligence its types, and its most important contemporary technologies, while preparing a comparison between modern data science and artificial intelligence as an attempt to remove confusion and confusion between

them from several aspects, While clarifying the administrative aspects of twinning the use the techniques of these two sciences in university libraries.

1.1. Research problem:

Library professionals have been dealing with big data since ancient times ,whether they realize it or not; the primary function of these institution is to collect and organize raw data which is present in the various types and forms of documents they possess, and the transform it into useful information and knowledge that can be consumed when needed by its beneficiaries.

And from him modern data science is the product of the twenty-first century based on data analysis and engineering in which a mixture of sciences, methods and models were employed which include: mathematical algorithms, statistical analyses computer science, machine learning and artificial intelligence techniques...ect.

With the aim of providing accurate information that can be exploited in make urgent decisions provide predictive insights and improve the user experience of various organizations products and services . its takes and functions are very similar to the principles and theories of library and information science in organizing and processing data and information .despite this modern data science is still subject to questioning the identity to its specialized affiliation due to the looseness of the main areas that constitute it.

Until now university libraries remain the center of scientific radiation and the environment for creativity and innovation in all fields, despite the intensity of competition they experience in the digital environment due to the multiplicity of free access outlets, They struggle to remain committed to the covenant and the established principle of proving and flowing information and its various sources in line with the course of the era that coincides with it, it moved from the spatial space bounded by walls to digital spaces and from restricted availability to free availability that knows no times limit or place, those responsible for it took care of its solution and services by employing information and communication technology techniques the

new ones of which became based on modern data science and intelligence, self-aware and quantum artificial, in order to maintain the position of university libraries in advancing scientific research outputs and their uniqueness in providing digital information services documentary stocks, and digital contents of quality and added value to improve their user experience on the one hand and comfort their competitors on the other hand represented in: academic and other smart search engines, virtual assistants, Smart chatbots, publishers websites, Digital libraries, electronic journal databases, specialized scientific platforms...ect.

Based on the above i want with the topic of this research to answer the following problem:

To which specialty field does modern data science belong? How can its techniques be exploited in developing university libraries?

The following questions branch out from this main question :

- 1 – what are the first roots of the emergence of modern data science and the factors for its development?
- 2– What are the main areas that make up this science?
- 3 – what are the functional connections and overlap between modern data science and library and information sciences?
- 4 – what are the Ingredients and applied fields of this science in university libraries?
- 5 – what are the returns on investing in modern data science in these libraries?
- 6 – what are the differences and administrative aspects of twinning the use of data science and artificial intelligence techniques in university libraries?

1.2. Importance of the research:

The importance of the research lies in the following points:

- Explain the historical origins of modern data science and the scientific initiatives that have support its current development.
- An attempt to scrutinize the specialized affiliation of this science and science related to it, and highlight its functional similarity ti libraries and information sciences, and its teaching importance in its specializations.
- The research will provide a strategic vision regarding the success factors of employing modern data science techniques in university libraries and the benefits of investing in it.
- This employment will help maximize the use of data sets resulting from various university library activities, and through feedback to its users through various digital means to understand their behavior . improve the services of these libraries and create an environment of creativity and innovation in them.
- Employing modern data science in university libraries will support the achievement of strategic improvement in several administrative aspects including: big data management, patterns and context . decision management and work procedures, aims management and risk management.
- Supporting the technical understanding and practical competence of university library professionals by comparison modern data science and artificial intelligence in terms of: the basics on which each science is based, the objectives, the type of data it works with, and the practical processing, typical applications and examples of use for each.
- Draw the attention of those in charge of university libraries to the fact that integrating the use of modern data science techniques, and artificial intelligence in these institutions will enhance the exploration of information sources, development and intelligence management of their paper collection, and digital contents rationalize policies for subscription to specialized scientific knowledge databases, and play an effective role in document mediation, and collective management .for the intellectual property rights of digital works you own or provide access to.



- This research if applied in the field to university libraries will enable them to achieve savings in costs, and financial expenditures and increase the efficiency of their performance through the of artificial intelligence techniques to develop the budgets of these institutions and increase their financial resources.

1.3. Research aims:

Through this research after trying to answer the main problem we aim to achieve the following:

-supporting the scientific knowledge and practical experiences of the researcher through modern data science techniques, and preparing students of departments and institutes of library science, and documentation in algerian universities to be fully prepared to take up on of the specializations of this science, and pushing them to be creative and innovative in it within the practical environment of university libraries.

- Creating scientific material foe those in charge of university libraries and their professionals and simplifying its understanding to facilitate knowledge and follow- up of the rapid and successive developments in the disciplines of library and information science and their new science courses.

- Clarifying the conceptual frameworks of modern data science and areas for exploiting its techniques in university libraries.

- Identify the benefits of this exploitation from the administrative, operational, service aspects, research tools in university libraries, and from the aspects of studying their users' behaviors, and information measurements.

- Controlling the concept of artificial intelligence and explaining the basic differences between it and modern data science and the effect of twinning the use of their techniques to work together in the modern administrative aspects of university libraries.

1.3. Research methodology:

This research required the use of two scientific methodologies using the methods described below:

- Descriptive approach: documentary research and content analysis of all documents and information sources that were used; A comparison between the various methods and technologies used in data science and artificial intelligence that have been applied in university libraries so far, with scrutiny in understanding and simplifying the narrative of the effectiveness of each technology and the scope of its employment to facilitate its exploitation by university library specialists.
- The historical approach by listing the signs of the emergence of modern data science, the factor of its development and aspects of hang and novelty in it, according to the different scientific approaches to it and its relationship to libraries and information sciences.

