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Essence of Soft Computing in Healthcare

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ABSTRACT

Soft-computing is a branch of computer science that utilizes approximations to find imprecise solutions to complex problems. Soft-computing techniques are tolerant of imprecision, uncertainty, partial truth, and approximations, and are characterized by their tractability, robustness, and low solution cost. The impact of soft computing in medical diagnosis cannot be overemphasized. A large number of soft computing methods have been successfully applied for diseases diagnosis and prediction. This paper is an introduction on the applications of soft computing in healthcare.

KEYWORDS: *soft computing, hard computing, computer science, healthcare*

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INTRODUCTION

We often come across problems that do not have precise information to solve them. There are certain scenarios which do not have exact and precise parameters. Such problems cannot be solved by traditional problem-solving methods. This is where soft-computing comes into play.

The term "soft computing" was coined by Lofti A. Zadeh in 1991. Since then, the area has experienced rapid development. Soft Computing became a discipline within computer science in the early 1990s. The terms "machine intelligence" and "computational intelligence" have been used to have close meaning as soft computing.

The principal premise of soft computing (SC) is that we live in a world that is imprecise and uncertain. Soft computing refers to the use of "inexact" solutions to computationally hard tasks [2].

Healthcare basically deals with the detection, treatment, analysis, prediction and prevention of a disease, injury, illness or any other impairment. The key segments of the healthcare industry is shown in Figure 1 [3]. A proper healthcare system that would supplement has become the need of the hour. The crisis of healthcare resources in terms of man and machine in our society has become crucial. The rural people are not getting proper treatment due to the lack of doctors and some die due to improper diagnosis by the chock doctors. The question is how to minimize this calamity. Researchers are seeking a solution that would provide the best results with no side-effects and cost effective. It has been observed that in healthcare system could not go ahead a single step without soft computing [4]. Healthcare organizations seek to derive valuable insights employing data mining and soft computing techniques on the vast data stores that have been accumulated over the years. The parameters that form the foundation in the development of good healthcare systems include quality, acceptability, scalability, efficiency, consistency, coverage, continuity and most importantly cost.

Conventional computing or hard computing (HC) requires an analytical, precisely stated model. Hard computing is deterministic and precise. Health care systems, however, are less ideal, highly uncertain, and stochastic in nature. There is lot of uncertainty and imprecision involved. Soft computing techniques have also been applied successfully in healthcare data for effectively diagnosing diseases and obtaining better results in comparison to traditional approaches. These approaches include neural networks, probabilistic models, evolutionary algorithms, artificial neural networks, fuzzy logic swarm intelligence, etc. Figure 2 compares hard computing and soft computing [5].

OVERVIEW OF SOFT COMPUTING

Soft computing (SC) is a branch of computer science that resembles the processes of the human brain. It may also be regarded as a newly emerging multidisciplinary field. Its main objective is to develop intelligent machines in order to solve real-world problems. It differs from the conventional hard computing as it can handle uncertainty, imprecision easily. While conventional hard computing is based on crisp values and binary numbers, SC uses soft values and fuzzy sets.

Soft computing, also known as a computational intelligence¸ is based on natural as well as artificial ideas. It differs from conventional computing that is hard computing. It is tolerance of imprecision, uncertainty, partial truth to achieve tractability, approximation, robustness, low solution cost, and better rapport with reality. In fact the role model for soft computing is human mind [6].

Soft computing refers to a collection of computational techniques in computer science, artificial intelligence, and machine learning. The techniques aim to exploit the tolerance of imprecision and uncertainty to achieve tractability, robustness, and low solution cost. Its principle components include:

- Expert systems
- Neural networks,
- Machine learning
- Probabilistic reasoning
- Evolutionary algorithms
- Artificial neural networks
- Fuzzy logic
- Swarm intelligence
- Interactive computational models

These computation methods or technologies provide information processing capabilities to solve complex practical problems. Some of these techniques are illustrated in Figure 3 [7].

