

## Soft Computing in Education: A Primer

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### ABSTRACT

Soft computing (SC) is an emerging branch of computer science that is tolerant to imprecise and uncertain problems with partial truth. It is one of the front running technologies which is defining the future of computing. The different components of SC are used in the development of computing systems that can easily perform difficult tasks without the need of human beings. Education in soft computing is a mean for promoting science and innovation in a changing society. This paper is a primer on the applications of soft computing in education.

**KEYWORDS:** *soft computing, hard computing, computer science, education, learning*

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### INTRODUCTION

Computing is essentially mapping the given set of inputs to output using a formal algorithm to solve a problem. It is suitable for problems that are easy to model mathematically. A mapping function converts the input of one form to another form of desired output using certain control actions. There are two types of computing models in computer science: hard computing and soft computing.

Hard computing deals with crisp, discrete or binary situations whereas soft computing deals with situations with uncertainty, imprecision, partial truth, vagueness and ambiguity. Hard computing is a process where we program the computer to solve certain problems using existing mathematical algorithms. Soft computing techniques solve problems by imitating the remarkable power of human to think logically and learn from mistakes in an imprecise scenario. It is the reverse of hard (conventional) computing [1].

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 C 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].

Education is an overall framework where dissemination and teaching are means to be used. An education process is a continuous improving of knowledge and skills of students

There are four types of activities related to the scientific advancement through education: Teaching, Research, Transfer, and Dissemination, as illustrated in Figure 1 [3].

### 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. The conventional methods require exact input data, use a precise methodology, and generate a precise output. It does not work when the input is not exact. We often come across certain problems without precise information to solve the problem. This kind of problems cannot be solved by traditional problem-solving techniques because they lack exact and precise parameters. This is where soft-computing techniques come into play. This is what our computers are not equipped for, but our human brain is. Figure 2 compares hard computing with soft computing [4].

According to Zadeh, a computing concept is regarded as hard computing if [5]:

- It provides precise results based on learning from experimental data.
- Algorithm used to solve a problem is unambiguous and adaptive.
- The control action is formally defined using an algorithm or a mathematical model.

Soft computing is a collection of computational techniques which 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 [6].

## APPLICATIONS

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, and robotics. The use of soft computing techniques in these fields help in making well informed decisions easily and quickly [7,8]. Education and learning stand out among many application areas of soft computing. Various applications of SC in education are presented as follows.

➤ **Education Management:** This is an area that involves the administration of education and academics. Technology helps both the students and teachers interact and collaborate with each other more efficiently. Many SC techniques have been employed in the area of education management such as for forecasting student enrolment, student and faculty performance evaluation, forecasting student grade point average among others. SC techniques like neural networks are used to evaluate the student course grading and evaluation and fuzzy logic for efficient learning and performance [9].

➤ **E-Learning:** E-Learning (also referred to as web-based education or e-teaching), is essentially as an electronic teaching strategy in which guidelines are created or configured to facilitate student learning and then distributed to targeted recipients by smart devices. It is a new context for education where large amounts of information describing the continuum of the teaching-learning interactions are endlessly generated. It has experienced rapid growth mainly in higher education and training. Elearning can be categorized d in two ways: one as teacher-based learning called synchronous e-learning, and the other as self-based asynchronous e-learning is a form of individual research. E-Learning course offerings are now available, and many new e-Learning platforms have been developed and implemented with varying degrees of success. The educational community is of the opinion that very soon half of the world's higher education courses will be delivered through e-Learning. There is the basic role of e-tutors and e-trainers in guaranteeing educational quality. Using soft computing techniques, knowledge can be extracted from the data produced and stored by e-Learning systems, allowing the classification, analysis, and generalization of the extracted knowledge [10].

➤ **Smart Learning:** Smart education is an implementation of IoT in higher education. This denotes the new way of interaction between the students and the teachers for generating a smart-based academic environment. Smart learning (S-learning) is an advanced form of education. It

focuses on the content of learners based on advanced computing technologies. The overall structure of a smart learning environment is shown in Figure 4 [11]. Mobile devices such as laptops, personal digital assistants, and mobile phones have become learning tools, especially for digital natives. This has led to the close integration of mobile devices and the curriculum. Mobile devices are expected to encourage innovation in education, communication, and cooperative skills [12].

