Application of AI and Soft Computing in Healthcare: A Review and Speculation

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Abstract: The crisis of healthcare resources in terms of man and machine in our society is the crucial issues. The calamity well observed at outbreak especially in rural areas where sufficient resources for healthcare management is very difficult to manage. The rural people are not getting proper treatment due to the lack of doctors and they most of the instance committed death due to improper diagnosis by the chock doctors. The question is how to minimize this calamity? The answer to this query is to grow technological consciousness in the glove that is the motivation of these reviews article. It has been observed that in healthcare system could not go ahead a single step without soft computing (SC) and it highly related to Artificial Intelligence in this AI-era. The aim of this article is to highlight and resolve these issues by the reviewing the recent development of artificial intelligence (AI). The paper finds link of AI and soft SC techniques in the field of medical diagnosis and healthcare management. This article reviews the methodology and application of each sub-component of AI-SC in the field of healthcare system. It encompasses most of the AI-SC recent development techniques to acquire the knowledge about this domain under a single umbrella. The goal of this review is to explore the application of AI-SC that could enhance diagnosis process of the critical diseases in terms of minimal cost as well as maximal crisis management.

Index Terms: Artificial Intelligence (AI), Knowledge Base (KB), Bayesian network (BN), Artificial Neural Network (ANN), Machine Learning (ML), and Fuzzy Logic (FL).

1 INTRODUCTION

Artificial intelligence (AI) and Soft Computing (SC) play a crucial role in the field of healthcare medical diagnosis. Now a day, doctors could not move ahead a bit without using the technological advancement. The technological advancement in this digital is incomplete if it is not amalgamated with AI and SC. The AI is technique to create intelligent machine. The SC is computing techniques to perceive and learn the real world data, by virtue of which the machine acquire artificial intelligence. Therefore, the machine can do as like human being if the philosophy of working of human being can be modeled using AI and SC techniques. This technological enhancement is being used in the healthcare system for sustainable medical diagnosis.

2 LITERATURE REVIEW

Healthcare information before computing systems may be deployed in diagnostic applications, they have to be ‘trained’ through information that are acquired from clinical activities, like screening, diagnosis, treatment assignment. The artificial intelligence technique such as machine learning and natural language processing review the artificial intelligence devices that have been found useful in the medical application. The authors analyzed the data via artificial neural network and support vector machine, and obtained prediction accuracy above 70%.

The article elaborates such AI and SC advancement in the following subsequent sections. In section 2, a brief literature reviews were incorporated to highlight the recent applications of AI-SC. The section 3, elaborated various AI techniques that was being developed and applied in healthcare system in different sub-sections. The subsections are knowledge representation (KR), intelligent search, ontology, Bayesian network (BN), logic programming, Fuzzy Logic (FL), Artificial Neural Network (ANN), Machine Learning (ML) and evolutionary computing. In section 4, mention the speculation and finding of the reviews. The section 5, lists the application of the reviews results and analysis. Finally, in section 6, the conclusions of the reviews precisely mentioned and the article is end with speculating the future scope.

The sophisticated algorithms need to be trained through healthcare data before the system can assist physicians with disease diagnosis and treatment suggestions[1]. The Distributed artificial intelligence (DAI) could allow the modeling of healthcare intuitions about the reasoning based on knowledge, actions, and planning. Distributed artificial intelligence taxonomy is viewed along three dimensions such as the social abilities of an individual agent, the organization of agents, and the dynamic control of this organization. AI techniques allow an individual agent to have a sophisticated local control in order to reason about its own problem solving and how this fits in with problem solving by other agents. They use directed acyclic graphs (DAGs) as a plan representation to present methods for the verification, generation, and execution of plans for multiple agents. The examination of the process of human interaction and social organization allows DAI designers to conceive a dynamically adoptive organization of agents[2].

