

**MACHINE LEARNING BASED
RECOMMENDATION SYSTEM**

**A THESIS SUBMITTED TO THE GRADUATE
SCHOOL OF APPLIED SCIENCES
OF
NEAR EAST UNIVERSITY**

**By
ABID UR REHMAN**

**In Partial Fulfilment of the Requirements for
the Degree of Master of Science
in
Software Engineering**

NICOSIA, 2019

ABID UR REHMAN

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SYSTEM**

**Approval of Director of Graduate School of
Applied Sciences**

Prof. Dr. Nadire Çavuş

**We certify this thesis is satisfactory for the award of the degree of Master of Science in
Software Engineering**

Examining Committee in Charge:

Assist. Prof Dr. Boran Şekeroğlu

Committee chairman, Head of Information
System Engineering, NEU

Assoc. Prof Dr. Yoney Kirsal Ever

Head of Department, Software Engineering,
NEU

Assoc. Prof Dr. Melike Şah Direkoglu

Supervisor, Department of Computer
Engineering, NEU

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Name, Last Name:

Signature:

Date:

To my parents

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ABSTRACT

The research explains the use of machine learning approaches and especially throws light on the issue of user based recommender systems. The new type of system which has been adopted by this research is combination of deep learning-based and user recommender type system of machine learning. Therefore, the model of hybrid system of deep learning system has been incorporated into this research which used the convolutional neural learning models. This system of learning has been explained as the method which is used to study various user's preferences in order to see their clicks. The data which employs studying the preferences or recommendations of the users is used in such a way to guide these machines. In the user recommendations systems, the technology of artificial intelligence is used so that the machines could learn things like a human mind. In the section of literature review, the researcher has emphasized the various models which are used in machine learning. The systems which play a role in the users' recommender systems involve examining the preferences of these users who use these systems. The methodology which has been used for this research is studying various characters who watch different movies which belong to two categories of action and comedy. So, the data which has been collected analyzed and predicted the preferences of these users by studying the already provided data. Hence, there are various datasets which are used in this research to predict the users' preferences.

Keywords: Machine learning; user recommender system; datasets; CNN model; deep learning

ÖZET

Araştırma, makine öğrenmesi yaklaşımlarının kullanımını açıklar ve özellikle kullanıcı merkezli tavsiye sistemleri konusuna ışık tutar. Bu araştırmayla benimsenen yeni sistem tipi, derin öğrenmeye dayalı ve kullanıcı danışmanı tip makine öğrenim sisteminin birleşimidir. Bu nedenle, evrimsel sinir öğrenme modellerini kullanan bu araştırmaya derin öğrenme sisteminin hibrit sistemi modeli dahil edilmiştir. Bu öğrenme sistemi, tıklamalarını görmek için çeşitli kullanıcıların tercihlerini incelemek için kullanılan bir yöntem olarak açıklanmıştır. Kullanıcıların tercihlerini veya önerilerini incelemek için kullanılan veriler bu makinelere rehberlik edecek şekilde kullanılır. Kullanıcı önerileri sistemlerinde yapay zeka teknolojisi, makinelerin insan zihni gibi şeyleri öğrenebilmesi için kullanılıyor. Literatür taraması bölümünde, araştırmacı, makine öğrenmede kullanılan çeşitli modelleri vurgulamıştır. Kullanıcıların tavsiye veren sistemlerinde rol oynayan sistemler, bu sistemleri kullanan kullanıcıların tercihlerini incelemeyi içerir. Bu araştırma için kullanılan metodoloji, iki eylem ve komedi kategorisine ait farklı filmler izleyen çeşitli karakterleri incelemektir. Dolayısıyla, toplanan veriler, önceden sağlanan verileri inceleyerek bu kullanıcıların tercihlerini analiz etti ve öngördü. Bu nedenle, bu araştırmada kullanıcıların tercihlerini tahmin etmede kullanılan çeşitli veri setleri bulunmaktadır.

Anahtar Kelimeler: Makine öğrenmesi; kullanıcı önerme sistemi; veri setleri; CNN modeli; derin öğrenme

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CHAPTER 1

INTRODUCTION

1.1 Introduction

These days, humans are learning a lot through machine learning which is a form of learning in which artificial intelligence is being utilized. It is a model which is based on intelligence-based data operating system which analyses data and recognizes various patterns accordingly. Since, there is a surge in the area of artificial intelligence, one needs to understand how these machines could be used to learn on the pattern of humans. So, there are various types of systems which are operated within a system to ensure how certain type of data is managed on the internet. Talking about the recommendation-based system on the internet, one may find that there are many systems which are used for suggesting various things to different users. Since, the machine learning systems are capable of creating ease in the life of humans, these systems are used to help users with the compilation of the data (Aggarwal, 2018).

The present research utilizes a novel method of building of recommender system which has been connected with the deep learning system of machine learning to fulfill various AI objectives. There is a system of recommendation in which the users get access to various applications which may be helpful for them in their daily life. The types of applications which are used for the purpose of recommendation are the ones which might perform content detection task or filter the content so that it could be used for providing information. There are three main forms of systems which are used as recommendation system which includes hybrid systems, content-based systems and collaborative filtering systems. The system of collaborative filtering is the one in which the people might receive the data that has been received from the similar sources. Actually, this application combines the data from various similar sources and send them to the users who seem to be interested in this type of information. Therefore, a form of filtering is being done which helps the users of similar interests to get to the right place.

These machine learning systems are basically used so that the machines are taught to learn things like human mind does. It is necessary to explain that there are different types of recommender systems which are used for studying various applications that play a role in

users' lives. One of the important systems is content-based system and another is collaborative filtering method of recommender system. However, there is another method known as hybrid system of filtering which is used for studying and analysing these user recommender systems. The technology which is applied in this context is also known as a deep learning-based model of recommender system. The type of deep learning-based system used for this research is the hybrid system of deep learning. The system of collaborative filtering does not consist of a single option only, but it has two basic types of systems also.

The first type of system includes memory-based system in which memory of the machine is used to examine which type of data is being visited over and over again by the users. However, the other form of systems is the model based system of recommendation in which the users get to be facilitated with hybrid and content-based systems. These types of systems have certain pros and cons which are specific to their system which cannot be ideal or perfect in nature. Moreover, it is necessary to understand that there is a traditional system of recommendation as well as modern system for recommendation. Since, the data which is available on the internet is huge and quite big, it becomes difficult for the people to manage it themselves. Therefore, machine learning systems are used in order to ensure that the people who are using such kind of data can get appropriate level of recommendations on their systems.

In the system of recommendation of machine learning, there is a deep learning technology which is used also. The effort has been made to use the novel system which has been built by combining recommender learning and deep learning. These are the neural networks which are based on biological learning models used for various algorithms. The types of tasks which these learning models perform are related to the artificial neural networks which might also incorporate convolutional neural models. These types of models are used to ensure that the hidden and various interconnected layers remain inside the system used for detecting images and various letters. So, these types of systems are not only used for single purposes, but they are multi-faced and can be incorporated for the fulfilment of various purposes. One thing which is specific to the use of neural networks is their intricate complexity which liken them to a biological system of neural based network (Gori, 2017).

1.2 Aims and Objectives

The thesis has been designed to investigate the machine learning based recommendation system which is much in practice these days. The research is intended to find the learning model which could be used for the recommendation system of the machine learning. The research has the following aims and objectives which must be fulfilled through carrying out this study:

- One of the basic aims of the conducting of this research is to find out an appropriate learning model which could be used and applied on this study.
- The aim of the research is to particularly build a novel approach of studying various AI applications and building a network having both the features of deep learning and recommender systems.
- The second purpose of the research is to find out the data which could be used for testing of the model in this research.
- The study aims to investigate the recommendations system based on hybrid system.
- Through carrying out this research, the researcher can make a recommendation-based system of machine learning.
- This research is helpful to find out which is the best form of method of recommendation for machine learning based systems in practice.
- This study may be used to carry out the research focused on building a network of connections which could give a boost to recommendation-based systems.
- This study may be helpful for streamlining the excess of data that is available on the internet. It could make it easier for the users to get access to the data which is scattered everywhere on the internet.
- The use of such recommendation-based systems makes the process of data filtering easier and convenient. It ends up providing user-friendly solutions to the people who are using the internet.
- The study is important for the creation of recommendation-based systems which might detect the data of users posted on internet found in memory based systems.
- The recommendation-based systems are easily used by the researchers for investigation keeping in view their great benefit and significance in the field of artificial intelligence learning systems.

- The study aims to give rise to a data which later can be used by the researchers to boost their machine learning mechanisms. It could set the example for other users to follow their learning models within their respective fields of sciences.

1.3 Motivation

The research has been conducted keeping in view the factors which are important for bringing to our mind the significance of machine learning based systems of recommendations. Since, such forms of data are used due to the abundance of such type of data that is found in excess, one might find these systems to be getting a lot of popularity these days. Out of the huge amount of data found in internet, the users can pick out the data that is mostly relevant to their specific purpose. They might use this data in order to see how it could be enhanced so that such models could be increasingly used to perform various purposes.

It has been observed that nowadays, the students and other learners of various classes are relying too much on internet or the data which is electronically produced. This data is being utilized and administered a lot to fulfill various purposes that is related to academics or one's area of study. However, these systems are not only used in academics or the area of learning and study, but it has its significance in others fields of life also. Since, the people find great difficulty in reaching to the data which is highly relevant to their use, they might like to use recommendations to reach to the right kind of data. Therefore, researches like this one must be conducted to find out the appropriate solutions to the problem of the management of the data.

The use of such systems in industries also cannot be underestimated because these systems ensure that the inner workings within these industries is going well. It is important to mention that recommendation-based systems make it easier for the users working in these industries to get benefit from the right kind of data which could be used for several purposes. However, it is necessary to use the learning model in such a way to boost the user's system and it should have the capacity to help out the users for performing various tasks of complex nature. These tasks can be related to one's academics or the area of industry which has the objective of benefiting the users in various ways.

There are various types of models of learning and the systems of recommendations which could be used to fulfil the methods of machine learning based systems of recommendations. It is necessary for us to find this study as the key area which acts as the field ground for the exploration of the data. The main motivation behind this study is the change of usage in the systems where users might consider electronic means of data for accessing all kinds of information. It is not possible otherwise because other means are worn out and not used in abundance. However, there is a great need to understand the fact that the use of these hybrid, content based and collaborative filtering methods are important for use in this type of user data-based systems of recommendations.

CHAPTER 2

RELATED WORKS

In this chapter about literature review, we will discuss various features of machine learning, different models about it and emphasize how user recommendations system are related to the concept of machine learning. The chapter has been divided into various sections, with each section throwing light on a specific area.

2.1 Concept of Artificial Intelligence

Artificial intelligence is an important concept in the field of sciences in the world today. It involves using machines to develop a concept of intelligence in them which is more like human thinking. So, the way humans think, the machines also are taught various things which become a reason for them to evolve. There are various fields in which artificial intelligence used for the benefit of humanity.



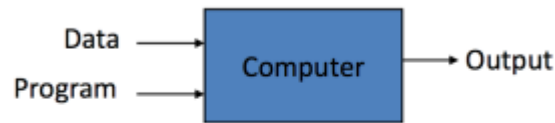
Figure 2.1: Artificial Intelligence

2.1.1 Machine Learning in Artificial Intelligence

In the area of computer sciences, the term artificial intelligence is widely used and it connected deeply to concept of machine learning. Without a doubt, the concept of machine learning is related to the capability of machines to learn like humans. Strangely, this concept implies that the machine can learn things like a human mind. So, if it gives out recommendations about a user's experience, it might learn the next time about the preferences

of these users. It is based on the concept of self-learning about machines that they can learn and adjust to different kind of information received by them.

Traditional Programming



Machine Learning



Figure 2.2: Machine Learning Vs Traditional Programming

There is a need to understand the working of machines that are capable of learning from experience. However, there are some differences that exist between machine learning and artificial intelligence. Let us review how these two things are different from each other on the basis of various factors. Artificial intelligence can be understood as the concept where the concept of intelligence is greatly encouraged. However, in machine learning, the people might be interested in the learning of a new skill. Therefore, one can see that both of these concepts are useful in their own respects.

There is a slight difference between the goals for each concept in which one is about machine learning and other is about artificial intelligence. The feature of artificial intelligence is more like decision-making based and machine learning cannot decide things on its own. It would not be wrong to say that the area of artificial intelligence serves an important role in wisdom while machine learning mostly concerns knowledge. In the area of artificial intelligence, one can find it working on the pattern of human mind. However, machine learning system operates on the basis of algorithms which perform art of self-learning (Burkov, 2019).

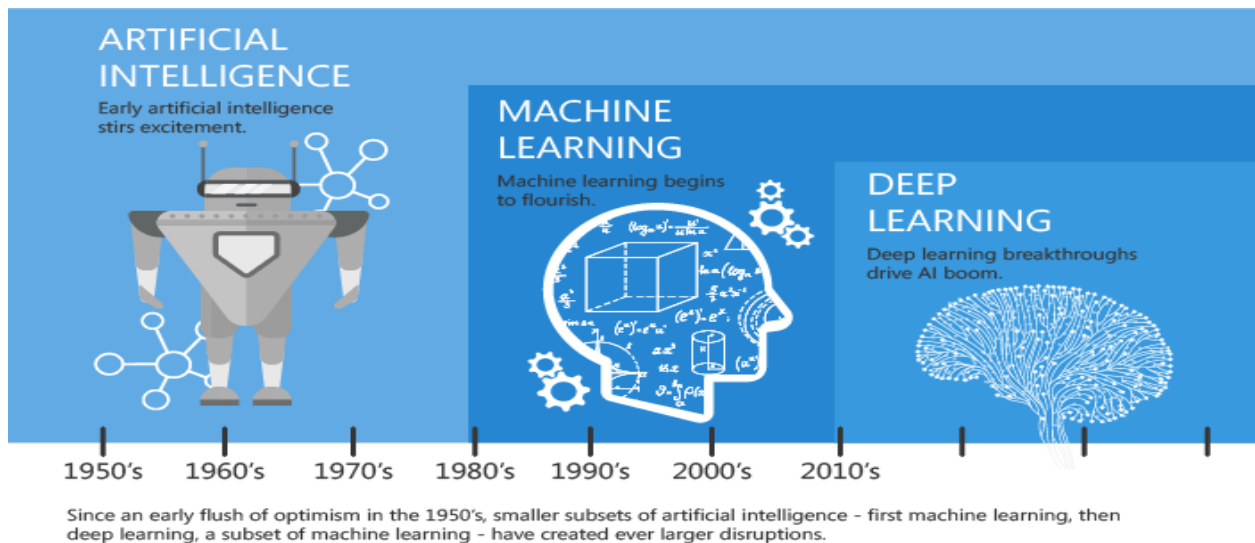


Figure 2.3: Artificial Intelligence and Machine Learning

2.1.2 Machine Learning Algorithm

Machine learning is the form of field of study in which computers are found to be performing the task of learning various concepts. It is no doubt one of the most exciting features of computer technologies in which they are not previously programmed. One can understand this thing about machine learning that this system has been evolved so much that it is quite different from the traditional form of machine learning. Previously, this system did not incorporate the idea of performing complex calculations which is added in it now (Guida, 2018).

