



Module name: Expert systems

Academic year: 2019/2020 Code: ZSDA-3-0288-s ECTS credits: 3

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

Study level: Third-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: <http://www.laiwd.agh.edu.pl>

Responsible teacher: prof. dr hab. inż. Skulimowski Andrzej M. (ams@agh.edu.pl)

### Module summary

This course will familiarize PhD students with the principles and methods of expert systems, in particular with the expert systems architecture, classification and most relevant applications. The students will acquire knowledge on inference engines, knowledge bases, uncertainty management, intelligent user interfaces, expert information fusion and other topics that will allow them to become effective expert systems users.

### Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	Students are capable of participating in expert knowledge elicitation from a group of experts, in expert panels; they can use information fusion tools and understand the relevance of consensus building processes among experts and expert systems	SDA3A_K02	Activity during classes
Skills: he can			
M_U001	Students can select an appropriate expert system's to solve a given problem in the area of their research or professional interests	SDA3A_U01	
Knowledge: he knows and understands			
M_W001	Students can design an expert system's composed of a knowledge base, inference engine, recommendation procedure and GUI	SDA3A_W02	Scientific paper

M_W002	Students know relevant reasoning methods used in rule-based expert systems and how to verify the consistency of the set of rules	SDA3A_W01	Presentation
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## Number of hours for each form of classes

Suma	Form of classes										
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
28	28	0	0	0	0	0	0	0	0	0	0

## FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	Students are capable of participating in expert knowledge elicitation from a group of experts, in expert panels; they can use information fusion tools and understand the relevance of consensus building processes among experts and expert systems	-	-	-	-	-	-	-	-	-	-	-
Skills: he can												
M_U001	Students can select an appropriate expert system's to solve a given problem in the area of their research or professional interests	-	-	-	-	-	-	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Students can design an expert system's composed of a knowledge base, inference engine, recommendation procedure and GUI	+	-	-	-	-	-	-	-	-	-	-
M_W002	Students know relevant reasoning methods used in rule-based expert systems and how to verify the consistency of the set of rules	-	-	-	-	-	-	-	-	-	-	-

## Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	28 h
Preparation for classes	12 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	30 h
Realization of independently performed tasks	15 h
Examination or Final test	2 h
Summary student workload	87 h
Module ECTS credits	3 ECTS

## Additional information

### Module content

#### Lectures

An application-oriented introduction to modern expert systems and related AI methods

1. Introduction to expert systems (ES) as one of the AI cornerstones: basic notions and trends, natural vs. artificial expertise
  2. Principles of expert systems architecture, design, and classification
  3. Knowledge bases as a major component of ES, knowledge representation, description logics and ontologies,
  4. Foundations of ES logics, production rules, inference models and causation, rule-based ES
  5. ES inference engines: forward and backward rule processing in diagnostic systems
  - practical issues, introduction to Prolog programming
  6. Case-based reasoning principles and their integration with diagnostic ES
  7. Uncertainty modeling in expert systems: probabilistic inference rules, Bayesian networks, fuzzy numbers, sets and rules, rough sets
  8. Uncertain knowledge representation: Hartley information measures, Möbius transform, belief functions and Dempster-Shafer possibility theory
  9. Methods of reasoning about the future: probabilistic and fuzzy anticipatory networks
  10. Trust and credibility management in ES. Principles of trust- and credibility based information fusion in ES: linking human and artificial ES expertise in a single information processing models
  11. Neural computing in ES. Feedforward networks and backpropagation, self-organizing maps (SOM)
  12. Intelligent decision analysis in ES. The bridge to IDSS: recommendations and their further use in IDSS
  13. Salient applications of ES in medicine, business rule processing, technical diagnostics, and others
  14. Global expert systems (GES) and global brain: the perspectives of ES and their fusion with human brains.
- Future prospects of ES methods and applications (moderated seminars)

### **Teaching methods and techniques:**

Lectures: Lectures with active participation of students, slide and software presentations as well as different audio-visual tools will be used

### **Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:**

Students receive grades for the presentation and the final semester report. The report presenting a solution to an expert-system-related problem can be prepared as a homework. In case of the grade 2,0, students have the right to pass the examination for the second time on a day specified at least 7 days beforehand.

