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Artificial Intelligence Algorithms for Healthcare Services

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Abstract A range of healthcare and medical sectors can benefit from the intelligent concepts, approaches, techniques, and algorithms provided by artificial intelligence (AI) paradigms. AI could streamline patient flow or treatment strategies and give doctors virtually all the data they require to make wise medical and healthcare decisions. Healthcare is just beginning to undergo a significant change because of AI, starting with the creation of treatment strategies and moving through the augmentation of repetitive tasks through medication management or drug research. It can be used in a wide range of contexts, including data management, drug research, diabetic treatment, and digital consultation. Furthermore, the benefits of AI enable the investigation of enormous datasets by algorithms in situations like those involving inaccessible geographic regions. Most other emerging technologies fall under the general heading of AI. Due to their significance in identifying patients with chronic diseases, their capacity to identify risk scenarios, and their ability to foster the development of novel remedies, these new technologies must be integrated into healthcare. As a result, a set of rules that are too complex and extensive for a human programmer to handle is given into an AI software to detect the similarities. The main objective of this paper is to analyze the major known AI algorithms and to show their usage with healthcare services.

Keywords: *Artificial Intelligence Algorithms, Healthcare Systems, Linear Regression, K-Nearest Neighbors, Artificial Neural Network, Hypermutation Genetic Algorithm, Fuzzy - Case Based Reasoning Algorithm*

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1. Introduction

Artificial Intelligence (AI) algorithms play nowadays an important role in the healthcare sector. They are entangled in the process of identifying a disease and knowing its diagnosis till proposing which appropriate medication can be administered.

According to Rayan et al. [1], the discipline of *machine learning (ML)* evolved from AI. The significance of ML for healthcare is found in the designing and creation of algorithms that allow computers to adapt their behavior in response to empirical data. By giving precise medical diagnoses, identifying diseases in their early stages, and performing disease analyses, ML plays a significant role in e-Health. Moreover, Schaar et al.'s [2] presentation of numerous uses of AI and ML included finding common people who would be at increased risk of infection during the COVID-19 pandemic. Additionally, AI and ML can be used to emergency room requirements such as patient triage, wait time, clinical monitoring, and diagnostic imaging interpretation [3]. As shown in [4,5,6], the use of electronic triage (e-triage) has been growing recently in emergency rooms, especially with the COVID-19 epidemic. The e-triage tool predicts the patient's health issues using predictive data and a machine learning algorithm. According to Ferdous et al. [7] there are numerous distinct machine learning algorithms for the various healthcare professions. As a result, they classified these algorithms based on disease prediction and added the accuracy level of each algorithm.

Furthermore, knowledge engineers have recently developed AI frameworks for creating smart health technology [8,9]. Additionally, Norori et al. [8] thought that while choosing which AI algorithm to utilize, it is essential to consider the idea of algorithmic bias. Biased algorithms may come from biased training data that is unjust or inaccurately representative.

The primary goal of this paper is to give a comparative analysis of the various uses of AI algorithms from a healthcare perspective. Additionally, we present as a case study, a smart tool to the medical professionals working in "Emergency Units" of the Egyptian hospitals to make swift decisions on the patients being transferred in ambulances.

The rest of the paper is organized as follows: Section 2 gives an overview of the major known AI algorithms in healthcare. Section 3 describes our comparative analysis regarding the usage of the various AI algorithms in healthcare. Section 4 presents our results and the proposed smart tool for the case study. Section 5 concludes the research work presented in this manuscript.