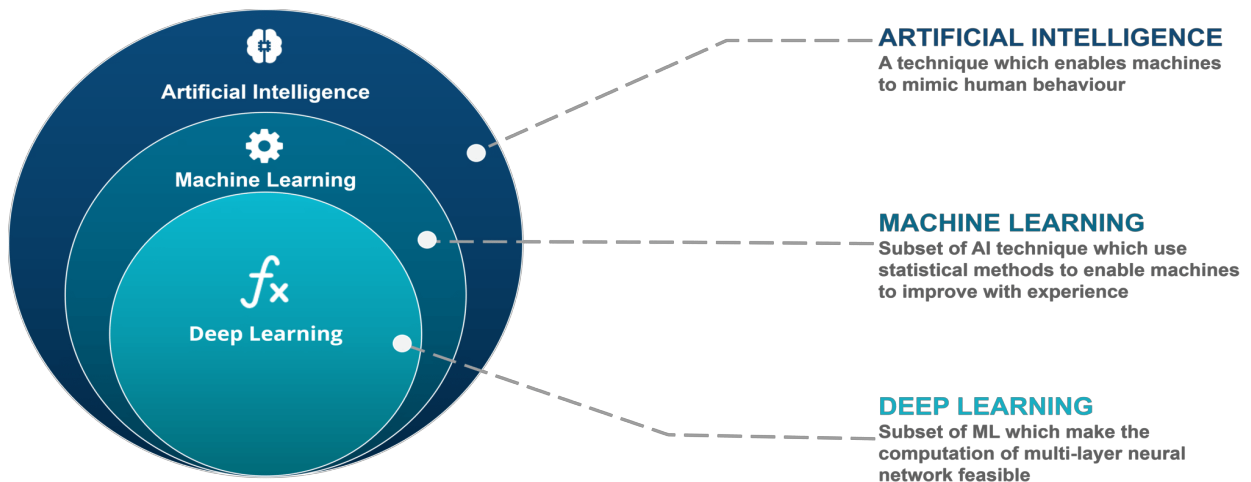


Figure 2.4: An Example of Relationship between Machine Learning and Artificial Intelligence

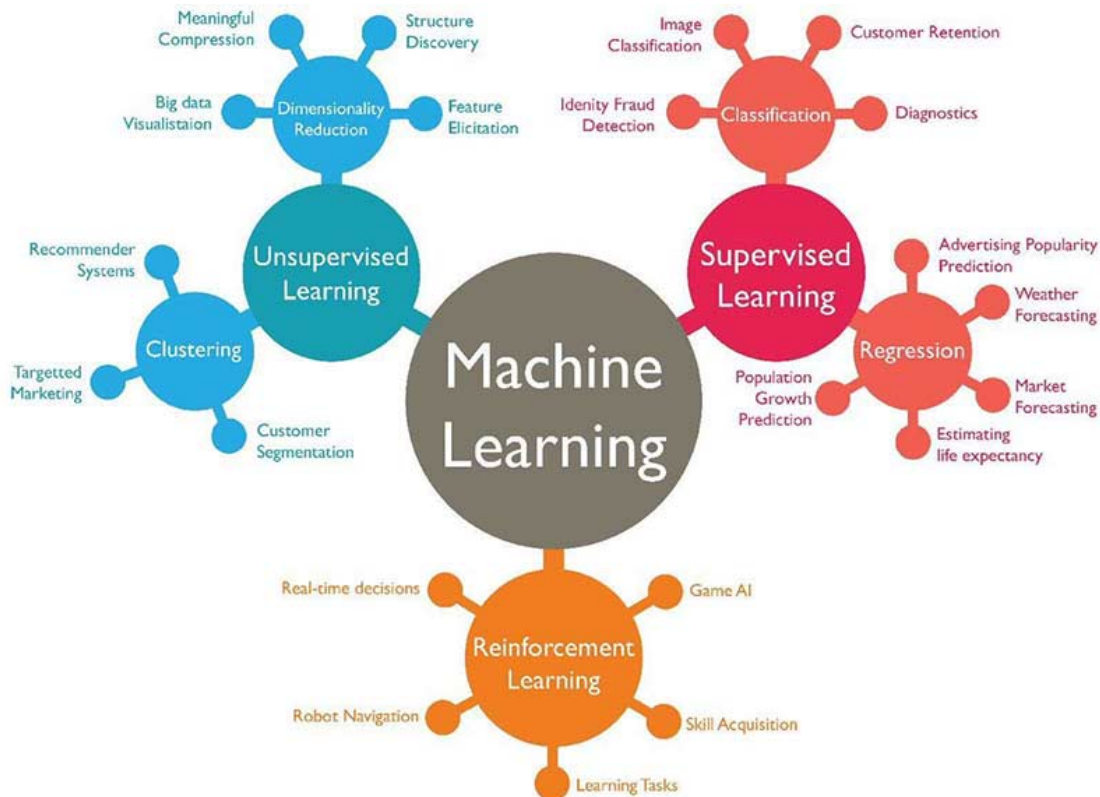


Figure 2.5: Machine Learning Algorithm

Basically, it is operated on the concept of self-learning so that the machine can learn to accept new changes. The rationale is same like human mind which can process and learn things faster which it comes across. Therefore, it has become much popular with time because the people have learnt to get benefit from using such system.

2.1.3 Machine Learning Types

Machine learning is a recent development in the field of artificial intelligence which can be further subdivided into various types. The three most important types of machine learning have been given below, namely supervised machine learning, unsupervised machine learning and reinforcement.

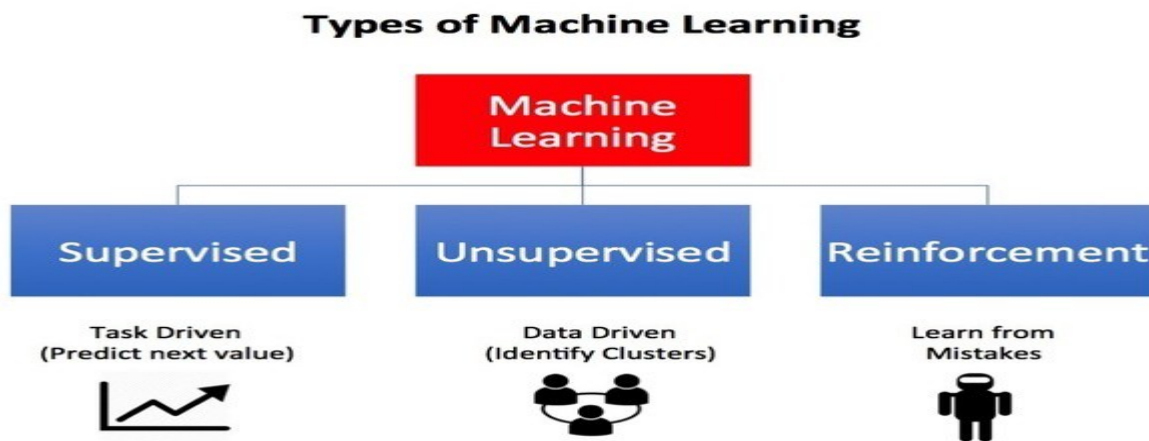


Figure 2.6: Machine Learning Types

2.1.3.1 Supervised Machine Learning

The simpler form of machine learning consists of using supervised paradigm of machine learning. It is based on the assumption of using flash card that help people to learn thing faster and better. However, there are certain form of algorithms which operate on the principle similar to flash cards. It can also be called task-oriented on the basis of its key focus on one aspect on a task. However, unsupervised form of machine learning is complete opposite of this supervised form of machine learning.

There are various techniques which are used in the process of supervised machine learning. These techniques include classification and regression techniques important for predicting responses of some kind. The models which are used to perform such processes include neural networks which are gaining popularity nowadays. These networks are built on formation of biological neural system. So, inspired by biological network of neurons, artificial neural networks are formed. There are various categories of artificial neural networks including convolutional neural networks which used multi-layered systems to identify images and voices for various purposes.

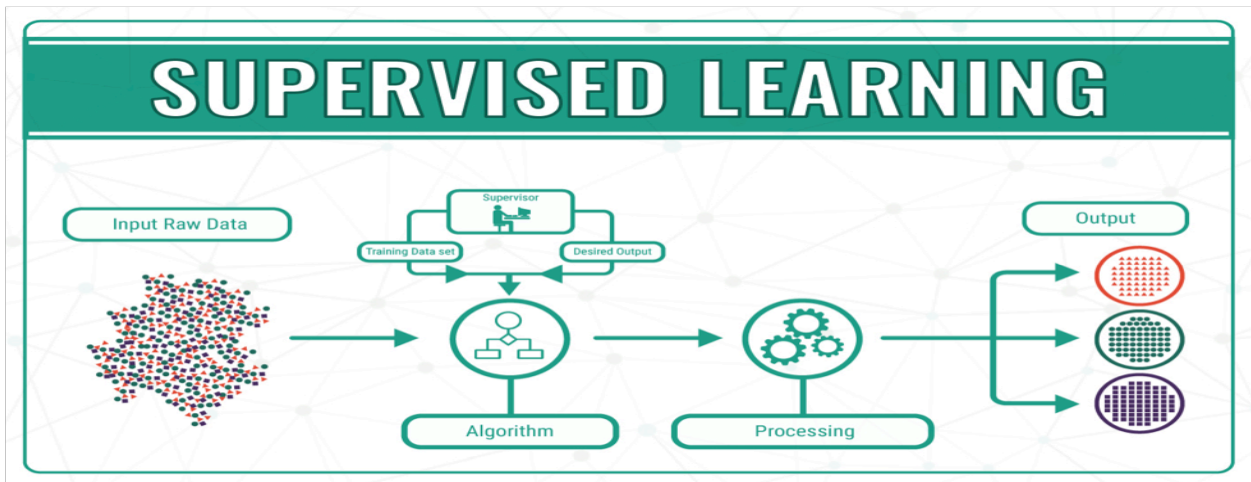


Figure 2.7: Supervised Form of Machine Learning

2.1.3.2 Unsupervised Machine Learning

In unsupervised machine learning, labels are not used or identified as is the case with supervised machine learning. In this form of machine learning, there is lot of data available and direction is not given to the machine. Instead, the machine automatically learns to organize the data which is incorporated within it. The use of unlabeled in made so much here that the data becomes difficult to be managed. However, it helps the data systems to become organized even if zero supervision is given in this regard. There are some features in this form of learning including recommendation systems and group user logs.

Clustering is a process which is widely used in this form of learning which employs various applications like object recognition and analysis of images. This is the technique which can detect even minute details and can found them in various set of images. Keeping in view these features about the unsupervised form of machine learning, one can find which one to use that is most appropriate to use. However, this decision is done on the basis of the necessity and the need to use the right kind of algorithm which is employed in a certain scenario. Most of the people use trial and error method of machine learning in order to see which one fits better in a certain case.

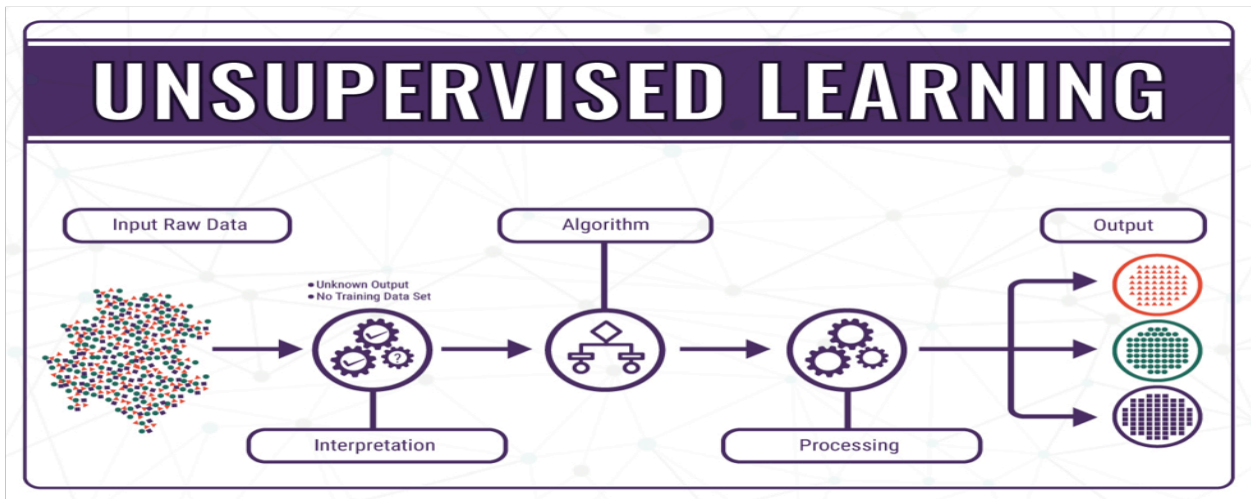


Figure 2.8: Unsupervised Form of Machine Learning

2.1.3.3 Reinforcement Machine Learning

Reinforcement is a basic concept in the science of behaviourism or experimental psychology. It is used to explain the incentive-based system where learning is initiated on the basis of reinforcement. There is classical example of a dog in an experiment conducted by a scientist by the name of Pavlov. He stressed on the need that learning can be performed by means of repeated stimuli. So, he concluded from this research that humans and other animals have the ability to learn things. Therefore, they can be reinforced to perform things that are quite difficult for them to learn otherwise. In this case, reinforcement learning framework is the one which used this same method of reinforcement learning.

Hence, the machines which operate on this function of reinforcement perform on the basis of hit and trial. These machines are the ones which utilize the concept of learning employed by human mind. This concept is the one which has been actually emphasized so much in the field of learning and the behavioral school of psychology as well.

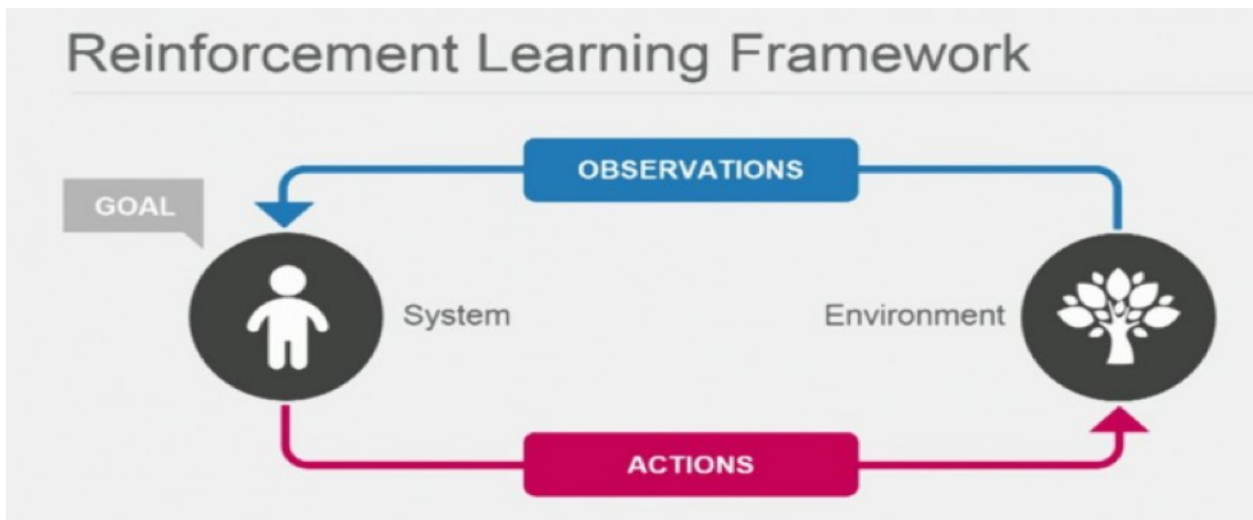


Figure 2.9: Reinforcement Learning Framework

2.1.4. Significance of Machine Learning

There are various fields of life where machine learning is being utilized in order to perform various functions. It is used for the field of finance in which trading is being done for algorithm and credit scoring. The area of image processing is especially important in this regard where the process of object recognition is performed by using such models. For the area of computer vision, machine learning is quite important also where the task of face recognition as well as object recognition is done.