AI techniques offer promising alternative methods to urban planning problems, and as AI technologies grow in capability and start to integrate multiple AI approaches, the resulting tools might be more powerful in future applications[3]. Integration of domain information and a data-driven, distributed prognosticative algorithmic rule (Tree-Lasso logistical Regression) resulted in a rise of interpretability of the ensuing model. This research aims to develop an accurate and interpretable predictive model for
hospital readmission based on the integration of data from electronic health records (EHRs)[4]. Moen et al proposes comparison of automatic summarization methods for clinical free text. Information overload in the health sector is becoming an increasing problem for clinicians. The summarization methods utilize word space models (WSMs) constructed from word co-occurrence statistics in a large corpus of clinical text. This work is a step towards exploring ways of automatically constructing indicative clinical text summaries by relying on purely statistical features for determining a sentence’s significance. It suggests that there are reasons to believe that it is beneficial for clinicians to use text summarization systems in their work. This study speculates the impact on documentation speed and quality, as well as health care quality and patient outcomes[5]. The major role of personalized medicine as posited by article [6] is to predict the possibility of an individual developing a disease, achieve accurate diagnosis, and optimize the best treatment available. A study[7], Genomic and Personalized Medicine for classification as a means of disease detection in the Decision Support System they developed. In an article[8], neural networks and decision tree were used to develop a patient specific real time alarm algorithms. The studies show the ability of ANN to diagnose accurately some diseases such as malignant melanoma, eye problems, and different forms of cancer by analyzing diagnostic criteria and spectral information. Support vector machine (SVM), in a related research[9], implemented and intelligent system based support vector machine and Radial Basis Function (RBF) type of Artificial Neural Network (ANN) to diagnose heart disease. They knew associate degree optimum set of seven variables obtainable at the time of designation, whose combination was useful to predict the outcome efficiently of the disease following therapy withdrawal in approximately 80% of cases[10]. In a article[11], the authors present an improved method to fuzzy soft sets in decision making based on ambiguity measure (AM) and Dempster–Shafer theory of evidence where AM is utilized to generate more suitable basic probability assignments (BPAs) of each alternative. The authors believe the proposed method has a promising future. The scientists have presented a generic, repeatable method for developing real-world BN models that combine both expert knowledge and data, when the data is based on complex questionnaires and interviews with patients that is available in medical problems. The method presented and covered a range of techniques for reducing the burden of expert elicited models, and planned research directions will investigate ways to minimize expert dependency without damaging the choice support edges illustrated in the paper[12]. Bayesian networks successfully used in the development of diagnostic systems, both medical and industrial, that diagnose a small number of defects and diseases[13]. The network construction algorithm takes a context-sensitive probabilistic knowledge base consisting of a set of context sensitive probability logic sentences or rules, a specification of the spatial and temporal scope, a set of evidence, and an optional query and generates a Bayes net for that particular modeling problem. Evaluation of the models shows that the autocorrelation links significantly improve prediction accuracy for some villages in regions of high incidence[14]. Value of data (VoD) analysis adopted in health care. An especially important application domain is medicine[15]. Several annotated data sets are publicly available for extracting adverse drug event (ADE) from social media. The Authors adopted different combination methods to develop several ensembles that delivered improved effectiveness compared to the individual constituent methods and the baseline methods, which provides more reliable decision-making support for stakeholders [69], such as patients, physicians, pharmaceutical companies and regulatory authorities[16]. The authors Hosseini et al propose a new artificial intelligence system for electroencephalogram (EEG) feature selection and classification that exploits the advantages of cloud computing and simultaneously increases detection accuracy while decreasing error rate. The proposed method is a solution for feature selection in the big data problem and, by selecting features that are more informative, it makes classification less complex, a distinct need for real-time computation[17].

3 METHODOLOGIES

AI is the study of creating intelligent computing devices, which encompasses Information Technology, Computer Application, Computer Science and Soft Computing. The realization of AI also includes symbolic, numeric, non-deterministic and distributed computation whereas soft computing encompasses the computing techniques to model real world problems that invoke vagueness and biological philosophy. The major components of AI are learning system, knowledge acquisition & knowledge representation, intelligent searching, reasoning, planning, logic programming as well as associate soft computing techniques such as fuzzy logic, artificial neural network and genetic algorithm.

3.1 Knowledge Representation (KR) and Reasoning by Intelligent Agent (Machine)

The projected program is receiving the symptoms from a patient for diagnosing and treatment of ischemic heart diseases by asking about: personal history, case history, symptoms, signs, and needs doing an investigation to give a correct diagnosis. The system uses the rule-based reasoning technique through straightforward querying of symptoms, signs, and investigation done to the patient[18]. The figure 1 depicts computerize medical diagnosis system.
The paper discusses architecture, and an experiment of abdomen pain using a model of a Knowledge-Based System for medical diagnosis. A different type of custom-built heuristic is incorporated with the fuzzy logic programming rule structure. This article proposes a general framework of knowledge-oriented call network for consolatory, diagnosing and awareness for the medical diagnosis sector. A few sample fuzzy rules area unit shaped with the assistance of domain specialists for inflammation case. Decision making by the practitioner within the management of patient’s knowledge could be an extremely intellectual activity, that involves the ability in gathering and evaluating the data regarding the patient; and ability to effectively utilize the massive body of medical. The knowledge domain of the system plays a key role within the procedure of decision-making by efficiency storing the domain data and patients history. The data collected from the sector professional is written within the logic programming language to create a rule base for the applying. A limitation of this medical examiner system is that solely symptoms entered by the technologist within the knowledge domain. The knowledge domain will be updated at any time with new symptoms and new diseases according to the structure in figure 2[20], [21].

In the presence of full awareness of all propositional variables for all agents, implicit, explicit and speculative knowledge are the same. It is different awareness of propositional variables in the root states but still have the same speculative knowledge. It is not merely the case that the information content of an epistemic awareness state is properly captured by the proposed notion of awareness bisimulation, which is a sanity check for a modal logic; but this is the case from the perspective of individual agents that are being modeled in the system. The author Hans et al started out with a logical language, that the authors interpreted on the class K all epistemic awareness models, and that the authors considered all accessibility relations are equivalence relations and that satisfy awareness introspection. If that is the case, given that speculative knowledge operators are bi-simulation quantifiers, the complexity of model checking may be non-elementary[22].