APPLICATIONS OF SC IN HEALTHCARE

Soft computing is used for solving real-life problems and can be applied in different fields such as education, healthcare, business, industry, engineering, power systems, transportation, communication systems, wireless communications, data mining, home appliances, robotics, etc. [8]. In the healthcare industry, one wrong decision can result in loss of lives or permanent damage to the patients. Medical doctors are increasingly turning to soft computing to diagnose the patients' ailments from the symptoms accurately and avoid wrong diagnosis. Typical applications of soft computing in healthcare include the following:

- **Medical Decision Making:** Healthcare practitioners need to diagnose a disease and make a decision about the treatments. Patients have symptoms, which are manifestations of the disease or a group of diseases. For proper diagnosis, the corrective treatment involves identifying the underlying cause of symptoms. Over the years, researchers from computer science, mathematics, and medical sciences have developed intelligent tools for supporting medical decision making. Modern digital technologies have allowed several soft computing systems to be successfully developed and used by healthcare professionals. In healthcare, decision making has relied traditionally on rule-based reasoning systems. Intelligent system based on soft computing (SC) techniques can help patient and doctors to express their observations that is inherently vague. SC techniques can handle such inputs and deduce some inference. SC not only helps in analyzing data but it is also very effective in finding relationship between diagnosis, treatment and prediction of the result in many clinical scenarios [9].
- **Medical Diagnosis:** Fast and reliable medical diagnosis is of vital importance in today's global world. For example, SARS or the bird flu are highly contagious and can threaten the world if they are not fought immediately and with high efficiency. It is necessary to quickly and surely diagnose the disease regardless of where the case is encountered in the world. Depending on indicators such as blood pressure and the health history of the patient, a first diagnosis is compiled using automated decision support systems [10]. Soft-computing techniques have been proposed to handle vagueness and imprecision in the diagnosis process. Soft-computing techniques in the diagnosis of tropical diseases such as malaria, leishmaniasis, typhoid fever, schistosomiasis,

yellow fever, onchocerciasis, lymphatic filariasis, ebola, chagas disease, chicken pox, African trypanosomiasis, and dengue. Since traditional diagnostic techniques could not curb the menace of tropical diseases, it is high-time soft computing techniques-which are cheaper, varied, and can handle fuzzy and confusable problems – should be employed [11].

