

# Soft Computing and Decision Support Systems (CSc 876/676 )

**Instructor:** Dr. Jozo Dujmović (English spelling/pronunciation: Yozo Douy-mo-vich)

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**Course Level:** Graduate or advanced undergraduate elective.

**Number of Credits:** 3 (three hours of lecture per week offered on Friday starting at 9:30 am)

**Prerequisite:** Essential prerequisite is a clear interest in individual creative work in the area of computational intelligence, based on standard preparation in mathematical modeling and software development. Advanced undergraduate seniors who completed 510 can get instructor's consent, but the research-oriented format of CSc 876/676 is different from the traditional homework-midterm-final format of CS undergraduate electives.

## Topics of interest

Humancentric aspects of artificial intelligence. Survey of soft computing and related areas of computational intelligence. Decision engineering methods, decision support tools, and a spectrum of decision-making applications. The concepts of granulation and graduation. Fuzzy sets, fuzzy logic, and fuzzy systems. Approximate reasoning. Possibility theory. Fuzzy decision making. Fuzzy controllers. Concept of rough sets. Computing with words, perceptual computing, and granular computing. Neural networks and their use. Modeling of human mental activities. Study of logic aggregation operators and information fusion models. Graded logic. LSP method for evaluation and optimization of complex systems. Applications of soft computing. Development and use of software systems for decision support.

## General goals:

- To promote critical thinking as a prerequisite and motivation for creative work.
- To be exposed to recent soft computing research results, decision methods, tools, and applications, and to participate in such research activities. (the knowledge that is created is different from the knowledge that is borrowed).
- To learn how to develop new techniques and software tools based on observation, experiments, and modeling of human mental activities.
- To learn how to find, read, and analyze research papers, and how to present research and development results in professionally correct and efficient scientific way.

## Specific goals:

Presentation of selected areas of soft computing in an advanced research-oriented way. In particular, the course will include in-depth presentation of the following topics:

- Observable properties of human reasoning and their modeling.
- Development, validation, and use of graded logic models.
- Graded logic as a soft computing generalization of classic Boolean logic.
- Decision engineering techniques based on the LSP method and corresponding software tools: evaluation and selection of complex objects and alternatives.
- Critical thinking that stimulates developments of soft computing methods and tools.
- Critical reading of modern literature in the area of computational intelligence.
- Cooperative experimental work in modeling human reasoning.
- Development of realistic and justifiable decision criteria.
- Development and use of professional-level decision support software (LSP.NT, etc.)
- Soft computing applications in real estate, medicine, ecology, space management, geography (GIS), strategic planning, computer science, and personal decision making.

**Projects and grading:**

CSc 876/676 has no exams. During the semester students will work on projects related to material presented in the class. Projects will stimulate creativity, independence, critical thinking, and have a moderate research component. Results will be reported in the form of technical reports or research papers. Individual projects will be graded and the final grade will be derived from the grades of individual projects.

**New book:**

This course has a unique opportunity that it is offered shortly after the publication of instructor's new book (download from <https://onlinelibrary-wiley-com.jplnet.sfsu.edu/doi/book/10.1002/9781119256489>): Dujmović, J., *Soft Computing Evaluation Logic*. J. Wiley and IEEE Press, 2018.

<https://www.wiley.com/en-us/Soft+Computing+Evaluation+Logic%3A+The+LSP+Decision+Method+and+Its+Applications-p-9781119256458>

The course is expected to benefit from this coincidence.

**Important textbooks:**

Klir, G.J. and B. Yuan, *Fuzzy Sets and Fuzzy Logic*. Prentice-Hall, 2002 India edition

Ross, T.J. *Fuzzy Logic With Engineering Applications*. J. Wiley, 2010.

Pedrycz, W., *Granular Computing*. CRC Press, 2013.

Mendel, J.M and D. Wu, *Perceptual Computing*. J. Wiley, 2010.

Ray, K.S., *Soft Computing and its Applications*. Vol. 1 and Vol. 2. CRC Press, 2015.