- **Remote Learning:** Recently developments in remote learning offer increasing possibilities for improving learning processes in education. A powerful social impact of remote learning is observed as a result of globalization, international standardization, and rising requirements of teaching qualifications. A remote distribution of resources changes structure, strategy, and performance of learning processes. Some advantages of remote learning include: (1) Flexible freedom of choice of disciplines, programs, and courses that are offered in learning cyberspace. (2) Possibilities to use the most advanced achievements in every particular field of consideration. (3) Convenience in respect to scheduling of learning preferences, personal user choice, individual mental abilities, and time of studying. (4) Continuous control of learning levels using the best virtual Internet controllable mentors. Soft computing decisions may be successfully integrated with existing mobile agents [13].
- **Student Evaluation:** To maintain quality in higher education there is a need to do students regular assessment. Traditional method of grading is widely used by many institutions to evaluate the students' academic performance for several decades. Fuzzy logic (FL) approach is the new idea for students' academic performance evaluation in educational field. The evaluation of students' performance using fuzzy techniques is adapted for evaluation based on obtained numerical scores in the assessment. FL with fuzzy expert system gives the interesting results for evaluation on the basis of qualitative and quantitative facts or data to measure students' performance. The results of FL are more realistic than traditional method of relative grading [14].
- **Quality of Education:** This has awakened the interest of investigators worldwide because they can be the answer of education problems. Researchers of education believe that the expectations and needs of human beings depend

on factors like the quality of curricula for which they are prepared, the infrastructure of the country in education, the academic environment which is developed, the faculty and the relationship between teachers and students, etc. Fuzzy logic can be used to measure the quality of education by using quantitative and qualitative values. The major advantage of fuzzy logic is that one can handle an unlimited number of indicators expressed in any unit of measurement [15].

### BENEFITS

Soft computing is a newly emerging computing method that combines various knowledge, technology, and methods to set up an intelligent system to solve complex problems under uncertain and inaccurate circumstances. The main aim of soft computing is to display psychological conduct of human brain. Just like a human brain, in order to solve complex problems, SC uses multiple techniques simultaneously in the computation in a harmonious manner [16]. In the field of education, soft computing techniques are used for improving the performance of students in academics. Students' evaluation system can be improved by using soft computing. Delivering technique of lesson can also be assessed with soft computing.

### CHALLENGES

One of the major challenges to implementing effective mobile learning programs is insufficient preparation of the teachers. This requires professional development of teachers before the adaptation to mobile-device based teaching. Soft computing needs well established Internet services and a lot of funds to run the program successfully. Without government assistance, it is quite impossible for educational organizations to set up and maintain the infrastructures. In order to remove humans and their assumptions, the machine cannot be too precise. There are also concerns of privacy and protection.

### CONCLUSION

The pervasiveness of the Internet has enabled online distance education to become far more mainstream than it used to be, and that has happened in a surprisingly short time.

Soft Computing refers to the science of reasoning, thinking, and deduction that recognizes and uses the real world phenomena of grouping, memberships, and classification of various quantities under study. It does not require strict mathematical definitions and distinctions for the system components. Some institutions are now offering soft computing in their curriculum. More information about soft computing in education can be found in the books in [17-23] and the following related journals:



- Computers & Education
- Applied Soft Computing
- Computer Applications in Engineering Education
- Journal of Multiple-Valued Logic and Soft Computing

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Figure 1 Four types of activities related to the scientific advancement through education [3].