- **Cardiac Health:** Based on the heart rate variability (HRV) analysis, cardiology experts can make an assessment for both the cardiac health and the condition of the autonomic nervous system that is responsible for controlling heart activity and, consequently, they try to prevent cardiovascular mortality. An enhanced ECG-based decision making system can exploit a collection of ontological models representing the ECG and HRV feature sets and a fuzzy inference engine [12].
- **Kidney Diseases:** Kidney failure implies that one's kidney have unexpectedly stopped functioning. Chronic kidney sickness depicts anomalous kidney function. Treatment may avoid or delay its progression, either by reducing and preventing the development of some associated complications, such as hypertension, obesity, diabetes mellitus, and cardiovascular complications. An early intervention can significantly improve the prognosis. A hybrid decision support system will allow one to consider incomplete, unknown, and even contradictory information, complemented with an approach to computing centered on artificial neural networks [13].
- **Medical Image Analysis***:* Soft computing techniques are used in medical image analysis and processing with real-world medical imaging applications. This includes image enhancement, segmentation, classification-based soft computing, and their application in diagnostic imaging, as well as an extensive background for the development of intelligent systems based on soft computing used in medical image analysis and processing. The soft computing approaches include fuzzy logic, neural networks, evolutionary computing, rough sets, and swarm intelligence [14].
- **Prediction Chronic Diseases:** The chronic disease is one of the biggest diseases facing societies all over the world. The chronic diseases such as cancer, asthma, heart, and diabetics are non-communicable diseases (NCD) as compared with another global disease that is an extremely serious type of global disease. The World Health Organization (WHO) has reported the chronic disease is one of the highest grave diseases that threaten human life in this world. They illuminate the behavioral habits from environmental factors that belong to increasing chronic diseases such as factors (unhealthy diet, physical inactivity, tobacco and alcohol use, air pollution, age, and heredity). A soft computing algorithm can improve the prediction process [15].
- **Patient Health Monitoring:** Health monitoring systems integrate health monitoring things like sensors and medical devices for remotely observe patient's records to provide smarter and intelligent healthcare services. They are becoming common in for the patients of type geriatric, dying, long suffering etc. either in the hospitals and homes. The health monitoring often monitors blood pressure, diabetes, respiration, body temperature, food and liquid intake, calories burnt, oxygen consumption, sleep quality, medicine remainder, etc. Tracking patient data from a health monitoring system helps the doctors to take preventive measures to save the life for a patient. Various devices like blood pressure monitor, temperature monitor, diabetes monitor, heart beat monitor, medicine remainder, etc. may be connected to the patients. The doctors collect the data of their patients regularly using these devices and analyze the data. Using the computational intelligence and soft computing methods, the doctors analyze the data and make predictions. The monitoring system using soft computing techniques is not only limited to classification and prediction, it is extended to other supervised and unsupervised learning algorithms to monitor, diagnose, and treat the patients [16].
- **Infectious Disease Modeling:** This is a multi-disciplinary research activity that has made significant inroads as a valuable and practical tool for public health experts and decision makers. Realistic infectious disease modeling must incorporate parameters aggregated from disparate database sources. These data may be incomplete, imprecise, insufficiently specific, or collated at varying levels of information granularity. With the ability to deal with imprecise, approximate, and vague scenarios, soft computing can play an important role in expanding the use of these models. Some soft computing approaches have been used for infectious disease modeling. The single greatest challenge with infectious disease modeling is that models are often developed with only the modelers in mind and not the public

health experts. Soft computing based approaches to infectious disease modeling do not suffer from this deficiency [17].

- **Privacy Preservation Electronic Health:** One of the biggest challenges facing healthcare is protecting the important sensitive data of electronic health records (EHRs) that are available over web. The real issues on EHRs is hiding the sensitive huge data especially stored in distributed environment and shared between numbers of stakeholders. It is very important to eliminate the superfluous data and maintains the privacy of individual record stored in EHRs. To construct an effective privacy framework for EHR's, fuzzy logic system is applied on different dataset that are available. In fuzzy logic-based privacy preservation model, the sensitive attributes of electronic health records values are set into five linguistic values such as Low, Very Low, Middle, High and Very High [18].

BENEFITS AND CHALLENGES

Soft computing methods can adapt themselves according to problem domain. This makes soft computing techniques more powerful, reliable, and efficient. It also makes the soft computing approaches more suitable and competent for healthcare data [19]. Soft Computing techniques aided by the technological advancements would undoubtedly curb the shortage in the availability of proper healthcare.

Implementation of soft computing systems for medical applications should be supported by a solid security shield that ensures the privacy and safety of medical data. There is a noticeable "research divide" between the universities and the community at large, which is sending the wrong signals to governments, the WHO, and other stakeholders. Research results are buried in the archives of universities with little or no publicity to the larger community.

CONCLUSION

Soft computing is essentially the study of science of reasoning, thinking, analyzing, and detecting that correlates the real world problems to the biological inspired methods. It is one of the front running technologies which is defining the future of computing. Soft computing approaches play a vital role in solving the different kinds of problems and provide promising solutions. The approaches have also been applied in healthcare data for effectively diagnosing diseases and obtaining better results in comparison to traditional approaches. Soft computing approaches can adapt themselves according to problem domain.

