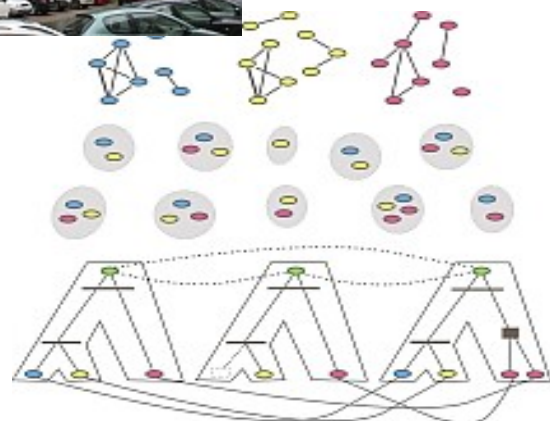
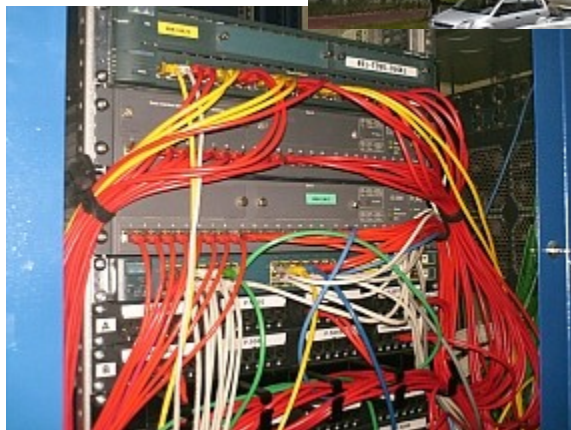


# THE FACULTY OF MATHEMATICS, INFORMATICS & MECHANICS (University of Warsaw)





## RESEARCH OVERVIEW

**The Faculty of Mathematics, Informatics and Mechanics (MIM)**, with 171 faculty members and researchers, is engaged in a wide spectrum of research areas, ranging from basic research in pure mathematics and theoretical computer science, to applied research in applied mathematics and applied areas of informatics. The Faculty consists of three Institutes: Mathematics (90 faculty members), Informatics (52 faculty members), and Applied Mathematics and Mechanics (with 29 faculty members).

Traditionally the Faculty has its strengths in selected areas of Mathematics and Informatics. In addition it expands the scope of research by focusing on some truly multidisciplinary areas such as Financial Mathematics or Computational Biology. An independent Section of Economic, Financial and Insurance Mathematics consists of faculty members from both Institutes: Mathematics and Applied Mathematics and Mechanics.

Almost 80 PhD students are involved in various research areas under supervision of the faculty members and researchers of MIM.

As a sign of recognition of research strength of MIM, it was invited to join in 2007 the European Research Consortium for Informatics and Mathematics (ERCIM) as a full member.

### *Basic Areas of Research:*

1. Algebra and Number Theory
2. Algebraic Geometry
3. Algebraic Topology
4. Algorithms and Data Structures
5. Concurrency and Communication
6. Dynamical Systems. Theory of Vector Fields and their Singularities
7. Geometry
8. Logic in Computer Science
9. Mathematical Analysis and Differential Equations
10. Mathematical Logic
11. Probability
12. Semantics and Formal Specifications
13. Topology and Set Theory

### *Applied Areas of Research:*

1. Artificial Intelligence
2. Biomathematics and Game Theory
3. Computational Biology and Bioinformatics
4. Databases
5. Financial Mathematics
6. Multiagent Systems
7. Numerical Analysis
8. Software Engineering
9. Statistics and Applied Probability
10. Theory and Applications of PDE's and Functional Analysis



## TEACHING OVERVIEW

There are close to 1500 undergraduate students at the Faculty, following a wide variety of courses (some 250 each year) that are offered at the undergraduate (i.e., first cycle, 3 years), advanced undergraduate (i.e., second cycle, 2 years) and graduate (PhD) level, and cover numerous topics in computer science - both theoretically and practically oriented - and in pure, applied and financial mathematics. Besides that, the Faculty offers basic courses in mathematics and informatics for around 2000 undergraduates studying at the Faculties of Economy, Management, Chemistry, Physics, Biology, Geography, Geology and Pedagogical Sciences.

Quality of education matters a lot for us. We are proud of our best students and their international achievements in the TopCoder tournament, ACM International Collegiate Programming Contests, Imagine Cup finals, International Mathematics Competitions for University Students (IMC) etc. Each year, more than 20% of first year undergraduates at the Faculty are former finalists and laureates of Polish olympiads in mathematics or informatics. Others can follow their studies in the company of the best and brightest; this is a stimulating and rewarding experience.

Our courses and diploma programs are designed to satisfy the needs and interests of students who have different aims, plans and aspirations but common passion for mathematics or computer science.

We offer diploma programs leading to the following degrees:

B.Sc. (first cycle degree) in Informatics

B.Sc. (first cycle degree) in Mathematics

B.Sc. (first cycle degree) in Mathematics for the joint diploma program in Economy and Mathematics, together with the Faculty of Economy.

B.Sc. (first cycle degree) in Bioinformatics

M.Sc. (second cycle degree) in Informatics

M.Sc. (second cycle degree) in Mathematics:

1. speciality: mathematical methods in finance
2. speciality: mathematical methods in insurances
3. speciality: applied mathematics
4. speciality: teaching of mathematics
5. general diploma, no formal specialization required

For our best students we have a special joint diploma program in informatics and mathematics. It requires a lot of effort and hard work but the students can obtain two B.Sc. and two M.Sc. diplomas during 6 years.