1.4. previous studies for research:

There have been many studies and research that have dealt with data science and big data and their relationships to the field of libraries and information in general. However, according to the references that the researcher was able to access, there is no previous study or research that has addressed modern data science in terms of identity of belonging and areas of practical application of its techniques in university libraries. The idea of this article is based on the following factors:

1- The researcher's prior knowledge in her field of specialization and the units she teaches, especially the information systems evaluation unit, the project and entrepreneurship leadership unit, the electronic indexing and unified standards unit, and the information systems risk management unit.

2-In-depth research for years in the doctoral project which thank god was completed in 2020 and id tagged with: description of digital content and its role in activating objective research through automated catalogs of university libraries:"a descriptive and analytical study in the libraries of universities in eastern Algeria".



3- Exploring references related to this topic in the library of the faculty of humanities and social sciences at the university of mohamed khaider biskra, and on the direct line (internet engines .social networking sites on related topics), This made it easy to deduce its elements as a personal effort of the researcher, and she was credited with adjusting its title, grading its presentation, clarifying its ambiguity, extrapolating what is meant by it, and narrating its content for the following studies:

The first study : By ola salah, 2023, Data science: the comprehensive guide. In which the researcher addressed the definition of data science, the science of its analysis and engineering, the difference between data science and artificial intelligence, the components of data science and its importance, the sciences on which it is based, the most important recent applied fields for it, the life cycle of a data science project, the scientific specializations of this science and its functions, and the skills required. Mastering it to hold one of his positions, and this guide ends by presenting the most important learning sources for data science.

Second study: By badr Al-Ghamdi, 2023, Data Science and Artificial Intelligence, through which the researcher presented the concept of data science and artificial intelligence, introduced the data scientist, the skills he must master, and his personal characteristics, and explained how the administrative work of data science works with artificial intelligence.

The third stud: By Chirag Shah, 2023, Sciencedirect-Elsevier, The past, the present, and the future of information and data sciences: A pragmatic view, Volume 07. In which he explained: the roots of data science and information science, and their complementary and interconnected relationships at the present time, and stressed that both disciplines have gained their place in science through different pasts, paths, and possibilities through what he discussed in this article, tracing their origins, understanding their paths in the present, and examining their paths. Looking forward, he has made several suggestions to ensure the feasibility of employing data science within

information science – as a unique advantage of the former with the strengths of the latter.

Fourth study: By Dulari Bhatt,2023, Data Science vs Artificial Intelligence [Top 10 Differences]. for in this article he answered: what is data science? what is artificial intelligence ? he also completed a comparison table between data science versus artificial and explained the differences in job roles between data science and artificial intelligence.

Fifth study: By Matt Crabtree, Adel Nehme, juil 2023, What is Data Science? Definition, Examples, Tools & More In it, the researchers concluded: "Today's world is witnessing tremendous growth in data, with data science standing at the forefront in providing meaningful insights and data-driven solutions in all sectors. Despite the wide range of skills and knowledge it requires, Mastering data science is a goal that can be achieved through continuous learning, curiosity, and patience". This guide has covered the basic aspects of data science, its diverse applications, essential skills and tools, the different roles, and a roadmap for entering this exciting field.

Six study: By Arsalan Mohammed,2022, Artificial Intelligence in Data Science: 5 Definitive Facts. for in it researcher addressed the following elements: what is artificial intelligence ? types of artificial intelligence? Purpose of artificial intelligence, applications of artificial intelligence? what is data science? Data Science Life Cycle, Purpose of Data Science, Applications of Data Science, Artificial Intelligence in Data Science: Understanding the Relationship, Role of Artificial Intelligence in Data Science, Comparison of Data Science and Artificial Intelligence in terms of goals, underlying technologies, and use cases.

2. Data science concept and development:

2.1. Definition of data science : it is not easy to define the definition of data science or as it is also called "data driven science" and it is natural for its definitions to be multiple, due to the looseness of the main areas that constitute this science and the multiplicity of its fields of circulation, therefore we will take the following definition:

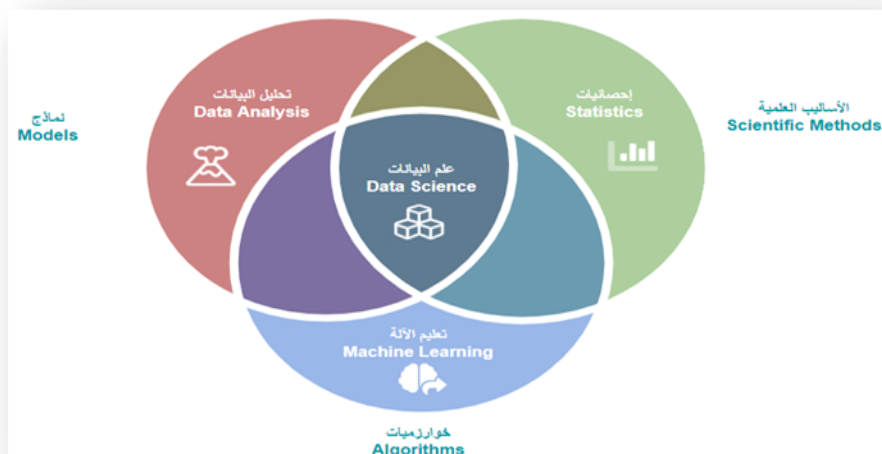


Matt and adel defined it as : "an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from structured and unstructured data after processing and analyzing it to gain insights for many purposes". (Matt Crabtree, Adel Nehme, 2023)

Defined in Wikipedia as: " a concept based on unifying statistics, data analysis, machine learning and their associated methods in order to understand and analyze an actual phenomenon using data; It employs theories and methods derived from multiple fields of knowledge in the context of mathematics, statistics, information science, and computer science. Data science also relies on machine learning techniques, artificial intelligence, and big data processing programs (Wikipedia, 2023).

