Intelligent Systems and Neural Networks
Course Syllabus

Basic Information

This is a course, which contributes to MSc award in Computer Science

Title of the Academic Program	Master's Degree Program in English "Digital intelligent control systems"
Type of the course	core /mandatory
Course period	1 semester from October 1st till February 1st (18 weeks)
Study credits	6 ECTS credits
Duration	216 hours
Language of instruction	English
Academic requirements	– BSc degree in Computer Science or equivalent (transcript of records), – good command of English (certificate or other official document) **Prerequisites** **To know:** calculus, linear algebra, basic statistics. **Possess:** programming.

Course Overview

Description

"Intelligent Systems and Neural Networks" is a core course.

The course provides students with practical knowledge in analysis and design of intelligent systems. Particular attention is given to applying artificial intellect and neural networks to control dynamic systems and make decisions regarding plan of actions.

Special Features of the Course

Emphasis of the course is placed on the teaching of AI fundamentals, not on providing a mastery of specific software tools or programming environments.

Assigned tasks and projects promote a 'hands-on' approach for training,

Course Aim

The aim of the course is to introduce the basic principles, techniques, and applications of Artificial Intelligence and to motivate and prepare students to apply them for research projects and for further study within advanced courses in professional fields.

Course Objectives

- Gain AI fundamentals, state-of-art, and historical perspective.
- Become familiar with principles of AI toward problem solving, inference, perception, and learning.
- Investigate applications of AI techniques in intelligent agents, genetic algorithms, artificial neural networks and other machine learning models.
- Experiment with a machine learning model for simulation and analysis.
- Explore the current scope, potential, limitations, and implications of intelligent systems.

Learning Outcomes of the Course (module)

By the end of the course, students will know:

- history of artificial intelligence (AI) and its foundations;
- new and promising methods using in AI, including evolutionary computation, neural networks, swarm intelligence;

By the end of the course, students will be able to:

- understand the specifics of various methods of artificial intelligence and their application in intelligent agents, control systems, artificial neural networks and other AI models.
- formalize real-world problems, select, and apply relevant AI models in projects that require inferences, perceptions, problem solving, intelligent control, and training.
- conduct scientific discussions on AI, its current scope and limitations, as well as social implications.

By the end of the course, students will possess:

- to develop software and hardware AI applications using professional tools.

Course Structure

Learning Activities	**Hours**
Lectures	18
Practice sessions / Seminars,	18
Self-study Assignments	144
Final Exam (including preparation)	36
Total study hours	**216**

Detailed Schedule

Week	Lectures	Practice sessions / Assignments	Hours[1] Lec/Lab/HA
Semester 1			
1	**Introduction** Course overview. Intelligent System: core terms and definitions. Artificial Intelligence: applications, benefits and challenges. Artificial general intelligence (AGI).	Getting started. To install the required sofrtware	2/0/2
2	**Fuzzy Logic** Biological analogues. Applications. Basic elements of fuzzy systems. Fuzzification. Fuzzy inference.	Design and study of an adaptive control system based on fuzzy logic	
3	**Artificial Neural Networks (ANN)** Biological analogues. ANN structures. Basic units. Network topology	Design and study of an ANN-based classifier.	2/2/2
4	**ANN training algorithms** Supervised learning. Gradient methods. Reinforcement learning. Unsupervised learning. Deep Learning	Applying a convolution ANN for pattern recognition	2/2/2
5	**ANN applications** Adaptive control using ANN and fuzzy neural networks. Direct and Indirect adaptive control. Self-tuning PID Controllers.	Design and study of an ANN-based adaptive control system	2/2/2
6	**Intelligent agent** Structure and architecture of agents. Classification. Applications.	Design and study of a control system based on an intelligent agent	
7	**Cooperative Intelligence** What is Cooperative Intelligence. Characteristics of cooperative intelligence. Cooperative Sensing and Tracking. Particle swarm optimisation (PSO). Ant colony optimisation (ACO). Multi-Agent Systems	Design and study of a control system based on cooperative agents	2/2/2
8	**Genetic algorithm (GA)** Biological analogues. Basic concepts, applications. GA operators: parental choice, discrete recombination, crossingover (binary recombination), mutation, selection. GA variety and modifications.	Design and study of an adaptive control system based on an GA	2/2/4
9	**Conclusion.** State-of-art and current trends	Review of scientific publications on a given topic. Evaluation of the applicability of AI methods for solving problems of your master's thesis	2/2/4
	18	**18**	**36**
36	**Final Exam**		**36**

[1] Hours designed for Classroom sessions, Web-sessions, Home Assignments etc.

Course Instructor and Tutor, Contact information

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Google Scholar page:
https://scholar.google.ru/citations?user=qPHGN3cAAAAJ&hl=ru
Additional information is available at:
http://structure.sfu-kras.ru/node/2043#main

Assessment

Assessment strategy	Points, max
Tests	20
Lab works	50
Final report	30

Grading policy for final assessment is:

- A (excellent work) 91–100 points
- B (above average) 81–90 points
- C (average) 71–80 points
- D (below average) 50–70 points
- F (failed) < 50 points

Attendance Policy

The course is designed to use e-learning and distance learning technologies.

The course can be implemented in two versions: classroom lessons or distance learning.

If the course is implemented as classroom lessons, students are expected to attend classes regularly. In case of missing an in-lab activity a student should perform additional work submitted to the instructor within a week after a class was missed.

If the course is implemented in a distance format:

1. It is recommended to attend online lectures.

If a student skips an online lecture, he or she must pass the e-course element "Lecture with test questions" on the relevant topic.

2. Timely submissions of work reports are anticipated.

If the work is not completed on time, you must contact the teacher through the e-course message indicating the reason for the delay and the estimated deadline. No more than 3 postponements are allowed.

3. Final exam is held in the format of videoconferences. It is mandatory and can only be rescheduled for good reason.

Web page of the course

Course materials and required reading materials are available on the webpage of the course **Intelligent Systems and Neural Networks Link: https://e.sfu-kras.ru/course/view.php?id=31519**, SibFU E-learning portal, www.e.sfu-kras.ru . You must be logged in to access this course.

Core reading

1. SS, V. C., & Hareendran, A. (2014). Artificial intelligence and machine learning. PHI Learning Pvt. Ltd..
2. Timothy J. Ross (2017). Fuzzy Logic with Engineering Applications, Fourth edition. 2017.
3. Bishop, C. M. (2014). Pattern recognition and machine learning. Springer.
4. Rothman, D. (2018). Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases. Packt Publishing Ltd.
5. Joshi, P. (2017). Artificial intelligence with Python. Packt Publishing Ltd.

Facilities, Equipment and Software

Software:

- Python IDE and libraries: Ceras, TenzorFlow.
- MS Office or Libra Office.
- Internet access

Equipment:

- PC