

**News Recommendation by Sentiment Analysis and User's Interest from
Social Media**



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Approval

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ABSTRACT

Individuals are using their favorite news sources for getting daily news but ultimately they are unable to get the news of desired interest. Every news website provides its own interface and news order; no one is providing personalized news and focusing on user's interest. Also Pakistan is facing many problems due to terrorism activities inside the country. These activities often make their space on media showing up a bad glimpse of our country though there are many good things/activities happening around us but we see news based on violence and hate speech everywhere on the web. Hence, there is need of an efficient and promising ranking algorithm which can process news coming from different sources and combine them on the basis of their semantics i.e. statement is positive or negative and user's interest from their social media preferences. This study presents methodology for ranking news on the basis of sentiment analysis and user's interest fetched from social media. To do so, we have modeled the relationship between user's social media preferences and news; we have extracted categories from social media mapped with general categories of news, this solution also considers sentiment of news. Sentiment analysis can rank the news so that user can look for positive news first to start their day with good mood. To provide promising results this research is carried out to integrate user's social media preferences and sentiment analysis to build a news recommendation system. Enduring experiments shows that our recommendation system provides positive news and news of user's interest as it make use of user's social media profile which is the most updated user profile maintained by user itself.

CERTIFICATE OF ORIGINALITY

I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by an-other person, nor material which to a substantial extent has been accepted for the award of any degree or diploma at National University of Sciences & Technology (NUST) School of Electrical Engineering & Computer Science (SEECS) or at any other educational institute, except where due acknowledgement has been made in the thesis. Any contribution made to the research by others, with whom I have worked at NUST SEECS or elsewhere, is explicitly acknowledged in the thesis.

I also declare that the intellectual content of this thesis is the product of my own work, except for the assistance from others in the project's design and conception or in style, presentation and linguistics which has been acknowledged.

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LIST OF ACRONYMS

API	- Application Program Interface
SDK	- Software Development Kit
RSS	- Rich Site Summary
DOM	- Document Object Model
XML	- Extensible Markup Language
URL	- Uniform Resource Locator
S.D	- Standard Deviation
ID	- Identification
PS	- Positive Sentiment
NS	- Negative Sentiment
NLP	- Natural Language Processing

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INTRODUCTION

1.1 Background

In the last decade, most of the people starting reading online news whether its web or mobile app. People are looking forward for news on web via surfing different pages, news websites and blogs. There are many commercial news engines and news channels websites available like Google News, Yahoo News. Both of these sources provides news by aggregating news from different sources. With the growing number of internet users new reading demand is also increasing considering this all search engines are providing access to search news.

News sources and news readers are increasing day by day to tackle this situation many news recommendation systems proposed. There are two types of recommendation system; one is information filtering and other is collaborative filtering. Information filtering make use of content to recommend news on the basis of features extracted from content while collaborative filtering make use of peer users opinion to recommend news on the basis of user's profile. In information filtering one can make user's profile by taking data implicitly or by taking data explicitly. Studies have shown both of these techniques are effective but implicit is more time taking than explicit. Explicit is fast as it take content as input preprocess it and provide results while implicit take time to build profile on the basis of user's behavior.

To provide user great experience of news reading personalized news recommendation systems has introduced. Many of these news sources user machine learning techniques to observe users behavior over time and recommend news on the basis of learned profiles. Machine learning techniques are time taking so some news recommendation system uses explicit actions to perform by user like select category of his/her interest at once and recommend news on the basis of user's set configuration. Google news provides both of these options to user to select category of his/her interest and later on monitor user's behavior to build user's profile for further recommendation. Personalized news recommendation has changed reading interest of user's as it's actually recommends user's favorite articles.

News recommendation systems are now considering user's social media activities to recommend news. Social media usage increased exponentially and its increasing day by day as user's can find everything related to their daily needs there on their social media profile. Many news recommendation systems has made analysis on user's social media profile on

Twitter¹ and Facebook². User's tweets are analyzed to fetch interest from user's tweets and recommend news on the basis of features extracted from tweets. In similar fashion user's posts and comments on Facebook are analyzed to build user's profile for recommendation. Research is carried out in this domain to build a network of user's and extract features from user's friend lists and their friends comments and posts to analyze collaborative results.

News recommendation can take several factors as input to recommend news. In general users are looking forward for news of their favorite categories and positive news. Users mostly use social media to start their day and look for pages they have liked and check for interesting news. Social media profiles are already built and user mostly use his/her social media profile. Sentiment analysis can rank the news so that user can look for positive news first to start their day with good mood. To provide promising results this research is carried out to integrate user's social media preferences and sentiment analysis to build a news recommendation system

1.2 Problem

News is daily need of a person but there is huge number of news sources available on the web. One can make use of his/ her favorite news website to get the daily news but they are unable to get the news of their interest. Most of the times when user visits some news website or even his/her favorite news website they see different kinds of news including politics, some are of fashion and some are of pure sports and all are intermingled. People always look forward for news of their interest though every news has its own significance but most of the time the user hopes for news of his her interest.

Every news website provides its own interface and news order; no one is providing personalized news and focusing on user's interest. Hence, there is need of an efficient and promising ranking algorithm which can process news coming from different sources and combine them on the basis of their semantics and user's interest from their social media preferences. News channels and feeds providers are just broadcasting their news on the basis of time and categories and all the news is so much intermingled that user has to make a way and find out the relevant news by scrolling over the website or checking other sources. Most of the time users get depressed by just passing over bundle of news. There is no solution available on web especially for Pakistan which can provide news of user's interest.

This research outlines an approach in which one can get the user's liking from social media by checking various criteria such as type of pages liked by the user and number of

¹ <https://twitter.com/>

² <https://www.facebook.com/>

pages of a news category; one can rank the news accordingly by checking the relevance of news and user's interest. Social media giants like Facebook and Twitter provide their application programming interface (API) to share the user's public information. Our recommendation system has fetched user's interest from social media profile; extracted news from different news sources in their respective general categories and score the news on the basis of a number of subcategories retrieved from the social media. This gives more promising results required by user.

1.4 Problem Statement

Variety of news are available on internet users have to check for news of their interest by traversing on pages. Users mostly finds news on the basis of hate speech and violence. There is need of recommendation system which can solve said issues.

1.5 Research Objectives

Objective of this research is to propose news recommendation system that

- Uses social media preferences to check the relevance of the news with user's interest.
- Ranks the news with respect to sentiment analysis.
- Presents the news in visually appealing form related to ranking and user's interest.

1.6 Scope of the Study

News recommendation needs several aspect to be considered. To provide great user experience a news recommendation system is developed considering users personalized approach towards news. Insight of literature review is carried out on news recommendation which covers findings, news analysis, news aggregation, personalized news and sentiment analysis. This research consists of five different aspects i.e. news aggregation, news preprocessing, feature extraction from social media, news ranking and sentiment analysis. Eight different news sources are used to aggregate news. News are preprocessed and stored in central database and later news is ranked on the basis features extracted from social media. Social media giant Facebook is used to extract user's interest from his/her profile. In this research I have used two features of user's profile which are user's gender and user's likes on his/her social media profile. Later sentiment analysis is carried out to rank the news i.e. positive news on top.

1.7 Thesis Organization

This research study is organized into five chapters. Chapter one describes the background of news recommendation, sentiment analysis, problem statement, objectives, scope of the study.

The second chapter of literature review covers the brief description of the personalized news, sentiment analysis, previous research findings, determination of the personalized news and good news. The third chapter includes the methodology to news aggregation and rank news on the basis of user's social media interest, positive news calculation. The chapter four of results and analyses describe news analysis and analysis of user's interest toward different news categories and sentiment analysis of different news sources. The chapter five presents the conclusion and recommendations on the basis of the current study results and future research. The thesis organization can also be illustrated by figure 1.1.

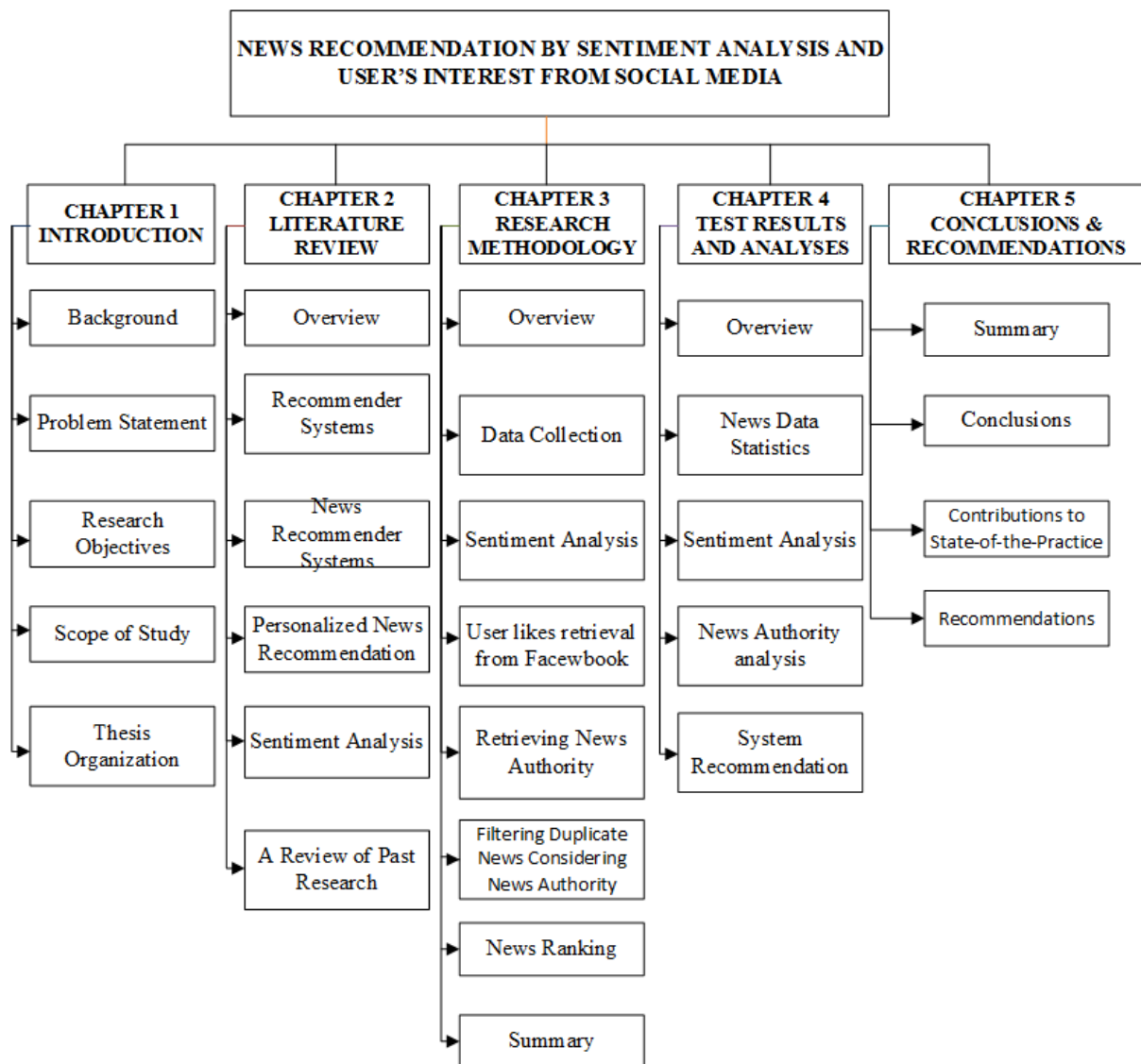


Figure 1. 1 Thesis Organization

LITERATURE REVIEW

2.1 Overview

Online news reading is very popular as nowadays web provides large access to news from thousands of online news sources. A key challenge to news provider is to recommend news that is interesting to read for that particular user. Pakistan is facing many problems due to terrorism activities inside the country. These activities often make there space on media showing up a bad glimpse of our beloved country though there are many good things/activities happening around us but we see news based on violence and hate speech everywhere on the web. This chapter describe past work in recommendation system and sentiment analysis domain. Various studies has been elaborated in this chapter to describe literature.

2.2 Recommender Systems

Recommender systems or recommendation systems are inherited from information filtering that use to process information and rank them accordingly. Recommender systems are of two types one is of collaborative information filtering and second is content based information filtering. Collaborative based information filtering process information taken by a model which builds its self by observing user's behavior over time and other user's which belongs to target user. Content based information filtering takes properties of content and extract features and recommend item on the basis of features extracted. Recommendation systems are now very common in many fields of computer science i.e. search engines, shopping sites, blogs, forums, news websites etc.

2.3 News Recommender Systems

News recommender systems are used to rank news. News recommendation systems inspects news and preprocess news to provide ranking on the basis of several factors. News recommendation systems considers categories, location, and authority of news sources and freshness of news. Location of news is considered by publishing same location news to target area. Authentication of news is taken from rating and view of news and then news is published and ranked top. Most of the news recommendation provides most recent news first which indicates freshness of news.

2.4 Personalized News Recommendation

Personalized news recommendation used to rank news on the basis of user's interest. Mostly personalized news recommendation systems take input from user or observe user's behaviors

to recommend news of user's interest. News websites are using news recommender systems to provide great user experience. Personalized news recommendation systems build user's profiles on the basis of various machine learning techniques or on the basis of categories selected by user. Machine learning techniques mostly make use of number hits for a particular category and user's browse history. Most of the popular news websites and search engines relies on their news recommendation systems. Google make use of both machines learning technique and user's configuration for particular news.

2.5 Sentiment Analysis

Sentiment analysis use to extract impact of statement, it's a use of natural language processing and text analysis. Sentiment analysis used by several data processing systems to get attitude of the speaker and context of the statement toward particular scenario. Sentiment analysis make use of different keywords to rank the statement or document positive or negative. Mostly review systems make use of sentiment analysis to process comments by users on products. Sentiment analysis is now common to tag news articles, blog and user's comments on forums.