**Fig.1. Architecture of an Intelligent Agent: Knowledge representation and reasoning system[19]**

**Fig.2. Structure of fuzzy knowledge base system**
Fig. 3. Transformation of thought: explicit and implicit learning.

From the above figure 3, it is clear that explicit and implicit learning are probably two different ways of learning and that they relate back to what the authors internalize because of the experiences. The explicit learning is conscious but the implicit relates to the unconscious or unaware aspects of the experience or learning. The people having experiences that are transmitted to the brain, those register in the mind create consciousness belong to explicit learning but there are others that the body learns which do not register in the mind, so they remain unconscious and belong to implicit learning[23]. So, AI techniques: ANN, ML and Deep Learning have the capability to register experiences, which belong to explicit learning. Hence, speculation is that it is possible to build artificial intelligence equipped with artificial human-like consciousness in the future. Populations suffer from complicated medical conditions and require much attention from an array of people, like doctors, nurses, family, and caregivers, among others. Taking into account all of these aspects, the author Costa at al presents the Cognitive Life Assistant(CLA) and its extension with a Social Emotional Model which provides a methodology to obtain the emotional state of a group of agents. Author explored AAL (ambient assisted living) and explains the Cognitive Life Assistant and its extension to get and manage emotional states by PAD (P = Pleasure, A = Arousal and D = Dominance) emotional model; simulation of a retirement home and the emotional response of the agents and the validation of the actions performed by the platform in real-life implementation. This approach used as a feedback in the decision-making process of the CLA, allowing the shift of the social emotion to a particular area of the PAD space; or shifting the emotional state of a group of agents in relation to other groups of agents. The CLA asks SEtA(Social Emotional Agent) to calculate the social emotion (SE) for the group of agents. Once all agents have evaluated the activities, they send the emotional results to the SEtA in order to calculate again the SE. This scenario corresponds to a very cohesive group of people that responds to the activities suggested by the caregiver agent very positively reaching a happy emotion as intended[24].
In the interaction with people in figure 4, application area, the robot is able to talk with the persons it perceives and help those people by recommending new activities along with giving reminders about scheduled activities. The robot is still in a prototype form, its design and abilities have been improved presenting human-like features like perceiving emotions of a group of people and displaying human identifiable emotions. The second one is the Emotion Display, that allows the robot to express empathy with people according to the emotional states previously detected. The third and last one is the User Interaction that allows the robot to enhance the user experience suggesting activities/events to the user based on his/her profile and medical condition and trying to persuade the users into accepting the suggested activities or events[25].

3.2 Intelligent Search
The searching is the interior part of AI where uninformed and informed search strategies are used. A core area of research in modern artificial intelligence (AI) is the development of autonomous agents that can interact effectively with other agents to assist in medical diagnosis. Albrecht et al given a set of examples which consist of game states and the opponent has chosen action in each state, the method learns multiple candidate models using hill-climbing search to improve the weight estimates iteratively until no further improvement is possible. A specification of possible types, type-based reasoning begins with a prior belief, which specifies the expected probabilities of types before any actions are observed. The authors show how existing exact and approximate planning methods can be adopted to compute this set of goals, essentially by solving the planning problem for the modeled agent such that the solution is consistent with the observed actions[26]. The figure 5 depicts the model for medical diagnosis where play key role.

The need for interpretation and summarization of time-oriented clinical data is very important because many clinical tasks require dealing with very large amounts of patient data[28]. Physicians at the point of care are mostly unable to review much of this unstructured information due to the abundance of notes within a patient EHR (electronic healthcare record) and the time constraint inherent in the clinical setting. The ultimate goal of the system is to generate a cohesive summary of a patient, similar to a summary written by an attending physician after reviewing the patient’s chart. The scientist focuses entirely on extracting informative sentences rather than cohesive sentences from a single clinical note. The output of the work presented here can be used as the input for downstream components to generate cohesive summaries across the longitudinal patient record[29]. The part-of speech (POS) tagging and ADE (adverse drug event) are depicted in figure 6.
Online health social websites have grown substantially over the past decades. The authors propose to consider an online healthcare social website as a heterogeneous healthcare information network, and develop the content-based approach and structural approach for recommending similar users in such a network. The authors Jiang et al. present two types of approaches for measuring user similarity in the heterogeneous healthcare information network, namely content-based approach and structural approach. The network contains four types of nodes, including User, Drug, Disease, and Adverse Drug Reaction (ADR). The authors' study is motivated to find similar users from online health social websites and recommend to consumers[30].

