

New Developments on the Geometry of the Traveling Salesperson Problem

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Abstract

This work introduces a new mathematical interpretation of the solution space for the Traveling Salesperson Problem (TSP); which is a combinatorial optimization problem that has applications in many fields, from logistics and manufacturing to design and configuration of products. The proposed interpretation shows that all solutions are contained on the edge of a sliced spheroid. Thus, modeling the solution space from a novel perspective. The contribution of this paper is fourfold: First the development of a linear programming problem which objective function value leads to an upper bound on the Euclidean distance from a current feasible TSP solution to the optimal one; second, if the current feasible solution is optimal the solution of the later model will provide information that might aid in a further effort of confirmation; third once the bound on the distance is found the computer effort to achieve TSP optimally is realized; and finally a set of heuristics which are highly suitable for parallel graphical processing unit (GPU) computing are proposed. Numerical experimentation shows that the heuristics and the GPU implementation can efficiently find solutions with an average of 3.5% of the lower bound solutions for symmetric TSP, and an average of 4.15% for asymmetric best known benchmark solutions. In addition, the computer effort to achieve optimality is also shown for these instances.

Keywords

Heuristics, spheroid, parallel programming, traveling salesperson problem

Biographies

Federico Trigos is a full professor at EGADE Business School of Tecnologico de Monterrey in Mexico. He holds a PhD in Industrial Engineering with dissertation in large scale optimization (Georgia Institute of Technology), a master's in finance (EGADE Business School), a Master of Science in Industrial Engineering with major in Production Distribution and Material Handling (Georgia Institute of Technology), a master's in engineering with major in Operations Research (ITESM Campus Monterrey) and a Bachelor of Industrial and Systems Engineering (ITESM Campus Toluca). He is an active researcher publishing and leading at EGADE Business School areas related with the sustainable development of quantitative tools to optimize strategic organizational performance (prescriptive business analytics). His research interests include Industrial and business statistics, simulation, mathematical programming,

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Javier Gonzalez-Sanchez's research takes place at the intersection of software engineering and human-computer interaction; and, it is focused on self-adaptation, artificial emotional intelligence, and developing and advancing development approaches for intelligent systems. It is a transdisciplinary research that applies innovative technologies including brain-computer interfaces, eye-tracking, physiological sensors, gestures and posture recognition, and augmented and virtual reality devices, while taking advantage of cloud, parallel, and pervasive computing. He collaborates with cross-departmental and multidisciplinary teams embracing computer science, human-computer interaction, industrial engineering, and education technology.

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