Headnote Prediction Using Machine Learning

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Abstract: *Headnotes are the precise explanation and summary of legal points in an issued judgment. Law journals hire experienced lawyers to write these headnotes. These headnotes help the reader quickly determine the issue discussed in the case. Headnotes comprise two parts. The first part comprises the topic discussed in the judgment, and the second part contains a summary of that judgment. In this thesis, we design, develop and evaluate headnote prediction using machine learning, without involving human involvement. We divided this task into a two steps process. In the first step, we predict law points used in the judgment by using text classification algorithms. The second step generates a summary of the judgment using text summarization techniques. To achieve this task, we created a Databank by extracting data from different law sources in Pakistan. We labelled training data generated based on Pakistan law websites. We tested different feature extraction methods on judiciary data to improve our system. Using these feature extraction methods, we developed a dictionary of terminology for ease of reference and utility. Our approach achieves 65% accuracy by using Linear Support Vector Classification with trigram and without stemmer. Using active learning our system can continuously improve the accuracy with the increased labelled examples provided by the users of the system.*

Keywords: *Judgment summary, head-note prediction, machine learning, text summarization.*

1. Introduction

Currently, Legal domain analysis has become an attractive research field for researchers. More and more intelligent systems are explored using legal documents, including Judgments/Orders Summarization, topic prediction using machine learning and Information retrieval [22]. In this research, we design, develop and evaluate headnote prediction using machine learning, without involving human interference using Supervised Learning algorithms and predict head-notes [5].

Head-notes are an interpretation of Judgment/Order written by the editor. Mostly legal Judgments are complex, lengthy and refer to other Judgments. In addition, it is citing as a 'precedent' in a given set of circumstances. These judgments later referred to in other cases [12, 20]. Headnotes divided into two main parts; i.e., one Law point that discussed in Judgment/ Orders and another is the editor's interpretation of that law into Judgment. However, they are only the editor's remarks and not the Courts' [7].

We summarize our key contribution as follows:

1. We have developed a data set for the experiment on judicial data to generate head-notes; there are few data sets available on different websites, however, these data sets are not relevant to the British Legal system.
2. We have developed the first-ever system in Pakistan for public sector organization free of cost with the aim that the public at large and legal professionals take advantage of this system and also encourage legal research. Active Learning Model designed a system that improves itself continuously if the user(s) update any part of the head-note or label either they accept predicted law points or reject it; we keep a record of these changes. This completely separate system performs the job of active learning and updating trained models. We design, develop and evaluate headnote prediction using machine learning, without involving human interference.

2. Background

All judgments that have been accepted for publication, along with headnotes, are published in law digests/journals. Some publishers also provide a law-site (website) with various search requirements for the public and litigants' convenience [10].

The publishers hire lawyers to review the Judgments, write the gist of the Judgments' and head-notes. Senior lawyers for proofreading prior publication review these judgments [6].

The editor must convey the highlighted reasoning of the judge and observation of the judge into the judgment [16].

Our research project will be concentrated mainly on proposing a unified organization that writes headnote automatically using a system's trained model that will reduce the human effort involved in writing headnote and a great deal of manpower involved in writing headnote / legal editorial [2].

Head-notes, writing problems naturally occur as a fundamental problem in the area of increasing pendency, delays in case disposition, the population of the nation, more workforce is needed, and writing down takes a lot of effort. Only a few Judgments are released and available to the public due to the time and effort involved [23]. Since the law is not abstract, it is dependent on it to resolve disputes and refer to other decisions. Justice is abstract but does not rely on abstract, in this research Lucy, and William revolves around the abstract nature of justice. Which he claims is still an untouched question. He has pointed out that law justice is not completely blind. Because you can never take the plea that, what offence you have committed is due to some of the outer inference of your health, nature, or another factor of your habit. Law never gives you the exemption on these reason else what was beyond your capacity and control due to any sudden enragement. He also points out that once a contract has been executed law has harsh implication to complete that it never considered that the efforts you made [4].

In the past, good research work developed to assist the legal domain and "legal assistant by computer" Westlaw and Lexis are a good example for us. Using technology in the legal domain, how computers assist in legal matters [1].

