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Research paper

The Design of Web Based Car Recommendation System using Hybrid Recommender Algorithm

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Abstract

Web based recommendations for any item is mandatory in E-commerce based web sites. This paper is about the design of web based car recommendation system using the hybrid recommender algorithm. The proposed hybrid recommender algorithm is the combination of user-to-user and item-to-item collaborative filtering method to generate the car recommendations. The user model is designed using demographic features, click data and browsing history. Item profile is built using the various attributes of car, 40 brands of car including 224 car types are used in this work. The synthetic dataset of 300 users with 10000 sessions is used to build user model. The proposed algorithm is evaluated with 100 real time users and shows the 83% accuracy in generating recommendations.

Keywords: *Collaborative Filtering algorithm, Recommendation system, Item profile, User model, Hybrid recommender system*

1. Introduction

Recommendation started on the beginning of humankind where humans used to recommend their fellow humans better way of hunting fishing and even to get fire. As the human population increases in the world, there is an increase in the number of product in the market. Due to globalization, there is an increase in the global trading which leads to a wide variety of items on a particular product e.g. to buy a soap, there are different types based on flavours, smell, brand (international) etc. it is equally applicable to cars also. As the number of vehicles in global market is increased, the information that any individual get on a particular product through internet is vast. People's craze towards car began from the Neolithic period, the last part of Stone Age when the invention of wheel was done. As the time passes, technology grew and stands on what we see today. Today most of the people are aware about what happens around them. As competition on the market increases, cars with similar features get into market. People will be confused on what to choose. Here recommendation algorithm plays the role since it helps the customers or end user in suggesting relevant product based on their taste. This research work is about web based recommender system on cars. The primary objective of this work is to recommend a car based on the user model and item profile. In this paper, a proposed hybrid recommender algorithm based on user-to-user and item-to-item collaborative filtering method is used to generate the car recommendations. The user model is designed with demographic features, click data and browsing history. Item profile is built using the various attributes of car. 40 brands of car including 224 car types are used in this work. The synthetic dataset of 300 users with 10000 sessions is involved in building user model. The proposed algorithm is tested with 100 real time users and shows the 83% accuracy in generating recommendations. This paper is organized in different sections as follows. Section 2 describes about Recommender Systems. Section 3 elaborates the various research work carried in this domain of recommending cars. Section 4 indicates the methodology applied in this domain. Section 5 specifies the conclusion and future work to be carried out in order to improve the performance of the system.

2. Recommender System (RS)

It is a software tool, which is used to recommend an item of interest for the user. By its design, RS is a personalized system for the user. Generally, RS is of great use for the users who lack experience / knowledge of choosing multiple alternatives and to evaluate the alternatives, which is more relevant than the others. There are two types of RSs. The first one is personalized RS and the second one is non-personalized RS. The more research is towards Personalized RS as its counterpart will be very generic in nature. Some of the examples of personalized RS include, movie RS, Item RS from Amazon, book recommendation, music recommendation etc. Individuals may seek the opinion (regarding book, music, CD, movie etc.) from others in order to make decisions. The core idea of the design of the RS revolves around this theme.

2.1 Reasons to Choose RS from Business Point of View

The following are the reasons of using RS in business domain.

To increase the sales.

- To sell more diverse items.
- To improve the user satisfaction.
- To increase the user loyalty.
- To better, understand the user requirements.

2.2 Components of RS

Users, Items, Transactions (Relations between user and RS) are the core components of a RS.

Items. Items are represented by a set of properties and features. Features of the items can be represented as a list representation, or as a set of attributes or as an ontological representation of the domain.

Users. RS can have multiple –diverse Users. In order to achieve personalization, different parameters like ratings of the user, demographic attributes like age, gender, profession, income etc, , behaviour attributes like browsing patterns, click stream data, search pattern etc , of the users are involved in the design of user models.

Transactions. It is a recorded interaction between a user and the RS. In general, transaction is a feedback (usually ratings) provided by the user. These ratings may be collected explicitly or implicitly.

