CLAIMS

1. A method of generating a recommendation for a target user based on an input using a neural network, the input comprising an indication of the target user, the method comprising:

identifying a target user cluster to which the target user is assigned from a plurality of user clusters;

looking up in a stored table, cluster scores for a plurality of candidate recommendation options for the target user cluster, the stored table comprising cluster scores for each recommendation option of the plurality of recommendation options;

ranking the plurality of candidate recommendation options according to the cluster scores for the target user cluster;

selecting a target set of recommendation options from the plurality of candidate recommendation options according to the ranking of the plurality of candidate recommendation options;

calculating a set of user specific recommendation scores corresponding to the target set of recommendation options using the neural network;

ranking the target set of recommendation options using the user specific recommendations scores; and

generating a recommendation for the target user based on the ranking of the target set of recommendation options.

2. A method according to claim 1, wherein the input further comprises an indication of a location of the target user, and each recommendation option is associated with a location and wherein selecting a target set of recommendation options from the plurality of candidate recommendation options comprises selecting the target set of recommendation options from recommendation options associated with a location within a threshold distance of the location of the target user.

3. A method according to claim 1 or claim 2, wherein the recommendation options are merchants.

4. A method according to any preceding claim wherein calculating a set of user specific recommendation scores corresponding to the set of candidate recommendation options using the neural network comprises inputting contextual features into the neural network.

5. A method according to claim 4 wherein the input further comprises an indication of a time stamp and wherein the contextual features comprise a feature dependent on the timestamp.

6. A method according to any preceding claim wherein the recommendation for the target user comprises a ranked list of recommendation options.

7. A pre-training method in a recommendation system, the recommendation system comprising data storage for a neural network configured to generate recommendation scores for recommendation options, the neural network comprising a user subnetwork that maps user features onto a user embedding space, the method comprising:

training the neural network;

clustering users in the user embedding space using the user subnetwork of the trained neural network to generate embedding space user clusters;

calculating cluster scores for the embedding space user clusters for each of a plurality of recommendation options; and

storing the calculated cluster scores and the trained neural network in the data storage.

8. A method according to claim 7, wherein calculating cluster scores for the embedding space user clusters for each of a plurality of recommendation options comprises determining a cluster center embedding vector in the embedding space for each embedding space user cluster and calculating the cluster scores using the cluster center embedding vectors.

9. A computer readable medium carrying computer executable instructions which when executed on a processor cause the processor to carry out a method according to any one of the preceding claims.

10. A recommendation system for generating a recommendation for a target user based on an input, the input comprising an indication of the target user, the recommendation system comprising a processor, data storage, and program storage, the data storage storing a neural network and stored table, the neural network configured to generate recommendation scores for recommendation options, the stored table comprising cluster scores for each recommendation option of a plurality of recommendation options, the program storage storing computer program instructions operative by the processor to;

look up cluster scores for a plurality of candidate recommendation options for a target user cluster in the stored table;

rank the plurality of candidate recommendation options according to the cluster scores for the target user cluster;

select a target set of recommendation options from the plurality of candidate recommendation options according to the ranking of the plurality of candidate recommendation options;

calculate a set of user specific recommendation scores corresponding to the target set of recommendation options using the neural network;

rank the target set of recommendation options using the user specific recommendations scores; and

generate a recommendation for the target user based on the ranking of the target set of recommendation options.

11. A recommendation system according to claim 10 wherein the input further comprises an indication of a location of the target user, and each recommendation option is associated with a location and wherein the program storage stores computer program instructions operative by the processor to: select the target set of recommendation options from recommendation options associated with a location within a threshold distance of the location of the target user.

12. A recommendation system according to claim 10 or claim 11, wherein the recommendation options are merchants.

13. A recommendation system according to any one of claims 10 to 12 wherein the program storage stores computer program instructions operative by the processor to: calculating the set of user specific recommendation scores corresponding to the set of candidate recommendation options using the neural network by inputting contextual features into the neural network.

14. A recommendation system according to claim 13 wherein the input further comprises an indication of a time stamp and wherein the contextual features comprise a feature dependent on the timestamp.

15. A recommendation system according to any one of claims 10 to 14 wherein the recommendation for the target user comprises a ranked list of recommendation options.

16. A recommendation system according to any one of claims 10 to 15 wherein the neural network comprises a user subnetwork that maps user features onto a user embedding space and wherein the target user cluster corresponds to a user cluster in the user embedding space.

17. A recommendation system according to any one of claims 10 to 16 wherein the program storage stores computer program instructions operative by the processor to:

training the neural network;

cluster users in the user embedding space using the user subnetwork of the trained neural network to generate embedding space user clusters;

calculate cluster scores for the embedding space user clusters for each of a plurality of recommendation options; and

store the calculated cluster scores and the trained neural network in the data storage.

18. A recommendation system according to claim 17, wherein the program storage stores computer program instructions operative by the processor to: calculate the cluster scores for the embedding space user clusters for each of a plurality of recommendation options by determining a cluster center embedding vector in the embedding space for each embedding space user cluster and calculating the cluster scores using the cluster center embedding vectors.