State Final Examinations	Academic Year: 2018/2019
Master's Degree Studies Program:	Engineering Informatics
Study Branch:	Information Technologies

Informatics

Compulsory Subject

1. Information entropy and its connection with information. Definition of information measure, including graphical representation. Transmission paths and transmission channels (ideal and noise). Characteristics of a discrete and a continuous transmission channel. Definition of transmission capacity and the channel capacity. A Shannon-Hartley theorem about the coding of noisy signals and Nyquist - Shannon - Kotelnikov theorem about signal sampling.
2. Computational complexity - definition of space and time complexity. Definition of terms: average, pessimistic, deterministic and non-deterministic complexity. Solvability of tasks, P, NP, NP-Hard and NP-Complete tasks, graphical visualization of relationships between classes. Examples of famous NPC combinatorial problems (Knapsack Problem, Bin Packing Problem, Vehicle Routing Problem and other).
3. Theoretical Informatics - definition of terms language, grammar, grammar hierarchy. Finite Automata and Turing / Post machines, basic description, classification, the equivalence of automata / machines.
4. Scheme of an artificial neuron. Definition of artificial neuron inner potential, some types of transfer functions and training of artificial neural networks. Problems of linear and non-linear separability (with examples, or images). Categorization of artificial neural networks, with schemes in appropriate cases.
5. Principles, a structure of training, validation and testing sets and their construction. The connection between network weights, training of neural network and geometric representation of the network training quality on the N-dimensional hypersurface of the global error. A connection of boundaries between classes and network training. The most frequent applications of neural networks.
6. Different types of neural network structure optimization. Particular options, or necessary mathematical formulas. The difference between binary and multivalued classification and demonstration of different types of classification on the number of output neurons and used transfer functions.
7. Supervised neural nets - Perceptron, Adaline and training of multi-layered network (Feedforward) with algorithm Backpropagation, the principle of activity and training algorithms, applications.
8. Auto-associative and hetero-associative neural nets - Hopfield, BAM, the principle of activity and training algorithms, applications.
9. Unsupervised neural nets - CLN, ART, Kohonen's SOM, the principle of activity and training algorithms, applications.
10. Principles of stochastic heuristic algorithms: Point-based strategy (Random Walk, Local search, Hill climbing algorithm, Tabu Search, Simulated annealing). The principles of predecessors of evolutionary algorithms - Population-based strategy: Evolution strategies (classification and principle of operation).
11. Evolutionary Computation Techniques - the central dogma of EVT and general principles, basic concepts (population, individual, cost function, soft constraints, hard constraints and penalization of cost function, handling with integer values and discrete sets, elitism, multicriteria optimization, Pareto set - the dominant and non-dominant solutions), methods for performance comparison of algorithms.

12. Genetic algorithms (types of selection, crossover, mutation), Gray code and the reason for its use. Variants and strategies for Genetic Algorithms (Parallel, Messy ...).
13. Principles of operation of evolutionary algorithms: Differential Evolution (basic principle, parameter settings and strategies, geometric model, modern adaptive version for adaptation of the parameters and strategies, ensemble mechanisms).
14. Principles of operation of bio-inspired swarm algorithms: Particle Swarm Optimization (PSO), Firefly, ABC algorithm. Geometric models and differences between particular strategies of SOMA algorithm.
15. Symbolic regression (genetic programming, grammatical evolution, analytical programming) principles, representation of individuals, terminal and functional sets, examples.
16. Fuzzy logic - the definition of the fuzzy set and its description, types of membership functions. Fuzzification, inference, defuzzification. Operations AND, OR, Complement. IF-THEN rules. Methods, examples.
17. Machine learning - supervised, unsupervised, semi-supervised. Supervised classification and regression methods, basic principles (Bayesian classifiers, Bayesian Networks, Support Vector Machines, k-NN algorithm, boosting).
18. Supporting methods for decision-making: decision trees - basic terminology, classification x regression tree, basic principles of methods (ID3, C4,5, Random forest, ...) examples. Related variables - entropy, information gain. Multi-criteria decision-making methods - TOPSIS, VIKOR.
19. Data mining as part of KDD (individual phases and processes, methods and techniques for preprocessing of data), an overview of data mining algorithms, description of algorithms: Random Search, k-Means (including variants Fuzzy and PlusPlus), DBSCAN, PCA, EM, PageRank.
20. Petri nets (description, use, classification, basic rules, constructs), C / E Nets – rules, example. P / T Nets – rules, example. And other modifications of P / T nets. Net workflow.