- Numerical ratings such as the 1-5 stars provided in the book recommender associated with Amazon.com.
- Ordinal ratings such as "strongly agree, agree, neutral, disagree, strongly disagree" can indicate user opinion regarding an item (usually via questionnaire).
- Binary ratings indicate if a certain item is good or bad.
- Unary ratings indicate that a user has observed or purchased an item.
- tags indicated by the user with the items

In transactions, implicit ratings are collected based on the user's actions (search key, clicks, browse pages etc.)

2.3 Types of RS

Content-Based: This system recommends items that are similar to the other items that the user liked in the past. The similarity of items is calculated based on the features associated with the compared items.

Collaborative Filtering: This system is called as "people-to-people correlation." Collaborative filtering is considered to be the most popular and widely implemented technique in RS. It works on Neighborhood methods, which is focused on relationships between items or between users.

Demographic: This system recommends items based on the demographic profile of the user.

Knowledge-Based: This system recommends items based on specific domain knowledge about how certain item features meet users needs and preferences of the user. This system will work better than others at the beginning. But if they are not fully equipped with learning components, then it may fail.

Constraint-Based Systems: This system is similar to Knowledge based RS. This system recommends based on explicit rules about how to relate customer requirements with item features.

Community-Based: This system recommends items based on the preferences of the users friends.

Hybrid Recommender Systems: This is the combination of any above-mentioned techniques, which is used to recommend items to users.

3. Related Work

The design of feedback based collaborative filtering recommendation algorithm is discussed in [1]. This feedback component is of two levels external and internal. External feedback is to collect information from open platforms like automobile websites, social media etc. and internal feedback is to collect information from users who got recommendations. Extraction of various comments from the feedback added with recommender algorithm makes a hybrid model. There are limitations for this as the feedback component contains spam comments. In [2], dynamic recommendation algorithms for news domain are elaborated. In news domain, user profile will not be available and recommending news articles for the users by using dynamic algorithms becomes difficult. The top k ranked automobiles recommendations for a user is discussed in [3]. In [4], item-based collaborative filtering technique in a web based recommendation system has generated better recommendations. This model works with the combination of item-based collaborative fitter and k-nearest neighbour technique. In [5], the design of web based recommender system using clustering algorithm and genetic algorithm is discussed.

Route recommender system [6] for vehicles is based on data acquired from internet and automobile. Here a prediction algorithm and information linking method is developed, which is used for implementing a prototype structure to check the recommended route. WUM recommender system [7] based on SUGGEST 3.0 technology recommends web pages that are not visited and might be of users' interest. Navigational and behavioural pattern of the users [8] in an e-commerce recommender system is analysed in this paper. Collaborative filtering based on Navigational and behavioural pattern analyses the confidence level between user clicks and items placed on basket with the items purchased. An elaborate survey of different methods and applications of recommender system in different domains is elaborated in this paper [9]. A recommender system to recommend mobile-apps is discussed in [10].

The design of a hybrid recommendation system using knowledge based and collaborative filtering techniques is discussed in [11]. The design of infrastructure based recommendation system for vehicles long charging period, limited stations for charging and undeveloped smart grid leads a tough time for usage of electric vehicles is discussed in [12]. A recommender system which guides visitors to find their appropriate automobile exhibition hall, is elaborated in [13]. Profiles of visitors are developed by taking their spatial and temporal features and obtain their interest based on clustering. Proposed model contain 3 modules which includes relevance module, quality module and integration module. Real world dataset is used to validate the proposed module and matched with different baseline models. A graph based recommender system using content based and collaborative filtering technique is discussed in [14]. A recommender system based on data warehouse that alters traditional two-dimensional approaches to multidimensional, hierarchical and profiling capability is discussed in [15].

From the literature, it is noted that building the item profile (car dataset) is difficult. Car dataset, which is available on the repository, became outdated because of the arrival of new car models in the automobile industry. As different sources provide different information about a particular car, consolidating and creating the repository is a challenging task. In addition, the rating for car from different users is not feasible. Many recommendation systems are designed either as content based or as collaborative filtering using ratings. This paper suggests the design of hybrid recommendation system using item-item collaborative filtering, user-user collaborative filtering and matching with user constraints.