It is not only used in industrial settings, but it is also employed in the case of medical science. So, in the treatment for tumors and cancers, tumor detection is being performed through the area of image processing and analysis. The area of energy also employs such machine learning networks which is used for weather forecasting. In the areas and fields of automation industry, manufacturing of industrial products and aerospace also, machine learning is highly significant. There are some voice recognition applications also which employ the use of processing of natural language.

If anyone is interested to know how he can use machine learning to perform various tasks, he might take into consideration the analysis of voice and images. Usually, in the case of complex mechanisms like problem-solving algorithms the use of machine learning is highly recommended.

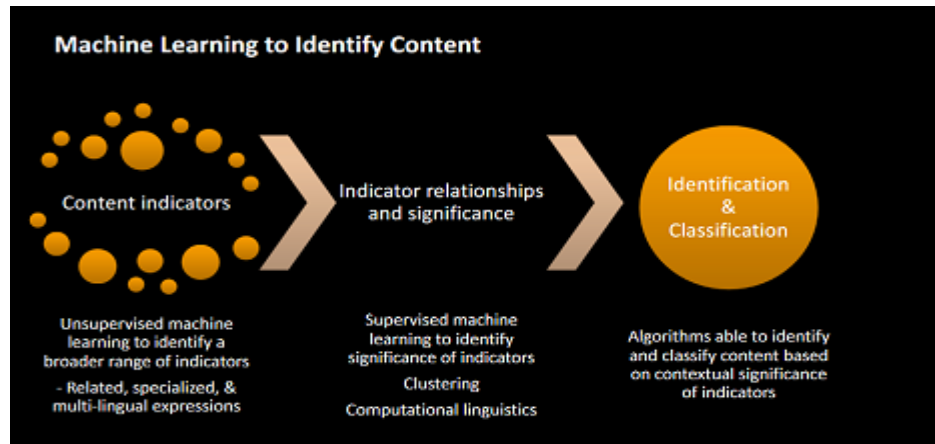


Figure 2.10: Machine Learning Process

2.2 Deep Learning Algorithm of Machine Learning

In order to find the most specialized form of machine learning, one can find deep learning to be an excellent area. In the sub-field or branch of machine learning in which such algorithms are used only which are similar to the biological working on human brain. The basic mechanism behind the working of deep learning algorithms is to learn by means of example just like humans. There are various kinds of technologies where deep learning algorithm is being used including the concept behind driverless cars. In driverless cars, these cars are able to identify various road signs and pedestrians through the technology of deep learning (Perrier, 2017).

In order to achieve impressive results out of deep learning models, one might see the use of labeled data as well as power of computing important. Not only, they are used in the concept behind driverless cars but they are also important in medicine and industry.

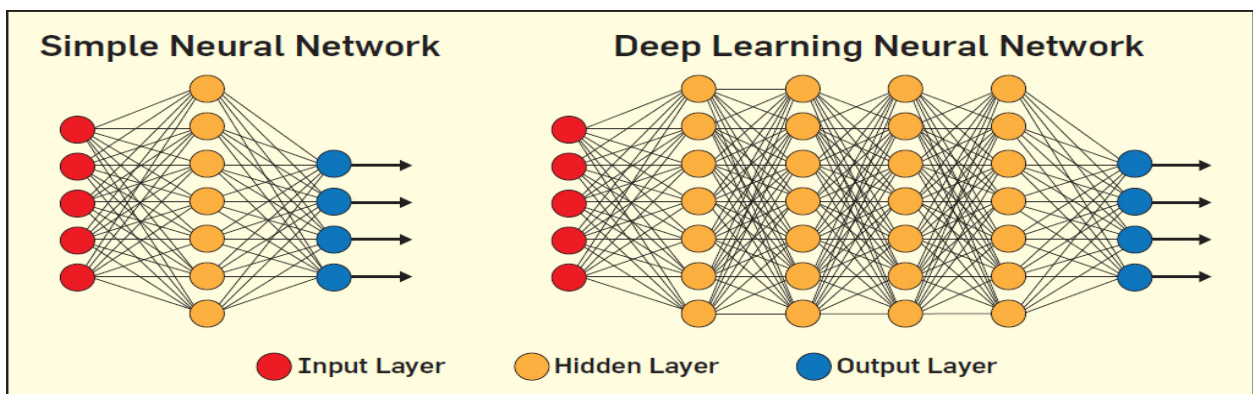


Figure 2.11: Deep Learning Neural Network

2.2.1 Difference between Machine Learning and Deep Learning

There is a great flexibility found in the concept of deep learning in which world is represented through various concepts in hierarchical form. It is important to mention that deep learning is the form of machine learning in which the people see the representation of world in different images' form. One needs to understand this fact that in order to form representations through machine learning, one need to know that structured data is important in this regard. There are different kind of neural networks of artificial sorts which play an important role in establishing the concept of deep learning. So, there is a great need to include structured data in machine learning paradigm whereas deep learning requires artificial neural networks (Raschka, 2017).

The most important of artificial network which is essential to be included in the system of deep learning is convolutional neural network. One point which must be included here in order to understand the working of these systems is that fact that they require labelled data in order to perceive things. However, the deep learning connections do not need intervention of human essential for the working of neural networks. One needs to focus on the quality of the data because the outcome depends entirely on the quality. Therefore, the focus should not be on the quantity, but on the quality and performance of these data which are utilized in these systems.

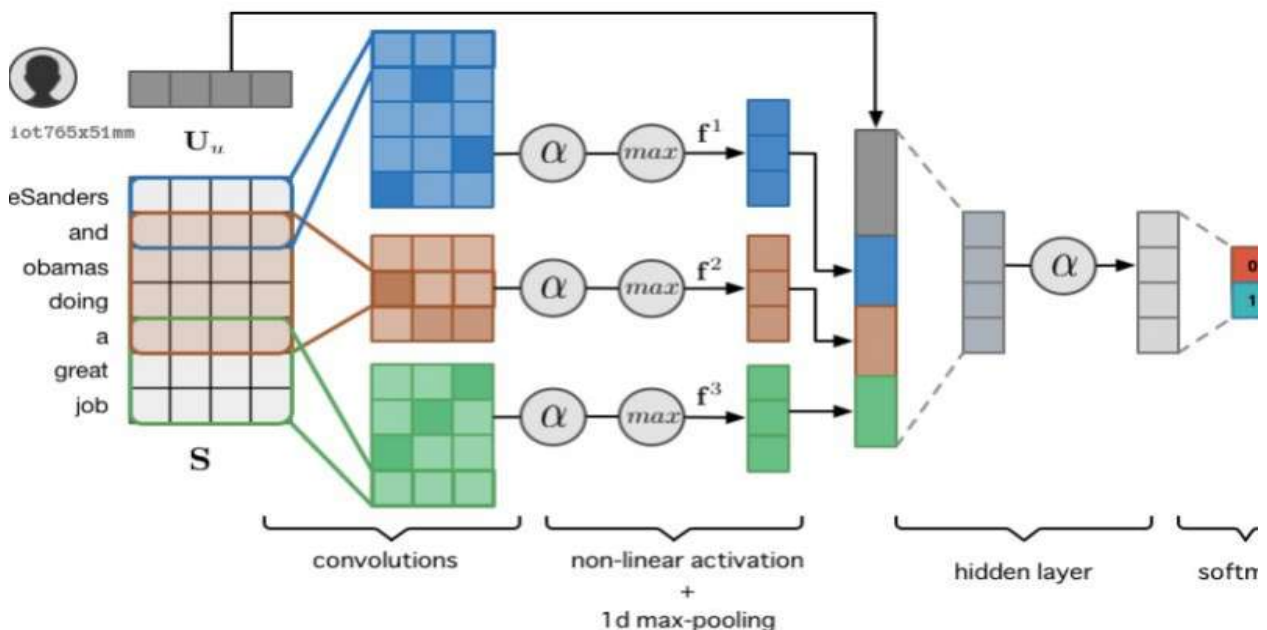


Figure 2.12: Deep Learning Framework

2.3 Recommender Systems

The world is changing a lot and we can it evolving in a different number of ways. Especially in the field of artificial intelligence, one can find recommender systems to be playing an important role. In order to completely understand these types of systems, one must know that these systems can only be run by means of providing interactive systems. The users do not anymore need to rely on static forms of data, but they need to use interactive systems that can tell them about their preferences. In this way, the users can control the amount of data received on their computers which they can control according to their whims and desires (Osinga, 2018).

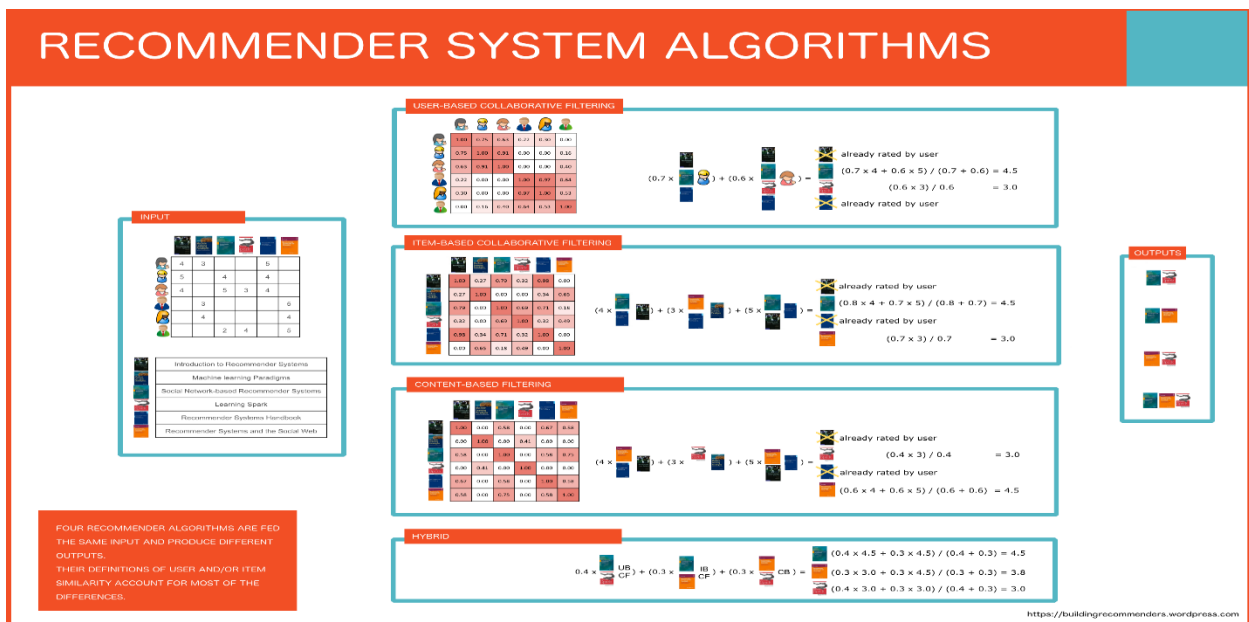


Figure 2.13: Recommender Systems

2.3.1 Related Works in Recommender Systems

Recommendation system is meant for an approach to get help in decision making, specifically for those users so far experiencing the complex type of information handling environment.

Taxonomic information handling

A hybrid approach of collaborative filtering was projected to handle and achieve in bulk the taxonomic information. Such a way is used to do product classification in an exact, reliable and consistent way by addressing the data sparsity (in databases it specified the total of cells of a table) issues e.g. relating to the CF (collaborative filtering technique) recommendations. These are made for profiles making with variation in terms of areas and implication of super-topic score (Ziegler et al, n.d.).

A hybrid recommender system approach can be used i.e. in Ghazantar and Benett because it offers a content-based structure for every individual user's profile so to search out the alike users. This framework intended for forming predictions (F.O.Isinkaye, 2015). Moreover, recommender system had been defined from the E-commerce point of view. It's uses as a tool can assist the users to do search by means of databases and repositories (as records of information and knowledge), which are users specific and are of their interest (F.O.Isinkaye, 2015).

Strong processes and algorithms

Recommendation systems come with strong processes and algorithms to be used for today's principal and most efficient online businesses including Netflix, Amazon, Google, etc. Though, recommendation systems' inner mechanisms couldn't let an unauthentic person to use some-one else Netflix account. But this approach encompassed some downsides. Through recommending just same items accessible but can't let the customers to open the diverse books of their interest (Pierre de, 2018).

Properties of previous work

Feedbacks

The feedback works behind the success of a recommendation system. Their ability to signify the user's up-to-date interests count a lot for the accurate accomplishment of recommender system. An exact model is crucial for getting the related and precise recommendations by means of any prediction techniques (F.O.Isinkaye, 2015).

Explicit feedback

It footed on the recommendation's accuracy and quantity (total) of ratings by the user.

Implicit feedback

It based on the automatic conclusions by system, using the preferences of users by monitoring their history and different actions e.g. purchasing trends, navigated sites history, online time spending, clicks, followed links and e-mail contents.

Hybrid feedback

This feedback is achieved by combining the strengths of explicit and implicit feedbacks. The purpose is to get better results in form of an excellent performing system by removing weak points.

Most common approach

Recommender systems may break down as: content based, collaborative filtering system, and hybrid type system (**combination of two or so**). **The most common approach is** collaborative filtering that is also known as **a meek vanilla version (Kevin Liao, 2018)**.

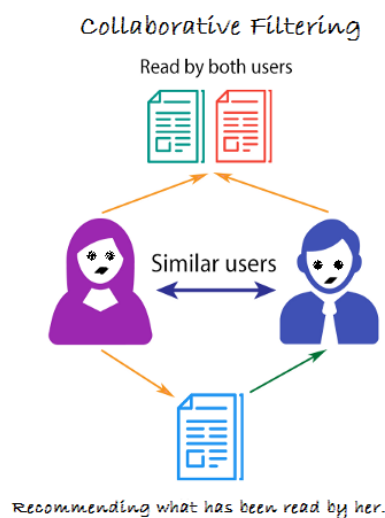


Figure 2.13.a: Collaborative Filtering

Diversity in recommendations

A system's improved range of recommendations can be attained with simple rules e.g. Youtube recommendations (Youtube, 2010) because the videos almost same to one another are deleted, as well the total of videos approaching from a singular channel becomes limited.

Findings

Under this article many things have been discussed including key standing points of building the recommender systems and methodologies with evaluation. But practically, firms should pick an option by keeping in view different potential factors of complexity (e.g. involving

problem-solving algorithms and such a case machine learning will be highly recommended), accurateness, and influences of business in terms of their typical limitations of resources like software or hardware costs.

Comparison with past studies

This study done with an intention to propose something different from the past studies e.g. by throwing light on same subjects but from different angles and perspectives because under discussion topics involved deep learning, recommender systems, content based, collaboration and hybrid recommender system and so on.

Future work

Youtube, Netflix, Amazon, Pinterest, etc. are relying on the recommender systems for the purpose to filter masses of contents besides making modifications in recommendations for their users. The future work may focus the more advance and sophisticated type methods to have a more improved recommender system with better properties of performance and scalability.

