

Bachelor's Track Program: Computer Science and Data Science

1. Open Doors winner's skill set

Winning the Open Doors competition requires a firm grasp of:

- one of the programming languages, such as Python; concepts of procedure-oriented and object-oriented programming; methods of algorithm description;
- mathematical fundamentals of computer science, including number systems, number base conversion, Boolean algebra, and standard Boolean operations;
- basic concepts of mathematics, including equations and inequalities, functions and their derivatives, and oriented and undirected graphs, as well as paths in a graph.

The winner is expected to demonstrate a solid command of the following skills:

- developing data processing algorithms and implementing them programmatically in a selected programming language;
- solving problems based on the listed mathematical concepts using one of the programming languages.

2. List of degree programs covered by the subject area:

2.1. List of bachelor's degree programs

01.03.02 Applied mathematics and computer science

02.03.02 Fundamental computer science and information technology

09.03.01 Computer science and engineering

09.03.02 Information systems and technologies

09.03.03 Applied computer science

09.03.04 Software engineering

11.03.02 Information and communication technologies and communication systems

3. Content

Field of science 1: Applied mathematics

Mathematics

1. Transformations of expressions containing powers and logarithms, and trigonometric expressions.
2. Equations, inequalities, and their systems.
3. Elements of mathematical analysis: the function and its derivative; rules for calculating derivatives; indefinite and definite integrals.
4. Elements of algebra: vectors and operations with them; matrices and matrix operations; matrix determinant.
5. Definition of probability; elementary properties: probability addition theorem, probability multiplication theorem.
6. Basic combinatorial numbers: number of placements (permutations), combinations.
7. Graphs: undirected, oriented, bipartite, complete; distances in graphs.
8. Graph traversal using breadth-first and depth-first search.

Field of science 2: Computer science and information systems

Computer science

1. Concept of information.
2. General characteristics of information collection, transmission, processing, and storage processes.
3. Units of information measurement.
4. Data structures.
5. Concepts of information systems and information technology.
6. Programming languages.

7. Concepts of procedure-oriented and object-oriented programming.
8. Methods of describing algorithms.
9. Unified system of software documentation.
10. Software life cycle.

Field of science 3: Computer science and artificial intelligence

Computer science

1. Introduction to machine learning; the role of AI in human life: ethics and regulation.
2. General overview of Python programming.
3. Organization of data input and output.
4. Programming linear algorithms.
5. Programming of branching algorithms; conditional operator.
6. Algorithmic structure of a loop; programming cycles with a set condition for continued operation.
7. Programming cycles with a set number of repetitions.
8. Data science.
9. Working with Python lists.
10. Python libraries; Pandas library; data structures in Pandas.
11. Data structure of the data frame; basic operations with datasets.
12. Descriptive statistics.
13. Data visualization.
14. Concept and types of machine learning; machine learning libraries.
15. Linear regression.
16. Nonlinear dependencies.

Field of science 4: Interdisciplinary applications of computer science

Computer science

1. General-purpose applications and their usage.
2. Text and image editors.
3. Calculators and spreadsheets.
4. Sound and video editors, multimedia players.
5. Communication programs and messengers.
6. Application software development tools.
7. Programming languages, integrated development tools.
8. Programming technologies; introduction to object-oriented programming .
9. Software security.
10. Principles of structural and functional organization of computer networks.
11. Reliability of software and hardware components in the information system.
12. Models and systems for managing access to information resources.
13. Identification, authentication, and authorization.
14. Authentication and authorization techniques.

Field of science 5: Software engineering

Computer science

1. Application software development tools.
2. Programming languages, integrated development tools.
3. Programming technologies, an introduction to object-oriented programming.
4. Interface and core functionalities of different platforms.
5. Programming object behavior using various programming languages.
6. Using standard containers for storing and processing multiple objects.
7. Programming object interaction.

8. Software requirements.
9. Software testing.
10. Software maintenance.
11. Software development management.
12. Software quality management.

