

Program: Computer & Data Science

This document outlines the scope of themes, which may be included in the Olympiad tests. The themes are grouped by areas and are followed by a list of recommended literature in the Russian and English languages.

Olympiad winner's skill set by subject

Analytical activity

The winner of the Olympiad

knows

- the theoretical foundations of computer science;
- criteria for evaluating the effectiveness of algorithms and data structures;
- regulatory documents in the field of information security;

can

- assess the development trends of the software market;

Project-oriented activities

The winner of the Olympiad

knows

- principles of software development;
- programming languages;
- principles of the operation of computers, functional structure of computers;

can

- use information security tools;
- use existing algorithms and data structures;
- use programming tools and environments, IDE, SDK, one or more related version control systems;

Research activities

The winner of the Olympiad

knows

- existing approaches to the verification of software models;
- main trends and frontier technologies in the field of Computer and Data Science.

can

- apply basic information-theoretical models to describe information processes and objects.

Content

Section 1. Applied mathematics

1. Big-O asymptotic notation.
2. Linear space: definition, examples. Dimension of a linear space. Matrices: rank, determinant, inverse matrix. Eigenvalues and eigenvectors.
3. Modular arithmetic. Fermat's little theorem. Finite fields of residues: definition, construction, performing computations in finite fields. The Euclidean Algorithm. GCDs as Linear Combinations. Bezout's theorem.
4. Number systems (decimal, binary, hexadecimal, octal). Converting between representations in different bases.
5. Boolean algebra. Standard Boolean operations: conjunction, disjunction, negation, implication, equivalence, exclusive OR, Sheffer stroke. Standard representations of Boolean functions: DNF, CNF, simplifying expressions using distributive property, De Morgan rules, absorption laws.
6. Boolean circuits. Complexity measures: circuit size and depth. Construction of Boolean circuits for Boolean functions.
7. Predicates. Logical inference. Representing predicates with quantified formulas.
8. Rules of inference. Resolution.
9. Finite automata. Non-deterministic finite automata. Regular languages.
10. Regular expressions. Converting between a regular expression and an automaton. POSIX Extended regular expressions.
11. Recursive definitions and structural induction.
12. Divisibility properties. GCD and LCM. Euclid's algorithm.
13. Probability: basic definitions and properties.
14. Distributions. Probability density functions.
15. Law of total probability.
16. Bayes' theorem.
17. Basic counting. Permutations and combinations with and without replacement.
18. Asymptotic growth of combinatorial numbers.
19. Generating combinations and permutations.
20. Inclusion-exclusion formula.
21. Graphs: undirected, directed, bipartite, complete. Subgraphs: induced subgraphs, spanning trees. Distances in graphs. Depth-first and breadth-first graph traversal.
22. Trees. Minimal spanning trees problem.
23. Planar graphs. Euler's formula

Section 2. Software engineering

1. Definition of software requirements
2. Software design process
3. Error and exception handling
4. Software security
5. Architecture patterns
6. User interface design process
7. Software complexity
8. Standards in construction

9. Code reuse
10. Executable models
11. Classification of operating systems
12. Software system modeling, UML
13. Basics of object-oriented programming
14. Software testing
15. Software maintenance
16. Reverse engineering
17. Software configuration management
18. Building of software
19. Software release management
20. Software engineering management
21. Quality management
22. Risk management
23. Software measurement techniques
24. Prototyping methods

Section 3. Information systems and computing

1. Information: collecting, transmitting, processing, accumulation, measurement; information units. Information and entropy
2. Data structures
3. The concept of the information system and information technology
4. Hardware and software information technology tools
5. Parallel processing. The main classes of parallel systems
6. The concept of a system. Systems in engineering, economics and nature. Types of systems. The control object and the control system. Information feedback. The subject of engineering cybernetics and information theory
7. Modeling as a research method in cybernetics. Types of models. Models of technical, biological and socio-economic systems. The black box concept. The problem of identification. Model validity
8. Pragmatic, semantic and syntactic aspects of information
9. Programming languages. Procedure-oriented and object-oriented programming. Ways of describing algorithms. The unified system of program documentation
10. Software life cycle
11. The principles of the structural and functional organization of computer networks. Packet-switched networks. TCP/IP protocol stack. Addressing in IP networks
12. Multithreading: basic concepts. Methods of synchronization in multithreaded applications
13. Process interaction. Shared memory, synchronization tools. Message queues and other means of data exchange
14. The reference model of open systems interaction (ISO OSI model) and its purpose. Data encapsulation. Layers of the OSI reference model.
15. Reliability of the software and hardware complex of the information system.

