

# Optimization Module for Abaqus/CAE based on Genetic Algorithm

K. Szajek<sup>1</sup>, W. Kacol<sup>2</sup>, T. Lodygowski<sup>1</sup> and M. Wierszycki<sup>1,2</sup>

<sup>1</sup>Institute of Structural Engineering, Poznan University of Technology, Piotrowo 5, Poland

<sup>2</sup>BudSoft, 61-807 Poznan, Sw.Marcin 58/64, Poland

**Abstract:** Genetic algorithms have become one of successful tools in design and topology optimization. The optimization module based on genetic algorithms was developed and employed in Abaqus/CAE by GUI and kernel scripting. The new module extends advanced functionality of Abaqus/CAE allowing to perform optimization directly in Abaqus Unified FEA product suite from SIMULIA. The genetic algorithms implemented in optimization approach are based on available GPL libraries. Significant improvement in evolving into optimal solution can be achieved when genetic algorithms are combined with neural networks which one can train by running Abaqus jobs, and substantially improve the efficiency of computations. In the paper the shape optimization problem of a tooth implant will be presented and discussed in detail. The particular Abaqus features useful in this application will be highlighted, as well. The presented approach seems to be extremely efficient in parallel computations.

**Keywords:** Design Optimization, Optimization.

## 1. Introduction

Genetic algorithms (GAs) have received wide popularity as optimization techniques during last decades and can compete successfully with the gradient-based approaches in many areas (Goldberg, 1989, Burczynski, 2004). GAs are stochastic search approaches which rely on the principle of the survival of fittest in natural selection. Unlike conventional optimization techniques GAs explore simultaneously the entire design space and therefore is likely to reach the global minimum. Improvement of global search process can be performed by incorporating in optimization neural networks (NN) which can learn and adapt changes over the time. In general, GAs require a lot computations (structural analysis in our case) and therefore high performance computing addresses ideally its needs, especially when combined with NN.

In the paper the process of optimization with the use of FEA, genetic algorithms and neural network is discussed. For a given criteria, based on finite number of solutions, better FE model is proposed. The existing open source libraries have been used: Galileo (for GA) and ffnnet (for NN). The whole optimization procedure was implemented with the use of Python scripting language. The FE model, numerical analysis and post-processing of results were performed with the use of the Abaqus Unified FEA product suite from SIMULIA. The integration of GA and NN libraries with FE tools was done by using the Abaqus Scripting Interface (ASI). The optimization was first performed solely with GA. The GA was used for fitness evaluation of a set of results obtained