Recommended recommender model

A hybrid approach looked fine at this point because with it different features from different available systems and technologies can be incorporated. But to reach to an intended improved item, more studies and researches have to be done in this field by using different types of feedback and methods.

2.3.2 Traditional Method Vs Recommender System

One can find the significance of these recommender system by comparing it with the traditional method of machine learning based recommendation systems. The old form of recommendation based system is related to the process of collaborative filtering. So, this method concerns taking note of the earlier recommendations of the users about a few things. Therefore, the previous ratings of the users about various systems is being considered in

traditional systems. However, in the latest form of recommender system, one may find certain architectural structures which are operated on the basis of different neural networks. In order to understand the various artificial neural networks, one need to know that there is a recommendation system based on the system of deep learning (Nicolos,2015).

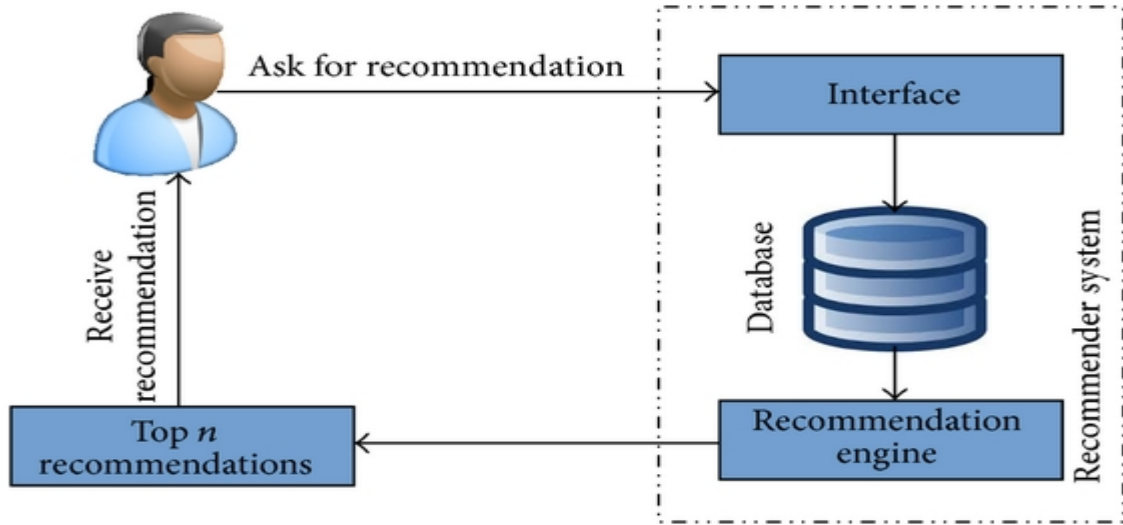


Figure 2.14: Traditional Recommendation System

2.4 Designing User Recommendation System

In order to form an intelligent based system of recommendation, one need to find certain systems which can produce accurate results. There is an intelligent based system in the case of recommendation systems which can be used in this modern world. So, like a salesperson, this system works in order to offer various options to different users who can access these systems to fulfil various needs. In order to properly use these types of systems, it is important for us to understand that these systems are programmed to cater to user's preferences. So, all these recommendations are installed in a system which helps the computers to identify various forms of preferences which are appreciated by these users (Alpaydin, 2016).

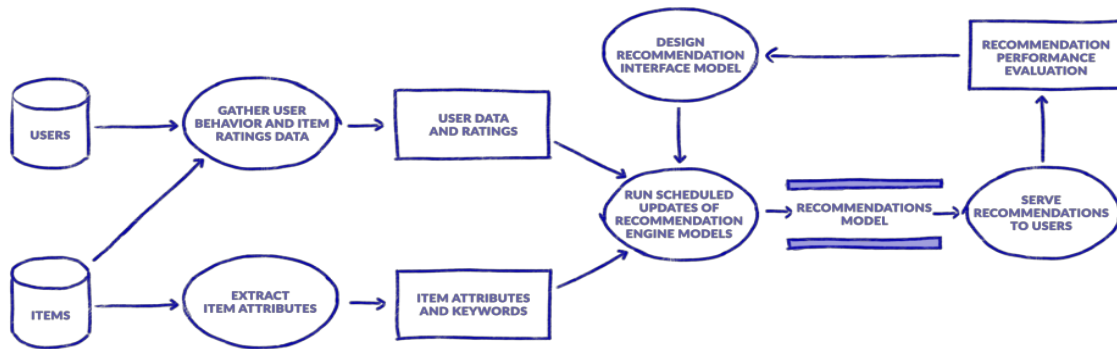


Figure 2.15: User Recommendation Systems

2.4.1. Significance of User Recommendation Systems

Out of different forms of user recommendation systems, there are many benefits which can be found in each one of them. These can be used for business purposes to increase the boost of sales and the marketers can use them for selling their products. The users can get recommendations on their computers which ultimately enable them to know about various products. So, they can access those products so that they can contribute to the success of those businesses. There are many advanced online business platforms which are running on the basis of these sort of systems. These user recommendation systems enable them to benefit from the fact that they can use these systems to earn money and receive greater number of sales as well (Prado, 2018).

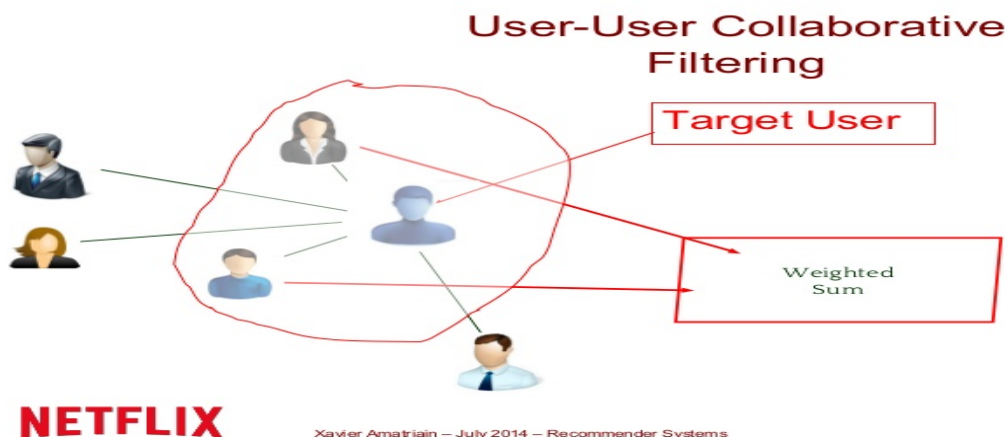


Figure 2.16: An Example of User Recommender System

2.4.2 Types of Recommender Systems

There are three basic forms of recommender systems which are mostly in use in various machine learning platforms. Let us discuss these types of systems to explain how they are connected to machine learning based systems.

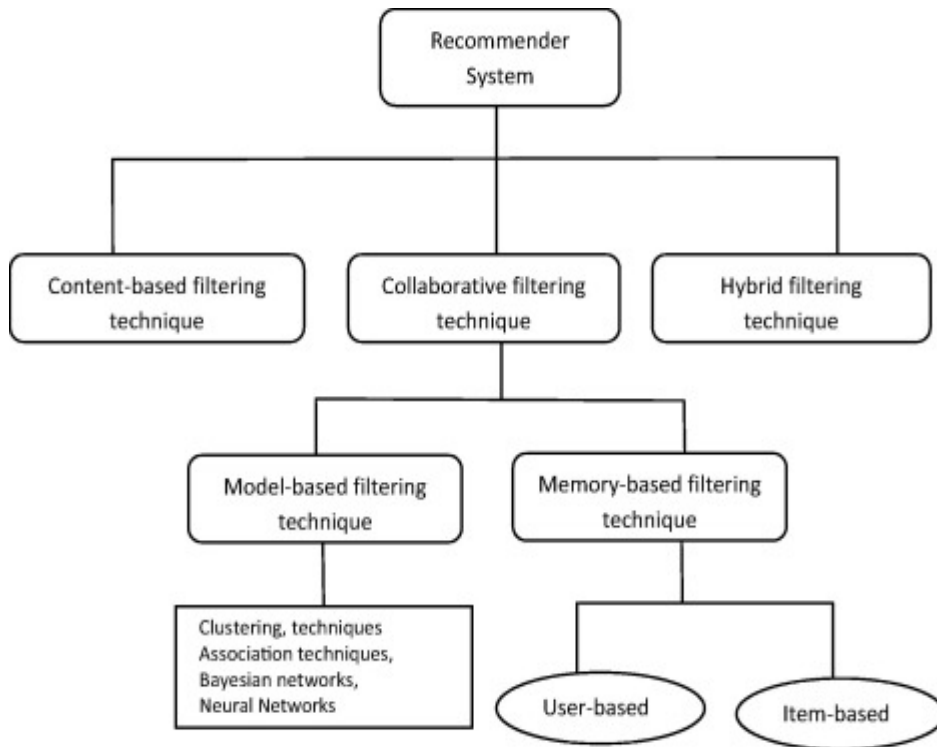


Figure 2.17: Types of Recommender Systems

2.4.2.1 Collaborative Filtering Recommendation System

This system is on the premise of the collection of the data about the users' preferences and desires about different sort of information. Here an analysis of the information about users is being done which is based on the content analysis. The system gets its instructions to filter out the information which predicts the fact how users will get access to such type of system. It also has further sub-types in its system including user-user sort of collaborative filtering, item-item collaborative filtering as well as some other algorithms. The basic premise behind using such sort of systems that the users are more likely to hit on the same things which they did before. Therefore, it is important for them to know that the users are predicted to take notice of such type of information more in the future also.

CF > Collaborative Filtering Techniques

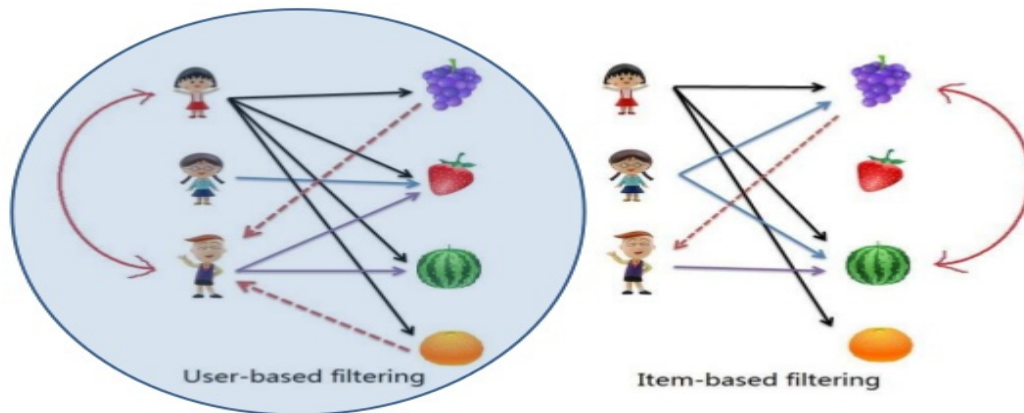


Figure 2.18: Collaborative Filtering Recommendation

The method of filtering of the data which has been given above can be termed as collaborative filtering method. This method requires the use of certain training models which makes this task easier. In order to find out a single parameter for implementing training model, one can take a look at the number of features in the dataset. The next step is to take into consideration the item's category where one does not need to label it, but to be aware of the item number. However, there are two sub-parameters for the training model also, including repetitions and rate of learning. The parameter of the learning rate includes knowing the parameter's variation of the rate which correlate strongly with these repetitions.

If these parameters are unable to give out accurate results, there might be some rules which must be applied to get the desired results. It can be done by increasing the repetitions in the case of smaller rate of learning. Furthermore, in case of larger learning rate, one must decrease these repetitions. It is possible that the rate of error gets lowered down to 0.0001 while the higher rate of learning could cause some error in computations. So, the predictions given in this case by the algorithms can be futile. The example which has been given above contains the rate of learning to be 0.01 with repetitions as 20000. Since, the user's preferences for movies are taken together as two categories of preferences having action and comedy.

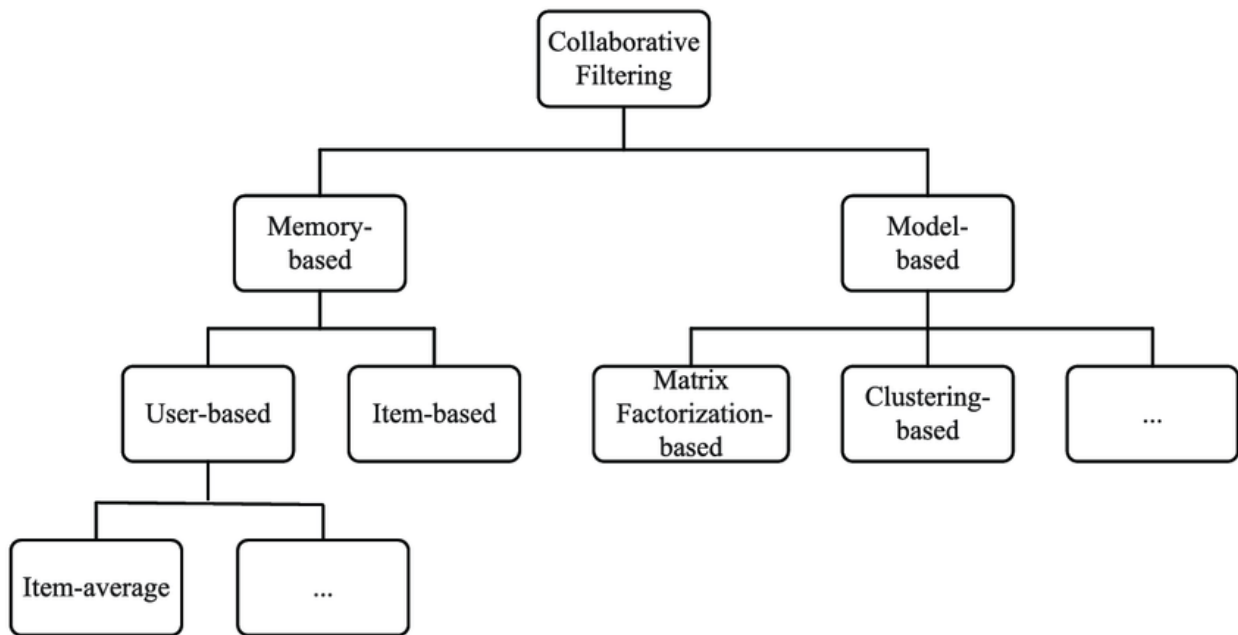


Figure 2.19: Collaborative Filtering

2.4.2.2 Content Based Filtering

The method of content-based filtering is based on the presumption that there are a few keywords associated with the certain level of items. It can be observed from the system's working that these keywords tend to detect and identify the content which is related to such items. One can find many sort of recommendations in this form of algorithms which attempts to encourage various forms of recommendations.

