National Research University
Higher School of Economics

FACULTY OF COMPUTER SCIENCE

Yandex

Faculty of Computer Science

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vocational education programmes

2 189
students

40
PhD students

274
faculty members

Building a New Faculty is an Ambitious and Complicated Project!

For us, this was an exceptional start-up that couldn't fail

Ivan Arzhantsev

Dean, Faculty
of Computer Science

From the very beginning, we were pursuing a challenging goal to create not merely a faculty but a full-fledged research centre. Our goal was to ensure a wide range of activities from developing state-of-the-art educational programmes to implementing world-class research projects relevant to business and education. Around the world this approach has become an institutional standard (consider universities like MIT and Caltech), but in Russia it is still not mainstream.

The main issue was to combine education with R&D while maintaining the integrity of both. Thankfully, our main partner, Yandex is a market leader.

We started with three schools, three departments and two laboratories, as well as two bachelor's and two master's programmes. Now the faculty is home to twelve laboratories, as well as to five departments established in cooperation with research institutions and industrial partners. Furthermore, we have developed a double degree programme in applied mathematics and information science with London School of Economics. The Faculty of Computer Science offers seven master's programmes including our new Data Science online master's programme. In addition, we are actively developing vocational education programmes in computer science.

Recently, we set to work on a unique Data Culture project. This project aims at making sure that all HSE University undergraduate students learn the core principles of data analysis, including skills for using basic technologies and methods for data processing in their respective fields.

Our partners today include major companies like Sberbank, Samsung, SAS, and JetBrains. Our professors and researchers present papers at major international conferences like NIPS and ICML. Furthermore, overall citation rate increases every year, as does the total number of publications indexed in Scopus and WoS. Our position on the QS World University Rankings has been consistently on the rise in Computer Science and in Mathematics.

Russia's best and brightest study with us. For instance, this year we have over 2,000 students. The faculty is popular among foreign applicants as well. Since 2016 the number of international students increased by 60%. This is all the more noticeable, since the faculty was only founded in 2014.

Now we are faced with an even harder task – not lingering or stalling but growing still, while maintaining the quality of our work. And we are ready to meet this challenge!

Education and Research at the Faculty of Computer Science

EDUCATION

Faculty of Computer Science

- School of Big Data and Information Retrieval
  - Yandex Department
- School of Data Analysis and Artificial Intelligence
- School of Software Engineering
  - Ivannikov Institute for System Programming of the Russian Academy of Sciences Department
- SAS Department
- Department of Intelligent Technologies in System Analysis and Control
- Department of Technologies for Complex System Modelling

RESEARCH

- Centre of Deep Learning and Bayesian Methods
  - Samsung-HSE Laboratory
  - Laboratory of Financial Data Analysis
- International Laboratory for Intelligent Systems and Structural Analysis
- International Laboratory of Stochastic Algorithms and High-Dimensional Inference
- International Laboratory of Theoretical Computer Science
- International Laboratory of Algebraic Topology and Its Applications
- Yandex Laboratory
- Laboratory of Methods for Big Data Analysis
- Laboratory of Process-Aware Information Systems
- Laboratory of Complex Systems Modelling and Control
- Laboratory of Bioinformatics
- Laboratory of Models and Methods of Computational Pragmatics

Schools

Vladimir Podolskii

Head of the School

School of Big Data and Information Retrieval

The research directions of the School cover many topics in computer science and data science, including data analysis, machine learning, computer vision, distributed computing, bioinformatics, theoretical computer science, applied topology. The School unites Yandex Department and Lab, Centre of Deep Learning and Bayesian Methods, Theoretical Computer Science Lab, Lab of Algebraic Topology and Its Applications, Complex Systems Modelling and Control Lab, and Bioinformatics Lab.

Sergei Kuznetsov

Head of the School

School of Data Analysis and Artificial Intelligence

The School carries out research in data mining, machine learning, formal concept analysis, semantic technologies and ontology engineering, natural language processing, recommender systems, social network analysis, and medical informatics. The School encompasses Intelligent Systems and Structural Analysis Lab and Models and Methods of Computational Pragmatics Lab.

Sergey Avdoshin

Head of the School

School of Software Engineering

The School's areas of expertise include software design, business process analysis and modeling, mobile applications, fuzzy logic, and process-aware information systems. Ivannikov Institute for System Programming has a department within the School.

Maxim Babenko

Head of the Department,
Head of Distributed
Computing Technology
Service, Yandex

Yandex Department

Yandex's partnership with HSE University started in 2008 and was followed by the opening of the Joint Department. In 2014, the department became part of the Faculty of Computer Science.

The department's primary areas include machine learning and information retrieval, algorithms and data structures, big data engineering, as well as computer vision, natural language processing, machine translation, dialogue systems, and mathematical methods in advertising technologies.

About Yandex

Yandex is a technology company that builds intelligent products and services powered by machine learning. Our goal is to help consumers and businesses better navigate the online and offline world. Since 1997, we have delivered world-class, locally relevant search and information services. Additionally, we have developed market-leading on-demand transportation services, navigation products, and other mobile applications for millions of consumers across the globe. Yandex, which has thirty offices worldwide, has been listed on the NASDAQ since 2011.

Joint Departments

Nikolay Filipenkov

Head of the SAS Department, Head of Credit Scoring and Risk Management Department in SAS EMEA

SAS Department

About SAS

SAS is the leader in business analytics software and services, and the largest independent vendor in the business intelligence market. Through innovative solutions, SAS helps more than 83,000 companies in 158 countries to improve performance and deliver value by making better decisions. Today, offices around the world employ about 14 thousand employees. In Russia and the CIS countries, SAS began operations in 1996.

Mikhail Posypkin

Head of the Department, Head of the Complex Physical and Technical Systems Modelling division of the Federal Research Centre for Computer Science and Control

Department of Intelligent Technologies in System Analysis Control

Federal Research Centre for Computer Science and Control of the Russian Academy of Sciences Department

About Federal Research Centre for Computer Science and Control

Federal Research Centre for Computer Science and Control specialises in fundamental and applied research in mathematics, system analysis and control, theoretical computer and information science, telecommunications infrastructure development.

