Tárgytematika / Course Description

Computational Intelligence

GKNM_INTA067

Tárgyfelelős neve / Teacher's name: dr. Kóczy László Tamás
Félév / Semester: 2022/23/1
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 2/2/0
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The aim of the course is to give an introduction to various soft computing methods and show their possible applications. The main topics of the course are fuzzy systems, evolutionary algorithmic methods, and artificial neural networks. The students will be able to find efficient (computational intelligence) solutions to numerous real-life engineering problems.

TANTÁRGY TARTALMA / DESCRIPTION

1.week Run-down of course requirements, introduction to the various fields of computational intelligence, and motivation.

2.week Overview of traditional (crisp) set theory, fuzzy sets, main types of fuzzy sets, properties of fuzzy sets.

3.week Overview of fuzzy set operations and fuzzy aggregation operators.

4.week Overview of traditional (crisp) relations, fuzzy relations. Operations on fuzzy relations (composition, transitive closure).

5.week Further operations on fuzzy relations (projection, cylindrical extension, cylindrical closure).

6.week Overview of fuzzy control systems and their applications. Knowledge-based expert systems.

7.week Fuzzy rule-based expert systems: Mamdani-, Larsen, and Sugeno- inference methods, defuzzification methods.

8.week Introduction to the basics of fuzzy rule-base reduction methods. The complexity of algorithms, methods to reduce algorithmic complexity, sparse rule-bases.

9.week Linear fuzzy rule interpolation methods.

10.week Hierarchical fuzzy rule-bases, hierarchical interpolation.

11.week Introduction to heuristic optimization, evolutionary algorithmic methods.

12.week Genetic programming, genetic algorithm, evolutionary algorithms, evolutionary programming.

13.week Introduction to artificial neural networks: neuron models, network topologies.

14.week Training of artificial neural networks. Neuro-evolution. Neuro-fuzzy systems.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

The course ends with a written OR spoken exam (depending on the number of students on the given exam). The exam covers all topics of the course. The written exam has a hard time limit of 60 minutes, while the spoken exam takes about 15-20 minutes/student.
Grading:

[0%-60%[: Fail (1)

[60%-70%[: Pass (2)

[70%-80%[: Satisfactory (3)

[80%-90%[: Good (4)

[90%-100%]: Excellent (5)

Students may also complete the course by submitting optional homework. The topic and the expected content require the teacher's approval no later than the fifth (5th) week of the semester. The deadline for final submission is noon on the first (1st) day of the ninth (9th) week in the semester. The homework can not be corrected, changed, or modified by any means after the submission. Homework achieving good (4) or excellent (5) grades are eligible for the final grade.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

Mandatory: course materials

Optional:

L. A. Zadeh. Fuzzy sets. Information and Control, 8(3):338–353, 1965.

L. A. Zadeh. Towards a theory of fuzzy systems. In R. E. Kalman and R. N. De Clairis, editors, Aspects of Networks and Systems Theory, pages 469–490. Holt, Rinehart &Winston, New York, 1971.

J. L. Castro. Fuzzy logic controllers are universal approximators.IEEE Trans. on SMC, 25(4):629–635, 1995.

J. J. Buckley. Sugeno type controllers are universal controllers. Fuzzy Sets and Systems, 53(3):299–304, 1993

J. Bruinzeel, V. Lacrose, A. Titli, and H. B. Verbruggen. Real time fuzzy control of complex systems using rule-base reduction methods. In Proc. of the 2nd World Automation Congress (WAC'96), Montpellier, 1996.

M. Higashi and G. J. Klir. On measures of fuzziness and fuzzy complements. Intern. J. of General Systems, 8 (3):169–180, 1982.

J. Dombi. A general class of fuzzy operators, the De Morgan class of fuzzy operator and fuzziness measures induced by fuzzy operators. Fuzzy Sets and Systems, 8(2):149–163, 1982.

R. R. Yager. On ordered weighted averaging aggregation operators in multilateral decision making. IEEE Trans. on SMC, 18(1):183–190, 1988.

L. P. Holmblad and J. J. Ostergaard. Control of a cement kiln by fuzzy logic. In M. M. Gupta and E. Sanchez, editors, Fuzzy Information and Decision Processes, pages 389–399. North-Holland, New York, 1982.

Kandel. Fuzzy Expert Systems. CRC Press, Boca Raton, FL, 1991.

M. Sugeno. An introductory survey of fuzzy control. Information Science, 36(1–2):59–83, 1985.

M. Sugeno, M. F. Griffin, and A. Bastian. Fuzzy hierarchical control of an unmanned helicopter. In Proc. of the 5th IFSA World Congress (IFSA'93), pages 1262–1265, Seoul, 1993.

L. T. Kóczy and K. Hirota. Rule interpolation in approximate reasoning based fuzzy control. In R. Lowen and M. Roubens, editors, Proc. of 4th IFSA World Congress, pages 89–92, Brussels, Belgium, 1991

L. T. Kóczy and K. Hirota. Approximate inference in hierarchical structured rule bases. In Proc. of 5th IFSA

World Congress (IFSA’93), pages 1262–1265, Seoul, 1993.

L. T. Kóczy and K. Hirota. Approximate reasoning by linear rule interpolation and general approximation. Internat. J. Approx. Reason., 9:197–225, 1993.

L. T. Kóczy and K. Hirota. Ordering, distance and closeness of fuzzy sets. Fuzzy Sets and Systems, 60:281–293, 1993.

L. T. Kóczy and K. Hirota. Interpolation in hierarchical fuzzy rule bases with sparse meta-levels. Technical Report 97/3, Hirota Lab., Dept. of Comp. Intelligent and Sys. Sci., Tokyo Institute of Technology, Yokohama, 1997.

L. T. Kóczy, editor. Fuzzy Logic. Texts. Fuzzy systems II. (Fuzzy Reasoning and Control), volume II. TEMPUS JEP MODIFY 07759/94 Modify, Budapest, 1997.

L. T. Kóczy. Algorithmic aspects of fuzzy control. Int. J. of Approximate Reasoning, 12:159–217, 1995.

L. T. Kóczy. Fuzzy if then rules models and their transformation into one another. IEEE Trans. on SMC, 26 (5):621–637, 1996.

H. Hellendoorn and C. Thomas. Defuzzification in fuzzy controllers. J. of Intelligent and Fuzzy Systems, 1 (2):109–123, 1993.

J. Gebhart, F. Klawon, and R. Kruse. Foundations of Fuzzy Systems. John Wiley, New York, 1994.

H. Hellendoorn, D. Driankov, and M. Reinfrank. An Introduction to Fuzzy Control. Springer, Berlin, 1993.

M. M. Gupta and J. Qi. Theory of t-norms and fuzzy inference methods. Fuzzy Sets and Systems, 40(3):431–450, 1991.

J. H. Holland. Adaption in Natural and Artificial Systems. The MIT Press, Cambridge, Massachusetts, 1992.

J. R. Koza. Genetic Programming: On the Programming of Computers by Means of Natural Selection. MIT Press, Cambridge, MA, USA, 1992.

M. Brown and C. Harris. Neurofuzzy Adaptive Modelling and Control. Prentice-Hall, 1994.