3.3 Ontology
Disease-specific-ontology is data bases destined to structure and represent illness-relevant data as well as disease etiology, diagnosis, treatment, and prognosis. The author Wang et al. assessed the feasibility of acquiring disease-specific concepts and relationships in the classes of causes and risk factors, sign and symptoms, diagnostic tests and results, and treatments by manually annotating terms from a representative and diverse set of popular knowledge sources in cardiology. Annotations were mapped to equivalent Unified Medical Language System (UMLS) concepts as shown in figure 7. Textual knowledge sources for extracting heart-failure-related concepts used to build a disease-specific vocabulary. This method helps determine the lower bound and/or upper bound of the number of sources for reaching near saturation for a disease-specific vocabulary with the corpus explored. The authors assessed the feasibility of obtaining a near-saturated disease-specific vocabulary using a diverse set of expert-curated textual knowledge sources. The authors estimated the number of sources needed to reach near saturation with four disease concept classes with heart failure. For the four concept classes explored in the heart failure condition, the vocabularies took six sources to reach near saturation with the best order of sources. The results support the conclusion that it is feasible to obtain near-saturated reference standards for disease-specific vocabularies of core concepts using a relatively small number of knowledge sources. When applying the method to other conditions, the authors recommend that the most optimal approach is to start the annotation with comprehensive textbooks on the topical disease, followed by relevant and most-updated clinical practice guidelines, and topic summary articles from evidence-based synthesized online resources such as up-to-date. For the vocabulary of core concepts is sufficient to reach near saturation with a relatively small number of sources regardless of the order of sources. The authors provided an underlying approach for the development of disease-specific reference vocabularies focused on the concept classes of causes and risk factors, signs and symptoms, diagnostic tests and results, and treatment[31].
A formal ontology is the specification of the concepts, their attributes and relationships, in a given domain of discourse. The main strategies that exist for accessing and modifying ontology in a programming language, and the approaches proposed for local closed world reasoning in the literature. It includes five components: (a) an optimized RDF quad store, implemented with an SQL database in SQLite3 and stored either in memory or on disk in a file, (b) meta-classes for OWL (Web Ontology Language) classes and constructs, (c) optional ontology-specific Python source files, defining methods to insert into OWL classes, (d) the HermiT OWL reasoner, for performing automatic classification, (e) the SPARQL engine from the RDFlib Python module as shown in fig. Owlready proposes constructs for creating ontology entirely in Python, including class and property definitions, with full support for complex constraints. It illustrates the two features of Owlready that were inspired by the particularities of medical ontology: local closed world reasoning and the easy definition of “role-filler” on classes using the dot notation. The figure 9 illustrates the interest of the high-level syntax proposed by Owlready for local closed world reasoning and for defining role-filler constructs and existential constraints, as well as its ability to deal with classes in a simple way, including the automatic classification of individuals and classes. It illustrated the use of the specific syntax for manipulating classes and role-fillers, and local closed world reasoning[33].

Infection constitutes the invasion of an organism’s body tissues by disease-causing agents. Authors Shen et al in this study describes the construction and optimization of the sensitivity and specificity of a decision support system named IDDAP (infectious disease diagnosis and antibiotic prescription) shown in figure 10, which is based on ontology for infectious disease diagnosis and antibiotic therapy. The ontology information, consisting of the relationships between infectious diseases and antibiotics, between antibiotics and pathogenic bacteria, between antibiotics and drugs, and between antibiotics and the patient's physical conditions, aids IDDAP in determining the therapeutic plan. This manuscript combined research on knowledge acquisition, ontology construction, system modeling and decision support in the infectious disease and antibiotic prescription fields[34].
3.4 Bayesian Network (BN)

The application of BNs to high level billing data from United States Centers for Medicare and Medicaid Services (CMS) has demonstrated its utility in uncovering non-obvious relationships in the data, in particular, a potentially critical interaction between 2-adrenergic agonist asthma medications and renal dysfunction. Results presented in this study lend strong support for the use of hypothesis free, data-driven methodology in “big data” approaches to healthcare research and management. The work presented in figure 11, provides a rationale for employing use of Bayesian artificial intelligence algorithms for the analyses of disparate healthcare, socioeconomic, demographic, genetic, and even data from wearable to advance medical research thereby improving patient outcomes and reducing treatment costs[35],[68].

![Fig.10. Decision support system named IDDAP (infectious disease diagnosis and antibiotic prescription)](image)

![Fig.11. Data processing work flow and BN representation](image)

Resulting health-care systems just about the globe are under ever-increasing stress. By means of a latent parameter-driven model, the author Perez shows it is possible to draw inference on contemporary and serial correlations on demand, over different medical and surgical specialties within a local facility. They allow them to describe the dependence between continuous latent state variables and discrete observed counts in terms of some probabilistic distribution; they pose a useful mean to relate electronic tasking information with patterns of workload in healthcare facilities. The focus is given to the study of distributional properties of model components, in order to unveil workload patterns during out of hours (OoH) shifts, and the assessment of the ability to quantify future task-demand, for providing support within intelligent management design. The authors note that seasonal effects on demand are likely to depend on the geographical location of each medical facility; studying localized solutions...
for demand estimation is of special relevance with aims to design intelligent roster schedules. The paper has explored the use of electronic task management alternatives in combination with modern statistical and machine learning methodology, in order to study the potential for contributions in the design of decision support systems for OoH workload management in local healthcare facilities is elaborate in figure 12[36].

