THE LIST OF TOPICS FOR M.SC. DIPLOMA EXAMINATION

ARTIFICIAL INTELLIGENCE

Master Programme

No.	Topic
	Process Mining
1.	What is a Petri net? How does it work? What are its applications? What are the limitations of the Petri net?
2.	Describe the rules of conduct of the α (alpha) algorithm. What is its purpose? What are its properties and limitations?
3.	Enumerate and characterize exemplary measures for four basic quality criteria of process models.
	Biologically-inspired Algorithms and Models
4.	Compare the principles and the operation of evolutionary strategies, differential evolution and evolutionary programming.
5.	Discuss the phenomenon of genetic drift and its consequences.
6.	Describe the techniques to control diversity in fitness values and in the contents of solutions.
7.	Enumerate the problems in competitive coevolution and explain possible remedies.
	Machine Perception
8.	Define classes/types of sensors, particularly those used in robotics.
9.	Describe the pinhole camera model, and define intrinsic and extrinsic parameters of a camera.
10.	What is the epipolar geometry in stereo vision and how it simplifies the image analysis?
11.	Describe briefly the Iterative Closest Points algorithm.
	Program Synthesis
12.	Describe the main types of program synthesis algorithms: enumerative, constraint-solving, deductive, stochastic/statistical.
13.	Define the task of formal verification. What is Satisfiability Modulo Theories, and how can it be used for verification?
14.	How can neural networks be used for program synthesis? Describe the most important approaches.
15.	Describe the most important aspects of genetic programming as a program synthesis algorithm. What kind of user intent does it support?
	Multivariate Statistics
16.	Explain how to solve the problem of missing values
17.	Describe the test of hypotheses related to population mean and covariance matrix (likelihood ratio test)
18.	Describe the basic idea of principal components analysis
	Multiobjective Optimization
19.	Describe the MOEA/D, NSGA-II, or NSGA-III algorithm (algorithmic details, components, pros, cons, etc.)

20.	Explain how evolutionary methods for MOO reduce the computational burden required to approximate the Pareto front compared to classical methods.
21.	Describe the WSM and ECM methods (algorithmic details, pros, cons, etc.)
22.	Describe GD, IGD, and HV performance indicators. What are their pros and cons?
Machine Learning Theory	
23.	Describe the optimal Bayes classifier for selected problems: classification with zero-one loss and regression with squared error loss
24.	Describe the Vapnik-Chervonenkis dimension and calculate its value for a specific non-trivial function class of your choice
25.	Define the loss function, the risk, the empirical risk, and provide a bound on the estimation error of the empirical risk minimization for a finite set of classifiers.
Selected Topics in Natural Language Processing	
26.	Discuss current research directions in a selected field of natural language processing
27.	Describe transformer architecture and its use for training large language models
Information Theory Methods in Data Analysis	
28.	'2D' versions of the entropy coefficient: definitions and applications in variable analyses.
29.	'Vector subdivision' property of the entropy coefficient (classic version vs '2D' versions).
30.	Main properties and generalizations of the entropy coefficient (classic version and '2D' versions).
Automated Machine Learning	
31.	Approaches to automated feature generation (synthesis)
32.	Automation of joint optimization of feature synthesis and model training hyperparameters: motivation, pipeline design, examples
33.	Conditional hyperparameter configuration spaces: motivation, pipeline design, examples
34.	Surrogate modeling: applicability conditions, model types, relation to multi-fidelity optimization
Introduction to Quantum Information and Quantum Machine Learning	
35.	Explain what is the fundamental difference between the operators representing any quantum gate and the projection operator representing a quantum measurement?
36.	Provide the content and discuss the meaning of the quantum non-cloning theorem
37.	Using the geometric interpretation of Grover's algorithm, explain why its computational complexity is of the order of
38.	Discuss the general scheme of the quantum algorithm for determining eigenvalues using the variational method (VQE), and explain why this algorithm is classified as the so-called to hybrid algorithms?
Machine Learning Operations (MLOps)	
39.	Explain the notion of technical debt in the context of information systems that include statistical models.
40.	Discuss steps involved in a typical ML Ops pipeline.
41.	Present five good practices and five anti-patterns in ML Ops

Mobile Application Development with AI Elements	
42.	Explain the difference between UIKit and SwiftUI frameworks.
43.	Describe the process of binding between UI and code in UIKit
44.	Describe frameworks that can be used to develop mobile games for iOS
Artificial Intelligence in Biomedical Informatics	
45.	What machine learning methods are used when assessing the quality of tertiary RNA structures? Please justify your answer.
46.	Explain what federated learning is and its benefits in medical applications. Outline the basic types of federated learning and aggregation techniques.
Introduction to Cognitive Science	
47.	Characterize the concept of two systems in the act of the human mind proposed by D. Kahneman.
48.	Maps of bounded rationality – characterize the issue of heuristics of judgment, risky choice, and framing effects.
Neuro-symbolic Integration	
49.	Promises of neuro-symbolic integration. (Why does it make sense to combine the two approaches and what does it bring to the table?)
50.	Kautz's categories of neuro-symbolic systems. (Describe the categories, give an example system in each category and explain why it fits into that category.)
Machine Learning with Graphs	
51.	Formulate the definition for graph embeddings. Describe the main embedding techniques and application areas. Briefly describe the ways to measure the quality of embeddings. List several graph embedding algorithms and briefly describe one of them.
52.	Formulate the problem of community detection in networks given as graphs or hypergraphs. Describe approaches for evaluating the quality of clustering (community detection) algorithms. List some of the existing community detection algorithms and briefly describe one of them.
Data science and machine learning for e-commerce	
53.	Key Performance Indicators (KPIs) in e-commerce: Clickthrough Rate (CTR), Conversion Rate (CR), Return On Advertising Spend (ROAS).
54.	Actionable forecasting-based regression for Google Shopping