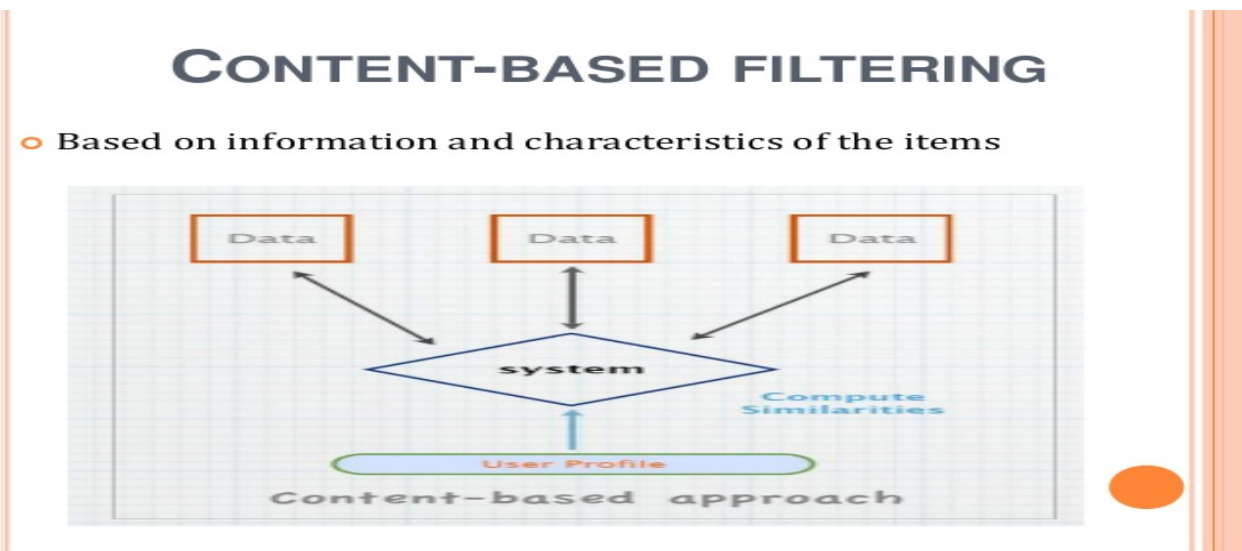


Figure 2.20: Content-Based Filtering

2.4.2.3 Hybrid Recommendation System

It has been found through research that the combination of content-based filtering as well as collaborative filtering results in the creation of a separate system. Such system is known to be hybrid recommendation system which has both the features of content-based filtering and collaborative filtering system. Such sort of systems takes into consideration the likes of the users so that it can adjust the system to the level of preferences held by users.

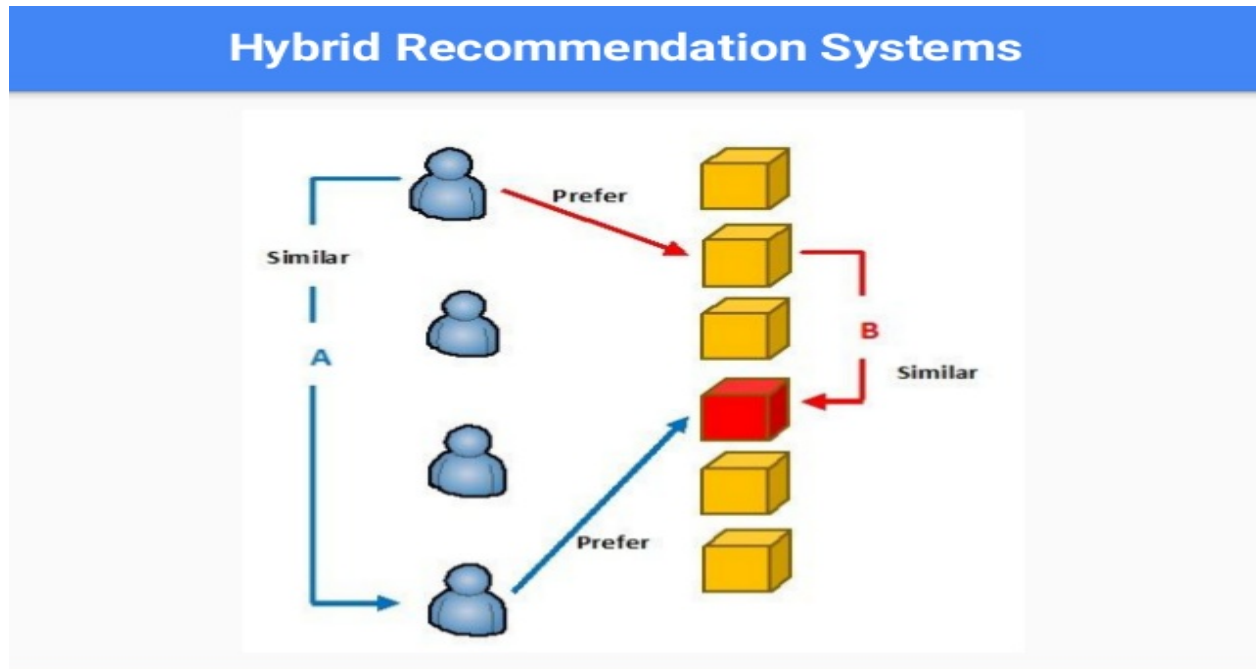


Figure 2.21: Hybrid Recommendation System

2.4.3 Processes of Recommender Systems

There are a series of steps which are followed in order to undertake these processes about recommender systems. These steps are about collection, storing, analysis and filtering of data which can be done step wise. These steps are mentioned below (Howey, 2017):

2.4.3.1 Collecting the data

In this step, the machine learning system uses data which is available and present in different forms, whether explicit or implicit in nature. The data which is termed explicit can be collected by looking at the reviews and opinion sharing of the users about various products. However, the data of implicit nature is related to the search log and history of the data which is accessed in a different form. This data can be accessed easily by keeping a look at the

search log or the history of users which notes down or collect the record about user's preferences.

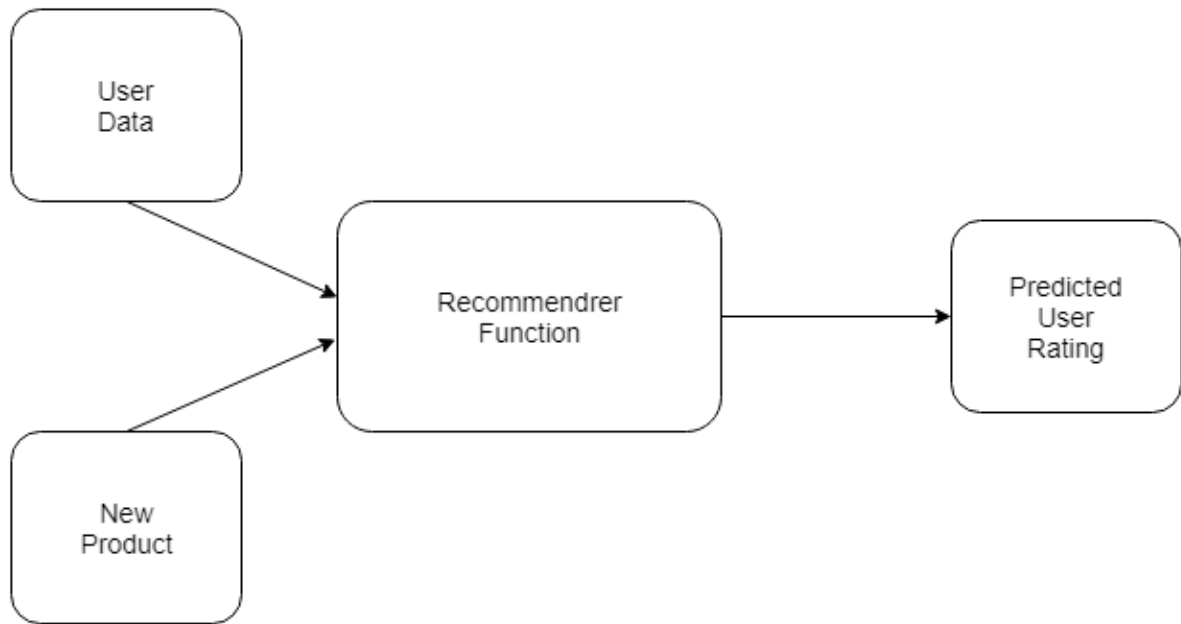


Figure 2.22: User based Recommender Systems

2.4.3.2 Storing of data

This steps involves storing the data which has been collected earlier or it involves saving the data in a system which keeps giving the recommendations later. Therefore, the storage of the given data helps in bringing out the recommendations which can be made about the system and can encourage facilitation of recommendations about users.

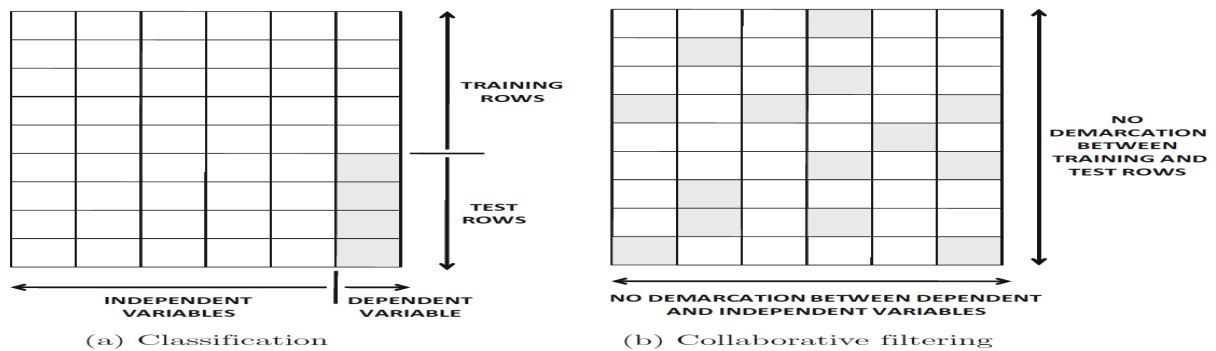


Figure 2.23: User based Recommender Systems

2.4.3.3 Analysing the data

After going through the above given steps, one may find the data moving toward the analysis stage in which data is analysed thoroughly. The systems used for the data analysis include real-time systems, batch analysis and near-real-time analysis form of data systems.

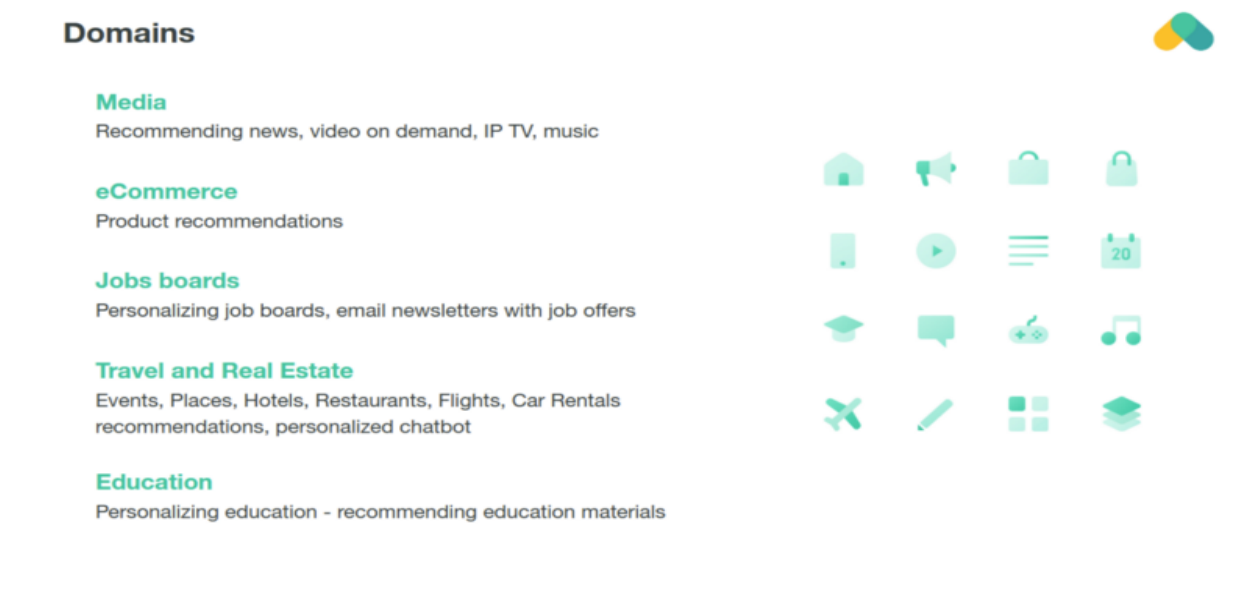


Figure 2.24: Recommendation based Systems

2.4.3.4 Filtering of data

This step involves giving recommendations to the users after carefully analysing the data which has to be filtered later on.

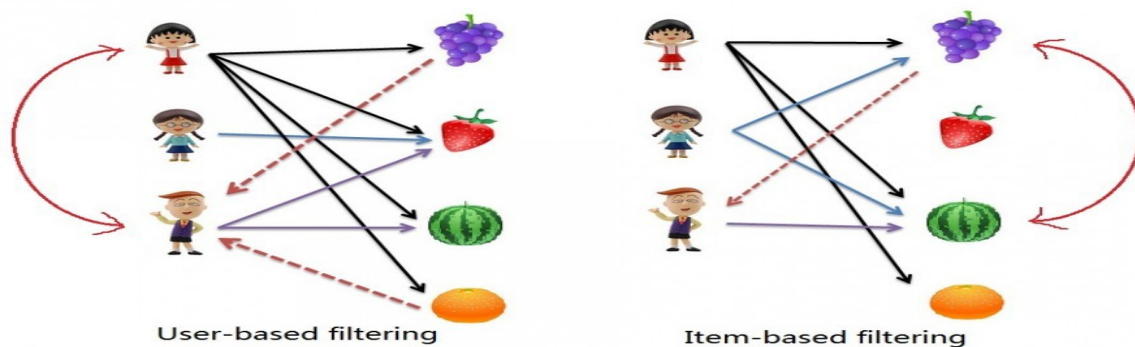


Figure 2.25: Filtering of Data in Recommender Systems

2.5 Significance of User Recommender

There are many benefits which can be achieved by using the system of user's recommendation. These types of benefits are mentioned here:

- The use of recommender systems helps in the boosting of revenue and help those companies who are using them to get a raise.

