extensible and flexible by nature. However, they suffer from the curse of dimensionality (i.e. the inability to solve large-scale problems within a reasonable amount of time and computing resources). Thus this type of optimizer is not suitable for solving large-scale VRPs with numerous constraints of different types which is a computationally taxing task, where finding a feasible solution is not trivial. Examples of such general-purpose mathematical optimizers include Google OR tools, Gurobi, CPLEX, etc.

[0005] As such, large-scale VRPs are often solved with routing optimizers based on heuristics algorithms and are capable of obtaining a good quality solution within a reasonable amount of time and computing resources. These heuristics-based optimizers are often specialized, developed to solve a particular variant of routing constraint/problem (e.g. with capacity and/or time windows) and do not offer much extensibility and flexibility. Moreover, the heuristics implemented are tuned for the intended variant and often do not do well when solving a different variant of the constraint/problem. This is the no-free-lunch theorem of algorithms which roughly states that no one algorithm is better than all others in solving a given problem – in other words, all algorithms have their own strengths and weaknesses depending on the properties of the problem at hand (e.g. type of constraints, problem size, etc). Examples of such specialized VRP optimizers include OptimoRoute, Circuit, Bringoz, etc.

[0006] There is thus a need to devise a novel method and system for adaptively identifying an optimal model to select a route to a location to address the issues, more particularly, to marry the benefits of exact (flexibility and extensibility) and heuristics (scalability and performance) methods.

[0007] Furthermore, other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

Summary

[0008] In a first aspect, the present disclosure provides a method for adaptively identifying an optimal model to select a route to a location, comprising: providing one or more first models based on a routing characteristic associated with the location; retrieving one or more first parameters associated with the routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter; selecting the optimal model from the one or more first models based on the effectiveness; generating a second model from the optimal model; determining if an effectiveness of the second model in minimizing the route expense parameter is greater than that of the optimal model; and setting the second model as the optimal model in response to a result of the determination.

[0009] In a second aspect, the present disclosure provides a system for adaptively identifying an optimal route connecting a plurality of destinations, the system comprising: at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code configured to, with at least one processor, cause the server at least to, comprising: provide one or more first models based on a routing characteristic associated with the location; retrieve one or more first parameters associated with the routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter; select the optimal model from the one or more first models based on the effectiveness; generate a second model from the optimal model; determine if the effectiveness of the second model in minimizing the route expense parameter is greater than that of the optimal model; and set the second model as the optimal model in response to a result of the determination.

[0010] Additional benefits and advantages of the disclosed embodiments will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various embodiments and features of the specification and drawings, which need not all be provided in order to obtain one or more of such benefits and/or advantages.

Brief Description of the Drawings

[0011] Embodiments and implementations are provided by way of example only, and will be better understood and readily apparent to one of ordinary skill in the art from the following written description, read in conjunction with the drawings, in which:

[0012] Figure 1 shows a block diagram illustrating a system for adaptively identifying an optimal model to select a route to a location according to various embodiments of the present disclosure.

[0013] Figure 2 shows a block diagram illustrating various components of a system for adaptively identifying an optimal model to select a route to a location according to an embodiment of the present disclosure.

[0014] Figure 3 shows a flow chart illustrating a method for adaptively identifying an optimal model to select a route to a location according to an embodiment of the present disclosure.

[0015] Figure 4 shows a flow diagram illustrating relationships of entities according to an embodiment of the present disclosure.

CLAIMS

1. A method for adaptively identifying an optimal model to select a route to a location, comprising:

providing one or more first models based on a routing characteristic associated with the location;

retrieving one or more first parameters associated with the routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter;

selecting the optimal model from the one or more first models based on the effectiveness;

generating a second model from the optimal model;

determining if an effectiveness of the second model in minimizing the route expense parameter is greater than that of the optimal model; and

setting the second model as the optimal model in response to a result of the determination.

2. The method of claim 1, wherein the step of retrieving one or more first parameters associated with a routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter comprises:

for the each of the one or more first models, generating at least one of a first route to the location, a first vehicle type, a first distance, a first time and a first load of the location, and wherein the step of selecting the optimal model from the one or more first models comprises:

identifying the at least one of the first route to the location, the first vehicle type, the first distance, the first time and the first load of the location of one of the one or more first models as those of the optimal model.

3. The method of claim 1 or 2, wherein the one or more first parameters comprises at least one of a location coordinate, a distance, a time, a load and a number of items to be unloaded/picked up at the location; a type, a load capacity, a speed and a capability of a vehicle; a number of available vehicles; and an accumulated time constraint, an

accumulated distance constraint, an accumulated load constraint, a route sequence constraint, an arrival time window constraint and a vehicle type constraint associated with the location.

4. The method of any one of claims 1-3, wherein the step of retrieving one or more first parameters associated with a routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter comprises:

for the each of the one or more first models, determining a value of the route expense parameter based on the one or more first parameters of the each of the one or more first models, a high value in the route expense parameter indicating a low effectiveness in minimizing the route expense parameter, wherein the step of selecting the optimal model from the one or more first models is based on the value of the route expense parameter.

5. The method of claim 4, further comprising:

applying a weightage to the value of the route expense parameter of the each of the one or more first models; wherein the step of selecting the optimal model from the one or more first models is based on the weighted value of the route expense parameter .

6. The method of any one of claim 1-5, wherein the route expense parameter relates to at least one of a load balancing cost, a travel time, a travel distance, a vehicle usage and an accumulated load at the location.