Andrei Sobolevski

Head of the Department, Director of the Kharkevich Institute for Information Transmission Problems

Department of Technologies for Complex System Modelling

Kharkevich Institute for Information Transmission Problems of the Russian Academy of Sciences Department

About the Kharkevich Institute for Information Transmission Problems

Established in 1961, the Institute for Information Transmission Problems specialises in fundamental and applied research in the fields of information transmission, distribution, processing, and control in technical and biological systems. Three Institute staff members were awarded Fields Medals in 1978, 1998, and 2006.

Arutyun Avetisyan

Head of the Department, Director of the Ivannikov Institute for System Programming

Ivannikov Institute for System Programming of the Russian Academy of Sciences Department

Established in 2015 in cooperation with the Ivannikov Institute for System Programming, the Department is the driving force behind the System Programming master's programme. The Department is also responsible for research in system integration and integrated development environments.

About Ivannikov Institute for System Programming

Founded in 1994, Ivannikov Institute for System Programming develops world-class technologies in fields such as operating systems, compilers, parallel and distributed computing, software verification and testing, big data, and semantic search.

Centre of Deep Learning and Bayesian Methods

Dmitry Vetrov

Director of the Centre,
Head of Samsung-
HSE Laboratory

Centre of Deep Learning and Bayesian Methods

The core of the Centre is a Bayesian methods research group with foremost expertise in machine learning and probabilistic simulation. The Centre studies combined neuro-Bayesian models, which combine neural networks and Bayesian approach – two most successful paradigms in machine learning.

> *Due to the ever-growing use of deep neural networks and deep learning, the world is undergoing a revolution in big data machine learning. In 2013-2016, researchers around the world were able to apply Bayesian modelling to big data analysis. Furthermore, since 2015, we see a tendency to merge neural-network and Bayesian models for machine learning.*

Samsung-HSE Laboratory

Started in 2018, this joint project is an integral part of the Centre of Deep Learning and Bayesian Methods. The Laboratory conducts research into the development of scalable complex probabilistic models.

Novi Quadrianto

Academic Director
of the Centre

Dr. Novi Quadrianto is an expert in Gaussian processes and their use in the analysis of heterogeneous data. Apart from his work at the Centre, he is an Assistant Professor at the University of Sussex. His area of expertise includes computer vision, AI optimisation, and ethical machine learning.

Evgeny Sokolov

Head of the Laboratory

Laboratory of Financial Data Analysis

A partner project with Sberbank, the Laboratory is focused on applying machine learning methods to financial services. The research agenda includes the interpretation of complex neural network models, reinforcement learning, natural language processing, and competing networks (GAN) in directional information removal from samples.
The idea of a new research unit was a natural continuation of joint projects with Sberbank, a longtime partner of the HSE University.

International Laboratory for Intelligent Systems and Structural Analysis

Sergei Kuznetsov

Head of the Laboratory

The Laboratory conducts fundamental and applied research in large-scale data analysis and intelligent systems. A particular focus is placed on integrating smart data analysis methods and applied logic.

> *The Laboratory deals with interpretable analysis of complex data. For instance, results obtained by a neural network can be fairly precise but of no use without interpretation in many applied domains such as healthcare, finance, and law.*

Andre Scedrov

Professor Andre Scedrov, a widely respected figure in the field of logic and formal methods in computer science, is one of the Laboratory's leading researchers. He also chairs the Mathematics Department at the University of Pennsylvania and is a member of the Steering Committee of the Logical Foundations of Computer Science (LFCS). His areas of interest include logic, data security, and formal methods for verification of information protocols.

International Laboratory of Stochastic Algorithms and High-Dimensional Inference

Alexey Naumov

Head of the Laboratory

Founded in 2018, the laboratory brings together Russian and foreign researchers working at the junction of various mathematical disciplines including modern statistics, probability, etc. The key topics of research are:

- uncertainty quantification in machine learning algorithms
- data analysis based on Monge-Kantorovich spaces geometry
- inference for discretely observed stochastic processes
- manifold learning
- convex and non-convex optimization
- random matrix theory and its statistical applications

The Laboratory holds an annual Structural Inference in High-Dimensional Models conference and Math of Machine Learning winter school.

Eric Moulines

Academic Supervisor of the Laboratory, Professor at Applied Mathematics at the Center of École Polytechnique (Paris). Professor Moulines is the world's leading expert in the fields of machine learning, mathematics, and computational statistics. In 2010, he received a silver medal from the French National Center for Scientific Research. In 2013, he also received an award by the French Academy of Science, becoming a member of the Academy in 2017.

Laboratory of Theoretical Computer Science

Nikolay Vereshchagin

Head of the Laboratory

Theory is an important part of Computer Science, both in terms of research and teaching. Currently, the main research directions are:

- computational complexity, including circuit complexity, communication and information complexity
- algorithmic information theory (Kolmogorov complexity theory) and its connection with classical information theory
- foundations of probability theory (algorithmic definitions of randomness, algorithmic statistics)
- the design and analysis of algorithms
- combinatorial optimisation
- algorithmic aspects of game theory

Vladimir Gurvich

specialises in combinatorial optimisation and algorithmic game theory. Some of the most interesting outcomes of his work include pseudopolynomial algorithms to predict winners in cyclical games, which also offer independent evidence of the existence of winning strategies for this game type.

International Laboratory of Algebraic Topology and Its Applications

Anton Ayzenberg

Head of the Laboratory

The Laboratory investigates the hitherto understudied relationships between algebraic topology and other areas of mathematics.

One of the rapidly developing areas in algebraic topology is toric topology, in which the connections between the algebraic and topological properties of smooth manifolds and various combinatorial structures are studied. Topological characteristics are described using discrete objects (such as graphs, hypergraphs, simplicial complexes, and partially ordered sets) and convex-geometric objects (such as polyhedra and fans).

The mathematical methods that form the basis of topological data analysis are essentially close to toric topology methods. Multidimensional data clouds are first encoded in a combinatorial manner and then translated into the form of some topological space. The obtained topological object is analyzed with the use of homological methods.

