UMA-OC report for 2022

Version: March 13, 2023

Contents

1 Team members, visitors, external collaborators

Faculty members

- Alès Zacharie
- Elloumi Sourour
- Grad Sorin-Mihai
- Jean Frédéric
- Perez Jérôme
- Russo Francesco
- Simonetto Andrea

Associate members

- Carpentier Pierre
- Costa Marie-Christine

Lecturers

- Bonrepaux Benjamin
- Lefèvre David

Non-permanent members

- Bourdais Thibaut (PhD) with Francesco Russo and Nadia Oudjane (EDF)
- Durán Mateluna Cristian (PhD) with Sourour Elloumi and Zacharie Alès
- Jorquera Bravo Natalia (PhD) with Sourour Elloumi and Safia Kedad-Sihoum (CNAM)
- Jerhaoui Othmane (PhD) with Frédéric Jean and Hasnaa Zidani (Insa Rouen)
- Kafnemer Meryem (PhD) with Frédéric Jean and Yacine Chitour (Université Paris-Saclay)
- Leparoux Clara (PhD) with Frédéric Jean and Bruno Hérissé (ONERA)
- Mauduit Eliabelle (PhD) with Andrea Simonetto and Mathieu Bruyen (Greenworking)
- Mencarelli Luca (Post-Doctorant)
- Verchère Zoé (PhD) with Sourour Elloumi and Andrea Simonetto
- Valentine Huré (PhD) with Zacharie Alès

Visitors

- Gebrie Anteneh Getachew
- Ohashi Alberto

Technical support

- Maurice Diamantini

1.1 PhD and HDR defences

- (HDR) Andea Simonetto. Optimizing through change for cyber-physical and social systems (sept. 2022).
- (PhD) Alan Teixeira Nicácio de Messias. Stochastic Analysis of non-Markovian irregular phenomena (fév. 2022).
- (PhD) Meryem Kafnemer. Stabilisation des équations des ondes (sept. 2022).
- (PhD) Othmane Jerhaoui. Théorie de viscosité des équations de Hamilton Jacobi du premier ordre sur certains espaces métriques (dec. 2022)

1.2 Postdoc funding

- Mencarelli Luca (funded by FMJH, 2 years)
- Dixit Avinash (funded by FMJH, 2 years) – position declined

2 Research topics

The Optimization and Control group focuses on the mathematics of decision making and studies systems of various kinds in three main research areas: optimization, dynamical systems and probability. The group develops mathematical, algorithmic and software tools for the analysis, control and optimization of various classes of systems, including those with dynamic or stochastic aspects. These developments call upon several branches of mathematics such as mathematical programming, graph theory, differential geometry, dynamical systems, analysis (convex, non-smooth, stochastic), linear algebra, probability, stochastic processes, and numerical analysis. Many of our works are at the intersection of these fields. The applications treated by the group are numerous, and are carried out in collaboration with various academic and industrial partners.

Keywords: Optimization, dynamical systems, probabilities.

Application fields: Cyber-physical systems, energy, transportation, health, logistics, planning, network problems, telecom, quantum computing, optimal control in aerospace applications, neurophysiology, astrodynamics and gravitation, finance.

3 Collaborations with academic or industrial institutions

3.1 Academic partners

- Insa Rouen (F. Jean): scientific collaboration, joint supervision of the PhD thesis of O. Jerhaoui.
- L2S, UMR CNRS-CentraleSupélec-Université Paris-Saclay (F. Jean): scientific collaboration
- University of Colorado Boulder, USA (A. Simonetto): scientific collaboration
- Università di Bologna, Italy (A. Simonetto): scientific collaboration
- Università di Padova, Italy (A. Simonetto): scientific collaboration
- IMT, Lucca, Italy (A. Simonetto): scientific collaboration
- Corvinus University of Budapest, Hungary (S.-M. Grad): scientific collaboration
- University of Tarapacá, Arica, Chile (S.-M. Grad): scientific collaboration

- Chemnitz University of Technology, Germany (S.-M. Grad): scientific collaboration
- Cnam, Université de Montpellier and Ecole des Ponts, France (S. Elloumi): scientific collaboration
- Université de Liège, Belgium (S. Elloumi): scientific collaboration
- Cnam, University of Avignon, ICHEC Belgium (Z. Alès): scientific collaboration

3.2 Industrial partners

- ONERA Palaiseau (F. Jean): joint supervision of the PhD thesis of C. Leparoux (and previously E. Flayac).
- Greenworking (A. Simonetto): joint supervison of the PhD thesis of E. Mauduit.
- EDF (A. Simonetto and S. Elloumi): joint supervision of an intern in a PGMO quantum and combinatorial optimization project
- EDF (Z. Ales): scientific collaboration

