Apprenticeship Learning from a Hyper-heuristic Mentor to Solve Vehicle Routing Problem

Extended Abstract

Raras Tyasnurita
Automated Scheduling, Optimisation and Planning Research Group, School of Computer Science,
University of Nottingham, United Kingdom
Raras.Tyasnurita@nottingham.ac.uk

ABSTRACT

Modelling real-world optimisation problems is not an easy task. Since the number of solutions grows exponentially with the size of the problem, an exhaustive search is expensive. A heuristic considers the computational speed is as important as the solution quality. It is a method derived from human intuition which applies educated guesses then checks the candidate solutions efficiently. A hyper-heuristic automates the design of heuristic optimisation method which generates or selects heuristics while solving hard computational problems. Automating the generation of hyper-heuristic based on apprenticeship learning seeks ways of putting relevant algorithmic components together through examples from a mentor. When the task is complicated, observing how the mentor demonstrates the action is more preferred since it is time consuming to create a manual. Successful implementation of artificial intelligence techniques show that a robot (apprentice) capable of mimicking and even outperform human (mentor). Using the same analogy of robot imitate human, this study constructs a new hyper-heuristic by utilising the expertise of a well-trained hyper-heuristic. This work collected a set of mentor traces in the form of data based on the relevant actions of the mentor while solving selected problem instances, then tested on the unseen cases to assess the generality. The empirical results indicate the success of apprenticeship learning algorithm achieves better performance than the mentor and compares favourably to the state-of-the-art methods.

KEYWORDS

hyper-heuristic, apprenticeship learning, vehicle routing problem

1 BACKGROUND

Imagine an organisation with a fleet of vehicles to deliver its products to customers. It might be a company who route several trucks to deliver/pickup goods, or a department who schedule regular visits for its personnel. Each organisation needs to determine the routes or sequence of stops to serve many orders, which minimise the overall operating cost. This example is called as Vehicle Routing Problem (VRP).

Think of it further; there are numerous options for this type of problem. For example, how to match order quantities with the vehicle capacity, pairing orders to be served on the same route, or take into account the customer demands of delivery time (time window) and the duration to unload products (service time).

Is it complex enough? How about serving hundreds to thousands of customers? Visualising VRP as a spider web of routes, you do not want to try every possible solution to check how much the cost incurred, comparing them, and pick the lowest one. Because this is an exhaustive search, you need to run the computer program for a very long time.

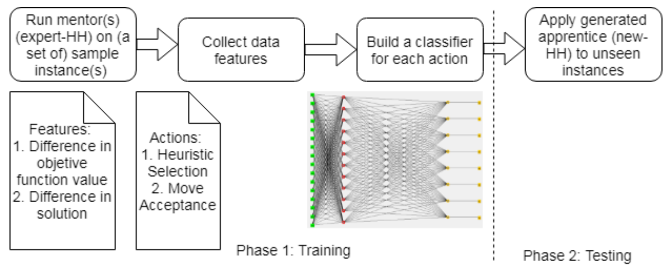

Figure 1: Proposed Framework

Research shows that a global optima would not be isolated but surrounded by many local minima. It means that the local minima are already a good enough solution if it has fulfilled the company budget. Consequently, sacrificing a guarantee of finding an optimal solution for the higher speed is preferable, and perhaps also guarantee of obtaining at least a certain level of solution quality, which is the aim of heuristic method.

2 PROPOSED METHOD

A hyper-heuristic defines a sequence of heuristics to find optimal solutions. Rather than generating a hyper-heuristic from scratch, this study propose an apprenticeship learning which not only record the behaviours from the well-trained hyper-heuristic, but also the pattern that could not be captured by the mentor. Apprenticeship learning is a branch of machine learning whose learning based on a mentor demonstration. It programs computers to optimise a performance criterion using the training data or experience. Artificial Neural Network as an apprenticeship learning algorithm is applied because of its flexibility to model a wide range of non-linear behaviour. Consequently, our proposed approach is classified in two phases of training (data generation,classifiers construction) and testing[1] [2]. The process flow is illustrated in Figure 1.

REFERENCES

[1] Raras Tyasnurita, Ender Özcan, and Robert John. 2017. Learning heuristic selection using a time delay neural network for open vehicle routing. In *IEEE Congress on Evolutionary Computation (CEC)*. 1474–1481.

[2] Raras Tyasnurita, Ender Özcan, Asta Shahriar, and Robert John. 2015. Improving performance of a hyper-heuristic using a multilayer perceptron for vehicle routing. In *The 15th UK Workshop on Computational Intelligence (UKCI)*.