### **Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:**

Lectures:

- Attendance is mandatory: No
- Participation rules in classes: Students are encouraged to initiate discussions and propose problems to be solved with expert systems methods and tools

### **Method of calculating the final grade**

The grade for the final report will be granted based on the number of points received, according to the rule that 50% of the maximum no. of points is necessary to pass (grade 3,0). All other grades are assigned according to the linear scale.

The final grade is the weighted average of these grades calculated according to the formula: Final grade =  $0,2 \cdot (\text{presentation or examination grade}) + 0,8 \cdot (\text{report grade})$

### **Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:**

Absence at up to three lectures or seminars are possible without a specific explanation. In case of absence from reasons independent from the student, such as illness or injury, the students may benefit from additional consulting hours with the lecturer

### **Prerequisites and additional requirements**

The knowledge of logics, algebra, probability, and higher-level computer programming languages are necessary to fully benefit from this course

### **Recommended literature and teaching resources**

1. S. Russel, P. Norvig (2009). Artificial Intelligence: A Modern Approach (3rd Edition), Prentice Hall, URL: [aima.cs.berkeley.edu](http://aima.cs.berkeley.edu)
2. Andrzej M.J. Skulimowski (2019). Selected methods and applications of multicriteria optimization. Komitet Automatyki i Robotyki PAN, Nr 19, Wyd. AGH, Kraków, s.380
3. Andrzej M.J. Skulimowski (2014). Anticipatory network models of multicriteria decision-making processes. International Journal of Systems Science 45(1), 39-59, <http://www.tandfonline.com/doi/full/10.1080/00207721.2012.670308>
4. Andrzej M.J. Skulimowski (2013). Universal Intelligence, Creativity, and Trust in Emerging Global Expert Systems. In: Rutkowski, L.; Korytkowski, M.; Scherer, R.; Tadeusiewicz, R.; Zadeh, L.A.; Zurada, J.M. (Eds.). Artificial Intelligence and Soft Computing. 12th International Conference, ICAISC 2013, Zakopane, Poland, June 9-13, 2013, Proceedings, Part II. Lecture Notes in Computer Science. Lecture Notes in Artificial Intelligence 7895, Springer-Verlag, pp.582-592, [https://doi.org/10.1007/978-3-642-38610-7\\_53](https://doi.org/10.1007/978-3-642-38610-7_53)
5. Andrzej M.J. Skulimowski (2017a). Cognitive content recommendation in digital knowledge repositories - a survey of recent trends. W: Artificial Intelligence and Soft Computing: 16th International Conference (ICAISC 2017), Zakopane, Poland, June 11-15, 2017, proceedings, Part 2, eds. Leszek Rutkowski et al., —: Springer International Publishing, Switzerland. Lecture Notes in Computer Science, LNAI 10246, s. 574-588, [https://doi.org/10.1007/978-3-319-59060-8\\_52](https://doi.org/10.1007/978-3-319-59060-8_52)
6. Andrzej M.J. Skulimowski (2017b). Expert Delphi Survey as a Cloud-Based Decision Support Service, IEEE 10th International conference on Service-Oriented Computing and Applications SOCA 2017, 22-25 Nov. 2017, Kanazawa, Japan. IEEE, Piscataway, s. 190-197,

<http://ieeexplore.ieee.org/document/8241542>.