The researchers present for each screen the sensitivity and counts of cancer cases detected by the models at specific thresholds for $\hat{A}$, which were determined based on the distribution of the positive Biopsy probability values, as well as the receiver operating characteristic (ROC) curve. The researcher tested other models on this dataset such as decision trees and a naïve Bayes model, but their performance was suboptimal compared to the Dynamic Bayesian Network (DBNs). The use of a DBN for the analysis rather than a BN network as in takes into account the temporal evolution of a cancer, with improved performance in the discriminative ability of the model in future screenings as shown in figure 13. This work is the first step in understanding how the authors may subsequently tailor the lung cancer screening process to optimize early detection while minimizing false positive findings[37].
The Bayesian summarization method consists of five steps: (a) mapping text to biomedical concepts, (b) feature selection, (c) preparing sentences for classification, (d) sentence classification, and (e) summary generation as shown in figure 14. Analyzing a large number of documents including the evaluation corpus, the authors observe that for the majority of inputs, the most probable value of all features is False because every concept within a text document appears in less than 50 percent of the sentences. With the help of the redundancy reduction method, the summarizer gives sentences containing low-frequency concepts a higher chance to be included in the summary. ChainFreq does not use all extracted concepts and utilizes BioChain as a filtering method, the Bayesian summarizer obtains relatively better scores using an appropriate threshold for filtering features[38].

3.5 Logic Programming
The logical thinking of medical practitioner involves a lot of subjective decision-making and its complexity makes traditional quantitative approaches of analysis inappropriate. The computer based diagnostic tools and knowledge base certainly helps for early diagnosis of diseases. The intelligent decision making systems can appropriately handle both the uncertainty and imprecision. The scientist in this paper discusses about the application potential of artificial intelligence in medical diagnosis[19], [39]. The logic programming PROLOG is used to diagnosis the disease as shown in figure 15.
Ontology and associated generic tools are unit applicable for information modeling and reasoning. The metaphysics and generic metaphysics tools will play a supporting role in sickness classification tasks, provided the factors in logical expressions involving no uncertainty. Author explored the use of Web Ontology Language (OWL) description logic for representing operational definitions of diseases and explained complex predicates’ modeling supported by OWL. This study shows that it’s potential to represent operational definitions of diseases with Web Ontology Language to classify real patient cases. Representing diagnostic criteria as descriptive information in metaphysics with OWL-DL formalism rather than rules in Semantic Web Rule Language (SWRL), Lisp or logic programming permits to require advantage of different resources already accessible in OWL for consistency checking and diagnostic classification tasks. The aim was to use ontology in order to formalize and compare different operational definitions of a single disease. The authors showed that ontology and generic ontology tools could play a supporting role in disease classification tasks, provided the criteria are logical expressions involving no uncertainty. Further works embody classification of patients in keeping with many completely different operational definitions of diseases[40]. The integration basic science and clinical discovery play a crucial in intelligent medical diagnosis as depicted in figure 16.
3.6 Fuzzy Logic

Fuzzy logics (FL) true extension of standard logic, and FL-controllers are a real extension of linear control models. Author present a Fuzzy Expert System (FES) to diagnosis of back pain diseases[42],[70] depend on medical observation symptoms, which represented as fuzzy rules or linguistic rules, the fuzzy rule is a rules that take the condition part-of linguistic values. The knowledge here represented as a set of fuzzy rules, which is extracted from human experts, and back pain diseases documents, the fuzzy rules example can be represented in Prolog format. The architecture of fuzzy expert system that used fuzzy rules to represent the diseases of backbone for human being, it can be conclude there is no doubt that fuzzy system ought to be applied for diagnosing of back pain diseases which gives recommendation for patient supported the symptoms that described as fuzzy ideas in antecedents of fuzzy rules[21]. Bruin et al detects and monitors infection using fuzzy logic. Electronic systems for the detection and monitoring of healthcare-associated infections (HAIs) have become common in clinical routine over the last decade. Using fuzzy sets and propositional fuzzy rules, the authors calculated how frequently, patient data are classified as normal, borderline, or pathological with respect to infection-related clinical concepts and HAI definitions for all of the incorporated fuzzy sets. With the fuzzy sets and fuzzy rules contained in its knowledge base, the Moni-ICU program showed a sizable borderline class for infection-related concepts. Based on the results of the study, clinical knowledge engineers and infection control experts are able to tune the knowledge base more accurately to optimize case recognition for both definite and borderline infection cases[43].

Fig.16. Integration of clinical and basic science in medical diagnosis[41].

Fig.17. The architecture of fuzzy decision support system
The application of computational intelligence to problems in daily life has become more common. In order to obtain a numerical value of the output coherently with the rule base and the generalization provided by the fuzzy logic framework, a defuzzification process was performed in improving anesthetic process. The proposed system based on knowledge of experts performed traditional controllers based on PID closed-loop systems, especially when comparing the time of Bispectral Index (BIS) in the excellent band. The observational study together with this comparative analysis revealed a robust performance of the fuzzy inference based controller guided by BIS. These results evidence that it is feasible to develop an automated infusion system using a fuzzy inference controller designed from intuitive logical rules for the control algorithm[44]. The basic components of fuzzy inference system are depicted in figure 17.

3.7 Artificial Neural Network
Artificial neural networks can be applied to the medical diagnosis of completely different diseases, for example detection of arrhythmias or coronary artery diseases, which are major causes of death worldwide. Artificial neural networks have proven suitable for satisfactory diagnosis of various diseases. Despite their wide application in modern diagnosis, they must be considered only as a tool to facilitate the final decision of a clinician, who is responsible for critical evaluation of the Artificial neural networks output. Medical information of patients that the expected designation is correct is eventually enclosed. ANNs have several advantages including the ability to process large amount of data Reduced likelihood of overlooking relevant information Reduction of diagnosis time[45].