Section 4. Information security

1. Basic concepts of information security. Key factors affecting information security
2. Major international information security standards, their purpose and scope
3. Information security policy, its place and role in organization management
4. Information security threats. Approaches to modeling information threats and attackers
5. Approaches to information risk management. Risk assessment. Risk scales and measurement criteria
6. Security information and event management (SIEM) systems. Design principles, tasks and goals of SIEM systems
7. Intrusion, prevention and detection systems in computer systems and networks; their purpose, goals and design principles
8. Network firewall systems: principles and tasks
9. Virtual Private Network (VPN): purpose, design principles and selection criteria
10. Access control models and systems
11. Identification, authentication and authorization. Authentication and authorization techniques
12. Steganography: the purpose and tasks. Techniques for embedding hidden information in executable files
13. Symmetric encryption systems. Block ciphers, their operation modes. Modern standards and protocols of symmetric encryption
14. Public key cryptosystems. The principles of construction. Modern standards and public-key encryption protocols
15. Public-key infrastructure, certification centers and digital certificates

Section 5. Data preprocessing and analysis

1. Decision support systems (DSS)
2. The concept of data warehouse (DW). Their purpose. Architecture
3. Physical DW. Virtual HD. Data marts (DM)
4. Data transfer. The ETL process. Data cleansing. DW and analysis
5. Types of data warehouses. Their purposes and architectures.
6. Multidimensional data models. Representation of data as a multidimensional cube
7. Machine learning. Definition. Purposes
8. Machine learning functions: classification, regression, frequent set search, clustering
9. Machine learning models. Predictive and descriptive machine learning models. Machine learning methods
10. Knowledge discovery process. Stages of data mining
11. Classification algorithms: Naive Base, C 4.5, BackProp, Support Vector Machine, etc.
12. Clustering algorithms: hierarchical, k-Means, DBScan, SOM
13. Algorithms for frequent set search: Apriori, FPG, etc.
14. Deep learning. Definition. Deep learning and machine learning

Recommended literature

Section 1. Applied mathematics

Sources	Corresponding topic
<p>1. Gallier J. Discrete Mathematics. Springer Science+Business Media, LLC 2011. ISBN 978-1-4419-8046-5. URL: https://link.springer.com/content/pdf/10.1007/978-1-4419-8047-2.pdf (Free access)</p>	<p>5) Boolean algebra. 6) Boolean circuits. 7) Predicates. Logical inference. Representing predicates with quantified formulas 12) Divisibility properties. GCD and LCM. Euclid's algorithm 17) Basic counting. Permutations and combinations with and without replacement. 18) Asymptotic growth of combinatorial numbers. 19) Generating combinations and permutations. 20) Inclusion-exclusion formula. 21) Graphs: undirected, directed, bipartite, complete. Subgraphs: induced subgraphs, spanning trees. Distances in graphs. Depth-first and breadth-first graph traversal. 22) Trees. Minimal spanning trees problem. 23) Planar graphs. Euler's formula</p>
<p>2. Hefferon J. Linear Algebra 4th Edition. Orthogonal Publishing L3C. 2020. ISBN 978-1944325114 URL: https://joshua.smcvt.edu/linearalgebra/book.pdf (Free access)</p>	<p>2) Linear space: definition, examples. Dimension of a linear space. Matrices: rank, determinant, inverse matrix. Eigenvalues and eigenvectors</p>
<p>3. Hopcroft, John E.; Motwani, Rajeev; Ullman, Jeffrey D. (2013). Introduction to Automata Theory, Languages, and Computation (3rd ed.). Pearson. ISBN 978-1292039053. URL: https://www-2.dc.uba.ar/staff/becher/Hopcroft-Motwani-Ullman-2001.pdf (Free access)</p>	<p>1) Big-O asymptotic notation 4) Number systems (decimal, binary, hexadecimal, octal). Converting between representations in different bases 5) Boolean algebra 7) Predicates. Logical inference. Representing predicates with quantified formulas. 8) Rules of inference. Resolution. 9) Finite automata. Non-deterministic finite automata. Regular languages. 10) Regular expressions. Converting between a regular expression and an automaton. POSIX Extended regular expressions. 11) Recursive definitions and structural induction.</p>