4 Own resources

4.1 From regional and local calls for projects

- PGMO project "Résolution globale des problèmes quadratiques par méthodes à intervalles et reformulation convexe (QIBEX)" 6 000 euros, 2021-2022. with Ecole des ponts and Université de Montpellier (S. Elloumi)
- PGMO project "EQu ECO: Efficient Quantum Encodings for Combinatorial Optimization", 10 000 euros, 2022-2023 (A. Simonetto, S. Elloumi)
- LMH PhD grants 2019-2022. PhDs of O. Jerhaoui and M. Kafnemer. 205 000€. (F. Jean)
- LMH IROE project. 12 000€. (F. Russo).
- PhD grant from ENS Paris Saclay 2020-2023. PhD of C. Leparoux. 82 000€. (F. Jean).
- LMH PhD grant 2020-2023. Half grant for Z. Verchère. 49 000 €. (S. Elloumi).
- IPP PhD grant 2020-2023. Half grant for Z. Verchère. 55 000 €. (S. Elloumi).
- LMH postdoc grant 2021-2023. 2 years grant for L. Mencarelli. 113 000€. (S. Elloumi).
- LMH postdoc grant 2022-2024. 2 years grant for A. Dixit (declined). 113 000€. (S-M.G).
- Région IdF PhD grant 2021-2024. PhD of T. Bourdais. 100 000€ (F. Russo).
- PGMO - IROE Project 2021-2023 "Learning to scale up the resolution of repeated optimisation problems". 10 000€. (Z. Alès).
- PGMO funding for the Workshop on "Optimal control theory", 2022. 1 200€. (F. Jean).
- PGMO project "Investigations on Differential Inclusions Governed by Structured Maximally" (DIFMOP), 2022-2024. 7 000€. (S-M.G).
- Hi!Paris project "Neural Networks for Mixed Variational Inequalities and Equilibrium Problems", 2022-2023. 10 000€. (S-M.G).
- E4C PhD grant 2022-2025. PhD of N. Jorquera. 110 000€. (S. Elloumi).

- PGMO-IROE project "Learning to scale up the resolution of repeated optimisation problems", 10 000 euros, 2021-2023 (Z. Alès)

4.2 From public or national association funding

- AID-DGA project 2020-2023. Méthodes de Recherche Opérationnelle pour la conception de réseaux optimaux et robustes. 180 000 euros. (Z. Ales, S. Elloumi)
- CIMPA-ICTP Research in Pairs for mathematicians grant 2022. 3 months grant for A.G. Gebrie for visiting ENSTA Paris. 10 000€ (S-M.G)

4.3 From international calls for projects

- MathAmSud project "Optimality conditions and proximal methods for generalized convex optimization problems" (OCPROGEC), 2023–2024 (with partners from Chile and Peru). 4 800€ (for 2023). (S-M.G).

4.4 From development, transfer and industrial collaboration

- ONERA PhD grant supplement 2020-2023. PhD of C. Leparoux. 33 000€. (F. Jean).
- Greenworking, support contract for a CIFRE, 2022-2025. 60 000€. (A. Simonetto).
- EDF, Mission of doctoral consultant (Thibaut Bourdais), 2022-2024. 16 000€. (F. Russo).

5 Indices of recognition

5.1 Awards or scientific distinctions

5.2 Other distinctions

- Fellow of the Corvinus Institute for Advanced Studies during the Summer Semester 2022 (S-M.G)
- double (online) plenary talk at the Workshop on Nonlinear Operator Theory (organized by AUST Nigeria & Fields Institute), 02-04/03/2022, Abuja, Nigeria (S-M.G)
- (online) plenary talk at the International Conference on Evolution in Pure and Applied Mathematics - ICEPAM-2022, 17/11/2022, Bathinda, India (S-M.G)

5.3 Stays in foreign laboratories

- F. Jean, 2 weeks as invited researcher in Universidad Tecnica Federico Santa Maria, Valparaiso (Chile).
- S-M. Grad, 4 weeks as invited researcher at the Corvinus University of Budapest, Hungary.
- S-M. Grad, 5 days as invited researcher at the University of Alicante, Spain.
- S-M. Grad, 3 days as invited researcher at the Babeș-Bolyai University of Cluj-Napoca, Romania.

5.4 Organization of international conferences/conventions

- Organization of the Workshop "Optimal Control Theory", June 22–24, 2022 at INSA Rouen Normandie, https://wcscp2022.sciencesconf.org. (F. Jean).

- member of the Organizing Committee of the 8th German-Polish Conference on Optimization - GPCO 2022, Apolda, Germany, September 27-30, 2022, https://gpco2022.uni-jena.de/ (S-M.G)
- member of the Program Committee of EUROPT 2022 (S. Elloumi)
- member of the organization committee of ISCO 2022 (Z. Alès)

5.5 Responsibilities in scientific groups or societies

- since 2017: committee member of the JFRO which organizes each year 2 or 3 workshop days in Paris on various operational research topics (Z. Alès)
- Organization in 2022 of the second day of the optimization group of IPParis (Z. Alès)

6 New software and platforms

- Creation of the Julia package `AutoExpe.jl` which enables to automates repetitive tasks in numerical experiments as well as the generation of result tables (https://github.com/ZacharieALES/AutoExpe.jl).

7 New results or perspectives

7.1 Viscosity theory of first order Hamilton Jacobi equations in some metric spaces

Participants: F. Jean, O. Jerhaoui

7.1.1 A General Comparison Principle for Hamilton Jacobi Bellman Equations on Stratified Domains

O. Jerhaoui, H. Zidani.

Study of finite horizon, first order Hamilton Jacobi Bellman equations on stratified domains, in relation to optimal control problems with discontinuous dynamics. Use of nonsmooth analysis techniques to derive strong comparison principles, deduce that the value function is the unique viscosity solution, and obtain some stability results of the Hamilton Jacobi Bellman equation.