Starting from the last year of first cycle studies, students have a far reaching freedom of choice and can construct their own individual program of study – satisfying the requirements of one of the diploma programs – in a vast number of ways, combining pure science with applications oriented topics in a proportion that suits their needs best and prepares them for a future career.



## INSTITUTE OF APPLIED MATHEMATICS AND MECHANICS

Scientific interests of the faculty of the Institute are concentrated on mathematical methods and models in physics, biology, medicine, and socio-economic sciences, theory and numerical methods for partial and stochastic differential equations, computational complexity, approximation theory, computer graphics, financial mathematics, game theory and statistics. The Institute employs 29 researchers who currently supervise 4 PhD students.

### Current grants:

#### Research grants

##### I. Founded by Polish Government

1. *Analysis of hydrodynamics equations and chemotaxis equations*, Dariusz Wrzosek (2006-2009)
2. *Analysis of physical and biological problems in the framework of mathematical entropies*, Piotr Gwiazda (2007-2010)
3. *Convergence rate of MCMC estimators and convergence of adaptive methods*, Wojciech Niemiro (2008-2010)
4. *Efficient approximation of functions*, Przemysław Wojtaszczyk (2008-2011)
5. *Mathematical models of evolutionary game theory and genetic networks*, Jacek Miękiński (2006-2009)
6. *Parabolic problems of surface evolution in the theory of phase transitions*, Piotr Rybka (2008-2011)
7. *Parallel algorithms for solving partial differential equations*, Maksymilian Dryja (2007-2010)

##### II. International

1. *Influence of delays on the models of angiogenesis process and immunotherapy of cancer*, Urszula Foryś (2008-2010)

### Basic Areas of Research:

#### 1. *Biomathematics and Game Theory*

Mathematical description of various biological processes and the analysis of mathematical models (ODEs, PDEs, delay equations, integro-differential equations, Markov processes) arising in mathematical biology. Mathematical description of tumour growth and its therapy. Stochastic models of genetic regulatory networks. Mathematical analysis and computer simulations of static and dynamic models of game theory. Differential and stochastic stability of Nash equilibria in models describing economic, social and biological processes. Equilibria in games with continuum number of players.



Group members and their respective research interests include:

Marek Bodnar	Delay differential equations and large systems of interacting particles in biology
Urszula Foryś	ODE and PDE with time delay that describe the immune systems
Mirosław Lachowicz	Integro–differential equation in biology, nonlocal equations, links between microscopic and macroscopic scales of description: from stochastic semigroups to PDEs, topological chaos and applications in biology
Jacek Miękiś	Evolutionary game theory, population dynamics, statistical mechanics of quasicrystals. Stochastic models of genetic regulatory networks
Monika J. Piotrowska	Equations describing development of tumours
Tadeusz Płatkowski	Evolutionary game theory, multiagent systems, population dynamics; cellular automata models, discrete velocity models in kinetic theory
Agnieszka Wiszniewska–Matyszkiewicz	Games with a continuum number of players in ecosystems and simplified economies; existence and properties of Nash equilibria in such games; mathematical economy

## ***2. Numerical Analysis and Approximation Theory Group***

Computational complexity and algorithms for continuous problems. Numerical methods for PDEs: analysis of error bounds, designing and analysis of methods for solving discrete problems, in particular parallel algorithms. Approximation theory, in particular wavelets and their applications. Computer graphics and computer aided geometric design.

Group members and their respective research interests include:

Pawel Bechler	Approximation theory: Wavelets and geometry of Banach spaces and their applications in theoretical questions of numerical methods and image processing
Maksymilian Dryja	Numerical methods of solving PDE. Discretization of PDEs by finite element and other methods; error bounds of these discretizations; designing and analysis of parallel algorithms for discretizations of PDEs by finite element method
Przemysław Kiciak	Computer graphics image synthesis, visualization, illumination models, rendering algorithms and computer aided geometric design (geometric continuity of curves and surfaces, shape optimization)
Piotr Kowalczyk	Numerical analysis; kinetic theory, the Boltzmann equation; numerical methods for kinetic equations; spectral methods for the Boltzmann equation, streamline diffusion and discontinuous Galerkin FEM for kinetic equations
Piotr Krzyżanowski	Numerical methods of solving PDE; discretization of PDEs by finite element and other methods; error bounds of these discretizations; designing and analysis of parallel algorithms for discretizations of PDEs by finite element method



Leszek Marcinkowski	Numerical methods of solving of PDEs, in particular domain decomposition methods for solving elliptic equations, mainly based on the abstract framework of additive Schwarz method (ASM); development of the methods on non-matching meshes
Krzysztof Moszyński <i>professor emeritus</i>	Numerical methods for PDEs; discretizations by finite difference and finite element methods; mathematical models of the turbulent flow and its numerical realization
Leszek Plaskota	Computational mathematics and numerical analysis; information based complexity and construction of efficient numerical algorithms for continuous problems: high dimensional problems, function approximation; integration, noisy information
Przemysław Wojtaszczyk	Approximation theory: Wavelets and geometry of Banach spaces and their applications in theoretical questions of numerical methods and image processing; interplay between functional analysis and nonlinear approximation; greedy approximation using wavelet bases and other dictionaries
Henryk Woźniakowski	Complexity of continuous problems: Computational complexity and algorithms for continuous problems such as approximation and integration in many dimensions, based on partial and noisy information

### 3. *Statistics and Applications of Probability*

Probabilistic and statistical models in applied sciences. Scientific computing. Financial mathematics and engineering. Theory and applications of stochastic differential equations.