	12) Divisibility properties. GCD and LCM. Euclid's algorithm
4. Lipschutz S., Lipson M. (2021) Schaum's Outline of Discrete Mathematics, Fourth Edition (Schaum's Outlines) 4th Edition ISBN: 978-1264258802 URL: https://www.accessengineeringlibrary.com/content/book/9781264258802 (Limit access)	6) Boolean circuits 12) Divisibility properties. GCD and LCM. Euclid's algorithm 17) Basic counting. Permutations and combinations with and without replacement 18) Asymptotic growth of combinatorial numbers 21) Graphs: undirected, directed, bipartite, complete. Subgraphs: induced subgraphs, spanning trees. Distances in graphs. Depth-first and breadth-first graph traversal 22) Trees. Minimal spanning trees problem 23) Planar graphs. Euler's formula
5. Pantsulaia G., Kvatadze Z., Giorgadze G. Elements of Probability Theory and Mathematical Statistics. Georgian Technical University Tbilisi 2013. URL: https://gtu.ge/book/ims/probability2013.pdf (Free access)	13) Probability: basic definitions and properties. 14) Distributions. Probability density functions. 15) Law of total probability. 16) Bayes' theorem.
6. Wegener, Ingo. The Complexity of Boolean Functions. John Wiley and Sons. 1987. ISBN 3-519-02107-2. Free electronic edition: URL: https://ecc.weizmann.ac.il/static/books/The_Complexity_of_Boolean_Functions/ (Free access)	3) Modular arithmetic. 4) Number systems (decimal, binary, hexadecimal, octal). Converting between representations in different bases. 5) Boolean algebra. 6) Boolean circuits.

Section 2. Software engineering

Sources	Corresponding topic
1. Bass L., Clements P., Kazman R. Software Architecture in Practice, 3rd ed., Addison-Wesley Professional, 2013. URL: https://edisciplinas.usp.br/pluginfile.php/5922722/mod_resource/content/1/2013%20-%20Book%20-%20Bass%20%20Kazman-Software%20Architecture%20in%20Practice%20%281%29.pdf (Free access)	Software system modeling, UML. Basics of object-oriented programming. Software testing Software configuration management Building of software Prototyping methods
2. Bourque P., Fairley R.E. "Guide to the Software Engineering Body of Knowledge	Definition of software requirements Software design process

<p>(SWEBOK(R)): Version 3.0" IEEE Computer Society URL: https://ieeecs-media.computer.org/media/education/swebok/swebok-v3.pdf (Free access)</p>	<p>Software security Architecture patterns Software complexity Reuse in coding Executable models Software maintenance Reverse engineering Software release management Software engineering management Quality management Risk management Software measurement techniques</p>
<p>3. INCOSE, Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities, version 4, International Council on Systems Engineering, 2012. URL: https://www.wiley.com/en-aw/INCOSE+Systems+Engineering+Handbook:+A+Guide+for+System+Life+Cycle+Processes+and+Activities,+4th+Edition-p-9781118999400 (Limit access)</p>	<p>Software security Architecture patterns User interface design process Standards in construction Reuse in coding Classification of operating systems. Software system modeling, UML. Basics of object-oriented programming. Software testing Software maintenance Reverse engineering Software release management Software engineering management Quality management Risk management Software measurement techniques</p>
<p>4. ISO/IEC/IEEE 24765: 2017 Systems and software engineering-Vocabulary. – 2017. URL: https://www.iso.org/standard/71952.html (Free access)</p>	<p>Definition of software requirements Software design process Standards in construction Software system modeling, UML Software maintenance Software configuration management Building of software Software release management Software engineering management</p>
<p>5. Naik S., Tripathy P. Software Testing and Quality Assurance: Theory and Practice, Wiley-Spektrum, 2008. URL: https://www.softwaretestinggenius.com/download/staqtpsn.pdf (Free access)</p>	<p>Software testing Software maintenance Reverse engineering Software configuration management Building of software</p>

