

## A REVIEW ON APPLICATIONS OF SOFT COMPUTING FOR PATIENT HEALTH MONITORING

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### ABSTRACT

The socioeconomic background of the urban and rural populations differs as a result of urban areas' exponential growth and quick industrialization. These people's well-being is in jeopardy since lifestyle changes might have an impact on an individual's or their family's health. Malnutrition and diseases that are both communicable and are other common health problems in many nations. The doctor-to-patient ratio (DPR), according to the World Health Assembly, is 1:1000. A doctor's job of keeping an eye on patients' health issues is a nervous one. A doctor sees a patient for seven to ten minutes on average, during which they are occupied taking notes on symptoms or entering data into the condition care administration. Smarter gadgets, Computational Intelligence (CI), and Soft Computer Technologies (SCT) could be of assistance to physicians in diagnosing and treating patients with a range of health problems by tracking patient data and offering cutting-edge care. The group of physicians may utilize the gathered data for their unnecessary research and forecasts, and local government officials could use the data to enhance

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### 1. INTRODUCTION

Ensuring an adequate level of health is essential for the advancement of any nation. A doctor is essential to the delivery of healthcare in society, as was previously mentioned. In addition to the physician, other factors that enhance the standard of healthcare in society include staff, infrastructure, and the socioeconomic status of the populace. This helps to establish the nation as a whole.

Regrettably, India's DPR falls below the WHO standard of 1:1000. There are a total of 1457 patients for every physician. Doctor to The patient Time (DPT), which is the duration of a visit, is known to have a negative impact on patients' care as well as doctors' workload and stress. After recovering from a serious illness, people's living standards and access to healthcare are negatively impacted by their financial situation.

### 2. PATIENT HEALTH MONITORING SYSTEM

In both hospitals and homes, health monitoring devices are quickly becoming a part of everyday life for patients who are elderly, terminally ill, suffering from chronic conditions, etc. In general, health monitoring keeps track of things like heart rate, insulin resistance, breathing, body temperature, amount of food and beverage consumed, number of calories burned, amount of oxygen consumed, quality of sleep, remaining medication, etc. Doctors can take proactive steps to preserve a patient's life by following medical information from a system for health monitoring. The Patient Health Monitoring System displays a number of devices that may be linked to the patient, including a blood pressure (BP) observe, temperature observe, diabetes monitor, heartbeat monitor, medication dispenser, and many more. Because of technological advancements, a large number of these gadgets are wearing.

These devices send their acquired data to the cloud. Regular patient data collection and analysis is done by the doctors. The medical professionals evaluate the data and create forecasts using computation intelligence (CI) and softer computing (SC) techniques. In light of this, the physicians diagnose and treat their patients. Emergency services are either requested by the patient in the event of a critical situation or may be given upon the doctor's request. The public cloud houses the data related to the services that were purchased.

Diagnostic services are also acquired in accordance with requirement. Block chain services are used to store case sheets of paper, diagnostic reports, and data related to the services received for later use. Because patient data is publicly accessible on a public ledger called block chain, any physician or group of physicians can easily examine every patient's case, regardless of location.

### 3. BENEFITS OF PHMS

Advantages of PHMS include:

- The individual provides real-time data collection.
- The physician offers immediate medical attention with the assistance of different suppliers of services.
- It is possible to avoid some expenses, such as redundant diagnostic testing and patient transportation to clinics.
- The block chain makes the patient data available to everyone.
- Patients typically receive better care from insurance firms.
- The patient doesn't have to wait for an appointment to see a doctor because the doctor keeps an eye on the patient's details.
- It is possible for different group doctors to communicate diagnosis data.
- The procedures and processes for diagnosis will be standardized.
- insurance providers are able to keep an eye on their patients' health and, if necessary, refer them for hassle-free hospital care in times of dire medical need.
- Pharmacy businesses will provide patients with timely medication delivery in accordance with the doctor's prescription. Consequently, this aids in the regularization of the pharmacists' chain of custody.
- Assistance in emergencies will be available as needed.
- Additionally, local governments use the information gathered to improve their own health care.

