ROC Team

Operations Research, Combinatorial Optimization, Constraints
## Permanent Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Institution</th>
<th>Research Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christian Artigues</td>
<td>DR CNRS</td>
<td></td>
<td>Scheduling, integer programming, constraint programming</td>
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<tr>
<td>Denis Arzelier</td>
<td>DR CNRS</td>
<td></td>
<td>Mathematical programming and control, Applications of modern control techniques to aerospace control problems</td>
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<tr>
<td>Cyril Briand</td>
<td>PR UT3</td>
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<td>Scheduling, integer programming, multi-agent optimization</td>
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<tr>
<td>Patrick Esquirol</td>
<td>MC INSA</td>
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<td>Scheduling, constraint programming</td>
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<tr>
<td>Emmanuel Hébrard</td>
<td>CR CNRS</td>
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<td>Constraint programming</td>
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<tr>
<td>Laurent Houssin</td>
<td>MC UT3</td>
<td></td>
<td>Cyclic Scheduling, control of discrete-event systems, optimization for telecommunications and space.</td>
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<tr>
<td>Marie-José Huguet</td>
<td>PR INSA</td>
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<td>Scheduling, constraint programming, Multi-modal path computation</td>
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<tr>
<td>Nicolas Jozefowiez</td>
<td>MC INSA</td>
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<td>Vehicle routing, transportation, integer programming, multi-objective optimization, metaheuristics</td>
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<tr>
<td>Pierre Lopez</td>
<td>DR CNRS</td>
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<td>Scheduling, constraint programming, optimization under energy constraints</td>
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<tr>
<td>Julien Moncel</td>
<td>MC UT1</td>
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<td>Graph theory, identifying codes, complexity, scheduling</td>
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<tr>
<td>Sandra U. Ngueveu</td>
<td>MC INP</td>
<td></td>
<td>Vehicle routing, branch-and-cut-and price, optimization for energy</td>
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## Affiliated researcher: Alain Haït PR ISAE

Project planning and scheduling, robustness, integer programming

## Postdoc: Margaux NATTAF ATER INSA

Scheduling under energy constraints
# PhD Students

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Year</th>
<th>Research Topic</th>
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</thead>
<tbody>
<tr>
<td>Ulrich M. Aivodji</td>
<td>MESR</td>
<td>2017</td>
<td>Privacy aware path optimization</td>
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<tr>
<td>Francisco Barbosa</td>
<td>Mexico</td>
<td>2017</td>
<td>Optimization for computer vision</td>
</tr>
<tr>
<td>Simon Belieres</td>
<td>ANR</td>
<td>2019</td>
<td>Math programming for transportation problems</td>
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<tr>
<td>Ludivine Boche-Sauvan</td>
<td>CIFRE Airbus D&amp;S</td>
<td>2017</td>
<td>Satellite test sequencing</td>
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<tr>
<td>Mickael Capelle</td>
<td>CIFRE TAS</td>
<td>2018</td>
<td>Optimization for earth observation satellites</td>
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<tr>
<td>Jean Thomas Camino</td>
<td>CIFRE Airbus D&amp;S</td>
<td>2017</td>
<td>Integrated payload optimization for telecommunication satellites</td>
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<tr>
<td>Clément Carbonnel</td>
<td>MESR</td>
<td>2016</td>
<td>Complexity of CSP</td>
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<tr>
<td>Azeddine Cheref</td>
<td>ANR</td>
<td>2016</td>
<td>Integrated scheduling and routing</td>
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<tr>
<td>Pierre Coupechoux</td>
<td>MESR</td>
<td>2017</td>
<td>Identifying colorings in graphs</td>
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<tr>
<td>Idir Hamaz</td>
<td>MESR</td>
<td>2017</td>
<td>Robust cyclic scheduling</td>
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<tr>
<td>Estèle Glize</td>
<td>MESR</td>
<td>2019</td>
<td>Multiobjective branch and price algorithms for vehicle routing</td>
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<tr>
<td>Yun He</td>
<td>MESR</td>
<td>2017</td>
<td>Integer programing for energy-aware vehicle routing problem</td>
</tr>
<tr>
<td>Caroline Morin</td>
<td>MESR</td>
<td>2018</td>
<td>Resource-constrained project planning and scheduling</td>
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Research domains