2.6 A Review of Past Research

Various techniques like machine learning, data mining and information retrieval are being used in the area of news recommendation. Using social media to get users interest is a modern technique and work is done at minor level i.e. extracting user's interest from comments and checking their relevance. Messenger and Whittle [1] have analyzed user's comments and checked the relevance of incoming news. This research paralleled and compared various alternatives to collect data from user comments on news article. A Research on User Profile Extraction from Twitter for Personalized News Recommendation indicated that a different method can be used to fetch user's interest in order to build personal profile using twitter as an information source to get service of personalized news recommendation; tweets, hastags and retweets can be used by this method to build user profile [2]. Oechslein and Hess gave their thoughts by using Facebook data in The Role of Social Ties in Social Recommender Systems by discussing several social bonding terms which can be used to proce [2]ss the news for recommendation like recommending, liking and sharing posts [3]. Real-Time News Recommendation System with Heterogeneous Social Footprints proposed a recommendation system which made use of social media foot prints to recommend news of user's interest; they made use of user's posts [4]. Personalized News Recommendation using Classified Keywords to Capture User Preference has argued on

recommendation system which made use of machine learning technique deep neural networks to recommend news on the basis of users past interacted news articles [5]. Many solutions are proposed by making use of twitter tweets, hash tags to build up user profile to recommend news, they capture profile information from twitter and analyze the data for further categorization [6, 7, and 8].

News ranking is becoming popular as bulk of news broadcasted daily by single channel. There are various news channels available and they provide with their own feeds to cater this problem. Study is made to take various news channels as authorities, freshness of news and semantics of news to map them to corresponding categories [9]. Research work is done in the area of collaborative filtering to recommend user things of their interest extracted from their friends on social media [10]. A study is made titled An Effective News Recommendation in Social Media based on Users Preference in which they have analyzed user generated comments to extract key words from comments and compare with key words extracted from news to recommend news on the basis of similarity match [11]. Yongjian Fan, Yanguang Shen¹, Jianying Mai [12] have proposed recommendation system for ecommerce solution which they maintain library and apply rules to library to recommend news, there model apply data mining techniques to extract user interest this data mining technique is fast and efficient. They have acquired user information from user and applied data preprocessing and then results processed to give recommendations. In another study researcher has developed algorithm which fetches interest from user's social media profile like twitter and Facebook they analysis user's tweets to get his/her interest and give recommendation [13].

There is a lot usage of recommendation systems Dmitry Bugaychenko and Alexandr Dzuba [14] proposed recommendation system for music on social media platform. They have observed user's liking for a particular artist and if other artist is of same category and provides music of same type they recommends artist b and c to same user. Another study has shown user recommendation can be done by analyzing user's comments. In "User Comments for News Recommendation in Social Media" they have proposed an adaptive recommendation system which process thread of users comments and gives recommendation [15]. Social media platforms are increasing day by day and user base is increasing exponentially there is good chance to get users data from user's profile there on social media. In this regard Irwin King, Michael R. Lyu, and Hao Ma mentioned several parameters which can be used to recommendation on the basis of social media preferences. They have defined scope of recommendation using social media preferences, described security constraints and collaborative filtering to recommend [16]. In another study researchers have proposed interest

graph technique for recommendations system their recommendation system and called it IGGRA. Their interest graph is different than social media graph they have proposed flexible graph which actually not only connect users but also relates user's interest and give recommendation.

News recommendation not only needs user's interest but it also needs to be ranked on the basis on sentiments of news so that users can get positive news on top, its human nature to see and feel better. Considering this sentiment analysis can help recommendation system to add a layer and provide good news on top. There is a lot of research is done in this domain and it will be covered next. In "Classification of Facebook News Feeds and Sentiment Analysis" [17] sentiment analysis solution to process user's feed on Facebook are developed. They have categorized user's feeds to positive and negative sentiments considering GMAIL primary, social tabs they proposed there should be categorization of user's feeds on social media on the basis of sentiment analysis. Considering trend of sentiment analysis recently solution for stock market sentiment analysis is developed. Patrick Uhr, Johannes Zenkert, and Madjid Fathi proposed sentiment analysis which process data and apply NLP techniques to present information to make decision making easy and do risk management. Their CIMAWA-based technique shows good results and provide information in well-formed graphs on stocks which makes stake holder's decision making easy. Sentiment analysis is vast domain and research is done to analyze user's reviews for products and rank news items on the basis of sentiments.

Considering the work done till now this research has developed a better solution which system will make use of the best features of current research done and use extra information from user's social media profile to recommend news, past work has presented several techniques to cop recommendation problem most of the techniques proposed are dependent on machine learning, collaborative filtering and take explicit information. To provide good implicit content based filtering technique which processes news on the basis of user's interest. This research focuses on the development of system which can make use of user's social media profile, extract user likes to process and rank the news respectively.

RESEARCH METHODOLOGY

3.1 Overview

This chapter describes research procedures followed in this thesis. News are fetched and aggregated to place in central database. Sentiment analysis is applied to news items and tagged with sentiment values. News are categorized and placed with specific categories. User's interest is retrieved from Facebook and recommendation against each user is saved against user's records. News are categorized in eight different categories so that user can have news of their respective categories. Proposed solution fetches user's interest from social media and maps about two fifty different Facebook categories to eight different categories and groups them to take count of each category and sort them. This Study is carried out to map these two fifty different categories and will be elaborated in ensuing sections. News authority source is figured out by checking news, media and news websites likes and filtered out different sources which user prefer on other sources like GEO, SAMA, ARY, AAJ NEWS etc. User's interest is calculated on mobile side and news data is retrieved on server side to avoid time delay. News are preprocessed on server side in preprocessing stop words and HTML tags are removed to check similarity on news and unique news are identified against bulk of news so that user get unique news in recommendation.

The Figure 3.1 shows the research methodology adopted for this study. This Figure illustrates user's interest calculation and news data obtained on server side. News data is retrieved using simple Pie RSS ³feed reader and against these RSS news description is fetched from different news websites by using DOM (Document Object Model) parser. To limit the scope of the study this research has used UI-CLASSIFY to tag news on the basis on sentiment analysis. User's interest is obtained using Facebook SDK and categories are mapped with mapping algorithm proposed in this research. This recommendation system takes pages liked by user and user's gender to provide instant recommendation. Authority source is considered to provide news from user's favorite news source. All the data is saved on centralized server for evaluation and result analysis. Results evaluation takes system recommendation and user's likes on his/ her social media profile. Users rating is retrieved by provide rate interface and used for results evaluation and testing purpose

³ <http://simplepie.org/>

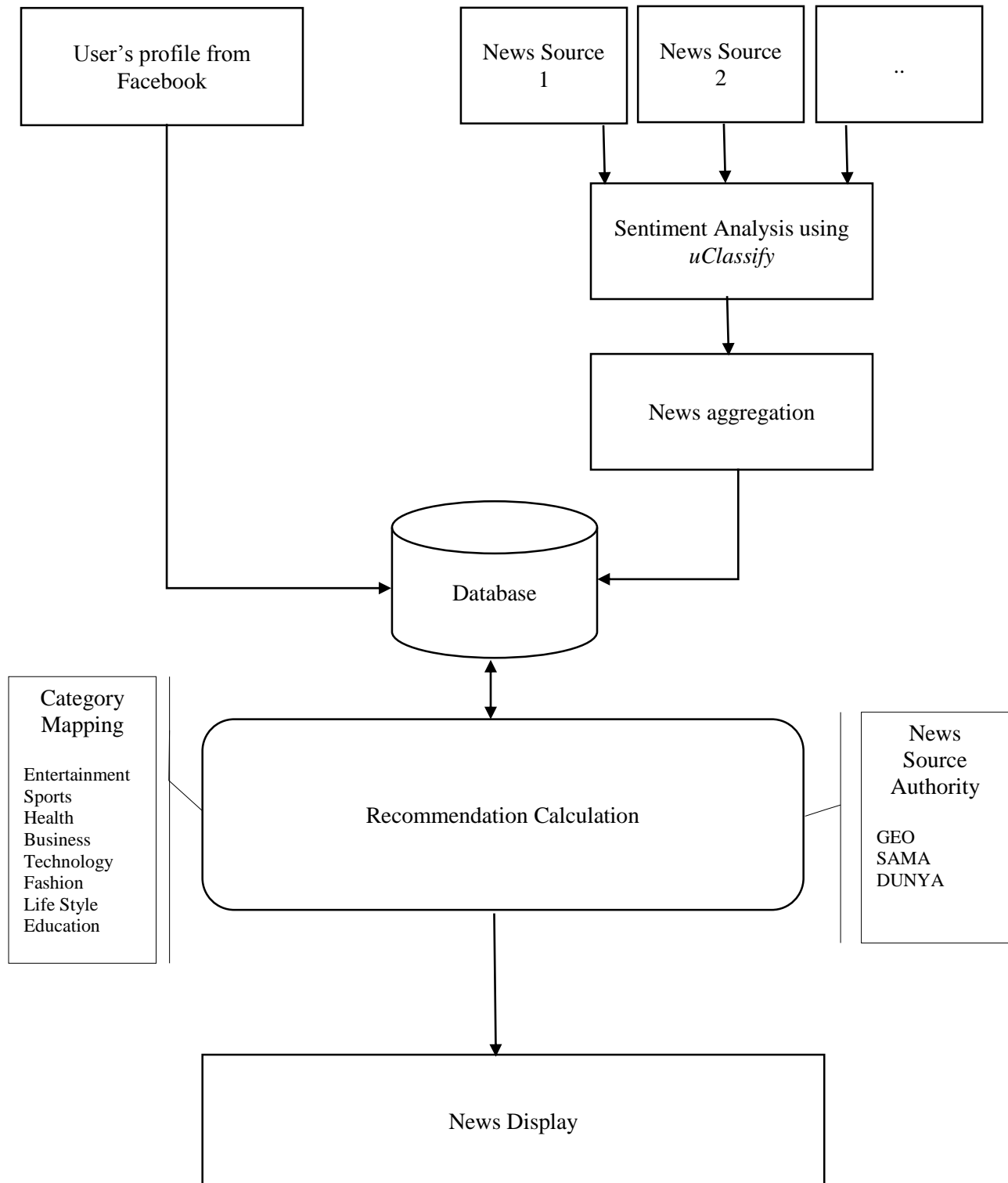


Figure 3. 1 Research Methodology

3.2 Data Collection

News are fetched from six popular national news sources GEO, SAMA, ARY, AAJ, DUNYA, and TRIBUNE. News scrapper is developed which actually retrieve news from news sources RSS by using Simple Pie RSS reader. RSS reader provides news category, data and small news description. News scrapper is developed to get complete given news URL of news from RSS feeds and one by one all news items are parsed from sentiment analysis API to get sentiments against each news item. News scrapper make http request to detailed news page and parse the news page to get details out of it for this purpose HTML DOM is used to parse news description tags on different news sources. After completing news fetching process, news are saved in database with following fields.

- News ID
- News Title
- News Category
- News Description
- News URL
- News Date
- News Source
- Positive Sentiment
- Negative Sentiment

3.3 Sentiment Analysis

To provide good news on top sentiment analysis on each news item is carried out for this purpose news scrapper pass the news to sentiment analysis API and gets sentiments out of it. Two sentiment analysis values is used which makes sum of 1 and saved against each news item in database. uClassify⁴ is popular API for sentiment analysis and its usage is increasing day by day due to its accuracy for this research trained on more than 2.8 million articles. We have used free version of uClassify which is 5000 requests per day. And every day our recommendation system use about three hundred hits of allowed limit. These sentiment values are used by

⁴ <https://uclassify.com/>

recommendation system to rank positive news on top. Figure below displays process of data collection of news.

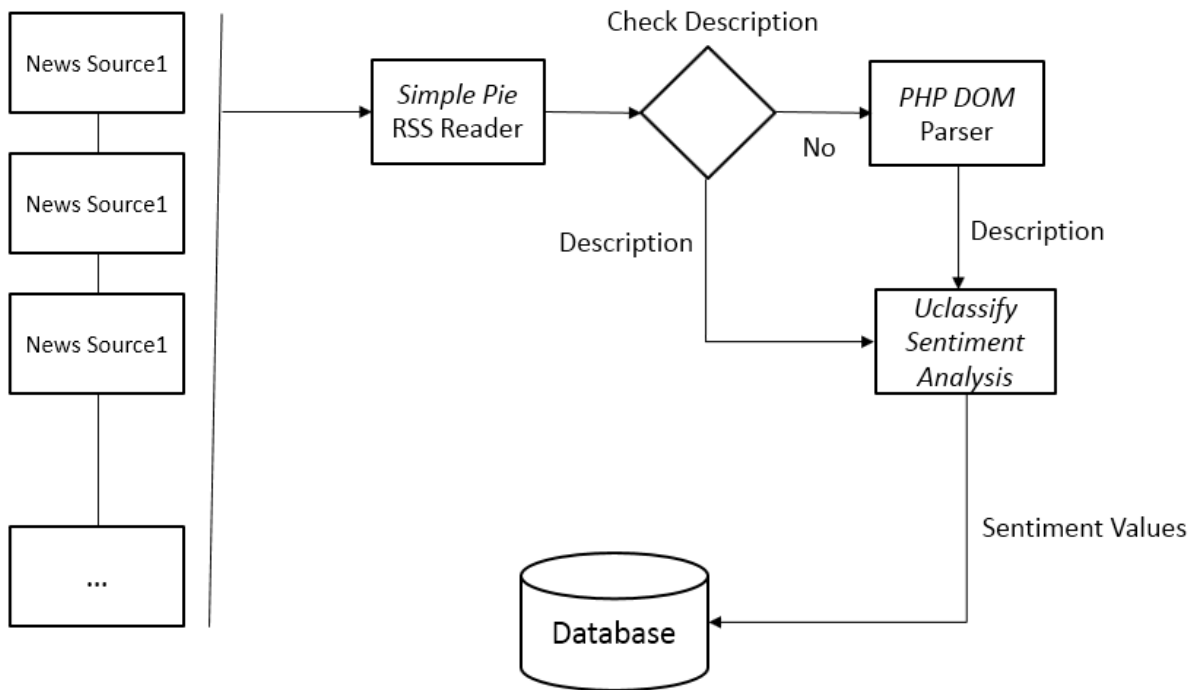


Figure 3. 2 News Data Collection

The following is the algorithm shown in figure 3.3 of process of data collection of news which takes news from different sources as input and place news in database with their sentiment values calculated by uClassify.