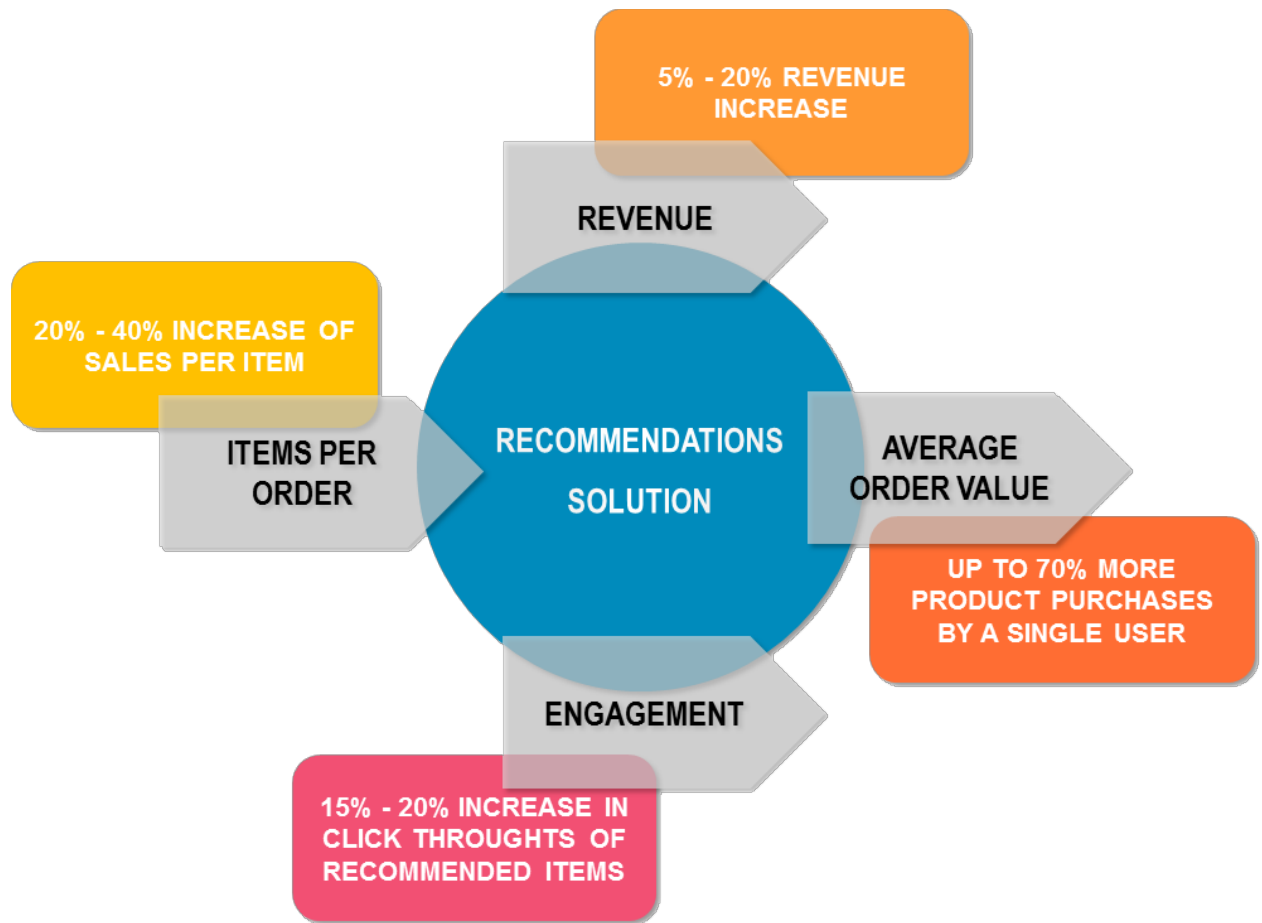


Figure 2.26: Benefits of User Recommender System

- Another benefit of using such form of systems consist of achieving a level of customer satisfaction. So, this is probably one of the best form of uses one can get after taking care of these systems.
- This system has the ability of personalizing things so that the people who are accessing this form of data can recommend different things to these users. Therefore, such systems know the data about yourself and like your family and friends help in recommending things to you.



Figure 2.27: User Recommender System Boosts Revenue

- These types of systems help the users in discovering a lot of things as well as explore much data. So, they can make use of these systems in order to find a huge network of information which is connected to their level of preferences.
- It also helps in making reports of the information which is personalized for the users who can use it to explore different form of information on the internet. So, it all leads towards the increase in sales in different forms by means of such user recommendation systems.

2.6 Summary Of The Chapter

The entire review of the literature suggests various aspects of the artificial intelligence as well as its relationship to machine learning which is an important area of artificial intelligence. It is important to mention that deep learning also is closely associated with this field of machine learning that is directly linked to artificial intelligence. There are various forms of deep learning networks which help in fulfilling various aspects about collecting data about users. So, the recommendation of users is undertaken by means of following certain models that contains data filtering methods.

The form of collaborative filtering, content-based filtering as well as hybrid based system is of paramount importance in this regard. These systems follow a series of steps which ensure

that such form of data is used, including data collection, storage of data, analysis and filtering of data respectively. All of these processes are used to ensure that the people are accessing the right kind of data which help them gain recommendation through such systems. It makes them discover and explore various forms of data which can be used to boost sales of their businesses also.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will explain the basics of the research as well as the advanced features of it which will be elaborated here. The focus of this chapter will be on measuring the proposed research question in order to see how the use of certain methodology will help in finding answers to the problem question. This section will be divided into various sections, with each one explaining different features of the methodology adopted by the researcher.

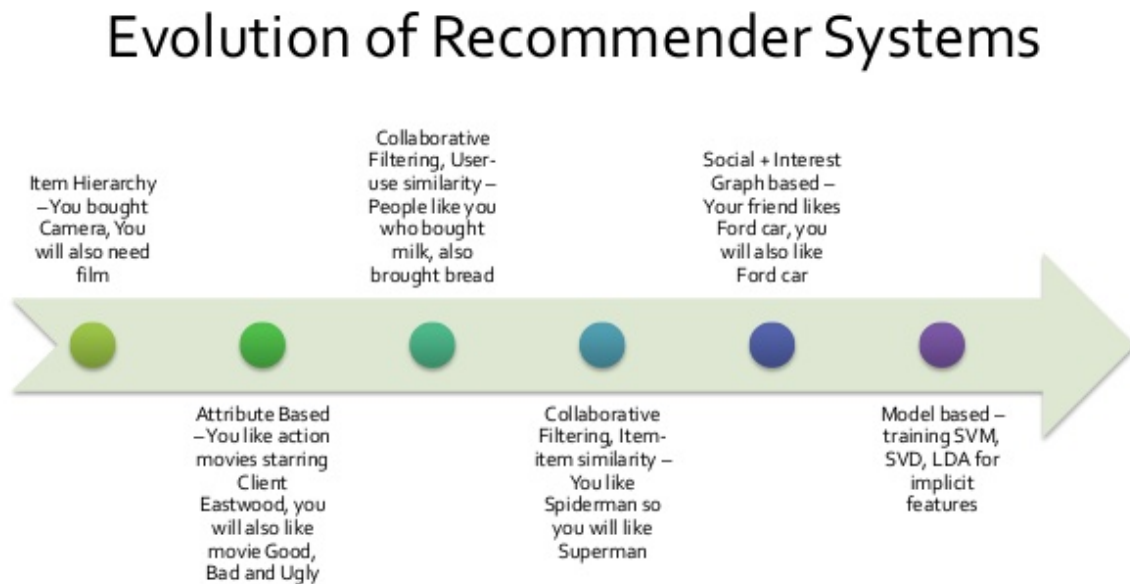


Figure 3.1: Features of Recommender Systems

3.2 Deep Learning Recommender System

The chapter talks about the recommender systems which will be used here as the key component of this research. The research used a novel method of hybrid filtering for deep learning. The system which will be used here will be Impulse-ML that is basically a component of a PHP library. So, in order to share the content which has been personalized for the sake of users, we need to take into consideration this recommender system. There are many benefits for using this recommender system which can be achieved in the form of

predicting the rating or giving preference to some item. So, they have the capacity to help the users in getting an increase number of rating on the choice of certain parameters.

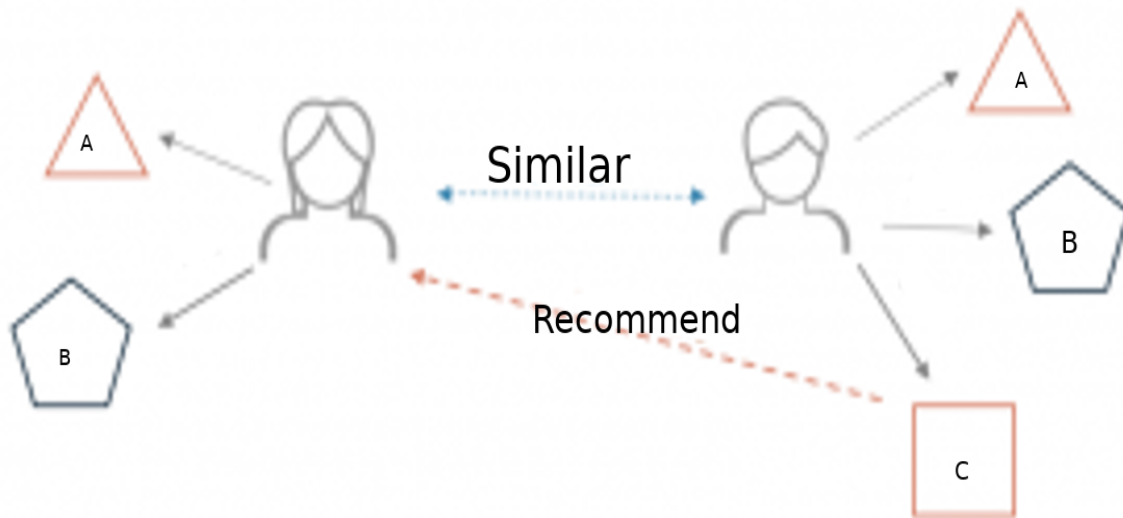


Figure 3.2: Recommender System

3.3. Hybrid Recommender System

One needs to follow a procedure in order to pass data on to Impulse-ML which can be done by knowing the dataset. Because of the lack of compatibility with other PHP applications, data can be passed to Impulse-ML directly. It is important to mention that one does not need to put a single category for every item, but one must adopt multiple categories. One also must be knowledgeable enough to put the data in the recommender system. Certain strings can also be used to save memory while these database keys correspond to primary keys. It is necessary to explain that there are three parameters which are required out of which the category and item must be added in the dataset while the third has to be numeric. It is also important to mention that these ratings may not consist of a certain increased or decreased level, but must be of different parameter of learning. One also has the option of using NULL in case of no rating given for the item but it is not essential to do so.

Hybrid Recommendations

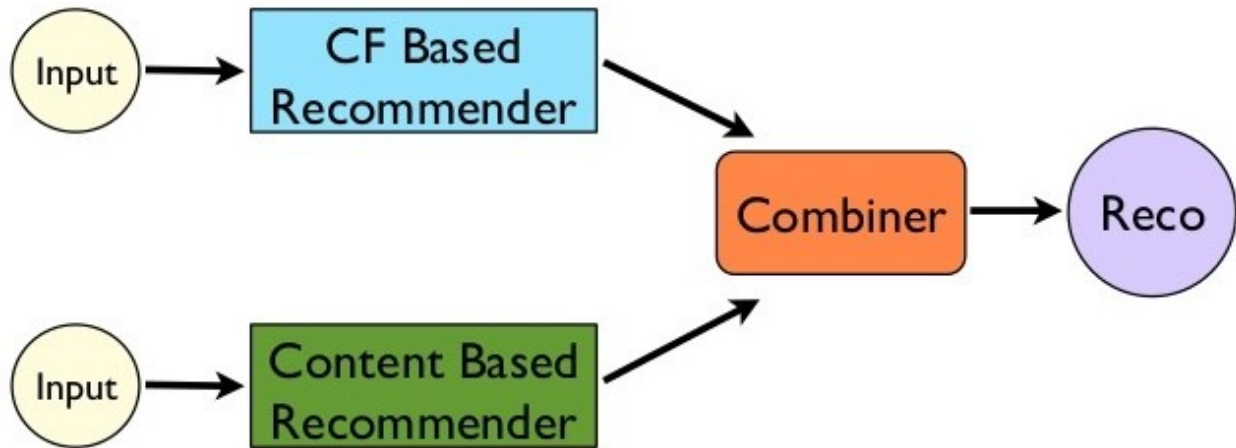


Figure 3.3: System Overview

The researcher made use of the user datasets in order to study the aspects of the hybrid system of learning. The users and their ratings was taken from a pre-existing dataset which did not require training. Therefore, the ratings as well as the users were collected from IMDB in order to check their movie preferences. Due to the use of pre-existing models, it can be inferred from the data that the researcher did not require training. Therefore, the trained model of convolutional neural learning was adopted and used by the researcher. The ratings which were used were 10 in number as per the samples used for this research. These 10 sampled user ratings were then studied by the CNN model of learning.

In order to predict the results, there are three ways which can be undertaken in order to handle this sort of data. So, the first sort of way for the prediction of results is rating the user according to the preferences which he or she has. An example can be given here of Anna whose preferences will be studied in order to predict her rating for Logan movie. So, this is one way of predicting the results but there is a big problem with using this method, that is, the use of improper learning model will cause issues. In other words, if one is using that model which is not properly trained, it will cause the results to be appeared differently.

The second method of prediction which is used is about findings the items which are similar or can be placed together in order of similarity. The third form of predicting results is predicting the rate to undertake for the user who does not seem to rate any movie. In this case, no previous computations have been available or seen before so this prediction has to be made anyway by finding some methodology. So, this is the model which is not completely trained and has great possibility for error. The rate of learning as well as repetition seem to be considerably low for such kind of example. In the second example, the rate of learning is supposed to be 0.1 and the repetition is 10000. Here, the rate of error for computation seems greater because of the higher rate of learning.

The third example shows the rate of learning to be 0.0001 with repetitions as 10000. The rate of error which is found in this case is good. However, in order to increase its learning rate, one needs to set an increased value for learning rate of repetition. The fourth type of example concerns the rate of learning to be 0.01 whereas the repetitions are considered as 100000. Here it is a good idea to try to lower down the number of repetitions. All of these examples which have been mentioned above are not considered good with huge datasets. However, there are some other type of adjustments which needs to be made in order to manage such types of datasets.

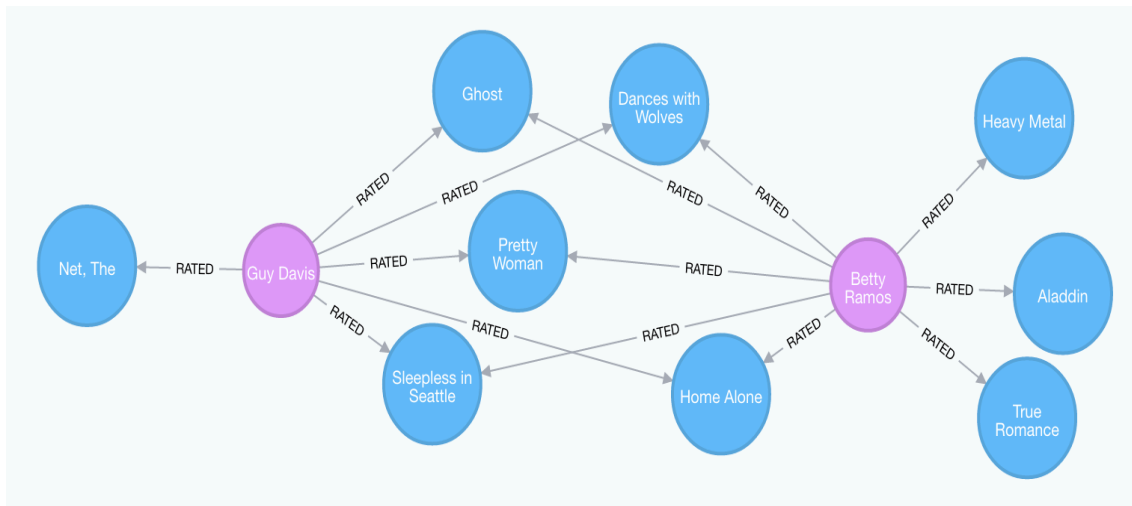


Figure 3.4: Examples of Datasets

3.4 Restoring of a Trained Model

It is important to mention that the researcher requires a huge amount of time in order to manage the time of training. So, there are two steps which must be undertaken in order to perform this job. One is saving while other function to be performed is about restoring the model which has been trained. It is important to mention that there are a couple of parameters which are employed in this regard including locating the directory which can be used to save the data. However, the second form of data is about creating the files of the data in the directory.