7.1.2 Deterministic optimal control on Riemannian manifolds under probability knowledge of the initial condition

F. Jean, O. Jerhaoui, H. Zidani

Study of an optimal control problem on a compact Riemannian manifold with imperfect information on the initial state of the system. The main tool is to extend the notion of viscosity solution to Hamilton-Jacobi-Bellman equations in Wasserstein space, and to show that the value function of the control problem is the unique viscosity solution of such an equation.

7.1.3 Viscosity Solutions Of Hamilton-Jacobi Equations In Proper CAT(0) Spaces

O. Jerhaoui, H. Zidani.

Introduction of a novel notion of viscosity solutions for first order Hamilton-Jacobi equations in proper CAT(0) spaces based on sets of test functions that are directionally differentiable and can be represented as a difference of two semiconvex functions.

7.2 Stabilisation of wave equations

Participants: F. Jean, M. Kafnemer

7.2.1 Weak Input to state estimates for 2D damped wave equations with localized and non-linear damping

M. Kafnemer, M. Benmiloud, Y. Chitour

Study of input-to-state (ISS) issues for damped wave equations with Dirichlet boundary conditions on a bounded domain of dimension two, with non-linear damping terms, including the case with disturbances.

7.2.2 Lp-asymptotic stability of 1D damped wave equations with localized and linear damping

M. Kafnemer, M. Benmiloud, F. Jean, Y. Chitour

Study of the L^p-asymptotic stability of the one-dimensional linear damped wave equation with Dirichlet boundary conditions in $[0, 1]$, with $p \in (1, \infty)$. Proof that the semi-group associated with the previous equation is well-posed and exponentially stable.

7.3 Optimal control under uncertainties for the vertical landing of the first stage of a reusable launch vehicle

Participants: F. Jean, C. Leparoux

7.3.1 Structure of optimal control for planetary landing with control and state constraints

C. Leparoux, B. Hérissé, F. Jean

Study a vertical powered descent problem in the context of planetary landing, considering glide-slope and thrust pointing constraints and minimizing any final cost. Proof of the Max-Min-Max or Max-Singular-Max form of the optimal control, study of the number of the singular and boundary arcs in more specific cases.

7.3.2 On the Accessibility and Controllability of Statistical Linearization for Stochastic Control: Algebraic Rank Conditions and their Genericity

R. Bonalli, C. Leparoux, B. Hérissé, F. Jean

Study of sufficient conditions for the accessibility and controllability of statistical linearization. We establish simple sufficient Lie-algebraic conditions for the accessibility and controllability of statistical linearization, and show that they are generic with respect to the drift and the initial condition.

7.3.3 Robust Motion Planning using Statistical Linearization

R. Bonalli, C. Leparoux, B. Hérissé, F. Jean

New approach of the robust motion planning problem, using a deterministic approximation which avoids the computational difficulties of stochastic optimal control. Proof of convergence of the method and application to the powered descent of a space vehicle.

7.4 Personalized and time-varying convex optimization

Main participants: A. Simonetto, E. Dall'Anese (UCBoulder), I. Notarnicola (U Bologna), G. Notarstefano (U Bologna)

7.4.1 Time-varying convex optimization: predictions and filtering

A. Simonetto, E. Dall'Anese

Study of continuous optimization problems that change over time due to external changes. A typical case is

$$\min_{x \in \mathbf{R}^n} f(x;t),$$

for a cost function parametrized over time t. If the time dependence is hidden in data streams y, then we look at the stochastic case $\min_{x \in \mathbf{R}^n} \mathbf{E}[f(x;y(t))]$, looking at expectations. We focus on first-order algorithms, and non-linear system parallels.

7.4.2 Personalized optimization: shape-constrained learning

A. Simonetto, E. Dall'Anese, I. Notarnicola, G. Notarstefano

Study of continuous optimization problems where the cost is comprised of a known engineering cost and a user's personal cost, which needs to be learned, as

$$\min_{x \in \mathbf{R}^n} f(x;t) + \sum_{i=1}^{N} U_i(x),$$

where the U_i are user's costs that are unknown and needs to be learned (N is the number of users). We focus on bandit-like settings, and shape-constrained learning for determining the best U_i that satisfies structural constraints. Some tools here are kernel methods and convex regressions.

7.5 Optimization, games, fairness, and society

Main participants: A. Simonetto, I. Notarnicola (U Bologna), F. Fabiani (IMT Lucca)

7.5.1 Learning for generalized Nash equilibrium problems

A. Simonetto, F. Fabiani

We focus on generalized Nash equilibrium problems, for time-varying and personalized equilibrium problems. This study takes most of the setting from Section 7.4, and focuses it for variational inequalities problems, such as equilibrium problems. Here we also look at hypo-monotonic games with regularizations by incentive design.

7.5.2 Incentive design in networks

A. Simonetto, F. Fabiani

Study of generalized Nash equilibrium problems similar to before, but that are coupled with linear systems. This problem models, e.g., digital market regulations design when influencers and the companies that pay them compete and play a mayor role.