Input

News from Various different Sources

Output

News Data Classified in to categories with their sentimental values

Retrieves News From RSS Feed

IF NewsHasDescription THEN

 Perform Sentimental Analysis

ELSE

 Retrieve URL from RSS Feed

 Parse HTTP Content of URL

 Read Description From Parsed Content

 Perform Sentimental Analysis

ENDIF

Add NewsTitle, NewsDescription, NewsSource, NewsCategories, NewsPositiveSentiment, NewsNegativeSentiment into Database

Figure 3. 3 News Data Collection

Sentiment values are categorized as positive and negative sentiment. The values of negative and positive sentiments makes sum of 1. Table 3.1 illustrates some samples of news saved in database with respective structures.

Table 3. 1 News data sample

ID	Title	Category	Description	URL	Date	Source	Sentiment	Sentiment
1	Euro lifts as hopes mount for Greek crisis resolution	Business	NEW YORK: The euro gained	http://feedproxy.google.com/~r/geo/hcg/~3/vPlyDMulqYY/story01.htm	2015-07-08 23:09:00	GEO	0.729041	0.270959
2	Clarke inspired by 2005 Ashes	Sports	Australia captain Michael Clarke has said he would "love" the upcoming Ashes	http://feedproxy.google.com/~r/GeoSport-GeoTvNetwork/~3/5yLyFATSywL/story01.htm	2015-07-08 21:09:00	GEO	0.83407	0.16593

3.4 Users Likes Retrieval from Facebook

This recommendation system uses Facebook SDK and asks for user likes, public profile permission from user and retrieve user's pages. It extracts category for each page likes by user and store it in hash map. Hash map is developed by making a map of Facebook pages categories and general news categories which are eight and defined by observing news categories which are mostly used to categorize news. There are 250 plus categories of Facebook pages and in this research we have filtered out about 50 categories which cannot be used for recommendation purpose and mapped about 200 categories to general news categories. This map is then used to group Facebook categories against general news categories and summed up to calculate count of pages which lie with general news categories and then this ranking is sorted to provide category rating. System recommendation is saved on database so that each time user uses app user's favorite categories retrieved from database to save category mapping time on mobile side. Below is an example of Facebook sports categories.

- Athlete
- Sports League

- Professional Sports Team
- Coach
- Amateur Sports Team
- School Sports Team
- Sports Venue
- Sports/Recreation/Activities

Figure 3.4 illustrates user's Facebook profile retrieval. Here we can see process followed to get user's profile from social media.

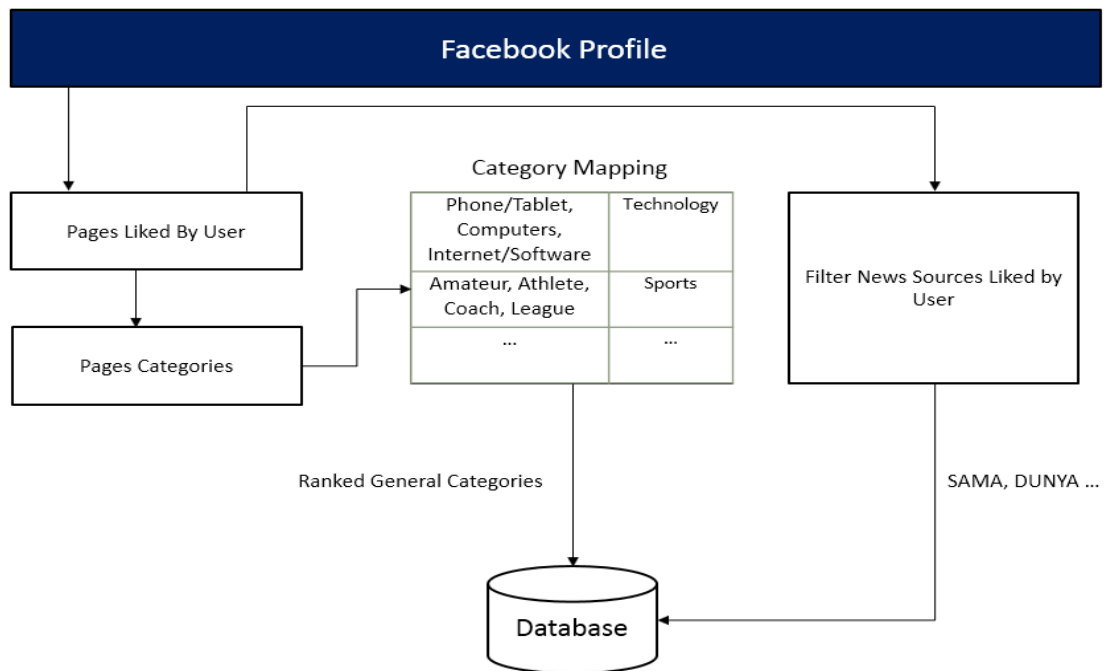


Figure 3. 4 User Likes Retrieval from Facebook

Algorithm displayed in figure 3.5 shows how to get user profile from social media, getting the system category recommendation and news sources.

Input

User Likes name, User Likes Categories, MapOfFacebookToGeneralNewsCategories

Output

System category recommendation, News authority sources

Login to Facebook

Get User Likes Permission

UserLikes = Initialize with cursor of first object

WHILE UserLikes != NULL

 Fetch User Likes In 25 offset

 Add UserLikes to UserLikesList

END WHILE

FOR i from 0 to size of UserLikesList DO

 Add UserLikes to UserLikesHashMap

 check UserLikesHashMap Corresponding to MapOfFacebookToGeneralNewsCategories

 Assign GeneralNewsCategories in UserLikesHashMap

END FOR

FOR i from 0 to UserLikesHashMapSize DO

 TotalCountOfEachSubCategory Corresponding To GeneralCategory

 Add TotalCountOfEachSubCategory and GeneralCategory into SystemRecommendationHashMap

 Sort SystemRecommendationHashMap Corresponding to CountKey

 Add SystemRecommendationHashMap value in SystemRecommendationList

END FOR

FOR i from 1 to Size of UserLikesList DO

 search for keywords of NewsChannelName in UserLikesList.LikeName

 IF NewsChannelName == UserLikesList.LikeName THEN

 Add UserLikesList.LikeName in AuthorityNewsSourceList

 END IF

END FOR

Add SystemRecommendationList into Database

Add AuthorityNewsSourceList into Database

Figure 3. 5 Retrieving user's profile from Facebook

In Table 3.2 category mapping of all Facebook categories against general news categories are mentioned.

Table 3. 2 Facebook pages category mapping to general news categories

Categories of pages on Facebook	General News Category
Actor/Director,Album,App,Artist,Arts/Entertainment /Nightlife,Award,Board,Channel,Character,Chart,Comedian,Concert,Entertainer,Fictional,Game,Games/Toys,Label,Media/News/Publishing,Movie,Music,Musician/Band,Network,Page,Producer,Radio,Record,Show,Song,Station,Studio,Theater,Tour,TV,TV/Movie,Venue,Video,Writer	Entertainment
Author,Book,Education,Library,Magazine,Middle,School,Series,Store,Teacher,University	Education
Amateur,Athlete,Coach,League,Professional,School,Sports,Sports/Recreation/Activities,Team,Venue	Sports
Doctor,Drugs,Health/Beauty,Health/Medical/Pharmaceuticals,Health/Medical/Pharmacy,Hospital/Clinic,Vitamins/Supplements	Health
Bank/Financial,Business,Consulting/Business,Entrepreneur,Institution,Local,Person,Services,Small	Business
Clothing, Jewelry/Watches	Fashion
Biotechnology,Computers,Computers/Technology,Electronics,Internet/Software,Office,Phone/Tablet,Software,Supplies,Telecommunication	Technology
Aerospace/Defense,Airport,and,Appliances,Attractions/Things,Automobiles,Automotive,Baby,Bags/Luggage,Building,Camera/Photo,Care,Cars,Cause,Chemicals,Church/Religious,Club,Commercial,Community,	Life Style

Community/Government,Company,Consumer,Dance r,Decor,Designer,Do,Energy/Utility,Engineering/Con struction,Equipment,Estate,Event,Farming/Agricultur e,Figure,Furniture,Gallery,Gear/Sporting,Goods,Goo ds/Kids,Government,Home,Hotel,Household,Improv ement,Industrials,Insurance,Journalist,Landmark,Law yer,Legal/Law,Materials,Merchandise,Mining/Materi als,Museum/Art,News,Non-Governmental,Non- Profit,Official,Organization,Outdoor,Parts,Party,Pati o/Garden,Personality,Pet,Photographer,Places,Planni ng/Event,Political,Politician,Product/Service,Public, Real,Retail,Services,Shopping/Retail,Spas/Beauty/Pe rsonal,Supplies,to,Tools/Equipment,Tours/Sightseein g,Transport/Freight,Transportation,Travel/Leisure,W ebsite,Wine/Spirits	
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3.5 Retrieving news authority

Study is carried out to get news authority from user's social media profile so that recommendation system can fully make use of user's profile on Facebook. To retrieve list of news sources user likes most another layer added which filters news sources by checking names of pages against popular news sources which is added for news data collection. If user has liked specific news page on Facebook makes an opinion that user likes that news source more than other news sources and willing to have news from that particular news source. List of news sources are maintained by filtering pages names and saved against user record on database. In next section we will discuss how news authority is used to recommend news of user's favorite news source.

3.6 Filtering Duplicate News Considering News Authority

News sources provide several news and mostly all news source provides similar news. To prepare final list of news for user this recommendation system filters out duplicate news by checking similarity of news. News description is used to check similarity of news, to process news similarity this recommendation system excludes stop words and html tags at first stage and

calculates news similarity. On the basis of news similarity developed algorithm remove one of news item from different news sources considering authority of news source. If there are no news source available for user's favorite news source or both of news source are present in list of favorite news source then recommendation system checks sentiment of news and excludes news which uses extreme, harsh and bad words. It queries news authority against user record and excludes news item of particular news source if it's not in the list of user's favorite news sources or of negative sentiment. Figure 3.6 shows working of removing duplicates news and authority consideration.

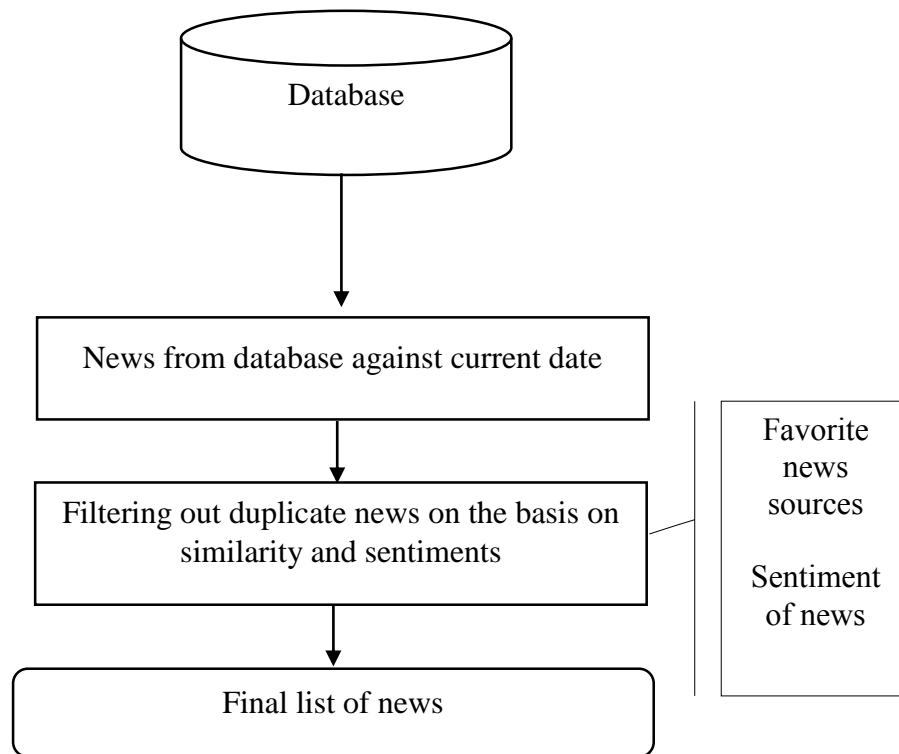


Figure 3. 6 News aggregation and removing duplicate news

The following is the algorithm shown in figure 3.7 is for recommended news and querying news from database corresponding to the news category table.

```

Input
NewsCategory, UserId
Output
Recommended News
Query News From Database Corresponding to NewsCategoryTable
Query NewsAuthoritySources Corresponding to UserId
FOR i from 0 to Size of NewsList DO
  FOR j from 0 to Size of NewsList DO
    Check Similarity of Each Item in NewsList with Other Items of NewsList
    IF Similarity > 70% THEN
      IF NewsListItem1.NewsSource Exists In NewsAuthoritySources THEN
        Exclude NewsListItem2
      ELSE IF NewsListItem2.NewsSource ExistsIn NewsAuthoritySources THEN
        Exclude NewsListItem1
      ELSE
        IF NewsListItem1.PositiveSentiment > NewsListItem2.PositiveSentiment THEN
          Exclude NewsListItem2
        ELSE
          Exclude NewsListItem1
        ENDIF
      ENDIF
    ENDIF
  END FOR
END FOR
IF NewsAuthoritySources.Size ==0 THEN
  IF NewsListItem1.PositiveSentiment > NewsListItem2.PositiveSentiment THEN
    Exclude NewsListItem2
  ELSE
    Exclude NewsListItem1
  ENDIF
ENDIF
Publish NewsList

```

Figure 3. 7 Filtering news against news authority and removing duplicates

3.7 News ranking

This recommendation of ranking news is on the basis of data processed and stored in database. Android mobile application is developed to display news to end user considering user's social media preferences and sentiment analysis. System fetches user's data for first time and stores in database and then recommend news on the basis of sorted categories. To make it simple, user gets categories ranked on first screen so that user gets his favorite category on top. On selection of particular category user finds news of that category on next screen. News screens displays news ranked on the basis of sentiment analysis. News are tagged with eight different color codes of green and red used to mention news sentiments. Figure 3.8 displays front end of developed app which illustrates front end interface for this recommendation system.