Main goal

Find structural properties and propose solution approaches for combinatorial optimization problems

- Study of a wide variety of problems
  - Scheduling, transportation, resource allocation, graph optimization
- Advances in optimization paradigms
  - Integer programming, constraint programming, decomposition approaches, metaheuristics
- Integration of practical aspects in combinatorial optimization
  - Uncertainty, cooperation, multiple objectives, human factors

Applying our research to practical problems in
- Space/aeronautics
- Transportation, production and logistics
- Energy management
Large variety of combinatorial optimization problems

Mixed-integer linear programming

Scheduling problems

Graph optimization problems

Constraint satisfaction problems

Vehicle routing problems

Resource allocation problems
Solution approaches models and algorithms

- **Structural properties and complexity analysis**
  - Characterization of optimal solutions in scheduling problems, Parameterized complexity for CSPs, structural properties of identifying codes in graphs, polyhedral studies of vehicle routing & scheduling problems

- **Extended formulations and decomposition methods**
  - Branch-and-cut, branch-and-price for vehicle routing & scheduling problems, novel extended formulations for scheduling problems, combinatorial benders decomposition, hybrid constraint programming / integer programming methods

- **Constraint propagation and learning in tree search**
  - Fast filtering (constraint propagation) algorithms for global constraints, enhanced lazy clause generation methods and learning strategies in tree search, improved limited discrepancy search methods
Beyond combinatorial optimization
Incorporating real-word characteristics in the models and methods

- **Robustness**

  Scenario relaxation-based robust optimization, flexible structures in scheduling, activity insertion problem in project scheduling, reoptimization

- **Cooperation**

  Multi-agent optimization for cooperation in networks, multiagent scheduling, distributed optimization for privacy, game theory and multi-objective optimization for pareto optimal Nash equilibria

- **Multiple objectives**

  Multi-objective mathematical programming: column generation/branch & cut, hybrid multi-objective metaheuristics

- **Human factors/ergonomics**

  Decision support in scheduling & routing: work domain analysis for ecological interface
Applications

Applying our research to practical problems

- Space/aeronautics (CNES, Airbus D&S, TAS, Amadeus)

  Scheduling Philae’s experiments, frequency assignment & payload optimisation for telecom satellites, scheduling earth observations, disruption management for commercial aviation, space rendezvous problem, orbital collision avoidance

- Transportation, production and logistics (SNCF, DHL, MOBIGIS, ANR TTD)

  Railway inspection planning, door-to-door freight transportation, passenger multimodal itinerary planning, carpooling, assembly line scheduling

- Energy management (NEXTER, FJMHE/EDF, ECO-INNOVERA)

  Energy aware production & logistics, energy source selection optimization in hybrid vehicles, scheduling under energy constraints with non-linear efficiency functions
Perspectives (1/2)

- Mixed-integer linear and non linear programming
  - Semidefinite optimization and convex relaxations: toward certified computing
  - Piecewise linear bounding of non linear constraints and objectives: application to energy management
  - Decision making under uncertainty: stochastic approaches, recoverable robustness (e.g. ATHENA ANR project)

- Learning for optimization and optimization for learning
  - Integrated SAT and CP based approaches for optimization (e.g.: Thesis Mohamed Siala SAT-based scheduling and sequencing)
  - Frequence-pattern mining for column generation in vehicle routing problems
  - Fast convergence of learning methods via discrete optimization and constraint programming (ex: collab. INTEL)
  - Learning for multiobjective optimization

- Complexity of NP-hard constraints
  - Parametrized complexity and approximation for NP-hard constraint propagation
  - Kernelization: finding a logically equivalent problem whose size depends on a parameter (e.g.: thesis Clément Carbonnel)
Perspectives (2/2)

- **Optimization for Space**
  - Towards a generic solver for scheduling and resource allocation in exploration problems (follow-up Rosetta success)
  - Embedded optimization and control (MAC/ROC collaboration)
  - Integrated optimization for satellite design (ex: thesis Jean-Thomas Camino)

- **Agile optimization for supply chain and transportation**
  - Reactive scheduling and resource allocation for highly flexible and reconfigurable manufacturing and transportation
  - Decision support for connected enterprise at the operational level, impact on transportation problems
  - Privacy-aware optimization for supply chain and transportation (e.g. thesis Ulrich Aivodji - collab TSF) - link with game theory