2.1. Headnote Prediction on Legal Documents

Digital Data is increasing day by day; similarly, in the legal context, unstructured data are increasing. It is no doubt that more data is available than ever before. Due to size and growth speed, it is not possible for people, to manually read everything due to the paucity of time. Hence, techniques applied to help people organize, search, filter and manage electronic documents. Every Court is maintaining its database; extracting Knowledge from these data is a challenging task [8].

The manual process of writing head-note is slow and required too much effort and expense for the publisher.
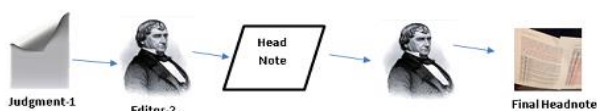

Figure 1. Process of manual head-note.

Figure 1 showing process how manual head-note process work described in steps.

- *Step* 1 In the first phase, "Editor-1" reviews judgments, finds out the legal topic discussed, extracts the gist of the Judgment, and writes a headnote.
- *Step* 2 Senior editor "editor-2" reviews headnotes of "editor-1" make requisite corrections, if required, and finalizes the headnotes.

The most important issue with the Journal is that they publish a limited number of judgments in their journals because they have a limited number of pages in the journal.

Currently, data collected from websites of respective Superior Courts of Pakistan such as shc.gov.pk, lhc.gov.pk, peshawarhighcourt.gov.pk, bhc.gov.pk and ihc.gov.pk.

Table 1. Reported Judgment and orders uploaded.

#	Court Name	Reported Judgments
1	"High Court of Sindh"	183,502
2	"Lahore High Court"	28,656
3	"Peshawar High Court"	15,276
4	"Balochistan High Court"	10,522
5	"Islamabad High Court"	23,406
	Total	**261,362**

Table 1 showing the total number of document (Judgment and Orders) uploaded on the websites of respective superior courts. These data are parsed and saved as text document into our dataset for further process detail is defined in section 4. All Superior courts of Pakistan recently started uploading tagline (catchphrase or slogan) of the case, which is a summary of the case that describes what the decision of the court was. These taglines usually dictated by the author Judge or any officers of the research branch of that court. However, these catchphrases are not case law of the judgment or headnote of the judgment. The tagline is just a short description or summary of the case [13].
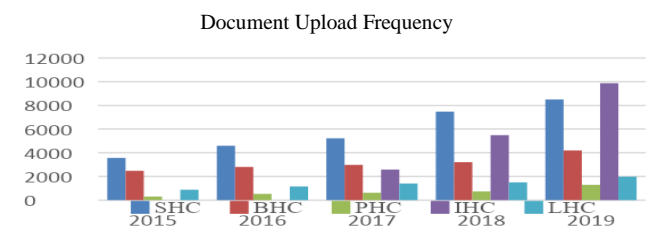

Figure 2. Reported Judgment and orders uploaded.

Figure 2. showing data uploaded by the superior court that was used for experiment purposes.

3. Literature Review

For the past many years, researchers are working on Legal data; on Government level and individually law firms are exposing data publically, to facilitate the Litigants (Judges, Lawyers, Organizations, and Public) data is being analysed using text classification algorithms. It is a very much challenging task to predict Judgments especially on prison terms of Legal documents [21].

Summarization of Judgment generally known as Headnotes, summarization of Judgments using Fuzzy Logic by member functions (f1 to f11) and Conditional Random Field Algorithm developed on three main law domains Rent Control, Income Tax and Sales Tax [15].

Automated text summarization is an important tool for litigants; legal practitioners often needs, support their cases with references and they need supporting Law/Judgments. It is difficult manually to find out reasoning from large Judgments. They often maintain diaries for summaries of Judgments. Thus, they can focus more on the legitimate problem rather than on finding text files [9].

In this research, the researcher identifies the Diversification method of legal documents for head note/summary of legal documents, the feature of legal documents extracted for ranking purpose, Cosine Similarity was used for the distance between two legal documents and finally produce a difference of both documents [11].

Another System was developed in 2016 "*CaseSummarizer*" standard summary method that generates a summary of legal documents, using word frequency with domain-specific knowledge. Evaluated using Recall-Oriented Understudy for Gisting Evaluation (ROUGE), Human Scoring and feedback by domain experts.