### 4. SOFT COMPUTING TECHNIQUES

While CI is sometimes referred to as "soft computing," there are really four distinct technological subfields within SC: probabilistic algorithms (PM), fuzzy math (FL), evolutionary computers (EC), and neural networks (NN). The shows the elements that make up SC. The PM manages ambiguity. FL models distinguish between the variables' true and false values. EC makes sure that the problems are optimized using the evolutionary techniques EP, ES, GA, GP, and CS. Neural Networks (NN) simulate human behavior in computing and solve important problems.

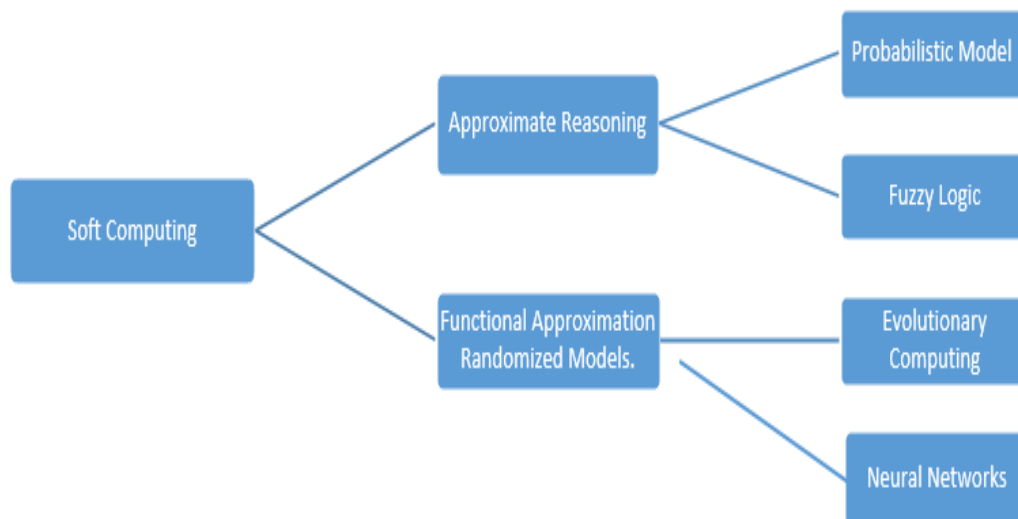


Figure 1. Components of Soft Computing

### 5. AMBIENT HEALTHCARE MONITORING SYSTEM

It has been essential for ambient medicine to comprehend patient behavior in a range of environments, such as residences, parks, and medical facilities. It's crucial to observe the patients' reactions in different situations. A variety of sensors, such as oxygen, carbon dioxide (CO<sub>2</sub>), temperature, and CO (carbon monoxide) sensors, are used to assess how a patient will react to different circumstances. Parallel to this, patient monitoring systems that log vital signs—such as body temperature, blood pressure, weight, glucose, and several others—are essential to helping physician assistants (PAs) deliver healthcare. These devices, which are directly connected to mobile phones, can help doctors keep an ongoing eye on their patients' daily activities and their ability to adapt to changes. developed a method for determining pulse rate. This used a plethysmography process and displayed the results digitally, allowing it to identify the pulse in real-time. Greg Ski proposed a smartphone app for heart rate monitoring. The pulse and temperature are important indicators of the existence of any illness in the body, hence monitoring them is essential to identifying any clinical occurrences early on and making appropriate treatment adjustments.

