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Statistical Modeling of Mystical Concepts in Khaghani's Divan Using Text Mining

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Abstract. Text analysis provides an exciting approach for extracting knowledge from text data. Recently, text analysis has been applied in many research fields. In this study it was demonstrated that how text analysis can be applied to literary researches. All the lines of Khaghani's Divan have been considered using different text analysis methods. Then the accuracy of the applied methods is compared.

Keywords: Classification, Khaghani, Literature, Text Mining.

1. Introduction

Prevalence of mystical thinking in Persian poetry has been the prelude of a drastic course in the Persian literature and mysticism; an evolution which has added meaning and profundity to Persian poetry. It is established that prevalence of mystical ideology in Iran has reached a level where all the poets and writers has voluntarily or not been engaged with it.

In this respect Afzal Aldin Khahgani E Shervani, the prestigious sixth century poet, introduced some variegated concepts claiming in various works to be the true successor of Sanaii. Proposed by himself, the idea has been the subject of controversy among mystics and scholars.

Moulana (Moulavi, 2007) takes an ambivalent stand to this issue of interest, after talking about grandeur of pain, he uses two lines by Khaghani as a support which proves the acceptance of Khaghani's mystical concepts. Somewhere else, Tabrizi (1990) says "two lines from Khaghani are worth the whole Sanaii's Divan". Oufi (1982) equals him in purity with Gonaid and in wisdom with Loghman. Also Jaami (1991) grants many other aspects to Khaghani's life than poetry.

All these instances reveal Khaghani's contemporaries' outlook on the mystical concepts introduced by him. Even though there are many biographers delving into the subject, none has ever mentioned a curious point about him. The present study opens a new window into the subject.

In the course of current studies, Forouzanfar (2001) after a discourse about biographers opens a part about Khaghani's change of attitudes; although there are some doubts to different versions of this, the totality of the issue concerning Khaghani's change of attitude from the beginning to the end is out of question. He sees mysticism of Khaghani of the medium level in contrast to the high level mystics concerning his way of thought. Confirming Forouzanfar, Sajjadi (2003) also considers Khaghani's mysticism on par with Sanaii as not belonging to the higher levels and like average mystics looking to superficialities and o not the higher good of the world.

Ghani (2001) includes Khaghani as a mystic, and credits some poets skilled in ode such as Sanaii and Khaghani also as old mystical poets. Zarinkub (1999) also considers khaghani on par with Sanaii as a man of insight and intuition. Madankan (2002) concludes that Khaghani is more of a tutor of mysticism than a real mystic and classifies his mysticism as theoretical in contrast with the real one, arguing that intuition in Khaghani is a temporary phase and does not persist.

Considering the above and along with the outlook of the present and the past, a text mining study of mystical concepts would be the most logical assessment of him; therefore the volume of mystical odes and lines, their distribution in the odes and the related subjects would provide the materials of analysis. From this point of vantage, due to the visibility of the dominance of concepts and expressions in in figures and digits, judging in accordance with the

prevalence of mysticism in his works would be closer to reality and it would be easier to show how much of his thoughts are flooded with mystical concepts.

In this paper, text mining and machine learning techniques are applied to literary studies. The rest of the paper is organized as follows. Section 2 concerns the literature review of the text mining and machine learning techniques. In Section 3, different issues such as samples, data collection, and applied approaches are considered in details. The results of text mining approaches and machine learning techniques are given in Section 4. Section 5 also concerns the discussions.

2. Text (Data) Mining

Many scholars have studied Khaghani's mysticism. However, statistics and text mining have never been the means. Hence, considering the fact that these kinds of studies bring the mystical colors of Khaghani's works in light, the significance of the work seems out of question.