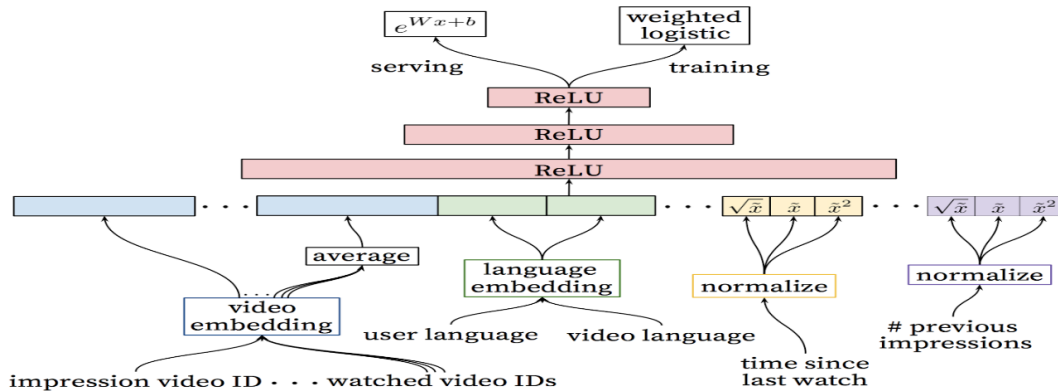


Figure 3.5 Training Model

3.5 Summary Of The Chapter

To sum up, the chapter explained the type of methodology used in the research as well as fully elaborated the procedures applied for the study. The models used for the research as well as the entire processes used have been explained in great detail. This section also talked about the training models for the recommender systems as well as thing which were necessary for such models. The next chapter will describe and evaluate the results of the study which will be followed by the discussion chapter. It will also include the study limitations as well as the future aspects and recommendations for future academics and researchers.

CHAPTER 4

EVALUATION

4.1. Introduction

The present research is focused on the deep learning models for recommender systems that ensure that these types of models are used for specific purposes. It is necessary to understand that the basic crux behind these sorts of deep learning based recommender systems is that they do have feature of artificial intelligence. Considering the basics of artificial intelligence, once can understand that it is the field through which one can learn the basics of working of human mind. The type of learning model which is used here is the content-based filtering. However, the models which are used for this research are pre-existing and does not contain some new aspect in it.

It is important to mention that there are many features and things that can be managed by means of artificial intelligence. The need to understand the field of artificial intelligence can be understood from the fact that it makes various devices and applications. These days, the technology has reached to such a level that various sort of people try to use various applications to improve their lives. There are driverless cars as well as other types of equipment which can be used so that others could use them for fulfilling various purposes. Through this area of artificial intelligence, one can understand this fact that there are many things that cannot be controlled through any other means.

This field of artificial intelligence causes that people to understand this area makes it easy for people to make use of various machines in their lives. Therefore, one can understand that the concept behind machine learning systems is that they are also made on the basis of the area of artificial intelligence. It is important to state that out of various systems of learning, one can take into consideration content based learning system, collaborative learning system or a network of hybrid learning system. However, the current research is focused on the deep learning system or model which enables the people to get access to neural networks. That is why the next section explains the convolutional neural network and links it with its role in the formation of the textual data.

4.2. CNN in the Formation of Text Data

Its importance can be greatly felt so that it could enable others to perform various form of textual operations. It might seem confusing to understand because of the complex matrices involved in these types of networks commonly known as convolutional neural learning models. Its example can be understood as the given structure which needs to be paid attention to:

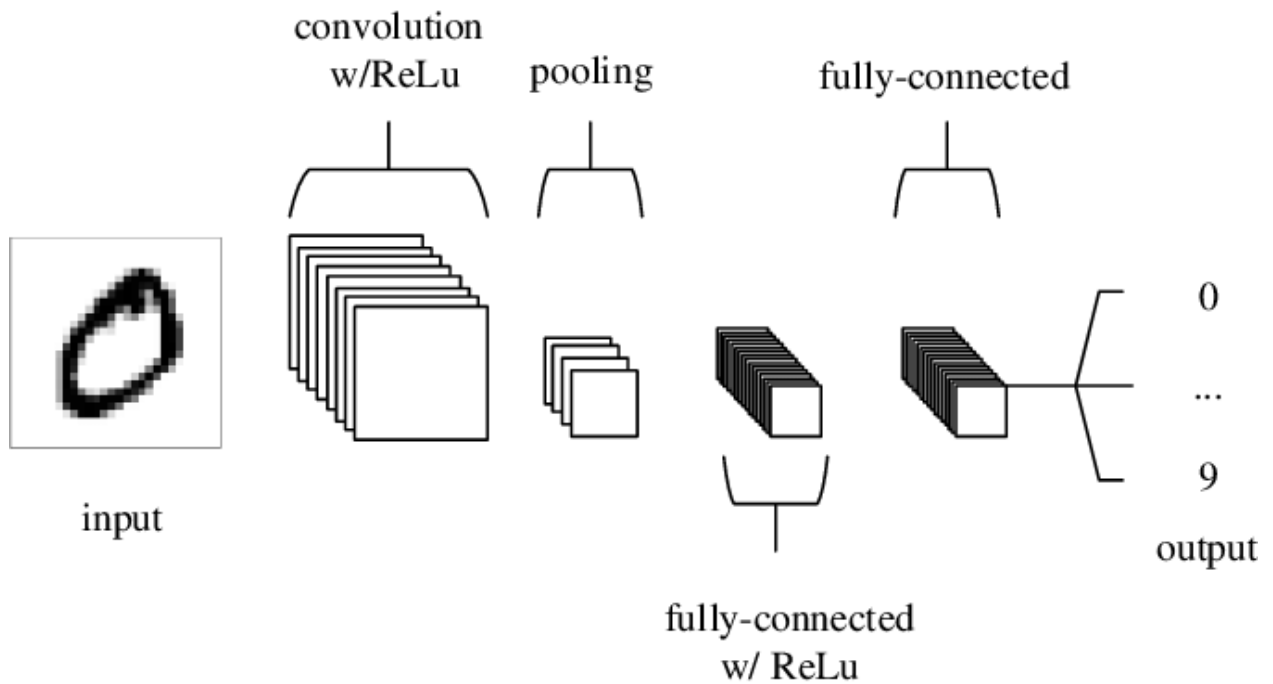


Figure 4.1: CNN Architecture

There is a need to understand the textual framework so that one can try and understand how such type of architecture could be used so that one may incorporate textual classification. It is not only used very much in the field of academics, but it is being used in some others field also. There are different approaches which are related to this usage and it enables others to not only detect spam but it contains the features of auto-tagging also. Some of these examples could be found in the form of the article categorization which can be understood to be the main area of text classification. There is an end-to-end feature of classification which has certain components like training text, labels and feature vector etc (Mohammed, Khan & Bashier, 2016).

These types of networks are based upon biological neural networks which are actually focused on creating various types of learning connections. There are many types of these connections which are involved in deep learning models including the most famous convolutional neural learning networks. Talking about the objectives of this research, one can focus on this fact that this research investigates the deep neural learning connections. The basic aim to study these sorts of recommender learning systems is that these are all forms of machine learning. It is also the aim of the researcher to take into consideration the data that is available on the internet which can be found there. The researcher has used these trained datasets to collect data from the samples which has made this task easier and enables others to use them for the user ratings. That is why, this has a special significance for this research (Mohammed, Khan & Bashier, 2016).

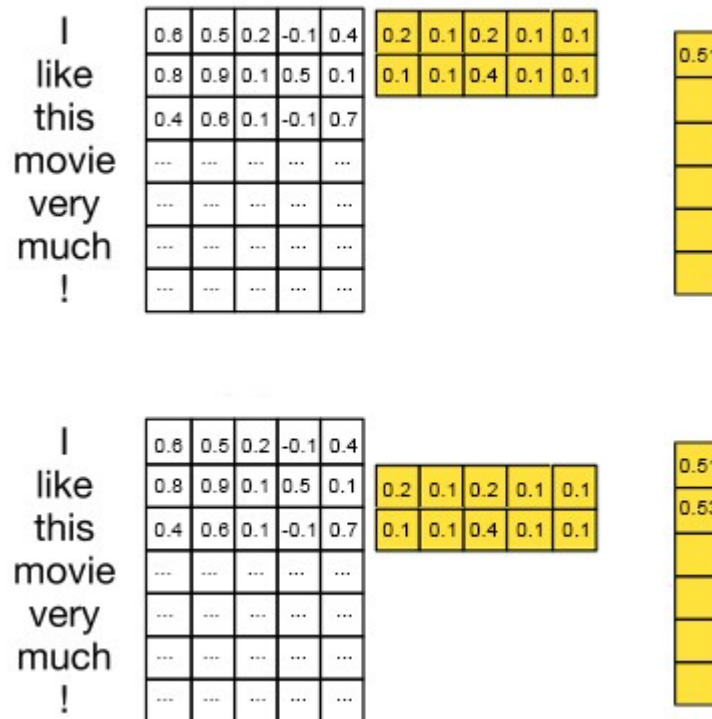


Figure 4.2: Examples of CNN Architectures

The chapter explains in detail the deep learning recommendation system in order to describe the user datasets as well that were incorporated in this research. The research questions of the study have been explained in this research through the various examples that were incorporated in this research. It can be understood about this study through an example which

can be given here of Anna whose preferences will be studied in order to predict her rating for Logan movie. So, this is one way of predicting the results but there is a big problem with using this method, that is, the use of improper learning model will cause issues.

In other words, if one is using that model which is not properly trained, it will cause the results to be appeared differently. The second method of prediction which is used is about findings the items which are similar or can be placed together in order of similarity. The third form of predicting results is predicting the rate to undertake for the user who does not seem to rate any movie. In this case, no previous computations have been available or seen before so this prediction has to be made anyway by finding some methodology. There are ten users whom will be given training in this case and these will be trained on the basis of CNN models.

It is important to mention that one can form a trained dataset if one is able to find out how it is translated into pixels. The people who are involved in this training of such type of user datasets know that their computers have certain images which are converted to pixels. In order to better evaluate the results of the study as well as find out the motivations behind this research, one must consider these questions as mentioned here. Current research question developed on data that consists of two sorts of movie categories with certain genre including comedy and action. There are various datasets that have been used in this research that must be deeply analyzed and evaluated. However, the data show that the characters of Anna and Barbara seem to be hating the action movies but Charles and Dave appear to love that. The things which are included in these trained datasets include the users Anna, Barbara, Charles and Dave and their ratings for IMDB has been incorporated for this study.

In the same way, we can see Barbara and Anna to be having fondness for comedy genre for movies whereas Dave and Charles do not seem to be in favor of watching them. Therefore, it becomes difficult for the data to predict the entire set of user's preferences without using a recommender system. In current study, three ways are undertaken in order to handle this sort of data. So, the first sort of way for the prediction of results is rating the user according to the preferences which he or she has. All of these results which were used in this chapter are capable of making us understand how to use these datasets appropriately. The significance of these types of results can be understood through using them properly. The researcher has used

the following quantitative data in order to get results for this research. The users that will be selected for training will be ten in number and they will be made to focus on their CNN specific training. Let us review the data which has been used for the current research. The analysis of these results will enable us to understand how to properly make use of these evaluations. Therefore, it must be kept in our mind to analyse these datasets as given below and find out how to properly access them for future directions. The explanation for this table has been given beneath this section as well.

The training model which has been used here has the certain features that will be explained here. The first dataset seems to have learning Rate of 0.0001 with 1000 iterations. This is given for untrained model which seems to have high errors while the rate of learning and iterations are quite low. In the second example, learning Rate is 0.1 while iterations are 10000. Here, the rate of learning is said to be high because it consists of computation error of numerical form. However, the third example consists of the learning Rate of 0.0001 while iterations are 100000 which is a good error but the rate of learning as well as iterations can be increased. For the forth example, we have learning Rate of 0.01 and iterations are 100000. Here, one may consider minimizing the iterations when the error may reach 0. Since, the average size of these datasets is small, these examples could be applied for larger datasets. It is important for us to incorporate here some examples of training which have following parameters as mentioned here.

Table 4.1: Learning Rates

Title	Value	Mode	Value
learningRate	0.0001	iterations	1000
learningRate	= 0.1	iterations	10000
learningRate	0.0001	iterations	100000
learningRate	0.01	iterations	100000

Table 4.2: Movie Users

Movie/User	Anna	Barbara	Charlie	Dave
The Dark Knight	0	0	5	5
Guardians of the Galaxy	0	-	-	5
Logan	-	0	4	-
Forrest Gump	4	5	0	0
The Kid	5	5	0	0
Avengers	0	0	5	5
PK	0	-	-	5
Superman	-	0	4	-
Spider Man	4	5	0	0
Frost	5	5	0	0
Invisible	0	0	5	5
Mr India	0	-	-	-
War	-	0	4	-
3 Idiots	4	5	0	0
God Father	5	5	0	0

The table with the amount of data given can be explained to be having four categories with fifteen movie names of items. Here it is necessary to know that this data consists of two sort of movie categories with certain genre including comedy and action. Here zero means the character hate that movie and rated the movie zero (0) while dash (-) means the characters is not interested in those movies and did not watch those movie. The data show that the characters of Anna and Barbara seem to be hating the action movies but Charles and Dave appear to be loving that. In the same way, we can see Barbara and Anna to be having fondness for comedy genre for movies whereas Dave and Charles do not seem to be in favor of watching them. However, the table does not seem perfectly complete owing to the fact that one item in the rating is omitted. Therefore, it becomes difficult for the data to predict the entire set of user's preferences without using a recommender system. In order to understand the operation of the recommender system, it is necessary to know that it can be done by using the data about the user's rating. So, it is utilized in order to predict the responses of the people

while they are delivered the links which they would prefer. So, the table which has been used above can be rebuilt in such a way:

Table 4.3: Movie/Users

Movie/User	Anna	Barbara	Charlie	Dave
The Dark Knight	-	-	-	-
Guardians of the Galaxy	-	0	5	-
Logan	0	-	-	4
Forrest Gump	-	-	-	-
The Kid	-	-	-	-
Avengers	-	-	-	-
PK	-	0	5	-
Superman	0	-	-	4
Spider Man	-	-	-	-
Frost	-	-	-	-
Invisible	-	0	5	-
Mr India	0	-	-	4
War	-	-	-	-
3 Idiots	-	-	-	-
God Father	-	-	-	-

According to the data which has been given in the table above, one can see that Anna seem to be having hatred for Logan movie as the rating goes to 0. However, the rating for Barbara goes to 0 for Guardians of the Galaxy as she does not like watching action movies. Moreover, the prediction for Charlie's preferences seem to be 5 because of his love for watching action. Likewise, Dave's prediction for Logan goes to 4 out of the love for watching action movies.

4.2. Significance

There are various fields of life where machine learning is being utilized in order to perform various functions. It is used for the field of finance in which trading is being done for algorithm and credit scoring. The area of image processing is especially important in this regard where the process of object recognition is performed by using such models. For the

area of computer vision, machine learning is quite important also where the task of face recognition as well as object recognition is done. It is not only used in industrial settings, but it is also employed in the case of medical science. So, in the treatment for tumors and cancers, tumor detection is being performed through the area of image processing and analysis.

