Requirement Engineering and ML

# Introduction:

Requirement Engineering (RE) is the key phase in the development of the software. RE is the first complete phase in the proposed literature e.g. waterfall model. As time passed software development models gets a different vision now the RE is the part of the life cycle from the beginning until the end of the project e.g. agile model. In simple words determining and managing the user needs related to the software and hardware is requirement engineering. Software system are developing over million lines of code, number of modules and documents. The primary goal of the software system is to satisfying the users by developing the software that can meet up their needs and expectations. This goal is achievable by applying different methodologies and engineering techniques. One of the key factor is to understand and identify the needs of users aka software requirements. Software requirement engineering is the process that helps to determine the requirements in a systematic way to know what functionalities the targeted system obtain to fulfil user needs. Formally RE defined as [1]:

“Requirements engineering is the branch of software engineering concerned with the real-world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior, and to their evolution over time and across software families."

Software requirements play key role in the success of the project. In USA, a survey conducted over 8380 project by 350 companies to know the project failure rates. The report overall results showed only 16.2 % projects were completed successfully and one-half (52.7%) of project were challenged and completed with partial functionalities, time delays and over budgeted. While 31% projects were never completed. The main cause told by the executive managers was the poor requirement. The major problem were the lack of user involvement (13%), requirements incompleteness (12%), changing requirements (11%), unrealistic expectations (6%), and unclear objectives (5%). [6]

Software requirement engineering has four mainly phases requirement elicitation, requirement analysis, requirement documentation and requirement verification [2]. Requirement elicitation [3] [4] helped to understand the stakeholders needs e.g. what features he wants in the software? .Requirement elicitation techniques are mostly derived by the social sciences, organizational theory, knowledge engineering and practical experience. For requirements elicitation different techniques exist in the literature that includes interviews, questioners, ethnography etc. Requirement analysis [5] is the next step after requirement elicitation. In this phase, software requirements are analyzed to check the conflicts and consistency of requirements. It is also make sure that requirements are clear, complete and inconsistent. Furthermore, the agreed requirements are documented. This documentation has a clear and precise definition of the system functionalities. It also acts as an agreement between stakeholders and developers. These functionalities and requirement are documented usually as diagrams, mathematically formulas or natural languages. These documents are used until the end of the projects [ref required].

System requirements are classified into functional requirements (FR) and non-functional requirements (NFR). Functional requirements are the system requirement that includes the main features and characteristics of the desired system. Non-functional requirements are the system properties and constraint [7].NFRs set the criteria for judging the operation of the system e.g. performance, availability, reliability etc.

On the other hand, machine learning (ML) is an emerging field of this era. Artificial intelligence (AI) is a well-known and mature field in computer science domain. Machine learning is a part of AI. Machine learning helped to solve complicated and hard problems efficiently. ML mainly relies on the data and its algorithms learns from the existing data and predict the unseen problem solution. Its learning process has a great inspiration from human learning i.e. learning from the examples. ML algorithms have proved to have a great impact in different fields e.g. business, medical, software engineering, computer security, data and communication networks etc. For the leaning process algorithm, another key factor is the feature. Features correspond to the characteristics of the learning and provide the base to the algorithm. In addition, feature helps to abstract the complexities of the information provided for the learning and shortening training times. In short, features help to reduce time and complexity of the models for learning.

ML algorithms divided into two categories; supervised learning and unsupervised learning [7]. In more details, the third category is reinforcement learning added later in ML. In supervised learning, data set is labeled that means it has some example with the defined features and output. New input or query will predict from the learning of the labeled data. All regression and classification algorithm came under the umbrella of supervised learning e.g. Logistic Regression, Decision Trees (DT), Support Vector Machine (SVM), Nearest Neighbors (NN), Naive Bayes, Random Forest and Artificial Neural Network (ANN) etc. [8]. On the other hand, unsupervised learning is from the unlabeled data. It covers all clustering algorithms e.g. k means clustering and hierarchical clustering etc. [Ref Required].

# Literature Review:

This section described the current trend in RE and ML. It will show what problems has been solved or automated by the ML.

**Requirement classification:**

The first and highlighted challenged problem in RE is from the requirement analysis. It deals with the classification of functional and non-functional requirements. Requirements are usually written in the natural language. These documents contains hundreds of the requirements. It is hard and time consuming to classify them manually. These classifications are not limited to only two FR and NFR but also the sub categories of NFR and quality attributes. This problem area can be categorized on the base of used datasets in the literature. Three different domains are part of this category i.e.