Text mining provides an exciting approach for extracting knowledge from text data. Recently, using text mining and sentiment analysis (SA) have sought to be exploited in many research fields. There are many applications and enhancements on SA algorithms that were proposed in the last few years. Hatzivassiloglou and McKeown (1997) established the first sentiment analysis, using syntactic structure. Turney and Littman (2003) established an opinion mining lexicon based on dependency criteria, which include two main stages. At the first stage, syntactic phrases including adjectives or adverbs are extracted from different sentences according to syntactic category label of phrases. At the second stage, the polarity of each extracted phrase is determined. Popescu and Etzioni (2007) introduced the OPINE method including four steps of features identification, identifying the reviews related to each feature, determination of reviews' polarity and the final ranking. In their method, Pointwise Mutual Information (PMI) calculation was used to identify the words. Abbasi et al. (2008) developed a hybrid genetic algorithm (namely Entropy Weighted Genetic Algorithm (EWGA)) that incorporated the Information Gain heuristic with the entropy metric for feature selection. Sotudeh and Horri (2008) tried to illuminate how countries are benefiting from Open Access advantage. Sotudeh and Horri (2009) investigated the countries positioning in open access journals system. Sotudeh (2010) tried to clarify the country's science system performance using regression analyses. Chen and Tseng (2011) have used two multiclass SVM-based approaches: One-versus-All SVM and Single-

Machine Multi-class SVM to categorize reviews. Maks and Vossen (2012) applied SA on news articles. Sotudeh (2012) tried to propose the use of specialty diversity, specialty stability, and the in evaluating the contribution sustainability of a science system at macro level. Li and Li (2013) applied SVMs as a sentiment polarity classifier. Unlike the binary classification problem, they argued that opinion subjectivity and expresser credibility should also be taken into consideration. The comparison between the parameters of two datasets or models has been considered in several works [Haghbin et al. (2011); Mahmoudi and Mahmoudi [(2014a), (2014b)], Mahmoudi et al. (2016), Mahmoudi et al. (2017), Mahmoudi et al. (2018), Mahmoudi (2018)]. Jalali et al. (2018) triggered the investigation and depicting of scientific trends in e-learning by using two scientometric methods named burst detection and clustering analysis. Mahmoudi and Abbasalizadeh [(2018a), (2018b), (2018c)] and Mahmoudi et al. (2018) applied clustering method to analyze Saadi's lyric poems, Quran and Moulana's divan, respectively.

3. Methodology

Based on the nature of the research, different issues such as samples, data collection, and statistical procedures are considered in detail in this section. The first part concerns the characteristics of the samples of the study and data collection. Then, the procedures which were applied to analyze the collected data are explained.

3.1. Data Collection

In this study, all the lines (8024 lines) of the odes in Khaghani's Divan have been considered. Table 3.1 indicates the descriptive statistics about the Khaghani's Divan.

Table 3.1: Descriptive statistics about the lines of Khaghani's Divan

N	Minimum	Maximum	Mean	Std. Deviation
132	15	208	60.79	33.41

As can be seen in Table 3.1, the Khaghani's Divan contained of 132 odes. The smallest and largest odes have 15 and 208 lines, respectively. Also the mean and the standard deviation of the lines for the odes of the Khaghani's Divan are 60.79 and 33.41, respectively.

First, these lines must be classified and coded into three categories:

- Mystical couplets: couplets revealing mystical expressions and concepts literally.
- Borderlines: couplets merging on both mystical and non-mystical interpretations.
- Non-mystical couplets: couplets with no sign of lexical of conceptual mysticism.

The classification is done based on the existence of mystical and borderlines combinations (given in Table 3.2), in the lines. We call this process as *Conceptometric* (measuring the concept).

Table 3.2: Different combinations to classify the lines

Type of Combination	
Mystical Combinations	**Borderlines Combinations**
love + perdition	love + idol
love + self-conscience	wine + joy
poverty + love	heart + lip
need (or want) of God	heart + hair
poverty + retreat	wine + lip
poverty + hermitage perdition +	wine + hair
retreat	love + cup
perdition + hermitage	wine + love
glory + heart	rose wine + love
love + heart	love + musician + cupbearer
heart + religion	drunkenness + love,
glory + hermitage	drunkenness + wisdom,
glory + retreat	drunkenness + sorrow
glory + hermitage + sky	wine + retreat
glory + retreat +sky	wine + hermitage
heart + sky	night + hair
Darvish	heart + mole
path + religion	love + wisdom + mole
heaven	love + night + light
heart + ego	love + night + glory
glory + heart + pray	love + night + fire

glory + heart + silence	
faith	
cloak	
monastery	
Sufi	
Dance	
glory + heart + Jesus	
glory + heart + Moses	
glory + heart + Mohammad	
consent	
resignation	
glory + sky + Mohammad	
sage	
trust	
light + heart	
light + hermitage	
light + retreat	
light + hermitage + sky	
light + retreat +sky	
light + heart + pray	
light + heart + silence	
light + heart + Jesus	
light + heart + Moses	
light + heart + Mohammad	
light + sky + Mohammad	

Based on these combinations, all of the lines are clustered into mystical, non-mystical, and borderlines categories.