Group members and their respective research interests include:

Przemysław Biecek	Bioinformatics (DNA sequence analysis, gene ontology oriented testing); population dynamics (Penna model, sex determination, evolution of recombination); mapping QTL and related problems (epistasis detection, SNP data, high correlation among markers); applications of statistics in medicine; multiple hypothesis testing problems; data engineering
Katarzyna Danielak	Order and record statistics – bounds, characterizations, hypothesis testing
Wojciech Niemiro	Markov Chains; Monte Carlo methods and algorithms in scientific computing, estimates of their precision, sequential methods, schemes of computation; applications to Bayesian statistics; probabilistic and statistical models in insurance: Models of reinsurance, optimal reinsurance contracts, methods of computing the probability of ruin, Bayesian models of credibility theory
Kazimierz Sobczyk	Stochastic dynamics of physical/engineering systems: applied theory of SDE; information dynamics: information flow in complex dynamical systems, maximum information entropy methods; stochastic modelling and analysis of fatigue accumulation; random material microstructures: modelling and mechanics of degradation processes



#### 4. Theory and Applications of PDEs and Functional Analysis

Existence and regularity of solutions to nonlinear partial differential equations and systems of equations. Existence of entropy solutions to nonlinear conservation laws. Reaction diffusion equations. Free boundary problems. Asymptotics, existence of attractors. Applications in biology fluid dynamics, plasma and growth of crystals.

Group members and their respective research interests include:

Marek Burnat <i>professor emeritus</i>	Mathematical models of the turbulent flow and its numerical realization; numerical experiments
Tomasz Cieślak	Theory of parabolic equations and systems, qualitative theory of PDEs and mathematical physic
Piotr Gwiazda	Nonlinear conservation laws; existence of weak entropy solutions. PDE in biomathematics; turbulence models, Young measures
Paweł Konieczny	PDE, especially the Navier–Stokes equations and related systems of fluid dynamics
Grzegorz Łukaszewicz	Mathematical theory of turbulence; existence, uniqueness and time asymptotics of global in time solutions of hydrodynamical equations, existence of global attractors, and estimates of their dimensions; energy transport in fluids
Marcin Moszyński	Topics on operator theory: Spectral theory for Jacobi operators and asymptotic methods for difference equations; chaos for strongly continuous semigroups in Banach spaces
Piotr B. Mucha	Regularity and qualitative analysis of solutions to the Navier–Stokes equations for the incompressible and compressible fluids - weak and regular solutions; free boundary problems related with Stefan-type problems and curvature flows - classical and singular models
Zbigniew Olesiak <i>professor emeritus</i>	Thermoelasticity in solid body mechanics
Andrzej Palczewski	Stochastic models in statistical physics
Zbigniew Peradzyński	PDE with application to hydrodynamics (e.g. plasma space thrusters), reaction-diffusion equations in mathematical biology, existence and propagation of nonlinear waves for nonlinear hyperbolic and reaction diffusion equations
Adam Piskorek <i>professor emeritus</i>	PDE and integral equations of mathematical physics
Piotr Rybka	Free boundary problems involving the Gibbs-Thomson law; flow of the singular mean curvature asymptotics of dissipative systems, variational problems of micromagnetics
Witold Sadowski	Existence of attractors in dynamical systems; existence and uniqueness of solutions in micropolar fluids; attractors in magnetomicropolar fluids
Piotr Szopa	PDE: equations of fluid dynamics; asymptotic behavior of solutions
Agnieszka Świerczewska-Gwiazda	Nonlinear PDE, turbulence models, Young measures
Dariusz Wrzosek	Qualitative analysis of nonlinear partial differential equations; mathematical modelling of 1) patens formation and 2) age-size-dependent population growth in biology



Anna Zatorska	Nonlinear PDE and calculus of variations; existence and regularity; theory for nonlinear elliptic-type equations and systems; p-harmonic mappings; subelliptic systems, systems with non-standard growth conditions; associated variational problems; analysis on metric spaces equipped with a doubling measure (with special interest in theory of p-harmonic functions on such spaces)
---------------	---

*In addition 6 faculty members of the Institute of Applied Mathematics and Mechanics form, jointly with 3 faculty members from the Institute of Mathematics, an independent **Section of Economic, Financial and Insurance Mathematics**. This Section is listed under separate heading.*



## INSTITUTE OF INFORMATICS

Institute of Informatics was formed in 1975, unifying foundational and experimental research on programming languages. Today it employs around 50 faculty members and trains 61 PhD students. The research goals comprise basic work in computer science, especially algorithms, logic, and specification theory, as well as various aspect of software engineering and several interdisciplinary topics, in particular bioinformatics.

### Current grants:

#### Research grants

##### I. Founded by Polish Government

1. *A Theory of Logic Programming in Modal and Description Logics*, Anh Linh Nguyen (2007-2009)
2. *Advanced problems in automata theory*, Damian Niwiński (2007-2010)
3. *An application of functional genomics and bioinformatics to characterization and development of the models of biological processes which are relevant in medicine and agriculture*, Jerzy Tiurnyn (2006-2009)
4. *Approximate multiagent systems*, Barbara Dunin-Kępicz (2008-2011)
5. *Biology and Biotechnology of Bacteriophages – selected tools and methods of bioinformatic analysis of phage genomes*, Jerzy Tiurnyn (2008-2009)
6. *Complex algorithmic problems in the modern theoretical computer science*, Wojciech Rytter (2007-2010)
7. *New techniques in graph algorithms: moderately exponential time algorithms, sparse graphs and their applications*, Łukasz Kowalik (2007-2009)
8. *Semantical considerations in non-classical logics applied in approximate reasoning*, Andrzej Szalas (2008-2010)

