www.faculty.it.pk.edu.pl

Cracow University of Technology
Faculty of Computer Science
and Telecommunications

Scientiae Radices

Interdisciplinary scientific journal

full open access

SciRad

Scientiae Radices does not charge any fee

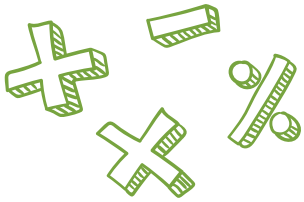
www.sci-rad.com

sci-rad@sci-rad.com

About the Faculty

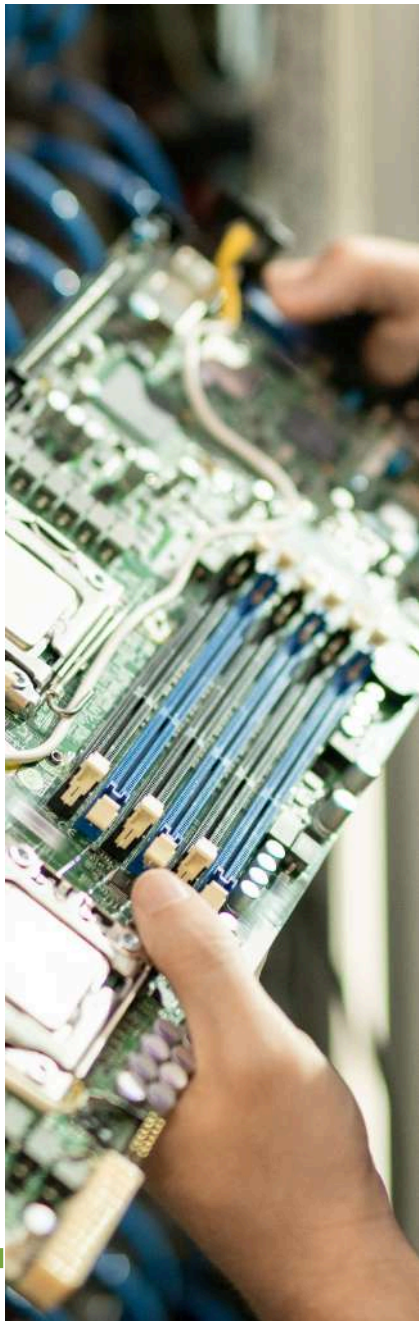
The Faculty of Computer Science and Telecommunications, part of the Tadeusz Kościuszko Cracow University of Technology, was established in January 1999. Initially known as the Faculty of Technical Physics and Computer Modelling, it has evolved significantly over the years. Our research and development efforts are focused on two key disciplines: Information and Communication Technology (Computer Science) Mathematics We offer a range of academic programs for both undergraduate and postgraduate students, including full-time, part-time, and doctoral studies in the following fields: Computer Science Mathematics Applied Mathematics As part of a university with 80 years of tradition, we are committed to providing high-quality education to over 14,000 students, ensuring they are well-prepared for the labor market. Our faculty participates in numerous international collaborations and student exchange programs through bilateral agreements and the Erasmus+ program, partnering with universities in 54 countries worldwide.

JOIN US!