4. Results and Discussion

This paper suggests the design of web based car recommender system. User model is designed based on the feedback about the car, likes and preferences about the car, user clicks and keyword search items. Item model is designed with all appropriate features of the car, which include mileage, price, power, transmission, brand etc. By matching the user model with item model, appropriate recommendations are generated in the system. This is represented in figure 1.

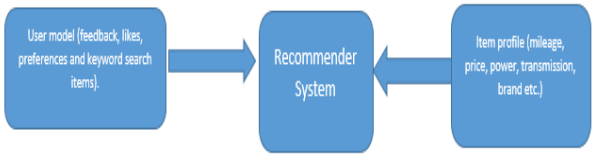


Fig.1General model

Various steps involved in this process are

1. Data collection
2. Data preprocessing
3. Execution of the recommender algorithms
4. Evaluation of the results
5. Interpretation of the results

4.1 Data Collection:

The backbone of the recommender algorithm is data, and the preparation of dataset. Once the dataset is prepared, it is divided into training and testing dataset. Training data set is used to train the algorithm and the testing dataset is used to test the performance of the recommender model. In this research, two datasets are used. Item profile dataset is car and the user model dataset is clicks stream dataset.
Datasets involved in the design of car recommender system namely Car dataset and item dataset are explained as follows:

Car dataset—Item Profile

Car dataset contains information about the different types of cars, brands and other associated parameters. Data regarding brands and car details were collected from different authentic websites like cardekho, cartrade, carwala and official websites of that particular car model. Recent car models available in the market till July 2017 including 40 brands and 224 car types are used in this research work. The attributes of the following categories like ENGINE & TRANSMISSION, CAPACITY, COMFORT and SAFETY are used in this research work.
Engine and transmission contain all the specification of car performance, capacity contain all non-technical features like weight, height, space, no of seats etc. Comfort and safety contain all the accessories additionally required for car as per user's convenience. The table 1 provides the list of attributes.

Table.1 Attributes of car

S.NO	Attributes
ENGINE & TRANSMISSION	
1	Top Speed
2	Acceleration (0-100 kmph)
3	Engine Displacement(cc)
4	Maximum Power
5	Maximum Torque
6	Engine Description
7	Turning Radius
8	No. of Cylinders
9	Drive Type
10	Turbo Charger
11	Super Charger
12	Valves Per Cylinder
13	Compression Ratio
14	Fuel Supply System
15	Gear box
16	Steering Gear Type
CAPACITY	
17	Seating Capacity
18	No of Doors
19	Length
20	Width
21	Height
22	Ground Clearance
23	Wheel Base
24	Front Tread
25	Rear Tread
26	Kerb Weight
27	Gross Weight
28	Front Headroom
29	Front Legroom
30	Rear Headroom
31	Rear Legroom
32	Fuel Tank Capacity (Litres)
33	Cargo Volume
34	Tyre Size
35	Tyre Type
36	Wheel Size
37	Alloy Wheel Size
38	No of Floors
COMFORT	
39	Air Conditioner
40	Power Steering
41	Rear A/C Vents
42	Engine Start/Stop Button
43	Remote Trunk Opener
44	Remote Fuel Lid Opener
45	Accessory Power Outlet
46	Transmission Type
47	Foldable Rear Seat
48	Navigation System
49	Adjustable Seats
50	Cassette Player
51	CD Player
52	CD Changer
53	DVD Player
54	FM/AM/Radio
55	Audio System Remote Control
56	Speakers Front
57	Speakers Rear
58	Integrated 2DIN Audio
59	Bluetooth Connectivity
60	USB & Auxiliary input
61	Low Fuel Warning Light
62	Automatic Climate Control
63	Air Quality Control
64	Rear Reading Lamp
65	Rear Seat Headrest
66	Rear Seat Centre Arm Rest
67	Heated Seats – Front
68	Heated Seats – Rear
69	Leather Seats
70	Fabric Upholstery
71	Voice Control
72	Cup Holders-Front
73	Cup Holders-Rear
74	Shock Absorbers Type
75	Trunk Light
76	Vanity Mirror
77	Glove Box Cooling
78	Bottle Holder
79	Seat Lumbar Support
80	Cruise Control
81	Multi-function Steering Wheel