**Recommended Literature:**

Kacprzyk, J. and W. Pedrycz, *Springer Handbook of Computational Intelligence*. Springer 2015.

S.N. Shahbazova (Ed.), *Fuzzy Logic and its Applications*. Selected Papers by Lotfi A. Zadeh. Little enterprise, 2016.

B. Kosko, *Fuzzy Thinking*. Hyperion, 1993.

J.M. Mendel, *Uncertain Rule-Based Fuzzy Logic Systems*. Prentice Hall, 2001.

V. Belton and T.J. Stewart, *Multiple Criteria Decision Analysis: an Integrated Approach*. Kluwer Academic Publishers (2002).

Zimmermann, H-J., *Fuzzy Set Theory and its Applications*. Kluwer Academic Publishers (1996).

C. Carlsson and R. Fullér, *Fuzzy Reasoning in Decision Making and Optimization*. Physica-Verlag (2002)

J. Fodor and M. Roubens, *Fuzzy Preference Modeling and Multicriteria Decision Support*. Kluwer Academic Publishers (1994).

R.L. Keeney and H. Raiffa, *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. John Wiley (1976).

P.S. Bullen, *Handbook of means and their inequalities*, Kluwer, 2003.

Beliakov, G., H. Bustince Sola, and T. Calvo Sanchez. *A practical guide to averaging functions*. Studies in Fuzziness and Soft Computing 329. New York: Springer; 2016.

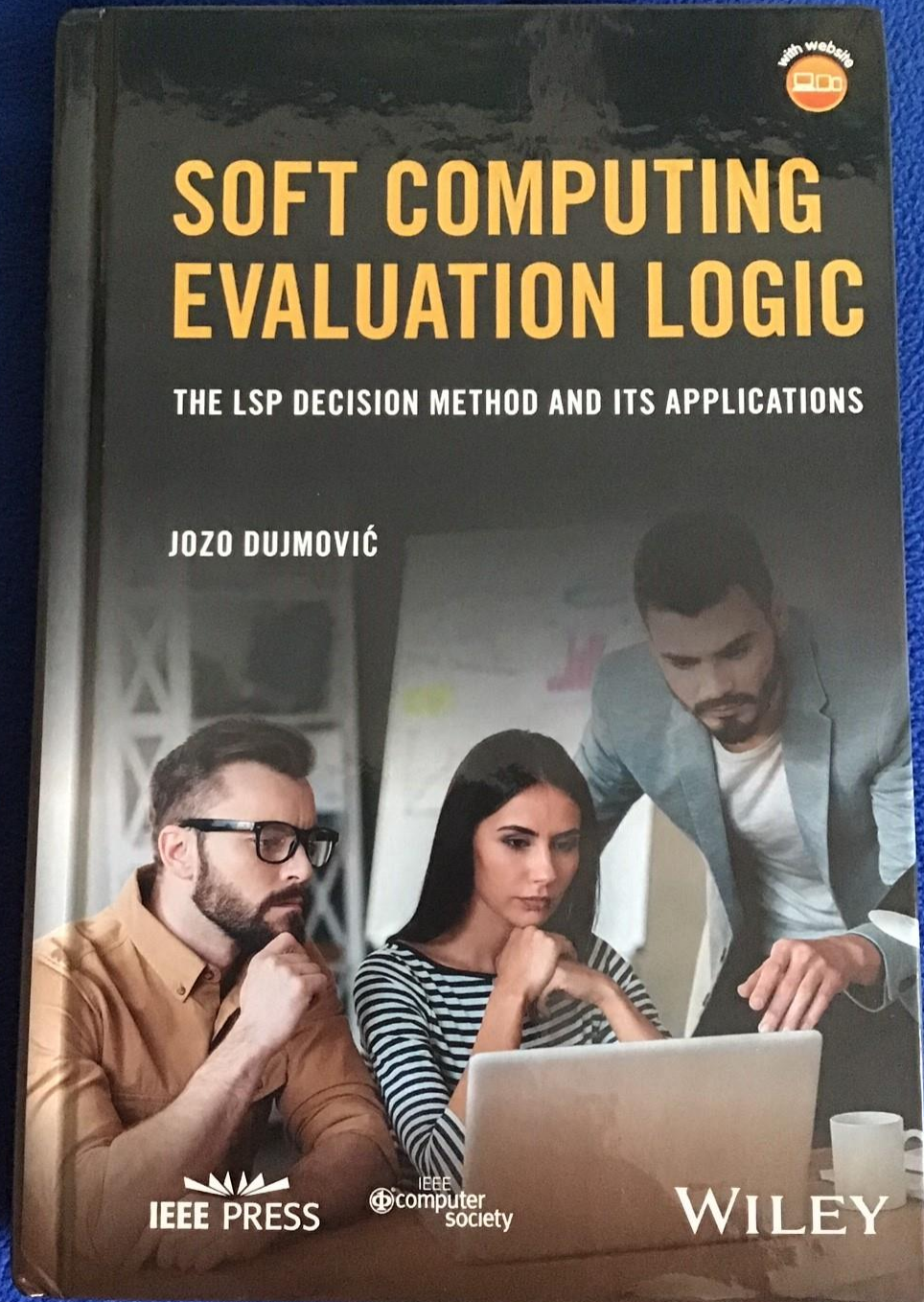
Ray, K.S., *Soft Computing and its Applications*. Vol.1 and Vol.2. CRC Press 2015.