## Scientific publications of module course instructors related to the topic of the module

1. Andrzej M. J. SKULIMOWSKI (2012). Discovering complex system dynamics with intelligent data retrieval tools. In: Intelligent Science and Intelligent Data Engineering: second Sino-foreign-interchange workshop, IScIDE 2011: Xi'an, China, October 23–25, 2011: revised selected papers, eds. Yanning Zhang [et al.]. Berlin, Heidelberg: Springer-Verlag, Lecture Notes in Computer Science 7202, pp. 614–626. [http://link.springer.com/chapter/10.1007/978-3-642-31919-8\\_78](http://link.springer.com/chapter/10.1007/978-3-642-31919-8_78)
2. Andrzej M.J. Skulimowski (2013). Universal Intelligence, Creativity, and Trust in Emerging Global Expert Systems. In: Rutkowski, L.; Korytkowski, M.; Scherer, R.; Tadeusiewicz, R.; Zadeh, L.A.; Zurada, J.M. (Eds.). Artificial Intelligence and Soft Computing. 12th International Conference, ICAISC 2013, Zakopane, Poland, June 9-13, 2013, Proceedings, Part II. Lecture Notes in Computer Science. Lecture Notes in Artificial Intelligence 7895, Springer-Verlag, pp. 582-592, [https://doi.org/10.1007/978-3-642-38610-7\\_53](https://doi.org/10.1007/978-3-642-38610-7_53)
3. Andrzej M.J. SKULIMOWSKI (2014a). An insight into the evolution of intelligent information processing technologies until 2025. In: IISA 2014: 5th International Conference on Information, Intelligence, Systems and Applications: 7–9 July, 2014, Chania, Greece. IEEE, pp. 343–348. <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6878810>
4. Andrzej M.J. SKULIMOWSKI (2014b). Anticipatory network models of multicriteria decision-making processes, International Journal of Systems Science, Vol. 45 (1), 39-59, DOI:10.1080/00207721.2012.670308, [<http://www.tandfonline.com/doi/full/10.1080/00207721.2012.670308>]
5. Andrzej M.J. SKULIMOWSKI (2016a). Impact of future intelligent information technologies on the methodology of scientific research. In: Proceedings 16th IEEE International Conference on Computer and Information Technology, Nadi, Fiji, IEEE CPS, pp. 238–247, 7–10 December 2016. doi: 10.1109/CIT.2016.118
6. Andrzej M.J. SKULIMOWSKI (2016b). The role of creativity in the development of future intelligent decision technologies. In: Knowledge, information and creativity support systems: recent trends, advances and solutions: selected papers from KICSS'2013 – 8th international conference on Knowledge, Information, and Creativity Support Systems, November 7-9, 2013, Kraków, Poland, eds. Andrzej M.J. Skulimowski, Janusz Kacprzyk. Advances in Intelligent Systems and Computing, vol. 364, Springer International Publishing, Switzerland, ISBN: 978-3-319-19089-1, pp. 279–297, [https://doi.org/10.1007/978-3-319-19090-7\\_22](https://doi.org/10.1007/978-3-319-19090-7_22).
7. Andrzej M.J. Skulimowski (2017a). Cognitive content recommendation in digital knowledge repositories – a survey of recent trends. W: Artificial Intelligence and Soft Computing: 16th International Conference (ICAISC 2017), Zakopane, Poland, June 11–15, 2017, proceedings, Part 2, eds. Leszek Rutkowski et al., —: Springer International Publishing, Switzerland. Lecture Notes in Computer Science, LNAI 10246, s. 574–588, [https://doi.org/10.1007/978-3-319-59060-8\\_52](https://doi.org/10.1007/978-3-319-59060-8_52)
8. A.M.J. Skulimowski (2017b). Expert Delphi Survey as a Cloud-Based Decision Support Service, IEEE 10th International conference on Service-Oriented Computing and Applications SOCA 2017, 22–25 Nov. 2017, Kanazawa, Japan. IEEE, Piscataway, s. 190–197, <http://ieeexplore.ieee.org/document/8241542>.
9. Andrzej M.J. SKULIMOWSKI (2019). Anticipatory networks. In: Poli R. (ed.), Handbook of anticipation: theoretical and applied aspects of the use of future in decision making. Springer International Publishing AG, Cham, pp. 995–1030. [https://link.springer.com/referenceworkentry/10.1007/978-3-319-31737-3\\_22-1](https://link.springer.com/referenceworkentry/10.1007/978-3-319-31737-3_22-1)
10. Andrzej M.J. SKULIMOWSKI (2018). Strategy building for a knowledge repository with a novel expert information fusion tool. In: 6th International Conference on Future-Oriented Technology Analysis (FTA): Future in the making : 4-5 June 2018, Brussels. pp.1–15, <https://ec.europa.eu/jrc/sites/jrcsh/files/fta2018-paper-c2-skulimowski.pdf>

## Additional information

Students are invited to participate in expert-system-related research and expert systems applications in finance carried out by the Student Scientific Society on Financial Modelling ([www.knwmf.agh.edu.pl](http://www.knwmf.agh.edu.pl))