The steps of this research are according to on cross industry standard process for data mining (CRISP-DM) model that has been named as the top methodology for data science projects. Six steps of implementing the CRISP-DM are as follows:

(1) Problem Understanding: Develop an understanding of the objectives and translate this into a data mining problem to construct a plan to achieve desired goals.

(2) Data Understanding: Identify initial source of data and evaluate raw data for data integrity problems.

(3) Data Preparation: Pre-process, scrub, and construct relevant data into final dataset.

(4) Modeling: Develop various models using comparable analytical techniques.

(5) Evaluation: Evaluate and assess the results of each model against each other and against the goals of the study.

(6) Deployment: Deploy the models for applying in analysis.

The proposed framework in our paper is based on CRISP-DM framework which has been illustrated in Figure 3.1.

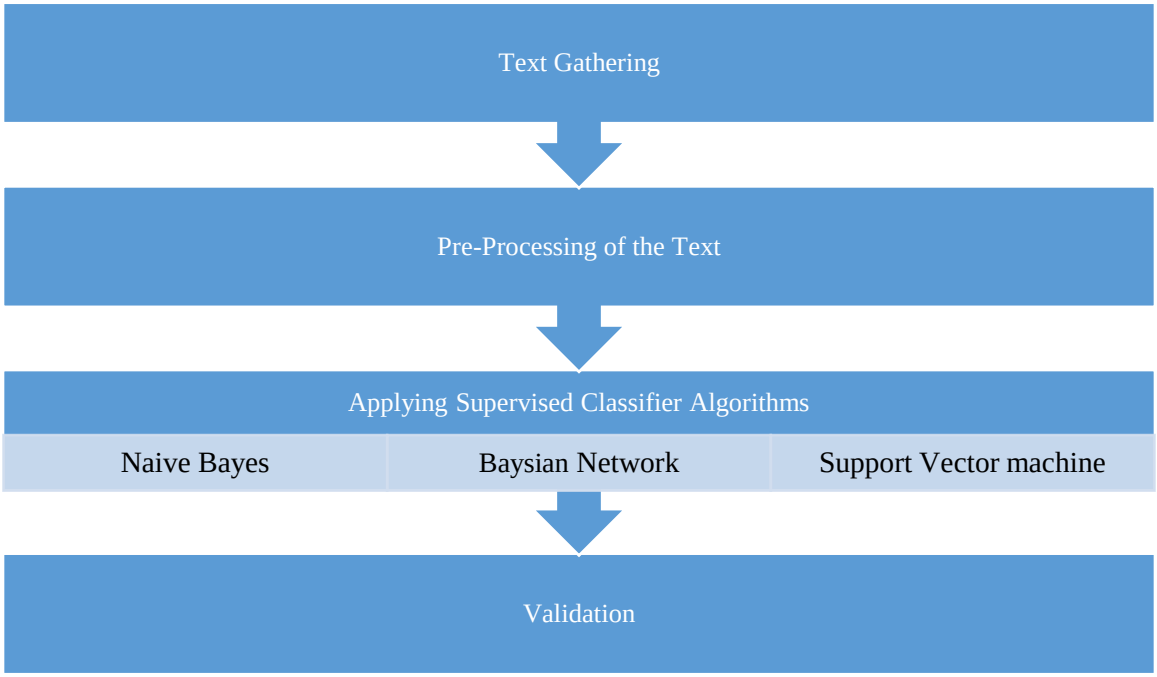

Figure 3.1: Steps of SA Framework

3.2. Data Analysis

As mentioned in Section 3.1, all the lines in Khaghani's Divan (Khaghani (2003)) must be classified and coded into three categories. In this research, understanding the mystical

concepts is the objective of the problem. Data understanding in this study refers to the mystical concepts of the lines of Khaghani. In modeling, we used three types of models including Naive Bayes and Sentiment Analysis. In evaluation phase, we compare the results.