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**USING SOFT COMPUTING INCIDENTS IN DIAGNOSTICS AND BASIC STUDIES**

It has been discovered that soft computing techniques perform remarkably well with uncertain data. Because they are based on approximations of models, they can also be tailored to specific problem domains. The ability to leverage important and relevant associations found in a set of data can also be applied to the diagnosis, prognosis, and management of numerous clinical occurrences. Imperfect data makes up a considerable portion of medical data because of imprecise test measurements, ambiguity and randomness regarding the usual range of test findings, inadequate understanding of biological mechanisms, and omitted information in many cases. This makes it challenging to determine whether a mathematical structure or direct computer procedure is most appropriate for handling this flawed, inadequate, Approximate or partially true data. Because they strike a decent balance by accurately examining randomness in genomics and healthcare data, soft computing approaches are consequently gaining a lot of traction in the healthcare sector. This makes the use of soft computing strong, dependable, and effective for a variety of healthcare applications, including drug discovery, comprehending the complex physiology, biology, and life spans of the microbes and their effects on human bodies, figuring out how biological molecules interact with one another in diseases, and identifying biomarkers. Clinical disciplines, basic sciences, and diagnostic measures are among the domains in which soft computing techniques are employed in the healthcare industry. The use of computerized methods and the state of these fields are covered in the sections that follow.

**6. SOFT COMPUTING IN BASIC SCIENCES**

The investigation of subjects intimately related to life and medicine, such as chemistry, biology, pathology, or bacteriology, is generally referred to as the basic sciences. For example, biochemistry requires the study of intricate processes, amino acids, nucleic acids, and the impact of genes on each other's enzyme activities. These subjects might be difficult to research. Furthermore, the complexities of these occurrences are not adequately captured by traditional mathematical models. Because of this, applications of genetic algorithms, fuzzy logic, and neural networks have been made in a variety of domains Pathologists, genetics, biochemistry, or cytology, biostatistics, histology, and other fields are among them. Another significant area in the fundamental sciences of medicine is genomics. Analysing genomic and proteome data is crucial to understanding the underlying causes of health issues in humans. Futcher et al. and Cato et al. identified tumours from genetic expression data by combining Fuzzy Logic or Neural Networking. In this instance, analysis of statistics did not function effectively. Feschuk researched fuzzy rules to find genes linked to certain cancer kinds. Genomic research is essential to comprehending genetic illnesses. In light of this, Wilson's disease patients can be classified using a fuzzy tagged neural gas soft computing technique, as suggested by Volkmann et al. The study used a neural network model, fuzzy logic, and the Gaussian variant. The clinical recognition of diseases is also studied in another area of genomics called microarray gene expression profiling. In gene expression data, their cellular configurations and network structure are important. To provide an unclear rule base for array data analysis, Ho et al. developed a complex logic model modified by algorithmic genetics to create an interpretable protein expression classifier. It was a really handy tool for profile analysis of gene expression. In a similar vein, pharmacology—the study of medication development—appears to employ soft computing in numerous contexts. The field deals with the detection of any therapeutic or medicinal substance, as well as their composition, toxicity, and medical uses. Agatonovic-Kustrin et al. suggested using genetic algorithms in conjunction with artificial neural networks to predict the corneal permeability of medications with structural variations.

**SOFT COMPUTING TECHNIQUES IN HEALTHCARE DECISION SYSTEMS**

Estimated models, as opposed to determinism models, are used in Soft Computing to address practical computing issues. It is impossible to define many real-world issues using precise deterministic mathematical models. Soft computing can help in this situation. We can solve complicated problems using soft computing by modelling the issue with variables and approximation logic. Soft computing is an umbrella term for a collection of approaches and combinations of several techniques rather than one method This is made up of things like fuzzy logic, fuzzy systems for expertise, evolutionary computing, genetic algorithms, and artificial neural networks. The diagnosis and eventual treatment of an illness in a human being might be considered the primary goals of healthcare. Healthcare issues are extremely complex, thus a doctor—a human being with a human mind—is absolutely necessary for the accurate diagnosis, treatment, and everything in between for a certain ailment. A system with deterministic will never be able to handle healthcare problems due to the sheer number of variables and reasoning that must be taken into consideration. Soft computing appears to be the sole viable solution for computers to effectively address the problems associated with medical choice systems. Soft computing takes its cues from nature, especially the human mind. If soft computing methods can replicate the human mind in some way, it would be reasonable to expect computer programs that can effectively handle healthcare issues and potentially even take the place of a clinical physician.