7.5.3 Incentive and fairness via optimization with feedback

A. Simonetto, I. Notarnicola

Study of algorithmic fairness and equitability in the long term, for optimization algorithms with feedback. These algorithms can be used to design subsidies in developed and under-developed countries, therefore imposing equitability as a constraint is key. However, equitability may be ill-defined, and it has to be learned while the algorithm runs.

7.6 Learning in structured language data

Main participants: A. Simonetto, E. Mauduit

7.6.1 Hierarchical graph coarsening

A. Simonetto, E. Mauduit

Based on real short-response text data, the study extracts clusters of most important themes linked with the answers, and organizes these clusters in a hierarchical way via tool such as graph coarsening. We also study various data mining algorithms as well as regularizations in optimization to extract the most representative clusters and themes.

7.7 Optimization and quantum computing

Main participants: A. Simonetto, S. Elloumi, Z. Verchere, L. Madden (UCBoulder)

7.7.1 Compilation of quantum circuits

A. Simonetto, L. Madden, S. Elloumi, Z. Verchere

Study how to best compile quantum circuit on real hardware to minimize depth or the number of qubits. We look at continuous optimization techniques, such as stochastic optimization and sketching, as well as combinatorial techniques. We also look at specific compilation for the circuits arising in binary polynomial optimization.

7.7.2 Efficient quantum embeddings for combinatorial optimization

A. Simonetto, S. Elloumi, J. Mikael (EDF)

Study how to best embed combinatorial optimization problems into a quantum circuit. An example is the sub-graph isomorphism problem.

7.8 Stochastic calculus via regularizations

Participants: F. Russo, P. Vallois

This monograph constitutes a self-contained contribution to stochastic analysis mixing probability functional analysis and pathwise techniques. It is a comprehensive book starting from elementary concepts in probability. It formulates the state of the art of stochastic calculus beyond semimartingales

7.9 Irregular Stochastic Analysis

Participants: F. Russo

7.9.1 Backward Stochastic Differential Equations with no driving martingales and pseudo-PDEs

A. Barrasso, F. Russo

A class of Backward Stochastic Differential Equations (BSDEs) with no driving martingale are discussed. When the randomness of the driver depends on a general Markov process X, those BSDEs are denominated Mar- kovian BSDEs. Moreover they can be associated to a deterministic problem, called Pseudo-PDE. That problem constitutes the natural generalization of the parabolic semilinear PDE which naturally appears when the underlying filtration is Brownian.

7.9.2 Crandall-Lions viscosity solutions for path-dependent PDEs: the case of heat equation.

A. Cosso, F. Russo

One develops a theory of viscosity solutions à la Crandall-Lions for path-dependent partial differential equations (PDEs), namely PDEs in the space of continuous paths $C([0,T];\mathbb{R}^d)$. Path-dependent PDEs can play a central role in the study of certain classes of optimal control problems, as for instance optimal control problems with delay.

7.9.3 Fokker-Planck equations with terminal condition and related McKean probabilistic representation

L. Izydorczyk, N. Oudjane, Nadia, F. Russo, G. Tessitore

Usually Fokker-Planck type partial differential equations (PDEs) are well-posed if the initial condition is specified. In this paper, alternatively, we consider the inverse problem which consists in prescribing final data: in particular we give sufficient conditions for existence and uniqueness. In the second part of the paper we provide a probabilistic representation of those PDEs in the form a solution of a McKean type equation corresponding to the time-reversal dynamics of a diffusion process.

7.9.4 Gâteaux type path-dependent PDEs and BSDEs with Gaussian forward processes

A. Barrasso, F. Russo

One focuses on path-dependent semilinear PDEs, where the derivatives are of Gâteaux type in specific directions k and b, being the kernel functions of a Volterra Gaussian process X. Under some conditions on k, b and the coefficients of the PDE, one proves existence and uniqueness of a decoupled mild solution, a notion introduced in a previous paper by the authors. One also shows that the solution of the PDE can be represented through BSDEs where the forward (underlying) process is X.

7.9.5 On some path-dependent SDEs involving distributional drifts

A. Ohashi, F. Russo and A. Teixeira

One studies (strong and in law) existence and uniqueness of a class of non-Markovian SDEs whose drift contains the derivative in the sense of distributions of a continuous function.

7.9.6 McKean SDEs with singular coefficients

E. Issoglio, F. Russo

One investigates existence and uniqueness for a stochastic differential equation (SDE) with distributional drift depending on the law density of the solution. Those equations are known as McKean

SDEs. The McKean SDE is interpreted in the sense of a suitable singular martingale problem. A key tool used in the investigation is the study of the corresponding Fokker-Planck equation.

7.10 Gravitationnal dynamical systems

7.10.1 Isochrone selfgravitating systems : Hamiltonian dynamics

J. Perez, P. Ramond

We revisit the classical problem of motion in isochrone potentials, from the point of view of Hamiltonian mechanics. First, we use a particularly well-suited set of action-angle coordinates to solve the dynamics, showing that the well-known Kepler equation and eccentric anomaly parametrisation are valid for any isochrone orbit (and not just Keplerian ellipses). Second, by using the powerful machinery of Birkhoff normal forms, we provide a self-consistent proof of the isochrone theorem, that relates isochrone potentials to parabolae in the plane, which is the basis of all literature on the subject. Along the way, we show how some fundamental results of celestial mechanics such as the Bertrand theorem and Kepler's third law are naturally encoded in the formalism.

