



The Roles of Expert and Smart Systems in Enhancing the Performance of Digital Libraries

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Abstract

Digital libraries would always possess more advantages as compared to physical libraries. Mostly the factor of maintenance of the digital library is easier than maintaining the physical library. Digital libraries do not need a physical building, do not need librarians to choose a book, does not consume more time to search for a book, reference, research paper, or any other resources. But while digitalizing a library, there is still a need for guidance or a route that would support the well-versed working of digital libraries. For that, the conventional libraries started shifting their services to an online or a virtual mode, so that they can provide better service for their consumers. This is a study to elucidate the ways and benefits of smart systems and expert systems when they are implemented in digital libraries. The major objective of the research is to find out how digital library services can be improved by applying smart systems and expert systems. In this study, the author has used an evolutionary algorithm called a genetic algorithm. The genetic algorithm is generally used in those cases where there is a need for a heuristic search, where the algorithm reflects the process of natural selection that finds the fittest units and is chosen for reproduction to produce the next generation. To prove the appropriateness of the genetic algorithm for this study, a tree map is illustrated. For a comparison of aspects, the radar chart is used.

Discipline: Information Systems & Technology, Electronic & Digital Library Management.

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1 Introduction

In earlier days it was very difficult to find a book in a library. One has to request the librarian to find the user's desired book or reference or any article so that the librarian can suggest a specific section of books or a shelf or rack. The librarian will suggest the books of his knowledge and the users are using those books. However, with the implementation of digital technologies, digital libraries arrived. In digital libraries, it is easier to find a book and the user can filter the articles and choose from a list of articles that means selecting a book is fully depending upon the interest of the user or the reader. While using digital technologies there is a possibility to have a diminution in the efficiency of the services provided by digital libraries. So, smart systems and expert systems were implemented in the digital libraries to improve the services of the digital libraries (Gul, et al, 2019). An overview of the preceding research suggests that smart systems and expert systems are serviceable intellectual systems in digital libraries and information or data knowledge that imitates the librarian expert's behaviors to assist selection and management. Correspondingly, it's far proven that the present-day records structures have an excessive ability to progress with the aid of using integration with artificial intelligence technologies (Anyira, 2011).

1.1 Digital Libraries

A digital library can be defined as the collection of organised documents in the electronic form, which is available on the Internet or on compact disc read-only memory discs. The digital library is also recognised in other terms such as Internet library or online library. An online storage of digital documents which includes radio, audio, text, images, or other electronic media formats all these are accessible through the Internet. The digital elements can contain digitalised documents such as photographs and print, which are created digitally using cameras on our computer systems and might be also available in social media posts (Ozeer et al., 2019). The major objective of maintaining a digital library is to provide benefits for organizations to access large quantities of digital documents. The real libraries always provide written and printed actual documents in a real library on the other hand, the digital libraries provide large references and knowledge in a safe space, anytime reference and unlimited access. There are three types of digital libraries namely digital archives, National Library collections, and institutional repositories.

1.2 Smart Systems

The smart system functions depending upon the actuators, controller and sensor, this helps to analyse and describe a scenario, and decision-making is performed depending upon the obtained information through the adaptive and predictive manner, this resultant action is termed a smart action. The smartness of a system is measured by looking at energy efficiency, network capabilities and loop control. The smart system generally contains different components such as actuators, decision-making components, sensors, transmitting elements and the control and command unit. These smart systems are widely used in various sectors like the health care sector, automatic sector,

environment, the Internet of Things, robots, smart city, machine learning, microelectromechanical systems, micro-bots, and so on.

1.3 Expert Systems

An expert system is used to bring out human behaviour and judgment using a computer program that relies on the technologies of artificial intelligence. The expert systems are generally meant to enhance but not replace human skills. The expert system can be defined as “an interactive and reliable computer-based decision-making system which uses both facts and heuristics to solve complex decision-making problems”. The major motive of the expert system is to find out the solution for the most complex problems in a particular field or domain. The association of expert systems and artificial intelligence again has the capability to resolve several problems that usually need support from a human expert. Additionally, expert systems and artificial intelligence systems can find out the reason and express knowledge in specific fields. The expert system can be considered as previous technologies of new intelligent systems such as deep learning systems, machine learning systems and artificial intelligence (Nahak et al., 2019).