##### II. International

1. *Automata: from Mathematics to Applications (AutoMathA)*, Mikołaj Bojańczyk (2005-2010)
2. *Games for Design and Verification (GAMES)*, Damian Niwiński (2008-2013)
3. *MOBIUS – Mobility, Ubiquity and Security*, Andrzej Tarlecki (2005-2009)
4. *SENSORIA – Software Engineering for Service-Oriented Overlay Computers*, Andrzej Tarlecki (2005-2009)

#### PhD dissertation grants

1. *Error resilience in compressed data – selected topics*, Wojciech Plandowski (2008-2009)
2. *Evolution of protein-protein interaction network*, Jerzy Tiurnyn (2008-2010)
3. *Sequential patterns in texts: extraction and analysis*, Jerzy Tyszkiewicz (2008-2009)
4. *Tools and Techniques for Extending Modularity and Expressiveness of Object-Oriented Languages*, Paweł Urzyczyn (2008-2010)



## Basic Areas of Research:

### 1. Algorithms and Data Structures

The group develops several branches of modern algorithmics and the underlying fields of discrete mathematics. The latter include combinatorics on words and on ordered sets, graph theory, formal languages, computational geometry, information theory, foundation of cryptography. The research on algorithms and data structures covers sequential, parallel and distributed computations especially text, graph, geometry and number theory algorithms, large scale algorithms, approximation and randomized algorithms, dynamic algorithms, radio algorithms, multi-party computations, and cryptographic protocols.

Group members and their respective research interests include:

Robert Dąbrowski	Combinatorics of words, text algorithms
Krzysztof Diks	Parallel and distributed computing, graph theory
Stefan Dziembowski	Cryptography, multi-party computation, data security
Łukasz Kowalik	Graph theory, graph algorithms, exponential-time algorithms, approximation algorithms
Mirosław Kowaluk	Computational geometry, large scale algorithms
Marcin Kubica	Text algorithms for molecular biology, linear graphs
Maciej Kurowski	Graph algorithms, large scale algorithms
Adam Malinowski	Fault tolerance, network communication
Marcin Mucha	Graph algorithms, approximation algorithms, data structures
Jakub Pawlewicz	Order statistics, algorithmic analysis of games
Marcin Peczarski	Combinatorics of ordered sets, minimum-comparison sorting
Wojciech Plandowski	Combinatorics of words, text algorithms, data compression
Piotr Sankowski	Algebraic methods in graph theory, dynamic algorithms, algorithmic game theory
Wojciech Rytter	Parallel algorithms, text algorithms, graph algorithms, combinatorics on words, radio algorithms
Tomasz Waleń	Text algorithms for molecular biology, approximation algorithms

### 2. Artificial Intelligence

The research group has diverse interests in artificial intelligence, comprising machine learning, data mining and natural language processing.

Group members and their respective research interests include:

Kazimierz Grygiel	Evolutionary algorithms, neural networks
Wojciech Jaworski	Databases and query languages for texts in natural language
Ewa Madalińska-Bugaj	Reasoning about actions and change, non-monotonic logics
Adam Przepiórkowski	Computational linguistics, linguistic engineering, natural language processing, corpus linguistic



Krzysztof Szafran	Computational linguistics, natural language processing - morphology and syntax
Andrzej Szałas	Commonsense reasoning, knowledge representation, knowledge discovery, data mining
Arkadiusz Wojna	Machine learning, data mining, decision systems

### *3. Automata Theory*

The interest of the group covers automata on finite or infinite trees, automata with data, timed automata, and other models. The research focuses on expressive power, hierarchies, decidability issues, relation to logic, topology, and game theory. Potential applications include program verification, model checking, and XML data management.

Mikołaj Bojańczyk	Logics for verification, automata theory Tree automata, automata with data, decidability issues, algebraic language theory
Eryk Kopczyński	Games with automata-theoretic criteria, positional determinacy of infinite games
Sławomir Lasota	Timed automata, automata-theoretic techniques in verification, equivalence-checking
Filip Murlak	Topological properties of automata on infinite trees, Wadge games
Damian Niwiński	Automata on infinite trees, decidability issues, topological aspect
Wojciech Plandowski	Formal languages, word equations
Wojciech Rytter	Formal languages, algorithmic aspect of automata theory

### *4. Computational Biology*

The group focuses on various areas of research within the field of computational biology. Research topics of the group members include analysis of mass spectrometry data, molecular evolution and modeling, protein structure prediction, regulatory networks, biological sequence analysis.

Group members and their respective research interests include:

Norbert Dojer	Gene regulation networks, Bayesian methods
Anna Gambin	Comparative genomics, peptide mass spectrometry, gene regulation networks, alignment analysis
Paweł Górecki	Comparative genomics, phylogenetics, molecular evolution
Piotr Pokarowski	Protein structure: prediction, simulation of folding and crystal growth processes
Jerzy Tiuryn	Genome evolution, alignment analysis, algorithms for molecular biology, systems biology, phylogenetics, molecular evolution
Jerzy Tyszkiewicz	Bioinformatic workflows
Bartosz Wilczyński	Regulatory network reconstruction, gene analysis
Damian Wójtowicz	Genome evolution, analysis of Markov chains, stochastic simulations, molecular evolution



## 5. Concurrency and Communication

The group members study various models of true concurrency, including Petri nets, process algebras, pushdown systems, cause-effect structures. The research topics cover workflow modeling, equivalence checking, and model checking.