7.10.2 Isochrone selfgravitating systems : galaxies properties

J. Perez, A. Mazur, T. Valour

We study the emergence of the isochrone property in the formation process of isolated galaxies.

7.11 Algorithms for nonconvex optimization problems

Main participants: S.-M. Grad, F. Lara, R.T. Marcavillaca (both University of Tarapacá, Chile), V.T. Phan (University of Southampton, UK), J. Puangpee (Chiang Mai University, Thailand)

7.11.1 Algorithms for solving generalized convex optimization problems

S.-M. Grad, F. Lara, R.T. Marcavillaca

Extensions of proximal point algorithms known to solve convex optimization problems beyond convexity, e.g. for problems involving different subclasses of quasiconvex functions.

7.11.2 Algorithms for solving generalized convex equilibrium problems

S.-M. Grad, F. Lara, R.T. Marcavillaca, V.T. Phan

Extensions of proximal point algorithms known to solve convex equilibrium problems and variational inequalities for similar problems involving different subclasses of quasiconvex functions.

7.11.3 Algorithms for solving fractional programming problems

S.-M. Grad, J. Puangpee

New proximal point type algorithms for solving fractional programming problems and continuous versions for them by means of dynamical systems.

7.12 Algorithms for vector optimization problems

Main participants: S.-M. Grad, T. Illés, P.R. Rigó (both Corvinus University of Budapest, Hungary), A. Grad (Babeș-Bolyai University of Cluj-Napoca, Romania), A.G. Gebrie (Debre Berhan University, Ethiopia)

7.12.1 Algorithms for solving smooth multiobjective optimization problems

S.-M. Grad, T. Illés, P.R. Rigó

New fully implementable descent-type algorithms for solving smooth multiobjective optimization problems.

7.12.2 Algorithms for solving nonsmooth vector optimization problems

S.-M. Grad, A. Grad, A,G, Gebrie

New full-splitting proximal point methods for vector-minimizing the sum of two cone-convex vector functions, of which at least one is nonsmooth.

7.13 Mirror-descent type algorithms for convex optimization problems

Main participants: S.-M. Grad, S. Bitterlich (Chemnitz University of Technology, Germany), A.G. Gebrie (Debre Berhan University, Ethiopia)

7.13.1 Mirror-descent type algorithms for solving structured convex optimization problems

S.-M. Grad, A,G, Gebrie

New full-splitting mirror-descent type methods for minimizing the sum of finitely many convex extended real-valued functions not assumed to be Lipschitz-continuous

7.13.2 Accelerated stochastic mirror-descent type algorithms for solving convex optimization problems

S.-M. Grad, S. Bitterlich

New fast stochastic full-splitting mirror-descent type methods for minimizing the sum of finitely many convex extended real-valued functions, with the additional goal of providing convergence statements for the generated iterative sequences (not only for the function values).

7.14 Optimality conditions for nonconvex optimization problems

Main participants: S.-M. Grad, M. Abbasi (University of Isfahan, Iran), M. Théra (University of Limoges, France), M. Fajardo (University of Alicante, Spain), J. Vidal-Nuñez (University of Alcalá, Spain)

7.14.1 Optimality conditions via sup-subdifferentials

S.-M. Grad, M. Abbasi, M. Théra

New Fermat-type characterizations of (local) optimal solutions to nonconvex optimization problems by means of the notion of sup-subdifferential.

7.14.2 Optimality conditions for evenly convex problems

S.-M. Grad, M. Fajardo, J. Vidal-Nuñez

Investigations on duality and optimality for optimization problems consisting in minimizing evenly convex functions, possibly subject to evenly convex constraints.

7.15 Investigations on connections between differential inclusions, generalized monotone operators, and optimization problems

Main participants: S.-M. Grad, S. Adly, M. Théra (both University of Limoges, France), M.N. Dao (Royal Melbourne Institute of Technology, Australia)

Study of the asymptotic behavior of the solutions of differential inclusions governed by structured maximally monotone operators, and by operators endowed with generalized monotonicity properties. When taking the involved monotone operators to be subdifferentials of (generalized) convex functions, new results on the solution sets of (generalized) convex optimization problems should be derived. We also aim to derive algorithms for solving (generalized) monotone inclusions and (generalized) convex optimization problems via discretizations of the considered dynamical systems.

7.16 Neural networks for mixed variational inequalities and equilibrium problems

Main participants: S.-M. Grad, V.T. Phan (University of Southampton, UK), G. Pany(Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar, India)

We aim to build and implement neural networks based on the currently best (in terms of costs and velocity) methods for solving mixed variational inequalities and mixed equilibrium problems. They will be used on concrete applications in fields like optimization, transportation, machine learning, signal processing etc.

7.17 Solving large scale discrete location and covering problems

S. Elloumi, Z. Ales, C. Duran

New strategies for exact solutions of large scale p-median problems.