Field of science 6: Hardware architecture

Computer science

1. Concepts of computer hardware; hardware architectures.
2. History of computing devices and systems; classification of computers.
3. Basic logical operations and schemes: conjunction, disjunction, negation; truth tables.
4. Circuit logic elements: registers; flip-flops; adders; multiplexers; demultiplexers; encoders; decoders; comparators.
5. Basic logic elements: principles of operation; truth tables; logical expressions; circuit diagrams.
6. Basic concepts of computer architecture; von Neumann architecture.
7. Classification of computer system architectures: Flynn's taxonomy and other computer architecture classifications.
8. Organization of processor operation and functioning; microprocessors of the CISC, RISC, and MISC types.
9. Processor command systems; processor registers: essence, purpose, types.
10. Computational parallelism; pipeline calculations; superscalarization; matrix and vector processors.
11. System boards: types, characteristics, and form factors.
12. Interface types: serial, parallel, and radial.
13. PC cases: types, characteristics, and form factors.
14. Power supplies: types, characteristics, and form factors.
15. Direct memory access; interrupts; drivers; Plug and Play specification.
16. Types of memory in informatization hardware: permanent, volatile, internal, and external.
17. Monitors and video adapters: structure, operating principles, and connection types.
18. Computer peripherals and connection interfaces.

4. Preparation materials

4.1. Recommended reading

Field of science 1: Applied mathematics

Reading list in English

1. Meyer A.R. Mathematics for Computer Science – Massachusetts Institute of Technology, 2010. – 519 p. URL: <https://archive.org/details/ost-computer-science-mcs/>
2. Sparks J.C. The Handbook of Essential Mathematics – Air Force Publication, 2006. – 205 p. URL: http://wpafbstem.com/pages_main/math_resources/math_handbook1.pdf
3. Stavelly A.M. A Gentle Introduction to Discrete Math Featuring Python – Published by The New Mexico Tech Press, a New Mexico nonprofit corporation, 2014. – 260 p. URL: https://webpages.math.luc.edu/~lauve/courses/215-fa2016/Stavelly_python_ebook.pdf

Field of science 2: Computer science and information systems

Reading list in English

1. Alvarado C., Dodds Z., Kuenning G., Libeskind-Hadas R. CS for All: An Introduction to

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| Computer Science Using Python. – Franklin, Beedle & Associates Inc., 2019. – 288 p. URL: https://www.cs.hmc.edu/twiki/bin/view/CSforAll/ |
| 2. Kopec D. Classic Computer Science Problems in Python. – Manning Publications; 1st edition, 2019. – 224 p. (Subscription) URL: https://livebook.manning.com/book/classic-computer-science-problems-in-python/about-this-book/ |
| 3. Wienand I. Computer Science from the Bottom Up. BottomUp – CS.com, 2022. – 205 p. URL: https://www.bottomupcs.com/ |

Field of science 3: Computer science and artificial intelligence

Reading list in English

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| 1. Joshi M. The AI Expedition: From Basics to Brilliance. – Smashwords, 2023. – 320 p. URL: https://freecomputerbooks.com/The-AI-Expedition.html |
| 2. Klimczak P. Limits and Prospects of Artificial Intelligence. – Transcript Publishing, 2023. – 290 p. URL: https://www.degruyter.com/document/doi/10.1515/9783839457320/pdf?licenseType=open-access |
| 3. Wang H. Introduction to Computer Programming with Python: – Athabasca University Press, 2023. – 504 p. URL: https://www.aupress.ca/books/oer-202301-introduction-to-computer-programming-with-python/ |

Field of science 4: Interdisciplinary applications of computer science

Reading list in English

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| 1. Downey A.B. Think Python: An Introduction to Software Design – CreateSpace, 2009. – 238 p. URL: http://www.greenteapress.com/thinkpython/thinkpython.html |
| 2. Guttman B., Roback E. An Introduction to Computer Security: The NIST Handbook – NIST, 2022. – 290 p. URL: https://csrc.nist.rip/publications/nistpubs/800-12/800-12.html/ |
| 3. Murray K. Microsoft Office 365: Connect and Collaborate Virtually Anywhere, Anytime - Microsoft Press; 1 edition, 2012. – 337 p. – URL: https://download.microsoft.com/download/1/2/F/12F1FF78-73E1-4714-9A08-6A76FA3DA769/656949ebook.pdf |

Field of science 5: Software engineering

Reading list in English

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| 1. Fleischmann A., et al. A Storybook about Business Process Modeling and Execution. – Springer-Verlag GmbH, 2013. – 144 p. URL: https://link.springer.com/content/pdf/10.1007/978-3-642-36904-9.pdf |
| 2. Marrer G. Fundamentals of Programming With Object Oriented Programming. – Gary Marrer, 2009. – 359 p. URL: https://ia600706.us.archive.org/13/items/bub_gb_TZ-qjncsv6QC/bub_gb_TZ-qjncsv6QC.pdf |
| 3. Seguin K. Foundations of Programming - Building Better Software - CodeBetter.com , 2008. – 179 p. URL: https://www.openmymind.net/FoundationsOfProgramming.pdf |