Mikiya Masuda

Professor at Osaka City University, Mikiya Masuda is an internationally renowned expert in algebraic topology and its relation to combinatorics, convex geometry, manifold analysis, and algebraic geometry. His particular interest lies in toric and equivariant topology. Apart from his research job, Professor Masuda teaches multiple classes for high-school and university students. He is the editor of Osaka Journal of Mathematics and Journal of the Mathematical Society of Japan.

Yandex Laboratory

Artem Babenko

Head of Yandex Laboratory, Head of Yandex Research

The head of Yandex Laboratory is Artem Babenko, who has been with HSE University since 2017. Research topics of the Laboratory are computer vision, natural language processing, crowdsourcing, information retrieval, and recommender systems.

Yandex Research is one of the Russian leaders in applied machine learning and information retrieval. Nowadays, Yandex Research is a group of young experts successfully conducting research in machine learning based on the latest developments in this area.

Yandex Research collaborates with world's leading research groups in machine learning: Cambridge University, Edinburgh University, Amsterdam University, etc. Among this cooperation, there are also joint PhD programs. Research topics of the Laboratory are computer vision, natural language processing, crowdsourcing, information retrieval, and recommender systems.

Elena Bunina

Chief Executive Officer, Director of HR and Educational Programs, Yandex in Russia

Yandex and HSE University have been partners in many ways for more than ten years. Yandex Department and Laboratory at the Faculty of Computer Science show our commitment to both education and research. I am glad that we can further facilitate the development of computer science and education in collaboration with HSE University.

Laboratory for Methods for Big Data Analysis (LAMBDA)

Andrey Ustyuzhanin

Head of the Laboratory

Founded in 2015, the Laboratory develops data analysis and machine learning methods to address various problems in fundamental sciences. Those may deal with the search for dark matter, matter/anti-matter balance, high energy cosmic rays, and gravitational lensing.

> *We are looking for ways to reclaim technologies developed for the power generation, aerospace, and additive manufacturing technology. Such projects are rare but quite exciting. Moreover, they help to highlight the universality and thoroughness of mathematical, computational, and technological description of our world.*

Joint work with CERN

The laboratory takes part in LHCb and SHiP collaborative projects of the European Organization for Nuclear Research (CERN). Machine learning methods are applied in the following projects:

- development of an algorithm for online analysis of LHCb data (performance enhanced by 1.5)
- fast Monte Carlo event simulation employing neural network models (the speed-up factor is 1000)
- design optimization of complex apparatus (for SHiP detector the save was about 1M CHF)
- monitoring data quality collected by LHCb and CMS detectors (required operations decreased 20 times)

Laboratory of Process-Aware Systems (PAIS Lab)

Irina Lomazova

Head of the Laboratory

The Laboratory was founded in 2013 under the supervision of Professor Wil van der Aalst, one of the leading experts in computer science and the author of highly influential research in business administration and process mining.

Processes are everywhere, and, without information systems supporting these processes, society would come to a grinding halt. Whenever you rent a car, book a flight, buy a book, file a tax declaration, or transfer money, process-aware information systems make this possible.

A Process-Aware Information System (PAIS) is a software system that manages and executes operational processes involving people, applications, and information sources based on process models. Process-aware information systems include Business Process Management (BPM) systems, Workflow Management (WFM) systems, Enterprise Resource Planning (ERP) systems, and case-handling systems.

The PAIS Lab aims to address urgent challenges related to business process management, process mining, and information systems development. The laboratory uses a mixture of formal methods (e.g., Petri nets and other models for concurrency), data-driven analysis (data/process mining), and systems engineering.

Laboratory of Complex Systems Modelling and Control

Alexander Shapoval

Head of the Laboratory

The Laboratory applies modern mathematical, computational, machine learning, and statistical tools to analyse data, construct predictions, detect anomalies, and assess probabilities of extreme events. The Laboratory collaborate with companies to perform analysis of big and small data provided by these organizations in order to help them create effective policies.

Along this way, we combine data-driven, first-principle, and machine-learning approaches. This leads us to hybrid models that account for the first principles and use machine learning to estimate unknown parameters and assess theoretical predictions.

> *We are proud of our theoretical research published in top peer-reviewed journals and applied projects requested by business partners. The laboratory makes it possible for researchers and business representatives to apply modern mathematical models and computational techniques in their activities.*

Laboratory of Bioinformatics

Maria Poptsova

Head of the Laboratory

Bioinformatics has become an integral part of any computer science department. A genome is a collection of programs, the algorithms of which are not completely clear yet. We put our expectations in application of machine learning methods to big data analysis in molecular biology.

The Laboratory primarily focuses on fundamental research of the role of DNA secondary structures in genome functioning, chromatin organization, and DNA-protein interactions. We cooperate closely with the leading institutions in this field.

Mikhail Gelfand

Professor Mikhail Gelfand is a member of the Academia Europaea. The main area of his research is comparative and functional genomics, which includes studies of evolution of bacterial genomes and their regulatory interactions, bacterial genome functional annotation and metabolic reconstruction, evolution of the exon-intron structure and splicing sites of eukaryotic genes, organization of chromatin structure and its relation to epigenomics and gene expression.

Laboratory for Models and Methods of Computational Pragmatics

Dmitry Ignatov

Head of the Laboratory

The Laboratory's area of expertise is analysis of unstructured data. The Laboratory studies recommending systems and services and develops methods for multimodal clustering and classification that allow profiling user's interests based on various modalities.

The Laboratory also works in natural language processing (NLP), in particular, question answering and information extraction. NLP-relevant machine learning methods are an important topic. This includes transfer learning and domain adaptation techniques in multilingual settings, as well as their various applications. The Laboratory is involved in digital Russian studies though creating new annotated data sources that represent society changes and such complex phenomena as education and economy digitalisation.

Russian Science Foundation Grants

Andrey Ustyuzhanin

Applications of probabilistic artificial neural generative models to development of digital twin technology for non-linear stochastic systems

Ivan Arzhantsev

Additive actions on complete algebraic varieties and their generalisations

Alexey Naumov

Analysis of high-dimensional random objects with applications to large-scale data processing

Nikolay Vereshchagin

Complexity problems in theoretical computer science

Alexandr Shapoval

Non-stationarity and fractality of dynamics in the evolution of complex systems: applications to physics of the Earth and the Sun

Anton Osokinv

Neural-network algorithms for one-shot object detection

Roman Avdeev

Combinatorial invariants of spherical homogeneous spaces

Anton Ayzenberg

Torus actions of complexity one and diagonalisation of periodic matrices

Applied Mathematics and Information Science

Evgeny Sokolov

Academic Supervisor of the Programme

This programme aims at training researchers, engineers, and developers who are highly skilled in theoretical and applied computer science. It incorporates the best practices of the leading computer science faculties at such institutions as EPFL, Stanford University, and Yandex School of Data Analysis, which offers one of the best computer science programmes in Russia.