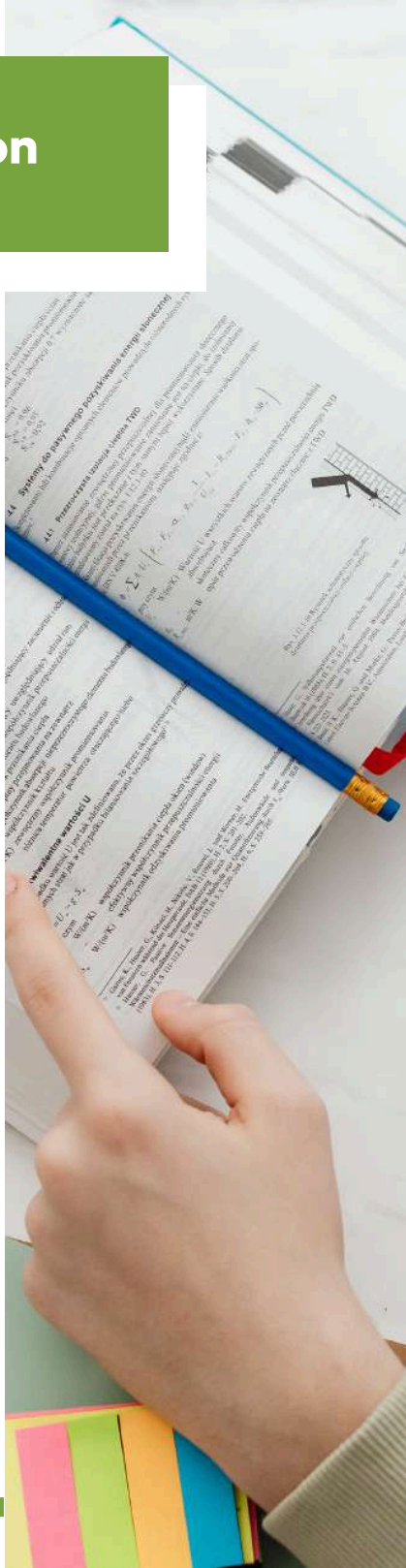
Scientific cooperation

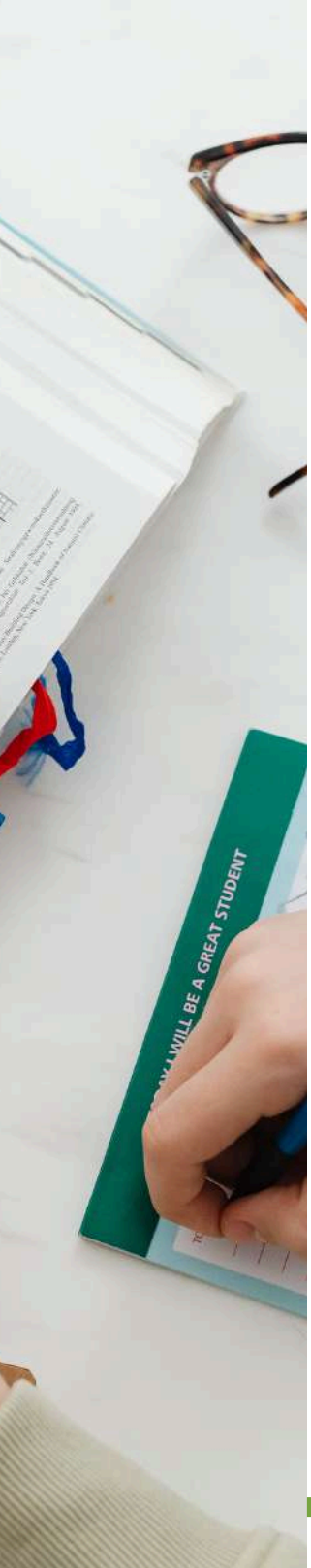
- Research grant applications
- Joint publications
- Scientific seminars
- Research visits
- Scientific conferences
- Doctoral supervision in computer science
- Development of research tools and software
- Advisory and consulting services
- Internships and fellowships
- Access to research facilities



Cooperation in education

- Conducting classes by visiting professors or professionals from companies
- Internships for students of all majors (Computer Science, Mathematics, Applied Mathematics)
- Guest lectures
- Completion of diploma theses in cooperation with other universities, scientific units or companies
- Implementation of projects in project classes
- Cooperation in the development of study programs
- International student exchange (Erasmus+ and other programmes)





- Cooperation with student research clubs
- Implementation of diploma theses in given topics
- Organization of competitions, hackathons and other events
- Providing technology solutions to the students
- Organizing training courses, workshops and summer schools
- Joint studies
- Student visits to workplaces and universities
- Events promoting company profiles
- Taking patronage of laboratories
- Upgrading of classrooms by business