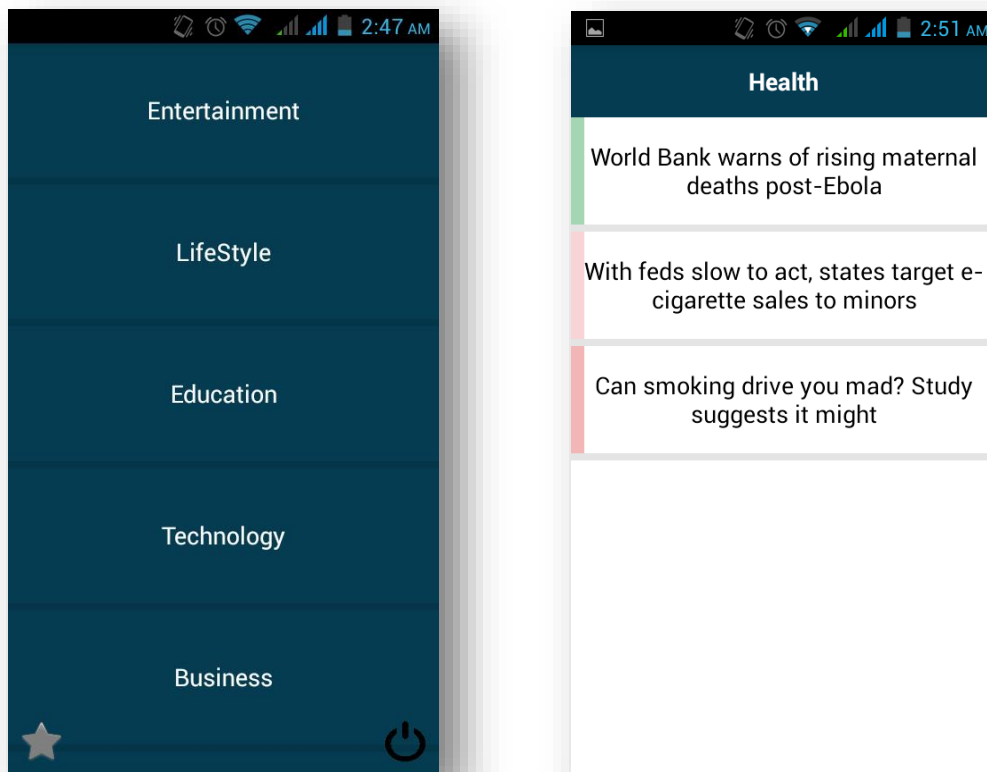


Figure 3. 8 Mobile application Screenshots

3.8 Summary

This chapter describes methodology of recommendation system. News aggregation, sentiment analysis, news authority and ranking of news source is mentioned in above sections. Developed system fetches profiles of user from social media and takes all the information for further processing to rank the news. User's interest change over time, so our recommendation system fetches user's profile information over some period to retrieve updated information. This recommendation system ranks the news on the basis of categories, authority of news source and sentiment analysis. These three aspects of sorting provide best results for news recommendation as user get news of its interest coming from his/her favorite news source and get sorted news on the basis of location. Most of the time news recommendation system ignores news source authority and the combine news from different news sources and provide which makes user somewhat suspicious, existing news recommendation systems ignores sentiment aspect too. Many news recommendation systems builds user profile over time and observe patterns but it take time and user may not get desired results at first. So news recommendation system presented by this paper is implicit in nature and does not take much time to rank the news.

TEST RESULTS AND ANALYSES

4.1 Overview

This chapter consists of data analysis, statistics and test results. First section will describe news statistics number of news sources, number of categories watch news source have and number of news against each news category. Second section will consist of sentiment analysis values news source comparison against positive vs negative news, news category comparison against negative vs positive values and statistical numbers against all these results i.e. mean, median, mode and standard deviation. Third section will consist of users liking for a particular news source and comparison of different news sources against user liking. Last and final chapter consist of user's liking for particular categories and system recommendation analysis, gender wise system recommendation comparison and relating it with previous studies.

4.2 News Data Statistics

This recommendation system takes news from six different news sources. All news sources are providing news of different categories and simple pie RSS reader used to extract results out of it. To provide stats of news data below graphs will describe overview of news numbers and their respective categories.

4.3 Sentiment Analysis

To compare the accuracy of uClassify with another sentiment analysis calculation API which is CoreNLP we have applied sentiment analysis techniques from both APIS's. In uClassify we have used a news scrapper which passes the news article to the API and in result the API returns two sentiment analysis values which describe that how much a negative and positive an article is using percentage. uClassify is popular API for sentiment analysis and its usage is increasing day by day due to its accuracy as well because of the fact that it has been trained over more than 2.8 million articles. Table 4.1 below describes the results of this evaluation in detail. Each of the article was evaluated through human analysis for calculating the accuracy to identify whether the article belongs to the same class as is classified by both algorithms. So results shows that uClassify performs better than CoreNLP. So we have used uClassify for classification of news to get better results.

Table 4. 1 Sentiment Analysis Statistical Data News

Total Articles	80
Exact Sentiment by uClassify and Core NLP	21
Equal Polarity	51
Different Polarity	29
Both Calculated Correct Polarity	42
Both Calculated Wrong Polarity	4
uClassify Calculated Correct Polarity	60
Core NLP Calculated Correct Polarity	58
Accuracy uClassify	75%
Accuracy Core NLP	72.5%

Sentiment analysis is applied by using uClassify API and statistics of sentiments are shown below which describes sentiment analysis values for news sources, separate graphs which illustrates percentage of sentiment values for different categories, comparison of sentiment values against each category and finally comparison of sentiment analysis values against each news source. Figures below show different categories of data coming from news sources. These figures show how much positive and negative news are coming from different news sources.