* App stores
* Social Media
* Specified Application or Software

Millions of users are sharing there reviews on app stores after downloading and using the app. They just not only rate the apps but also write the likes and disliked features. It is not easy to get the requirements in such a complicated data. New features identification, classification of FR and NFR, and summaries of the reviews for the improvements of app is done with ML [12-14]. For the automated classification of FR and NFR [12] used total 932,338 online reviews of the 40 top paid and free apps on app stores from top 10 different categories. Semi supervised algorithm self- training, RASCO, Rel-RASCO for self-labelling is used. This semi supervision technique overcome the manually annotation problem and showed that only small amount of labelled data achieve high accuracy. Naïve Bayes classification achieved the best results out of the kNN, C4.5 and SMO. The [13] proposed another study on the classification of FR and NFR and experimented on 6696 raw user reviews from iBook and 4400 raw user reviews from WhatsApp. It used the different concept i.e. augmentation of user reviews. It is effective to improve user reviews classification results by adding textual semantics to the sentences .The user reviews augmented by several most similar words for the better classification results. The bagging algorithm showed beast result in comparison to Naïve Bayes and J.48. [14] Produced a classification method identifying bug reports and feature requests from user reviews. Total 146,057 reviews for 40 apps were collected from apple stores and google play stores. In the last, 4400 reviews were selected for further experimentation. The proposed model showed the upwards of 70 percent precision and 80 percent recall could be obtained using multiple binary classifiers, as an alternative to a single multiclass classifier. For the classification binary Naive Bayes algorithm used. The results shown that the commonly used NLP techniques, stop word removal and lemmatization, could negatively affect the performance of this classification task.

In the paper [15] main goal was to transform the online reviews in to the evolutionary requirements. Karplersky internet security 2011 from Amazon and mobile app of Tune-In Radio Pro V3.6 from the app store data was taken as a dataset. The characteristic analysis of the reviews considered for the automated task analysis and used relation-based propagation approach (SRPA) technique for the identification of opinion about common software features. Each set manually labelled the potentionel software feature, opinion and the polarities in the reviews and then classify the reviews on the base of relevant opinion semantics.. For clustering the opinion expression network algorithm Grivan Newman used in the proposed methods S-GN. The input of the J-K means and S-K means are set of the same number of clusters produced by the S-GN. The GN algorithm produced the optimized number of the cluster considering the global network topology that reduce the cluster containing mixed categories. For the second problem, system helped developer and propose the set of related evolutionary requirement of the system. The second problem in this study made it more interesting. By adding polarization of the reviews and helping the developer to know the related requirements. It is actually an intersection of the idea discussed above and give a new insight to this domain.

Social media e.g. twitter and Facebook has become the other popular platform to gather the requirements from user posts. Users are sharing their new features requests, feedback and bug report via tweets. Tweets as a big dataset used ML to classify theses tweets into meaningful categories e.g. new request, bug etc. [16-17]. These classifications and the information from theses tweets helped industry to know the user feedback for the software improvements. ALERTme [16] approach proposed for classifying, grouping and ranking tweets in software evolution process. For this total 68108 tweets i.e. collection of two-month tweets of Spotify, dropbox and Slack software data set was used. The output was binary classification i.e. improvement request or other. For the automated classification supervised learning algorithm Multinomial Naïve Bayes used. Further improvement request were considered for the grouping and it helped to sort the request and summarize them accordingly. That helped to reduce the human effort to analyses the each tweet for eliciting the requirements and knowing the issues in the software. As a last step, these summaries and tweets were ranked on the base of high worthy tweets. The one drawback of this study is the high number of manual annotations for labeling the data as request or others. In addition, the majority voting schemes used to solve the disagreements. Three annotators did this process and it took 13.5 hours for each annotators to complete the task. The next study [17] classify and summarize the Tweets. Total 4000 randomly selected tweets from ten different software were selected. The proposed model classify them into bug, requirement and spam using Naïve Bayes and SVM. The results showed that 50% of data contained useful technical feedback and achieved an average classification F1 of 72% using SVM that was better than the state of the art in literature [16]. The reason was the feedback dedicated to technical stakeholders i.e. developer related tweets were focused and analyzed. Tweets dataset labelled manually. Different techniques with VSM and NB as a preprocessing e.g. stop word removing, sentimental, stemming, and Bag of words implemented. However, results showed that these parameters did not improve to help the results of ML algorithm for classification of the tweets. Unlike the political tweets are polarized and carry the emotions software tweets are neutral in nature.