Python language uses an Natural Language Toolkit (NLTK) package used to split documents into a chunk of sentences. In addition, sentences scored using Term Frequency-Inverse Document Frequency (TF-IDF). The authors also identified some weaknesses of the system. i.e. sentence repetition and some important information missed during summarization [19].

Another experiment applied to legal documents, using Machine Learning technology to predict ruling, Law Topic and date of the ruling of the French Supreme Court. In this paper, 126,000 documents were analysed from the 1800s until the present day. In this paper Lexical feature, Support Vector Machine (SVM) used to predict the ruling, Law topic and date of the ruling [3].

A pillar of AI research is computer-based systems for human-to-human communication since 1950. This study aims to see if Language Models (LM) based on transformer neural networks can predict conversation quality. While the three (BERT, GPT2, XLNet) use the same approach, transformers, at their heart, have structural differences that distinguish them when applied to the current problem domain. Due to its traditional language modelling approach, which integrates the structural knowledge about a sequence, GPT2 performs the worst. When predicting a target token, XLNet improves its correlation score by using additional positional knowledge. Language Models cannot replace human annotative [17].

The ubiquitous task for Conditional Random Fields (CRF) is to generate labels using CRF. However, the author of this study used a two-step label generation method. Bayesian neural networks are used to identify labels that have a high chance of being incorrect. The proposed method should refine the unknown labels only, avoiding the refinement's side effects on the right labels. Furthermore, the proposed model can capture several sets of label dependencies and word-label interactions in parallel, avoiding the need for Viterbi encoding of the CRF and allowing for faster prediction [6].

Conduct experiments on a real-world large-scale dataset of criminal cases in the civil law system. Experimental results show that the method outperforms state-of-the-art LJP methods on all judgment prediction tasks. Based on the topological structure between multiple tasks, we extract the information from the fact description via the Transformer- Hierarchical Attention Networks (HAN) encoder [6].

4. Research Methodology

The proposed method begins by collecting the judgments of the superior courts. The data extractor model developed in python extracts judgment and saves it into Databank. After collecting judgment and data wrangling, we labelled all judgments with law points and developed the dataset for training purpose. An active learning model was developed that improves itself by increasing the data set. Finally, we conducted experiments to increase the accuracy of the model. For the second part of Head-note, we had generated a summary of judgment by three methods cosine similarity, gensim summarization and rank base System. All results compared with manually generated headnotes.

4.1. Proposed Model

In this research, the proposed model was divided into five steps.

- Data Scraping.
- Data Set Generation.
- Data Clean and Knowledge-Based system.
- Law point prediction.
- Text Summarization and interpretation of the document.

4.2. Data Scraping

We created a framework for collecting judgments, and this system copies judgments/documents into our DocBank document bank from all Pakistani High Courts' websites, including shc.gov.pk, lhc.gov.pk,bhc.gov.pk, peshawarhighcourt.gov.pk, and ihc.gov.pk. We have created a website Dictionary that lists the Uniform Resource Locator (URLs) of the various High Courts where the relevant documents can be found. We created a python DE (Module) to fetch documents from specified URLs by sending HTTP requests to the web addresses. This module retrieves documents and stores them in a predefined structure in our DocBank (Document Bank).

We process only those Judgments that are announced and these documents are public documents.

Process of Data Scraping and Judgments Collection is defined in the dataset generation section.

4.3. Data Set Generation

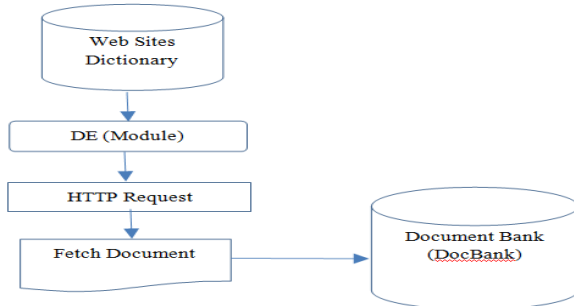The second most important goal of this research was Dataset creation.

