

CLAIMS

What is claimed is:

1. A system for bipartite matching in a transportation problem, the system comprising:
one or more processors; and
a memory having instructions stored therein, the instructions, when executed by the one or more processors, causing the one or more processors to:
receive a first set of transportation consumers and a second set of transportation suppliers;
create a minimum priority queue for each unmatched transportation consumer of the first set, wherein the minimum priority queue for each unmatched transportation consumer of the first set comprises unmatched transportation suppliers of the second set;
determine a first set of edge data in which lower-bound reduced costs for matching each unmatched transportation consumer with the unmatched transportation suppliers is less than or equal to zero;
determine an exact cost of each edge data in the first set of edge data; and
match each unmatched transportation consumer of the first set with an unmatched transportation supplier of the second set based on the exact cost of each edge data in the first set of edge data to find an augmenting path,
wherein when the step of matching is unsuccessful such that an augmenting path is not found by the matching, the one or more processors is further caused to determine a lower-bound of a minimum reduced cost of the first set of edge data by initializing a candidate value as the minimum reduced cost for which the exact cost has been determined, the minimum reduced cost being a minimum of the reduced costs, and
wherein the minimum priority queue is refined by the determined lower-bound of the minimum reduced cost.
2. The system of claim 1, wherein the memory further comprises instructions to cause the one or more processors to match each unmatched transportation consumer of the first set with an unmatched transportation supplier of the second set using a Breadth-first search (BFS) algorithm.

3. The system of claim 1 or claim 2, wherein the memory further comprises instructions to cause the one or more processors to give a first label to the first set of transportation consumers and a second label to the second set of transformation suppliers, and wherein the exact cost of each edge data is based on the lower-bound reduced costs, the first label and the second label.
4. The system of claim 3, wherein the memory further comprises instructions to cause the one or more processors to update the first label to obtain an updated first label and configured to update the second label to obtain an updated second label based on the minimum reduced cost.
5. The system of claim 4, wherein the memory further comprises instructions to cause the one or more processors to obtain the updated first label by addition of the first label with the minimum reduced cost and configured to obtain the updated second label by subtraction of the second label with the minimum reduced cost.
6. The system of claim 4 or claim 5, wherein the memory further comprises instructions to cause the one or more processors to determine if there are any unmatched transportation consumers, and configured to determine a second exact cost of each edge data based on the lower-bound reduced costs, the updated first label and the updated second label and configured to match the unmatched transportation consumers based on the second exact cost.
7. The system of any one of claims 1-6, wherein the memory further comprises instructions to cause the one or more processors to update the minimum priority queue for each unmatched transportation consumer of the first set after the exact cost of each edge data in the first set of edge data is determined by arranging the minimum priority queue according to an ascending order of the exact cost of each edge data.
8. The system of any one of claims 1-7, wherein the memory further comprises instructions to cause the one or more processors to update the minimum priority queue for each unmatched transportation consumer of the first set after the exact cost of each edge data in the first set of edge data is determined by removing unmatched transportation suppliers which have the lower-bound reduced costs for matching each unmatched transportation consumer of more than zero.

9. The system of any one of claims 1-8, wherein the first set of transportation consumers comprises a set of passengers and the second set of transportation suppliers comprises a set of drivers, and wherein the exact cost of each edge data in the first set of edge data is a distance between each passenger in the set of passengers and each driver in the set of drivers.

10. A method for bipartite matching comprising:

using one or more processors to:

receive a first set of transportation consumers and a second set of transportation suppliers;

create a minimum priority queue for each unmatched transportation consumer of the first set, wherein the minimum priority queue for each unmatched transportation consumer of the first set comprises unmatched transportation suppliers of the second set;

determine a first set of edge data in which lower-bound reduced costs for matching each unmatched transportation consumer with the unmatched transportation suppliers is less than or equal to zero;

determine an exact cost of each edge data in the first set of edge data;

match each unmatched transportation consumer of the first set with an unmatched transportation supplier of the second set based on the exact cost of each edge data in the first set of edge data to find an augmenting path,

wherein when the step of matching is unsuccessful such that an augmenting path is not found by the matching, the one or more processors is further caused to determine a lower-bound of a minimum reduced cost of the first set of edge data by initializing a candidate value as the minimum reduced cost for which the exact cost has been determined, the minimum reduced cost being a minimum of the reduced costs, and

wherein the minimum priority queue is refined by the determined lower-bound of the minimum reduced cost.

11. The method of claim 10, further comprising using the one or more processors to:

match each unmatched transportation consumer of the first set with an unmatched transportation supplier of the second set using a Breadth-first search (BFS) algorithm.

12. The method of claim 10 or claim 11, further comprising using the one or more processors to:

give a first label to the first set of transportation consumers and a second label to the second set of transportation suppliers, wherein the exact cost of each edge data is based on the lower-bound reduced costs, the first label and the second label.

13. The method of claim 12, further comprising using the one or more processors to:

update the first label to obtain an updated first label and configured to update the second label to obtain an updated second label based on the minimum reduced cost.

14. The method of claim 13, further comprising using the one or more processors to:

obtain the updated first label by addition of the first label with the minimum reduced cost; and

obtain the updated second label by subtraction of the second label with the minimum reduced cost.

15. The method of claim 13 or claim 14, further comprising using the one or more processors to:

determine if there are any unmatched transportation consumers;

determine a second exact cost of each edge data based on the lower-bound reduced costs, the updated first label and the updated second label; and

match the unmatched transportation consumers based on the second exact cost.

16. The method of any one of claims 10-15, further comprising using the one or more processors to:

update the minimum priority queue for each unmatched transportation consumer of the first set after the exact cost of each edge data in the first set of edge data is determined by arranging the minimum priority queue according to an ascending order of the exact cost of each edge data.

17. The method of any one of claims 10-16, further comprising using the one or more processors to:

update the minimum priority queue for each unmatched transportation consumer of the first set after the exact cost of each edge data in the first set of edge data is determined by removing unmatched transportation suppliers which have the lower-bound reduced costs for matching each unmatched transportation consumer of more than zero.

18. The method of any one of claims 10-17, wherein the first set of objects comprises a set of passengers and the second set of objects comprises a set of drivers, and wherein the exact cost of each edge data in the first set of edge data is a distance between each passenger in the set of passengers and each driver in the set of drivers.

19. A non-transitory computer-readable medium storing computer executable code comprising instructions for bipartite matching according to any one of claims 1 to 9.

20. The system of any one of claims 1-9, wherein the memory further comprises instructions to cause the one or more processors to populate the minimum priority queue in a lazy manner.

21. The system of any one of claims 1-9, wherein a key for the second set of transportation suppliers in the minimum priority queue is the lower-bound costs.

22. The system of any one of claims 1-9, wherein the memory further comprises instructions to cause the one or more processors to return to the step of the determining the first set of edge data from the minimum priority queue, wherein the step of determining the exact cost of each edge data in the first set of edge data comprises determining the exact cost of each edge data if the exact cost is not determined; and wherein the memory further comprises instructions to cause the one or more processors to end the instructions when either the first set of transportation consumers or the second set of transportation suppliers is fully matched.