Group members and their respective research interests include:

Piotr Chrzastowski-Wachtel	Petri nets, workflow modeling
Ludwik Czaja <i>professor emeritus</i>	Petri nets, cause-effect structures, message passing, parallelism
Agata Janowska	Communication protocols, concurrency theory, timed automata
Sławomir Lasota	Concurrency theory, process algebra, communication protocols, bisimulation equivalence, timed automata
Marcin Peczarski	Communication protocols

## 6. Databases

The research on database theory and practice concern various topics, such as XML data management, dataflows, object-oriented databases, databases for humanities.

Group members and their respective research interests include:

Mikołaj Bojańczyk	XML query languages
Linh Anh Nguyen	Deductive databases
Filip Murlak	XML schema mappings
Krzysztof Stencel	Database management, object-oriented databases and query languages
Jacek Sroka	Dataflow languages and specification
Andrzej Szalas	Deductive databases, object-oriented and distributed databases, knowledge databases
Jerzy Tyszkiewicz	Dataflow languages, logics for databases, querying the Web, databases and query languages for texts in natural languages, databases in the humanities

## 7. Logic in Computer Sciences

The research group has several scientific interests: type theory in relation with functional programming, term rewriting and automated proof assistants, logical foundations of verification. The latter comprise temporal logic, program logics, monadic logic, and their relations to automata and games. The research topics concern in particular the expressiveness of various logical calculi, decidability issues, and efficiency of model checking.



Group members and their respective research interests include:

Marcin Benke	Lambda calculus, type theory
Mikołaj Bojańczyk	Temporal logic
Jacek Chrząszcz	Lambda calculus, term rewriting, proof-assistants
Piotr Hoffman	Category theory, semigroups
Damian Niwiński	Fixed point logics
Linh Anh Nguyen	Modal logics, logic for databases
Aleksy Schubert	Lambda calculus, type theory, complexity of logical systems
Andrzej Szalas	Approximate reasoning, non-classical logics, automated reasoning
Andrzej Tarlecki	Logic, universal algebra, and category theory in computer science
Jerzy Tyszkiewicz	Logic for databases, finite model theory, Kolmogorov complexity
Paweł Urzyczyn	Lambda calculus, type theory, logics for verification
Daria Walukiewicz-Chrząszcz	Lambda calculus, term rewriting

## 8. Multiagent Systems

The group focuses on theoretical foundations of multiagent systems. The group members study various aspects of distributed cooperative problem solving, in order to construct a formal model of this complex process.

Group members and their respective research interests include:

Barbara Dunin-Kępicz	Formal modeling of BDI systems, multimodal logics, formal models of various dialogue types
Linh Anh Nguyen	Reasoning about knowledge and belief, multimodal logics, system MProlog
Andrzej Szalas	Knowledge fusion, knowledge representation, multimodal logics

## 9. Semantics and Formal Specification

The research group has diverse interests in formal methods of semantic description, formal specification, and systematic development of software systems, and in mathematical foundations of such methods. Research topics of the group include requirements specification, architectural design, software development, trust management, as well as the advanced mathematical methods of the area, related to and relying on algebra, co-algebra, category theory and logic.

Group members and their respective research interests include:

Jacek Chrząszcz	Formal verification of software, proof-carrying code
Ludwik Czaja <i>professor emeritus</i>	Algebraic specification of concurrent systems



Piotr Hoffman	Architectural specification, semantics, CASL specification formalism
Bartosz Klin	Process algebras, coalgebraic and bialgebraic methods
Sławomir Lasota	Process algebras, coalgebraic methods
Mirosława Miłkowska	Formal specification of requirements
Aleksy Schubert	Formal verification of software, proof-carrying code
Andrzej Tarlecki	software specification, design and development, semantics, CASL specification formalism
Daria Walukiewicz-Chrząszcz	Formal verification of software, proof-carrying code

### *10. Software Engineering*

The research group has diverse interests in software engineering, both in its foundational and practical aspects. The research topics include functional and object-oriented programming languages, logic programming, operating systems, real time systems, software development methodology, formal documentation and specification.

Group members and their respective research interests include:

Jacek Chrząszcz	Functional and object-oriented programming, code quality, Java
Krzysztof Ciebiera	Computer networks, security, WWW programming
Robert Dąbrowski	Programming methodology, software specification and verification, software paradigms, object-oriented programming
Marcin Engel	Automated theorem proving
Janusz Jabłonowski	Object-oriented programming, formal software specification and verification
Agata Janowska	Specification and verification of real time systems, model-checking of timed systems
Marcin Kubica	Model-checking, automated theorem proving
Jan Madey	Trace specifications, formal documentation and specification methods
Mirosława Miłkowska	Logic programming, specification and verification of logic programs
Janina Mincer-Daszkiewicz	Operating systems, distributed systems, computer networks, performance evaluation
Linh Anh Nguyen	Logic programming, multimodal logic programming
Aleksy Schubert	Functional and object-oriented programming, code quality, Java
Andrzej Tarlecki	Mathematical foundations of software engineering
Władysław M. Turski	Programming methodology, mathematical aspects of software engineering, metrics



## INSTITUTE OF MATHEMATICS

The Institute employs 90 researchers which makes it one of the largest institutions of this kind in Poland. The research at the Institute covers a wide range of topics touching nearly every field of modern mathematics, in particular: Algebra and Number Theory, Mathematical Logic and its applications, Mathematical Analysis, Differential Equations, Dynamical Systems, Probability and its applications, Topology, Geometry, Set Theory, Algebraic Topology, Algebraic Geometry. The faculty members supervise 24 PhD students.