Figure 3. Process of data scraping.

Figure 3 showing that how data are scrap from predefine websites using self-developed Data Extractor module (DE).

Pakistan's legal system is based on british legal system. We do not have any ready dataset to be an experiment on. Therefore, we decided to create our dataset for our research purpose.

Table 2. 25 unique law points, subjects/statutes.

#	Law Point	#	Law Point
1	Admiralty	14	Illegal Dispossession Act, 2005
2	Arbitration Act,1940	15	Imports and Exports (Control) Act, 1950
3	Banking matter	16	Income-tax
4	Civil Procedure Code CPC	17	Industrial Development Bank Ordinance (IDBO)
5	Civil Procedure Law (UAE)	18	Limitation
6	Companies matters	19	PEMRA Ordinance, 2002
7	Constitution of Pakistan, 1973	20	Police Law - Police Act, 1861
8	Contract Act	21	Qanoon-e-Shahadat Order, 1984
9	Criminal Procedure Code Cr.P.C 1898	22	Service matters
10	De-attachment of property	23	Sindh Mining Concessions Rules, 2002
11	Environment Law	24	Specific Performance
12	Fatal Accident	25	Specific Relief Act
13	Guardian and Ward Act, 1890		

As shown in Table 2 we had selected 25 unique law points, subjects/statutes. These are collected after informal interview and discussion with legal experts, Judges, Lawyers and Law graduates. Initially, we used Law Journals and law sites that are providing manually generated head-notes and we created a dataset for training purposes. In parallel, we have developed a system that will enable us to add a topic in any judgment to collect Data from a concerned person and use it for training. This system improves it day by day as the data set increases by end-users.

4.4. Law Point Prediction

In the first phase, we have converted the Final Cleaned Document into a matrix of TF-IDF. We have used n-grams features to improve performance.

We have used four main algorithms of Machine Learning to predict law points.

- Linear Support Vector Classification.
- Logistic Regression.
- Naive Bayes classifier for multinomial models
- A random forest classifier.

4.5. Text Summarization and Interpretation of document

In this research, we are using an unsupervised method to extract a summary. We tested three methods for Summary Generation.

- Cosine Similarity
- Gensim Summarization
- Rank base System

In this, research Ranked Base Summary (RBS) introduced that rank the sentences and displayed (N) Sentences in Summary where n represents the total number of sentences required for the summary. This system counts the total number of word occurrences (W_n) and finally sums all words in sentences (S_n). Where S_n is the rank of sentence and summary of Document is Top Ranked Sentences of given Document.

$$S_n = \text{Max} \left(\sum W_n \right). \quad (1)$$

$$RBS = \text{Top}_n \left(\text{Max} \left(\sum W_n \right) \right). \quad (2)$$

4.6. Data Extraction and Experimental Setup

In phase-1, Judgments collected from respective superior Courts of Pakistan (Sindh High Court, Lahore High Court, KPK High Court, Balochistan High Court and Islamabad High Court). Label each Judgment with law/act/ordinance along with a section with the help of publisher books and feedback from a domain expert.

Table 3. Generated dataset from different sources.

#	Judgments	Label
	…	"Constitution of Pakistan Art.199 "
1	...	"Criminal Procedure Code (V of 1898) Section 417"
2	…	"Cooperative Societies Act (VII of 1925) Section .54"
3	…	"Arbitration Act (X of 1940) S.34"
4	…	"Illegal Dispossession Act (XI of 2005) S.3"
5	…	"Specific Relief Act (I of 1877) Ss.42"
6	…	…

Table 3 showing sample dataset, which is used in this research. The first column is serial number #, Second column Judgments contain text data of the

Judgment and the third column is the label against that Judgment. We have developed 87, 120 labelled judgments out of 261, 362 judgments.

5. Results

The outcomes of this research would be beneficial for legal practitioners, legal researchers, Judges, Advocates and the public at large. By using an evolving combined technique, this research was able to automate the first step of giving automated legal points addressed in judgement, then produce the judgement summary and form a headnote. This research provides a valuable appreciation to bring the headnote writing problems closer to the real cases of the court by developing a new automated system.

