An Evolutive Computation Solution for the TSP: Possible Application to Organizations

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Summary

This Thesis researches a possible improvement in the performance of the solution of certain NP-hard combinatorial optimization problems . Examples of these are pure sequencing problems. A summary of conventional methods is presented, and a comparison with those belonging to the field of Evolutive Computation is made. Also, a proposal of eventual improvements to the latter is included. The practical applications discussed in this thesis are strongly related to administration, network design in general, and circuit design.

Introduction

As opposed to Philosophy and Psychology, which also deal with intelligence, the task of artificial intelligence is oriented to the creation and understanding of artificial intelligent entities. Artificial intelligence can be defined as the effort to develop computer-based systems (software y hardware) that act as intelligent entities. Some intelligent systems are supported on human experience and knowledge, and on reasoning patterns as well. Even though applications based on artificial intelligence are much more limited than those based on human intelligence, they are of great interest due to several reasons:

. To preserve the expertise of highly qualified people of an organization, in case they leave the organization.

. To store information in an active way to create an organizational knowledge data base from which the staff can study or even learn rules that are not written in books.

. To create a mechanism that is not subject to human errors caused, for example, by tiredness, worries, etc. This feature may be particularly useful when tasks are carried out in environments which are dangerous for human beings. For this same reason, it is also useful during crisis:

– To avoid tasks which are boring and unsatisfactory for human beings.

– To suggest solutions to specific, massive problems that are too complex to be analyzed by human beings in a short period of time, according to the knowledge base of the organization.

This thesis focuses on one of the areas belonging to artificial intelligence: evolutive computation, which involves a series of techniques to solve a wide variety of problems and is conceptually based on the method living organisms use to adapt to their environment, the evolution process. Some of the areas for which evolutive computation offers solutions are: optimization, product design, and industrial systems monitoring. This thesis is particularly focused on the optimization area, more specifically on the traveler problem (TSP). This is a pure sequencing problem very similar to scheduling problems, in particular, that of Flow-Shop Scheduling. The TSP is an interesting problem to solve from the mathematical and

computational viewpoints. It is also used as a tool in project administration, network design, circuit design, among others.

The aim of this thesis is to achieve, by means of the study and analysis of classic and evolutive mechanisms, a substantial growth in the performance of the solution of a hard-NP combinatorial optimization problem widely used in administration and industry: the problem of the commercial traveler. This is supported by the presentation of a series of results and their corresponding analysis; these results were obtained by incorporating possible improvements to an advanced evolutive algorithm, specially designed by Michalewicz, to solve the Euclidean TSP.

This thesis is divided in chapters. The first chapter provides a clear and concise definition of the traveler problem, as well as descriptions of some of its practical applications. The second chapter introduces the concept of evolutive computation, together with a detail of the different types of systems comprising it: Evolutive Strategies, Evolutive Programming, Genetic Programming, except for Genetic Algorithms. These are treated in chapter 3 with greater detail. Chapter 4 summarizes multiplicity characteristics in advanced evolutive algorithms, whereas chapter 5 describes a series of conventional methods to solve the TSP. The resolution of the TSP by means of genetic algorithms is included in chapter 6. An advanced evolutive algorithm specially designed for the Euclidean TSP is described in chapter 7, this algorithm is innovated by applying the multiplicity feature. Finally, the general conclusions of this thesis are included.