

# Design of a Food Recommendation System using ADNet algorithm on a Hybrid Data Mining Process

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## Abstract

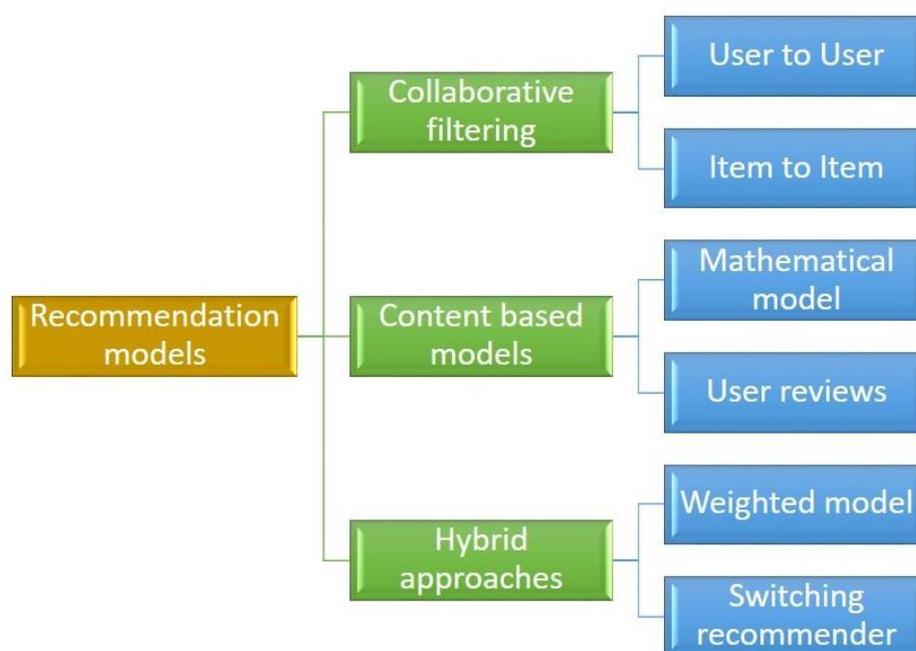
Hybrid data mining processes are employed in recent days on several applications to achieve a better prediction and classification rate along with customer satisfaction. Hybrid data mining processes are the combination of different form of data considered for a neural network decision. In some cases, the different form of data represents image along with numerical data. In the proposed work, a food recommendation system is developed with respect to the flavour taste of the customer and considering the review comments of previous customers. The suggestions given by the users are taken into account as a feedback layer in the neural network for fine tuning the accuracy of the prediction process. The architectural design of the proposed model is employed with an ADNet (Adaptively Dense Convolutional Neural Network) algorithm to enable the usage of low range features in an efficient way. To verify the performance of the developed model, a pizza flavour recommender dataset is employed in the work for analysis. The experimental work analysis indicates that the ADNet algorithm works in a better way on a hybrid data analysis than the traditional DenseNet and ResNet algorithms.

**Keywords:** Food recommendation system, flavour prediction, ADNet, feedback neural network, customer satisfaction

## 1. Introduction

A decade before, recommendation systems were represented as a promotional strategy. However, in recent days, users look for a reliable recommendation system for their purchases. The recommendation systems are very popular especially in the area of hotel and restaurant evaluations. Most of the present recommendation systems work on the principle of the filtering process of data. In some strategies, the users are allowed to find out specific topics from the

existing user reviews [1-3]. However, the review system analysis models fail at certain times due to the submission of fake reviews in the systems [4,5]. Therefore, the necessity of making a hybrid architecture of prediction models are increased. Figure 1 explores the types of recommendation models available so far for designing a prediction algorithm.



**Figure 1.** Types of recommendation systems

### 1.1 Collaborative filtering

The collaborative filtering technique takes the recommendation models by analysing the common behaviours among the different users. The basic information among different users are considered in this model for providing a suggestion. The general basic information are, the user age, location, previous trials and so on. In the same way, the filtering model gives suggestion to the user by analysing the product or item that they have purchased earlier. The computational complexity of collaborative filtering models are comparatively less and it can be applied to any complex product recommendation systems [6,7].

### 1.2 Content based models

The content based models work almost similar to the item to item filtering process. Though, the system requires a keyword by the user for predicting the related products, it is very helpful for suggesting better products of the same kind when a user searches online. The content based models are also employed with a mathematical model for analysing the contents read by

the user on various products [8,9]. Therefore, the memory space requirement of the content based models are slightly high when compared to the collaborative filtering approaches.