It was also stated that data science is: " a field of applying analytical skills and scientific methods to extract valuable and important information from raw data or structured or unstructured data in order to make decision develop strategic plans in a specific field of work, analyze systems or build preconception about their behavior". In short data science in the science responsible for extracting useful information from scattered, worthless data in its raw form after cleaning it, correcting its errors, Removing duplicate values from it and treating missing values from it, it is similar to the process of extracting something useful from water" (Ola salah2023)

Fig.1: the concept of modern data science



Source: (abdullah el-noafal 2019).

2.2. Signs of the emergence of modern data science: it was previously called " datalogy" and has recently become called " data science " which is one of the new sciences that appeared at the beginning of the twenty-first century in developed countries especially in the usa as an alternative to computer science, the beginnings of the emergence of modern data science go back to the year 1962, when john tukey published an article under the name " the future of data analysis" pointing out in his introduction the relationship between statistics and data analysis (frank –peter schilling and all, 2021) after which the scientist "peter naur" completed a brief survey in 1974 about computer methods for analyzing data and the (IASC) international association for computing was established in 1977. (Leslie Walcott,2017)

Statistician jeff wu proposed data science as an alternative term for statistics in a 1985 lecture at the Chinese academy of sciences, and then repeatd the proposal in a 1998 lecture entitled: Under the title: "Statistics = Data Science "(Chirag Shah, 2023) , the first datd exploration workshop was held in 1989 organized by Gregory Piatsky- Shapiro under the name "exploring knowledge through data" and it is still held periodically today under the name " exploring knowledge and data mining ". in 1994 business week published a cover story .. database marketing, and on the accasion of the international federation of classification societies (IFCS) conference the term " data science " was included for the first time in the title of the conference titled " data science classification and related methods " (Keith D, 2021), and in 1996 Usama fayyad and GREGORY piatetsky- Shapiro and padhraic smyth" to publish the term " data mining to discover knowledge in databases" (usama Fayyad and all .199.page 38)

In the late 1990s and early 2000s datascience developed as a recognized and specialized field and many academic publication of data science were initiated by proponents such as: Jeff Wu and Williams, in fact Williams Cleveland pioneered the concept of modern data science. research into the field of data science has then expanded since mis-2010 many new programs and even departments have emerged scross the usa, and around the world that specifically address data science needs, on the other hand, some universities have established data science as a specialization in their master's offers for computer science, information science, business administration, or statistics. The goal of this was to find a quick way to teach data science on campus and to create many doctoral offers at its level. (Chirag Shah, 2023 Ibid)

In 2013 IBM stated that existing data had doubled in the past two years, after which companies noticed the importance of transforing the data they had into plans and projects to benefit from it for year to come large companies acknowledged the importance of modern data science and its role in achieving great developments, a former apple manager stated that the increase in sales was due big data and data mining amazon also stated that its book sales increased due

to this science, Google and amazon used deep learning, has been able to recognize sound and words since 2015; and is now competing to employ generative intelligence self-aware and quantum learning.

Which resulted in an unprecedented revolution in data science applications and artificial intelligence technologies, Among them: smart chat sites – CHATGPT4, and virtual assistants such as for example: amazon alexa, siri from apple. google brad...ect. (academy post complex 2021).

Data stocks have expanded significantly since the beginning of the twenty – first century thanks in large part to rapid and successive developments in processing and storage that have been characterized by efficiency and effectiveness especially in terms of cost on a large scale (badr el-ghamdi2023); Abd el rahman farraj Dr explained the specialized affiliation of this science saying : " although data science in the subject of interest for three main disciplines: libraries and information sciences, computer science, and statistics, one of its applications which is big data is disputed by an infinite number of subject specializations due to its significant impact on all facilities almost life".(abd el rahman farraj.2018)

Ola salah emphasized that data science is currently considered one of the sciences that most drives technical progress in the fields of machine learning, online research, automatic voice, and image recognition transportation , health, Risk exploration and many others; this field has become one of the most important fields in the digital world. and there is no wonder about that, as it is the science that is concerned with extracting the value hidden in data which today is the most important corporate asset to the point that it has become called- the new oil, the new gold or the science of the new century. (Ola salah, op.cit).

2.3. modern data science: The identity of specialized affiliation:

Computer scientists are biased towards attributing modern data science to their specialized field, and statisticians consider it as an alternative term for statistics, and mathematicians attribute the credit for its emergence to mathematical algorithms; forgetting the virtue of



libraries information and documentation sciences and their primacy in dealing with huge quantities of data for long historical decades and its professionals are busy organizing, processing ,search tools to retrieve it when needed ; so that they can draw from the abundance of knowledge stored in libraries and information centers, They excel and innovate in their specialized field.

One of the virtues of the library information and documentation sciences specializations is that they are capable of development and the melting pot in line with the course of the era in which its synchronization, it is not immune from exploiting modern data science and its technologies in its practical institution especially university ones, which were created to serve all segments of society and be a center of scientific and cultural radiation for them.

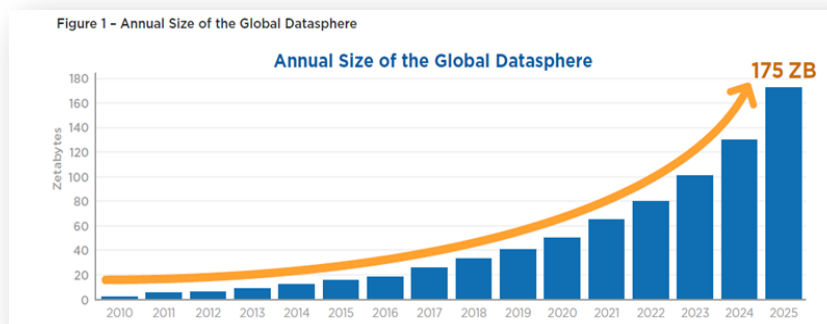
Modern data science based on computer science, and machine learning is divided into the following specialization: software engineering, programming and its languages, computer information systems, information systems security confidently artificial intelligence, mobile computing.