	<p>Software release management</p> <p>Software engineering management</p> <p>Quality management</p> <p>Risk management</p> <p>Software measurement techniques</p>
<p>6. Sommerville I. Software Engineering, 9th ed., Addison-Wesley, 2011. URL:https://engineering.futureuniversity.com/BOOKS%20FOR%20IT/Software-Engineering-9th-Edition-by-Ian-Sommerville.pdf (Free access)</p>	<p>Software design process</p> <p>Error and exception handling</p> <p>Architecture patterns</p> <p>User interface design process</p> <p>Standards in construction</p> <p>Reuse in coding</p> <p>Classification of operating systems.</p> <p>Software system modeling, UML.</p> <p>Basics of object-oriented programming.</p> <p>Software testing</p> <p>Software configuration management</p> <p>Building of software</p> <p>Prototyping methods</p>

Section 3. Information systems and computing

Sources	Corresponding topic
<p>1. Rainer R. K., Prince B., Cegielski C. G. Introduction to Information Systems: R. Kelly Rainer, Brad Prince, Casey Cegielski. – John Wiley & Sons Singapore Pte. Limited, 2015. URL: https://humdiana.files.wordpress.com/2018/03/introduction-to-information-system-edisi-5-tahun-2014.pdf (Limit access)</p>	<p>Information: collecting, transmitting, processing, accumulation, measurement; information units. Information and entropy</p> <p>Hardware and software information technology tools</p> <p>Parallel processing. The main classes of parallel systems</p> <p>The concept of a system. Systems in engineering, economics and nature. Types of systems. The control object and the control system. Information Feedback. The subject of engineering cybernetics and information theory</p> <p>Modeling as a research method in cybernetics. Types of models. Models of technical, biological and socio-economic systems. The "black box" concept. The problem of identification. Model validity</p> <p>Programming languages. Procedure-oriented and object-oriented programming. Ways of</p>

Sources	Corresponding topic
	describing algorithms. The Unified system of program documentation Software life cycle Reliability of the software and hardware complex of the information system
2. Tanenbaum A. S. et al. Computer networks //Prentice-Hall international editions. – 1996.-813 p. URL: https://github.com/gsahinpi/acm361/blob/master/Computer%20Networks%20-%20A%20Tanenbaum%20-%205th%20edition.pdf (Free access)	Information: collecting, transmitting, processing, accumulation, measurement; information units. Information and entropy Data structures The concept of the information system and information technology Hardware and software information technology tools Pragmatic, semantic and syntactic aspects of information The principles of the structural and functional organization of computer networks. Packet-switched networks. TCP/IP protocol stack. Addressing in IP networks Multithreading: basic concepts. Methods of synchronization in multithreaded applications Process interaction. Shared memory, synchronization tools. Message queues and other means of data exchange The reference model of open systems interaction (ISO OSI model) and its purpose. Data encapsulation. Layers of the OSI reference model. Reliability of the software and hardware complex of the information system
3. Акимова Е. В. Вычислительная техника. Учебное пособие для СПО Издательство: Лань, 2022 URL: https://lanbook.com/catalog/informatika/vychislitel'naya-tekhnika/ (Ограниченный доступ)	The concept of information: a general description of the processes of collection, transmission, processing and accumulation of information, its measurement. Units of measurement of information. Information and entropy The concept of information system and information technology The concept of a system. Systems in technology, economics, wildlife. System types. Control object and control system.