**Journals that publish research in soft computing:**

IEEE Transactions on Fuzzy Systems, IEEE Transactions on Syst., Man, Cybern., International Journal of Approximate Reasoning, Applied Soft Computing, Fuzzy Sets and Systems, International Journal of Uncertainty, Fuzziness, and Knowledge-Based Systems, International Journal of Intelligent Systems, Information Sciences.

**Conferences on soft computing:**

FUZZ-IEEE, IPMU, IEEE WCCI, WCSC, EUSFLAT, AGOP, MDAI (Proceedings of these conferences contain the latest research results in this area).





## A NOVEL APPROACH TO DECISION ENGINEERING, WITH A VERIFIED FRAMEWORK FOR MODELING HUMAN REASONING

*Soft Computing Evaluation Logic* provides an in-depth examination of evaluation decision problems and presents comprehensive guidance toward the use of the Logic Scoring of Preference (LSP) method in modeling complex decision criteria. Fully aligned with current developments in computational intelligence, the discussion covers the design and use of LSP criteria for evaluation and comparison in diverse areas, such as search engines, medical conditions, real estate, space management, habitat mitigation projects in ecology, and land use and residential development suitability maps, with versatile transfer to other similar decision-modeling contexts.


Human decision making is rife with fuzziness, imprecision, uncertainty, and half-truths—yet humans make evaluation decisions every day. In this book, such decision processes are observed, analyzed, and modeled. The result is *graded logic*, a soft computing mathematical infrastructure that provides both formal logic and semantic generalizations of classical Boolean logic. Graded logic is used for logic aggregation in the context of evaluation models consistent with observable properties of human reasoning. The LSP method, based on graded logic and logic aggregation, is a vital component of an industrial-strength decision engineering framework. Thus, the book:

- Provides detailed theoretical background for graded logic
- Provides a theory of logic aggregators
- Explains the LSP method for designing complex evaluation criteria and their use
- Shows techniques for evaluation, comparison, and selection of complex systems, as well as the cost/suitability analysis, optimization, sensitivity analysis, tradeoff analysis, and missingness-tolerant aggregation
- Includes a survey of available LSP software tools, including ISEE, ANSY and LSP.NT.

With quantitative modeling of human reasoning, novel approaches to modeling decision criteria, and a verified decision engineering framework applicable to a broad array of applications, this book is an invaluable resource for graduate students, researchers, and practitioners working within the decision engineering realm.

**JOZO DUJMOVIĆ**, ScD, is a professor of computer science and former chair of the Computer Science Department at San Francisco State University, where he teaches and researches soft computing, software metrics, and computer performance evaluation. He is the author of more than 170 refereed publications and the founder and principal of SEAS, a company specializing in soft computing decision models and software support for the LSP method.

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