

## Chapter 24

# Use of GVRP as a Model of Two Specific Real World Problems and Its Bioinspired Solution

**Jorge Rodas**

*Universidad Autónoma de Ciudad Juárez, Mexico*

**Alberto Ochoa-Zezzatti**

*Universidad Autónoma de Ciudad Juárez, Mexico*

**Daniel Azpeitia**

*Universidad Autónoma de Ciudad Juárez, Mexico*

**Raymundo Camarena**

*Universidad Autónoma de Ciudad Juárez, Mexico*

**Tania Olivier**

*Universidad Autónoma de Ciudad Juárez, Mexico*

### ABSTRACT

*The aim of this chapter is about the inclusion of real world scenarios, viewed as a Generalized Vehicle Routing Problem (GVRP) model problem, and treated by bio inspired algorithms in order to find optimum routing of product delivery. GVRP is the generalization of the classical Vehicle Routing Problem (VRP) that is well known NP-hard as generalized combinatorial optimization problem with a number of real world applications and a variety of different versions. Due to its complexity, large instances of VRP are hard to solve using exact methods. Thus a solution by a soft computing technique is desired. From a methodological standpoint, the chapter includes four bio inspired algorithms, ant colony optimization and firefly. From an application standpoint, several factors of the generalized vehicle routing are considered from a real world scenario.*

### INTRODUCTION

This chapter is interested in biologically inspired computing, a branch of natural computing (de Castro 2006) where algorithms inspired from nature are developed to solve highly complex problems, in particular problems that cannot be addressed in a satisfactory way with traditional approaches. Under this paradigm, algorithmic models of processes observed in nature are developed and implemented on computers to explore solution spaces.

In the scientific literature, there is a growing interest in the exchange of ideas between natural systems and computational systems. Bio-inspired algorithms are representative of this trend and have been

DOI: 10.4018/978-1-4666-9779-9.ch024

applied to a large variety of problems, including optimization problems. Among them, Vehicle Routing Problems (VRP) have generated a lot of attention, because they are inherently complex and hold a central place in real-world distribution activities.

Dantzig and Ramser (1959) proposed VRP for the first time with the objective to design optimum routing of a fleet of gasoline delivery trucks between a depot and a large number of service stations. VRP is a generic name given to a whole class of problems in which a set of routes for a fleet of vehicles based at one or several depots must be determined for a number of geographically dispersed customers (Laporte et al., 1989, 2002; Calvete et al., 2004; Baldacci et al., 2010). A depot, a set of geographically dispersed customers with demands, and a set of vehicles define it with capacity. In addition, customers must be visited exactly once and the total customer demand of a route must not exceed the vehicle capacity (Clarke & Wright, 1964; Laporte et al., 2002; Novoa et al., 2006). Its objective is to find a collection of  $K$  simple ways each corresponding to a vehicle route with minimum cost, distance or time.

To achieve this objective, high number of research has been conducted on VRP to design and develop different models and optimization methods. VRP models are differed by inclusion or exclusion of different restrictions. The commonly used restrictions on capacity of vehicle, total time, windows time, precedence relations between pairs of destinations, the number of depots (Laporte, 1992; Madsen et al., 1995; Paolo & Daniele, 2002; Chenghua & Xiaofeng, 2011) and others.

It is common to find the well-known travelling salesman problem (TSP), a canonical combinatorial optimization problem, widely studied in the scientific literature mentioned above. Given a graph with a number of vertices and a cost associated with each arc, the TSP looks for a least cost tour that visits each vertex exactly once (where the cost of a tour is the sum of its arc costs) (Lawler et al., 1985). In vehicle routing problems, side constraints are introduced to limit the number of vertices that can be visited with a single tour, thus leading to solutions that cover all vertices with different routes that start from and end at a particular vertex, called the depot. These problems are used to model various real-world applications. In the manufacturing sector, for example, they model transportation activities within the supply chain, that is, the movement of goods from suppliers to factories and then to customers. In the service sector, they include activities such as mail delivery, garbage collection, and public transportation, in another. (Potvin, 2009).