2. AI Algorithms in Healthcare

Although Vaishya et al. [10] discussed the importance of AI algorithms / applications from the perspective of COVID-19 pandemic; it is still a fact that their research applies to different aspects in healthcare. They found seven important uses for AI in the COVID-19 pandemic. First, AI can be utilized for early infection detection and diagnosis. Second, AI can create a smart platform for automatic tracking and forecasting of this virus's spread. Thirdly, AI can successfully maintain contact tracing of the persons and assist in analyzing the degree of this virus infection. Fourthly, AI technology can monitor and predict the virus's characteristics from the data at hand, as well as project the number of cases and death. Five: AI can be used to analyze existing medications and vaccines and create new ones. Sixth, AI can lighten the load on healthcare professionals by supplying digital strategies and decision science. The seventh area of use for AI is real-time data analysis, which allows for the provision of up-to-date knowledge that can aid with illness prevention. This section goes over some of the most well-known AI algorithms and illustrates how they are used in the healthcare industry.

2.1. Applications for Some Well-Known AI Algorithms

Linear regression (LR) is one of the most popular AI algorithms used for healthcare services. Regression's primary goal is to provide a method that is effective in forecasting dependent qualities from a set of characteristic variables. Using the linear regression approach, Taloba et al. [9] established a model to forecast the overall cost of healthcare. In order to identify the attributes most impacted by the total cost of maintenance, they employed linear regression to investigate the link between total maintenance and other properties in datasets. To determine the Pearson's correlation coefficient (PCC) for each simple linear regression sample, 75% of the dataset's data were trained, and 25% of the data were tested. Taloba et al. [9] research unambiguously demonstrated that Medicare program spending on healthcare is closely related. This discovery might inspire preventative actions. An intrinsic approach that could be modified by variables that can be altered is demonstrated by autocorrelation. As a result, clinicians can target these medicines to the appropriate HCHN group using more precise machine-learning algorithms. According to Taloba et al. [9], the suggested approach requires less training time and lowers the possibility of overfitting. The new linear regression approach proposed has a 97.89% accuracy rate for calculating the cost of medical care for patients.

Another type of algorithm that interact with healthcare are the neighborhood algorithms. A survey on the different types of applications using the *Variable Neighborhood Search (VNS)* algorithm in many areas of healthcare was presented by Lan et al. [11]. Applications covered in the survey were subdivided based on their problem usage such as: home health care, operating room, nurse rostering, routing optimization, and others. The efficiency of techniques plays a crucial role in solving the complex optimization problems that are NP-hard and require the consideration of numerous realistic and complicated constraints in the field of health care. It has become vital to increase service quality and provider efficiency in recent years due to the rising demand for healthcare services. According to Lan et al.'s [11] survey, VNS's adaptability and focus can deliver effective solutions for challenging healthcare issues in a timely manner. Moreover, VNS can also be applied to more general health care areas including disease detection and treatment.

Machine Learning (ML) architecture, which is one of AI applications, for a particular task is still a challenge. Sánchez-Gutiérrez and González-Pérez [12] introduced a machine learning approach for classifying medical data into many categories. Two parts make up this approach: a classifier system and a constrained Boltzmann machine. It employs a discriminant pruning technique to choose the most prominent neurons in the neural network's hidden layer, which subtly results in a choice of features for the input patterns feeding the classifier system. Based on the information gathered from the training dataset and the votes of the nearest neighbors, they used the *K-Nearest Neighbors (K-NN)* technique to generate a new model class. The k-NN classification algorithm collects data from a training set and utilizes it to classify the new examples. This technique is also known as memory-based learning or instance-based learning. Sánchez-Gutiérrez and González-Pérez [12] chose the same classifier (K-NN) to produce consistent results across all experiments and to be able to assess patterns in the multi-class studies. As a result of merging the K-NN algorithm with their proposed approach, the outcomes after pruning the neural network by up to 90% were positive.