As for teaching data science in library and information departments it is concerned with the following specializations: data management, data analysis, data engineering, Big data information organization and smart learning resources, Systems analysis, design and management, digital content creation project, Information measurements and many others...ect.

and in its entirety it is based on three intersecting specializations represented by: data science, data analysis science, and data engineering science.

Because "***IDC**" expects that there will be 175 zettabytes of data in the following graph shows a zettabyte equals 71.000 bytes, meaning that 1 zettabyte contains 21 zeros, and for this reason we are truly living in the era of the big data explosion and we need a way to process this crazy amount of data (andy patrizio. Lbid).

Fig.2: IDC forecasts the increasing volume of data in the digital world.



Source: (www.predinfer.com, 2023)

According to a report issued by the same organization IDC global spending on technologies and services that enable digital transformation will likely reach 1.8 \$ trillion in 2022 (IDC.12 MAI 2022) and Gartner estimates that by 2022 there will be 90% of organization's strategies are based on considering information as a highly valuable asset of organizations in addition to considering data in general as core competency; in a report issued by Forester, it stated that nearly 40%of data decision makers global analytics are already implementing and expanding big data technology with an estimated 30% additional plan to do so over the next year. (Abdullah Al-Nawfal, previous reference)

Processing this huge amount of data is a very difficult task for any institution or entity, which is why there has been an urgent need for effective tools and techniques to process and analyze this data and qualified people capable of dealing with it, data science began to take shape as a combination of several sciences mentioned above that integrate to accomplish the following:

- Collect raw data and prepare it for processing or qualitative analysis.
- transforming these large amounts of raw unstructured data into valuable information .
- Presenting data and displaying it visually to clarify strategies or decisions based on the results of analyzing that data.

- Extracting ideas and insights from the analyzed data using smart technologies and machine learning algorithms.
- Develop business development strategies based on the results of analysis and study.
- Making correct or close to correct expectation in various fields. (Ola Salah, 2023,op. cit.)

3. data science and library and information science: aspects of connection and functional overlap:

Libraries specialists, who in ancient times used to deal with information vessels of different shapes and types, today face new challenges and challenges, represented by changing methods and tools for organizing and preparing the primary data on which these sources are based. In fact, data itself is nothing new to libraries professionals. For others, data science is an emerging specialty in recent years, as they are the professionals from ancient times who have dealt with huge amounts of data and strive to manage it within administrative, operational, and service frameworks.

If the primary task of data science is to transform raw data and data chaos into actionable knowledge that can be used by decision makers, then the task of libraries specialists is to facilitate access to information and its sources throughout the evolutionary eras that humanity has known from engraving to touch, to create knowledge in local communities.

It is easy to see the overlap between these two sciences if one examines the life cycle of data science: collecting and storing data, preparing data, exploring and visualizing, experimenting and predicting, Extracting and broadcasting. (Mett Crabtree, Adel Nehme, op.cit) we find that it largely coincides with the principles and theories of library and information science in dealing with data and information in its various sizes and forms to facilitate its transmission and retrieval for those who request it.

The libraries specialist does not have to become a programmer but rather he only has to know the various software tools that can

transform raw or unstructured data into information and knowledge, he does not need to be a data based engineer, but rather understands the foundations of information retrieval, he also does not need to be a statistician but he should be has a clear understanding of how descriptive Abstracts and basic tests of numerical data work, a librariansies specialist also does not need to be a display designer, but he does need to know how to display data in an effective manner.

We conclude by saying that: The libraries and information profession in the academic environment has become in need of continuous training to raise efficiency, experience, and superior skills in accomplishing tasks and functions, especially those related to standards, tools, and methods for organizing and preparing its collections and the information services it provides in digital networked formats, and employing modern techniques and applications of data science To be proactive in discovering the needs of beneficiaries of university libraries, and their tribal orientation on the one hand, and improving their experience on the other hand; all of this will not be possible unless there are data scientists in university libraries who possess the following characteristics:

- Creativity, curiosity, accuracy, attention to detail, passion, patience self-development, constant pursuit of progress, and development, and not to give up, and feel bored with routine, and office work.
- Staying prepared to pursue one of the computer science branches, Knowledge of business strategies, core knowledge, and decision-making skills. (chance. latfoem.2019)
- Critical thinking skills, logical thinking and understanding through deduction.
- Communication and teamwork skills (Dario Radečić, 2021), data analysis, planning organization, problem solving and the ability to simplify and explain complex matters and extract ideas to make predictions and recommendations.
- Ability to craft excellent visuals and stories to communicate data insights and convey results to users(2022. Paramita guha).
- The ability to store and learn a lot of new information, as this specialization requires new information.

-Good level in mathematics, statistics, quantitative techniques, accuracy in dealing with computers and electronic devices, and artificial intelligence (Dario Radečić, Ibid), and the ability to apply them to data science practices (Paramita Guha, Ibid).

-Good skills in science technology engineering, and mathematics or what is known as ***STEM** skills.