82	Touch Screen
83	Front Suspension
84	Rear Suspension
SAFETY	
85	Anti-Lock Braking System
86	Parking Sensors
87	Central Locking
88	Driver Airbag
89	Passenger Airbag
90	Side Airbag-Front
91	Side Airbag-Rear
92	Rear Seat Belts
93	Smart Access Card Entry
94	Seat Belt Warning
95	Brake Assist
96	Door Ajar Warning
97	Crash Sensor
98	Anti-Theft Alarm
99	Power Door Locks
100	Child Safety Locks
101	Side Impact Beams
102	Front Impact Beams
103	Day & Night Rear View Mirror
104	Passenger Side Rear View Mirror
105	Engine Immobilizer
106	Centrally Mounted Fuel Tank
107	Rear Camera
108	Traction Control
109	Automatic Headlamps
110	Follow Me Home Headlamps
111	Front Brake Type
112	Rear Brake Type
113	Drag Coefficient
114	Braking Time
115	Height Adjustable Front Seat Belts
OTHERS	
116	Bore x Stroke
117	Price
118	Body type
119	Country of Assembly
120	Country of Manufacture
121	Synchronizers
122	Clutch Type
123	Fuel type
124	Warranty Time
125	Warranty Distance

User Model

A Synthetic user profile of 10,000 users is created where each record depicts the demographic details, click details and purchase details (car bought). The session details are created based on the figure 2.

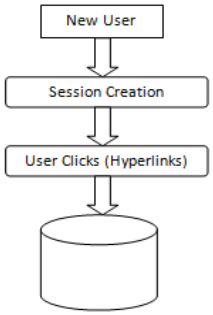


Fig.2 Session details

Besides the demographic user details, the following details related to clicks such as *Session-Id*, *Time-Stamp* and *Item-Id*, are recorded. *Session-id* represents session number, which is represented as integer. *Time-stamp* represents the time when the user has clicked in the format YYYY-MM-DDThh:mm:ss.SSSZ. *Item-id* represents the unique id of item that has been clicked, it is represented in the form of integer.

The purchase details contain the unique id of item that has been bought, it is represented in the form of integer. Test file contains only clicks of the user. The summary of dataset is shown in table 2.

Table.2 summary of dataset

No. of Session	10000
No. of Users	300
No. of Items	224
No. of brands	40

4.2 Data Pre-Processing

After removing the incomplete instances, Item profile has 125 attributes of 40 car brands of 224 car types. A random survey of 300 users was conducted to rank the attributes of car, which are considered for buying. The selected attributes are Engine, Displacement, Body type, Price, Fuel type, No of doors, Seating capacity, Transmission Type, Drive type, Ground clearance, Front Suspension, Rear Suspension, Shock absorbers type, Driver airbag, Passenger Airbag, Front Brake Type, Rear Brake Type.

4.3 Execution of the Recommender Algorithms

In this research work, the item-to-item collaborative filtering algorithm is combined with user-to-user collaborative filtering algorithm to generate effective recommendations. The proposed algorithm works as shown in figure 3.

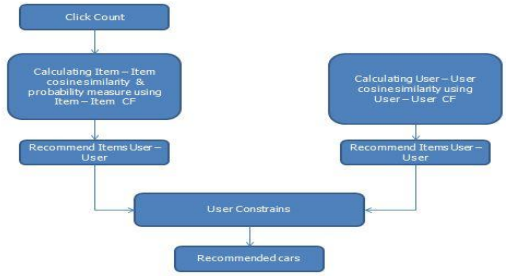
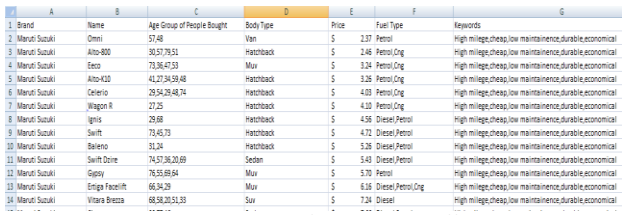


Fig.3 Working of algorithm

Similarity between the items (cars) is calculated using item to item Collaborative filtering recommender algorithm. The total number of clicks for every item (car) by each user in a session is recorded. Similarity between the items is calculated based on the probability of occurrence clicks for each item.