Furthermore, doctors can use *Artificial Neural Networks (ANNs)* as a potent tool to model, interpret, and analyze complex clinical data for a variety of medical applications. To enhance service delivery at a lower cost, health care organizations are utilizing machine learning approaches, such as ANNs. Additionally, as Deep Learning frameworks develop and gain popularity, techniques based on ANNs have grown more and more appealing in the medical field. In natural issues, such medical disorders with extremely imbalanced data, ANN performs better. Accordingly, a new Artificial Neural Network (ANN) model was put up by Fong-Mata et al. [13] to improve the "Accuracy and Sensitivity / Recall" of an unbalanced dataset. The original training dataset was produced using a brand-new data augmentation approach. For the goal of training and validating the suggested ANN model, a new dataset of synthetic cases represented by a matrix with 10,000 cases was created. To handle the evaluation of the "Accuracy and Sensitivity/Recall" dataset, they also developed a new algorithm. Utilizing the well-known k-fold cross validation approach, validation/test is carried out. 59 actual cases from a public hospital were used in the external validation/test, which was carried out utilizing historical data. Fong-Mata et al. [13] compared their results against other machine learning methods. Their findings were 96.31% for Specificity, 68.35% for Sensitivity/Recall, 81.30% for Precision, and 90.99% for Accuracy which were considered almost higher than the other approaches.

Moreover, the goal of *Generative Adversarial Network (GAN)* is to enrich existing data by creating new, artificial data. They produce new, previously unheard-of data and learn the distribution of the training set. GAN produces the entire output at once. As a result, Vaccari et al. [14] performed a data augmentation from patient data received through "Internet of Medical Things" (IoMT) sensors using GAN. The application of GAN would result in a significant production of data in accordance with the case's criticalities. Furthermore, because these data are synthetic and do not contain personal information, they can be transferred between different organizations without raising any privacy concerns. Vaccari et al. [14] chose to utilize a GAN method to perform data augmentation on a modest starting dataset. This was due to the significance of a sufficiently large dataset in the healthcare setting for implementing refined machine learning algorithms. These algorithms should be capable of recognizing diseases, according to several essential factors. This technique simulated the monitoring of extra persons in their many critical parameters to see how the machine learning algorithm responds and advances with more data. The results showed how artificial datasets produced by a well-structured GAN are comparable to actual datasets.

Furthermore, Alwateer et al. [15] suggested an appropriate method for quickly and accurately processing medical data in real-time while reducing the amount of computation required. By recommending an Ambient Healthcare strategy that uses the *Hybrid Whale Optimization Algorithm* and Naïve Bayes Classifier to do feature selection on data and subsequently classify it. Accordingly, processing time can be decreased while performance is increased. The suggested method makes use of a hybrid algorithm that has two steps. The Whale Optimization Algorithm was used as a feature selection strategy in the initial step with the goal of reducing the number of features for huge data. The second stage then used the Naïve Bayes Classifier to do real-time data classification. The Naïve Bayes Algorithm (NB) is a classification method based on the Bayes Theorem that presumes predictor independence. Naïve Bayes has several benefits including simplicity, speed, and efficiency. NB is better suitable for text data and fog computing support because it takes less training data, is scalable, handles both continuous and discrete data, and handles them both well. The Naïve Bayes model is easy to build and particularly useful for very big datasets. Along with simplicity, Naïve Bayes also offers quite sophisticated categorization techniques. Fog computing is the foundation of the suggested strategy because it improves corporate agility, security, privacy, and provides deeper insights at lower operating costs. The results of the experiments showed that the suggested hybrid algorithm (WOA for optimization and NB for classification) can decrease the number of dataset characteristics, increase accuracy, and speed up processing. The average rate of accuracy improvement is 3.6%. Additionally, it increased processing speed by cutting processing time by an average of 8.7%.