Sources	Corresponding topic
	<p>Information. Feedback. Subject of technical cybernetics and information theory</p> <p>Modeling as a scientific method of cybernetics. Model types. Models of technical, biological and socio-economic systems. The concept of "black box". Identification problem. Adequacy of models</p> <p>Pragmatic, semantic and syntactic aspects of information</p> <p>Programming languages. Concepts of procedural-oriented and object-oriented programming. Methods for describing algorithms. Unified system of program documentation</p> <p>Software life cycle</p>
<p>4. Голицына О.Л, Максимов Н.В. Информационные системы / Московская финансово-промышленная академия. - М.: 2004. - 329 с.</p> <p>URL: http://lib.maupfib.kg/wp-content/uploads/Studmed.ru_golicyna-ol-maksimov-nv-informacionnye-sistemy_1d2b315966f.pdf (Свободный доступ)</p>	<p>The concept of information: a general description of the processes of collection, transmission, processing and accumulation of information, its measurement. Units of measurement of information. Information and entropy</p> <p>The concept of information system and information technology</p> <p>Hardware and software information technology</p> <p>The concept of a system. Systems in technology, economics, wildlife. System types. Control object and control system. Information. Feedback. Subject of technical cybernetics and information theory</p> <p>Modeling as a scientific method of cybernetics. Model types. Models of technical, biological and socio-economic systems. The concept of "black box". Identification problem. Adequacy of models</p> <p>Pragmatic, semantic and syntactic aspects of information</p> <p>Programming languages. Concepts of procedural-oriented and object-oriented programming. Methods for describing</p>

Sources	Corresponding topic
	algorithms. Unified system of program documentation
<p>5. Олифер В. Г, Олифер Н. А. Компьютерные сети. Принципы, технологии, протоколы. Учебник для вузов</p> <p>URL: http://naymov.com/edu/ukit/olifer.pdf (Свободный доступ)</p>	<p>The concept of information: a general description of the processes of collection, transmission, processing and accumulation of information, its measurement. Units of measurement of information. Information and entropy</p> <p>Data Structures</p> <p>Parallel data processing on a computer. Main classes of modern parallel systems</p> <p>Principles of structural and functional organization of computer networks. Computing networks with packet switching. TCP/IP protocol stack. Addressing in IP networks</p> <p>Multithreading: basic concepts. Synchronization Methods in Multithreaded Applications</p> <p>Process interaction. Shared memory, means of synchronization. Message queues and other means of communication</p> <p>Reference model of open systems interaction (ISO OSI model), its purpose. Data encapsulation. Layers of the OSI Reference Model</p> <p>Reliability of the software and hardware complex of the information system</p>
<p>6. Хопкрофт, Джон, Э., Мотвани, Раджив, Ульман, Джеффри, Д. Введение в теорию автоматов, языков и вычислений, 2-е изд.. : Пер. с англ. —М. : Издательский дом "Вильямс", 2008.</p> <p>URL: https://files.nazaryev.ru/ifmo/third-year/%D0%90%D1%80%D1%85%D0%B8%D0%B2%203/6%20%D1%81%D0%B5%D0%BC%D0%B5%D1%81%D1%82%D1%80/%D0%A2%D0%B5%D0%BE%D1%80%D0%B8%D1%8F%20%D0%B0%D0%B2%D1%82%D0%BE%D0%B</p>	<p>The concept of information: a general description of the processes of collection, transmission, processing and accumulation of information, its measurement. Units of measurement of information. Information and entropy</p> <p>Data Structures</p> <p>The concept of information system and information technology</p> <p>Parallel data processing on a computer. Main classes of modern parallel systems</p> <p>Programming languages. Concepts of procedural-oriented and object-oriented</p>

Sources	Corresponding topic
<p>C%D0%B0%D1%82%D0%BE%D0%B2/%D0%9B%D0%B8%D1%82%D0%B5%D1%80%D0%B0%D1%82%D1%83%D1%80%D0%B0/%D0%94%D0%B6%D0%BE%D0%BD%20%D0%A5%D0%BE%D0%BF%D0%BA%D1%80%D0%BE%D1%84%D1%82,%20%D0%A0%D0%B0%D0%B4%D0%B6%D0%B8%D0%B2%20%D0%9C%D0%BE%D1%82%D0%B2%D0%B0%D0%BD%D0%B8,%20%D0%94%D0%B6%D0%B5%D1%84%D1%84%D1%80%D0%B8%20%D0%A3%D0%BB%D1%8C%D0%BC%D0%B0%D0%BD%20%D0%92%D0%B2%D0%B5%D0%B4%D0%B5%D0%BD%D0%B8%D0%B5%20%D0%B2%20%D1%82%D0%B5%D0%BE%D1%80%D0%B8%D1%8E%20%D0%B0%D0%B2%D1%82%D0%BE%D0%BC%D0%B0%D1%82%D0%BE%D0%B2,%20%D1%8F%D0%B7%D1%8B%D0%BA%D0%BE%D0%B2%20%D0%B8%20%D0%B2%D1%8B%D1%87%D0%B8%D1%81%D0%B%D0%B5%D0%BD%D0%B8%D0%B9%20(2008).pdf (Свободный доступ)</p>	<p>programming. Methods for describing algorithms. Unified system of program documentation Software life cycle</p>