Tracks:

- Data Analysis and Intelligent Systems
- Decision Making and Analysis
- Machine Learning and Its Applications
- Distributed Systems
- Theoretical Computer Science

Software Engineering

Valery Shilov

Academic Supervisor
of the Programme

This programme trains highly qualified software developers and architects, as well as software quality and development process managers. The programme covers all stages of software development, including mathematical, methodological, economic, legal, marketing, and administrative aspects. This programme has received the prestigious IBM Faculty Award and the globally recognized ABET accreditation.

Core disciplines:

- Introduction to Software Engineering
- Programming
- Operating Systems
- Computer System Architecture
- Databases
- Software Design
- Software Quality Assurance and Testing
- Software Systems Architecture Design
- Development and Analysis of Requirements
- Software Project Management
- Group Dynamics and Communication in Software Engineering
- Software Engineering Economics
- Intellectual Property Law

Data Science and Business Analytics

Tamara Voznesenskaya

Academic Supervisor of the Programme

HSE and University of London Double-degree programme

This programme trains data scientists with thorough understanding of applied economics, including the financial sector. The programme gives an ample opportunity to master mathematical skills in the long-standing traditional Russian manner. It also gives sufficient training in contemporary programming and multiple computer science fields, including data analysis, machine learning, project management, and software development. In addition, the students will be able to train their professional skills through working with big data and developing analytical models for the financial sector.

Language of instruction: English

- Bachelor's degree in Applied Mathematics and Computer Science from HSE University
- Bachelor of Science (BSc) in Data Science and Business Analytics from University of London

Master of Data Science: Online Programme

Vladimir Podolskii

Head of School of Big Data and Information Retrieval

Russia's first fully online master's programme taught in English is offered through Coursera, one of the world's most popular online learning platforms. The programme puts emphasis on hands-on, project-based training. Students can enroll in the programme from anywhere in the world and complete the courses on their own schedule. Applications are open in February and September.

Tracks:

- Data Scientist
- Machine Learning Engineer
- Researcher in Data Science

The programme curriculum consists of twenty-one courses divided into four blocks: mathematics, programming, specialisation, and projects. Students start with the mathematics and programming blocks. In order to successfully complete the programme, students must earn 120 ECTS credits. Graduates receive master's degree in Data Science from HSE University.

Industry partner: Yandex

Language of instruction: English

Data Science

Sergei Kuznetsov

Academic Supervisor
of the Programme

This programme offers training in current methods and instruments of data analysis, machine learning, information retrieval systems, social network analysis, and scalable algorithms.

Partners: Yandex School of Data Analysis, Kharkevich Institute for Information Transmission Problems.

Tracks:

- Intelligent Systems and Structural Analysis
  (in cooperation with the International ISSA Lab)
- Theoretical Computer Science
  (in cooperation with the International TCS Lab)
- Internet Data Analysis
  (in cooperation with Yandex School of Data Analysis)
- Complex Systems Modelling
  (in cooperation with the Kharkevich Institute)

Languages of instruction: Russian and English

Double-degree programme: students have an option to spend their second year at the University of Clermont Auvergne (France).

Statistical Learning Theory

Alexey Naumov

Academic Supervisor
of the Programme

Double-degree programme with Skoltech

The programme trains the next generation of scientists to carry out fundamental research and work on challenging problems in statistical learning theory. This field is at the cutting edge of several areas of mathematics and computer science, encompassing mathematical statistics, machine learning, optimisation, information and complexity theory. Students work in groups and actively participate in research projects, studying with globally leading experts in statistics, optimisation, and machine learning.

Core disciplines:

- Stochastic Calculus
- Optimization Methods
- Modern Statistical Methods
- Mathematics for Data Science
- Machine Learning Methods Based on Multidimensional Statistics
- Statistics of Random Processes
- Convex Optimization in Data Science
- Computational Linear Algebra

Language of instruction: English

Financial Technologies and Data Analysis

Alexey Masyutin

Academic Supervisor
of the Programme

The programme is a result of partnership between HSE University and Sberbank, a leader in banking technologies in Russia and Eastern Europe. It focuses on the intersection of mathematical and programming skills and financial industry understanding. Graduates will be able to build and implement predictive models using various types of data (numerical and textual data, graph structures, audio, and images) and, more importantly, they will learn to bring value to business through machine-learning models.

Industry Partner: Sberbank

Core disciplines:

- Deep Learning
- Big Data Processing
- Bayesian Methods for Data Analysis
- Natural Language Processing: Generative Models
- Banking IT-infrastructure
- Risk Management

Data Analysis in Biology and Medicine

Mikhail Gelfand

Academic Supervisor
of the Programme

The program trains researchers capable of developing computational methods to solve various problems in biology and medicine. Modern experimental techniques in life sciences produce large, constantly accumulating amounts of biological data. Analysis of such data requires deep knowledge of computer science and task-specific algorithms, yielding a high demand for professionals in computational biology with strong mathematical and biomedical skills. Programme graduates receive interdisciplinary education necessary for biomedical data analysis.

Core disciplines:

- Modern Methods of Data Analysis
- Data Analysis in Biomedicine
- Algorithms in Bioinformatics
- Applied Statistics
- Molecular Biology
- R Programming

System and Software Engineering

Konstantin Degtyarev

Academic Supervisor of the Programme

The programme trains prospective project managers and development-team leaders, who can systematically manage software development at both engineering and administrative levels within a given budget and limiting factors. This includes, among other factors, the ability to discuss the work process with stakeholders, to propose alternatives, and to make decisions that are a compromise on tech stacks in use, requirements, perceived complexity of systems, cost and time constraints, as well as existing risks. Graduates are qualified to manage software development projects, organise business in the field of software development and IT management, analyse and maintain life-cycle software-product processes, and do research in software engineering and related domains.