With DGA, we consider the problem of covering a set of earth units by a connected high altitude telecommunication network. The problem is how to locate the network in order to maximize the units covering. We are interested in introducing strong modelizations of this problem and developping efficient resolution algorithms for its resolution.

7.18 Uncertainty in Discrete optimization

Z. Ales, S Elloumi

We introduce a novel way of handling uncertain data scenarios by building solutions whose variation from a scenario to another is as small as possible.

Z. Ales, S Elloumi, C. Duran, N. Jorquera-Bravo

We study a particular location problem, the p-center problem, where both the distances and the demands may vary in intervals. We show that the infinite set of scenarios can be reduced to a finite discrete set and this allows us to explore exact solution methods.

7.19 Polynomial optimization with integer variables

S. Elloumi, Z. Verchère

We investigate the problem of how to efficiently reformulate unconstrained polynomial optimization problems with binary variables into a linear problem.

S. Elloumi, A. Lambert, E. Rodriguez-Heck, Y. Crama

Again for the unconstrained polynomial optimization problems with binary variables, we consider reformulations into quadratic problems and study the impact of this step on the whole solution method.

S. Elloumi, A. Lambert, G. Trombettoni, B. Neveu

For the mixed-integer quadratically constrained quadratic programs, we make two approaches cooperate: the quadratic convex reformulation, based on semi-definite programming, and the interval methods with reliability aspects. This allows to build an efficient reliable exact solution method.

7.20 Optimization and Energy

S. Elloumi, N. Jorquera-Bravo, A. Plateau

We consider efficient design of hydrogen pipeline network which can be formulated by a polynomial optimization problem. We show that by discretizing the diameter values, the optimization problem becomes more realistic and more tractable.

7.21 Identification of optimal decision trees

Z. Alès, A. Lambert (CEDRIC laboratory, France), V. Huré (CEDRIC laboratory, France)

We introduce new models and algorithms to improve the construction of optimal decision trees in the context of supervised classification.

7.22 Learning variable and node selection in branch-and-bound algorithms

Z. Alès, S. Kedhad-Sidhoum (CEDRIC laboratory, France), Come Bissuel (EDF, France), Olivier Juan (EDF, France)

In collaboration with EDF and in the context of repeated problems, we propose learning approaches to improve the choices of the next variable to branch on or the next open node to consider in branch-and-bound algorithms.

8 Scientific production

Papers

[1] Zacharie Alès and Sourour Elloumi. Minimizing recovery cost of network optimization problems. *Networks*, August 2022.

[2] Adrien Barrasso and Francesco Russo. Backward Stochastic Differential Equations with no driving martingale, Markov processes and associated Pseudo Partial Differential Equations. *Journal of Stochastic Analysis* , 3(1), 2022.

[3] Adrien Barrasso and Francesco Russo. Gâteaux type path-dependent PDEs and BSDEs with Gaussian forward processes. *Stochastics and Dynamics*, 22:2250007,, 2022.

[4] Thomas Bittar, Pierre Carpentier, Jean-Philippe Chancelier, and Jérôme Lonchampt. A Decomposition Method by Interaction Prediction for the Optimization of Maintenance Scheduling. *Annals of Operations Research*, January 2022.

[5] Thomas Bittar, Pierre Carpentier, Jean-Philippe Chancelier, and Jérome Lonchampt. The stochastic Auxiliary Problem Principle in Banach spaces: measurability and convergence. *SIAM Journal on Optimization*, 32(3):1871–1900, September 2022.

[6] Andrea Cosso and Francesco Russo. CRANDALL-LIONS VISCOSITY SOLUTIONS FOR PATH-DEPENDENT PDES: THE CASE OF HEAT EQUATION. *Bernoulli*, 28:481–503, 2022.

[7] Cristian Durán Mateluna, Zacharie Alès, and Sourour Elloumi. An efficient Benders decomposition for the p-median problem. *European Journal of Operational Research*, November 2022.

[8] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-Inertial Proximal Point Type Algorithms for Quasiconvex Minimization. *Journal of Global Optimization*, 2022.

[9] Lucas Izydorczyk, Nadia Oudjane, Francesco Russo, and Gianmario Tessitore. Fokker-Planck equations with terminal condition and related McKean probabilistic representation. *Nonlinear Differential Equations and Applications*, volume 29(10), 2022.

[10] Meryem Kafnemer, Mebkhout Benmiloud, Frédéric Jean, and Yacine Chitour. Lp-asymptotic stability of 1D damped wave equations with localized and linear damping. *ESAIM: Control, Optimisation and Calculus of Variations*, January 2022. 32 pages.

[11] Clara Leparoux, Bruno Hérissé, and Frédéric Jean. Structure of optimal control for planetary landing with control and state constraints. *ESAIM: Control, Optimisation and Calculus of Variations*, 28, 2022.

[12] Luca Mencarelli, Julien Floquet, Frédéric Georges, and Dominique Grenier. Mixed integer (non)linear approaches for the satellite constellation design problem. *Optimization and Engineering*, September 2022.

[13] Ivano Notarnicola, Andrea Simonetto, Francesco Farina, and Giuseppe Notarstefano. Distributed Personalized Gradient Tracking with Convex Parametric Models. *IEEE Transactions on Automatic Control*, pages 1–1, 2022.