The chapter is organized as follows. Section 2 introduces a brief overview of the general Vehicle Routing Problem (VRP). Then, Sections 3 to 6 introduce the selected four bio-inspired algorithms, namely Ant Colony Optimization (ACO) and Firefly (FF, in this order, and describe their application to two real world logistic problems treated as VRPs. Section 7 results obtained from the 4 algorithms application to real world problems are discussed. Concluding remarks follow in Section 8.

## **VEHICLE ROUTING**

The aim of vehicle routing is to determine optimal collection or delivery routes for a fleet of vehicles in a transportation network (Laporte, 1992, 1997; Toth & Vigo, 2001). These NP-hard problems generalize the classical Traveling Salesman Problem (TSP) by requiring both an assignment of vertices to vehicles and a sequencing of these vertices within each vehicle route to obtain a solution. A large number of variants are reported in the literature, depending on the objective function to be optimized and the types of constraints to be satisfied. These variants are reviewed in the following.

17 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/use-of-gvrp-as-a-model-of-two-specific-real-world-problems-and-its-bioinspired-solution/145642](http://www.igi-global.com/chapter/use-of-gvrp-as-a-model-of-two-specific-real-world-problems-and-its-bioinspired-solution/145642)

## Related Content

---

### Orientation for Results: Focus on Knowledge and Popular Participation

Leila Maria dos Passos Ribeiro Melo, Joao Conrado de Amorim Carvalho and Emmanuel M.C.B. Sabino (2019). *Strategy and Superior Performance of Micro and Small Businesses in Volatile Economies* (pp. 281-302).

[www.irma-international.org/chapter/orientation-for-results/221194](http://www.irma-international.org/chapter/orientation-for-results/221194)

### The Marketing Implications of Value Chain Governance Strategies of Wine Products Using Geographical Indications (GIs) in Italy and UK

Raymond Hawkins-Mofokeng, Maurizio Canavari and Martin Hingley (2017). *International Journal of Food and Beverage Manufacturing and Business Models* (pp. 13-35).

[www.irma-international.org/article/the-marketing-implications-of-value-chain-governance-strategies-of-wine-products-using-geographical-indications-gis-in-italy-and-uk/196168](http://www.irma-international.org/article/the-marketing-implications-of-value-chain-governance-strategies-of-wine-products-using-geographical-indications-gis-in-italy-and-uk/196168)

### Science, Spiritualism, and Language: A Bond of Inseparableness With Life

Lily Kumari Padhy and Deepanjali Mishra (2019). *Science and Spirituality for a Sustainable World: Emerging Research and Opportunities* (pp. 85-97).

[www.irma-international.org/chapter/science-spiritualism-and-language/232775](http://www.irma-international.org/chapter/science-spiritualism-and-language/232775)

### Business Models of Sustainable Open Educational Resources (OER)

Shouhong Wang (2019). *International Journal of Applied Management Theory and Research* (pp. 1-16).

[www.irma-international.org/article/business-models-of-sustainable-open-educational-resources-oer/232709](http://www.irma-international.org/article/business-models-of-sustainable-open-educational-resources-oer/232709)

### How Spiritual Leadership Affects Job Satisfaction and Workplace Deviant Behavior (Study at the Regional Secretariat of the City of Palangkaraya)

Benny Hutahayan (2020). *International Journal of Applied Management Theory and Research* (pp. 61-73).

[www.irma-international.org/article/how-spiritual-leadership-affects-job-satisfaction-and-workplace-deviant-behavior-study-at-the-regional-secretariat-of-the-city-of-palangkaraya/244220](http://www.irma-international.org/article/how-spiritual-leadership-affects-job-satisfaction-and-workplace-deviant-behavior-study-at-the-regional-secretariat-of-the-city-of-palangkaraya/244220)