1.4 Implementation of Smart Systems and Expert Systems on Digital Libraries

Smart systems are widely used in digital libraries to enhance the services for readers and users. Google Assistant, QR codes, bar codes, OPAC and cloud computing are some of the smart systems implemented in digital libraries. The Google Assistant is one of the main features of the digital libraries, Google Assistant enables voice searching and voice commands which lets the devices to complete various operations just by saying “Ok google”. This conversational interaction between technology and human beings is designed to ease the work of people. With this Google assistance, an acutely integrated assistant project was set up using Python which was a library completely written in Python which is supported by the common hardware Raspberry Pi 3 (László, B., et al, 2019). QR codes have the ability to connect unlimited information so that the service providers can link their digital library catalogue to the QR code. Digital library service providers can just have a website or a URL, where the readers can place their smart devices and just scan that QR code like a bookstore entrance. After the scanning, the readers can directly go through the catalogue of their library and pick their book. The technology called QR code is used widely like a media that can deliver any information to the end users and the readers. The major motive for using QR codes is to enhance their service efficiency. The present-day uses QR code technology to give quick access to references where the content might be subject to copyright.

2 Literature Review

A study conducted in 2016 disclosed that the belief of consumers towards the services of digital libraries, references and services are found to be more satisfiable. The consumers became highly satisfied and aware all of the resources that are available in the digital library. Wi-Fi, World

Wide Web and search engines are comparable to the abstract, online databases, online indexes, video CDs, portals, online abstract, and CD-ROMs. Simultaneously factor was investigated that influenced the implementation of digital libraries among the research people. The results were published conveying that the features of the interfaces brought a cognitive response that has an ability to bring foresight to the scholar's objective to make use of digital libraries. However, the direction, system features, and personal differences will affect the effectiveness. "Usefulness is directly affected by system characteristics and system quality". In conclusion, they have found that the usefulness of digital libraries had the highest intention to use such libraries. In another research, the researcher worked with the "flow experience". The flow experience is defined as the greatest experience depending upon the activity that was completed by comparing perceived challenges and perceived skills. The study discloses that more handlers experienced flow in using digital libraries than other common physical libraries. In the case of quality of the digital libraries, a research paper was submitted in 2014 which concluded that the quality can be analyzed from two factors: the quality of the digital library services and the quality of the information. Based on the handler's insight study, digital libraries offer better service and system quality than virtual communities with better information (Baryshev, et al., 2018).

3 Research Methodology

The digital libraries are provided physically and also remotely through intra-network. So that the two methods for providing digital library services are online mode and offline or physical modes. The libraries which function in offline mode would implement technologies such as the Internet of Things to obtain data in real time. Along with that the digital library system, implementing the Internet of Things (IoT) with the collaboration of technologies for automating libraries' conventional crucial processes, would give the experience of the next-generation digital library. The readers can make use of the IoT to access all the services from the digital library easily. Solving complex problems humans might take a long period but that is not the same in the case of machines, the machines just need relevant and appropriate data to solve similar complex problems. In real-world applications, the genetic algorithm is used widely. There are a few basic building blocks of genetic algorithms such as population, chromosomes, gene, allele, fitness function, genetic operation and solution, the selection has three types like rank rounded selection, event selection and roulette wheel revolution. The genetic algorithm has five different working stages such as initialization, fitness assessment, selection, reproduction and termination (Baryshev et al., 2015).



Figure 1: Genetic algorithm for digital library systems.

4 Implementation

Implementation is the accomplishment or exercise of a strategy or a plan, a way or any proposal, specification, model, idea, preferred or coverage for doing something. As such, the implementation section is the motion that needs to comply with any initial questioning for something to virtually happen (Anyira, 2011).

- Step 1. Initialization - Generate an initial observation. This observation is typically generated randomly and can be of any size, from only a few units to thousands.
- Step 2. Evaluation - Each element of the observation is then evaluated and calculated for the 'fitness' for that unit. The fitness value is then calculated by analyzing how well it fits with the anticipated necessities. These necessities could be uncomplicated, “faster algorithms are better”, or extra composite, “stronger materials are better but they shouldn't be too heavy”.
- Step 3. Selection – This step helps to constantly improve the observation’s total fitness by removing the corrupted projects and only keeping the finest units from the observation.
- Step 4. Crossover - All through at the time of crossover it generates new units by compounding features of the selected units.
- Step 5. Mutation - Transformation characteristically works by the construction of very minor variations at random to a unit’s “genome”.
- Step 6. Repeat! - Now the next generation could be started yet again from step two up until the calculation reaches a conclusion condition.