### Current grants:

#### Research grants

##### I. Founded by Polish Government

1. *Algebraic topology*, Stanisław Betley (2008-2011)
2. *Dynamical systems and geometry*, Henryk Żołądek (2005-2008)
3. *Formula hierarchies in weak arithmetics and their extensions by counting quantifiers*, Leszek Kołodziejczyk (2008-2011)
4. *Geometric and ergodic properties of dynamical systems*, Anna Zdunik (2007-2010)
5. *Group actions on algebraic varieties and birational maps*, Mariusz Koras (2007-2010)
6. *Interactive process mining*, Andrzej Skowron (2008-2011)
7. *Nonlinear geometric and variational problems*, Paweł Strzelecki (2005-2008)
8. *Orlicz-Sobolev Spaces and their Applications to the Nonlinear Elliptic PDE's, Probability Theory and Calculus of Variations*, Agnieszka Kałamajska (2005-2008)
9. *Properties of rings expressible in terms of ideals*, Jerzy Matczuk (2008-2011)
10. *Random series and stochastic integrals*, Stanisław Kwapien (2005-2008)
11. *Semigroup theoretical methods in the study of associative algebras and their representations*, Jan Okniński (2007-2010)
12. *Stochastic systems and their applications*, Tomasz Bojdecki (2005-2008)
13. *The strategy of mathematical education in Poland*, Zbigniew Marciniak (2007-2009)
14. *Topology and Borel structure of function spaces*, Witold Marciszewski (2008-2011)
15. *Varieties, bundles, algebraic structures and their moduli*, Jarosław Wiśniewski (2007-2010)

##### II. International

1. *Geometric curvature energies*, Paweł Strzelecki (2008-2010)

#### PhD dissertation grants

1. *Hypercontractivity and functional inequalities for product measures*, Krzysztof Oleszkiewicz (2007-2008)
2. *Limit theorems for branching particle systems*, Tomasz Bojdecki (2006-2008)
3. *Linear meromorphic differential equations and multiple zeta values*, Henryk Żołądek (2008-2011)
4. *Probabilistic properties of logarithmically concave measures*, Rafał Łatała (2007-2008)
5. *Singular homology planes*, Mariusz Koras (2007-2008)



## Basic Areas of Research:

### 1. Algebra and Number Theory

The research areas of this team include Ring Theory (mainly associative), Module Theory as well as Group Theory, Semigroup Theory and Number Theory. Lattice theoretical approach to algebraic structures is studied. Other branches of Universal Algebra, including partial algebras are also represented.

Group members and their respective research interests include:

Wiktor Bartol	Universal algebra, in particular: theory of partial algebras, lattice theory, subalgebra and congruence lattices of an algebra
Jerzy Browkin <i>professor emeritus</i>	Number theory
Jan Krempa	Ring theory; selected problems in group theory and number theory
Zbigniew Marciniak	Noncommutative algebra, group rings, group cohomologies
Tomasz Maszczyk	Non-commutative geometry
Jerzy Matczuk	Ring theory, Hopf algebras
Dorota Niewieczerzal	Near-rings
Jan Okniński	Noncommutative rings, algebraic theory of semigroups, theory of matrices
Konrad Pióro	Universal algebra, in particular: theory of partial algebras, lattice theory, subalgebra and congruence lattices of an algebra, graph representation of an algebra
Jacek Pomykała	Elementary and analytic number theory, cryptography, some aspects of computational complexity
Edmund Puczyłowski	Associative rings, theory of modules and lattices
Mikołaj Rotkiewicz	Lie algebras, graded manifolds and supergeometry
Mariusz Skalba	Number theory (polynomial and exponential congruences, multiplicative diophantine equations, elliptic curves, arithmetic properties of digital expansions, geometry of numbers)
Andrzej Strojnowski	Group rings, group theory
Barbara Terlikowska-Osłowska	Group theory and ring theory

### 2. Algebraic Geometry

The research interests of the scientific team include algebraic group actions and quotients, linearization problems, moduli problems, toric geometry, surfaces and higher dimensional algebraic varieties, Fano varieties, affine geometry and relations to algebraic topology.



Group members and their respective research interests include:

Andrzej Białynicki-Birula	Algebraic group actions and quotients
Maciej Borodzik	Complex affine surfaces, plane affine curves
Oskar Kędzierski	Toric geometry, G-Hilbert schemes, quiver representations
Mariusz Koras	Affine algebraic varieties, actions of algebraic groups, linearization problems
Adrian Langer	Moduli problems, surfaces and higher dimensional geometry, positive characteristic problems
Tomasz Maszczyk	Complex algebraic geometry, non-commutative geometry
Michał Szurek	Fano varieties
Jarosław Wiśniewski	Fano varieties, Mori theory, toric geometry, applications to phylogenetics
Henryk Żołądek	Affine algebraic geometry, Jacobian conjecture, classification of complex plane algebraic curves

### 3. Algebraic Topology

Research is carried on within algebraic K-theory, homotopy theory, topology of transformation groups, homological algebra, knot theory and topology of algebraic varieties.

