

Claims

1. A logistic recommender system for automatically matching freight service to an order in the logistics business, the logistic recommender system comprising:

5 a processor, memory and instructions stored on the memory and executable by the processor to:

receive a plurality of driver and order data;

pre-process the received plurality of driver and order data and translate the plurality of driver and order data to form a training dataset expressed as a matrix of shape, $(n * b) \times m$, where

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n is the number of drivers,

b is the average number of biddings per driver, and

m is the length of a vector comprising the order_vector and the driver_profile_vector at time T;

15 train a model of a Siamese neural network with a triplet loss function based on the training dataset comprising instructions to: obtain the driver_profile_vector at a particular time point as an anchor, obtain one of the order_vector representing the order that the driver bid for at that time point as a positive_order_vector, obtain one of the order_vector representing the order that the driver did not bid for at that time point as a

20 negative_order_vector;

receive a driver_vector and an order_vector;

feed the driver_vector and the order_vector to the trained model to output a driver encoded vector and an order encoded vector;

calculate a cosine distance between the driver encoded vector and the order encoded vector; and

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classify a match in response to the cosine distance being less than a predetermined threshold.

2. The logistic recommender system according to claim 1 wherein the instruction to pre-process the received plurality of driver and order data and translate the plurality of driver and order data to form the training dataset comprises instructions to:

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generate an order_vector for each of the plurality of driver and order data, the order_vector representing a characteristic of an order that the driver has bid for bidding N at time T and containing order number, route, cargo weight, truck model type, price, pickup and dropoff time;

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generate a driver_activity_history_vector for each driver, the driver_activity_history_vector representing activity of the driver up to time T-1 when the driver made the bidding N and containing driver identification number, time stamp, location, route history, cargo weight history, truck model type history, price history, pickup history and dropoff time history;

generate a driver_stable_profile_vector for each driver, the stable_driver_profile_vector includes driver identification, truck type and preferred routes;

combine the driver_activity_history_vector and the driver_stable_profile_vector to form a driver profile vector; and

combine the order_vector and the driver profile vector to form the (n * b) rows in the matrix.

3. The logistic recommender system according to claim 2 wherein the instruction to combine the driver_activity_history_vector and the driver_stable_profile_vector to form the driver profile vector further comprises instructions to:

encode categorical variables in the driver profile vector into integer lists ; and

pad with replacement the integer lists to align the length of each integer list to a maximum length for that integer list.

4. The logistic recommender system according to claim 3 wherein the instruction to encode categorical features into integer lists is one of one-hot-encoding and integer encoding.

5. The logistic recommender system according to claim 3 wherein the instruction to combine the driver_activity_history_vector and the driver_stable_profile_vector to form the driver profile vector further comprises instructions to:

standardise numerical variables using z-score standardization which can be expressed in the following expression:

$$x' = (x - \text{mean}(X)) / \text{std}(X)$$

where x is one instance of a numerical variable, mean(X) is the mean of X, std(X) is the standard deviation of X, and x' is the standardized version of x.

6. The logistic recommender system according to claim 1 wherein the instruction to train the model of the Siamese neural network with the triplet loss function based on the training dataset further comprises instructions to:

feed the anchor, positive_order_vector and negative_order_vector to the Siamese neural network where two vectors along a horizontal axis are concatenated and thereafter flattened to a required length before applying the triplet loss function which can be expressed in the following expression,

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$$L(A, P, N) = \max(\|f(A) - f(P)\|^2 - \|f(A) - f(N)\|^2 + \alpha, 0)$$

where $f(A)$, $f(P)$, $f(N)$ are representation of the flattened anchor vector, positive vector and negative vector respectively, and α is a margin.

7. The logistic recommender system according to claim 6 wherein the instruction to
10 train the model of the Siamese neural network with the triplet loss function based on the training dataset further comprises instructions to:

repeat the training of the model for 200 epochs to obtained a trained model.

8. The logistic recommender system according to claim 1, wherein the predetermined
15 threshold is 0.8.

9. The logistic recommender system according to claim 1 further comprising instructions to:

receive a plurality of order_vectors;

20 feed each of the plurality of the order_vectors to the trained model to output a plurality of order encoded vectors;

calculate a cosine distance between the driver encoded vector and each of the plurality of the order encoded vectors;

25 recommend the order encoded vectors with cosine distance being less than 0.8.