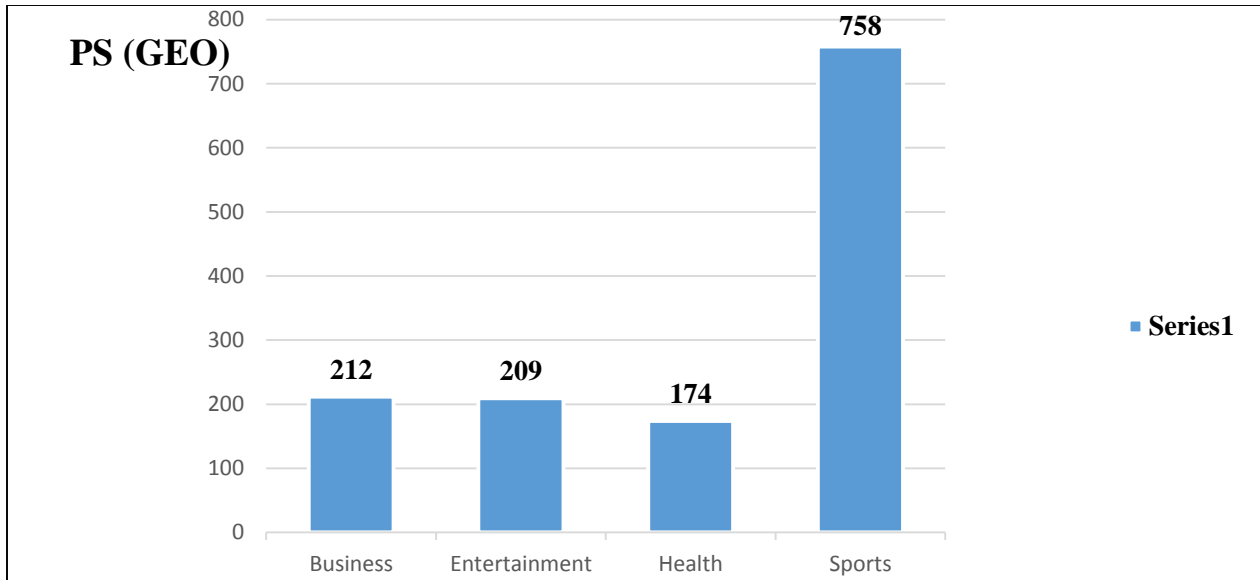


Figure 4. 1 GEO news positive entries

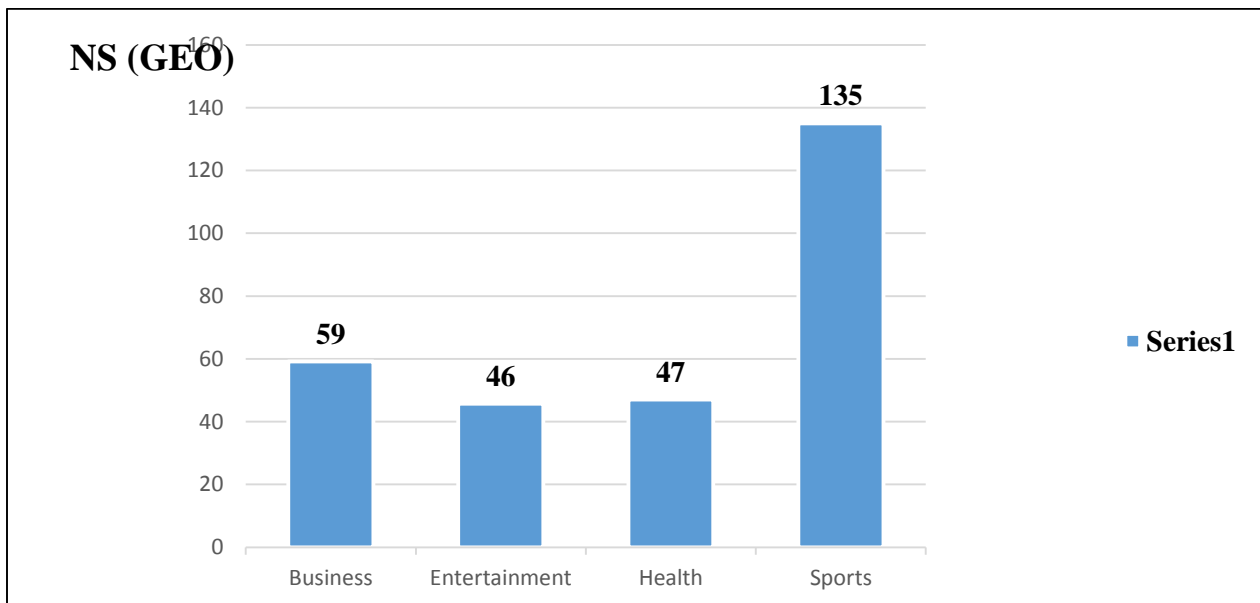


Figure 4. 2 GEO news negative entries

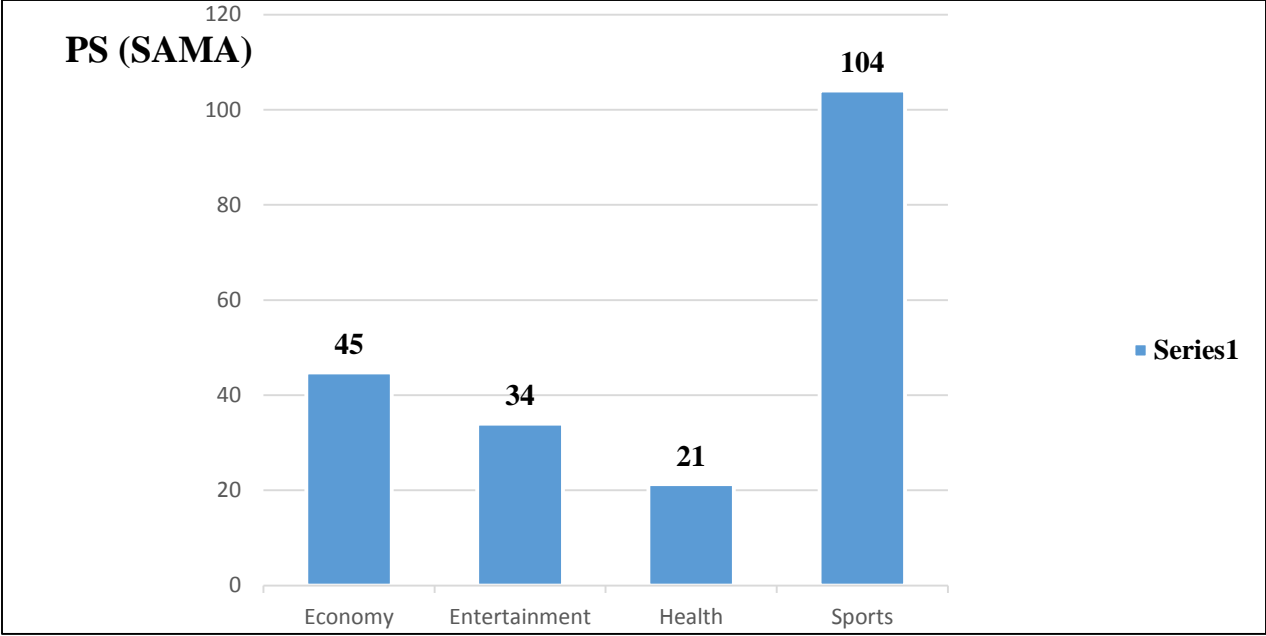


Figure 4. 3 SAMA news positive entries

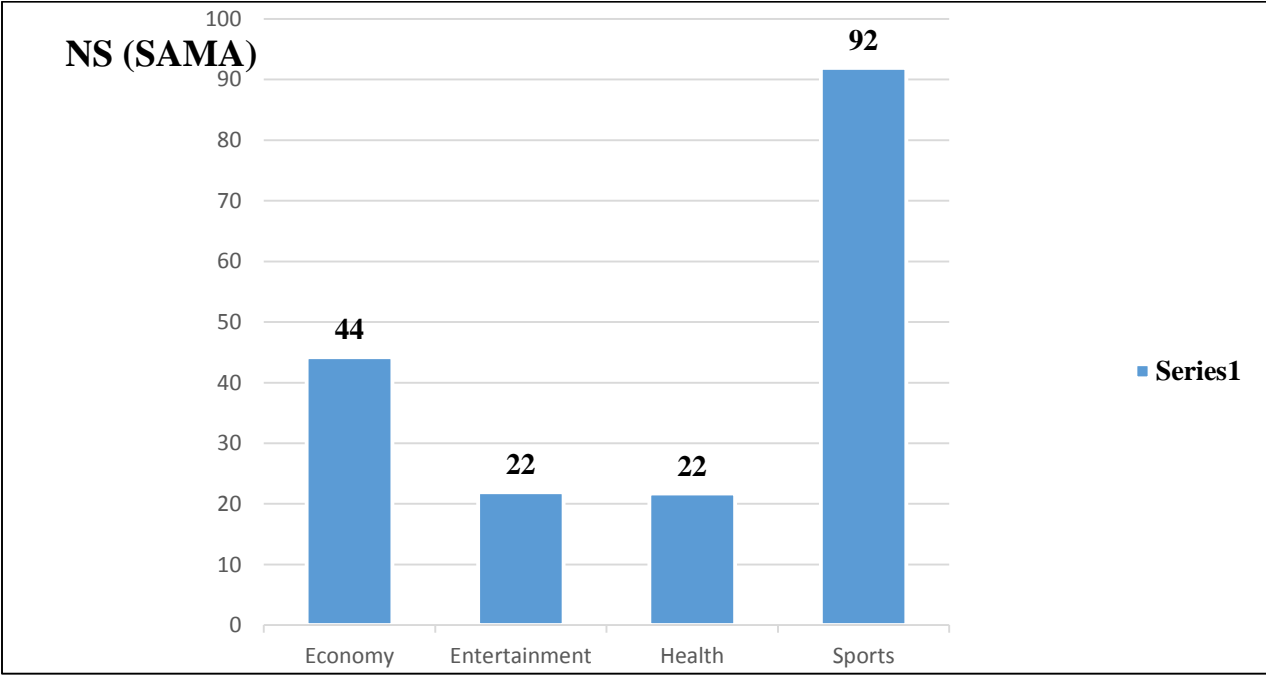


Figure 4. 4 SAMA news negative entries

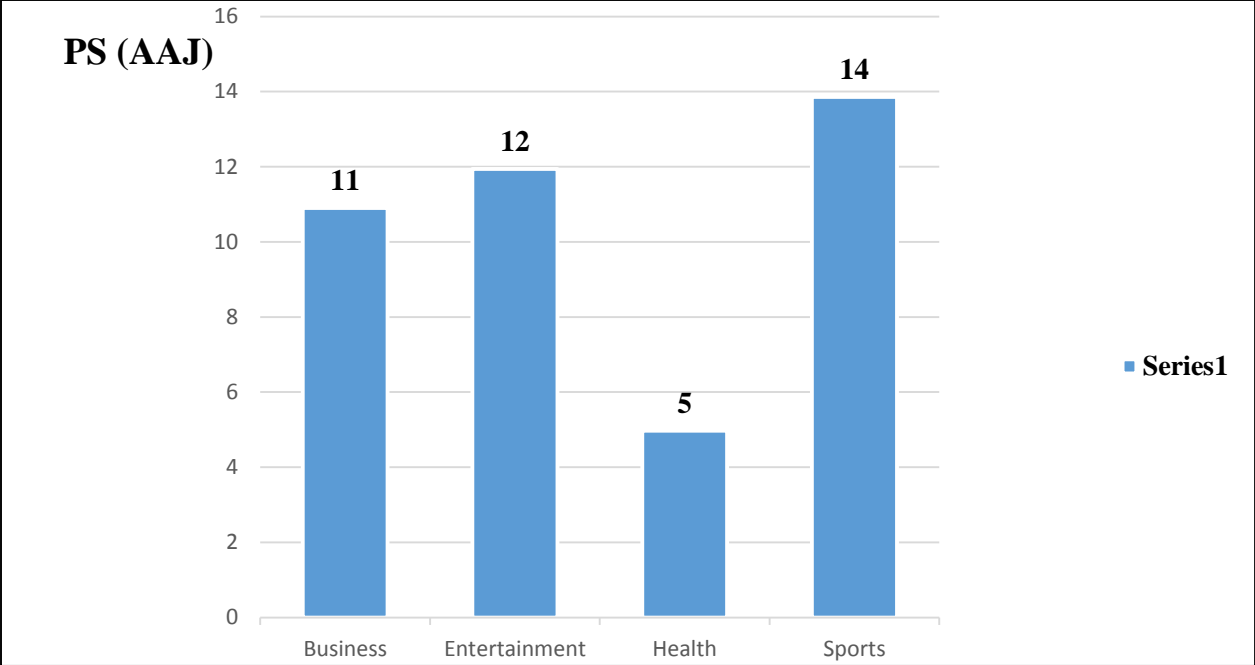


Figure 4. 5 AAJ news positive entries

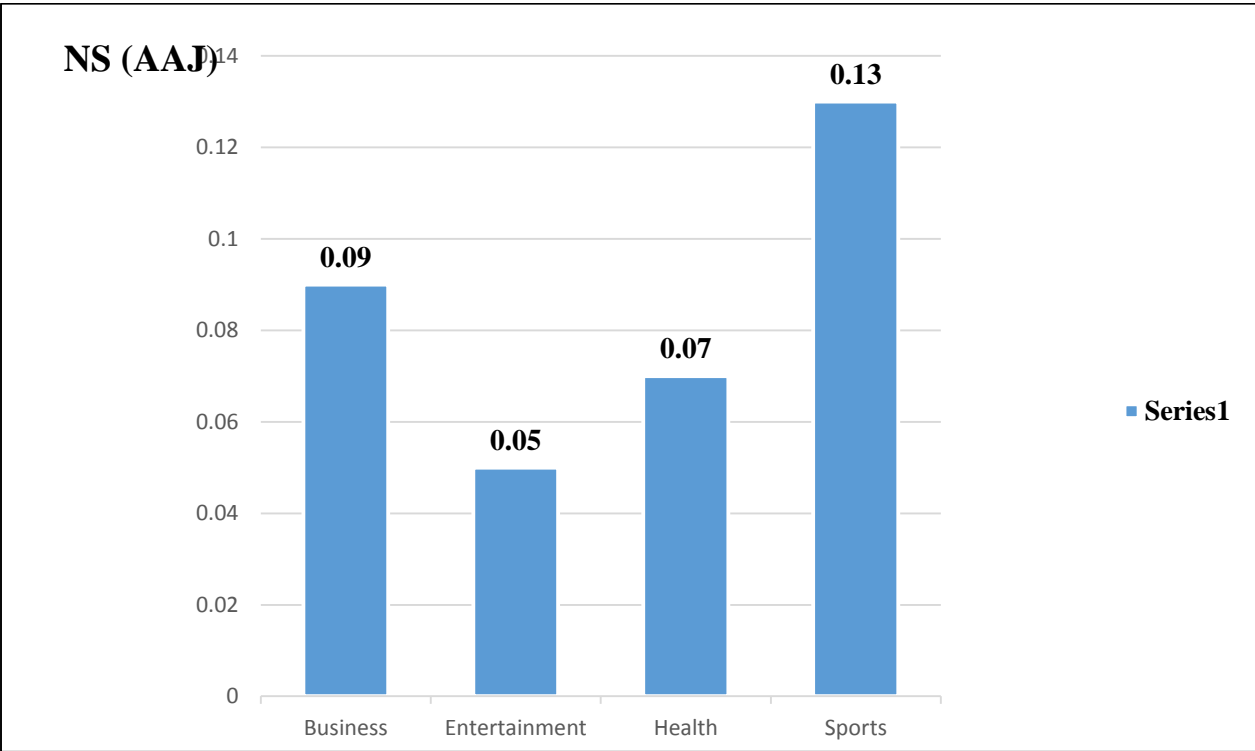


Figure 4. 6 AAJ news negative entries

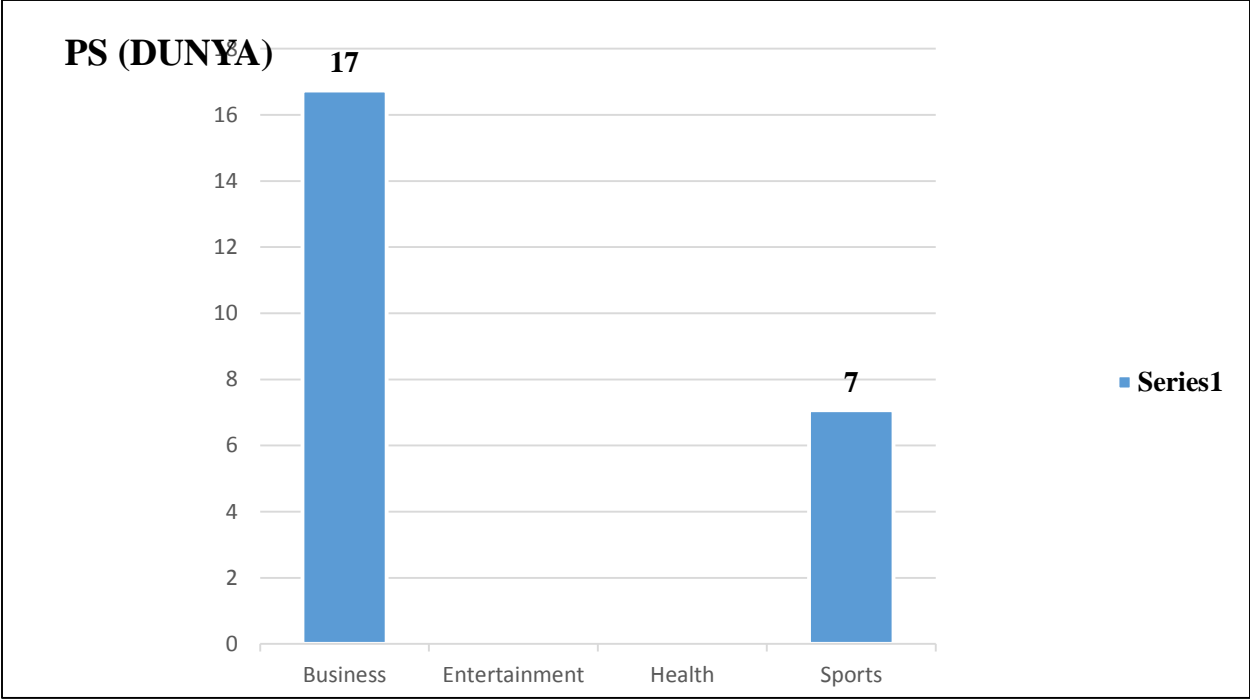


Figure 4. 7 DUNYA news positive entries

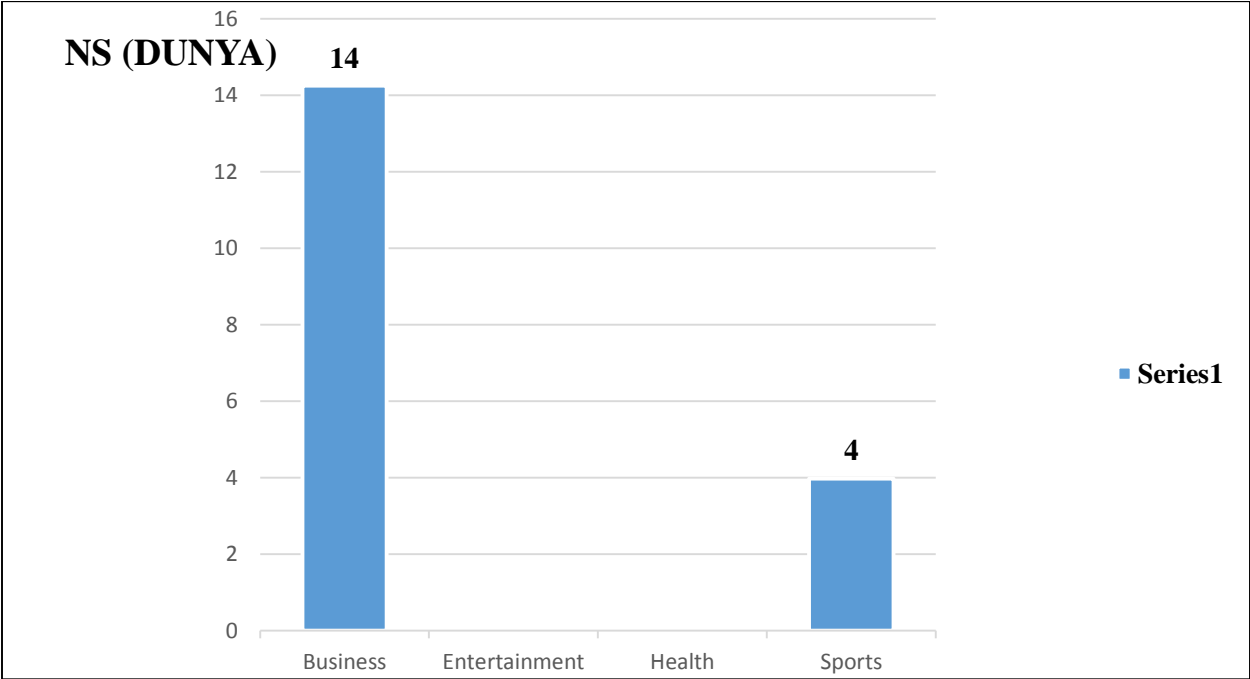


Figure 4. 8 DUNYA news negative entries

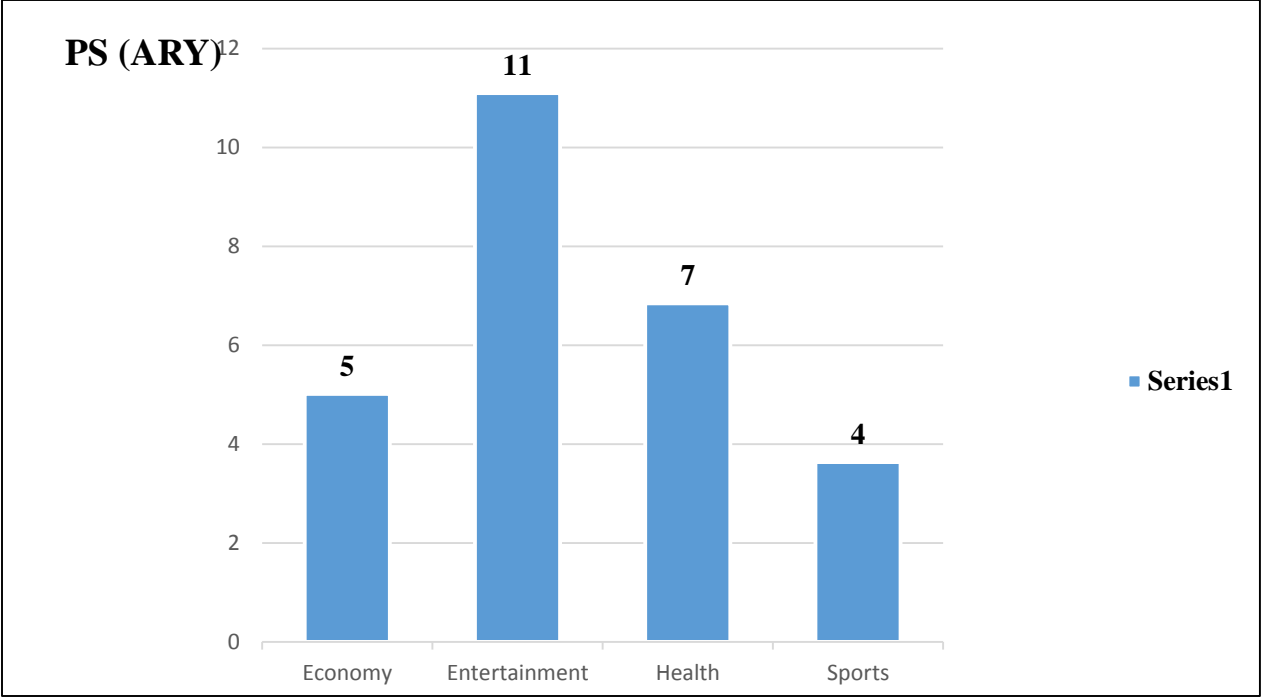


Figure 4. 9 ARY news positive entries

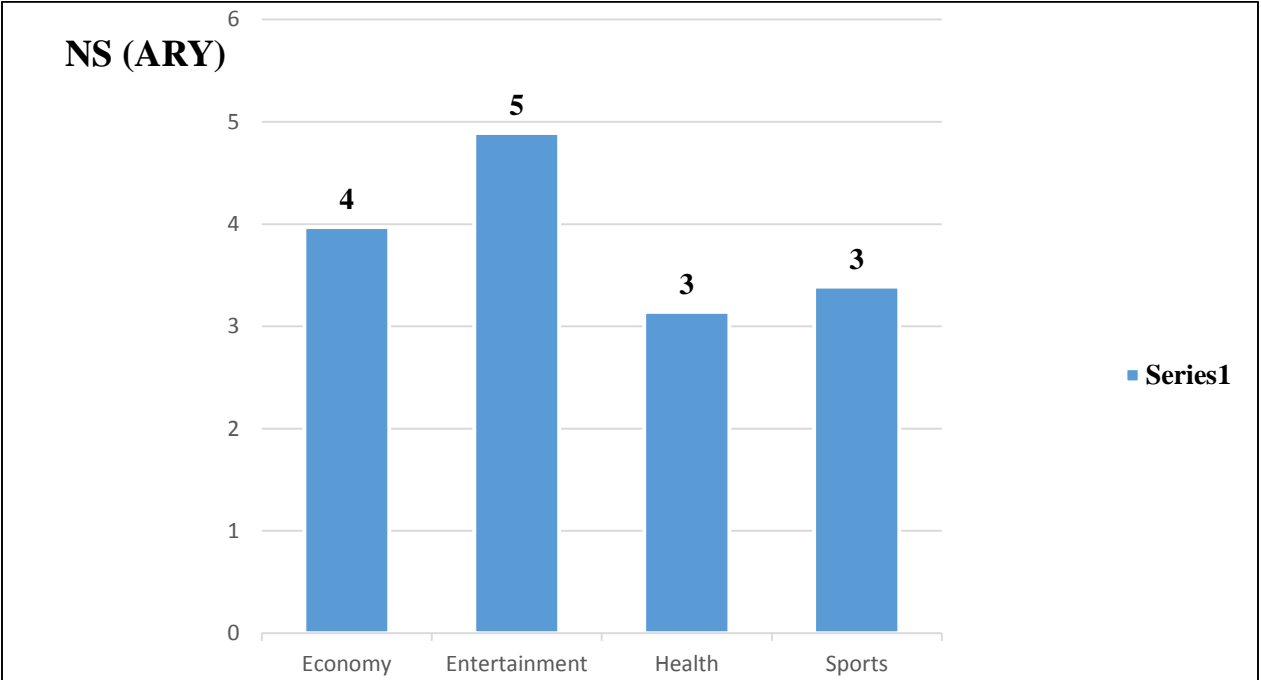


Figure 4. 10 ARY news negative entries

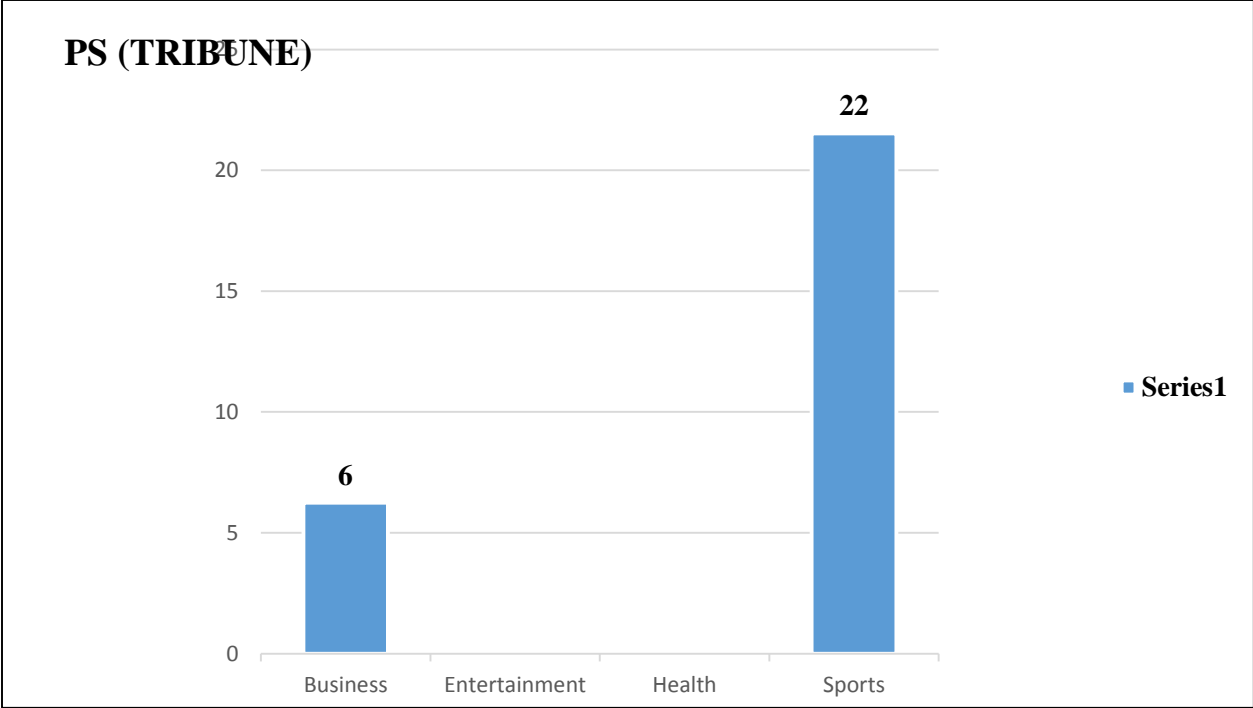


Figure 4. 11 TRIBUNE news positive entries

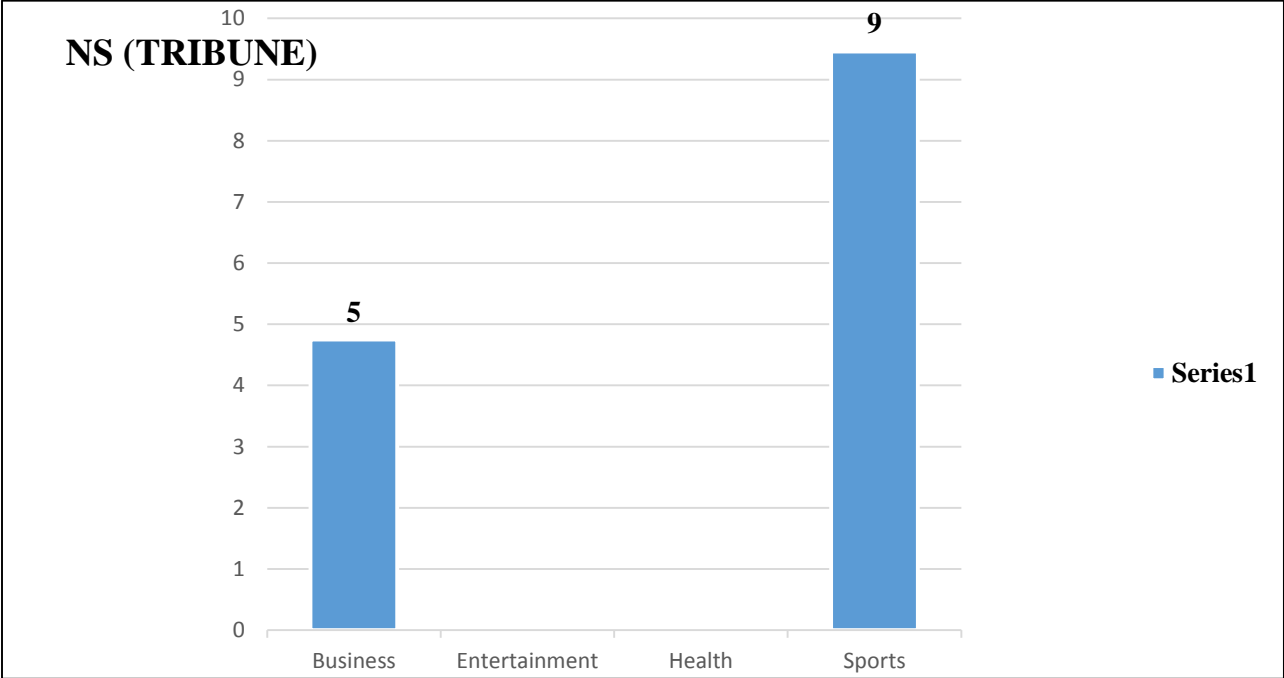


Figure 4. 12 TRIBUNE news negative entries

Table 4.2 illustrates statistical data of news. Geo news provides more news than other news so its data entry is more than other news sources. SAMA news provides Technology news and its Technology news values are added.

Table 4. 2 Sentiment Analysis Statistical Data News

NEWS	Category	Value	Sentiment	News	Mean	S.D	Median	Min	Max
Geo	Business	212	Positive	271	0.78	0.11	0.81	0.44	0.93
	Entertainment	209		255	0.79	0.12	0.82	0.1	0.93
	Health	174		221	0.68	0.23	0.78	0.06	0.91
	Sports	758		788	0.82	0.07	0.84	0.48	0.94
	Business	59	Negative	271	0.22	0.11	0.19	0.06	0.55
	Entertainment	46		255	0.19	0.17	0.17	0.06	0.55
	Health	47		221	0.21	0.09	0.19	0.06	0.55
	Sports	135		788	0.17	0.07	0.15	0.05	0.5
SAMA	Economy	45	Positive	88	0.5	0.02	0.49	0.14	0.97
	Entertainment	34		56	0.6	0.12	0.59	0.28	0.93
	Health	21		43	0.49	0.14	0.48	0.25	0.87