Group members and their respective research interests include:

Stanisław Betley	Algebraic K-theory, homotopy theory and homological algebra in functor categories
Agnieszka Bojanowska	Homotopy theory and group actions
Marcin Chałupnik	Homological algebra and representation theory, in particular homological properties of modular representations of general linear groups via functor categories
Stefan Jackowski	Homotopy theory of classifying spaces of compact Lie groups and related spaces; homological algebra in functor categories; equivariant topology
Tadeusz Koźniewski	Algebraic and geometric topology
Paweł Traczyk	Knot theory; polynomial invariants of knots and links
Andrzej Weber	Topology of algebraic varieties: in particular intersection homology, weight filtration, equivariant cohomology Thom polynomials and other homological or numerical invariants of singularities
Krzysztof Ziemiański	Homotopy theory of classifying spaces of compact Lie groups, p-local groups and related spaces



## 4. Dynamical Systems

### *Theory of Vector Fields and their Singularities*

The research interests of the group include real and complex one-dimensional dynamics, and geometry of fractal sets. Multidimensional complex dynamics is also studied. Another important area of research is the theory of singularities of vector fields and distributions and related topics in real analytic geometry.

Group members and their respective research interests include:

Krzysztof Barański	Complex dynamics, geometry of fractal sets
Marcin Bobieński	Differential geometry, polynomial vector fields, generalized Abelian integrals and limit cycles in higher dimensional differential systems
Maciej Borodzik	Affine algebraic geometry (classification of complex plane algebraic curves, application to the problem of limit cycles of polynomial vector fields)
Paweł Goldstein	Gradient vector fields and their phase portraits
Joanna Jaroszevska	Markov operators
Piotr Jaworski	Singularities of sets and functions, real algebraic and analytic geometry
Michał Krych	Holomorphic dynamics
Karol Krzyżewski <i>professor emeritus</i>	Ergodic theory of smooth dynamical systems
Piotr Mormul	Singularities of Pfaff systems and distributions; geometric control theory; contact geometry
Tadeusz Mostowski	Complex and real analytic sets, singularities of sets and analytic functions, applications to differential equations
Waldemar Pałuba	One dimensional real dynamics
Witold Szczęchła	Dynamical systems, stochastic games
Anna Zdunik	Holomorphic dynamics, ergodic theory of smooth dynamical systems
Henryk Żołądek	Differential equations: polynomial vector fields, normal forms of singularities, holomorphic foliations

## 5. Geometry

The research interests of members of the group include: selectors for convex and star bodies and problems on the border of convex geometry and the approximation theory (e.g. Chebyshev sets in hyperspaces of compact convex sets).

Group members and their respective research interests include:

Marek Kordos	Projective geometry, non-euclidean geometries, history of mathematics
Maria Moszyńska <i>professor emeritus</i>	Geometry of convex sets, fractal geometry
Tomasz Żukowski	Geometry of convex sets



## 6. *Mathematical Analysis and Differential Equations*

Research problems considered in this group include, but are not limited to, various questions in the theory of partial differential equations, with emphasis on existence and regularity problems for nonlinear elliptic and subelliptic equations and systems. Connections to variational calculus, weak convergence methods and related topics in the theory of function spaces are also studied. Another topic of study is complex analysis.

Group members and their respective research interests include:

Paweł Goldstein	Non-linear partial differential equations
Agnieszka Kałamajska	Sobolev spaces, variational calculus
Ewa Ligocka <i>professor emeritus</i>	Complex analysis, functional analysis, partial differential equations, potential theory
Katarzyna Pietruska-Pałuba	Geometric analysis, analysis on fractals
Waldemar Pompe	Variational calculus
Paweł Strzelecki	Geometric analysis, non-linear partial differential equations, variational calculus
Wojciech Wojtyński	Lie groups and algebras

## 7. *Mathematical Logic and its Applications*

The research area of one part of this group includes applied logic, mainly the logic and algorithmic methods in artificial intelligence are intensively studied. The other group works in pure logic (i.e. weak theories in arithmetics, and Category Theory).

Group members and their respective research interests include:

Leszek Kołodziejczyk	Mathematical logic: weak theories of arithmetic, in particular metamathematical properties of weak arithmetics (provability of consistency statements) and partial collapses of some hierarchies of formulae
Andrzej Skowron, Marcin Szczuka Hung Son Nguyen	Logic and algorithmic methods in artificial intelligence Logic and algorithmic methods in artificial intelligence; Reasoning under uncertainty, approximate reasoning about vague concepts, rough sets and rough mereology, data mining and knowledge discovery, non conventional models of computing (e.g., evolutionary computing, neural networks, granular computing, computing with words, autonomic computing, perception based computing), decision support systems, approximate reasoning in multiagent systems, complex adaptive systems.
Marek Zawadowski	Logic, category theory, higher dimensional category theory and its applications, particularly in multitopic categories; also first order categorical logic, topos theory, intuitionistic and modal logics, descent theory



## 8. Probability. Stochastic Analysis and its Applications

The main areas of research of the probability group are: limiting behavior of the stochastic processes, stochastic analysis, martingale and other stochastic inequalities, limit theorems for U-statistics and theory of chaos, applications to geometry of convex sets and theory of graphs.