![Fig.18. ANN model for Medical diagnosis](image)

Artificial neural networks have been extremely valuable for learning from examples and making predictions for unseen examples. Some potential biomedical engineering fields where neural networks can be applied in future are electrophysiology, biomaterials, biotechnology, biosensors, modeling, instrumentation, rehab engineering, medical analysis, prosthetic, informatics, imaging, clinician, biomechanics, computers devices[46]. An electrocardiogram (ECG) reflects the heart's activity and provides a large amount of information about the state of the heart. An approach based on deep neural networks, such as lead convolutional neural network (LCNN) or long short term memory (LSTM) network, and rules inference for Premature ventricular contraction (PVC) detection was proposed by Zhou et al, which avoided some of the limitations. To enhance the overall detection performance, the authors used rules inference to test those recordings that were classified as non-PVC class and PVC class by the ensemble learning method. The authors used rules inference to test those beats that had been classified into non-PVC class and PVC class by the method combined LCNN and LSTM[47]. Ovarian cancer is the second leading cause of gynecologic cancer deaths in the world, affecting nearly 2% of the female population over their lifetime. The authors used the data mining classification techniques to construct a medical diagnostic scheme for predicting recurrent ovarian cancer. These important risk factors are often fundamental indicators that provide useful information for identifying the recurrence of ovarian cancer. Five data mining classification techniques, including support vector machine (SVM), C5.0, extreme learning machine (ELM), multivariate adaptive regression splines (MARS), and random forest (RF), were used to construct five medical diagnostic models and rank the importance of risk factors. The first stage of the proposed diagnostic scheme is to identify the candidate risk factors as predictor variables. The identified important predictor variables serve as the input variables for SVM, C5.0, ELM, MARS, and RF to develop the five diagnostic schemes for diagnosing the recurrence of ovarian cancer as shown in figure 19. The above information can support the important influence of personality and clinical symptom representations on all phases of guide interventions, with the complexities of multiple symptoms associated with ovarian cancer in all phases of the recurrent trajectory[48].

![Fig.19. The classification techniques to construct a medical diagnosis](image)

3.8 Machine Learning
The distinct feature extraction methods namely: physicochemical properties and Position Specific Scoring Matrix (PSSM) are used for extracting salient, useful and pertinent discrete information from the protein sequences which are further used for training and testing the predictor efficiently. The predicted outcomes of KNN, PNN and SVM
classifiers in combination with PSSM based feature space using dataset. Two different feature extraction methods namely: physiochemical properties, algorithms, and feature spaces, it is observed that the performance outcome of the proposed prediction model is very efficient on all the three datasets than the existing methods in the literature so far. The authors Tahir et al will add this feature into the model in order to investigate the performance of hypothesis[49]. Today health care providers and hospital administrators are interested in predicting length of stay (LOS) for economic and organizational reasons. In the study, model consists of different steps of pre-processing and the use of the Bayesian boosting method for modeling, which led to remarkable results in identifying factors related to patients LOS in hospital as shown in figure 20. The prediction model based on the indicators such as gender, age, episode type and medical specialty according to data mining approach Crisp (CRISP-DM) which used 6 learning method including average prediction, multiple regression, decision tree, artificial neural network ensemble, support vector machine, and random forest[50].

Knowledge gathering and data mining processes to obtain useful knowledge from data are considered a necessity. The Authors Kazemi et al in this model can help physicians predict the type of existing kidney stones, based on the general characteristics of each patient. The proposed data mining algorithms, based on an adequate retrospective medical dataset, provided a decision support system for predicting the stone type in the treatment phase. The different ensemble learning methods such as Bagging, Boosting, Voting, and Stacking with Rule Based Algorithms are employed for classification purpose[51]. The model building techniques in ML is shown in the following figure 21[52].

Fig.20. The Clinical data extracting process.

Fig.20. Machine-learning-based patient-specific prediction models
3.9 Uncertainty
EMR (electronic medical record) data is difficult to interpret for four main reasons: First, the text of physician and nursing notes is less formal than that of traditional textbooks, making it difficult to consistently identify disease and symptom mentions as depicted in figure 21. Learning a graph of candidate causal relations involving diseases and symptoms from EMRs is the first step toward learning models that perform diagnostic inference directly from the real data that is continuously being generated from the healthcare system. There were a number of differences between the edges suggested by the learned models and marked as correct by the clinical evaluators and those contained in the Google health knowledge graph. Using the results of the clinical evaluation, we can infer that if a filtering step were added to the pipeline, to achieve perfect precision with a corresponding recall of 60%, physicians would have to discard fewer than 2 out of 10 suggested edges[53].