	Sports	104		196	0.53	0.19	0.5	0.13	0.96
	Technology	24		47	0.51	0.17	0.48	0.1	0.85
	Economy	44	Negative	88	0.49	0.2	0.5	0.02	0.85
	Entertainment	22		56	0.39	0.18	0.41	0.06	0.71
	Health	22		43	0.5	0.14	0.51	0.12	0.74
	Sports	92		196	0.46	0.19	0.49	0.03	0.84
	Technology	24		47	0.48	0.17	0.51	0.14	0.89
AAJ	Business	11	Positive	11	0.99	0.006	0.99	0.97	0.99
	Entertainment	12		12	0.99	0.001	0.99	0.991	0.997
	Health	5		5	0.98	0.016	0.99	0.95	0.99
	Sports	14		14	0.99	0.01	0.99	0.96	0.99
	Business	0.09	Negative	11	0.008	0.006	0.006	0.002	0.021
	Entertainment	0.05		12	0.004	0.001	0.004	0.002	0.008
	Health	0.07		5	0.01	0.016	0.007	0.066	0.044
	Sports	0.13		14	0.009	0.01	0.004	0.001	0.03
DUNYA	Business	17	Positive	31	0.54	0.09	0.48	0.3	0.69
	Sports	7		11	0.63	0.18	0.78	0.46	0.78
	Business	14	Negative	31	0.45	0.09	0.51	0.3	0.57
	Sports	4		11	0.36	0.16	0.21	0.21	0.53

ARY	Economy	5	Positive	9	0.55	0.09	0.57	0.37	0.68
	Entertainment	11		16	0.71	0.12	0.68	0.47	0.9
	Health	7		10	0.63	0.2	0.59	0.42	0.95
	Sports	4		7	0.51	0.09	0.5	0.37	0.68
	Economy	4	Negative	9	0.44	0.09	0.42	0.31	0.62
	Entertainment	5		16	0.28	0.12	0.31	0.09	0.52
	Health	3		10	0.38	0.2	0.4	0.04	0.57
	Sports	3		7	0.48	0.09	0.49	0.31	0.62
TRIBUNE	Business	6	Positive	11	0.56	0.1	0.57	0.56	0.73
	Sports	22		31	0.69	0.09	0.73	0.5	0.8
	Business	5	Negative	11	0.43	0.1	0.03	0.26	0.53
	Sports	9		31	0.3	0.09	0.26	0.19	0.49

4.4 News source authority analysis

Six news sources are used for news data, to provide users with news from their favorite news source news authority considered. To check user’s favorite news source all user’s likes are filtered out and user’s favorite news sources are stored in database. Figure 4.13 below shows most favorite news channel of users and news sources comparison with each other against current user base. In this analysis we have gathered data of forty users.

