ROC Team

Operations Research, Combinatorial Optimization, Constraints

Permanent Staff

Christian Artigues (head)	DR	CNRS		Scheduling, integer programming, constraint programming
Denis Arzelier	DR	CNRS		Mathematical programming and control, Applications of modern control techniques to aerospace control problems
Cyril Briand	PR	UT3		Scheduling, integer programming, multi-agent optimization
Patrick Esquirol	MC	INSA		Scheduling, constraint programming
Emmanuel Hébrard	CR	CNRS		Constraint programming
Laurent Houssin	MC	UT3		Cyclic Scheduling, control of discrete-event systems, optimization for telecommunications and space.
Marie-José Huguet	PR	INSA		Scheduling, constraint programming, Multi-modal path computation
Nicolas Jozefowiez	MC	INSA		Vehicle routing, transportation, integer programming, multi-objective optimization, metaheuristics
Pierre Lopez	DR	CNRS		Scheduling, constraint programming, optimization under energy constraints
Julien Moncel	MC	UT1		Graph theory, identifying codes, complexity, scheduling
Sandra U. Ngueveu	MC	INP		Vehicle routing, branch-and-cut-and price, optimization for energy

Affiliated researcher: Alain Haït PR ISAE  Project planning and scheduling, robustness, integer programming

Postdoc: Margaux NATTAF ATER INSA  Scheduling under energy constraints

PhD Students

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

Research domains

Main goal

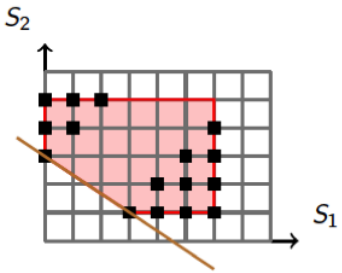
Find structural properties and propose solution approaches for combinatorial optimization problems

- 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

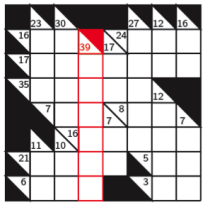
- Space/aeronautics
- Transportation, production and logistics
- Energy management

Large variety of combinatorial optimization problems



$2S_1 + 3S_2 \geq 9$

Mixed-integer linear programming

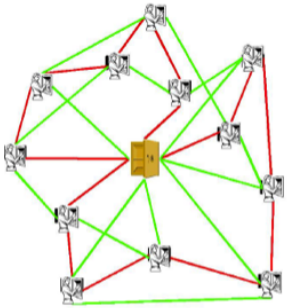


$\sum_{i=1}^{6} x_i = 39$

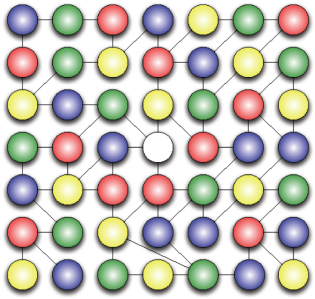
$\textsc{AllDifferent}(\{x_1, \ldots, x_6\})$

Constraint satisfaction problems

Scheduling problems



Vehicle routing problems



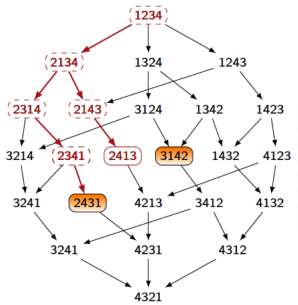
Graph optimization problems

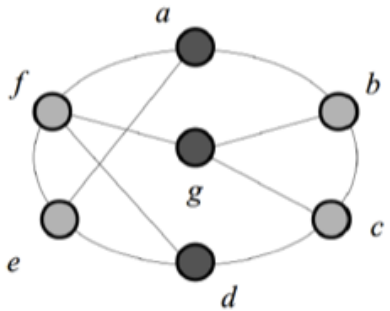
	Tue. am	Tue. pm	Wed. am	Wed. pm
Alice	✓			✓
Bob		✓		
Charlie	✓		✓	✓
Dave		✓	✓	
Eve		✓	✓	