Core disciplines:

- Formal Methods in Software Engineering
- Applied System Analysis
- Software Engineering Methodology
- Advanced Databases
- Enterprise Software Systems Development
- Software Business Management
- Software Risk Management
- Effective Management of Virtual Teams
- Psychology of Software Development Team Management
- Data Analysis
- Digital Interactive Product Development
- Software Engineering: Development Management (research seminar)

Language of instruction: English

Double-degree programme: students have an option to spend their second year at Lappeenranta University of Technology LUT (Finland).

System Programming

Alexander Petrenko

Academic Supervisor of the Programme

The programme trains researchers and developers who are able to master and advance cutting-edge technologies in system software development, analytical tools, and mechanisms for hardware/software system construction and transformation. The curriculum consists of a wide range of research-oriented and engineering courses. Students have the opportunity to participate in research projects supported by Russian and international companies.

Partner: Ivannikov Institute for System Programming of the Russian Academy of Sciences (ISP RAS)

Core disciplines:

- Software Verification
- Computer Networks and Telecommunications
- Parallel Programming
- Advanced Database Management Systems
- Applied System Analysis
- Formal Methods in Software Engineering
- Operating System Kernel Construction
- Theoretical Cryptography

Doctoral School of Computer Science

Sergei Obiedkov

Academic Director

The School offers three- and four-year doctoral programmes.
PhD students typically work in the Faculty's research labs and participate in various research projects. They are often involved in teaching and supervision of bachelor's and master's students.

Tracks

- Theoretical Computer Science
- System Programming
- Artificial Intelligence
- Data Analysis

Data Culture

Sergey Roshchin

HSE Vice Rector

The humanities used to be independent from computer science and information technologies, but these areas are becoming intertwined, as texts are now processed with the latest data analysis methods. A lawyer may need to review hundreds of cases, a historian must browse through thousands of documents in different languages, an economist wants to generate an accurate forecast - and big data can help them all.

Olga Podolskaya

Project Head

Since September 2017, HSE University has been implementing its Data Culture project, which aims at making sure that all undergraduate students possess a clear understanding of the latest Data Science technologies and know how to apply them in their field.

Evgeny Sokolov

Leading Project Expert

Data Culture is a generic term referring to a set of skills and behavioural patterns in regards to working with data.

The Faculty of Computer Science is responsible for the project's implementation. We bring together top data science experts from Yandex and other IT companies to develop customised courses in programming and data science for students of many different specialisations all across HSE University.

Online Education

HSE University is one of the global leaders in online education. The university has launched over ninety courses on Coursera alone. The Faculty of Computer Science is actively engaged, providing courses and specialisations through Coursera and Stepik.

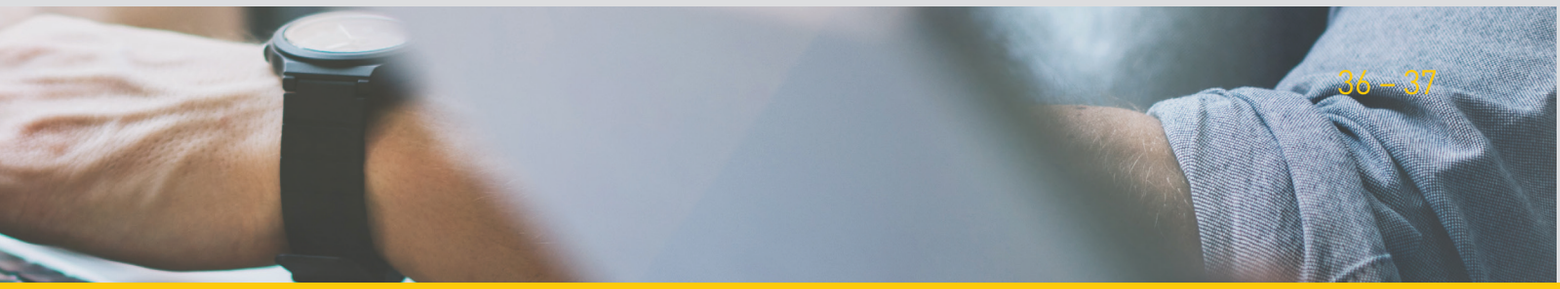
Specialisations on Coursera

Mathematics for Data Science
Part of the Master of Data Science degree

Introduction to Discrete Mathematics for Computer Science
Offered jointly by the University of California San Diego and HSE University
Industry Partner: Yandex

Data Structures and Algorithms
Offered jointly by the University of California San Diego and HSE University
Industry Partners: Computer Science Center, Yandex, JetBrains

Advanced Machine Learning
Industry Partner: Yandex
Outstanding Educator 2019 Coursera Award



