Special Issue On Evolutionary Computation In Aerospace Sciences

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Guest Editorial

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In the aerospace sciences, many applications require the solution of global single and/or multi-objective optimization problems, including mixed variables, multi-modal, and non-differentiable quantities. From global trajectory optimization to multidisciplinary aircraft and spacecraft design, from planning and scheduling for autonomous vehicles to the synthesis of robust controllers for airplanes or satellites, evolutionary-based techniques have become an important – arguably inevitable – tool for tackling these kinds of problems, providing useful and non-intuitive solutions. Not only have aerospace sciences paved the way for the ubiquitous application of evolutionary computation, but moreover, they have also led to the development of new approaches and methods.

In the last two decades, evolutionary computation techniques have been used to find optimal trajectories, design optimal constellations or formations, evolve hardware, design robust and optimal aerospace systems (e.g. reusable launch vehicles, re-entry vehicles, etc.), evolve scheduled plans for unmanned aerial vehicles, improve aerodynamic design (e.g. airfoil and vehicle shape), optimize structures, and improve the control of aerospace vehicles.

In most cases, basic evolutionary heuristics have been hybridized with other techniques, such as gradient methods, set oriented techniques or branch and prune methods, or modified to better adapt to the specific application under investigation. This has led to the creation of new heuristics, new meta-heuristics, or new hybridizations that have proven very effective. However, the aerospace community and the evolutionary computation (EC) community have maintained a certain degree of separation. Many aerospace problems are still poorly known to the EC community and vice versa, with many EC techniques remaining poorly known to the aerospace community.

For this reason, in 2007 it was decided to organize a special session specifically addressing the topic of evolutionary computation in space within the 2007 IEEE Congress on evolutionary computation (CEC) in Singapore. The special session was intended to be a single forum wherein both the aerospace and EC communities could interact, exchanging research and ideas. The session was successful and attracted the attention of the organizers of the CEC. Thus, at the IEEE CEC in Trondheim in 2009, a second special session was organized. This second special session attracted over 17 papers; three of which were nominated for the best paper award. In 2010, a new special session on evolutionary computation in aerospace sciences was organized within the 2010 IEEE World Congress on computational intelligence (WCCI).

The main objective of this special issue is to portray the diverse efforts made in the application of evolutionary computation techniques, or related methods, to aerospace problems. The issue collects articles, written by researchers from around the globe, for a stimulating and synergetic discussion on recent advances in evolutionary methods for the solution of aerospace problems. In particular, articles describing evolutionary methods specifically devised, adapted, or tailored to address problems in aerospace applications, or evolutionary

methods that have been demonstrated to be particularly effective at solving aerospace-related problems.

This special issue collects extended and revised versions of some of the papers accepted in the special session at the WCCI 2010, plus a number of original contributions. From the optimal control of unmanned and manned aero-vehicles, to the single and multi-objective optimization of space trajectories, from the optimal design of airfoils, to the robust design of aerospace systems and the conceptual design of space missions, this special issue gives a unique overview on the state-of-the-art in evolutionary computation applied to aerospace problems.

This special issue is made of two parts. This first part collects a number of developments and applications of evolutionary computation to problems in aeronautics and aircraft design and control. The second part will be dedicated to space and a number of recent advances in single and multi-objective optimization for space mission design.

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