Resource allocation problems

Solution approaches models and algorithms

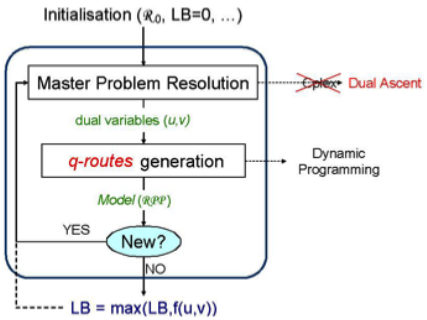
- Structural properties and complexity analysis





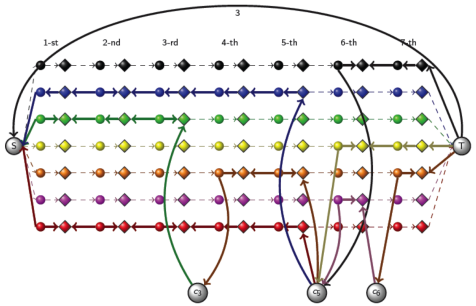
Characterization of optimal solutions in scheduling problems, Parameterized complexity for CSPs, structural properties of identifying codes in graphs, polyhedral studies of vehicle routing & scheduling problems

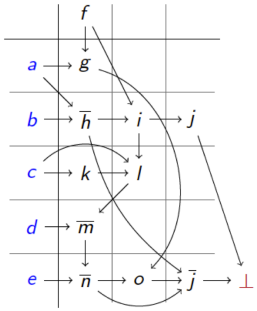
- Extended formulations and decomposition methods



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



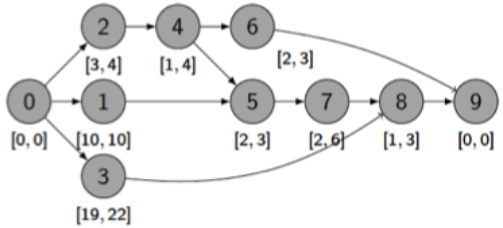


Fast filtering (constraint propagation) algorithms for global constraints, enhanced lazy clause generation methods and learning strategies in tree search, improved limited discrepancy search methods

Beyond combinatorial optimization

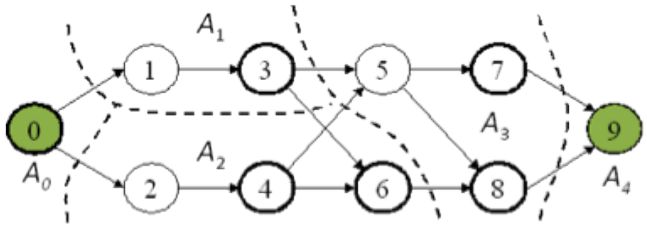
Incorporating real-word characteristics in the models and methods

- Robustness



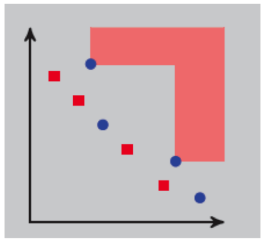
Scenario relaxation-based robust optimization, flexible structures in scheduling, activity insertion problem in project scheduling, reoptimization

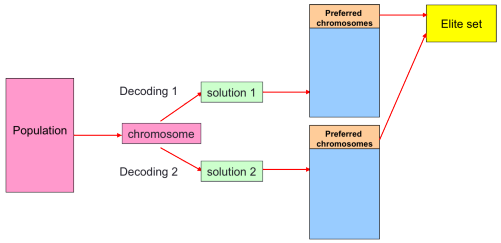
- Cooperation



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

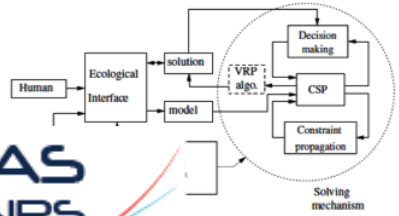
- Multiple objectives





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

- Human factors/ergonomics

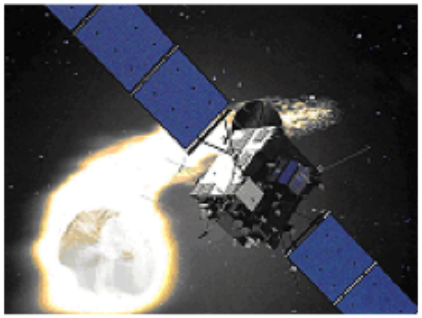


Decision support in scheduling & routing: work domain analysis for ecological interface

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, FJMH/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