This research developed a dataset for experiment purpose, developed an automated system that generates head-note using machine learning techniques, which stimulate the researchers to examine further the area of automated legal processes. This research also provides a chance to work closely with a knowledgeable team of legal scholars, Judges and advocates enhancing the Centre's activities.

5.1. Text Summary Results

Here are a few Generated summaries from the System; in some cases, the RBS summary is returning the accurate result, and in other cases, Gensim Algorithm is returning good results. Both are nearly the same, but we found Gensim more accurate as compared to other techniques.

Table 4. Comparison of summary generated with different algorithms.

	Summery	Avg. Sent.	Avg. Word/Sent
Cosine Sim.	2786	4.2	3
Gensim Sum.	2786	2	1.5
RBS.	2786	2.1	1.6

Table 4 showing a detailed comparison of the text summary generated by the different algorithms is defined in Table 4. We generated a total of two thousand seven hundred eighty-six summary using our algorithms, on average 4.2 sentences and 3 words per sentences updated/modify by a domain expert in system generated summary using cosine similarity algorithm. With gensim summary, average 2 sentences and 1.5 words per sentences updated and average 2.1 sentences and 1.6 words per sentences with RBS system. We are recording changes by domain experts on system-generated summaries for improvement.

5.2. Classification Results and Analysis

For the predicting first part of the head-note law point discussed in judgment, we used four algorithms to predict the law point. We have also experimented by

including law definitions from books into the dataset on the recommendation of the domain expert.

Table 5. Using law definitions.

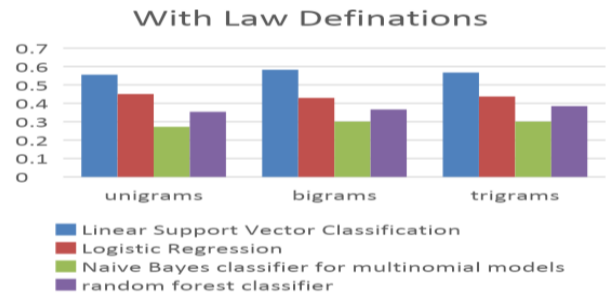|	Using law definitions into the dataset			
	Linear Support Vector Classification	Logistic Regression	Naive Bayes classifier for multinomial models	random forest classifier
Unigrams	0.556	0.450	0.272	0.354
Bigrams	0.582	0.430	0.300	0.367
Trigrams	0.567	0.437	0.300	0.385

Figure 4. Using law definitions.

As shown in Table 5 and Figure 4, we got 57% accuracy with trigrams, 58% Accuracy in bigrams and 56% accuracy in n-grams using Linear support vector classification, which is the highest accuracy so far using law definitions into the dataset. Law definitions saved into our document bank (DocBank) with the label.

Table 6. Results without law definition.

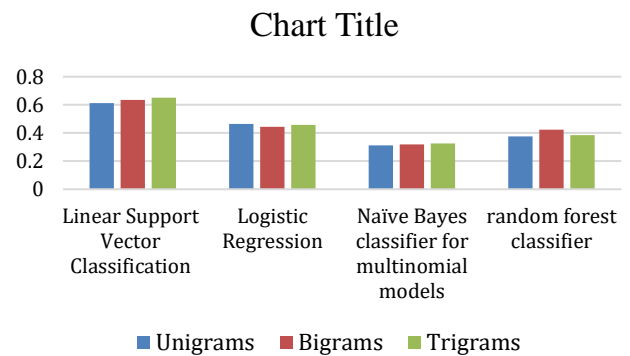|	Dataset without Law definition			
	Linear Support Vector Classification	Logistic Regression	Naïve Bayes classifier for multinomial models	random forest classifier
Unigrams	0.613	0.4647	0.312	0.375
Bigrams	0.636	0.443	0.319	0.424
Trigrams	0.650	0.457	0.326	0.385

Figure 5. Results without law definitions.

As shown in Table 6, and Figure 5 showing how we got 65% Accuracy with trigram, 63% accuracy with bigram and 61% accuracy with unigrams, using linear support vector classification. This is the highest

accuracy and it is clear that results improved after removing law definitions from the dataset.