[14] Ana Ospina, Andrea Simonetto, and Emiliano Dall'Anese. Time-Varying Optimization of Networked Systems With Human Preferences. *IEEE Transactions on Control of Network Systems*, pages 1–12, 2022.

[15] François Pacaud, Pierre Carpentier, Jean-Philippe Chancelier, and Michel de Lara. Optimization of a domestic microgrid equipped with solar panel and battery: Model Predictive Control and Stochastic Dual Dynamic Programming approaches. *Energy Systems*, July 2022.

[16] Cyrille Vessaire, Jean-Philippe Chancelier, Michel de Lara, Pierre Carpentier, Alejandro Rodríguez-Martínez, and Anna Robert. Multistage Optimization of a Petroleum Production System with Material Balance Model. *Computers & Chemical Engineering*, 167:108005, November 2022.

HDR manuscripts

[1] Andrea Simonetto. *Optimizing through change for cyber-physical and social systems*. Habilitation à diriger des recherches, Institut Polytechnique de Paris, September 2022.

PhD manuscripts

[1] Alan Teixeira Nicacio de Messias. *Stochastic Analysis of non-Markovian irregular phenomena*. Theses, Institut Polytechnique de Paris ; Universidade federal da Paraíba (Brésil), February 2022.

Conferences

[1] Zacharie Alès, Sourour Elloumi, M. Yassine Naghmouchi, Adèle Pass-Lanneau, and Owein Thuillier. Planification optimisée du déploiement d'un réseau de télécommunication multitechnologie par dispositifs aéroportés sur un théâtre d'opérations extérieures. In *23ème congrès annuel de la Société Française de Recherche Opérationnelle et d'Aide à la Décision*, Villeurbanne - Lyon, France, February 2022. INSA Lyon.

[2] Zacharie Alès, Sourour Elloumi, and Adele Pass-Lanneau. Algorithmes de placement optimisé de drones pour la conception de réseaux de communication. In *Conference on Artificial Intelligence for Defense (CAID) 2022*, Actes de la 4ème Conference on Artificial Intelligence for Defense (CAID 2022), Rennes, France, November 2022. DGA Maîtrise de l'Information.

[3] Zacharie Alès, Valentine Huré, and Amélie Lambert. Modélisations d'arbres de décision optimaux. In *23ème congrès annuel de la société Française de Recherche Opérationnelle et d'Aide à la Décision (ROADEF 22)*, Lyon, France, February 2022.

[4] Zacharie Alès, Valentine Huré, and Amélie Lambert. New optimization models for optimal classification trees. In *32nd European Conference on Operational Research (EURO 2022)*, Espoo, Finland, July 2022.

[5] Nicola Bastianello, Andrea Simonetto, and Emiliano Dall'Anese. OpReg-Boost: Learning to Accelerate Online Algorithms with Operator Regression. In *Learning for Dynamics & Control Conference*, Stanford, United States, June 2022. Code available here https://github.com/nicola-bastianello/reg4opt.

[6] Cristian Durán Mateluna, Natalia Jorquera-Bravo, Zacharie Alès, and Sourour Elloumi. Robust MILP formulations for the two-stage p-Center Problem. In *PGMO Days 2022*, Palaiseau, France, November 2022.

[7] Filippo Fabiani, Andrea Simonetto, and Paul J. Goulart. Learning equilibria with personalized incentives in a class of nonmonotone games. In *European Control Conference*, London, United Kingdom, July 2022.

[8] Sorin-Mihai Grad. Recent trends in vector optimization. In *Workshop on Nonlinear Operator Theory*, Abuja, Nigeria, March 2022. African University of Science and Technology and Fields Institute.

[9] Sorin-Mihai Grad and Sandy Bitterlich. Stochastic incremental mirror descent algorithms with Nesterov smoothing. In *International Online Conference on Optimization - ICOP22*, Fez, Morocco, January 2022.

[10] Sorin-Mihai Grad and Sandy Bitterlich. Stochastic incremental mirror descent algorithms with Nesterov smoothing. In *Journées SMAI MODE 2022*, Limoges, France, June 2022. Loïc Bourdin.

[11] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Extending the proximal point algorithm beyond convexity. In *2nd International Conference on Nonlinear Applied Analysis and Optimization - ICNAAO & NMD-2022*, Varanasi, India, December 2022. Tanmoy Som.

[12] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Extending the proximal point algorithm beyond convexity. In *Variational Analysis and Optimisation Webinar*, On Line Streaming, France, April 2022.

[13] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Extending the proximal point algorithm beyond convexity. In *International Conference on Evolution in Pure and Applied Mathematics - ICEPAM-2022*, Bathinda, India, November 2022.

[14] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-inertial proximal point algorithms for problems involving strongly quasiconvex functions. In *GdR MOA Annual Days 2022*, Nice, France, October 2022. Samuel Vaiter.

[15] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-inertial proximal point algorithms for problems involving strongly quasiconvex functions. In *PGMODAYS 2022*, Palaiseau, France, November 2022.

[16] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-inertial proximal point algorithms for problems involving strongly quasiconvex functions. In *Workshop on Operational Research and Applied Statistics*, Ho Chi Minh City, Vietnam, August 2022.

