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Vehicle Routing Problem: Using Wisdom of Artificial Crowds and Genetic Algorithms

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*Abstract*—This paper presents a novel approach to solving the vehicle routing problem, a generalization of the Traveling Salesman Problem, using Wisdom of Artificial Crowds and genetic algorithms. It provides evidence showing improvements in route estimations over standard genetic algorithms at the cost of runtime.

*Index Terms*—Shortest path problem, Genetic algorithms, NP-hard, Routing

# INTRODUCTION

The Vehicle Routing Problem (VRP) is a generalization of the well-known Traveling Salesman Problem (TSP). VRP has been a topic of scientific publication since it was first introduced by George Dantzig and John Ramser in 1954 [1] and studied longer in its special TSP case with record of mathematicians Thomas Kirkman and W. R. Hamilton’s work as far back as the 1800s.

The context of the problem is that there is one depot with one or more vehicles that must deliver goods to one or more customers with preference to minimizing the cost of travel. This contrasts with TSP which only has one vehicle per depot. The problem is considered a non-deterministic polynomial-time hard problem due to its factorial complexity. Advancements in VRP have been of interest to many research domains including scheduling, controls, and more [2] and proven to be valuable for vital industries such as agriculture [3].

# Prior Work

## Genetic Algorithms

Genetic Algorithms were first introduced by John Holland in 1962 based on principles from biology, theoretical genetics, automata theory, and artificial adaptive systems [4]. They have been proven to be valuable tools for approximating solutions to problems subject to high time complexity when solved by formal methods with research applications in publication since 1967 [5].

## Wisdom of Artificial Crowds

“Wisdom of Crowds” (WOC) was first coined by James Surowiecki in 2004 where he argues, “Under the right circumstances, groups are remarkably intelligent, and are often smarter than the smartest people in them. Groups do not need to be dominated by exceptionally intelligent people in order to be smart. Even if most of the people within a group are not especially well-informed or rational, it can still reach a collectively wise decision” [6].

This concept of WOC has been applied to a variety of problems including TSP with promising results. Researchers at University of California, Irvine and the University of Adelaide observed the average performance of their aggregation method out performing even the best individual when applying WOC to the results of individuals’ attempts at producing optimal paths for TSPs [7].

“Wisdom of Artificial Crowds” (WoAC) is a metaheuristic algorithm inspired by the nature-based behavior utilized in WOC [8].

# Proposed Approach

## Genetic Algorithm

The genetic algorithm implemented is inspired by sexual reproduction of gametes in biology. This algorithm retains a constant population of “chromosomes” which are representations of possible solutions for the given problem. These chromosomes are a set of alleles that describe its performance. The algorithm makes use of two methods, crossover and mutation, to evolve the population overtime while weeding out the poor performers and mating the good performers through crossover.

# Experimental Results

## Data

## Results

# Conclusions

# Acknowledgements

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