Section 4. Information security

Sources	Corresponding topic
<p>1. Eagle C., Nance K. The Ghidra Book: The Definitive Guide No Starch Press (September 1, 2020), 608 p. URL: https://www.amazon.com/Ghidra-Book-Definitive-Guide-ebook/dp/B0852N9Y4Q (Limit access)</p>	<p>Basic concepts of information security. Key factors affecting information security Major international information security standards, their purpose and scope Information security policy, its place and role in organization management Approaches to information risk management. Risk assessment. Risk scales and measurement criteria Security information and event management (SIEM) systems. Design principles, tasks and goals of SIEM systems</p>

Sources	Corresponding topic
<p>2. Easttom W. Computer Security Fundamentals. 4th Edition. Pearson IT Certification; 4th edition (October 22, 2019). 512 pages URL: https://www.oreilly.com/library/view/computer-security-fundamentals/9780135774854/ (Limit access)</p>	<p>Basic concepts of information security. Key factors affecting information security Major international information security standards, their purpose and scope Security information and event management (SIEM) systems. Design principles, tasks and goals of SIEM systems Intrusion, prevention and detection systems in computer systems and networks; their purpose, goals and design principles Access control models and systems</p>
<p>3. Ferguson N., Schneier B., Kohno T. Cryptography Engineering: Design Principles and Practical Applications 1st Edition, Wiley, 2011.P. 386. URL:https://theswissbay.ch/pdf/Books/Computer%20science/Cryptography/cryptography-engineering-design-principles-and-practical-applications.pdf (Free access)</p>	<p>Identification, authentication and authorization. Authentication and authorization techniques Steganography: the purpose and tasks. Techniques for embedding hidden information in executable files Symmetric encryption systems. Block ciphers, their operation modes. Modern standards and protocols of symmetric encryption Public key cryptosystems. The principles of construction. Modern standards and public-key encryption protocols Public-key infrastructure, certification centers and digital certificates</p>
<p>4. Rhodes-Ousley M. Information Security: The Complete Reference, Second Edition 2nd Edition Publisher : McGraw-Hill Education; 2nd edition. 2013. 896 pages URL:https://d.cxcare.net/InfoSec/Information%20Security%20The%20Complete%20Reference,%202nd%20Edition/Information%20Security%20The%20Complete%20Reference,%202nd%20Edition.pdf (Free access)</p>	<p>Basic concepts of information security. Key factors affecting information security Major international information security standards, their purpose and scope Information security threats. Approaches to modeling information threats and attackers Intrusion, prevention and detection systems in computer systems and networks; their purpose, goals and design principles Virtual Private Network (VPN): purpose, design principles and selection criteria Access control models and systems Identification, authentication and authorization. Authentication and authorization techniques</p>

Sources	Corresponding topic
<p>5. Schultz C. P., Perciaccante B. Kali Linux Cookbook - Second Edition: Effective penetration testing solutions. Packt Publishing; 2nd Revised edition (September 12, 2017). 438 p.</p> <p>URL: http://dl.hellodigi.ir/dl.hellodigi.ir/dl/book/Kali%20Linux%20Cookbook%20%28Second%20Edition%29.pdf (Free access)</p>	<p>Security information and event management (SIEM) systems. Design principles, tasks and goals of SIEM systems</p> <p>Intrusion, prevention and detection systems in computer systems and networks; their purpose, goals and design principles</p> <p>Network firewall systems: principles and tasks</p> <p>Virtual Private Network (VPN): purpose, design principles and selection criteria</p> <p>Access control models and systems</p> <p>Identification, authentication and authorization. Authentication and authorization techniques</p>