Effective appointment scheduling (EAS) is critical for hospital management quality and patient happiness. To provide outstanding service to patients arriving at varied times, it is critical to assess fairness in appointment scheduling systems. Therefore, Ala et al. [16] presented and solved the appointment scheduling problem model at the hospital using the fairness approach. They used a two-objective mathematical model of fairness in fuzzy environments. The Whale Optimization Algorithm (WOA) and the Non-Dominated Sorting Genetic Algorithm (NSGA-II) multi-objective optimization methods were used to solve the problem. There are numerous sorts of Whale Optimization Algorithm (WOA) modifications and implementations. Rather than conducting scheduling research, their proposed algorithm examines the optimization of a long-term admission strategy. In terms of computing time and harmonizing use, WOA outperforms other common algorithms. The whale optimization algorithm (WOA) is structured similarly to the classic WOA for optimizing scheduling procedures, with the addition of a local search operator to optimize solutions. The proposed model is solved using the meta-heuristic algorithms' random WOA essence. Experiment results revealed that the suggested algorithm-optimized strategy outperforms both the FCFS and WOA tactics.

A further approach to extract and identify the medical phrases from 16 unstructured clinical notes was published by Abbas et al. [17]. The Unified Medical Language System (UMLS) *Metathesaurus* is used in this extraction and identification phase to precisely match the medical terms. To create a list of one medical phrase vs numerous concepts, the next step is to identify all concepts associated with each medical term. As a result, each concept's entity type and a collection of semantic types are determined. One term can refer to several concepts, and each concept can refer to a single entity type for each semantic type. The resulting algorithm can aid in the conversion of the unstructured medical notes into a structured format that is easily ascribed to useful medical terminology. This data preparation aids in the training and testing of machine learning prototypes.

2.2. Case-Based Reasoning (CBR) Applications

Decision-making is complicated because of ambiguity, specifically in the fields of medicine and public health [18]. Accordingly, the value of AI in healthcare stems from the various features it provides, such as decision-making in either patient diagnosis or treatment. The various algorithms that AI has to provide, and the supporting technologies are what make it possible to provide various services. In the healthcare industry, for instance, the *Case-Based Reasoning (CBR)* approach can be utilized to memorize case histories and experience data that will later be retrieved for educating about current issues. CBR is an AI strategy that has broad applicability for creating intelligent systems in fields related to the health sciences [19]. It stands for information in the form of noteworthy examples from the past or cases. CBR is comparable to problem solving, which involves remembering and bringing back experience data to resolve related problems [18]. CBR is a hybrid qualitative and quantitative paradigm for storing and retrieving experience. It is particularly well adapted to the health sciences, where case studies are used to guide current practice and experience plays a significant role in learning new skills and information [19].

For example, Ying el al. [18] merged the CBR with the multi-agent system (MAS) to reveal the clinical decision support industry's ontological applicability. According to the clinical approach, a multi-agent system (MAS) for decision-aiding assistance utilizes and combines databases, knowledge bases, ontologies, and multiple styles of reasoning. They used the MAS to ensure communication between disparate medical knowledge bases. It provides users with an interactive experience through the supervisor agent and guarantees the compatibility of data models and knowledge stored in the agents. Ontologies agents offer semantic interoperability of knowledge. In order to specify the rules and interfaces for knowledge representation and request response, a multi-agent system must be implemented. After that, CBR maps the data to the already-existing bases to give doctors a list of clinical recommendations. The knowledge should be portrayed in a way that is both understandable and complex enough to cover most issues. The matching technique maps and extracts comparable clinical situations in this instance, then offers visual recommendations. As a result of their work, clinical information retrieval from medical knowledge bases to facilitate question-answering between MAS and end users. This helps to lessen the number of inappropriate quotations found in existing medical databases, which necessitate a time-consuming sorting procedure incompatible with medical practice and increase the accessibility of knowledge obtained from clinical processes. Moreover, they demonstrated how CBR can be used to find the best drug or treatment based on similar clinical instances, enhance knowledge representation, and produce medical ontologies at various stages of the clinical process. The method that combines MAS and CBR can help formal reasoning in the disciplines of medicine and related ones.