The area of energy also employs such machine learning networks which is used for weather forecasting. In the areas and fields of automation industry, manufacturing of industrial products and aerospace also, machine learning is highly significant. There are some voice recognition applications also which employ the use of processing of natural language. If anyone is interested to know how he can use machine learning to perform various tasks, he might take into consideration the analysis of voice and images. Usually, in the case of complex mechanisms like problem-solving algorithms the use of machine learning is highly recommended.

Out of different forms of user recommendation systems, there are many benefits which can be found in each one of them. These can be used for business purposes to increase the boost of sales and the marketers can use them for selling their products. The users can get recommendations on their computers which ultimately enable them to know about various products. So, they can access those products so that they can contribute to the success of those businesses. There are many advanced online business platforms which are running on the basis of these sorts of systems. These user recommendation systems enable them to benefit from the fact that they can use these systems to earn money and receive greater number of sales as well.

There are many benefits which can be achieved by using the system of user's recommendation. Such as the use of recommender systems helps in the boosting of revenue and help those companies who are using them to get a raise. These types of systems help the users in discovering a lot of things as well as explore much data. So, they can make use of these systems in order to find a huge network of information which is connected to their level of preferences. It also helps in making reports of the information which is personalized for the users who can use it to explore different form of information on the internet. So, it all leads towards the increase in sales in different forms by means of such user recommendation systems.

4.3. Theoretical Contributions

This study theoretically contributes to the literature of machine learning and recommendation system. The theories are basically considered the models or systems of knowledge that explains various aspects about something. In order to analyse and evaluate the need to find out various meanings behind studying theories, it is necessary to understand these theoretical connections or paradigms. In general, it contributes to the literature of machine learning positive outcomes with the intervention of recommendation system along with collaborative filtering and content based filtering. This study is the first attempt to empirically validate the model of learning through training and testing phase with underlying recommender database.

4.4. Practical Implications

Artificial intelligence engineers accompany abilities on programming, normal language preparing, measurements, connected math and working information of instruments, for example, IntelliJ, Eclipse and the sky is the limit from there. By using these systems, it becomes easier for the people to make sure that these features are capable of providing various features. In the event that you are an AI applicant, you should need to consider progressively about turning into an AI engineer. Apart from these, the scope for jobs in artificial intelligence and machine learning also ranges across job roles like these the ones given here:

- Full stack developer
- Software architect
- Data analyst
- Data warehouse engineer
- Product manager
- Front-end developer

Machine learning undertakings include issues, for example, controlling and grouping extensive quantities of vectors in high-dimensional spaces. The traditional calculations we presently use for tackling such issues require significant investment. Quantum PCs will probably be truly adept at controlling high-dimensional vectors in huge tensor item spaces. Almost certainly, both the advancement of both administered and unsupervised quantum AI calculations will tremendously expand the quantity of vectors and their measurements

exponentially more rapidly than established calculations. This will probably result in a gigantic increment in the speed at which AI calculations will run.

It is important to mention that the concept of machine learning plays an important role for enabling users to take benefit from the use of such computers. These computers are basically trained in such a way so that others could make use of the software applications which are utilized for this cause. Basically, the concept of machine learning enables the users to get benefit from such form of computers that are capable of self-learning. The areas of machine learning important in this regard include using speech recognition as well as properly utilizing the features of web search. The use of machine learning has broadened too much that others can try to benefit from it in order to use the innovation patterns of the area of artificial intelligence.

Unsupervised learning happens when no marks are given to the learning calculation. It is left individually to discover structure in the information. Unsupervised learning can be an objective in itself, for example, finding shrouded designs in information, or methods towards an end, regularly called highlight learning. All things considered, propels in structure more intelligent, unsupervised learning calculations will prompt quicker and progressively precise results. Collaborative learning is tied in with using distinctive computational substances so they work together so as to deliver preferred learning results over they would have accomplished without anyone else. Personalization can be incredible, yet it can likewise be similarly irritating. Therefore, several precautions must be taken in order to appropriately benefit from their use.

We have every single experienced proposal that appear to hold up under no real connection to anything that we may really be keen on. Later on, clients will probably get increasingly exact proposals and adverts will wind up both progressively viable and less incorrect. The client experience will inconceivably improve for all. This innovation incorporates unit like APIs and administrations through which designers can make increasingly discoverable and shrewd applications. The use of all these systems ensure that the people are capable of benefiting from their use. These systems must all be utilized in such a way that they make lives of people easier by using AI applications. So, they cause engineers to specifically gain useful insights into literature and find answers in a specific manner.

AI APIs will enable engineers to present insightful highlights, for example, feeling location; discourse, facial, and vision acknowledgment; and language and discourse understanding into their applications. The eventual fate of this field will be the presentation of profoundly customized figuring encounters for all. These are things I think can and ought to occur in the AI's splendid future, however it is similarly similar to that the presentation of some new obscure troublesome innovation will result in an eventual fate of which will we could never have anticipated. Therefore, it becomes easier for someone to look towards the future beforehand so that one could get assistance from its use.

The use of machine learning enables users to properly focus on the computer programs which could be properly used for accessing various form of data. These forms of data could be properly used considering their features of learning that have the capacity to cause various observations. However, the aim of using machine learning systems is that they make the task of learning easier. The people also are able to use these systems so that they can use them for fulfilling their particular sort of objectives helpful for taking specific decisions in the future.

CHAPTER 5

CONCLUSIONS AND FUTURE WORK

This section will conclude the topic of the research as well as enable the people to properly benefit from this form of research. The chapter will enable the reader to deeply analyze the future works as well as future directions about this research. One can study the ways this research goes towards as well as find meanings to various sort of problems. There are features like supervised learning, unsupervised learning as well as reinforcement based systems of learning. These forms of systems make use of huge data sets or things which are accessible in massive amount. The use of cognitive technologies is also especially important to consider in this regard which enable the users to process various sort of information.

The research focuses on the need to develop a framework for machine learning which can be explained by studying various aspects about user recommender systems. These systems are too much in use and they can be explained in such a way that it enables the users to get benefit from them. The appropriate use of such sort of systems cause one to understand the user recommender systems which are integral to play their part in such a way that the people are able to use them in various applications. These applications of human learning have the potential to engage human beings into such an interesting feature about internet.

Current study aimed to test the proposed research framework drawn with the help of previous literature to elucidate the probable associations between machine learning based on recommendation system. Moreover, it specified the underlying mechanism of these probable associations through developing a learning model and using database. As well as explore the hybrid, content based and collaborative filtering methods that are important for use in this type of user data based systems of recommendations. Overall in study there are two fundamental ways are discussed to deal with recommendation system – collaborative filtering and content based.

This section discusses the findings of this study according to the research questions that were addressed in this study. The entire study suggests various aspects of the artificial intelligence as well as its relationship to its important area as machine learning. It is important to mention that deep learning also is closely associated with this field of machine learning that is directly

linked to artificial intelligence. There are various forms of deep learning networks which help in fulfilling various aspects about collecting data about users. So, the recommendation of users is undertaken by means of following certain models that contains data filtering methods.

The form of collaborative filtering, content-based filtering as well as hybrid based system is of paramount importance in this regard. These systems follow a series of steps which ensure that such form of data is used, including data collection, storage of data, analysis and filtering of data respectively. All of these processes are used to ensure that the people are accessing the right kind of data which help them gain recommendation through such systems. It makes them discover and explore various forms of data which can be used to boost sales of their businesses also. Therefore, it must be understood carefully and must be understood as such. The next section talks about the future scope which is related to this research.

5.1. Future Scope

It is important to find out the future scope of this research by taking into consideration the fact this deep learning based recommender system is used for understanding various aspects. These aspects are about the need to study the related works that could be accessed or utilized so that one could properly use them. However, one can try to take into consideration the previous works done in the literature that enable the researcher to find various answers to their research questions. Thus, one needs to understand that they must be keenly organized or studied so that it makes it possible for someone to get benefit from them.

5.2. Recommendations

There are some of the recommendations which can be given in relation to the topic which has been presented here. These recommendations are about the ways to make use of user recommendation systems in much better form. However, one must keep this in mind that these suggestions are different for different people. It is not only one segment of people who get affected by such kind of recommendations, but there are some other people also who are influenced by it. It can be understood in such a way that some of the suggestions are given for researchers who would like to work on similar topics. However, there are others also who would like to benefit from such works of academic nature. These people include academicians

and others associated with field of education who would like to know more about such researches. These recommendations are given below:

1. The researchers should try to fill in the gaps which have been left in the literature on the given topic. They should try their best to conduct researches on such topics so that they can conduct studies that give good outcomes.
2. The researchers must not only try to work on similar topic, but they should also try to work on other areas also. It will enrich their knowledge and will enable them to conduct researches that will act as good contributions in the field of knowledge.
3. For academicians and others associated with the field of education, this sort of researches might act as good database. They can use them in their education and learning experience and might teach others these lessons.
4. The use of such researches is important for anyone who wants to make a mark in such field of knowledge. It will enable him to get his answers through that kind of research which makes him know a lot about a new area.
5. So, this area about machine learning serves an important part for anyone who is interested in this field. Therefore, such type of researches must be conducted in such a manner that people should benefit from their significance.

5.3. Limitations of the Study

Every research has some pitfalls that are faced by the researchers that are considered the limitations of the study. Apart from the imperative contributions of this study, it has several limitations which will be discussed in this section. Present study investigates data in one point of time; a cross-sectional research would be effective to compare sample results over time. Moreover, a multi-level model using structural equation modeling can further explore the potential outcomes of machine learning. Present research conducted on micro level which constitute non-parametric data, future research should be conducted on macro level and data collected should be parametric so that data can allow a comparative study on the basis of gender difference that how particular gender perceive machine learning based on recommendation system.

It is important to mention that the hybridization of content based and cooperative filtering based suggestion is proposed in this study. The loads of various qualities of a thing are figured from the communitarian informal organization utilizing relapse investigation. Further examinations on other weight estimation methods like scanty relapse also, isometric projections are being considered. Additionally, more thorough execution assessment dependent on human judgment will be attempted. A model for a trust-based recommendation framework that combines the concepts of social systems administration and trust connections: operators utilize their trust connections to alter the data that they need to master and their social system to reach information that is located a long way from them. Likely, the most striking consequence of this work is that the recommendation framework self-sorts out in a state with performance close to the ideal. However, the performance on the worldwide level is a rising property of the framework which is achieved without explicit coordination from the local interactions of specialists.

With this model, future research endeavour towards structure an archetypal display for recommendation frameworks by combining the concepts of social systems administration and trust connections. Therefore, all of these concepts must be used together in such a way to promote the use of such connections which are based on trust and administration of social systems. All these things suggest that the people can endeavour to keep the use of these models in mind in order to specifically take benefit out of these learning models. To summarize this entire research discussed here, the type of methodology used in the research as well as fully elaborated the procedures applied for the study. The models used for the research as well as the entire processes used have been explained in great detail. Current study explained in detail everything about the training models for the recommender systems as well as other things which were necessary to use for such models.

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APPENDICES

APPENDIX 1

IMPULSE RECOMMENDER

```
<?php

namespace Impulse;

class Exception extends \Exception
{
    // codes
    const PATH_NOT_DIR = 1;
    const PATH_EXISTS = 2;
    const EMPTY_MODEL_ID = 3;
    const INCORRECT_MODEL_TYPE = 4;
    const MODEL_ID_ALREADY_SET = 5;
    const ITEM_EXISTS = 6;
    const CATEGORY_EXISTS = 7;
    const ITEM_NOT_EXISTS = 8;
    const CATEGORY_NOT_EXISTS = 9;
    const PARAMETER_NOT_EXISTS = 10;
    const PARAMETER_NOT_INTEGER = 11;
    const PARAMETER_SHOULD_BE_GREATER = 12;
    const ITEM_OR_CATEGORY_NOT_FOUND = 13;
    const PARAMETER_NOT_DOUBLE = 14;
    const PARAMETER_NOT_BOOL = 15;
    const PATH_NOT_WRITABLE = 16;
    const PATH_NOT_FILE = 17;

    protected static $messages = [
        self::PATH_NOT_DIR => 'Path :path is not a directory.',
        self::PATH_EXISTS => 'Path :path exists.',
        self::EMPTY_MODEL_ID => 'Dataset model ID should be not
empty.',
        self::INCORRECT_MODEL_TYPE => 'Dataset model ID should
be string or integer.',
        self::MODEL_ID_ALREADY_SET => 'Dataset model ID is
already set.',
        self::ITEM_EXISTS => 'Item with ID = :id already exists
in dataset.',
        self::CATEGORY_EXISTS => 'Category with ID = :id
already exists in dataset.',
        self::ITEM_NOT_EXISTS => 'Item with ID = :item not
exists in dataset',
        self::CATEGORY_NOT_EXISTS => 'Category with ID =
:category not exists in dataset',
```

```

        self::PARAMETER_NOT_EXISTS => 'Parameter :param is
required.',
        self::PARAMETER_NOT_INTEGER => 'Parameter :param should
be an integer.',
        self::PARAMETER_SHOULD_BE_GREATER => 'Parameter :param
should be greater than :value.',
        self::ITEM_OR_CATEGORY_NOT_FOUND => 'Item or category
not found',
        self::PARAMETER_NOT_DOUBLE => 'Parameter :param should
be type of float.',
        self::PARAMETER_NOT_BOOL => 'Parameter :param should be
type of boolean.',
        self::PATH_NOT_WRITABLE => 'Path :path is not
writable.',
        self::PATH_NOT_FILE => 'Path :path is not file.'
    ];

    public static function create($code, array $messageParams =
[])
    {
        $message = self::$messages[$code];
        $message = self::prepareMessage($message,
$messageParams);

        return new Exception($message, $code);}

    public static function prepareMessage($message,
$messageParams)
    {
        foreach ($messageParams as $name => $value) {
            $message = str_replace(': ' . $name, ' ' . $value .
' ', $message);
        }
        return $message;
    }
}

```

APPENDIX 2

FILE MANAGER

```
<?php
/**
 * @package impulse-ml-recommender-php
 * @author <rehman.abid147@gmail.com>
 */

namespace Impulse;

require_once __DIR__ . '/Exception.php';

use \Impulse\Exception as ImpulseException;

class FileManager
{
    /**
     * Checks if $name directory can be created in $dir
     directory.
     * @param $dir
     * @param $name
     * @throws ImpulseException
     */
    public function checkCreateDirectory($dir, $name)
    {
        FileManager::checkNotDirectory($dir);
        FileManager::checkNotWritable($dir);

        $path = $dir . DIRECTORY_SEPARATOR . $name;

        FileManager::checkPathExists($path);
    }

    /**
     * Checks if $path is existing directory.
     * @param $path
     * @throws ImpulseException
     */
    public static function checkNotDirectory($path)
    {
        if (!is_dir($path)) {
            throw
ImpulseException::create(ImpulseException::PATH_NOT_DIR, [
                'path' => $path
            ]);
        }
    }
}
```

```

/**
 * Checks if directory is writable.
 * @param $path
 * @throws ImpulseException
 */
public static function checkNotWritable($path)
{
    if (!is_writable($path)) {
        throw
ImpulseException::create(ImpulseException::PATH_NOT_WRITABLE, [
            'path' => $path
        ]);
    }
}

public static function checkPathExists($path)
{
    if (is_file($path) OR is_dir($path)) {
        throw
ImpulseException::create(ImpulseException::PATH_EXISTS, [
            'path' => $path
        ]);
    }
}
}

```

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