-The ability to formulate problems and deal with numbers and this can be achieved with analytical and logical thinking skills

- Familiarity with programming languages and engineering skills as the specialization includes applications in civil engineering

- The ability to learn the English language is essential due to the abundance of materials presented in English in this field, in addition to the technical terms that must be learned, understood, and utilized. (Forsa platform, .op.cit)

3.1. Areas of application of modern data science in university libraries:

The networked digital environment is characterized by an abundance of modern data science technologies and applications to the point of luxury and glut, which has made most institutions of all specializations compete to employ the modern ones to create added and renewed value in the products and services they provide in the competitive market that staying there for the distinguished has become a matter of creativity and innovation, likewise university libraries have not neglected to employ data work which; we will discuss briefly below:

3.1.1. Speech recognition: or audio technology is the result of continuous progress in artificial intelligence technology based on the exploitation of data science algorithms as the human voice is the analog signal that is converted into digital signals and redirected to recognize patterns, as it works the algorithms here convert the audio terms generated by speech into text, Each search engine has its own voice search tool. For example, the "Ok Google" engine uses Google. apple uses "Hey Siri", amazon uses "Hey Alexa"...ect. (Maneesh Kumar Bajpai, Preeti Sharda,2021)

This technology is used in university libraries in many functions and services. including for example: accountability of web catalogs, copy or enriched cataloging, preparation of indexes, Abstracts and authority files, search engines for electronic journal databases, or in the virtual reference service that supports improving the user experience and saves him the trouble of writing and multiple search descriptors, and the experience of automated accountability...etc.

The opposite of technology has recently emerged which is converting written texts into audio clips . an example of which in the website service: ChatPDF which enables the conversion of any PDF file into audio clips and video clips...ect.

3.1.2. Image recognition or OCR optic character recognition: it is one of the data science techniques that:"it converts images that contain text into text formats that can be read, modified, copied, Pasted, and saved"; among its most important open sources we mention: Tesseract, Easy OCR kraken, Ocrd, GOCR, Ocular... ect. (hamza mousa 2022)

This technology was introduced to solve the problem of the impossibility of processing text contained in images using word processing programs, through it, text images, such as a PDF file, are converted into text data that can be analyzed by data and information management systems and programs in libraries, to facilitate operations, automate processes, and improve work productivity.

Among the areas in which this technology has been applied within university libraries are: digitization, Electronic archiving, automated restoration of manuscripts by improving the quality of dots per inch, achieving accuracy in the level of letters, refining their edges and the edges of images and improving printing so that it appears clear and free of any impurities and indexing text generated using text lexical parsers.

Image recognition technology also makes use of the ability to search in various digital formats such as: doc, rft, txt, Pdf,...ect; in addition the technology supports the ability to edit any old document,

and access it from anywhere, backup copies and translation...ect. (quality systems company.2023).

3.1.3. Online search engines: providing suggestions for search descriptors and displaying results is thanks to data science, and its algorithms that make the online search experience faster, more effective and more satisfying for the user. university libraries can employ data science to improve accountability with their search and retrieval systems (for more see: torchi hayat .2020 chapter three .p 293) the most prominent of which today are weebpacs? Especially cloudpacs and airpacs, which enable its user to expand the scope of benefit from the library 's collections and link him to relevant sources on the internet through cloud computing applications and smart phone and tablet technologies. (see also torchi hayet.ibid .chapter one p 100-108).

3.1.4. Products recommendation systems: Most companies, such as Goole, Amazon, and Netflix, rely on data science, which provides very useful technology in improving the experience of the users of these companies by recommending the products of these companies to their users by knowing their tendencies and behaviors, or what is known as personalized recommendation; when you search for something and then find suggestions for similar things later, it is the result of applying data science algorithms. (Ola Salah, 2023, .op.cit) University libraries can also exploit this science in the same context, especially when it comes to recommending modern information sources and playing the role of mediation or- a distribution point-between Its beneficiaries and publishers are online.

3.1.5. Discovering risks: university libraries face many risks whether related to the physical components or their digital part. Such as the dangers of fires, floods and damage to information sources due to the influence of various biological and chemical factors not to mention the technical dangers such as the danger of viruses, hacking of their integrated automated systems, And infringement of the ownership rights of information sources which it owns orprovides direct access to and data science helps in this by designing smart sensors or automated programs that enable early detection of most of these risks and

provide plans to avoid them or reduce their severity and prevent penetration of its technical security devices and support them. (Torch Hayet,2018)

3.1.6. Marketing for information services: data science techniques included in the outputs of the administrative technical and service work of university libraries available on the internet contribute to creating their strongest marketing campaigns and advertisements aimed at ensuring the loyalty of their beneficiaries while expanding the circle of benefit by attracting new ones through various digital spaces for scientific and social communication.

Data science can also be exploited to monitor the behavior and tastes of the academic audiences towards information services and the collections of these libraries develop strategic plans to develop the design of information systems, and forecasting modern publishing trends to achieve precedence and added value in its paper and digital assets and the information services that it will provide in the future in a way that will surprise its beneficiaries, ensuring its survival in its competitive environment.

Diana Hope confirms the researcher's vision in this regard saying: "In fact, library professionals have become more dependent on big data than ever before. In addition to using it to store resources, it is also used to improve and expand their successful marketing strategies, which helps them reach the largest possible number of people." of beneficiaries and enhancing their relationship with libraries. Big data analytics can also be used to better identify target demographics, allocate recommended books to new customers and reach them more cost-effectively.(diana hope. 2022)

3.1.7. Social network analytics: social media networks are witnessing intensive use by current users to the extent of addiction creating a fertile environment for e-commerce, digital content industry, various scientific manifestations, human development programs, scientific, social, political, and cultural communication environment, etc. These networks have been equipped with data science techniques that enable the collection and analysis of data on behavioral patterns and human awareness, including sentiment

analysis related to what is published in the aforementioned fields, identifying the most influential individuals, and measuring interaction rates through alternative metrics based on likes, comments, shares, and clicks on links.