We have used Stemmer to test our results because it was discovered that results improved when the vocabulary terms in the dictionary were omitted and some words that we had as a feature were stemmed using chi-square. Since the results improved by 5% after eliminating the terminology terms, we decided to use Stemmer in our dataset. The following outcomes have been observed.

Table 7. Using stemmer.

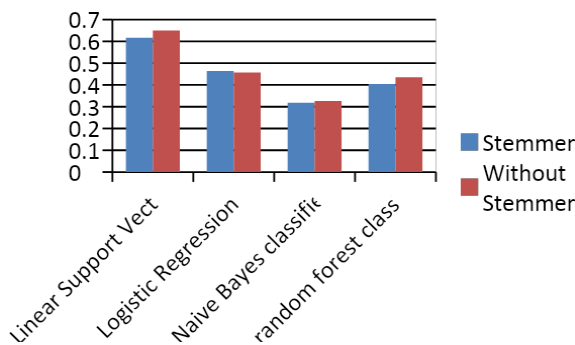|	Using Stemmer			
	Linear Support Vector Classification	Logistic Regression	Naive Bayes classifier for multinomial models	random forest classifier
Stemmer	0.617	0.464	0.318	0.404
Without Stemmer	0.650	0.457	0.326	0.435

Figure 6. Using stemmer.

Table 7 and Figure 6 as a result of using stemmer in our dataset, the accuracy decreased by 4%, since in the legal domain, most of the domain terms that should have more weightage become meaningless for the model when we use stemmer. In our case, the stemmer strategy failed, but our keyword, Dictionary, performs admirably and produces excellent results as compared to stemmers.

Table 8. System Generated Headnote.

Arbitration Law (Arbitration Act, 1940 Section 15) if illegality is separable from the main award, the same can be modified/corrected by *invoking* section 15 of the Arbitration Act, 1940.
Civil Procedure Code CPC (Suit for Recovery. Decreed.) Two Suits i-e, Suit for Recovery filed by the plaintiff and suit for Declaration, Cancellation and Damages filed by the defendants were decided in a single judgment. The Suit of Plaintiff was decreed whereas the Suit of the defendant was dismissed.
Civil Procedure Code CPC (Recovery of Earnest Money and Damages), Tort Law Suit for Recovery of Earnest Money and Damages decreed. The defendant had not any authority from the owner of the apartment for its sale, hence, the defendant through misrepresentation and fraud, induced the plaintiff in paying the amount in rupees fifty thousand towards part payment/earnest money for the sale of the apartment. Defendant no. 1 was directed to pay the earnest money and the damages of rupees five hundred thousand to the plaintiff.

In "Table 8 System Produced Headnote" showing, the outcome of system generated head-note using

machine learning that is validated and accepted by the individual concerned.

6. Conclusions and Future Work

We have investigated the characteristics of the headnote of superior courts of Pakistan, such as SHC, LHC, PHC BHC and Supreme Court of Pakistan etc. In the first step, we predict law points used in the judgment by using text classification algorithms. The second step generates a summary of the judgment using text summarization techniques. We have Achieve 65% accuracy, so far.

We have investigated the use of various supervising learning techniques for heading, Top/Law/Act Prediction such as linear support vector classification, logistic regression, naive bayes classifier for multinomial models and random forest classifier and we found Linear Support Vector Classification more accurate in our case. We have used three techniques for Summary of the Judgment from which on Ranked Base System modify/developed, the algorithm(s) based on the powerful text summarization and extract the subject words. However, we found gensim algorithm generating more accurate summary and best fit for our case.

We have added a module into a web application for the editor to view the machine generated headnotes. In the initial phase, these headnotes are reviewed and approved by the editor; once it is approved, it is visible freely to all public. We are on the conclusion that the Problem of manually writing Head-notes can be solved efficiently using machine learning, without involving humans.

Following this study, a large number of research areas in the judiciary have been explored. We will boost our performance in the future by using a different dataset and different neural network approaches as define in [14] GloVe and Region Based Convolutional Neural Networks (RCNN). The judgement summary is derived from the entire substance of the judgement; however, we can strengthen by extracting the summary from a particular area of the judgement.

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