Continuing Education Centre

Olga Podolskaya

Director of the Centre

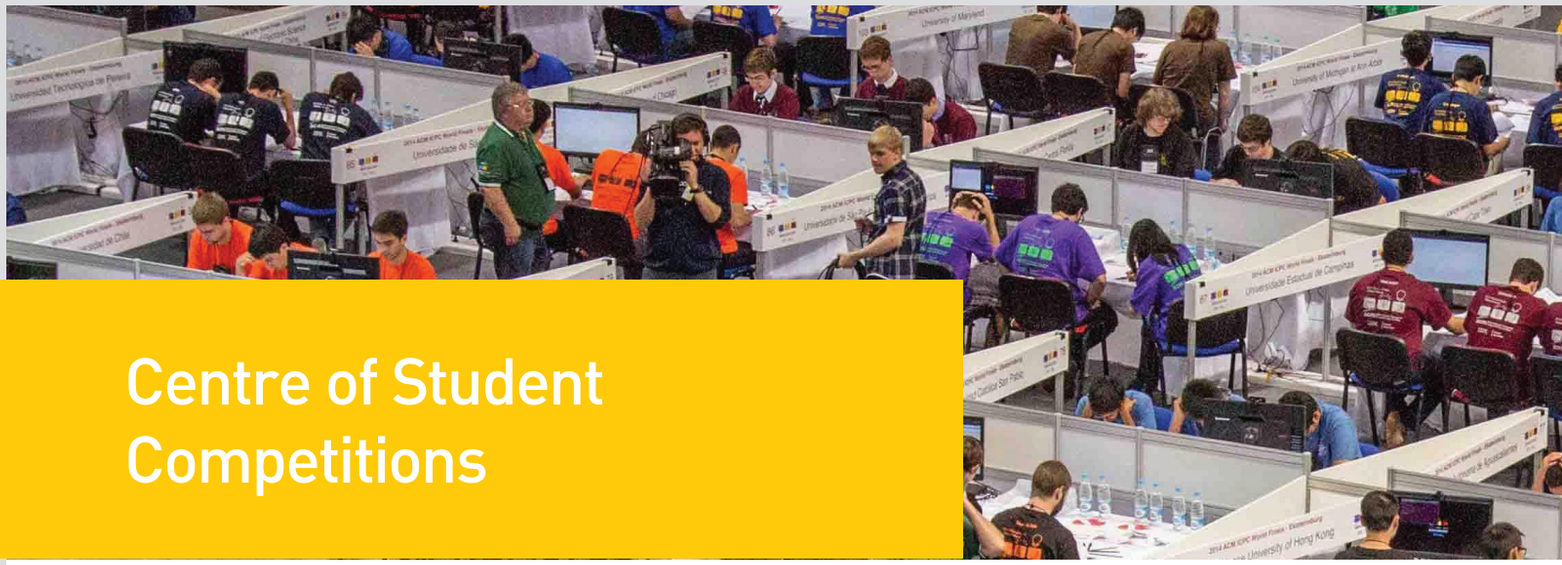
The Continuing Education Centre of the Faculty of Computer Science has been implementing vocational education programmes in mathematics, programming, data analysis and machine learning since 2016. Students of the Centre's programmes are those who want to expand their knowledge in these fields and to gain new professional skills. There is a wide range of courses designed for all levels of training: from programmes that do not require basic knowledge in programming and mathematics to advanced courses on modern methods and problems.

Main activities:

- professional retraining and advanced vocational programmes in Data Science
- development and implementation of corporate programmes by companies' requests
- mentoring and consulting

Evgeny Sokolov

Academic Supervisor of the Centre



Centre of Student Competitions

Mikhail Gustokashin

Director of the Centre

Programming

Competitive programming provides participants with inestimable experience in developing complex algorithms, as well as in fast and accurate coding. The winners of these competitions are highly valued at IT companies, because of the skills required in the most ambitious projects.

2014	2015	2016	2017	2018	2019
ICPC bronze medal	ICPC finals	ICPC semi-finals	ICPC finals	ICPC finals; 2nd place at Yandex. Algorithm Championship	ICPC bronze medal

Andrey Gavrilyuk

Expert of the Centre of Student Competitions

Mathematics

Problem-solving skills are essential for achieving top results in any field. To start an innovative project, get a prestigious job, or obtain breakthrough results one has to know how to find solutions to complex, often ambiguously specified problems. With this in mind, student competitions offer a wonderful start, which can open up many amazing opportunities.

2015	2016	2017	2018	2019
IMC gold and bronze medals	IMC: two gold medals and a bronze medal	IMC silver and bronze medals	Prize medal at Vojtech Jarnik Olympiad	IMC gold, silver, and bronze medals

Partners

Geunbae Lee

Head of AI Center,
Samsung Research

Samsung

Samsung Electronics is a global tech leader, which actively uses deep learning models in its R&D activities. Nevertheless, so as not to fall behind its competitors, it's simply not enough to use standard solutions. New technologies are needed. This is even more important given that the field of deep learning is still developing, and, with every year, new models appear while older ones quickly get phased out. All of this means that humanity still has not found the best possible solution for processing large amounts of data. Therefore, building partnerships with top academic centres in the field of machine learning and AI at universities around the world helps Samsung keep its fingers on the pulse of these developments and follow the latest advancements, as well as obtain exclusive access to new technologies developed by its partners.

HSE University's cooperation with Samsung led to the creation of Samsung-HSE Laboratory in 2018. Part of the Centre of Deep Learning and Bayesian Methods, the Laboratory is engaged in research of deep neural networks, probability, and optimisation.

Andrey Chertok

Managing Director
for Research and
Development, Head
of the Academy of Data
Technologies, Sberbank
Corporate University

Sberbank

Sberbank is Russia's top bank in terms of capitalization, as well as one of the top-20 banks in the world. One of the reasons for Sberbank's success is its serious approach to digital transformation. This means a significant increase in the number of models and algorithms, which have replaced routine operations and automated decision making in many areas. Therefore, we have a keen interest in computer science, machine learning, and AI.

Sberbank is cooperating with many industrial and academic experts in these areas. In my view, the HSE Faculty of Computer Science plays a very important role here. Based on the results of our cooperation so far, I can say that the faculty is a leader in this field and is capable of effectively meeting all challenges posed by the industry. With this in mind, we are definitely eager to develop our partnership well into the future.

Sberbank's productive partnership with HSE University resulted in the Laboratory of Financial Data Analysis. The Laboratory conducts research on such topics as complex models interpretation, natural language processing, and reinforcement learning. Another Sberbank-HSE joint project is Financial Technologies and Data Analysis master's programme. It aims at teaching students to analyse different data, develop models for machine learning and predictable analytics, and create business value through mathematical modelling.

Julia Sanina

HR Director,
SAS Russia/CIS

SAS

SAS was founded in 1976 and is currently the world's biggest private IT company specializing in business analytics solutions and services. The company has been working with talented students for over four decades as one of its most important initiatives.

The founding of the SAS Department at the Faculty of Computer Science in 2018 is only a natural continuation of the collaborative relationship that SAS and the Faculty have enjoyed since 2014.

The department aims at improving the quality of training in data analysis. Students of the department learn the ins and outs of deep analytics techniques and business problem solving in areas such as Risk Analysis and Forecasting, Client Analytics, Data Storage and Data Management.

Since 2018, the department has offered the course Data Analysis in Business. The goal of the course is to teach students current approaches, tools, and methods of data mining that are used in applications. The inter-faculty course Data Analysis on SAS Platform is presents the basics of SAS technologies for programming and data analysis. Students of other departments and specialties are invited to join the course.