The formula of the Genetic algorithm (Anyira, 2011) is

$$P(C_{50}) = \left| \frac{f(C_{50})}{\sum_{i=1}^{Npop} f(C_i)} \right| \quad (1).$$

Here, the $P(C_{50})$ denotes the probability of selected observation and the letter f stands for a non-negative fitness function. The “overall performance” of a “genetic algorithm” relies upon distinctly at the technique used to convert research solutions into genes and “the unique criterion for success,” or what the fitness feature is virtually measuring.

Other crucial information is the chance of crossover, the chance of mutation, the dimensions of the populace, and the wide variety of repetitions. These values may be adjusted after measuring the algorithm’s overall performance on a limited experimental turn. “Genetic algorithms” are utilized in a lot of applications. Some distinguished examples are machine learning and automated programming. They also are properly applicable to modelling spectacles in social systems, population genetics, the human immune system, ecology, and economics (Kim et al., 2004).

5 Results

In this study, the effective algorithm used is the genetic algorithm because the frequency of using the genetic algorithm is comparatively larger than other revolutionary algorithms. What is a

tree map? A tree map is also termed a proportional map and a box map. It is called a tree map because the data visualization of the tree map is similar to a tree, like a tree has its branches and subbranches, Similarly, a tree map also has its own branches and sub-branches. The treemap chart is mainly used to create a hierarchical view of the data obtained for the analysis. This treemap makes it easy for the learners to understand the patterns and analyse them. Treemaps provide a comparison of the sections that create the entire concept in an arrangement of snuggled rectangles in a comparatively minor space (Figure 2). As an advantage, the tree maps also sort all its objects respectively in the natural ordering.

Percentage-wise analysis:

- Genetic algorithm: 68%
- Genetic swarm algorithm: 4%
- Simulated annealing algorithm: 4%
- Particle swarm optimization algorithm: 8%
- Ant bee colony algorithm: 4%
- Liang-Mendel Tuning algorithm: 4%
- Differential evolution algorithm: 4 %
- Hybrid stem cell algorithm: 4%

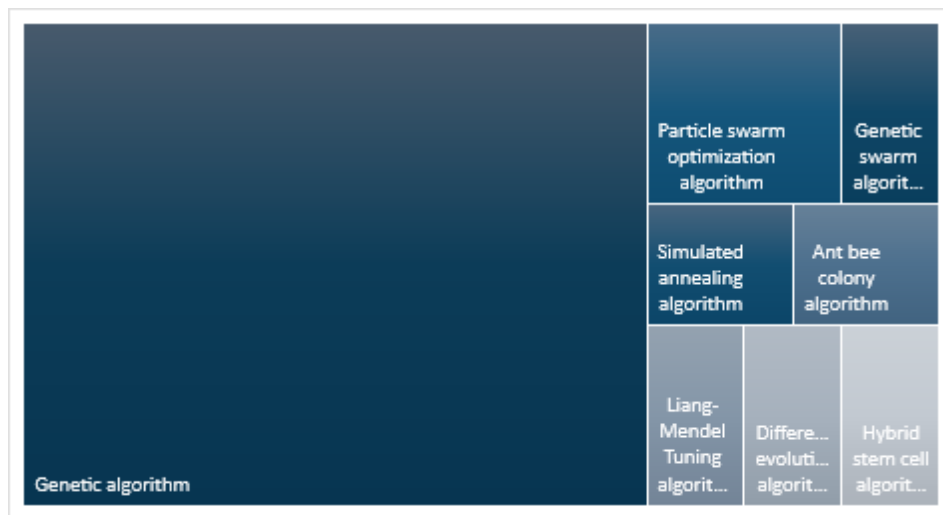


Figure 2: Treemap of algorithms used in digital libraries.

Conferring to the study the majority of the research scholars use the genetic algorithm in such cases. As a result, around 68% of the researchers are making use of the genetic algorithm. But this does not mean that other algorithms are inefficient, every algorithm works efficiently in its use case but here it is recommended to use the genetic algorithm for better analysis. According to the study, digital libraries are growing smarter along with expert systems and smart systems implementation. Due to the random use of such systems, it is observed a satisfied and effective working of digital libraries. The implementation of expert systems and smart systems in digital

libraries has filled the space between the provisions provided by digital libraries and drastically competing and changing human needs (Zimmerman et al., 2019).