Findings are all modeled as manifestations of disease in the current Quick Medical Reference, Decision Theoretic (QMR-DT) belief network. The authors investigate the sensitivity of the QMR-DT belief-network model to prior probabilities of diseases. The current QMR-DT model uses the fitted leak probabilities from an assessment of findings of various types among imports of the range 1 to 5. Since it is not practical to use exact algorithms to compute posterior probabilities of diseases from the QMR-DT belief network given an arbitrary set of findings, the authors use a simulation algorithm. The authors use simulation algorithms solely to compute the posterior marginal probabilities of diseases implied by the QMR-DT belief-network model, rather than to compute heuristic scores according to some other model. The authors intend to augment the current QMR-DT belief network model with additional relationships among findings and among diseases. The authors' belief is

Fig.20. Representation of Knowledge graph from EMR.
that as the authors more accurately model the relationships among disease and findings in internal medicine, the diagnostic performance of the QMR-DT system will continue to improve[54]. Health care systems based on Machine Learning (ML) technologies are increasingly demanded for the prevention of lifestyle-related and chronic diseases as well as for emergency care and life support. The Trauma and Injury Severity Score (TRISS) model predicts the probability of survival for a patient on arrival at a hospital. Models learnt from given data are calibrated and their accuracy is statistically evaluated by goodness-of-fit tests. Bayesian method is analytically tractable for trivial cases when the likelihood functions and probability distributions of given data and model parameters are known. A new approach to building BNs from given data has been recently proposed in within a generalized framework capable of providing a repeatable method for building BN models from patient questionnaires and interviews containing contradictory responses. The TRISS methodology does not support the estimation of predictive survival probability density that is required for evaluating an individual confidence interval for a patient in order to assist practitioners with making risk-aware decisions. The proposed method was shown to be capable of reducing uncertainty intervals and increasing the prediction accuracy in all groups of patients, especially in the group with multiple injuries. Schetinin et al found that the accuracy of predicting outcomes of patients with multiple injuries has to be improved[55].

3.10 Evolutionary Computing
The researchers introduced GAs and some of their applications in various fields of medicine. Genetic algorithm and some other meta-heuristics are inspired by biology, the experts of other fields of science are more aware of them and these methods are frequently used to solve complex problems. Due to the inherent complexity of medicine, optimization methods could be of great value for physicians and medical researchers. The lack of an efficient interaction between computer scientists and physicians on the one hand and the unfamiliarity of complex mathematical formulas among the medical professions on the other is responsible for this situation. Improving the interaction and understanding between physicians, computer scientists, and engineers, which could happen via joint journal clubs or attendance of physicians’ ground rounds and case report presentations, could solve the problem[56].

4 SPECULATION
The speculation is that healthcare system could be enhanced by incorporating the above mention AI and soft computing techniques. Recommender systems are a classical example for machine learning applications; they have not yet been used extensively in health informatics and medical scenarios. Scientists provide a three-part research framework to access health recommender-systems, suggesting incorporating domain understanding, evaluation and specific methodology into the development process as shown in figure 22.

In an article authors applied the GA-BPNN method to filter the extracted features and classify the six types of ECG signals. The filtered features were inputted into the optimized BPNN classifier for classification. Figure 21 presents the overall block diagram of the proposed method for ECG signal classification[57].
In this article, authors give a proposed intelligent Health Recommender Systems using Restricted Boltzmann Machine (RBM)-Convolution Neural Network (CNN) deep learning method. It provides an insight into how big data analytics can be used for the implementation of an effective health recommender engine, and illustrates an opportunity for the health care industry to transition from a traditional scenario to a more personalized paradigm in a tele-health environment[58]. The figure 22 depicts the proposed architecture of an intelligent machine, which can use the above mention techniques along with recommender system to get a better model for intelligent medical diagnosis as well as services to the society.

5 RESULT AND ANALYSIS

The review of this article finds the various application areas of AI and soft computing in the field of healthcare system:

- Medical Diagnosis:
  - The clinical and multi-omics data is to ensure early detection of cancer and infectious disease. In order to reach its full potential, personalized medicine needs precise mathematical models, and this will only be achieved with models tailored to the data for a given patient. The methodology presented here is a first step toward the personalization of a logical model to different patient profiles such that their results can be matched to clinical data and patients' sub-grouping. The personalization strategies presented here have been compared to well-established signatures and NPI score, and the outcomes of these patient-specific models have shown to correlate well with clinical data. The RNA expression level will affect the activity level of the genes but may not alter its regulation[59].
  - EHR data and Expert Knowledge ensures AI based medical diagnosis and assessment of widespread diseases. Knowledge is information that can be used in decision-making process. A knowledge base uses knowledge representation formalism to capture the subject matter expert's knowledge and codifying it according to the formalism, which is called the knowledge engineering. Sophisticated expert systems can be enhanced with additions to the knowledge base or to the set of rules. The core components of expert systems are the knowledge base and the reasoning engine. Using Artificial Intelligence (AI) techniques, computers are able to give diagnosis of a specific disease called as medical expert systems. Medical expert systems will

FIG.21. Representation of recommender system in healthcare.

FIG.22. Architecture of an Intelligent Machine
begin to appear, and researchers in medical artificial intelligence continue to make a progress in key areas such as knowledge acquisition, model-based reasoning and system integration for clinical environments. Clinical decision support systems (CDSS) aim to provide clinicians or patients with computer generated clinical knowledge and patient-related information that can be intelligently filtered or presented at appropriate times to enhance patient care[60).