JetBrains

Vera Oleinikova

Coordinator of JetBrains
Educational Projects

JetBrains is a world leader in creating instruments for software development, as well as the initiator of a large number of educational programmes. In three years of the company's partnership with the HSE Faculty of Computer Science, many joint projects have been implemented, including lectures held by JetBrains developers on Kotlin, Scala, and Python, IDE development technologies , instruments for .Net and Visual Studio , and team project systems (TeamCity). Since 2017, thanks to JetBrains' support, the Faculty has been offering a course in Kotlin, which gives students the opportunity to study a first-class language for Android development. Likewise, the Faculty professors often give lectures at JetBrains. For instance, Professor Dmitry Vetrov held a mini-course on developing machine learning-based predictive models. Furthermore, the faculty's students and alumni have a chance to take part in summer internships on JetBrains product teams and projects, joining the company's Moscow office. JetBrains' partnership with the faculty is extremely important, as it enhances the general educational environment, which, in turn, will have a very positive impact on the IT sector.

Partnerships in Basic and Applied Research

Irina Plisetskaya

Deputy Dean
for Development,
Finance and Administration

During six years of the faculty's existence, the joint departments of Yandex and SAS, as well as the Samsung laboratory, have been launched. Yandex supports Yandex Lab and LAMBDA. In cooperation with Sberbank, the Faculty operates the Financial Data Analysis Lab and a joint Financial Technologies and Data Analysis master's program. In 2019, the Board of Trustees was established.

> *For companies, partnerships with the Faculty offer opportunities for attracting well-known researchers and the most talented IT students, in order to develop new ideas and effective solutions for their key projects and activities.*

Key forms of partnership:

- Joint laboratories and departments
- Research projects
- Consulting services
- Student projects and internships
- Joint master's programmes

Completed research projects for private companies:

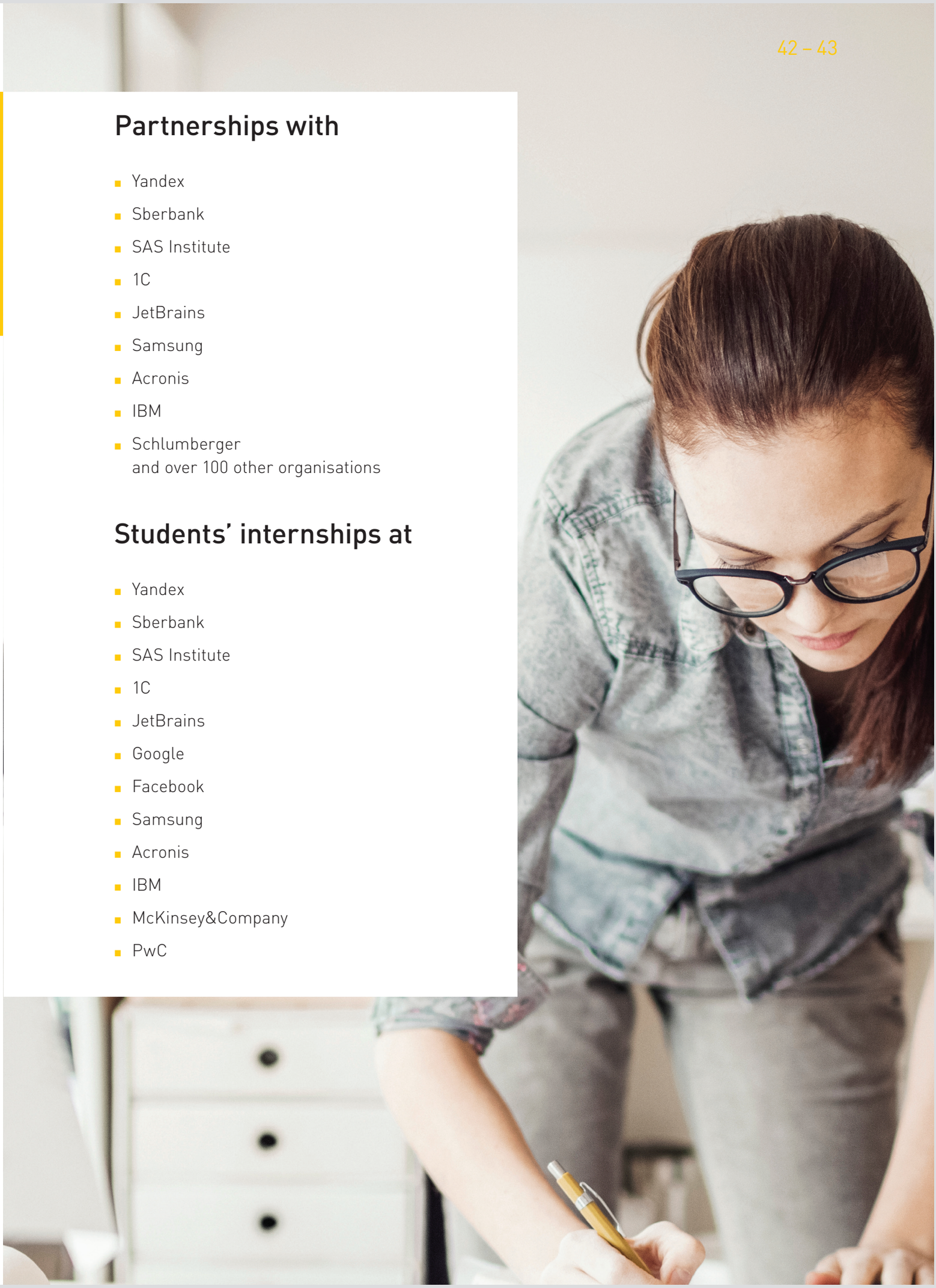
- Development of data analysis algorithms to predict flow dynamics in oil and gas wells
- Incremental learning for deep neural networks (Development of AI learning technologies)
- Development and application of the latest reinforcement machine learning methods in banking (business)
- Research and development of reinforcement learning and deep learning methods for text analysis and image generation

Partnerships with

- Yandex
- Sberbank
- SAS Institute
- 1C
- JetBrains
- Samsung
- Acronis
- IBM
- Schlumberger
  and over 100 other organisations

Students' internships at

- Yandex
- Sberbank
- SAS Institute
- 1C
- JetBrains
- Google
- Facebook
- Samsung
- Acronis
- IBM
- McKinsey&Company
- PwC



International Summer School on Deep Learning and Bayesian Methods

In partnership with Samsung AI Center

School participants learn state-of-the-art methods and techniques required for up-to-date research in machine learning. They also have hands-on experience using probabilistic modelling to build neural generative and discriminative models, learn modern stochastic optimization methods and regularization techniques for neural networks, and master the ways to reason about the uncertainty about the weight of the neural networks and their predictions.

