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MOO Methods for Multidisciplinary Design Using Parallel Evolutionary Algorithms, Game Theory and Hierarchical Topology: Numerical aspects and Implementation of Model Test Cases (Part 2)

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1. SUMMARY

These lecture notes describe the use and implementation of a framework in which mathematical as well as engineering optimisation problems can be analysed. The foundations of the framework and algorithms described -Hierarchical Asynchronous Parallel Evolutionary Algorithms (HAPEAs) - lie upon traditional evolution strategies and incorporate the concepts of a multi-objective optimisation, hierarchical topology, asynchronous evaluation of candidate solutions and parallel computing. In a step by step approach, the implementation of EAs and HAPEAs for solving multi criteria optimisation problems is conducted providing the reader with the knowledge to reproduce these hand on training in his – her- academic or industrial environment.

2. INTRODUCTION AND MOTIVATION

Design and optimisation in aeronautics are complex tasks as non-linearities, multi-objective, multidisciplinary considerations are involved in the optimisation procedure. In order to handle this level of complexity it is desirable to develop a system, which facilitates integration of a series of design tools, graphical user interfaces, post-processing capabilities and others to solve the problem, such a system is termed a framework. This lecture focuses on the requirements, development and implementation of a framework that uses evolutionary techniques and a series of analysis tools in which different multidisciplinary and multi-objective problems in aeronautics can be analysed. The fundamental idea with this framework is to simplify the task of integration to the user so he/she can focus on the problem itself. The idea on the development of this framework is a generic system that can be easily developed, maintained and extended.

The lecture is organized as follows: section 3 describes some of the requirements for a robust framework, section 4 describes the framework and its components, section 5 describes the implementation of the framework, section 6 describes the HAPEA algorithm, section 7 details the numerical implementation of HAPEA, section 8 describes and applies the methodology to mathematical and aeronautical design test problems and section 9 provides conclusions and avenues for future research.

3. REQUIREMENTS FOR A MULTI-OBJECTIVE MULTIDISCIPLINARY DESIGN OPTIMISATION (MDO) FRAMEWORK IN AERONAUTICS.

For a framework to be robust, practical and efficient it needs to satisfy a series of requirements, these can be subdivided in (i) problem formulation and (ii) optimisation methods, (iii) problem execution, (iv) architectural design and (v) information access [2-5,22,31,32,34].