Geetha et al. [20] used the *Fuzzy CBR decision support system* to predict the priority of COVID-19 patients enrolling in hospitals. They provided a decision-making model to treat patients by accounting for all the variables and prioritizing patients in order to improve care. Ranking high-risk persons to low-risk individuals using this model makes it simple to assist COVID-19 patients in receiving prompt medical care. Thanks to this algorithm, the problem of the increase in hospitalized patients will become easier to handle. Making the correct choices can be quite helpful for medical professionals. The fuzzy method is increasingly being integrated with CBR processes to make it easier to handle imprecise and uncertain knowledge and to replicate human decision-making. The point of care is improved by this model that incorporates a structure for knowledge management and sharing with experts. The suggested technique started by employing data mining to extract the useful metrics from the patients' previously generated structured discharge summaries. Then, by eliminating the strong influence of a certain factor, they effectively provided a solution using the cobweb model. Finally, a fuzzy approach analyzed the disease's similarities and contrasts it with prior cases using established CBR system techniques to derive a summary of the condition. Algorithm 1 [20] shows the Fuzzy CBR system used.

Setting parameters α and β based on experts opinion

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if $\alpha = a$
$\beta = b$
a **and** b **are random real number** $\in [-10, 10]$
for $1 < i < m$
for $1 < j < n$
i = **number of COVID-19 patients**
j = **number of factors in the analysis**
m **and** n **are random number** $\in [1, \infty]$
$f(x_{ij}) = \frac{1}{1 + exp^{-\beta(y_j - \alpha)}}$ **right shoulder sigmoid function**
$f(x_{ij}) = \frac{1}{1 + exp^{\beta(y_j - \alpha)}}$ **left shoulder sigmoid function**

Cobweb area model solution of each patient

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find $f(x_{ij}) \leftarrow d_{ij}$
determine $Ca(P_i)$
$NCa(P_i) \leftarrow$ **normalize** $Ca(P_i)$
for all i
sort $NCa(P_i)$ **by ascending order**
max$\{(NCa(P_i))\} \leftarrow$ **sort** $NCa(P_i)$

figure 1. The proposed Fuzzy CBR approach [20]

2.3. Genetic Algorithm (GA) Applications

Metaheuristic algorithms are utilized to address real-world complicated problems in a variety of domains [21]. Metaheuristic algorithms rely heavily on intensification and diversification. A good balance of these aspects is essential to handle the real-life challenge effectively. Among metaheuristic algorithms, the *Genetic Algorithm (GA)* is well-known. GA's fundamental components are chromosome representation, fitness selection, and biologically inspired operators. The genetic algorithm (GA) is an optimization technique inspired by natural selection. The new populations are created by iteratively applying genetic operators on individuals already present in the population. GA dynamically changes the search method based on crossover and mutation probability to find the best answer. GA can evaluate numerous entities and generate multiple best solutions. As a result, GA offers superior worldwide search capabilities. Accordingly, Katoch et al. [21] surveyed many GA applications since with their excellent accuracy rates, GAs have been used in a variety of NP-hard tasks. The surveyed ones that are related to healthcare services dealt with medical imaging, medical prediction problems, or feature selection.