Group members and their respective research interests include:

Radosław Adamczak	Concentration of measure, probability in Banach spaces, U-statistics, random matrices, probabilistic methods in convex geometry
Tomasz Bojdecki	Stochastic analysis, stochastic processes in the space of distributions. Limit theorems for empirical processes related to particle systems; analysis of the corresponding limit processes
Witold Bednorz	General theory of processes and their connections with functional analysis and approximation theory; majorizing measures techniques
Jacek Jakubowski	Stochastic analysis; applications to financial mathematics
Stanisław Kwapien	Analytic methods in probability; probabilistic methods in functional analysis. General theory of stochastic integration. Inequalities for sums of independent random variables, martingales and other probability inequalities
Rafał Łatała	Theory of chaos and U-statistics; estimations of tails and moments, limit theorems. Probabilistic methods in analysis and convex geometry, stochastic inequalities
Piotr Miłoś	Stochastic analysis, branching particle systems, limit theorems for branching systems, superprocesses
Krzysztof Oleszkiewicz	Stochastic inequalities, probabilistic methods in analysis, graph theory, discrete harmonic analysis and convex geometry.
Adam Osękowski	Commutative and noncommutative martingale inequalities; Burkholder method
Katarzyna Pietruska-Pałuba	Diffusion processes on fractals, differential inequalities and their applications in probability
Anna Talarczyk	Stochastic analysis, stochastic processes in the space of distributions. Limit theorems for empirical processes related to particle systems; analysis of the corresponding limit processes
Jakub Wojtaszczyk	Asymptotic convex geometry; logarithmically concave random variables and variables equidistributed on high-dimensional convex bodies; the concentration of measure phenomenon; functional analysis

## 9. Topology and Set Theory

In Topology, the research interest of the scientific team focuses on general and geometric topology, dimension theory, continua theory and descriptive set theory. In Set Theory, research interests of the group concentrate on combinatorial and descriptive set theory and its applications to measure theory, topology and analysis. It includes the study of: special subsets of the reals; cardinal coefficients, combinatorics of partial orders and Boolean algebras, properties of ideals in Polish spaces and of definable ideals on countable sets, invariant measures and ideals, PCF theory, combinatorial methods in topology.



Group members and their respective research interests include:

Józef Chaber	General topology, descriptive set theory (topological aspects of Borel, analytic, projective, etc. sets)
Ryszard Engelking <i>professor emeritus</i>	General topology, dimension theory
Wojciech Guzicki	Set theory, cryptography
Adam Krawczyk	Infinite combinatorics, cardinal coefficients, combinatorial methods in topology, independence proofs
Marcin Kysiak	The structure of the real line, ideals in Polish spaces, combinatorics of partial orders
Witold Marciszewski	General topology, infinite-dimensional topology, descriptive set theory, Banach spaces theory
Henryk Michalewski	Function spaces and groups with pointwise topology, descriptive set theory and its applications to topology, PCF theory
Andrzej Nagórko	Geometric topology, geometric group theory
Sławomir Nowak	Geometric topology, homotopy theory, shape theory
Elżbieta Pol	General topology, dimension theory, continua theory
Roman Pol	Dimension theory, descriptive set theory (topological aspects of Borel, analytic, projective, etc. sets)
Mirosława Reńska	Dimension theory, continua theory
Karol Sieklucki <i>professor emeritus</i>	Geometric topology, fixed point theory
Mirosław Sobolewski	Continua theory, fixed point theory
Henryk Toruńczyk	Geometric topology, topological properties of infinite-dimensional spaces
Piotr Zakrzewski	Ideals in Polish spaces, invariant measures and ideals, definable ideals on countable sets, special subsets of the reals, combinatorics of Boolean algebras

### ***10. Didactics of Mathematics***

Zbigniew Semadeni <i>professor emeritus</i>	Didactics and epistemology of mathematics
--	---

*In addition 3 faculty members of the Institute of Mathematics form, jointly with 6 faculty members from the Institute of Applied Mathematics and Mechanics, an independent **Section of Economic, Financial and Insurance Mathematics**. This Section is listed under separate heading.*



## SECTION OF ECONOMIC, FINANCIAL AND INSURANCE MATHEMATICS

Research undertaken by members of this section include: modelling of financial markets, portfolio analysis, pricing of derivatives, risk measures, risk management, application of copulas in finance, credit risk, probabilistic and statistical models in insurance, credibility theory, mathematical economy, game theory, high dimensional numerical algorithms with financial applications.

Section members and their respective research interests include:

Jacek Jakubowski	Term structure models, bond markets, futures markets, measuring and management of risk, pricing of financial derivatives, credit risk
Piotr Jaworski	Risk theory, portfolio analysis, statistical and probabilistic methods in mathematical finance, theory of copulas
Karol Krzyżewski <i>professor emeritus</i>	Portfolio analysis, risk measures, decision-making under uncertainty, asset pricing
Jacek Mięgisz	Evolutionary game theory, econophysics
Wojciech Niemirowicz	Probabilistic and statistical models in insurance: Models of reinsurance, optimal reinsurance contracts, methods of computing the probability of ruin, Bayesian models of credibility theory
Andrzej Palczewski	Financial mathematics: modelling interest rate dynamics and interest rate products, stochastic portfolios of interest rate products, portfolio optimization by stochastic control methods relation to PDE methods.
Jan Palczewski	Stochastic control of Markov processes in discrete and continuous time with applications to various portfolio optimization problems in market models with transaction costs; evolutionary finance and interactions in markets: stability of stochastic differential equations, ergodicity of Markov processes
Leszek Plaskota	Computational mathematics and numerical analysis; construction of efficient numerical algorithms for high dimensional problems applications in finance.
Agnieszka Wiszniewska-Matyskiel	Games with a continuum of players and their applications in ecosystems, simplified economies and models of financial market; existence and properties of Nash equilibria in such games; mathematical economics





**UNIVERSITY OF WARSAW**

**Faculty of Mathematics, Informatics and Mechanics**

Address: Banacha 2; 02-097 Warsaw; Poland

Phone: (+48) 22 55 44 214

Fax: (+48) 22 55 44 200

E-mail: [mim@mimuw.edu.pl](mailto:mim@mimuw.edu.pl)

Web page: <http://www.mimuw.edu.pl>