A Study about Problem Size Influence in the Minimization of Constrained Weight of Skeletal Structures with Nash Genetic Algorithms

David Greiner[1], Jacques Periaux[2], José María Emperador[1], Blas Galván[1] and Gabriel Winter[1]

[1]Instituto Universitario de Sistemas Inteligentes y Aplicaciones Numéricas en Ingeniería (SIANI), Universidad de Las Palmas de Gran Canaria (ULPGC), Campus de Tafira Baja, 35017 Las Palmas de Gran Canaria, España
e-mail: david.greiner@ulpgc.es

[2]International Center for Numerical Methods in Engineering (CIMNE) - Universidad Politécnica de Cataluña, Campus Norte UPC, 08034 Barcelona, Spain
& IT Faculty, University of Jyväskylä, Finland
e-mail: jperiaux@gmail.com

ABSTRACT

Among the advances in meta heuristics and evolutionary algorithms for engineering design and optimization [1], their hybridization with game strategies has been shown in recent years as a methodology to improve performance and results of the optimum design procedure in computational engineering, particularly in aeronautical engineering and CFD problems [2], as well as in structural engineering problems [3].

In this study, we handle the use of virtual Nash genetic algorithms (Nash GAs) to speed up the optimization search. The minimum constrained weight optimization problem (taking into account constraints of allowable stresses and displacements) of high interest in structural engineering practice, is solved using a game-theory based Nash genetic algorithm (Nash GAs). This procedure performance is applied on different sets of variable splitting of the problem on two test case problems consisting of a discrete sizing cross-section types 55-member and 105-member skeletal steel structures (frame type) and compared with a standard panmictic genetic algorithm.

Numerical results of this approach of the structural test case indicate that a significant increase of performance can be achieved using the Nash strategy, both with significant advantages in algorithm robustness in finding the optimum design solution, and in convergence speed-up, illustrating the potential of Nash games for other complex engineering problems. Advantage of the Nash optimization approach is enhanced with the increment of the problem size.

REFERENCES

[1] D. Greiner, B. Galvan, J. Periaux, N. Gauger, K. Giannakoglou, G. Winter, *Advances in evolutionary and deterministic methods for design, optimization and control in engineering and sciences. In: Computational Methods in Applied Sciences*, Vol. 36, Springer, New York, 2015.

[2] J. Periaux, F. González, DSC. Lee, *Evolutionary optimization and game strategies for advanced multi-disciplinary design*. In: Intelligent Systems, Control and Automation: Science and Engineering Series. Vol. 75, Springer, New York, 2015.

[3] D. Greiner, J. Periaux, J.M. Emperador, B. Galván, G. Winter, "Game Theory Based Evolutionary Algorithms: A Review with Nash Applications in Structural Engineering Optimization Problems", *Arch Computat Methods Eng*, Vol. **24**, pp. 703-750, 2017.