Healthcare organizations should be laying the cultural foundation today for upcoming technology changes in the near future. What will be needed in the future is not just the breakthroughs in technology, but breakthroughs in creative thinking and the ability of leaders to think differently [20]. The shortage of healthcare practitioners and increased demand could crash healthcare systems in the coming years. More information about soft computing in healthcare can be found in the books in [14,21-27] and the following related journals:

- Soft Computing
- Applied Soft Computing Journal
- Applied Computational Intelligence and Soft Computing
- Journal of Healthcare Engineering
- Journal of Soft Computing and Decision Support Systems
- International Journal on Soft Computing

REFERENCES

[1] K. Taylor, "What is soft computing?" https://www.hitechnectar.com/blogs/applications-soft-computing/

[2] M. N. O. Sadiku, Y. Wang, S. Cui, S. M. Musa, "Soft computing: An introduction," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. 8, no. 6, June 2018, pp. 63-65.

[3] "All about healthcare industry: Key segments, value chain, needs and competitive advantage," https://www.predictiveanalyticstoday.com/what-is-healthcare-industry/

[4] S. Das and M. K. Sanyal, "Application of AI and soft computing in healthcare: A review and speculation," *International Journal ff Scientific & Technology Research,* vol. 8, no. 11, November 2019, pp. 1786-1806.

[5] B. Xavier, and P. B. Dahikar, "A comprehensive study on the significance of soft computing in healthcare systems," *International Journal of Engineering Research & Technology*, vol. 4, no. v2, February 2015, pp. 278-281.

[6] S. K. Das et al., "On soft computing techniques in various areas," *Computer Science & Information Technology,* 2013, pp. 59-68.

[7] "Difference between AI and soft computing," March 2020, https://www.geeksforgeeks.org/difference-between-ai-and-soft-computing/

[8] M. Dahiya, "Applications of soft computing in various areas," *International Journal of*

Engineering Sciences & Research Technology, vol. 6, no. 5, May 2017, pp. 712-716.

[9] A. Bhatia, V. Mago, and R. Singh, "Use of soft computing techniques in medical decision making: A survey," *Proceedings of International Conference on Advances in Computing, Communications and Informatics,* September 2014, pp. 1131-1137.

[10] M. Ulieru, M. Hadzic, and E. Chang, "Soft computing agents for e-Health application to the research and control of unknown diseases," *Information Sciences,* vol. 176, no. 9, May 2006, pp.1190-1214.

[11] S. B. Oyong et al., "Application of soft computing techniques in the diagnosis of tropical diseases: A systematic review," *Journal of Tropical Diseases and Public Health,*vol. 8, no. 5, 2020.

[12] G. Acampora et al., "Evaluating cardiac health through semantic soft computing techniques," *Soft Computing*, vol. 16, 2012, pp.1165–1181.

[13] J. Neves et al., "A soft computing approach to kidney diseases evaluation," *Journal of Medical Systems,* vol. 39, Article number 131, August 2015.

[14] N. Dey et al., *Soft Computing Based Medical Image Analysis.* Springer, 2018.

[15] T. H. H. Aldhyani, A. S. A. Alshebami, M. Y. Alzahrani, "Soft computing model to predict chronic diseases," *Journal of Information Science and Engineering,* vol 36, 2020, pp. 365-376.

[16] Y. V. R. N. Pawan, K. B. Prakash, and P. K. Vadla, "Patient health monitoring using soft computing techniques," *IOP Conference Series: Materials Science and Engineering*, vol. 872, 2020.

[17] N. J. Pizzi, "Soft computing and infectious disease modeling: A review and prescription," *Proceedings of the Annual Meeting of the North American Fuzzy Information Processing Society,* August, 2012.

[18] A. Kumar, R. Kumar, and S. S. Sodhi, "Intelligent privacy preservation electronic health record framework using soft computing," *Journal of Information and Optimization Sciences,* vol. 41, no. 7, 2020, pp. 1615-1632.

