Soft Computing

Fourth Stage

Computer Engineering Department/ University of Diyala

Lecturer

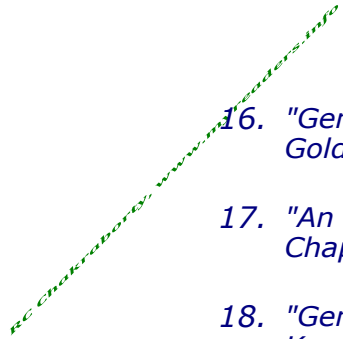**Dr. Baidaa Al-Bander**

Course Content

Soft Computing topics: Introduction to soft computing, Fundamentals of neural network, Back propagation network, Associative memory, Adaptive resonance theory, Fuzzy set theory, Fuzzy systems, Genetic algorithms & modeling, and Hybrid systems.

References: Textbooks

1. *"Neural Network, Fuzzy Logic, and Genetic Algorithms - Synthesis and Applications", by S. Rajasekaran and G.A. Vijayalaksmi Pai, (2005), Prentice Hall, Chapter 1-15, page 1-435.*

2. *"Soft Computing and Intelligent Systems - Theory and Application", by Naresh K. Sinha and Madan M. Gupta (2000), Academic Press, Chapter 1-25, page 1-625.*

3. *"Soft Computing and Intelligent Systems Design - Theory, Tools and Applications", by Fakhreddine karray and Clarence de Silva (2004), Addison Wesley, chapter 1-10, page 1-533.*

4. *"Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence" by J. S. R. Jang, C. T. Sun, and E. Mizutani, (1996), Prentice Hall, Chapter 1-15, page 1-607.*

5. *"Soft Computing: Integrating Evolutionary, Neural, and Fuzzy Systems", by Tettamanzi, Andrea, Tomassini, and Marco. (2001), Springer, Chapter 1-9, page 1-323.*

6. *"Neural Networks: A Comprehensive Foundation", by Simon S. Haykin, (1999), Prentice Hall, Chapter 1-15, page 1-889.*

7. *"Elements of Artificial Neural Networks", by Kishan Mehrotra, Chilukuri K. Mohan and Sanjay Ranka, (1996), MIT Press, Chapter 1-7, page 1-339.*

8. *"Fundamentals of Neural Networks: Architecture, Algorithms and Applications", by Laurene V. Fausett, (1993), Prentice Hall, Chapter 1-7, page 1-449.*

9. *"Neural Network Design", by Martin T. Hagan, Howard B. Demuth and Mark Hudson Beale, (1996) , PWS Publ. Company, Chapter 1-19, page 1-1 to 19-14.*

10. *"An Introduction to Neural Networks", by James A. Anderson, (1997), MIT Press, Chapter 1- 17, page 1-585.*

11. *"Fuzzy Sets and Fuzzy Logic: Theory and Applications", by George J. Klir and Bo Yuan, (1995), Prentice Hall, Chapter 1-17, page 1-574.*

12. *"Introduction To Fuzzy Sets And Fuzzy Logic", by M Ganesh, (2008), Prentice-hall, Chapter 1-10, page 1- 256.*

13. *"Fuzzy Logic: Intelligence, Control, and Information", by John Yen, Reza Langari, (1999), Prentice Hall, Chapter 1-17, page 1-543.*

14. *"Fuzzy Logic with Engineering Applications", by Timothy Ross, (2004), John Wiley & Sons Inc, Chapter 1-15, page 1-623.*

15. *"Fuzzy Logic and Neuro Fuzzy Applications Explained", by Constantin Von Altrock, (1995), Prentice Hall, Chapter 1-8, page 1-368.*

16. "Genetic Algorithms in Search, Optimization, and Machine Learning", by David E. Goldberg, (1989), Addison-Wesley, Chapter 1-8, page 1-432.

17. "An Introduction to Genetic Algorithms", by Melanie Mitchell, (1998), MIT Press, Chapter 1- 6, page 1- 203,

18. "Genetic Algorithms: Concepts And Designs", by K. F. Man, K. S. and Tang, S. Kwong, (201), Springer, Chapter 1- 10, page 1- 348,

19. "Genetic algorithms and engineering design", by Mitsuo Gen, and Runwei Cheng, (1997), John Wiley & Sons Inc, chapter 1- 10, page 1-411.

20. "Practical genetic algorithms", by Randy L. Haupt, (2004), John Wiley & Sons Inc, Chapter 1- 7, page 1- 251.

21. Related documents from open source, mainly internet. An exhaustive list is being prepared for inclusion at a later date.
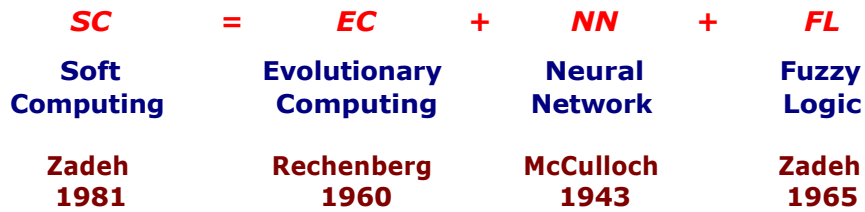
Introduction

Basics of Soft Computing

What is Soft Computing?