Field of science 6: Hardware architecture**Reading list in English**

1. Englander I. The Architecture of Computer Hardware and System Software. – John Wiley & Sons, 2009. – 708 p. URL: [https://aitskadapa.ac.in/e-books/CSE/SOFTWARE%20ENGINEERING/The%20Architecture%20of%20Computer%20Hardware%20and%20System%20Software%20\(%20PDFDrive%20\).pdf](https://aitskadapa.ac.in/e-books/CSE/SOFTWARE%20ENGINEERING/The%20Architecture%20of%20Computer%20Hardware%20and%20System%20Software%20(%20PDFDrive%20).pdf)
2. Ledin J. Modern Computer Architecture and Organization. – Packt Publishing, 2020. – 561 p. URL: [https://viterbi-web.usc.edu/~yudewei/main/sources/books/Modern%20Computer%20Architecture%20and%20Organization%20Learn%20processor%20architecture%20including%20RISC-V,%20and%20design%20of%20PCs,%20cloud%20servers,...%20\(Jim%20Ledin\)%20\(z-lib.org\).pdf](https://viterbi-web.usc.edu/~yudewei/main/sources/books/Modern%20Computer%20Architecture%20and%20Organization%20Learn%20processor%20architecture%20including%20RISC-V,%20and%20design%20of%20PCs,%20cloud%20servers,...%20(Jim%20Ledin)%20(z-lib.org).pdf)
3. Patterson D.A., Hennessy J.L. Computer Organization and Design. – Morgan Kaufmann, 2017. – 1074 p. URL: <https://dpo-india.com/Resources/NIST/An-Introduction-to-Computer-Security-The-NIST-Handbook.pdf>

4.2. Recommended online courses**Field of science 1: Applied mathematics**

Online courses in English	Link	Course description
1. Maths for Programmers	URL: https://www.scaler.com/topics/course/math-s-for-programmers/	This comprehensive course is designed for beginner programmers seeking to improve their mathematical skills. It covers basic mathematical concepts commonly used in programming, including algebra, computational methods, probability, and statistics. The course provides a deeper understanding of how mathematics is applied in programming and how it can be used to improve code.
2. Linear Algebra	URL: https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/	The course explains the concept of algebra and the meaning of linear; its blocks cover vectors, linear independence, matrices, linear transformations, matrix multiplication, and applications.
3. Calculus	URL: https://www.khanacademy.org/math/calculus-1	The course provides insight into limits and continuity, with a focus on derivatives—their definition, fundamental rules, and applications; function analysis; and integrals with their applications.

Field of science 2: Computer science and information systems

Online courses	Link	Course description
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in English		
1. Computer Science Fundamentals	URL: https://code.org/curriculum/csf	This course introduces fundamental concepts of computer science and explores how computers and technology impact the modern world.
2. Introduction to Computer Science	URL: https://pll.harvard.edu/course/cs50-introduction-computer-science	This entry-level course develops algorithmic thinking and problem-solving skills. Topics include abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Programming languages covered are C, Python, SQL, and JavaScript, along with CSS and HTML. Applied tasks are drawn from fields such as biology, cryptography, finance, and criminology.
3. Introduction to Computer Science and Programming	URL: https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/	The course covers topics ranging from fundamental principles of computing to the mathematical foundations essential for computer science. It introduces core concepts of computer operation applicable across software and systems, while developing practical skills for writing entry-level interactive graphics programs. The numerical mathematics component equips students with computational tools for problem-solving and modeling.

Field of science 3: Computer science and artificial intelligence

Online courses in English	Link	Course description
1. AI For Everyone	URL: https://www.deeplearning.ai/courses/ai-for-everyone/	This course introduces the essential terminology of artificial intelligence—including neural networks, machine learning, deep learning, and data science—while exploring the capabilities and limitations of AI, the experience of developing machine learning and data science projects, peculiarities of working with AI teams and developing an IA strategy in business settings, and the ethical and societal dimensions of AI. Although primarily non-technical, the course also benefits programmers seeking insight into the business applications of AI.
2. AI Overview	URL: https://www.elements.ofai.com/	This course provides an overview of artificial intelligence, covering its technical foundations, practical applications, development strategies, current challenges, and future prospects.