Moscow 2017, 2018, 2019

International Summer School on Machine Learning in High Energy Physics

In partnership with Yandex School of Data Analysis and EPFL

The School covers the relatively young area of data analysis and computational research that is emerging in High Energy Physics (HEP). School participants receive theoretical and practical introduction to this field. A wide range of topics ranging from decision trees to deep learning and hyperparameter optimisation is covered with concrete examples and hands-on tutorials.

St. Petersburg 2015 Lund 2016 Reading 2017 Oxford 2018 Hamburg 2019

International Winter School on Math of Machine Learning

In partnership with Sirius University of Science and Technology

The School covers modern trends in machine learning with a strong emphasis on mathematics behind them. This intense four-day workshop consists of three interdisciplinary mini-courses by world-class scientists, poster sessions by participants and master classes by industrial partners. Key topics of the School are reinforcement learning, deep learning, computation optimal transport, MCMC, and statistical inference.

The first School took place in February 2020 in Sochi, Russia.

Summer School on Machine Learning in Bioinformatics

In recent years, the importance of big data analysis in biology has become evident. Computational biology is a new and quickly developing field of data science. The demand for tailored knowledge of bioinformatics in medicine, research, and industry is on the rise. Summer School on Machine Learning in Bioinformatics is fit to provide multidisciplinary knowledge in this area. The School will cover such topics as applied bioinformatics, bioinformatics of DNA, RNA and proteins, elementary genomics, modern methods of data analysis, and molecular biology.

The first School takes place in 2020 in Moscow.

International Data Analysis Olympiad (IDAO)

The Olympiad is organised by the HSE Faculty of Computer Science and Yandex. It introduces young developers and analysts to current issues in Data Science.

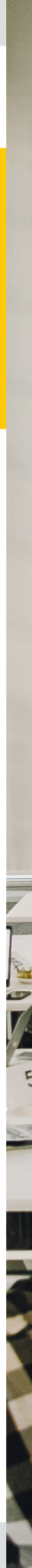
The Olympiad aims to bridge the gap between the all-increasing complexity of machine learning models and performance bottlenecks of the industry. The participants have not only to maximize the quality of their predictions, but also to devise resource-efficient algorithms. This is a team machine learning competition divided in two stages. The first online stage is open to all participants. The second offline stage is the on-site finals, in which the top thirty performing teams from the online round will compete at the Yandex office in Moscow.

The Olympiad is held for the third time in 2020 in Moscow.

Key numbers of IDAO 2020:

- 1,287 teams registered for the Online Round
- 83 countries
- 34 teams in the Final Round

	2018	2019	2020
Online round participants	1,533	2,187	2,756.
Final round teams	41	31	34
Participating countries	55	78	83




IDA
INTERNATIONAL
DATA ANALYSIS OLYMPIAD
IDA
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Foreign Partners

The Faculty of Computer Science aims to develop cooperation with leading foreign educational and research institutions as well as IT companies. We are eager to identify opportunities for our students to learn about the latest achievements in information technology and applied mathematics, to acquire skills for working in a global environment, and to rely on the experience of leading international universities.

The Faculty is involved in various joint activities with the following international academic partners:

- École polytechnique (Paris)
- European Organization for Nuclear Research (CERN)
- University of Helsinki
- Eindhoven University of Technology
- University of Groningen
- University of Twente
- Ghent University
- University of London
- TU Dresden
- Sapienza University of Rome
- University of Padova
- Charles III University of Madrid
- University of California, San Diego
- Stellenbosch University
- Chinese University of Hong Kong

Student Mobility

Mobility programmes enable students to spend one or two semesters abroad and earn credits at a foreign university. The Faculty constantly seeks to extend its exchange network and sign new agreements with foreign universities focused on Computer Science.

Diego Granziol

PhD student at Oxford University, had a research internship at the Faculty of Computer Science

During the course of my stay I worked at Bayesian Methods Research Group headed by Prof. Dmitry Vetrov. I cannot stress enough how lucky and privileged I was to be given the opportunity to come to Russia and work with the Bayes group. The atmosphere was warm and welcoming.

As a result of the internships I have submitted a piece of work to NeurIPS and to the ICML Theoretical Physics in Deep Learning workshop, where it was accepted and presented. It was focused on understanding generalization from the perspective of the deviations of the true risk surface to the empirical risk surface.

Nikita Moshkov

PhD student at the HSE Faculty of Computer Science, had an internship at Broad Institute of MIT and Harvard

It was an inspiring experience. I was in the Imaging Platform group, which is led by Anne Carpenter. This group is famous for developing a tool CellProfiler, which is widely known among biologists working with images. Besides that, this group has many papers in high impact journals. My project was in applied machine learning – I had to train a model for cell segmentation and do preliminary data analysis of the image datasets we had. I hope that this work will result in a good publication someday.

International Rankings

QS WORLD UNIVERSITY RANKINGS®

	2017	2018	2019	2020
QS Overall	411-420	382	343	322
QS Top 50 Under 50	51-60	48	38	38
QS Mathematics	151-200	101-150	101-150	101-150
QS Computer Science and Information Systems	351-400	251-300	201-250	151-200

BEST GLOBAL UNIVERSITIES U.S.News & WORLD REPORT 2020

	2017	2018	2019	2020
US News Best Global Universities for Mathematics	181	144	107	105

THE WORLD UNIVERSITY RANKINGS

	2017	2018	2019	2020
THE Overall	401-500	351-400	301-350	251-300
THE Computer Science	–	–	301-400	301-400

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

	2017	2018	2019
ARWU Overall	101-150	76-100	76-100

cs.hse.ru

2020