- Image Data and Deep Learning ensures expert diagnosis of medical imaging disease screening. The most widely used deep learning method is convolution neural networks (CNNs). Deep learning methods have a wide application in the medical field and diagnosis is conducted through use-cases of deep learning networks. It is safe to assume that deep learning will continue to diversify its uses[61].

- Therapeutics:
  - HER data and clinical guidelines ensure AI bases treatment of common disease. The AI where computers perform tasks that are usually assumed to require human intelligence is currently being discussed in nearly every domain of science and engineering. JASON finds that AI is beginning to play a growing role in transformative changes underway in both health and health care, in and out of the clinical setting. Health and Human Services asked JASON to assess the full impact that AI can have on health and health care in the context of how Artificial Intelligence could shape the future of public health, community health, and health care delivery from a personal level to a system level[62].

- Human AI interaction in robotic surgery: Human and Artificial Intelligence Interaction are presenting prodigious and exciting technological opportunities for mutual development even in today’s current technological climate, but the real potential for mutual development is in the near future and beyond which has the potential to be overwhelming. With the continued rapid development of not just technology but in quantum research, the potential for Artificial Intelligence to evolve at a frightening speed is within the grasp. With Quantum Computing bringing the ability to process big data in abundance this will in turn skyrocket AI development leading to the advancement of BCIs, with AI having the ability to not just pinpoint but to map and increase for example DNA mapping identifying genes in strength and intelligence[63]. Apart from the robots that assist the surgeon, in autonomous robots equipped with artificial intelligence. It is aimed to reach a device that monitors all vital signs at the same time during the operation and gives verbal warnings when necessary, analyzes all the current information needed for the moment, performs pathological examination. It determines surgical margins in solid organ tumors, applies appropriate surgical technique with zero margin of error, and calculates the possible postoperative complications, beside only increasing the vision and eliminating hand shivering[64].

- Data driven precision medicine ensures digital-clinical therapies guide. Next-generation sequencing (NGS) has achieved great advances in medicine and clinical practice, as well as in basic research field. Ultra-rare diseases have been occurring constantly, because every new baby will have de novo mutations in its genome, posing a small chance of the mutations causing an unseen phenotype. Thus, it would be important to improve prompt and accurate diagnoses and suggest appropriate treatment options for ultra-rare disease patients[65].

- Population Health Management:
  - Patient oriented information system for healthy life style and early disease prediction. The collection of high quality accurate patient data acquired through digitized disease management protocols that involve constant tracking of interventions and patient outcomes in day-to-day clinical settings. This data can be used for translational research to assess the treatment effectiveness, evaluate options to further personalize the therapies, and improve personalized medicine guidelines based on the new evidence generated[66]. The wide adoption of machine learning and optimization algorithms in real deployment is difficult to succeed. It is believed that human beings will enjoy more and more smart healthcare applications in the coming decades. It is worth ensuring the health services are financially viable and environmentally sustainable to safeguard the future health of the patients and the health services availability in the future[67].

- Administration and regulation in healthcare:
  - Big data in disease monitoring and hospital management ensures quality based outcome. Spark is capable of using big medical data generated from multiple sources to gain insights and knowledge using various Machine Learning library (MLLib). The development of smart healthcare applications will provide accurate treatment decisions by analyzing the clinical data of the patients using advanced Machine Learning (ML) techniques. The big data analytical tools extract knowledge from patients’ care data to provide innovative healthcare services to the patients to save their lives and to develop innovative techniques to diagnose and treat various diseases. Health Care Assistants (HCA) such as Remote Patients Monitoring (RPM) are generating a huge amount of data in real time using IoT medical sensors and ambient sensors. The Cloud repositories are used to store patient’s medical data to enable applying different analytical techniques to extract the medical knowledge such as detecting patients’ health status, innovating methods for the diagnosis of different diseases, and how to treat them[68]. This development puts biomedical Informatics on the cusp of a new era where these technologies are used to deal with big data and get unprecedented knowledge in the medical field.

6 CONCLUSION AND FUTURE SCOPE
The conclusion of the review article is that the different
techniques of AI and Soft Computing are amalgamated together to acquire artificial intelligence in electronics hardware as well as to develop intelligent software, which can serve the society in sustainable way. The implication of the review is that the article finds the applied correlation between AI and soft computing in the field of healthcares. The findings is that AI is a big term in modeling machine intelligence whereas soft computing is a part of AI for perceiving real world data and modeling machine learning. The authors’ implication is that this review article acquired almost all the techniques of AI and soft computing in a single umbrella, so that researchers could get the idea of developing AI model for healthcare management. The unresolved part of this review article is that it is true the AI and soft computing techniques automatically as well as intelligently assist the doctors with the developed AI tools. Now the question is that is it possible to develop an AI-Doctor, which can serve in remote village areas as like a real doctor and it is very essential in our society. The future scope is to use the concept of block-chain and bit coin technology in health care system to acknowledge 100% accurate medical diagnosis and treatment with the help of miner doctor as well as a panel of doctors connected together in a distributed network.

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