Moreover, Ouertani et. al. [22] discussed the limitation of Home Health Care (HHC) resources and how it is difficult to establish an appropriate health care delivery system that contributes to global cost reduction. Also, due to the NP complexity of the HHC routing difficulties, accurate approaches cannot solve the HHC routing problem in a reasonable computational time, especially for big data sets. As a result, numerous meta-heuristics were developed to address the issue. For example, Ouertani et. al. [22] used the genetic algorithm to solve the Home Health Care (HHC) services problem in a realistic and demanding way. They handled it as a dynamic Vehicle Routing Problem (D-VRP) with the goal of minimizing trip costs. To address it, a *Hypermutation Genetic Algorithm (HGA)* was created and tested in an experimental study against two state-of-the-art techniques. They demonstrated that their concept is quite promising and outperforms rival alternatives in many circumstances. They began by developing an initial routing plan that includes all known patients. Following that, online requests are included into the routing plan in order to be visited at the right moment by re-optimizing routes that contain both known and new patients. This was executed in the form that when a new request is discovered while another patient is being treated, the route is modified once the current service is completed to include both the other patients and the newly demanded ones. When compared to rival algorithms, the created dynamic HGA performs extremely well. According to the normalized score, Ouertani et. al. [22] approach outperformed the previous algorithms, indicating that the suggested HGA is stable regardless of patients count. The results of their experiments showed that the average variation for most cases did not reach 6%. These preliminary results provided a strong indication of the performance and efficiency of the proposed technique to solving the D-HHC services. The suggested Hypermutation Genetic Algorithm (HGA) [22] is shown in Algorithm 2.

```
Randomly generate P of size N
Evaluation: evaluate individuals in P
repeat
  if Environmental change then
    Re-adapt solutions in P
    Hypermutation: apply mutation operator with a
    high rate to solutions in P
  else
    Selection: select chromosomes from P
    Crossover: apply the BCRC
    Mutation: apply the swap mutation
    Evaluation: evaluate the obtained solutions
    Replacement: elitism replacement of solutions
  end if
until (Stopping criterion)
```

figure 2. The proposed HGA approach [22]

3. Comparative Analysis of the AI Algorithms in Healthcare

All the aforementioned AI algorithms, presented in Section 2, dealt with how they can aid the various healthcare services in different disciplines. Table 1 summarizes our comparative analysis by giving the description and pinpointing the points of strength of each algorithm in the healthcare sector.

4. A Case Study with Egypt's National Hospitals

Hospitals are increasingly focusing on the problem of response delays caused by the out-of-date patient documentation records. Egypt, a fast-modernizing country, is starting to replace its antiquated manual systems with electronic ones, particularly in the developing new smart cities. Additionally, it is crucial to preserve a patient's life from the time the incident is recorded until it is transferred to the hospital for rapid treatment. As a result, the integration of computer technology, such as AI algorithms, would unquestionably enhance the quality of the country's healthcare services.

In this paper, we used Egypt's national hospitals as a case study to illustrate how quickly a patient's life might be saved in an emergency situation. Finding the closest ambulance to the reported patient was one of our objectives. As a result, the Hypermutation Genetic algorithm (HGA), which was developed to solve similar routing difficulties, was the best solution to complete this assignment.

The doctor can review the patient's prior medical records while on the transfer journey. Additionally, the doctor could be offered a clever plan of action based on earlier tests carried out on similar individuals. This is thought to speed up the completion of the necessary processes prior to the patient arriving at the hospital. Moreover, the doctor can also offer the ambulance driver further instructions on how to take care of the patient while it is being transported. The additional plan of action, which is based on previous similar cases, was another objective of this study to accomplish. This was to facilitate fast information access for the hospital's chosen physician assigned to the transferred patient. The exact fit for this challenge was to utilize the Fuzzy Case-Based Reasoning (CBR) algorithm to get more information on how to handle the patient based on related cases for its high performance of self-adaptation.

Accordingly, a smart tool prototype was created that applied a heuristic Cloud-based system that accesses all data on Egyptian citizens and people living in Egypt. Using the Hypermutation Genetic Algorithm (HGA), the system simultaneously allocates a new patient's ambulance request. After being alerted to the patient's condition, the specialized doctor logs into the system and accesses the patient's medical history. These data are listed in chronological sequence according to the doctor's area of competence. The Fuzzy Case-Based Reasoning (Fuzzy CBR) approach was used in this system to present more medical diagnoses based on previously memorized comparable circumstances.