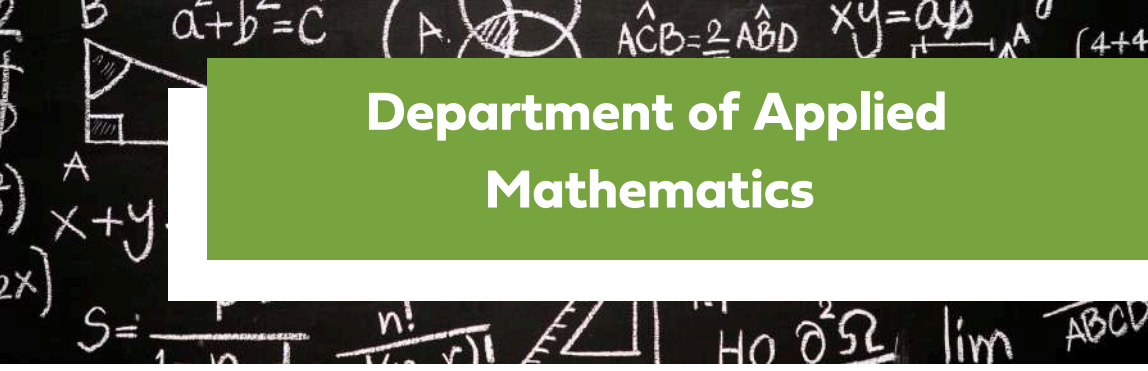
...and many, many more....

Department of Computer Science

Department of Computer Science

The Department of Computer Science at our Faculty engages in broad-ranging research activities within the field of computer science and computational science. The focus areas include:

- Artificial Intelligence: Development of methods such as evolutionary algorithms, artificial immune systems, artificial neural networks, agent systems, and fuzzy inference systems for data analysis, optimization, and technical modeling.
- Computational Methods: Innovations in high-performance computing, parallel and distributed programming algorithms, and cloud and edge computing systems, emphasizing computational efficiency and security.
- Computer Modeling: Advanced research in digital landscape modeling, virtual and augmented reality, and finite element methods (FEM) for on-site data analysis.
- Collaborations: Partnerships with renowned institutions like Jyvaskyla Polytechnic (Finland), University of Texas at Austin, and University of Alberta, among others.
- Our research aims to develop cutting-edge computational methods applicable in various fields, including bioinformatics, economic informatics, and technical modeling.



Department of Applied Mathematics

Department of Applied Mathematics

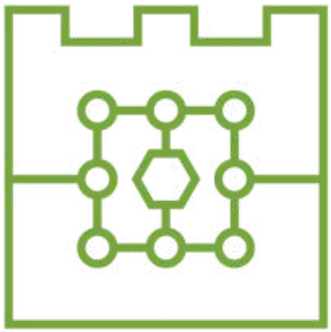
The Department of Applied Mathematics excels in research and educational projects within the mathematics discipline. The key research areas include:

- Mathematical Disciplines: Research in algebra, functional analysis, differential equations, differential geometry, and real and complex algebraic geometry.
- Advanced Topics: Exploration of o-minimal structures, topology, multiplicity theory, number theory, statistics, fluid mechanics, complex analysis, approximation theory, and graph theory.
- Educational Projects: Active involvement in numerous educational projects to enhance mathematical knowledge and its applications.
- Collaborations: Cooperation with international research institutions and participation in interdisciplinary research projects. Our department is committed to advancing mathematical research and contributing to various scientific and practical applications.

$$X\frac{1}{2} = \frac{-b \pm \sqrt{b^2 - 9ac}}{2a}$$

Research groups in our faculty

- **Complex Systems Modeling Group**
- **Embedded Machine Learning**
- **Machine Learning and Optimization**
- **Computational Intelligence and Cybersecurity**
- **BioMed AI Research Group**
- **Computer Graphics and High Performance Computing**
- **SiMoDatAn: Simulation, Modelling and Data Analytics**
- **Materialica+**