3. Introduction to Artificial Intelligence with Python	URL: https://pll.harvard.edu/course/cs50s-introduction-artificial-intelligence-python	This course explores the concepts and algorithms underlying modern artificial intelligence, examining the ideas behind technologies such as game engines, handwriting recognition, and machine translation. Through practical projects, students study the theory behind graph search algorithms, classification, optimization, and reinforcement learning, gaining experience with machine learning libraries and acquiring the foundational knowledge necessary to develop intelligent systems.
4. Dispute Resolution and Artificial Intelligence	URL: https://stepik.org/course/122051	The main goal of this course is to broaden participants' understanding of the modern legal landscape amid technological advancements. Whether at the beginning or the peak of their legal careers, participants will examine how technology—already an integral part of daily legal practice—is transforming not only legal tools but also legal actors, with robots increasingly taking on roles traditionally held by humans. The course also provides a platform for sharing perspectives on legal issues related to robotics and for engaging with insights from the authors and forward-thinking legal professionals worldwide.

Field of science 4: Interdisciplinary applications of computer science

Online courses in English	Link	Course description
1. Introduction to Computer Science and Programming	URL: https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/	The course covers topics ranging from the basic principles of computing to the mathematical foundations required for computer science. Participants will learn the fundamental concepts of computer operation, applicable to any software or computer system. They will also acquire practical skills to write interactive graphics programs at an entry level, while the Numerical Mathematics component provides computational tools needed to solve problems and model at various stages of computer science studies.
2. Computer Science Fundamentals	URL: https://code.org/curriculum/csf	This course introduces students to the fundamental concepts of computer science and explores how computers and technology impact the world around them.
3. Network	URL:	This course provides the foundational knowledge

security and database vulnerabilities	https://coursesity.com/course-detail/network-security--database-vulnerabilities--	necessary to understand network security. It covers local area networks, TCP/IP, the OSI model, and basic routing concepts. The course explains how network technologies influence security systems within organizations and identifies network components that protect against cybersecurity attacks. Additionally, it addresses database vulnerabilities and equips students with the tools and knowledge to detect vulnerabilities in various databases, including SQL Injection, Oracle, Mongo, and Couch.
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Field of science 5: Software engineering

Online courses in English	Link	Course description
1. Introduction to Software Engineering	URL: https://www.geeksforgeeks.org/software-engineering/software-engineering/	The course focuses on foundational knowledge of software development and programming, while exploring diverse roles and career paths within the IT industry.
2. Introduction to Computer Science	URL: https://pll.harvard.edu/course/cs50-introduction-computer-science	This entry-level course teaches algorithmic thinking and effective problem solving. Topics covered include abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Programming languages studied include C, Python, SQL, JavaScript, CSS, and HTML. Tasks are drawn from applied fields such as biology, cryptography, finance, and criminology.
3. Introduction to Artificial Intelligence with Python	URL: https://pll.harvard.edu/course/cs50s-introduction-artificial-intelligence-python	This course explores the concepts and algorithms underlying modern artificial intelligence, examining the ideas behind technologies such as game engines, handwriting recognition, and machine translation. Through practical projects, students study the theory behind graph search algorithms, classification, optimization, and reinforcement learning, gaining experience with machine learning libraries and acquiring the foundational knowledge necessary to develop intelligent systems.

Field of science 6: Hardware architecture

Online courses in English	Link	Course description
1. Computer Architecture	URL: https://www.mygreatlearning.com/academy/learn-for-free/courses/computer-architecture-digital-components	This course teaches the design of computer architecture for complex modern microprocessors.
2. Computer Architecture	URL: https://www.codecademy.com/learn/computer-architecture	This course introduces the main physical components of a computer, explains the significance of binary digits 0 and 1, and explores how the instruction set architecture connects hardware and software. It covers computer architecture from basic operation to data-level concurrency. The course culminates in a project to create a processor simulator in Python.
3. Introduction to Computer Science	URL: https://pll.harvard.edu/course/cs50-introduction-computer-science	This entry-level course teaches algorithmic thinking and effective problem solving, covering topics such as abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Programming languages include C, Python, SQL, JavaScript, CSS, and HTML. The course uses task sets from applied fields like biology, cryptography, finance, and criminology.