### 1.3 Hybrid approaches

The hybrid recommendation systems are the combination of collaborative filtering process and content based models. The system starts to work by giving equal weightages to both models at the beginning and it will reframe the weightage when the present user changes the rating of the product. The accuracy of such weighted hybrid model are not always equal but it changes time to time and user to user. To improve the accuracy of the hybrid approaches, switching strategy was introduced to propose the outcome of a content based prediction results and if it doesn't work, the algorithm is designed to project the collaborative filtering results [10,11]. The recent advancements in the prediction and suggestion systems are summarized in the upcoming section.

## 2. Literature review

An improved K means algorithm along with a cuckoo search algorithm was developed to increase the speed of recommendation in IoT based applications. A clustering method of collaborating filtering technique was employed in the work to improve the precision rate by 5.2% in comparing to the previous multi-class co-clustering model [12]. An advance natural language processing technique called spaCy was employed to sort out the optimum resumes for a job by analysing the given feature attributes [13]. The pre-trained neural network algorithms are employed for stock price prediction. A comparative analysis was performed among the traditional CNN, SVM, LSTM, RNN and MLP algorithms and found satisfied with the results of CNN when the features are analysed with an Auto Regressive Integrated Moving Average (ARIMA) data [14].

A hybrid algorithm called many objective evolutionary technique was designed to combine the three major recommendation models like user and item based collaborative filtering and content based filtering approaches. The performances of the developed hybrid model was analysed with the traditional collaborative filtering techniques and found satisfied with the hybrid model on all three different movie lens dataset. The maximum attained accuracy of the hybrid model was 98.867% [15]. A machine learning technique based on ensemble approach was developed to classify the music genres from GTZAN database. The developed algorithm achieves an accuracy rate of 73.17%, when it was employed with a

maximum voting ensemble approach [16]. A project auditing system was proposed to observe the quality of work by analysing the estimation and the outcome cost of the project. The review process also considered the change in time and location of the project and provided change in weightages on their analysis [17].

A self-organizing map neural network approach was structured as a hybrid recommendation system by employing both collaborative filtering and content based filtering for their analytic process. The weightages of the predictions on both filtering techniques were analysed in the self-organizing maps to predict a better output [18]. The neural network algorithms are employed in recent years on several applications. A CNN based image analysis technique was developed to detect the presence of mask on human face. The architecture of the CNN is collaborated with a ReLU activation function for observing a better accuracy rate in minimal computational time [19]. A Convolutional Neural Network (CNN) algorithm was merged with a Particle Swarm Optimization (PSO) technique for enabling a better recommendation system. The focus shift points of the users are calculated in the work by CNN algorithm and taken into account by the PSO for analysing the closer value among the users for suggesting the predicted results [20]. The performances of the CNN algorithms are always better when it undergoes some slight modifications. To achieve a better precision and accuracy rate, the CNN architectures are updated with a dense layer model. The experimental projections of such modified CNN are always better than the traditional CNN model [21].

A multi-criteria recommendation system was employed in a TripAdvisor dataset by the help of a collaborative filtering technique. The dataset comprises of seven different criteria ratings along with an overall rating of different hotels. The performances of the developed approach looked satisfied than the traditional single DNN, SVD and KNN approaches [22]. A patient diet recommendation system was developed by analysing the medical datasets which represents the list of flavours that can be avoided for the patients. A separate patient detail dataset was created for this work from various online sources for the evaluation. An experimental study was carried out in the work with RNN, MLP, LSTM, Naïve Bayes and GRU models. However, the experimental results of the LSTM showed a betterment in terms of precision at the rate of 98% on allowed foods and 89% on not allowed foods [23].

A Naïve Bayes based deep learning algorithm was framed to predict the coronary artery disease of a human being. The performances of the developed algorithm was analysed over the traditional SVM approach. An efficient preprocessing step was included in the work to remove the speckle noise presence from the data samples. The feature extracted from the dataset are

