# VI Escuela de Verano en Sistemas Complejos

***Instituto de Sistemas Complejos de Valparaíso –ISCV-***

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## Abstract

Course
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# On the traveling salesman problem and solving combinatorial optimization problems

Though the computer sciences have made great progress in recent decades, there are important open questions concerning the inherent difficulty of certain combinatorial optimization problems. The class of problems referred to as NP-Complete are of special interest. Though many of these problems are easy to state, requiring little if any mathematical background to understand them, the development of efficient solution methodologies has proven elusive. In fact, the Clay Institute of Mathematics offers a million dollars for finding any such methodology, or proving that none exists.

Despite these important theoretical hurdles, there exists a practical interest in being able to solve NP-Complete problems. This due the frequency with which they appear in industry and engineering. In this course we will describe the basic concepts behind algorithms used to solve these types of problems in practice, using as an example the Traveling Salesman Problem. This problem can intuitively be described as follows: Consider a set of cities and a table indicating the distance between each pair of them. Define a tour as an ordering the cities, or equivalently, as a route through the cities, such that every city is visited exactly once, and such that it returns to its starting point. The traveling salesman problem consists in finding a tour of minimum total length.

This course is divided in three parts. First we discuss how to obtain upper bounds on the optimal solutions to the problem. For this we construct reasonably good tours using heuristics. Next we discuss how to obtain lower bounds on the optimum solution value. For this we relax certain problem conditions in order to obtain another problem which is easier to solve. Finally, we discuss how to successively refine these upper and lower bounds so as to find the optimal solution, or at least provide a tour with a precise quality estimate.

**Complementary material:**
(Download at www.iscv.cl)

[1] http://www.tsp.gatech.edu/
[2] http://en.wikipedia.org/wiki/Traveling_salesman_problem
[3] http://en.wikipedia.org/wiki/Computational_complexity_theory
[4] http://www.claymath.org/millennium/P_vs_NP/

An excellent source of material is the book: The traveling salesman problem: a computational study. By David L. Applegate, Robert E. Bixby, Vasek Chvátal and William J. Cook. For more information:

[5] http://www.tsp.gatech.edu/book/index.html