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## SOFT COMPUTING IN CLINICAL APPLICATIONS

It's clear that soft computing approaches are most effectively employed in the clinical sciences. Of the technical approaches, 48% were used in the clinical setting. Soft computing frameworks find specific applications in the fields of anaesthesia, neurology, heart disease, and rehabilitation. In many of these fields, neural fuzzy algorithms have been used to give physicians clinical support. Soft computing systems with adaptive functioning have been successfully used in clinical sciences, such as analgesia, blood pressure management, and unconsciousness. An overview of every field and how they use techniques for soft computing is provided under.

- **Soft Computing in Cardiology**

For heart disease, soft computing is heavily utilized, especially when utilizing ECG data. ECG is widely used by medical professionals in cardiology. Doctors can identify patients who are at risk of cardiovascular events or even death from cardiac abnormalities by using ECG data for diagnosis and cardiac function monitoring. An electrocardiogram, or ECG, is a graph that displays the electrical rhythm of the heart. The y-axis on this graph denotes electrical activity voltage, and the x-axis denotes time. Adaptive neuro-fuzzy algorithms for categorization of ECG data were proposed by Nami et al. and others. The system they use is demonstrated to have an accuracy of over 97%. Their approach consists of five steps, each of which is briefly described below:

- Preparation: First, the data is normalized, meaning that every feature is levelled up to the same extent. There is noise filtering since ECG signals might be noisy. In order to complete the filtering process and produce a noise-free signal, the signal is sent through an intermediate pass filtering system, an elementary pass filter, and an edge filter.

- Energy spectrum and ICA-based aspects: a power spectrum and independent component analysis (ICA) are utilized to extract valuable features that will be the input feature vector files.

- **Soft Computing in Neurology**

The investigation of the ontologies of the brain and spinal cord is known as neurology. Neurology is the study, diagnosis, treatment, and prognosis of disorders affecting the central, peripherally, and autonomic nervous systems. There is a vast amount of incomplete or unclear data in clinical neurology. Soft computing technology can therefore be used in this field to support clinicians in diagnosing and making decisions regarding a variety of neurological illnesses. Electroencephalogram (EEG), sleep, and electromyogram (EMG) analyses are the main focus of neurological research. A dynamic adaptive fuzzy approximator was introduced by Zhang et al. to allow for a non-linear distinction between single-sweep evoked potentials. Additionally, it performed well when predicting non-stationary EEG timeseries. A neural network approach for categorizing epilepsy based on EEG patterns was presented by Ogalala et al. A person's cortical excitability entirely breaks down when they have epilepsy. Therefore, a precise technique for a proper diagnosis is required for its management and subsequent forecast.

## SOFT COMPUTING IN MEDICINE AND REHABILITATION

Techniques for soft computing have applications in physical medicine, critical care, and rehabilitation. These fields are primarily related to therapy, helping someone recover from an illness that is fatal, helping them cope with life's challenges, or helping them become accustomed to their responsibilities following a severe medical condition, including shock or trauma. This also covers organ transplants and the temporary substitution of any technological device, like a pacemaker, for an organs's activities. Uses of soft computing in critical care, pulmonology, EEG monitoring, anaesthesia, blood pressure and breathing regulation, and physiotherapy are covered in this section. Kwok et al. created a plurality of per (MLP) model and a neuro-fuzzy inference system that is adaptive (ANFIS) for ventilator control. The decisions made by the clinician could be effectively modelled by both of these models. The idea behind the investigation was that, for patients whose lungs aren't working effectively, mechanical lung ventilation is vital for removing carbon dioxide and supplying oxygen. Compared to the MLP model, the adaptable fuzzy-neural model was easier to understand. In a similar vein, Paetz et al. created an understanding-based neural net that helps patients in hospitals to prevent septic shock by recognizing it. Belal and others.