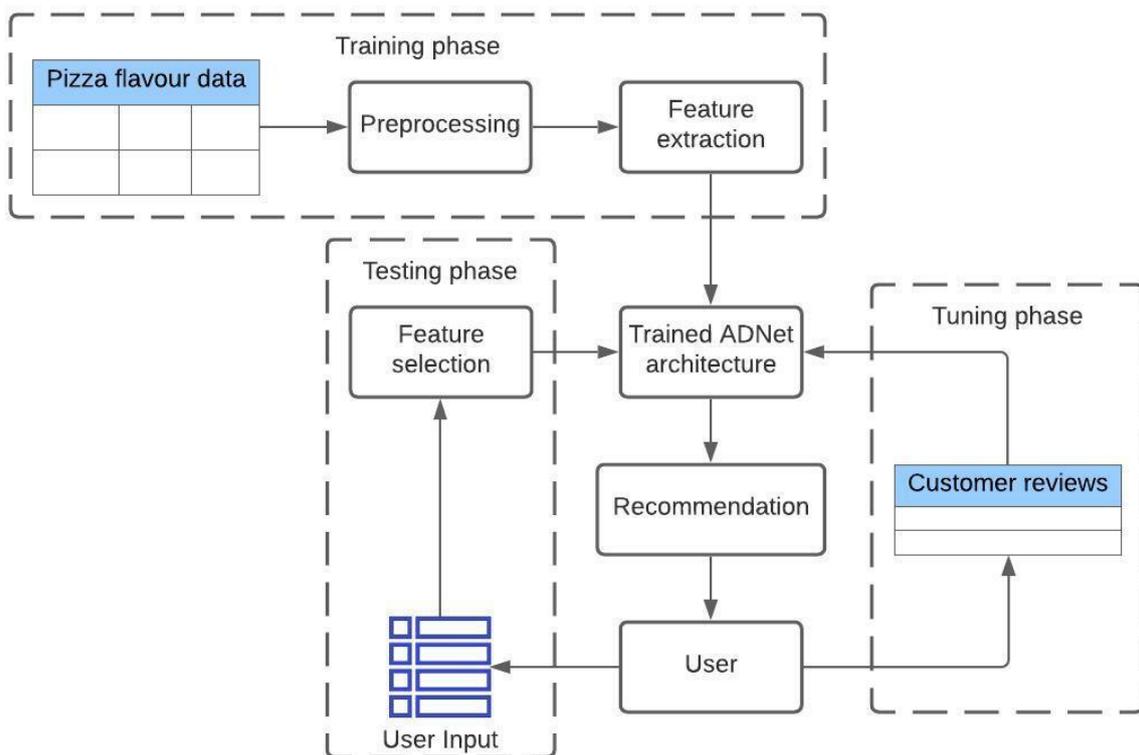
involved in the analysis with equal weights on all the attributes, and the experimental observation showed huge variations on accuracy and sensitivity in a better side on Naïve Bayes approach [24]. The opinion of fine grained users plays a major role in achieving a better accuracy rate on prediction models. However, such steps are avoided in most of the analysis work to reduce the time consumption. An aspect based opinion mining algorithm was designed to overcome such limitations by employing a multi-channel deep convolutional neural networks. The aspect specify ratings from the user opinions are calculated in the work to achieve a better prediction rate [25].

A two stage recommendation system was proposed to analyse the location and preference of a user in the cloud environment. A fuzzy clustering algorithm was utilized in the work for segregating the users based on their geographical locations. Similarly, an iterative adaptive neural fuzzy algorithm was included to receive the preferences of other users from the same location. The performances of the developed model was verified with a WS-DREAM dataset and the results indicated that the prediction accuracy keeps increasing when the sample counts are increased for the training process [26]. The literature observations explore that the hybrid neural network algorithms and hybrid feature selection algorithms perform well when compared to the regular neural networks. Therefore, a hybrid recommendation is designed in the work and is explored in the upcoming section.