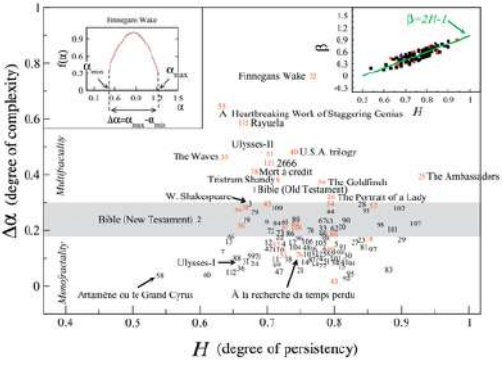


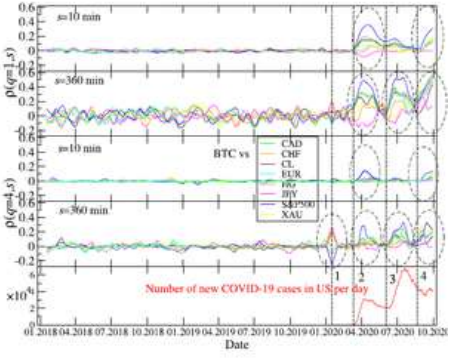
Complex Systems Modeling Group

The interdisciplinary activity of the Complex Systems Modeling Group focuses on understanding the dynamics of complex systems using modern methods from computer science and statistical physics. Our main research goal is to comprehend these dynamics and apply the findings to practical solutions, particularly in emerging phenomena and technologies. The results of our research are applicable in various industries.

Research Scope/Specialization:

- Blockchain technology applications
- Complex networks characteristics
- Climate change modeling
- Sentiment patterns in texts
- Financial markets characteristics Finite element method applications in solid mechanics, fluid dynamics, and electromagnetics
- Modeling building structures under extreme loads (explosion, seismic, progressive ruin)
- Quantitative linguistics





Contact: Marcin Wątorek, PhD
Head of Research Group
E-mail: marcin.watorek@pk.edu.pl

Embedded Machine Learning

Our group aims to bridge specialists from machine learning and embedded systems. While deep learning models excel in solving complex problems, they require extensive training data and resources. Our goal is to develop machine learning methods suitable for embedded devices with limited computational power and memory. This involves techniques such as compressing model parameters, pruning insignificant weights, and using fewer bits for parameter encoding, potentially down to single-bit encoding in binary neural networks. Additionally, we focus on few-shot learning methods for scenarios with limited training data. These algorithms have practical applications in fields like the Internet of Things and particle physics experiments.

Research Scope/Specialization:

- Machine learning model compression
- Neural network pruning and quantization
- Binary neural networks
- Few-shot learning
- Applications in IoT, robotics, military, particle physics

Contact:
Maciej Jaworski, PhD, DSc, Assoc. Prof. of CUT
Head of Research Group
E-mail: maciej.jaworski@pk.edu.pl

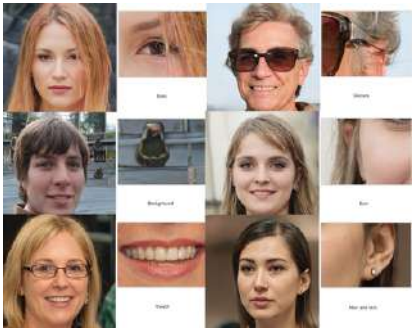
Machine Learning and Optimization

Scientific research of our group focuses on the development of modern algorithms of artificial intelligence. We are particularly interested in methods of machine learning and optimization using nature-inspired metaheuristics.

Research Scope/Specialization:

- Deep learning and neural networks
- Face recognition with local patterns
- Ensemble classification
- Evolutionary and memetic computation
- Multiobjective optimization
- Game theory in machine learning and optimization
- Fuzzy methods for time series analysis
- Data intensive computing

Research Project:
INFOSTRATEG-I/0025/2021,
Detection of Manipulated Audio-Video Content to Protect Against the Spread of Deepfake News.