University libraries can employ data analyzes of social media spaces in developing the design of their web catalogs and benefit from the accountability of experts in the subject disciplines they serve to support the formation of valuable collection and compare them with the collections of their local or international counterparts . get to know the most creative and influential authors knowing the research trends and objective needs of its users and the popularity of the documents it possesses both living and dead . social network analyzes also support identifying the most effective academic search engines and electronic journal databases...ect.

3.2. Elements of employing modern data science in university libraries

Until now university libraries are still dealing with different types and sizes of data . whether descriptive or analytical .due to the paper or digital collections they possess or the research data of its beneficiaries and the traditional and automated management data of its systems ...ect, therefore the tasks carried out by the newly emerging data science have been, and are still being practiced in libraries for a long time therefore it was necessary for those responsible for it to provide basic Ingredients to achieve the maximum benefit from employing modern data science techniques, the most important of which are the following:

- Establishing data archives in any of the specialized fields and establishing research data facilities.
- Preparing data for open and interconnected collections analyzing and visualizing data for research and investigation purposes.
- Establishing local data infrastructures and preparing their metadata plans.
- Supporting researchers by using text mining mechanisms.

- Expanding the scope of information literacy programs to include dealing with data and even preparing special programs for them. (Abdul Rahman Farraj, op. cit.)
- Providing advice on copyright and intellectual property rights arising from big data applications and analyses .
- Ready to deal with data science applications. (ibid., 2018)
- They must also be able to create new services or improve the services provided and they cannot keep up with rapid change without understanding technology and they must be more active, creative and flexible. (Ibtisam bint Saeed Al-Shahoumiya, Ruqaya bint Khalfan Al-Abdalia, 2020)
- The strength of the technical skills of university libraries specialists to expand and innovate new research directions, especially at the level of methods of exploring information and its services information technologies and their legal and legislative foundations.
- The availability of smart devices and highly advanced automated processing systems.
- Support privacy and technical security of data.

3.3. Benefits of exploiting modern data science in university libraries:

In general the following benefits can be achieved from exploiting modern data analytics in university libraries:

- Studying the behaviors of university libraries users and predicting their future needs.
- Knowing the rates of benefit from the library in terms of collections services and research tools.
- The level of their catalogs OPACs or websites and their usability.
- Bibliometrics and webometrics studies that aim to reveal the structural characteristics of university library collection and their various sources and support decisions for their development, the adequacy of their storage spaces and their scientific impact factors.
- Developing and upgrading its information services by supporting the good ones and creating others in line with the expectations of its beneficiaries and the added value of its competitors services in the digital environment.

Ahmed ismail Baghdadi mentioned other returns for investing in data science in library institutions:

- Enhancing the decision-making process, discovering knowledge, and take measures related to securing data especially related to people.
- Full understanding of community needs.

4. -data science with artificial intelligence in university libraries.. differences and administrative aspects.

4.1. artificial intelligence: concept, types, and technologies :

4.1.1.definition of artificial intelligence:

Many researchers contributed to providing a definition of it, and these definitions differed according to scientific affiliation, interpretation contexts, and the technological environment in which each researcher grew up. Therefore, this term remains controversial because no precise definition is provided for it.

Artificial intelligence is defined in the Oxford Dictionary as:" a field of study concerned with making computers mimic intelligent human behavior " (oxford advanced American dictionary); it is defined in the encyclopedia britannica as:" the ability of digital computers robots with automatics control to perform tasks normally associated with intelligence living organisms and this term is frequently applied to the project of developing systems that have the intellectual processes characteristic of humans such as the ability to reason or discover meaning or generalization or learning from previous experiences (copeland.b.j, 2023).

The American library association defines artificial intelligence as:" a science that seeks to create intelligent machines that work and interact more like humans and its developments depend on deep learning, machine learning and natural language processing that help computers accomplish specific tasks by processing large amounts of data" data such as pattern recognition, data input to drive predictions and feedback data to improve accuracy over time (site of American library association,2020).

The father of artificial intelligence "MrCarthy" presented an innovative definition of it, which included: " the science and engineering of making intelligence machines ", but he modified his previous definition in 2007 and made it comparable to intelligence computer programs when he said:" Artificial Intelligence is the science and engineering of making intelligent machines, especially computer programs". (hindi abdellah . hindi ahmed .2022.p.135).

4.1.2. types of artificial intelligence:

There are many types of artificial intelligence that there is no space to go into detail . as their theoretical approach has taken many classifications, including: purely reactive, . strong and limited memory artificial intelligence, theory of mind and self-aware intelligence: (for more information look: nikita duggal 2023); the types of artificial intelligence are also divided based on capabilities: narrow intelligence general, and superior intelligence, on the basis of function it is intelligence: interactive machines, limited theory, thepry of mind, and self-awareness intelligence . as shown in the following figure: (look also: avijeet biswal .2023)

Fig. 3: types of artificial intelligence according to capabilities and functions.