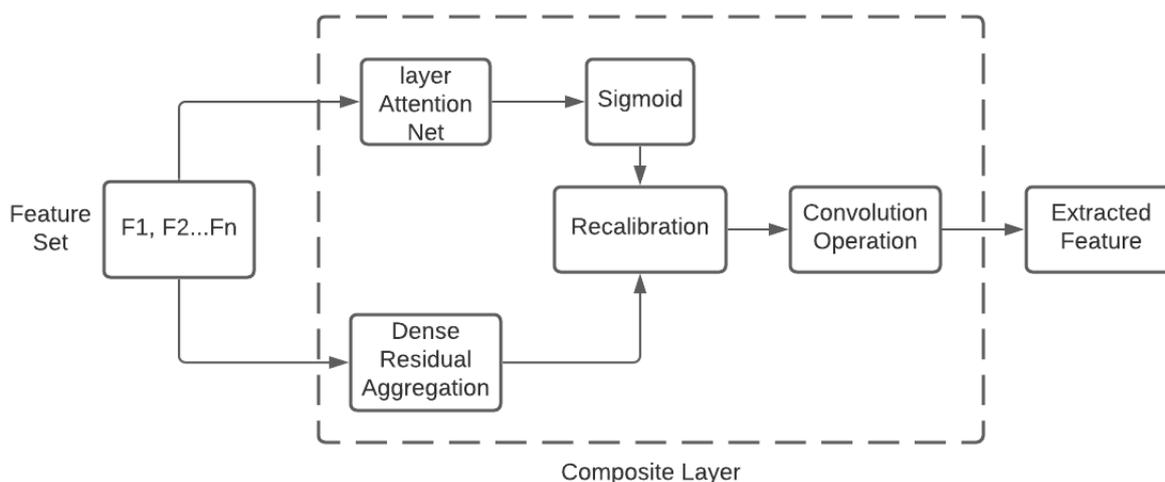
### **3. Proposed Method**

The architecture of the proposed hybrid data mining model is shown in Figure 2. The training of ADNet algorithm is performed with a pizza flavour dataset downloaded from kaggle.com [27]. The dataset contains 15 ingredient details of 16 types of pizzas. All the available information in the dataset are pre-processed to find the missing and wrong entry regarding the ingredients.

The ADNet algorithm is trained from the features extracted from the pre-processed dataset. In the testing process, the user is allowed to select their favourite ingredients and the respective features are selected in the ADNet algorithm for recommending a specific pizza. The trained ADNet model is fine-tuned each time the review comments are received from the user. The review comments given by the user are extracted to observe their ratings on each feature selection. The review comments employed in the work for fine tuning process are collected from various online sources on the specific kind of pizzas. Figure 3 represents the architectural view of an ADNet algorithm.



**Figure 2.** Architecture of the proposed hybrid recommendation system



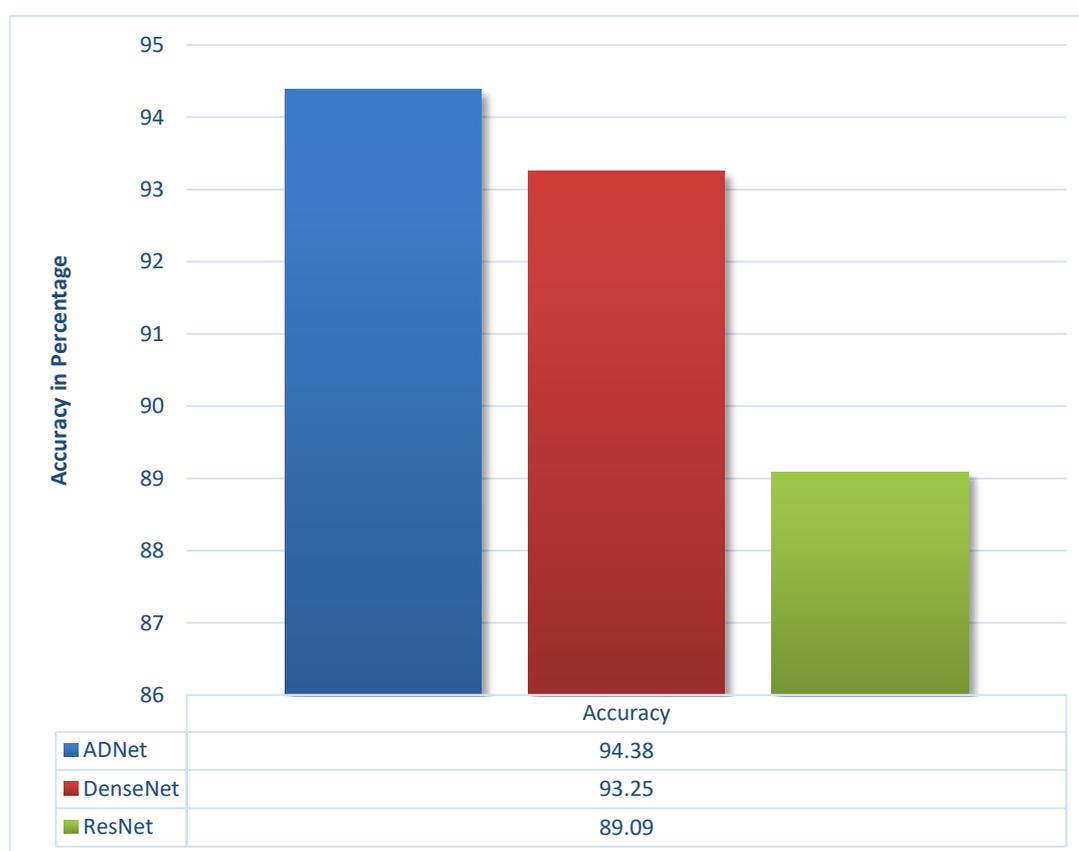
**Figure 3.** Architecture of an ADNet algorithm