The third category is dealing with requirement classification using the software product data i.e. written in SRS. This data is composed of different software function and nonfunctional requirements. The nonfunctional requirements have subcategories that include availability, fault tolerance, legal, look and feel, maintainability, operational, performance, portability, scalability, security and usability. This dataset is provided by the Requirement Engineering (RE) conference and named as Quality attributes (NFR) dataset. The size of the total data set has 625 requirements with 225 FR and rest with NFR’s subcategories. For the automated classification of FR and NFR and identification of the subcategories of NFR [18] support vector machine (SVM) algorithm used. The data was not equally distributed some NFR with lowest number ignored. Data was under sampled and for solving the under sampling problem external data i.e. User Comment dataset from the amazon was added and hybrid approach proposed with the new dataset. This dataset contains performance and usability requirements. For the identification of specific NFRs, proposed methodology achieve the highest precision and recall for security and performance NFRs with ~92% precision and ~90% recall. Two mainly goals were target in [19] first is classifying the FR and NFR and second identification of NFR category. The data was pre-processed as a first step. Feature co-occurrence and regular expression used to increase the weight of influential words used in NFR. The supervised learning algorithm J.48 DT used for the classifying the FR and NFR. For achieving the categorization or classification of NFR, topic modeling unsupervised algorithm LDA and BTM applied. For generation of the topic result showed BNB worked better out of clustering, k-means, LDA, BTM. Another study for solving the same problem with NFR dataset additionally security dataset was conducted [20].Software requirements were classified and the focus was more on the security related requirements. ML algorithm CNN with specific setting in Tensor-Flow helped to achieve the goal and better results. In all these classification problem human input is involved for the annotation of the requirements. Semi-supervision requires less human effort in labeling requirements than fully supervised methods. The semi-supervised approach [21] using Naïve Bayes resulted in accuracy rates above 70%, considerably higher than the results obtained with supervised methods using standard collections of documents.

# Problem Statement:

Software requirement elicitation and analysis was only limited to the meetings, interviews and documented data etc. All the tasks were manual and needed more effort and time. With the recent data trend from different sources the user satisfaction and opinion is more integrated into the industry. Recent Study has shown that user analytics tools and techniques are helping developers and practitioner to deal with the large numbers of user feedback by filtering, classifying, and summarizing them, to decide what requirements and features they should add, change, or eliminate.Different ML algorithm has used for making it automated with different settings and parameters. Most of the studies are using the app data or twitter data. Recent study [] shown that data from twitter and app stores reviews can complement each other. The use of the similar apps and tweets can give more knowledge and help to get the better result. The effect of these results in the real project is missing and not explained in the studies.

1. Reusability
2. Data from appstore tweets and amazon software review does not exist
3. Which stakeholder have a particular interest in which topic for assigning the weight to the tweets or etc

When the requirements engineers use the classifier to pull out and group comments on issues, those posts by people with higher expertise values for the topic might be given more weight. In fact, tools could be developed that would sort the comments by the expertise of the poster.

\*\* these security problem if identified on the right level of abstraction can be reusable across the multiple systems even as a set to meet the same security objective. Pattern and similarities in grammer or phrasing the requirement may exist and allow the security requirement to be reused across multiple software with minor tweak to content. Paper hidden in plain sight

Reusability is missing in the above studies, if reusable the results and studies of there impact

### [**A quantitative analysis of current**security **concerns and solutions for cloud computing**](https://link.springer.com/article/10.1186/2192-113X-1-11)

Hold a limited conversation as was done in the case study, or extract a

subset of the comments made.

2. Through human analysis determine the categories represented by the posts

and label the text in preparation for using the classifier.

3. Train the classifier to recognize the categories using the labeled posts.

4. Run the remaining posts through the classifier and have the classifier do

the labeling.

5. Use the output to see if stakeholders in general held similar or dissimilar

views. In posts from outside the small initial group, if the posts were

about the same topic, were the conclusions the same?

6. Investigate posts that failed to be recognized by the classifier. These may be

sources of requirements not thought of by the initial group. Use these to start

new discussion threads that can be analyzed by repeating the process.

For judging the expertise the question can be directed to the related person. Thoes who answered and solve the problem will scored high and and those who did not answere or poorly answered will score low and it alos define the expertise level.

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