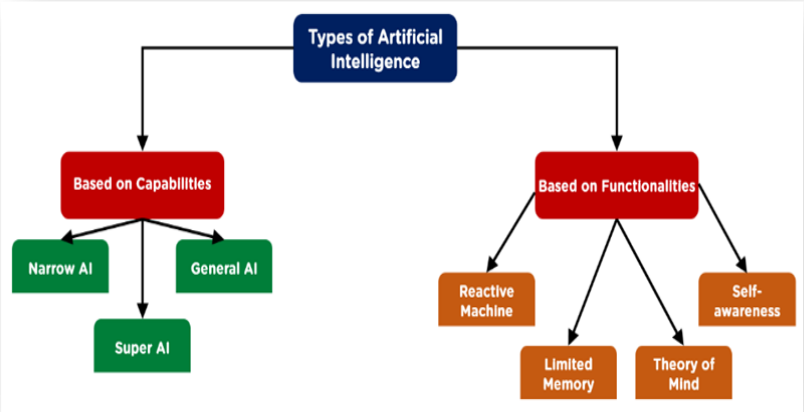
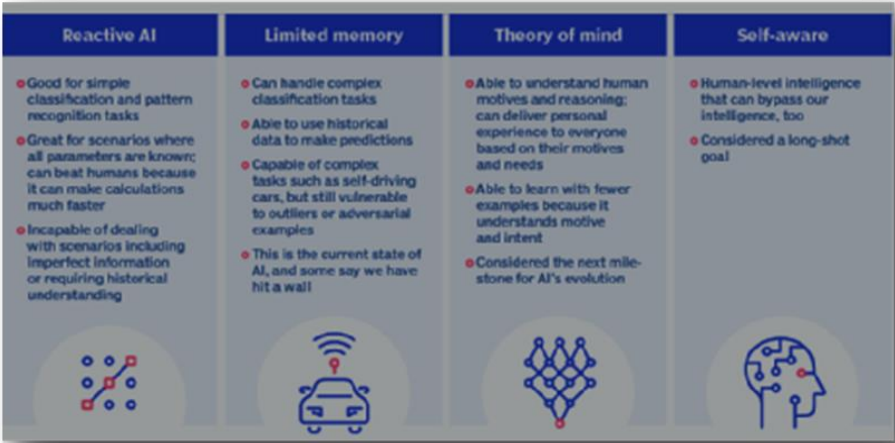


Fig. 4: Types of artificial intelligence according to functions



Source: (Great Learning Team, Aug 17, 2023).

4.1.3. artificial intelligence techniques:

Artificial intelligence is based on a group of modern and developed technologies, including: machine learning, natural language processing, augmented reality, internet of thing technology:(look jack frankenfiled .2023), and quantum computing technology (look also himanshu painuly . 2023), low –code/ No code technologies: (for more information look .. gaudenz boesch.2023)

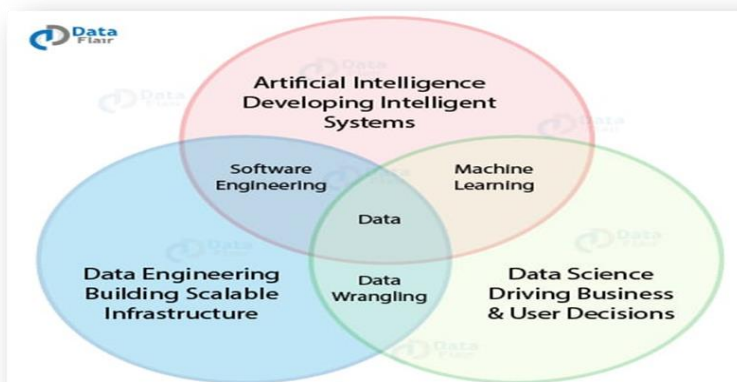
4.2. balancing aspects between data science and artificial intelligence:

After providing a simple overview of the concept modern data science and artificial intelligence, in this element we will discuss the comparison between these two fields and the common relationships between them.

If data science deals with data extraction, transformation and storage in a first stage, artificial intelligence works in data science applications on processed data in a second stage, the image below shows what results from the connection between data science,artificial

intelligence and data engineering, which forms the branch of machine learning and software engineering. (Arsalan Mohammed, 2022)

Fig. 5: Artificial Intelligence and Data Science and Engineering



Source: (Link: <https://data-flair.training/blogs/wp-content/>, 2023)

Data science and artificial intelligence are intricately intertwined, the former will be worthwhile if implemented correctly, while the latter depends on the former to be successful in addition to the ability to make smarter decisions and better control risks to deal with different activities, and from it the success of artificial intelligence depends. It relies on feeding data into learning, inferring, and creating reactions to situations that were not programmed into the machine and vice versa (Arsalan Mohammed, Ibid.), as artificial intelligence plays a major role in enhancing the capabilities of modern data science through the following points:

*- Machine learning: which resulted from companying those two sciences, by placing a limited amount of data in the program to predict the appropriate probapility through analysis and using machine learning algorithms such as regression and classification.

*- Artificial intelligence is not fully represented in modern data science because the latter only deals with predictive analysis and uses machine learning tools for that. Machine learning is just a subset of artificial intelligence, and artificial intelligence can provide many more complex tools for analysis. (Ola Salah, op. cit.).

The following table summarizes the difference between modern data science and artificial intelligence from several aspects so that we can understand the similarities and differences:

Budget aspects	Modern data science	Artificial intelligence
Basic	-includes processes such as data assimilation analysis visualization and communication of derived ideas.	-it is the chievement of a forecasting model with the aim of predicting or classifying future events and trends .
Objectives	-Identify the pattern that need to be found within the raw data of the project under study. -Identify hidden patterns within data to generate meaningful results . insights and ideas to make informed decision.	-automating processes and placing self-managment data within the studied software unit. - enabling computes and machines to work with human intelligence based on the data provided previously and in the future and explaining the outputs.
The type of data it work on	-different types of data such as raw data . structured and unstructured data.	-standard types of data in the form of vectors and built-in types . visual textual and numerical data.
Technologies used	-mathematical and statistical techniques, machine learning algorithms , and data analysis and visualization tools . among them we mention : SQL for data	-algorithms , machine learning and deep leaning on a large scale, and the most important tools for this: keras ,

	migration , power BL , tableau python programming language, NLP MATLAB, tensorFLOW statistics, ++R.	spark , tenso flow , scala scikit learn , caffe, kaffee...ect.
Required skills	Logical thinking , programming knowledge, database management skills, strong presentation skills to convey ideas in a meaningful way, data mining skills, data wrangling , data exploration and visualization.	A strong foundation in mathematics and statistics combined with knowledge of programming , complex machine learning and deep learning algorithms and concepts.
Scientific processing	Pratical processing it follows a consistence procedure typical of a data science pipeline , which includes all steps from ingesting data to communicating insights, itt requires a high degree of scientific processing.	The emphasis in on creating a model object that can be fed into models that generate outputs and thus models very complex in scientific processing because they are intended to mimic human perception.