10. A logistic recommender method for automatically matching freight service to an order in the logistics business, the logistic recommender method comprising:

receiving a plurality of driver and order data;

30 pre-processing the received plurality of driver and order data and translate the plurality of driver and order data to form a training dataset expressed as a matrix of shape, $(n * b) \times m$, where, n is the number of drivers, b is the average number of biddings per driver, and m is the length of a vector comprising the order_vector and the driver_profile_vector at time T ; and

35 training a model of a Siamese neural network with a triplet loss function based on the training dataset comprising obtaining the driver_profile_vector at a particular time point as an anchor, obtaining one of the order_vector representing the order that the driver bid

for at that time point as a positive_order_vector, obtaining one of the order_vector representing the order that the driver did not bid for at that time point as a negative_order_vector;

receiving a driver_vector and an order_vector;

5 feeding the driver_vector and the order_vector to the trained model to output a driver encoded vector and an order encoded vector;

calculating a cosine distance between the driver encoded vector and the order encoded vector; and

10 classifying a match in response to the cosine distance being less than a predetermined threshold.

11. The logistic recommender method according to claim 10 wherein the step of pre-processing the received plurality of driver and order data and translate the plurality of driver and order data to form the training dataset comprises:

15 generating an order_vector for each of the plurality of driver and order data, the order_vector representing a characteristic of an order that the driver has bid for bidding N at time T and containing order number, route, cargo weight, truck model type, price, pickup and dropoff time;

20 generating a driver_activity_history_vector for each driver, the driver_activity_history_vector representing activity of the driver up to time T-1 when the driver made the bidding N and containing driver identification number, time stamp, location, route history, cargo weight history, truck model type history, price history, pickup history and dropoff time history;

25 generating a driver_stable_profile_vector for each driver, the stable_driver_profile_vector includes driver identification, truck type and preferred routes;

combining the driver_activity_history_vector and the driver_stable_profile_vector to form a driver profile vector; and

30 combining the order_vector and the driver profile vector to form the (n * b) rows in the matrix.

12. The logistic recommender method according to claim 11 wherein the step of combining the driver_activity_history_vector and the driver_stable_profile_vector to form the driver profile vector further comprises:

encoding categorical variables in the driver profile vector into integer lists ; and

35 padding with replacement the integer lists to align the length of each integer list to a maximum length for that integer list.

13. The logistic recommender method according to claim 13 wherein the step of encoding categorical features into integer lists is one of one-hot-encoding and integer encoding.

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14. The logistic recommender method according to claim 13 wherein the step of combining the driver_activity_history_vector and the driver_stable_profile_vector to form the driver profile vector further comprises:

standardising numerical variables using z-score standardization which can be expressed in the following expression:

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$$x' = (x - \text{mean}(X)) / \text{std}(X)$$

where x is one instance of a numerical variable, $\text{mean}(X)$ is the mean of X , $\text{std}(X)$ is the standard deviation of X , and x' is the standardized version of x .

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15. The logistic recommender method according to claim 10 wherein the step of training the model of the Siamese neural network with the triplet loss function based on the training dataset further comprises:

feeding the anchor, positive_order_vector and negative_order_vector to the Siamese neural network where two vectors along a horizontal axis are concatenated and thereafter flattened to a required length before applying the triplet loss function which can be expressed in the following expression,

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$$L(A, P, N) = \max(\|f(A) - f(P)\|^2 - \|f(A) - f(N)\|^2 + \alpha, 0)$$

where $f(A)$, $f(P)$, $f(N)$ are representation of the flattened anchor vector, positive vector and negative vector respectively, and α is a margin.

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16. The logistic recommender method according to claim 15 wherein the step of training the model of the Siamese neural network with the triplet loss function based on the training dataset further comprises:

repeating the training of the model for 200 epochs to obtained a trained model.

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17. The logistic recommender method according to claim 10 , wherein the predetermined threshold is 0.8.

18. The logistic recommender method according to claim 10 further comprising: receiving a plurality of order_vectors;

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feeding each of the plurality of the order_vectors to the trained model to output a plurality of order encoded vectors;

calculating a cosine distance between the driver encoded vector and each of the plurality of the order encoded vectors;

5 recommending the order encoded vectors with cosine distance being less than 0.8.