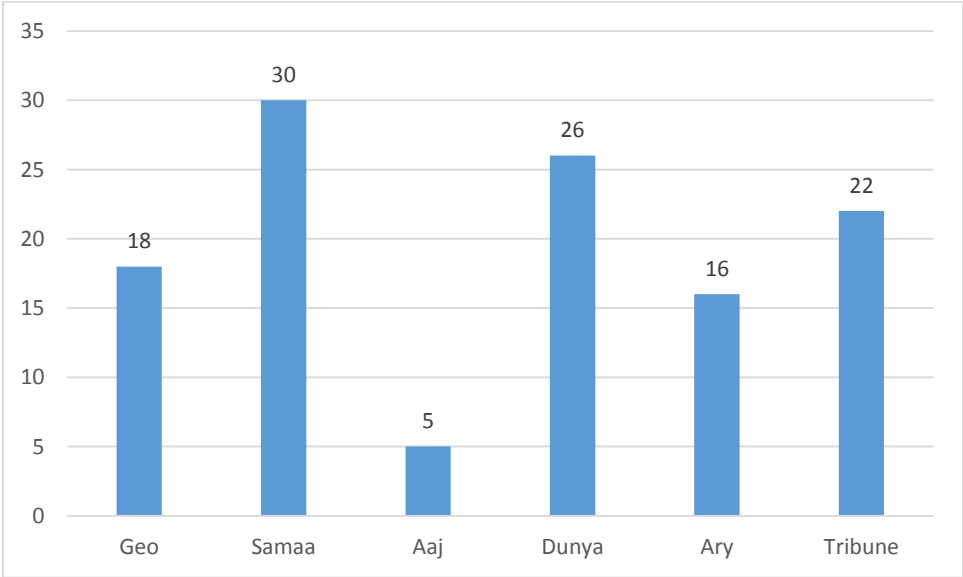


Figure 4. 13 Users preferred news source

4.6 System recommendation

System recommendation is categorized into eight different categories. This recommendation takes users interest from Facebook as input and provide recommendation on the basis of Facebook categories mapping over general news categories. Table 4.2 illustrates that users like entertainment most, education second, sports third, technology fourth, lifestyle fifth, business sixth, business seventh and last is health. This recommendation analysis has helped to set default rating for future is users are not willing to use their Facebook account or they are nor Facebook users.

In order to evaluate system we have provided user with evaluation screen in android app where user have rated recommendation out 5 scale. First we have provided news without personalized recommendation and asked users to rate the application and got results which are mentioned in table 4.3. Results shows that mean is below average shows that users are not satisfied with existing news system, So there is need of personalized news recommendation for which results are shown in next section.

Table 4. 3 System Recommendation Evaluation without personalization

Mean	2.3
S.D	1.3
Median	2
Min	0
Max	2

To provide news of user's interest we have retrieved users interest from social media explained in section 3.4. Results mentioned below in table 4.4 states that mean is above average and these results are quite satisfactory.

Table 4. 4 System Recommendation Evaluation Category Search

Mean	3.1
S.D	0.8
Median	3
Min	0
Max	3

To improve results we have improved accuracy of news recommendation by direct category mapping explained in section 3.4 results shows that it has shown 28% better accuracy as mean is way above than average and standard deviation is normal mentioned in table 4.5.

Table 4. 5 System Recommendation Evaluation Category Mapping

Mean	4.22
S.D	0.97
Median	5
Min	2
Max	5

Tables 4.6 and 4.7 displays overall user's interest toward particular news categories. Table shows that users are more interested in entertainment then education and so on. This ranking has been used to provide default system recommendation so that if users are not willing to provide there likes or afraid of using Facebook on external apps.

Table 4. 6 Category Distribution

Users	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8
User 1	Entertainment	Education	Sports	Technology	Lifestyle	Business	Fashion	Health
User 2	Entertainment	Education	Lifestyle	Fashion	Business	Technology	Health	Sports
User 3	Entertainment	Sports	Lifestyle	Education	Business	Technology	Fashion	Health
User 4	Entertainment	Sports	Education	Business	Lifestyle	Fashion	Technology	Health
User 5	Education	Technology	Lifestyle	Sports	Health	Entertainment	Fashion	Business
User 6	Entertainment	Education	Sports	Lifestyle	Business	Technology	Fashion	Health
User 7	Entertainment	Sports	Education	Lifestyle	Business	Fashion	Technology	Health
User 8	Entertainment	Education	Lifestyle	Sports	Fashion	Business	Technology	Health
User 9	Entertainment	Education	Technology	Lifestyle	Business	Sports	Fashion	Health
User 10	Entertainment	Education	Sports	Lifestyle	Business	Technology	Health	Fashion

Table 4. 7 Users Overall Categories Preference

Category	Rank
Entertainment	1
Education	2
Sports	3
Technology	4
Lifestyle	5
Business	6
Fashion	7
Health	8

To check detailed category statistics on each rank we have performed analysis on each category rank and generated images shown below which explains over all users' categories distribution on each rank.

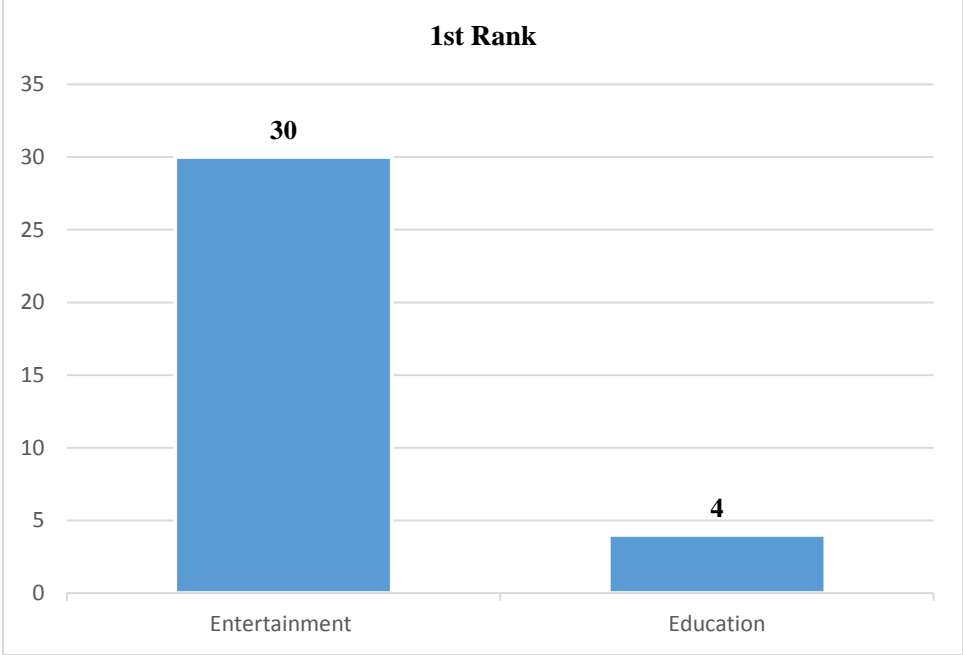


Figure 4.14 (Overall first rank category distribution)

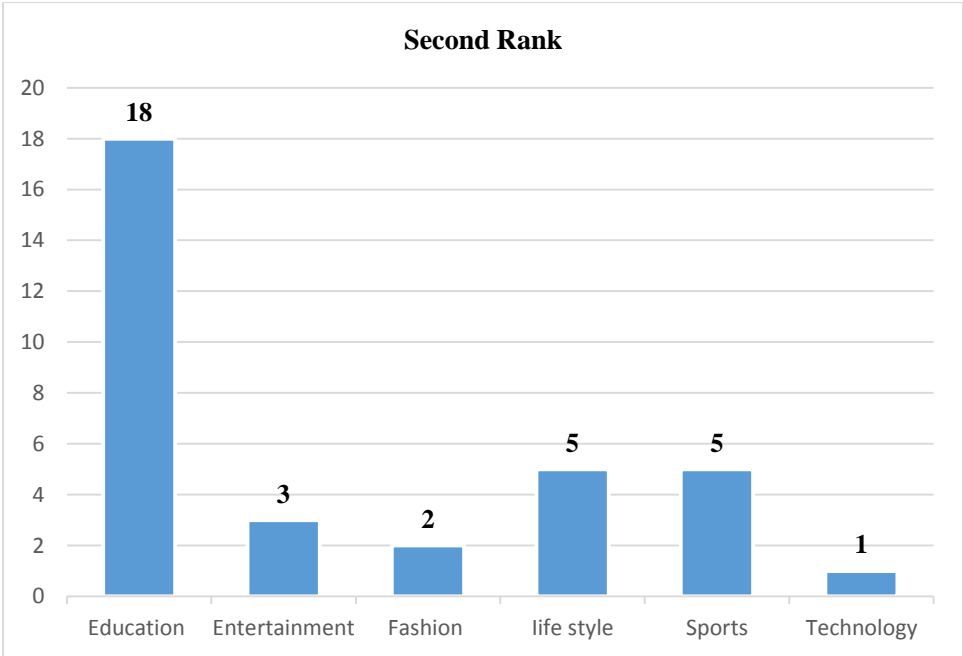


Figure 4.15 (Overall second rank category distribution)

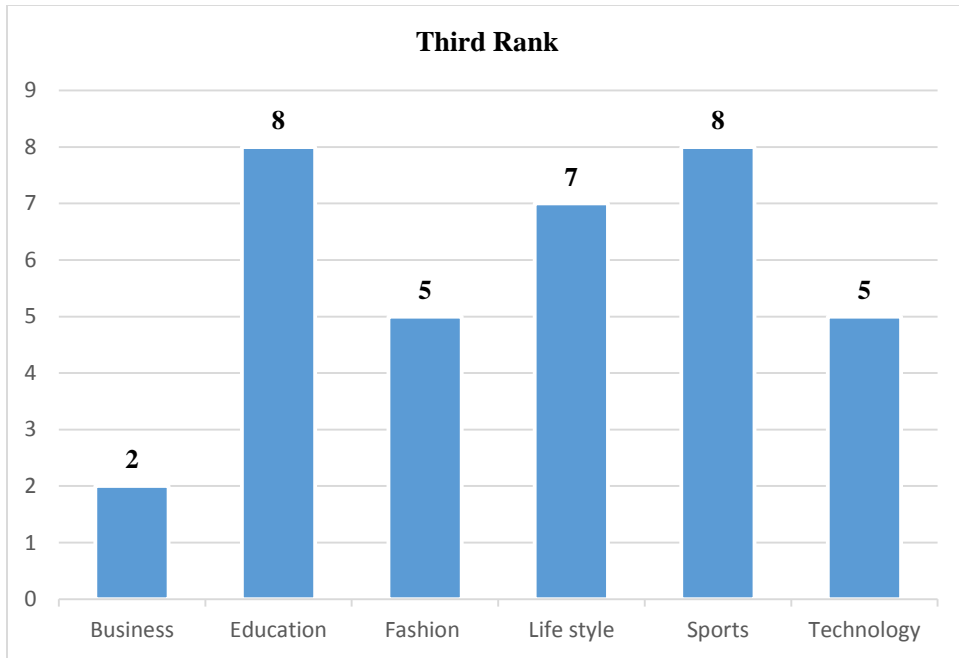


Figure 4.16 (Overall third rank category distribution)

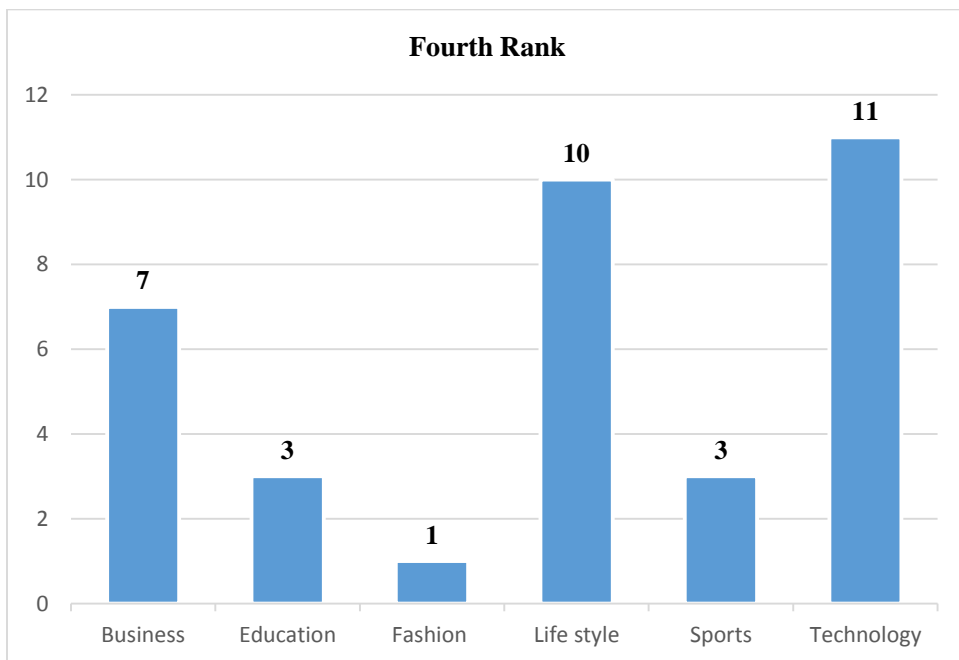


Figure 4.17 (Overall fourth rank category distribution)

