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Infrastructure of a Knowledge Base for Optimization Algorithms and Problems

The goal of the Josef Ressel centre for heuristic optimization HEUREKA! is to research and develop self-adaptive meta-heuristics. This project aims to solve one of the preconditions of this undertaking: a database storing the entities involved in the testing of heuristic algorithms as well as in the analysis of optimization problems.

HeuristicLab
Database Design and Implementation
Heuristic Optimization
Optimization Algorithms and Problems

Introduction

Optimization, generally stated, deals with choosing the best solution for a given problem from a set of alternative solutions which satisfy given constraints. Optimization problems can be found in various disciplines including engineering, economy, biology, transportation, scheduling, manufacturing etc. There exist numerous and very different algorithms for this purpose, most of them developed for specific problem definitions.

Heuristic algorithms trade accuracy for computational speed, thus producing good results in reasonable time, but for which there is no proof of global optimality. These are used when the available resources are not enough to find optimal solutions with exact methods. Meta-heuristic algorithms are independent of a certain problem and use combination of different search strategies in order to adapt more easily to different search spaces.

The Josef Ressel centre for heuristic optimization HEUREKA! was officially started on October 1, 2008, with the goal of researching and developing powerful self- adaptive meta-heuristics. The idea that lies behind the goal is to analyze problem characteristics, test algorithms and evaluate the results. Based on the test results the meta-heuristics strategies are adapted and further developed. The tests are executed in HeuristicLab, a framework for developing and testing heuristic optimization methods and parameters.

This project aims to solve the main preconditions of the research started by the HEUREKA! centre: a database storing the entities involved in the testing of heuristic algorithms as well as in the analysis of optimization problems.

The first step was to understand the characteristics of the data used and generated by optimization tests. The data has two main sources: the user, who sets up problems and algorithms as well as builds and configures experiments, and the HeuristicLab engine, which executes the experiments and produces results.

Moreover we can say that the data belongs to four main groups: algorithms, problems, experiments and runs, which encapsulate the results. The requirements of a database, designed to store the optimization data, are analyzed and documented. The application, built to manipulate the database, was designed and implemented through four steps: the data access layer, first using the ADO.NET data access technology then the LINQ to SQL object-relational mapping tool; the implementation of a client-server architecture using the programming model provided by Windows Communication Foundation; a basic graphical user interface; and the design of a security infrastructure to maintain the permissions given on HeuristicLab entities, integrated in the knowledge base application.

The application developed through this project is aimed to be the basis for the knowledge base application integrated in the HeuristicLab framework, to facilitate the research and development of heuristic methods.