Table 1. Comparison of some Major AI Algorithms for Healthcare Services

Algorithm Name	Characteristics	Points of Strength
Linear Regression [9]	It is a way to forecast a dependent property from a set of specific variables. It is a statistical way for applications such as calculating the cost of total healthcare expenses.	It is used to get the main properties affecting the total cost of maintenance. It is used to forecast the potential healthcare expenses using smart devices. The new linear regression approach proposed by Taloba et al. [9] has a 97.89% accuracy rate for calculating the cost of medical care for patients.
Variable Neighborhood Search [11]	It offers solution for healthcare optimization problems in a short time by using the neighborhood perturbation method.	It is used for problems such as: home healthcare, routing optimization, and others.
K-Nearest Neighbors [12]	It can be named as memory- or instance- based learning. K-NN generates a model from the training data set so to use it later for obtaining new interpretations.	It is used to differentiate pruning hidden neural network layers for medical data processing. As a result of merging the K-NN algorithm with the proposed approach by Sánchez-Gutiérrez and González-Pérez [12], the outcomes after pruning the neural network by up to 90% were positive.
Artificial Neural Network [13]	It is a tool to analyze and model medical diseases that have the property of unbalanced data.	It is used to back-propagate an unbalanced dataset to achieve a learning Accuracy. The findings of Fong-Mata et al. [13] were 96.31% for Specificity, 68.35% for Sensitivity/Recall, 81.30% for Precision, and 90.99% for Accuracy which were considered almost higher than the other approaches.
Generative Adversarial Network [14]	It uses data augmentation to produce pure synthetic health data without including the personal data to assure privacy and to abide by the criticality of the health cases.	"Internet of Medical Things" (IoMT) sensors are used to monitor patient's data and accordingly augment. The results of Vaccari et al. [14] showed how artificial datasets produced by a well-structured GAN are comparable to actual datasets.
Whale Optimization Algorithm [15, 16]	It has a low number (three operators) of hyperparameters to demonstrate the humanback whales' actions. WOA has many types that affects positively the computation time and matching utilization other than ordinary algorithms.	It is used to select a minimum number of features from a bigger dataset. It is used in hospitals to fairly schedule patient's timing. Alwateer et al.'s [15] results showed that the average rate of accuracy improvement is 3.6%. Additionally, it increased processing speed by cutting processing time by an average of 8.7%. Experiment results by Ala et al. [16] revealed that the suggested algorithm-optimized strategy outperforms both the FCFS and WOA tactics.
Fuzzy Case-Based Reasoning [20]	It is a knowledge-based way to distinguish new disease diagnoses based on similar past cases. It can self-adapt and offers decision making for uncertain medical cases.	It is used to measure and compare similarity with previous cases in order to prioritize the patient's case.
Genetic Algorithm [21, 22]	It is an optimization algorithm with high search capabilities to reach a new population by changing the probability and mutation of the old population one.	A Hypermutation Genetic Algorithm (HGA) is used to decide the minimum cost route for the Dynamic Vehicle Routing Problem for Home Health Care (D-HHC). The results of Ouertani et. al. [22] experiments showed that the average variation for most cases did not reach 6%.

5. Conclusions

The impetus for this research was the requirement of saving an emergency patient's life from the moment the case is reported until it is transferred to the hospital for rapid care. In order to create smart wellness hospitals, it was necessary to combine computer technology with the healthcare sector. This study focused on the problem of response times that hospitals have as a result of the outdated patient records. Additionally, it tackled the issue of how to integrate various technologies into a solid software solution for Egyptian hospitals, particularly the emergency unit. This study focused on providing the on-site emergency physicians with a straightforward but clever tool that would hasten the process of acquiring the patient's previous data who had similar symptoms.

The objectives of this research were found to be helped by the aforementioned AI algorithms. Therefore, we compared various artificial intelligence algorithms that have been shown to be most effective in the healthcare domain. The research suggested to send the patient to the closest ambulance car using the Hypermutation Genetic Algorithm (HGA). Additionally, due to the Fuzzy Case-Based Reasoning algorithm's great self-adaptation performance, it was chosen for the research to make case diagnoses based on analogous prior cases.

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