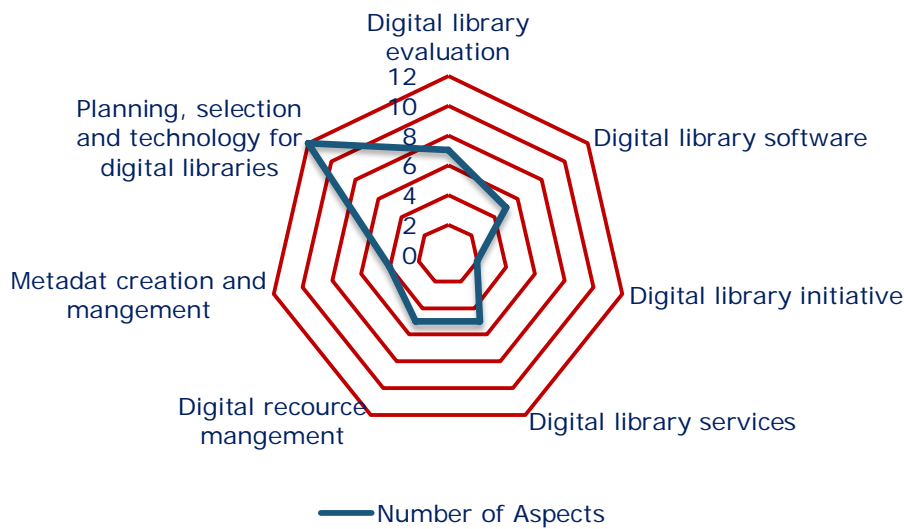


Figure 3: Radar chart for a number of aspects involving digital libraries.

Figure 3 is an illustration of a radar chart. The radar chart is represented to figure out the comparison between two or more than two groups or items depending upon distinct factors or features. These radar charts are also known as spider charts due to their appearance. In this analysis it is clear that digitalization is improving a lot and it helps in the efficiency of digital libraries. The planning, selection and technology for digital libraries need more characteristics compared to others (Nwabueze et al., 2019).

6 Discussion

In the prevailing day, genetic algorithms are utilized by huge agencies to enhance agendas and layout products that vary from huge planes to minute computer chips to medications. The “Los Alamos National Laboratory” has used them to investigate the statistics from satellite broadcasting. They have been used to produce practical computer graphics for movies. There also are many packages for “genetic algorithms” inside the economic sector, consisting of figuring out fraud and predicting marketplace fluctuations (Gardiner, 2019). They are even getting used to the improvement of new styles of artwork and music. According to “Leicestershire County Council” study conducted in the year 2021, the subsequent services are concentrated in a digital library:

- Library substances may be borrowed, renewed and returned and charge of fees for the use of the self-provider booths.
- Collect reserved gadgets that might be watching for series on the reservation series factor and borrow them the use of the self-provider booths.
- Use the general public PCs and unfastened digital library Internet WiFi.

7 Conclusion

Digital libraries are associated with developing traits and improvements in the delivery of education. Distance training, virtual classrooms, online instructions and comparable traits are synonymous with training at this age. Digital libraries are converting the landscape of records service transport in today's world. As customers get extra sophisticated in their records searching for endeavors, libraries should reply undoubtedly with the aid of adopting techniques and improvements to satisfy the desires of their customers. Failure to satisfy as much as customers' expectancies might see them being with the aid of using-surpassed for different records providers. In the beyond decade, laptop generation has ended up progressively effective and smooth to use. With the arrival of the World Wide Web, the manufacturing and alternate of virtual data has extended exponentially. Subsequently, the improvement of digital libraries is gaining growing consequence (Leicestershire County Council, 2021). The massive extent of files in digital libraries, the innumerable varieties of those files and the dynamic nature of digital files name for computerized mechanisms that accelerate the feature of digital library cataloguing at the same time as keeping the effectiveness of human cataloguers. Expert systems and smart systems were proposed as a likely answers for this cataloguing requirement.

8 Availability of Data and Material

All information is included in this work.

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