- The idea of soft computing was initiated in 1981 when Lotfi A. *Zadeh* published his first paper on soft data analysis "What is Soft Computing", Soft Computing. Springer-Verlag Germany/USA 1997.].

- Zadeh, defined Soft Computing into one multidisciplinary system as the fusion of the fields of Fuzzy Logic, Neuro-Computing, Evolutionary and Genetic Computing, and Probabilistic Computing.

- Soft Computing is the fusion of methodologies designed to model and enable solutions to real world problems, which are not modeled or too difficult to model mathematically.

- The aim of Soft Computing is to exploit the tolerance for imprecision, uncertainty, approximate reasoning, and partial truth in order to achieve close resemblance with human like decision making.

- The Soft Computing – development history

SC	=	EC	+	NN	+	FL
Soft Computing		Evolutionary Computing		Neural Network		Fuzzy Logic
Zadeh 1981		Rechenberg 1960		McCulloch 1943		Zadeh 1965

EC	=	GP	+	ES	+	EP	+	GA
Evolutionary Computing		Genetic Programming		Evolution Strategies		Evolutionary Programming		Genetic Algorithms
Rechenberg 1960		Koza 1992		Rechenberg 1965		Fogel 1962		Holland 1970

Introduction

To begin, first explained, the definitions, the goals, and the importance of the soft computing. Later, presented its different fields, that is, Fuzzy Computing, Neural Computing, Genetic Algorithms, and more.

Definitions of Soft Computing (SC)

Lotfi A. Zadeh, 1992: "Soft Computing is an emerging approach to computing which parallel the remarkable ability of the human mind to reason and learn in a environment of uncertainty and imprecision".

The Soft Computing consists of several computing paradigms mainly:

Fuzzy Systems, Neural Networks, and Genetic Algorithms.

- Fuzzy set: for knowledge representation via fuzzy If – Then rules.

- Neural Networks: for learning and adaptation

- Genetic Algorithms: for evolutionary computation

These methodologies form the core of SC.

Hybridization of these three creates a successful synergic effect;

that is, hybridization creates a situation where different entities cooperate advantageously for a final outcome.

Soft Computing is still growing and developing.

Hence, a clear definite agreement on what comprises Soft Computing has

not yet been reached. More new sciences are still merging into Soft Computing.

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Goals of Soft Computing

Soft Computing is a new multidisciplinary field, to construct new generation of Artificial Intelligence, known as **Computational Intelligence**.

- The main goal of Soft Computing is to develop intelligent machines to provide solutions to real world problems, which are not modeled, or too difficult to model mathematically.

- Its aim is to exploit the tolerance for **Approximation, Uncertainty**, **Imprecision**, and **Partial Truth** in order to achieve close resemblance with human like decision making.

  Approximation: here the model features are similar to the real ones, but not the same.

  Uncertainty: here we are not sure that the features of the model are the same as that of the entity (belief).

  Imprecision: here the model features (quantities) are not the same as that of the real ones, but close to them.

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Importance of Soft Computing

Soft computing differs from   hard (conventional) computing. Unlike hard computing, the soft computing is **tolerant of imprecision, uncertainty, partial truth, and approximation**. The guiding principle of soft computing is to exploit these tolerances to achieve tractability, robustness and low solution cost. In effect, the role model for soft computing is the   human mind.

The four fields that constitute Soft Computing (SC) are: **Fuzzy Computing** (FC), **Evolutionary Computing** (EC), **Neural computing** (NC), and **Probabilistic Computing** (PC), with the latter subsuming belief networks, chaos theory and parts of learning theory.

Soft computing is not a concoction, mixture, or combination, rather, **Soft computing is a partnership** in which each of the partners contributes   a distinct methodology for addressing problems in its domain. In principal   the constituent methodologies in Soft computing are complementary rather than competitive.

Soft computing may be viewed as a foundation component for the emerging field of Conceptual Intelligence.

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Applications of Soft Computing

The applications of Soft Computing have proved two main advantages.

- First, in solving nonlinear problems, where mathematical models are not available, or not possible.

- Second, introducing the human knowledge such as cognition, recognition, understanding, learning, and others into the fields of computing.

This resulted in the possibility of constructing intelligent systems such as autonomous self-tuning systems, and automated designed systems.

The relevance of soft computing for pattern recognition and image processing is already established during the last few years. The subject has recently gained importance because of its potential applications in problems like:

- Remotely Sensed Data Analysis,
- Data Mining, Web Mining,
- Global Positioning Systems,
- Medical Imaging,
- Forensic Applications,
- Optical Character Recognition,
- Signature Verification,
- Multimedia,
- Target Recognition,
- Face Recognition and
- Man Machine Communication.

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