7. The method of claim 1, wherein the step of generating the second model from the optimal model comprises:

generating at least one of a second route to the location, a second vehicle type, a second distance, a second time and a second load of the location, and wherein the step of setting the second model as the optimal model in response to a result of the determination comprises:

identifying the at least one of the second route to the location, the second vehicle type, the second distance, the second time and the second load of the location of the second model as those of the optimal model.

8. The method of claim 7, the step of generating the second route to the location comprises one of:

(a) adding a new location to the route; or

(b) wherein the location is one of a plurality of locations and the route to the location selected by the optimal model is a route connecting the plurality of locations in a sequence, removing the location from the route, or switching the sequence of the location and another location of the plurality of locations.

9. The method of any one of claims 1-8, further comprising:

determining if the effectiveness of the second model is greater than an effectiveness of a previously generated second model.

10. The method of any one of claim 1-9, wherein the second model is one of a plurality of second models and the generation of the second model is based on a weightage, the second model having a highest weightage as compared to that of the remaining of the plurality of second models.

11. The method of claim 10, further comprising:

increasing/decreasing the weightage of the second model in response to the result of the determination of the effectiveness of the second model.

12. The method of any one of claims 1-11, further comprising:

determining if a total number of second models generated or a total processing time exceed a pre-configured threshold condition, the total processing time representing a total time spent in adaptively identifying the optimal model to select the route to the location, wherein the generation of the second model from the optimal route is carried out in response to determining the total number of second models or the total processing time does not exceed the pre-configured threshold condition.

13. The method of any one of claims 1-12, wherein the route is one of a plurality of routes to different locations, and the optimal model to select the plurality of routes to the different locations is adaptively identified.

14. A system for identifying an optimal route connecting a plurality of destinations, the system comprising:

at least one processor; and

at least one memory including computer program code;

the at least one memory and the computer program code configured to, with at least one processor, cause the server at least to, comprising:

provide one or more first models based on a routing characteristic associated with the location;

retrieve one or more first parameters associated with the routing characteristic to determine an effectiveness of each of the one or more first models in minimizing a route expense parameter;

select the optimal model from the one or more first models based on the effectiveness;

generate a second model from the optimal model;

determine if the effectiveness of the second model in minimizing the route expense parameter is greater than that of the optimal model; and

set the second model as the optimal model in response to a result of the determination.

15. The system of claim 14, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to, further:

for the each of the one or more first models, generate at least one of a first route to the location, a first vehicle type, a first distance, a first time and a first load of the location; and

identify the at least one of the first route to the location, the first vehicle type, the first distance, the first time and the first load of the location of one of the one or more first models as those of the optimal model.

16. The system of claim 14 or 15, wherein the one or more first parameters comprises at least one of a location coordinate, a distance, a time, a load and a number of items to be unloaded/picked up at the location; a type, a load capacity, a speed and a capability of a vehicle; a number of available vehicles; and an accumulated time constraint, an accumulated distance constraint, an accumulated load constraint, a route sequence constraint, an arrival time window constraint and a vehicle type constraint associated with the location.

17. The system of any one of claims 14-16, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to, further:

for the each of the one or more first models, determine a value of the route expense parameter based on the one or more first parameters of the each of the one or more first models; a high value in the route expense parameter indicating a low effectiveness in minimizing the route expense parameter, wherein the step of selecting the optimal model from the one or more first models is based on the value of the route expense parameter.

18. The system of claim 17, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to further:

apply a weightage to the value of the route expense parameter of the each of the one or more first models; wherein the step of selecting the optimal model from the one or more first models is based on the weighted value of the route expense parameter.

19. The system of any one of claims 14-18, wherein the route expense parameter relates to at least one of a load balancing cost, a travel time, a travel distance, a vehicle usage and an accumulated load at the location.

20. The system of claim 14, wherein, to generate the second model from the optimal model, the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to:

generate at least one of a second route to the location, a second vehicle type, a second distance, a second time and a second load of the location:

identify the at least one of the second route to the location, the second vehicle type, the second distance, the second time and the second load of the location of the second model as those of the optimal model.

21. The system of claim 20, to generate the second route to the location, the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to perform one of:

(a) an addition of a new location to the route; or

(b) wherein the location is one of a plurality of locations and the route to the location selected by the optimal model is a route connecting the plurality of locations in a sequence, a removal of the location from the route, or a switching of the sequence of the location and another location of the plurality of locations.

22. The system of any one of claims 14-21, further comprising:

determining if the effectiveness of the second model is greater than an effectiveness of a previously generated second model, wherein the setting of the second model as the optimal model is carried out in further response to determining the effectiveness of the second model being greater than the effectiveness of the previously generated second model.

23. The system of any one of claims 14-22 wherein the second model is one of a plurality of second models and the generation of the second model is based on a weightage, the second model having a highest weightage as compared to that of the remaining of the plurality of second models.

24. The system of claim 23, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to further:

increase/decrease the weightage of the second model in response to the result of the determination of the effectiveness of the second model.

25. The system of any one of claims 20-24, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the server at least to further:

determine if a total number of second models generated or a total processing time exceed a pre-configured threshold condition, the total processing time representing a total time spent in adaptively identifying the optimal model to select the route to the location, wherein the generation of the second model from the optimal route is carried out in response to determining the total number of second models or the total processing time does not exceed the pre-configured threshold condition.

26. The system of any one of claims 14-25, wherein the route is one of a plurality of routes to different locations, and the system is configured to adaptively identify the optimal model to select the plurality of routes to the different locations.