

■ Wed.A.16

Wednesday, 11:30-13:00, Room 1.6, Organized Session

Aircraft conflict detection and resolution

Cluster: Global optimization and mixed-integer programming

Session organized by: *Laureano F. Escudero*

1. Aircraft conflict detection and resolution: A mixed-integer nonlinear optimization model by turn change maneuvers

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The aircraft collision detection and resolution problem in air traffic management by turn change maneuvers is presented. A two-step approach is presented. The first step consists of a nonconvex Mixed Integer Nonlinear Optimization (MINLO) model based on geometric constructions. The second step consists of a set of quadratic optimization models where aircraft are forced to return to their original flight plan as soon as possible once there is no aircraft in conflict. The main results of extensive computation are reported by comparing the performance of state-of-the-art nonconvex MINLO solvers and an approximation by discretizing the possible angles of motion for solving a Sequence of Integer Linear Optimization (SILO) models in an iterative way. Minotaur, one of the nonconvex MINLO solvers experimented with, gives better solutions but requires more computing time than the SILO approach. However, the latter requires only a short time to obtain a good feasible solution. Its value in the objective function has a reasonable goodness gap from the Minotaur solution.

2. Aircraft conflict detection and resolution by mixed-integer nonlinear optimization models by turn change maneuvers using a variable neighborhood search approach

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The aircraft Conflict Detection and Resolution (CDR) problem in air traffic management consists of finding a new configuration for a set of aircraft such that their conflict situations are avoided. A conflict situation occurs if two or more aircraft violate the safety distances that they have to keep during the flight. A geometric construction is used in order to detect the conflict situations between each pair of aircraft under consideration. In this paper we propose a VNS approach for solving the CDR by turn changes based on the reformulation of the problem as an unconstrained one by an exterior penalty function method. The first improvement local search and the shaking operator consist of changing direction of the aircraft by a given parameter and moving several aircraft at once by a random parameter based on the k -value of the VNS approach, respectively. This metaheuristic compares favourably with previous best known methods. It is worth to point out the astonishing time required to obtain the first feasible solution, which is crucial for this specific problem whose response time should be almost in real time in order to be useful in a real-life problem. A comparative study with up to 25 aircraft is presented.

3. Aircraft conflict avoidance by mixed-integer nonlinear optimization models combining turn and velocity change maneuvers

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Aircraft conflict detection and resolution is crucial in Air Traffic Management to guarantee air traffic safety. When aircraft sharing the same airspace are too close to each other according to their predicted trajectories, separation maneuvers have to be performed to avoid risks of collision. We propose new mixed-integer Nonlinear optimization models combining turn-changes and velocity-changes separation maneuvers. These separation maneuvers are performed by each aircraft at instant times which are decision variables of the problem, and each aircraft is allowed to perform only one type of maneuver. The pros and cons of the models are discussed.

■ Wed.A.17

Wednesday, 11:30-13:00, Room 1.7, Organized Session

Applications in design problems

Cluster: Applications of continuous optimization in science and engineering

Session organized by: *Jordi Castro*

1. Improvements of sequential and parallel bi-blending algorithms

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The semi-continuous quadratic mixture design problem is a bi-objective problem where the best robust design of a product has to be found. The design is based on mixing raw materials, subject to quadratic constraints and semi-continuity of the variables. The Pareto solution minimizes both the cost and the number of used raw materials. In the Quadratic Bi-Blending (QBB) problem, the Pareto front is determined by the simultaneous design of two products sharing raw materials, with their material availability limits. A specific Branch-and-Bound (B&B) algorithm for the QBB problem implies two B&B algorithms, one for each product, sharing the Pareto front and capacity constraints. In this way, the dimension of the search region for each B&B procedure is smaller than the combined search space. The algorithm aims at finding all solutions and determining the subspace where better designs can be found using higher accuracy of the solutions. The most time consuming part of the procedure is the combination of the finally obtained feasible sets of the two products. Here, we investigate a new B&B search strategy for QBB problems. The strategy performs a stepwise search with an iteratively increasing accuracy. Experimental results show an average improvement of 32% in the execution time when several combination steps are done, instead of just the final one. Additionally, a parallel version is presented, showing a better improvement in the execution time.

2. Protecting three-dimensional tables of data: An application of interior-point methods to statistical disclosure control

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National Statistical Agencies (NSAs) have to guarantee that disseminated data do not provide individual confidential information. To achieve this goal, statistical disclosure control techniques have to be applied to real data before publication. In this work we consider a particular technique for tabular data named "controlled tabular adjustment" (CTA). Given a statistical table, CTA looks for the closest safe table using some particular distance. In this work we focus on three-dimensional (3D) tables (i.e., tables obtained by crossing three variables) using the L1 distance. We show that L1-CTA in 3D tables can be formulated as a large linear optimization problem with block-angular structure. These problems are solved by a specialized interior-point algorithm for block-angular constraints matrices, which solves the normal equations by a combination of Cholesky factorization and preconditioned conjugate gradients. Computational results are reported for large instances, resulting in linear optimization problems of up to 50 millions variables and 25 millions constraints.

3. A global optimization method to solve engineering design problems

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Distribution based artificial fish swarm is a new heuristic for continuous global optimization. Based on the artificial fish swarm paradigm, the new algorithm generates trial points from the Gaussian distribution, where the mean is the target point and the standard deviation is the difference between the current and the target point. A local search procedure is incorporated into the algorithm aiming to improve the quality of the solutions. The adopted approach for handling the constraints of problem relies on a simple heuristic that uses feasibility and dominance rules. A comparison with a previous version, where the mean of the Gaussian distribution is the midpoint between the current and the target point, is investigated using a set of engineering design problems.

■ Wed.A.18

Wednesday, 11:30-13:00, Room 1.8, Organized Session

Robust optimization II

Cluster: Robust optimization and optimization in finance

Session organized by: *Huan Xu*

1. Efficient design of robust SVMs

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