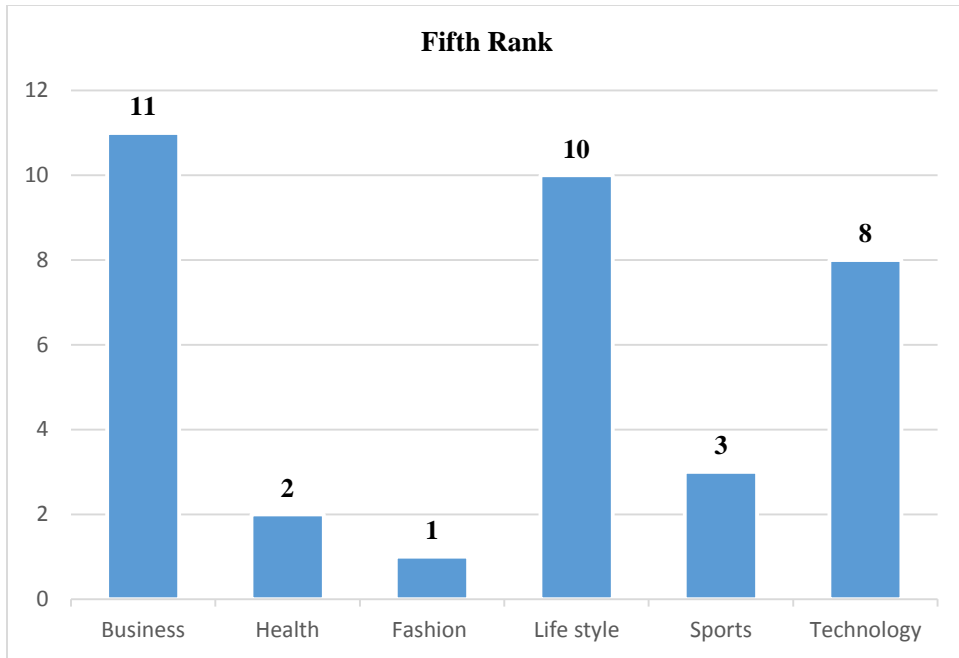


Figure 4.18 (Overall fifth rank category distribution)

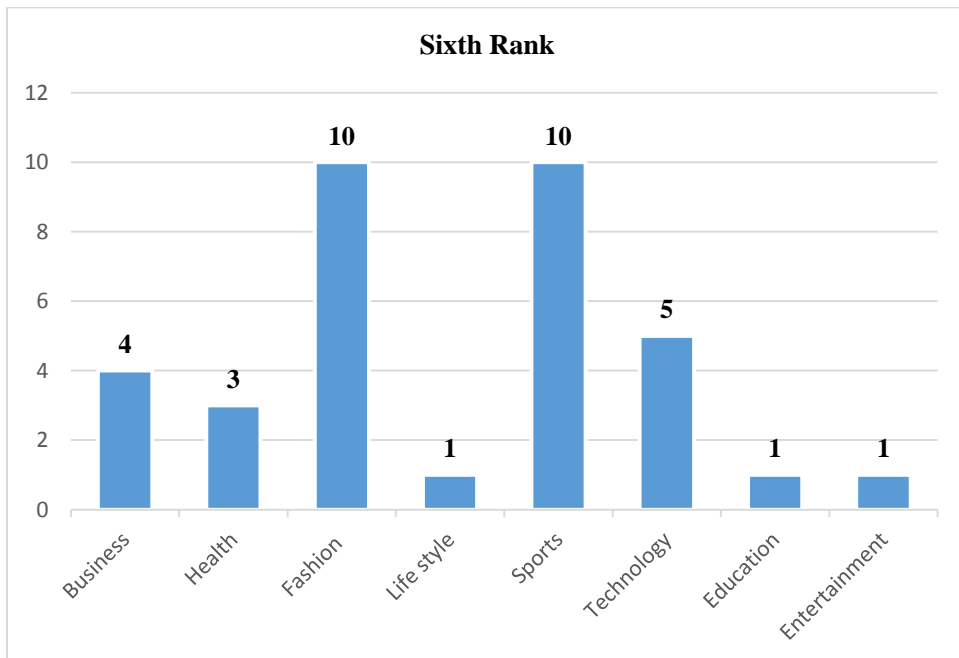


Figure 4.19 (Overall sixth rank category distribution)

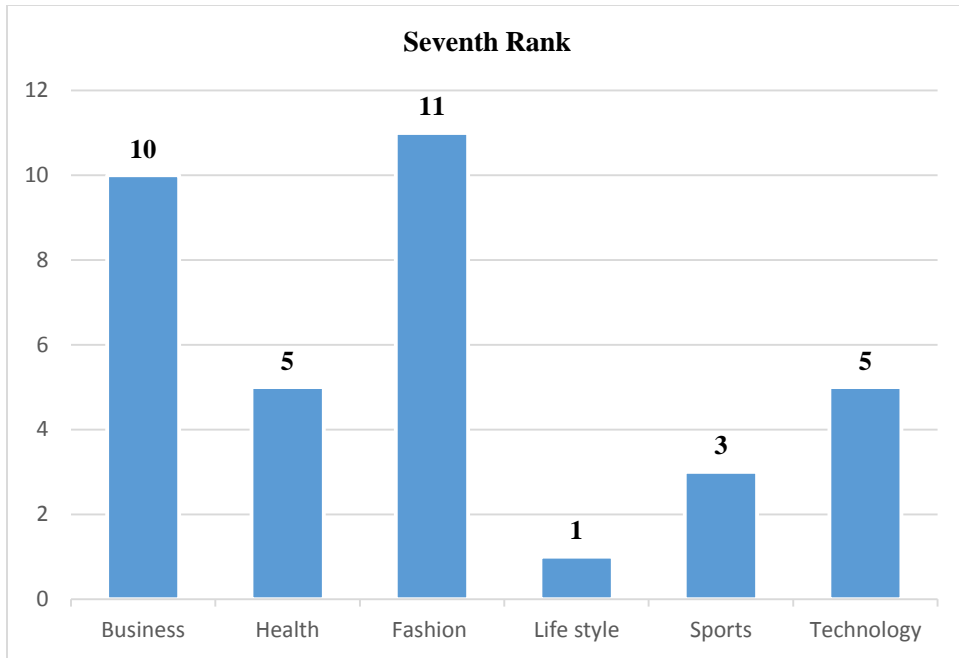


Figure 4.20 (Overall seventh rank category distribution)

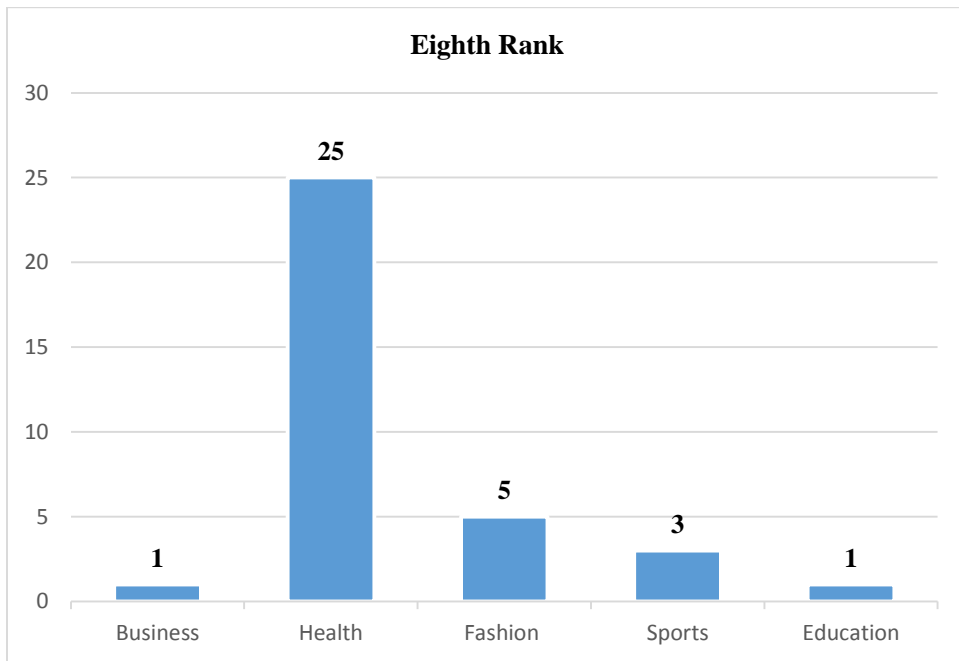


Figure 4.21 (Overall eighth rank category distribution)

Conclusion and Future Work

5.1 Summary

News sources and viewers of news increasing day by day to cater this problem this research is carried out to develop a solution which take care of all possible parameters for new recommendation. Every news website is providing its own interface and news order, no one is providing personalized news and focusing on user's interest, there is need of an efficient and promising ranking algorithm which can process news coming from different sources and combine them on the basis of their semantics and score the news on the basis on sentiment analysis and user's interest from their social media preferences. News channels and feeds providers are just broadcasting their news on the basis of time and categories and all the news stuff is so much intermingled, user has to make a way and find out the relevant news by scrolling over the website or checking other sources. Most of the time users get depressed by just passing over bundle of news on violence or hate speech. There is no solution available on web specially for Pakistan to make use of sentiment analysis and make use of user's interest so that user can read the news in which they are interested in a go and filter out the spam news in which they are not interested. Traditional news recommendation system take news from different news sources and aggregate them to provide news to end user. They monitor user's interaction over time to push recommendation in future. This needs user's interaction for a long time so that their recommendation system learn user's profile. Social media platforms have large user base and users do use their profile on daily basis. So there is a good chance to get their profile and process to get interest out of it. This research uses Facebook profile of user and extract interest out of it and provide news on the basis of recommended categories. In general news in Pakistan are based on hate speech and violence which gives bad impact of Pakistan and users here in Pakistan are tired of getting bad news daily. There are many good happening over here but news sources provide random news which actually effect user's moral. This study not only provides news of user's interest but also rank them according to sentiments of news. In this way user can get good news on top and start their day with good mood. This recommendation system provides end results by passing over five steps of processing one is news collection, two news processing,

three sentiment analysis, four user's profile extraction from social media and last one is ranking on the basis of data collection.

5.2 Conclusion

Online news reading is very popular as nowadays web provides large access to news from thousands of online news sources. A key challenge to news provider is to recommend news that is interesting to read for that particular user. In this paper, research on recommending personalized news recommendation system is presented which fills the wide gap present in literature. This recommendation system can provide best results for news recommendation; this recommendation system keeps all aspects to provide news of user's interest. This recommendation system can solve problem of news source selection as there are several news sources available on the web, it also take sentiments of news into account to provide recommendation on the basis words used in news description. In news recommendation all aspects of news should be considered and this recommendation system process all news data and user's social media profile to provide best results.

5.3 Contributions to State-of-the-Practice

Pakistan is facing many problems due to terrorism activities inside the country. These activities often make there space on media showing up a bad glimpse of our beloved country though there are many good things/activities happening around us but we see news based on violence and hate speech everywhere on the web. Sentiment analysis is a technique used to extract impact of the statement or corps i.e. statement is positive or negative. Sentiment analysis used to filter news based on harmful activities and displaying good news of new inventions in Pakistan, betterment in industry, new relief packages from government, new opportunities, scholarship schemes, housing schemes, international awards achievers and news of users interest technology, real estate, stocks, foods, sports etc. Sentiment analysis ranking provides users with news showing good image of over beloved country focusing on major achievement all around and interesting facts. Research is carried out on sentiment analysis to analyze news, comments, reviews, articles, blogs and tweets.

5.4 Future Work

Designing a recommendation system always needs more work as user's priorities change by time; we have designed a news recommendation system which keeps most of the aspects in account to rank the news. More work can be done by integrating machine learning which can learn user patterns over time though our recommendation system which will provide best result initially but these results can be improved by incorporating machine learning techniques. Pages information can be analyzed to get more encouraging results for recommendation for this we will be analyzing about, description, location and posts of the pages liked by user. In this regard this study aims to add amendments to current research so that we can add more features with change of time. This study has taken user's profile from social media and in future twitter's social media profile will be added to gain more user base and facilitate users from all around world.

REFERENCES

- [1] A. Messenger and J. Whittle, "Recommendation Based on User-generated Comments in Social media," 2011.
- [2] Y. Fan, Y. Shen and J. Mai, "Study of the Model of E-commerce Personalized Recommendation System Based".
- [3] D. Yup Kang, D. Kyun Han, G. Sim, J. Jung, H. Jeon, S. Lee, J. Park and S. Moon, "PADAC^2: Real-Time News Recommendation System with Heterogeneous Social Footprints," 2014.
- [4] C. Z. C. Z. X. L. Q. L. Yuan Xue, "An Effective News Recommendation in Social Media based on Users'," 2008.
- [5] L. Xiaofeng, C. Chuanbo and L. YunSheng, "Algorithm for Ranking News," 2007.
- [6] A. Sharma and D. Cosley, "Network-Centric Recommendation: Personalization with and in Social Networks," 2011.
- [7] Y. Shanshan, C. Donglin, M. Yufeng and L. Bing, "A Personalized Recommendation Algorithm Based on Interest Graph".
- [8] S. Shankar, J. Rajendra, S. Sabya, M. Chandan and M. Uma, "Classification of Facebook News Feeds and Sentiment Analysis".
- [9] O. Phelan, K. McCarthy and B. Smyth, "Using Twitter to Recommend Real-Time Topical News," 2009.
- [10] U. Patrick, Z. Johannes and F. Madjid, "Sentiment Analysis in Financial Markets".
- [11] O. Oechslein and T. Hess, "The Value of a Recommendation: The Role of Social Ties in Social," 2014.
- [12] P. Marco, S. Fabrizio, V. Hossein and V. Rossano, "Making Your Interests Follow You on Twitter".
- [13] C. C. a. L. Y. LIU Xiaofeng, "Algorithm for Ranking News".
- [14] F. Liu and H. Joo Lee, "Use of social network information to enhance collaborative filtering performance," vol. 37, no. 7, 2010.
- [15] K. Joong Oh, W. Jo Lee, C. Gyun Lim and H. Jin Choi, "Personalized News Recommendation using Classified Keywords to Capture User Preference," 2014.
- [16] W. Jo Lee, K. Joong Oh, C. Gyun Lim and H. Jin Choi, "User Profile Extraction from Twitter for Personalized News Recommendation," 2014.
- [17] W. Jia, L. Qing and P. C. Yuanzhu, "User Comments for News Recommendation in Social".

[18] K. Irwin, R. L. Michael and M. Hao, "Introduction to Social Recommendation".

[19] B. Dmitry and D. Alexandr, "Musical Recommendations and Personalization in a Social".