Contact:
Michał Bereta, PhD, DSc, Assoc. Prof. of CUT
Head of Research Group
E-mail: michal.bereta@pk.edu.pl

Computational Intelligence and Cybersecurity

Our research concentrates mainly on developing intelligent algorithms for solving different kinds of problems in high-performance environments. We are developing novel methods based on Artificial Neural Networks, Genetic and Evolutionary Algorithms, Multi-Agent Systems, Game Theory, and Blockchain Algorithms. The main applications of our methods include task scheduling problems in computational clouds, advanced monitoring systems for grids and clouds, security threat detection and defense, data modeling and recognition, and building novel cryptography schemas.

Research Scope/Specialization:

- Artificial Neural Networks
- Blockchain Algorithms
- Cryptography
- Big Data Security
- Cloud Computing
- Security Genetic and Evolutionary Algorithms
- Multi-Agent Systems Game Theory

Contact:
Agnieszka Jakóbik, PhD
Head of Research Group
E-mail: agnieszka.jakobik@pk.edu.pl

BioMed AI Research Group

Our research focuses on advanced machine learning methods, including computational intelligence, deep learning, and evolutionary computing. We specialize in pattern recognition, signal analysis, data mining, and optimization. Key projects involve diagnosing cardiac arrhythmias, ischemic heart disease, and cancers; gesture recognition using specialized gloves; and hyperspectral classification of blood-like substances. Our work also includes assessing bank loan applicant credibility and classifying materials using electronic nose signals.

Research Scope/Specialization:

- Machine Learning, Computational Intelligence, Ensemble Learning, Deep Learning,
- Evolutionary Computing
- Pattern Recognition, Signal Processing, Data Mining
- Optimization, Sensor Technology, Biocybernetics, Medicine
- Quantum Computing, Computer Networks, Data Transmission Security
- Quality Assurance in Computer Networks, System and Application Security

Contact:
Paweł Pławiak, PhD, DSc, Assoc. Prof. of CUT
Head of Research Group
E-mail: pawel.plawiak@pk.edu.pl

Computer Graphics and High Performance Computing

Our research primarily focuses on the applications of computer graphics and high-performance parallel computing. We specialize in processing spatial data, such as point clouds and digital models of terrain, buildings, and other objects in multidimensional space. This type of big data requires significant computing power and optimization algorithms, which is another key area of our research. Additionally, we explore the integration of real-world footage with computer-generated objects using computer vision techniques, including camera tracking, relighting, and augmented and mixed reality.

Research Scope/Specialization:

- Computer Graphics, High-Performance Computing, Spatial Data Processing
- Point Cloud Computing, Optimization Algorithms
- Computer Vision, Augmented and Mixed Reality, Video Image Processing
- Artificial Intelligence, Computational Geometry, Data Visualization

Contact:
Paweł Ozimek, PhD, DSc, Assoc. Prof. of CUT
Head of Research Group
E-mail: pawel.ozimek@pk.edu.pl

SiMoDatAn: Simulation, Modelling and Data Analytics

SiMoDatAn focuses on intelligent methods and models in data-intensive computing. Our work is based on Shannon's definition of a model, creating conceptual frameworks that describe systems and support decision-making in complex situations. We utilize simulations to study models when direct manipulation is impractical. The group addresses the fragmented nature of data research, promoting cross-disciplinary collaboration to manage and extract value from Big Data.