Section 5. Data analysis and machine learning

Sources	Corresponding topic
<p>1. Alpaydin E. Introduction to Machine Learning. London: The MIT Press. ISBN 978-0-262-01243-0. Retrieved 4 February 2017. URL:https://kkpatel7.files.wordpress.com/2015/04/alpaydin_machinelearning_2010.pdf (Free access)</p>	<p>Multidimensional data models. Representation of data as a multidimensional cube</p> <p>Machine learning. Definition. Purposes</p> <p>Machine learning functions: classification, regression, frequent set search, clustering</p> <p>Machine learning models. Predictive and descriptive machine learning models. Machine learning methods</p>
<p>2. Bishop, C. M. (2006), Pattern Recognition and Machine Learning, Springer, ISBN 978-0-387-31073-2</p> <p>URL: http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20-%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf (Free access)</p>	<p>Machine learning. Definition. Purposes</p> <p>Machine learning functions: classification, regression, frequent set search, clustering</p> <p>Machine learning models. Predictive and descriptive machine learning models. Machine learning methods</p> <p>Knowledge discovery process. Stages of data mining</p> <p>Classification algorithms: Naive Base, C 4.5, BackProp, Support Vector Machine, etc.</p> <p>Clustering algorithms: hierarchical, k-Means, DBScan, SOM</p>
<p>3. Hastie T., Tibshirani R., Friedman J. The Elements of Statistical Learning. Springer. 2001</p> <p>URL:https://link.springer.com/content/pdf/10.1007/978-0-387-84858-7.pdf (Free access)</p>	<p>The concept of data warehouse (DW). Their purpose. Architecture</p> <p>Physical DW. Virtual HD. Data marts (DM)</p> <p>Data transfer. The ETL process. Data cleansing. DW and analysis</p>

Sources	Corresponding topic
	Types of data warehouses. Their purposes and architectures. Multidimensional data models. Representation of data as a multidimensional cube Knowledge discovery process. Stages of data mining
4. Ian W., Elbe F. Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations. Department of computer science University of Waikato. 3th ed, 2011 URL: https://www.researchgate.net/publication/30876208_Data_Mining_-_Practical_Machine_Learning_Tools_and_Techniques_with_JAVA_Implementations (Limit access)	Decision support systems (DSS) Machine learning. Definition. Purposes Machine learning functions: classification, regression, frequent set search, clustering Machine learning models. Predictive and descriptive machine learning models. Machine learning methods Classification algorithms: Naive Base, C 4.5, BackProp, Support Vector Machine, etc. Clustering algorithms: hierarchical, k-Means, DBScan, SOM Algorithms for frequent set search: Apriori, FPG, etc.
5. Mohri M., Rostamizadeh A., Talwalkar A. Foundations of Machine Learning. USA, Massachusetts: MIT Press. 2012, ISBN 9780262018258. URL: https://cs.nyu.edu/~mohri/mlbook/ (Free access)	Machine learning. Definition. Purposes Machine learning functions: classification, regression, frequent set search, clustering Machine learning models. Predictive and descriptive machine learning models. Machine learning methods Knowledge discovery process. Stages of data mining Classification algorithms: Naive Base, C 4.5, BackProp, Support Vector Machine, etc. Clustering algorithms: hierarchical, k-Means, DBScan, SOM
6. Umberto Michelucci. Advanced Applied Deep Learning. Convolutional Neural Networks and Object Detection. Publisher: Apress Berkeley, CA 2019. 285 p. URL: https://link.springer.com/content/pdf/10.1007/978-1-4842-4976-5.pdf (Free access)	Deep learning. Definition. Deep learning and machine learning
7. Хомоненко, Смагин, Косых. Методы и модели исследования сложных	Decision support systems (DSS). Data warehouse concept. Appointment. Architecture.