[17] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-inertial proximal point algorithms for problems involving strongly quasiconvex functions. In *XIII International Symposium on Generalized Convexity and Monotonicity*, Arequipa, Peru, September 2022.

[18] Sorin-Mihai Grad, Felipe Lara, and Raul Tintaya Marcavillaca. Relaxed-inertial proximal point algorithms for problems involving strongly quasiconvex functions. In *XI International Seminar on Optimization and Variational Analysis – OVA11*, Alicante, Spain, September 2022.

[19] Frédéric Jean, Othmane JERHAOUI, and Hasnaa Zidani. A Mayer optimal control problem on Wasserstein spaces over Riemannian manifolds. In *18th IFAC Workshop on Control Applications of Optimization*, volume 55, pages 44–49, Gif-sur-Yvette, France, 2022.

[20] Clara Leparoux, Bruno Hérissé, and Frédéric Jean. Optimal planetary landing with pointing and glide-slope constraints. In *61st IEEE Conference on Decision and Control*, pages 4357–4362, Cancun, Mexico, 2022. IEEE.

[21] Liam Madden, Albert Akhriev, and Andrea Simonetto. Sketching the Best Approximate Quantum Compiling Problem. In *2022 IEEE International Conference on Quantum Computing and Engineering (QCE)*, Broomfield, CO, United States, September 2022. 10 pages, 4 figures, 1 table.

[22] Luca Mencarelli. An Outer Approximation Algorithm for 0-1 Polynomial Programming. In *HUGO 2022 - XV. Workshop on Global Optimization*, Szeged, Hungary, September 2022.

[23] Luca Mencarelli, Julien Floquet, Frédéric Georges, Baptiste Guillaud, and Wissal Mellouki. The Satellite Constellation Design Problem via MI(N)LP Boosted with a Genetic Algorithm. In *PGMO Days 2022*, Palaiseau, France, November 2022.

[24] Andrea Simonetto and Ivano Notarnicola. Achievement and Fragility of Long-term Equitability. In *Artificial Intelligence, Ethics, and Society (AIES)*, Oxford, United Kingdom, August 2022. 12 pages, 7 figures.

Books

[1] Frédéric Jean. Géométrie Différentielle et Application au Contrôle Géométrique. Lecture, April 2022.

[2] Francesco Russo and Pierre Vallois. *Stochastic calculus via regularizations*, volume 11 of *Bocconi & Springer Series*. Springer International Publishing, November 2022.

Prepublications

[1] Elena Bandini and Francesco Russo. Path-dependent SDEs with jumps and irregular drift: well-posedness and Dirichlet properties. working paper or preprint, November 2022.

[2] Riccardo Bonalli, Clara Leparoux, Bruno Hérissé, and Frédéric Jean. On the Accessibility and Controllability of Statistical Linearization for Stochastic Control: Algebraic Rank Conditions and their Genericity. 23 pages, July 2022.

[3] Pierre Carpentier, Jean-Philippe Chancelier, and Michel de Lara. Time Consistency for Multistage Stochastic Optimization Problems under Constraints in Expectation. working paper or preprint, August 2022.

[4] Andrea Cosso, Fausto Gozzi, Mauro Rosestolato, and Francesco Russo. Path-dependent Hamilton-Jacobi-Bellman equation: Uniqueness of Crandall-Lions viscosity solutions. working paper or preprint, April 2022.

[5] Cristian Durán Mateluna, Natalia Jorquera-Bravo, Zacharie Alès, and Sourour Elloumi. Robust MILP formulations for the two-stage weighted vertex p-center problem. working paper or preprint, April 2022.

[6] Filippo Fabiani, Andrea Simonetto, and Paul J. Goulart. Personalized incentives as feedback design in generalized Nash equilibrium problems. working paper or preprint, May 2022.

[7] Elena Issoglio and Francesco Russo. A PDE WITH DRIFT OF NEGATIVE BESOV INDEX AND LINEAR GROWTH SOLUTIONS. working paper or preprint, December 2022.

[8] Elena Issoglio and Francesco Russo. SDEs WITH SINGULAR COEFFICIENTS: THE MARTINGALE PROBLEM VIEW AND THE STOCHASTIC DYNAMICS VIEW. working paper or preprint, December 2022.

[9] Frédéric Jean, Othmane Jerhaoui, and Hasnaa Zidani. Deterministic optimal control on Riemannian manifolds under probability knowledge of the initial condition. working paper or preprint, September 2022.

[10] Clara Leparoux, Bruno Hérissé, and Frédéric Jean. Robust Motion Planning of the Powered Descent of a Space Vehicle. working paper or preprint, November 2022.

[11] Alberto Ohashi and Francesco Russo. ROUGH PATHS AND SYMMETRIC-STRATONOVICH INTEGRALS DRIVEN BY SINGULAR COVARIANCE GAUSSIAN PROCESSES. working paper or preprint, June 2022.

[12] Alberto Ohashi, Francesco Russo, and Alan Teixeira. ON SDEs FOR BESSEL PROCESSES IN LOW DIMENSION AND PATH-DEPENDENT EXTENSIONS. working paper or preprint, November 2022.