Titolo del progetto: Mathematics and its applications

Algebra/Geometry: 1. Representation theory of Lie algebras, vertex algebras and related structures; algebraic groups and symmetric varieties. 2. Algebraic combinatorics: Coxeter grous and Kazhdan-Lusztig polynomials, symmetric functions. Group theory: profinite groups, verbal subgroups. 3. Discrete mathematics; graphs, polytopes, matroids. 4. Algebraic topology, combinatorial topology, hyperplane arrangements, Artin groups. 5. Algebraic number theory and arithmetic geometry; combinatorial aspects of commutative algebra. 6. Complex algebraic geometry: Hodge theory, Calabi-Yau varieties, Hyperkähler manifolds, Chow groups and derived categories. 7. Fano Varieties and toric geometry, birational geometry, enumerative geometry, fibrations and moduli spaces. 8. Classical algebraic geometry: secant varieties and tensors, Brill-Noether theory on curves, Homogeneous spaces. 9. Low dimensional topology, knots and braids; geometric topology, Lie groups and geometric group theory. 10. Differential geometry: conformal and contact manifolds, Cartan geometry, quantum homogeneous spaces, Hopf algebras. Translation surfaces, continued fractions algorithms, diophantine conditions in dynamics.

Analysis and Probability: 1. Functional analysis and abstract equations: functional analytic methods for PDEs problems; degenerate or singular evolution equations in Banach spaces; function spaces related to operator theory; inverse problems; 2. Applied PDEs and probability: PDE or stochastic modeling of financial markets; geometric analysis modeling of the visual cortex in Lie groups; FK percolation and applications; mathematical models in medicine and biology; 3. Evolution equations: evolutions equations with real characteristics, asymptotic behavior of hyperbolic systems; 4. Qualitative theory of PDEs and calculus of variations: sub-Riemannian PDEs; a priori estimates, solvability and hypoellipticity of linear PDEs; analytic regularity of solutions of PDEs; spectral theory of differential systems with polynomial coefficients; geometric fully nonlinear PDEs; potential analysis of second order PDEs; geometric measure theory in Carnot groups; differential forms and differential geometry in Carnot groups; free boundary value problems; Hamilton-Jacobi equations; 5. Harmonic analysis: singular integral operators and related function spaces (Hardy; Bergman: Dirichlet, etc.) over domains with minimal regularity; applications to PDE and to complex analysis.. 6. Stochastic differential equations of partial/backward/mean-field type, purely diffusive or with jumps; stochastic optimal control, Hamilton-Jacobi-Bellman equations; probabilistic numerical methods for AI.

Numerical Analysis: 1. Numerical Linear Algebra: matrix equations, matrix functions, large-scale eigenvalue problems, spectral perturbation analysis, preconditioning techniques, ill conditioned linear systems, optimization problems; 2. Inverse Problems and Image Processing: regularization and optimization methods for illposed integral equation problems, image segmentation, deblurring, denoising and reconstruction from projection; analysis of noise models, medical applications; 3. Geometric Modelling and Computer Graphics: Curves and surface modelling, shape basic functions, refinable functions, subdivision schemes, interpolation methods, parallel graphics processing, realistic rendering; 4. Matrix and tensor analysis and computations for PDEs, image processing and statistics. 5. Numerical approximation of (stochastic/parametric) PDEs: finite element methods, boundary element methods, adaptivity, approximation of high-dimensional problems.

Mathematical Physics: Disordered Statistical Mechanics. Multiscale equilibrium models. Out of equilibrium, spin glass dynamics. High dimensional inference and statistical mechanics. Statistical physics methods for machine learning. Boltzmann Machines and Artificial Intelligence. Dynamics of/on complex networks. Random Matrix Theory. Random optimization problems. Quantum information theory. Quantum computing and quantum machine learning. Quantum statistical mechanics. Non-linear wave propagation and non-equilibrium thermodynamics. Non-equilibrium thermodynamics and modified theories of gravity. Mathematical models of non-linear and non-local viscoelasticity. Mathematical models of multi-phase flows. Non-equilibrium thermodynamics problems in bounded domains.

Mathematics for Economics and Finance: 1. Mathematical economics (nonlinear dynamical systems in economics, agent-based models in economics and finance); 2. Mathematical finance (hedging models, credit risk models, fuzzy models in finance, high frequency finance and market microstructure models); 3. Graph theory and network models in financial, economic, and transportation systems

OTHER TOPICS MAY ALSO BE CONSIDERED