Sources	Corresponding topic
<p>систем и обработки больших данных Издательство: Лань, 2020 г. URL: http://i.uran.ru/webcab/system/files/bookspdf/metody-i-modeli-issledovaniya-slozhnyh-sistem-i-obrabotki-bolshih-dannyh-monografiya-1-e-izd/metody.pdf (Ограниченный доступ)</p>	<p>Physical data stores. Virtual data stores. Data marts. Data transfer. ETL is a process. Data cleaning. Data Warehouse and Analysis Data warehouses. Appointment. Architecture. Multidimensional data model. Representation of data in the form of a multidimensional cube. Knowledge discovery process. Stages of Data Mining</p>

Recommended online courses

Section 1. Applied mathematics

1. Mathematical Thinking in Computer Science (Coursera)
 URL: <https://www.coursera.org/learn/what-is-a-proof>
2. Combinatorics and Probability (Coursera)
 URL: <https://www.coursera.org/learn/combinatorics>
3. Single Variable Calculus (Coursera)
 URL: <https://www.coursera.org/learn/discrete-calculus>
4. Data Science Math Skills (Coursera)
 URL: <https://www.coursera.org/learn/datasciencemathskills>
5. Algorithms on Graphs (Coursera)
 URL: <https://www.coursera.org/learn/algorithms-on-graphs>

Section 2. Software engineering

1. Software Development Lifecycle (Coursera)
 URL: <https://www.coursera.org/specializations/software-development-lifecycle>
2. IBM DevOps and Software Engineering Professional Certificate (Coursera)
 URL: <https://www.coursera.org/professional-certificates/devops-and-software-engineering>
3. IBM Full Stack Software Developer Professional (Coursera)
 URL: <https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer>
4. Software Engineering Specialization (Coursera)
 URL: <https://www.coursera.org/specializations/software-engineering>
5. Software Design and Architecture Specialization (Coursera)
 URL: <https://www.coursera.org/specializations/software-design-architecture>

Section 3. Information systems and computing

1. Information Systems (Coursera)
 URL: <https://www.coursera.org/specializations/information-systems>
2. Fundamentals of Network Communication (Coursera)
 URL: <https://www.coursera.org/learn/fundamentals-network-communications>

3. Introduction to Computer Science and Programming (Coursera)
URL: <https://www.coursera.org/specializations/introduction-computer-science-programming>
4. TCP/IP and Advanced Topics (Coursera)
URL: <https://www.coursera.org/learn/tcp-ip-advanced?specialization=computer-communications>
5. How to Code: Simple Data (EdX)
URL: <https://www.edx.org/course/how-to-code-simple-data>
6. Information Technology Foundations(EdX)
URL: <https://www.edx.org/course/information-technology-foundations>

Section 4. Information security

1. Introduction to Cybersecurity & Risk Management (Coursera)
URL: <https://www.coursera.org/specializations/information-security>
2. IBM Cybersecurity Analyst Professional Certificate (Coursera)
URL: <https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst>
3. IT Security: Defense against the digital dark arts (Coursera)
URL: <https://www.coursera.org/learn/it-security>
4. Information Systems Auditing, Controls and Assurance (Coursera)
URL: <https://www.coursera.org/learn/information-systems-audit>
5. Data, Security, and Privacy (Coursera)
URL: <https://www.coursera.org/learn/data-security-privacy>

Section 5. Data analysis and machine learning

1. Free Machine Learning Course (fast.ai)
URL: <https://www.fast.ai/>
2. Machine Learning Course by Stanford University (Coursera)
URL: <https://www.coursera.org/learn/machine-learning>
3. Deep Learning Course (Coursera)
URL: <https://www.coursera.org/specializations/deep-learning>
4. Free Machine Learning Data Science Course (EdX)
URL: <https://www.edx.org/professional-certificate/harvardx-data-science>
5. Free Machine Learning Introduction Course (Udacity)
URL: <https://www.udacity.com/course/intro-to-machine-learning-nanodegree--nd229>
6. Machine Learning Course (Stanford School of Engineering)
URL: <https://online.stanford.edu/courses/cs229-machine-learning>
7. Data Analysis Essentials (EdX)
URL: <https://www.edx.org/course/data-analysis-essentials>
8. Data Processing and Analysis with Excel (EdX)
URL: <https://www.edx.org/course/data-processing-and-analysis-with-excel>
9. Machine Learning Specialization (Coursera)
URL: <https://www.coursera.org/specializations/machine-learning-introduction>
10. BI Foundations with SQL, ETL and Data Warehousing (Coursera)
URL: <https://www.coursera.org/specializations/bi-foundations-sql-etl-data-warehouse>