Similarity between the users is calculated using user to user Collaborative filtering recommender algorithm. Similarity with respect to demographic features, user clicks and browsing history (search keywords) is calculated between users.

The output of item-to-item recommender algorithm is combined with the output of user to user recommender algorithm to generate the final recommendations.



	A	B	C	D	E	F	G
1	Brand	Name	Age Group of People Bought	Body Type	Price	Fuel Type	Keywords
2	Maruti Suzuki	Omni	57,48	Van	$ 2.37	Petrol	High milege,cheap,low maintainence,durable,economical
3	Maruti Suzuki	Alto-800	30,57,79,51	Hatchback	$ 2.46	Petrol,Cng	High milege,cheap,low maintainence,durable,economical
4	Maruti Suzuki	Eeco	73,36,47,53	Muv	$ 3.24	Petrol,Cng	High milege,cheap,low maintainence,durable,economical
5	Maruti Suzuki	Alto-K10	41,27,54,59,48	Hatchback	$ 3.26	Petrol,Cng	High milege,cheap,low maintainence,durable,economical
6	Maruti Suzuki	Celerio	29,54,29,48,74	Hatchback	$ 4.03	Petrol,Cng	High milege,cheap,low maintainence,durable,economical
7	Maruti Suzuki	Wagon R	27,25	Hatchback	$ 4.10	Petrol,Cng	High milege,cheap,low maintainence,durable,economical
8	Maruti Suzuki	Ignis	29,68	Hatchback	$ 4.56	Diesel,Petrol	High milege,cheap,low maintainence,durable,economical
9	Maruti Suzuki	Swift	73,45,73	Hatchback	$ 4.72	Diesel,Petrol	High milege,cheap,low maintainence,durable,economical
10	Maruti Suzuki	Baleno	31,24	Hatchback	$ 5.26	Diesel,Petrol	High milege,cheap,low maintainence,durable,economical
11	Maruti Suzuki	Swift Dzire	74,57,36,20,69	Sedan	$ 5.43	Diesel,Petrol	High milege,cheap,low maintainence,durable,economical
12	Maruti Suzuki	Gypsy	76,55,69,64	Muv	$ 5.70	Petrol	High milege,cheap,low maintainence,durable,economical
13	Maruti Suzuki	Ertiga Facelift	66,34,29	Muv	$ 6.16	Diesel,Petrol,Cng	High milege,cheap,low maintainence,durable,economical
14	Maruti Suzuki	Vitara Brezza	68,58,20,51,33	Suv	$ 7.24	Diesel	High milege,cheap,low maintainence,durable,economical

Fig.4 above is screen shot of dataset with different attributes

4.4 Evaluation of Result

Accuracy is the parameter used to evaluate the performance of the recommender algorithm. The trained model is tested for 100 different users where 83 said satisfactory with the recommendations and 17 said not satisfactory with the recommendations.

4.5 Interpretation of Results

The performance is evaluated as ratio of total number of satisfactory recommendations to the total number of recommendations generated. 83% is the accuracy of the proposed system, which indicates a good performance of the system.

5. Conclusion

As the global market rises and the demand of new brands on Indian economy leads to arrival of new models. All outside car manufacturers see Indian market as their place to grow in their share on global car economy. As world moves to the peak of a new era, recommendation become an unavoidable fact. Almost all the technical and non-technical things in today's world wave hands to recommendation. The main fact that the recommendations got deeply rooted in new technology is due to its accuracy, precision and reliability. Recommendation gives a personalized choice to user's requirements. In the proposed approach, the hybrid algorithm, which is the combination of user-to-user and item to item based collaborative filtering recommendation algorithm is efficient in suggesting recommendations.

The main problem with car dataset is that they are dynamic data because it is difficult to predict the car model that will be expelled from their brand. Further, the performance of the proposed system can be improved by using a real time network which allows to build websites and access the session details. This research work can be further extended as Knowledge based recommender systems by using different knowledge representations. Expert recommendations using expert system can also be considered using knowledge bases. In this current research work, 2D models are used to define user model and item profile which can be enhanced to ontological based user model and item profile.

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