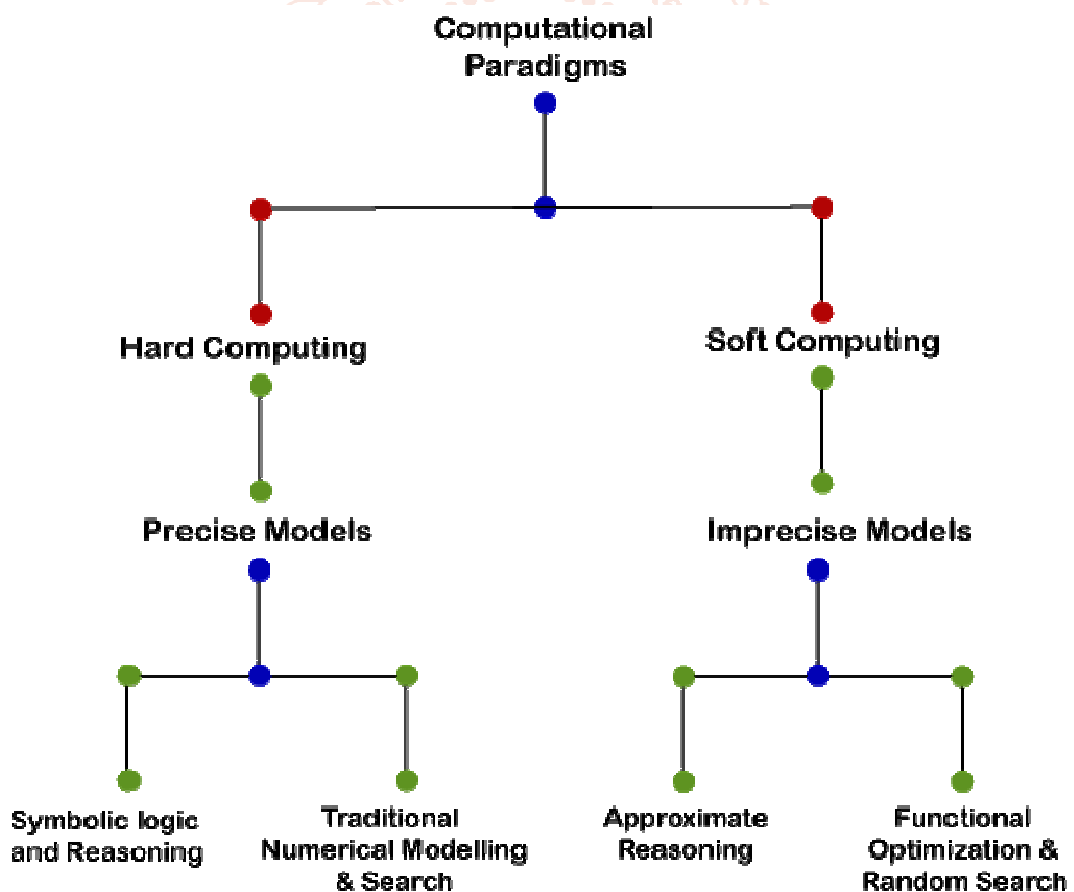


Figure 2 Comparing hard computing with soft computing [4].

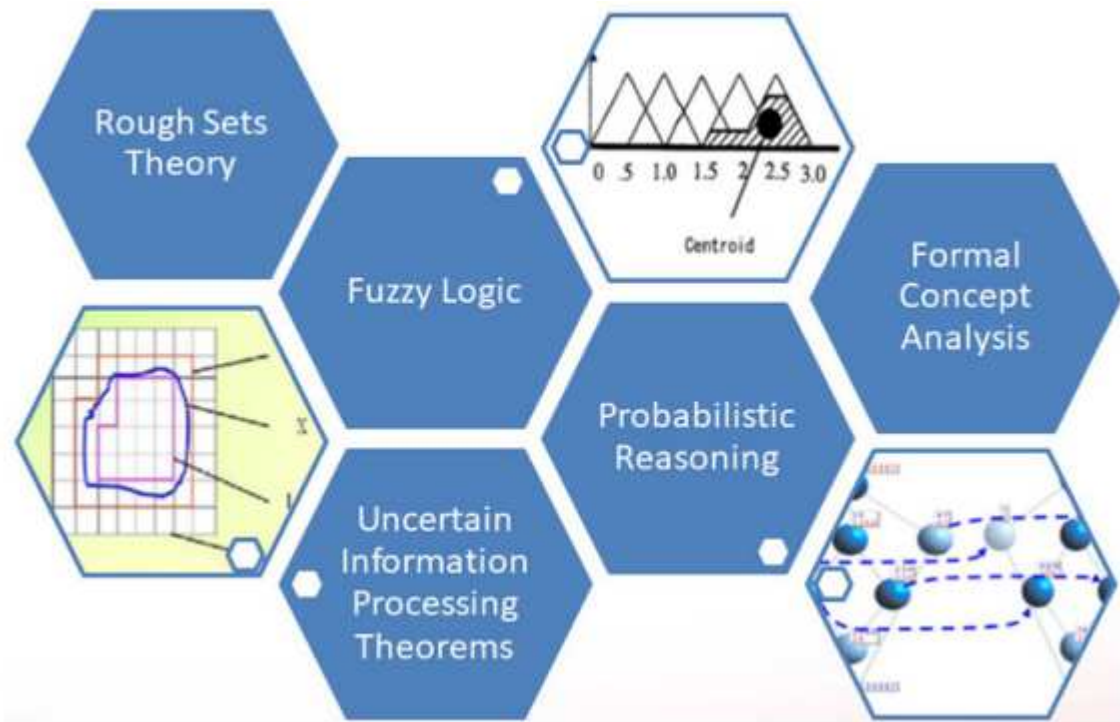


Figure 3 Some soft computing techniques [6].

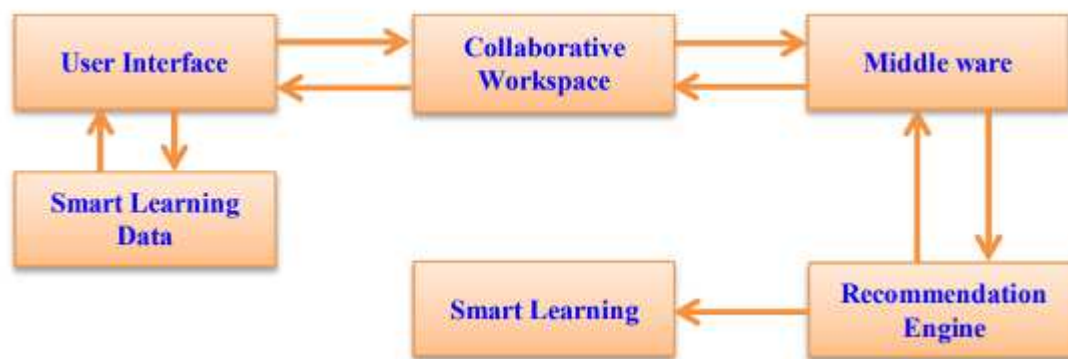


Figure 4 The overall structure of a smart learning environment [15].