Typical application	-identify common pattern and trends in the market. -generate statistical insights to support decision making. -conduct exploratory data analysis EDA for the business. -work related to predictive analytics. -anomaly detection , classification , predictive modeling and sentiment analysis.	-in the case of business data that requires high accuracy . -the need to speed up the decision –making process. -the need to separate the emotional and logical aspects of decision making. -Companies need to automate repetitive tasks. -the need to conduct a detailed risk analysis. -speech recognition, automated imaging and recommendation engines
Examples of use	-discove customer behaviors and increase sales using future demand forecasting. -effective management of campaigns through customer segmentation -fraud detection and prevention. -improving operation and financial analysis..ect.	-speech recognition devices such as : Amazon Alexa and apple's siri. - recommendation engins: netflix viewing suggestions, amazon Product catalog suggestion. - robots ,chabots, online games, voice assistance systems..ect.

Table.1: the basic differences between data science and artificial intelligence (the researcher after reading several sources, the most important of which were: Ola salah, 2023, arsalan mohamed, 2022, dulari bhattk,2023)

There are other paths that are beginning to take shape that reflect the significant impact of modern data science on artificial intelligence with the increasing push towards what is known as "explainable AI" which provides information that helps users understand how machines learning models work and the amount of trust they should place in the results of the work of these units, when making decisions , In addition to the role of data science in formulating responsible artificial intelligence design principles to ensure the fairness of all technologies used and ensure their unbiasedness and transparency transparent. (Ola Salah, previous reference, 2023).

4.3. Administrative aspects of modern data science work with artificial intelligence in university libraries:

Twinning the use of modern data science with artificial intelligence will bring about a change in the names and functions of scientific administration that were familiar to university libraries administrators, to modern administrative aspects that work in a networked manner that enables achieving the returns mentioned in the following table:

	Data science	Artificial intelligence
Data management	Collect , verify , store, secure, process and modify data ,	using real-time data, giving personalized suggestions to build machine learning, identifying relevant information and establishing relationships.
Pattern management	Continuous search for patterns of interest for institutions. Report it , help take specific actions and address it in advance.	-identify signals and events , expected and unexpected trends, uncover answer possibilities in detail , identify and learn decision mechanisms and challenges and take additional actions to deliver faster and better results.
Context management	Extracting contextually relevant information from collected and interpreted data.	-facilitating complex computer operations that use data with a single context , extracting subtle contextual differences to continue interpreting data in different contexts m whether interacting with the user or not , thanks to the many forms of natural

		language applications foe reviewing human communications and interactions.
Decision management	Ensuring the development and maintenance of automatic decision-making machines.	Feeding appropriate information for decision –making , expanding the scope of key resources such as: big data and applying its tasks to customer expectation , enhancing user experiences, the effectiveness of problem solving, providing recommendations on verifying decision options , analyzing and predicting the results of decisions , as well as tracking the outputs effectively.
Work process management	Organizing , arranging and coordinating any activity and designing project plans as requested by superiors	analyze these activities , and try to link them to previous decision – making steps , modify special criteria, or recommend a new procedure.
Goal management	Set and monitor goals in order to provide input , as well as help evaluate success and make suggestions for all assets to improve performance.	Help guide humans , robots , applications and scalable underlying data through automated adjustment of targets that track evolving condition.
Risk management	Using big data , to continuously track occurrences and identify emerging problems and threats	.identify and respond to the occurrence of event situation, trends, system logs and personal input such as social networking sites. to potential threats . additionally , problems such as cultural , political , or consumer behavior .ect

Table.2: administrative aspects of data science work with artificial intelligence in university libraries (badr el ghamdi, 2023. Data science and artificial intelligence , previous reference) (transferred to adapted table).

5. Conclusion:

Based on the above, it is clear that investing in modern data science techniques in university libraries will bring huge benefits in its various aspects, especially in its administrative functions, as shown in the table above, and these benefits will increase if the exploitation of this science techniques is twinned with artificial intelligence applications, which will be presented, if the Lord permits, in other works by the researcher.

The most important results and recommendations that emerged from this research were summarized in the following points:

- Credit is due to the technological revolution that the digital world is experiencing in various fields and services based primarily on the application of inferential, analytical, or statistical methods of modern data science.
- Modern data science born of the twenty-first century in which a mixture of sciences methods, and were employed , the most important of which are: mathematical algorithms, statistics analyses, computer science, machine learning and artificial intelligence techniques, is very similar in its tasks and functions to the principles and theories of libraries and information sciences, in organizing and processing data and information, despite the multiplicity of viewpoints regarding the identity of specialized affiliation.
- Modern data science in one of the sciences that most drives technical progress in the fields of machine learning , online research , automatic recognition of voice and image , meanings of words , transporatation , health and risk exploration ... , which makes it mandatory to exploit it in university libraries, with the provision of a specialist or data scientist who is characterized by. with the skills mentioned above.
- If modern data science deals with data extraction, transformation and storage in a first stage, Artificial intelligence works in data science applications on data processed in a second stage; hence, the success of the latter depends on feeding data into cognitive or quantum intelligent learning, inference, and creating reactions to situations that were not programmed in the machine...etc., and vice versa.

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- IDC:** the international data corporation.-
- STEM:** science & technology & engineering & mathematics.-
- OCR:** optical character recognition-