[19] S. Gambhir, S. K. Malik, and Y. Kumar, "Role of soft computing approaches in healthcare domain: A mini review," *Journal of Medical Systems,* vol. 40, no. 12, October 2016, pp. 1–20.

[20] D. Marbury, "Six healthcare technologies coming in the next 10 years," February 2019, https://www.managedhealthcareexecutive.com/view/six-healthcare-technologies-coming-next-10-years

[21] H. Malik, A. Iqbal, and A. K. Yadav 9eds.), *Soft Computing in Condition Monitoring and Diagnostics of Electrical and Mechanical Systems: Novel Methods for Condition Monitoring and Diagnostics*. Springer, 2020.

[22] A. M. Mishra, G. Suseendran, T. N. Phung, *Soft Computing Applications and Techniques in Healthcare*. Boca Raton, FL: CRC Press, 2020.

[23] M. Gui et al., *Computational Intelligence and Soft Computing Applications in Healthcare Management Science*. IGI Global, 2020.

[24] R. Ali and M. M. S. Beg, *Applications of Soft Computing for the Web.* Springer 2017.

[25] P. Debnath and S. A. Mohiuddine (eds.), *Soft Computing Techniques in Engineering, Health, Mathematical and Social Sciences.* Boca Raton, FL: CRC Press, 2022.

[26] F. Saeed et al. (eds.), *Recent Trends in Data Science and Soft Computing: Proceedings of the 3rd International Conference of Reliable Information and Communication Technology*. Springer 2019.

[27] S. Borah and R. Panigrahi (eds.), *Applied Soft Computing: Techniques and Applications.* Apple Academic Press, 2022.

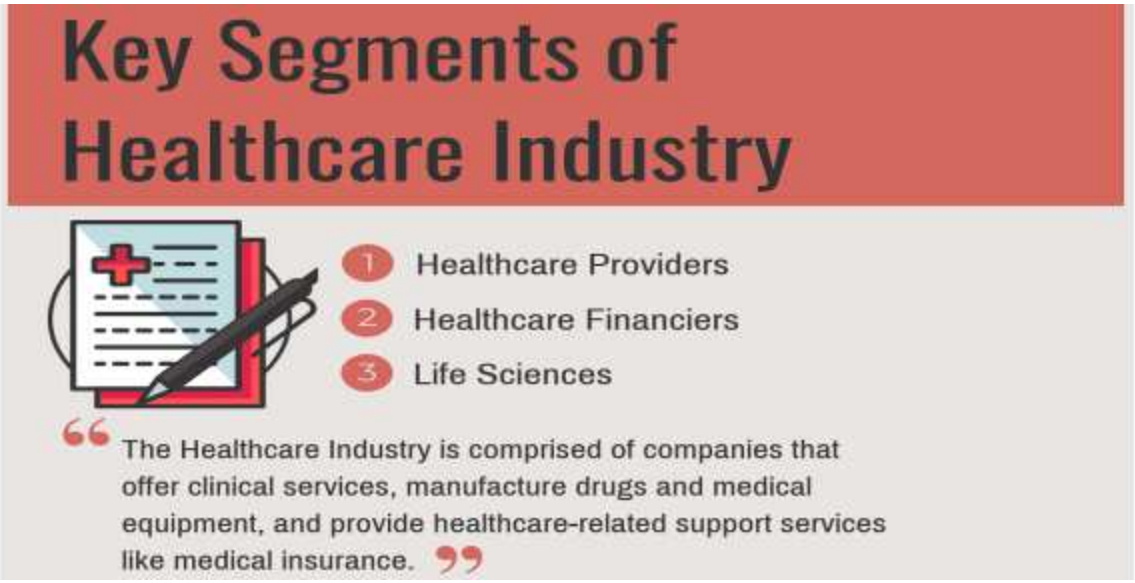

Figure 1 The key segments of the healthcare industry [3].