## SOFT COMPUTING USED IN ADDITIONAL CLINICAL DOMAINS

Other than the clinical domains that were covered. Soft computer technology have been widely used in oncology, paediatrics', dermatology, endocrinology, and other therapeutic settings. Obeli et al. have made significant contributions to the field of dermatology, which studies skin and skin-related issues, by addressing issues with erythema to-squamous disease identification. For the purpose of distinguishing between the six disease forms that share similar clinical characteristics, they put out an ANFIS model. For this, they created a six-ANFIS classifier model. The field of endocrinology, which is related to internal medicine or hormonal secretions and their connections to physiology and pathology, has benefited greatly from the effective application of soft computing tools. due Endocrine and the body's metabolic processes are intimately connected. Soft computing is essential for simulating metabolic systems since the

available data in this area is quite limited. A hybrid neuro-fuzzy approach was created by Bellari et al. to represent metabolic processes dynamically. Additionally, the application generally studies the dynamics of intracellular thiamine. In a similar vein, Chen and colleagues created a neuro-fuzzy system to forecast parathyroid hormone levels. Monitoring of blood parathyroid medication is essential in haemodialysis patients because aberrant levels of this hormone lead to renal bone disorders. Involving clinical data, Chen et al. suggested a coactive neuro-fuzzy interpretation systems (CANFIS) for blood PTH concentration. A neural fuzzy guidance system for cancer subtype identification was created by Tung et al. In their investigation, gene expression data were used. Additionally, their investigation was effective in identifying juvenile acute lymphoblastic leukaemia. Sun et al. employed neuro-fuzzy approaches in oncological applications in a related study. It was thought that the Neuro-fuzzy framework was a more accurate and dependable technique for categorizing breast and prostate cancers.

## 7. CONCLUSION

Gentle computing's capacity to solve complicated issues in a manner similar to that of a person means that it has the potential to bring about a revolutionary change in the healthcare sector. It is the ideal tool for resolving the shortcomings of conventional medical decision support systems, which are based on conventional AI approaches and analytical or mathematical models. It does this by simulating human decision making and logical thinking. When managing, manipulating, and mining data, soft computing is impervious to imprecise, ambiguous, and incomplete data. Healthcare data is highly variable and contains a great deal of randomness, therefore soft computing functions flawlessly. Soft computing's great adaptability alongside data processing approaches make it particularly helpful in solving complex, real-world issues. Combining soft computing techniques improves their performance compared to using them alone. Artificial neural networks and logic that is fuzzy, or artificial neural networks and genetic algorithms, are examples of hybrid approaches that are highly effective in processing data, identifying features, and producing insightful conclusions. Medical records and data are by their very nature sensitive. They hold extremely nuanced information that could be crucial for disease diagnosis and treatment. Soft computing methods support clinicians in their decision-making by identifying these subtleties in medical data. Fuzzy logic, genetic algorithms, and synthetic neural networks are three general categories for soft computing methods. They are all inspired by the ways in which humans have developed, evolved, and survived. In particular, genetic algorithms mimic how people have evolved to thrive in harsh environments. Natural selection and the survival principle of the fittest serve as the fundamental ideas. Three genetic operators are the focus of their work: mutation, crossover, and selection. Control problems are the main applications for fuzzy logic. Fuzzy logic, sometimes referred to as fuzzy reasoning, solves problems using human language. It uses statement schemes based on IF-THEN. Likewise, information is carried by artificial neural networks, which mimic human neurons. They communicate with one another through connections, and as a group, they process information, send signals, and make decisions. These artificial neurons are stimulated by activation processes. Thus, a framework that combines these soft computer technologies can assist in decision-making in a manner similar to that of humans. This enables more dependable, resilient, economical, and time- and cost-effective use of and creation of intelligent systems, rules-based expert systems, and computer-assisted diagnostics. Since models used in soft computing methodologies are based on approximations, there is no set way that a system should operate or a process should be modeled. As a result, it could be challenging to comprehend and select the best approach to a challenge. Thus, it is vitally important to choose the finest characteristics of these methods, combine them, and use incomplete, ambiguous, and poor data to make an informed choice.

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