Research Scope/Specialization:

- Machine Learning and AI in data-intensive computing
- Cybersecurity: anomaly and attack detection, cryptographic methods
- Blockchain
- Energy awareness in Big Data systems
- Data pre-processing and analytics
- Sentiment analysis
- Applications in finance, e-health, smart city, transportation
- Models for Data Intensive (DI) infrastructures
- Parallel programming models for DI
- Algorithms for Big Data and DI computing
- Network architectures for DI analytics
- Big Data storage and management in cloud and fog systems

Contact:
Joanna Kolodziej, PhD, DSc, Assoc. Prof. of CUT
Head of Research Group
E-mail: joanna.kolodziej@pk.edu.pl

Materialica+

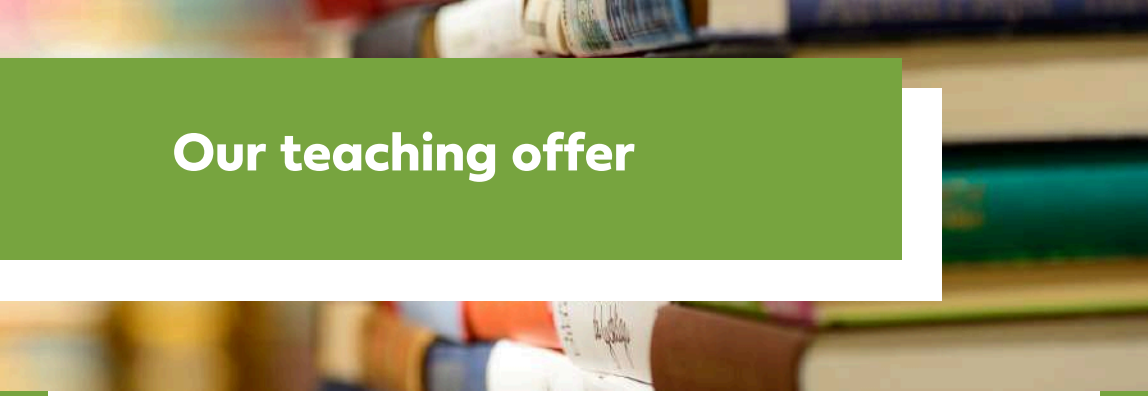
Materialica+ is an international scientific group focusing on boundary value problems and their applications in the elasticity of composites, porous media, and biological structures. We employ symbolic-numerical computations to develop new formulas essential for engineers and researchers. Our research includes the study of dispersed composites randomly embedded in matrices, with a special focus on critical regimes related to optimal packing of inclusions and extremal physical constants. We investigate regular and random structures using the representative volume element (RVE) approach and e-sums, systematically documented in our publications. Additionally, we have developed an effective algorithm for computing structural sums as discrete multiple convolutions, leveraging image analysis and machine learning methods for heterogeneous structures.

Research Scope/Specialization:

- Boundary value problems in elasticity of composites
- Symbolic-numerical computations
- Dispersed composites and optimal packing of inclusions
- Extremal physical constants (rigid and soft inclusions)
- Representative volume element (RVE) approach
- Structural sums and multiple convolutions
- Image analysis and machine learning for heterogeneous structures

Contact:
Prof. Wladimir Mitiuszew
Head of Research Group E-mail:
wladimir.mitiuszew@pk.edu.pl

MATERIALICA+
Research Group
Computational Design
& Structural Analysis



Our teaching offer

PhD studies (doctoral school):

- Computer Science

Master studies (in Polish):

Computer Science (full and part-time)
- Cybersecurity
- Data Science
- Intelligent Systems and Augmented Reality

Applied Mathematics (full-time):
- Data Analytics -
- Mathematics in Finance and Economics

Mathematics (full-time):
- Mathematics in Finance and Economics
- Mathematical Modelling

Bachelor studies (in Polish):

Computer Science (full and part-time)

Applied Mathematics (full-time)
- Data Analytics
- Mathematics in Finance and Economics
- Mathematics with Computer Science

Mathematics (full-time)
- Mathematics in Finance

Erasmus+ courses

Please visit:

www.erasmus.pk.edu.pl/incoming-students/

Faculty of Computer Science and Telecommunications
Cracow University of Technology
Warszawska 24 street
31-155 Kraków, Poland

e-mail: it@pk.edu.pl