Computer Science MSc (2021) – Final Exam topics

Mathematics and the theory of computation

1. Mathematical Background of Machine Learning: Linear Algebraic, Stochastic, Numeric and Optimization Methods. Scalar Product, Feature Normalization, Gradient Descent, Gradient Checking (Numerical), Normal Equation, Gaussian Distribution, Multivariate Gaussian Distribution, Dimensionality Reduction (PCA).

2. Linear Regression (one/multiple variables), Polynomial Regression, Logistic Regression, Binary Classification, Multiclass Classification (One-vs-all), Regularization (overfitting, underfitting), Regularized Linear Regression, Regularized Logistic Regression, Neural Networks, Backpropagation Algorithm.

3. Train/Validation/Test Sets, Diagnosing Bias vs. Variance, Regularization and Bias/Variance, Learning Curves (training set size), Error Metrics for Skewed Classes, Recommender Systems, Stochastic Gradient Descent, Mini-Batch Gradient Descent, Map Reduce and Data Parallelism.

4. Symmetric encryptions, basic design principles, AES. Stream ciphers, modes of operation.

5. Asymmetric encryptions. Encryptions based on discrete logarithm and elliptic curve discrete logarithm problem.

6. Hash functions, digital signatures, ECDSA. Key exchange algorithms. TLS protocol.

7. Complexity of conventional algorithms, complexity classes, NP-hard problems; efficient data structures.

8. Optimization problems, dynamic programming. Suboptimal solutions, real time algorithms.

9. Randomized algorithms, complexity of randomized algorithms, Las Vegas and Monte Carlo methods. Parallel architectures, network and PRAM models, parallel complexities.

10. Minimization of multivariable functions: gradient method, Newton's method, quasi-Newton methods.

11. Least squares approximations, linear and nonlinear case. Singular value decomposition, Gauss-Newton method, Levenberg-Marquardt method.

Information technology

1. Data models and their implementations. Relation, object, object-relation, XML and NoSQL databases. Practical database design and UML.
2. Query processing and optimization, database tuning. Modelling and architectures of information systems.
3. Data Warehousing and OLAP. Information retrieval.
4. The programmable graphics pipeline. Incremental raster graphics algorithms for drawing 2D primitives. Filling and clipping. Basic interpolating and approximating curves. Joining curves.
5. Coordinate systems. 2D and 3D transformations. Classification and composition of transformations. Transformation between coordinate systems. Viewing and projections.
6. Surface representation techniques. Data structures for surfaces. Visibility algorithms. Light and material properties. Illumination and shading models. Texturing.
7. The concept of data mining and its role in the KDD process. Basic data mining tasks. Preprocessing. Data exploration.
8. Supervised data mining. Decision trees, rule-based and nearest neigbour methods. Naive Bayes, support vector machines. Ensemble methods. Assessing: accuracy and other metrics, ROC curve.
9. Unsupervised data mining. Frequent itemset and association rules. Distance and similarity, basic clustering (K-means, hierarchical, DBSCAN). Anomaly detection.