LIST OF ENTRANCE EXAM QUESTIONS

FOR THE INTERNATIONAL MASTER'S DEGREE PROGRAM

ITMO

BIG DATA AND MACHINE LEARNING

Differential Equations, Probability theory & Optimization Methods

1. Ordinary differential equations (ODE). The Cauchy problem. ODEs of Higher order and ODEs systems.
2. Differential Equations in Partial Differential coefficient of the First Order. First integrals. General solution. The Cauchy problem.
3. Combinatorics: permutation, combinations.
4. Classical definition of probability, random events, sample space, power set, properties of classical probability.
5. Conditional probability. A theorem on total probability formula, Bayes' rule.
6. Random variable: definition, distribution function of a random value and its properties, independent random variables.
7. Definitions of numerical characteristics for discrete and continuous random variables: mean, dispersion, mode, median, moments.
8. Law of large numbers.
9. Central limit theorem.
10. Approximation and interpolation of functions.
11. Numerical integration.
12. Numerical methods for solving a system of linear algebraic equations.
13. Numerical methods for solving a system of nonlinear equations.
14. Optimization problems. Types of optimization problems.
15. Nonlinear programming problem. Methods of local and global optimization.
16. Methods for a local extremum search for the multidimensional optimization problem.
17. Methods for a global extremum search for the multidimensional optimization problem.
18. PCA, SVD. Definitions, relation.

Programming

19. Static data structures: vectors, arrays, tables.
20. Data structures: lists (stack / queue / deque, operations, application).
21. Hierarchical data structures: trees (types, storage, operations).
22. Data structures: heaps (types, construction, algorithms). Hashing.
23. Data structures: graphs (storage, basic algorithms on graphs).
24. Algorithm's complexity (concept, an estimation of complexity with the examples of sort and search algorithms)
25. Imperative and declarative programming. Most popular paradigms.
26. Object-oriented programming. Encapsulation. Inheritance. Polymorphism. SOLID.
27. Design patterns: creational, structural, and behavioral patterns.
28. Concurrency & Parallelism. Definition, differences, problems.
29. Database transactions: properties, main principles.
30. Indexes in databases. Aims, internal structures.

RECOMMENDED READING

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to algorithms. MIT press.
2. Bruce, P., Bruce, A., & Gedeck, P. (2020). Practical statistics for data scientists: 50+ essential concepts using R and Python. O'Reilly Media.
3. Strang, G., Strang, G., Strang, G., & Strang, G. (1993). Introduction to linear algebra (Vol. 3). Wellesley, MA: Wellesley-Cambridge Press.
4. Gautschi, W. (2011). Numerical analysis. Springer Science & Business Media.