The ADNet architectures are developed to increase the efficiency of low level features available in an image or data. This has been achieved by reusing the same low level feature for multiple time in the training process. Similarly, a dense residual aggregation model was designed to merge low level features into the multi-level feature representations. A novel layer attention algorithm is also employed in the ADNet architecture to make a reliable

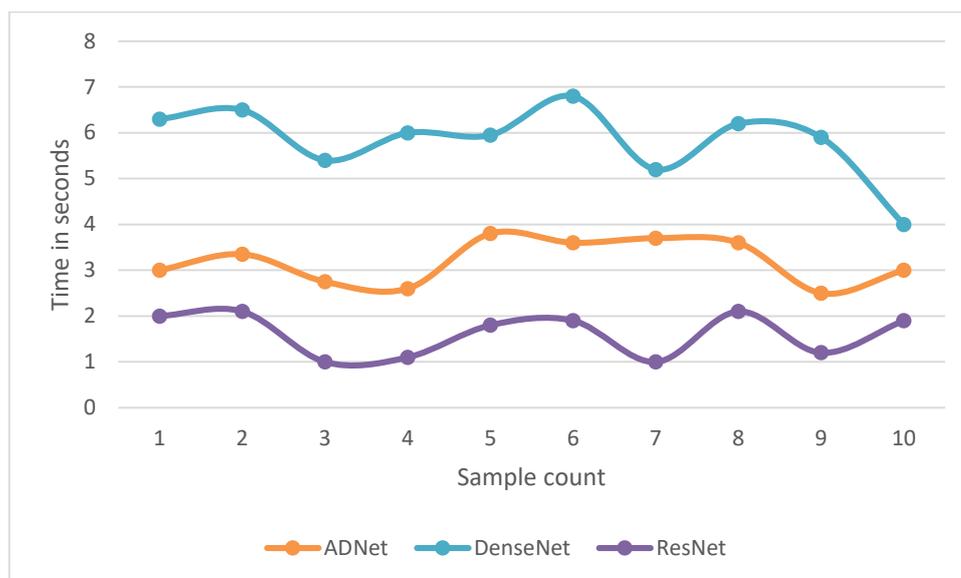
communication between the neighbourhood layers [28]. This leads to the formation of an automatic connection or disconnection among the layers when the connections are over dense, and it makes the ADNet to be a unique algorithm from the traditional DenseNet and ResNet algorithms.

#### 4. Experimental Analysis

The performance of the proposed ADNet based hybrid algorithm is compared with its previous models ResNet and DenseNet. The ResNets are also called as residual networks developed to address the vanishing gradient issue of the deep learning algorithms. The vanishing gradient issues are common in CNN based architectures when the number of layers increases beyond a certain limit. The ResNet model addresses such issues by making a skip connection between the layers. The DenseNet is quite opposite to the ResNet algorithm where all the layers involved in the architecture are connected directly to each layer or at least one. Therefore, the model makes ‘n’ number of dense blocks between the convolution and pooling layers of CNN. Figure 1 indicates the accuracy and computational efficiency of the verified algorithms for 200 sample tests.



**Figure 3.** Accuracy comparison for the verified algorithms



**Figure 4.** Computational speed difference among the verified algorithms

The experimental projection indicates that the accuracy of the ADNet algorithm shows a better performance rate of 94.38% which is comparatively better than the DenseNet algorithm by 1.13% and ResNet by 5.29%. However, the computational speed of ResNet shows a betterment over the ADNet at the rate of 1.58 seconds in an average of 10 samples. It occurs due to the reduction of interconnection made between the network layers. The performances of DenseNet are almost closer to that of the ADNet in terms of accuracy, though its performance on computational efficiency is not up to the mark to that of ADNet. The average computational speed of DenseNet is 5.82 seconds which is 2.6 seconds faster than the ADNet algorithm in average.

## 5. Conclusion

Recommendation systems are present in every mobile application as an advertising and suggesting tool of their own products. The accuracy in suggestion makes the system more reliable for the users. Therefore, the necessity of making a reliable recommendation system increases day by day. The neural network algorithms are the present solution for several complex problems. Hence, an adaptively dense layer convolution neural network algorithm is employed in the work with a hybrid architecture. This improves and fine tunes the accuracy of the recommendation process to a certain extent than the regular approaches. The accuracy level of 94.38% can be improved further, when the review given by the users are pre-processed with the right feature selection module.

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### Author's biography

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