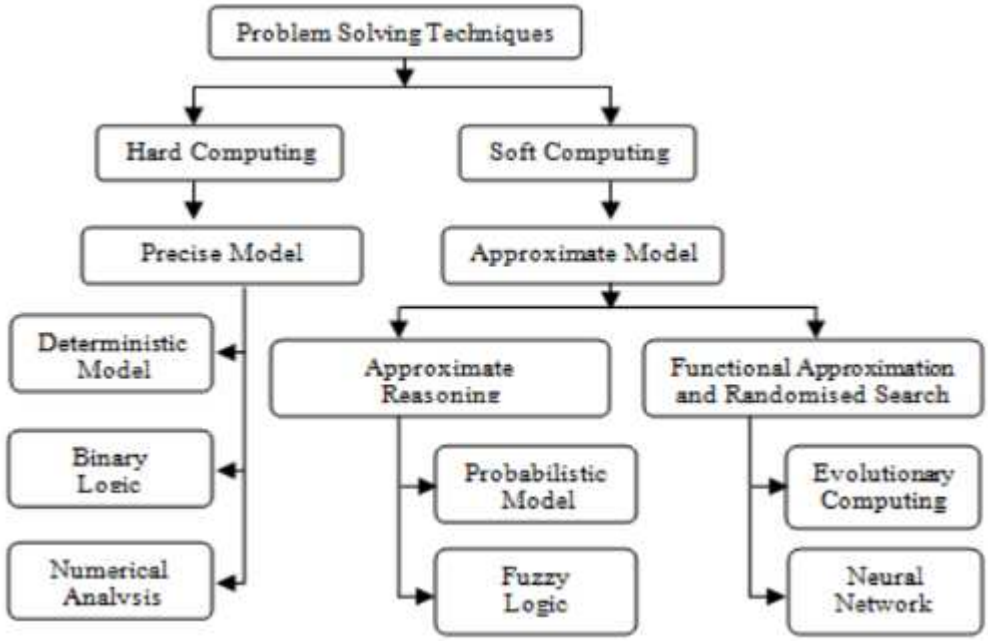

Figure 2 Comparing hard computing with soft computing [5].

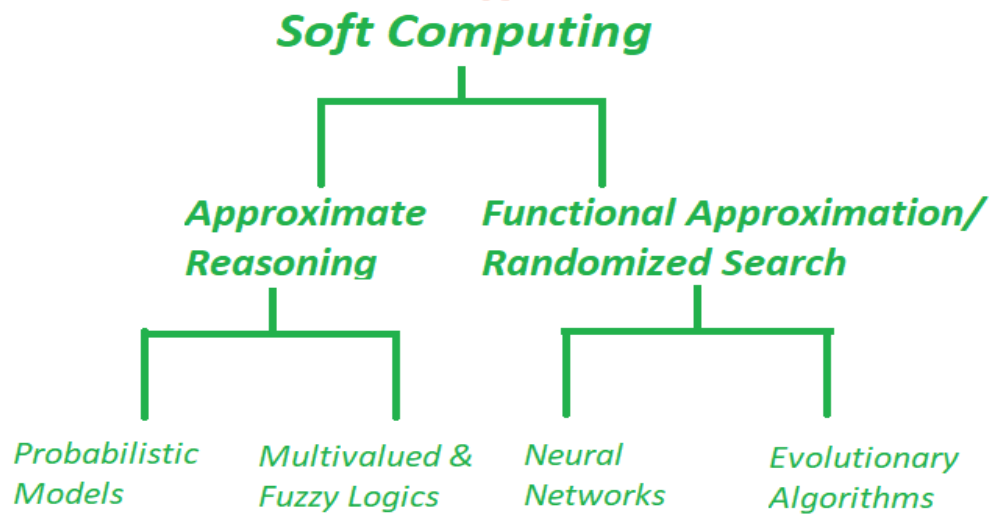

Figure 3 Soft computing approaches [7]