3.2.1. Sentiment Analysis (SA) is an interesting field of research in text mining field which study of individuals', attitudes and emotions toward a topic. In SA, each word has been labeled as positive or negative. For their classification, Machine learning techniques have been used in most of the studies (Behoora and Tucker (2015); Yagci and Kitsikoudis (2015). Machine learning approach is based on well-known maximum likelihood (ML) algorithms to solve the SA text classification problem. The problem of text classification in Sentiment Analytics is defined as follow:

We have a set of training records D = $\{X_1, X_2,\ldots, X_n\}$ where each record is labeled to a class and then the classification model is applied to the class labels for a given instance of unknown class which can predict based on class label. Because of having class label, the supervise learning is utilized in most of the SA problems just like this study. The supervised learning method is always based on labeled training data sets that are available in the study. There are many kinds of supervised classifiers in literature. Naive Bayes Classifier, Bayes Network and Support Vector Machines (SVM) are represented as the most frequently used classifiers in SA which we describe them here.

3.2.1.1. Naive Bayes Classifier (NB). The Naive Bayes classifier is the simplest and most commonly used classifier. Naive Bayes classification model computes the posterior probability of a class, based on the distribution of the words in the document. The model works with the BOWs feature extraction which ignores the position of the word in the document. It uses Bayes Theorem to predict the probability that a given feature set belongs to a particular label.

$$\Pr(label|features) = \frac{\Pr(label) \times \Pr(features|label)}{\Pr(features)}.$$

$\Pr(label)$ is the prior probability of a label or the likelihood that a random feature set the label. $\Pr(features|label)$ is the prior probability that a given label, a feature set is being classified as the label. $\Pr(features)$ is the prior probability that a given feature set is occurred. Given the naive assumption which states that all features are independent, the equation could be rewritten as follows:

$$\Pr(label|features) = \frac{\Pr(label) \times \Pr(f_1|label) \times \ldots \times \Pr(f_n|label)}{\Pr(features)}.$$

3.2.1.2. Bayesian Network (BN). The main assumption of the NB classifier is the independence of the features. The other extreme assumption is to assume that all the features are fully dependent. This leads to the BN model which is a directed acyclic graph whose nodes represent random variables, and edges represent conditional dependencies. BN is considered a complete model for the variables and their relationships. Therefore, a complete joint probability distribution (JPD), over all the variables, is specified for a model. In text mining, BN is costly in terms of computational complexities; that is why, it is not frequently used.

3.2.1.3. Support Vector Machines Classifiers (SVM). The main principle of SVMs is to determine linear separators in the search space which can best separate the different classes. Text data are ideally suited for SVM classification because of the sparse nature of text, in which few features are irrelevant, but they tend to be correlated with one another and generally organized into linearly separable categories. SVM can construct a nonlinear decision surface in the original feature space by mapping the data instances non-linearly to an inner product space where the classes can be separated linearly with a hyperplane (Aizerman et al. (1964)).

Then based on the result of SVM, all the lines in Khaghani's Divan had been classified and coded into three categories (Mystical, Non-mystical, and Borderline), and the data gathered from classified categories were fed into the computer item by item according to their own values (codes) and were analyzed using the Statistical Package for Social Sciences (SPSS) Version 24, and R software.

4. Results

The first subsection concerns the text mining analysis. The second and third Subsections report the descriptive statistics about the different line's categories, and the different ode's categories, respectively. Subsection four concerns the trend analysis of the lines.

Three classifying algorithms have been implemented on the lines. 80% of labeled lines in the data set have been considered as a training set and 20% of labeled lines have been considered as test set for evaluating three classifiers on the data set. The results of applying Naive Bayes, Bayesian Network and SVM show the accuracy 78.43%, 74.97% and 86.54 %, respectively baed on a cross-validation approach. According to the results, SVM has been chosen as the best classifier among other classifier algorithms. At last, the results has been shown in a recommender system which gets a data set as input and calculates the accuracy of the data set regard to three classifier mentioned algorithms. The algorithm behaviors are summarized in the Table 4.1.

Table 4.1: Results of the accuracy of Naive Bayes, Bayesian Network and SVM algorithms

Algorithm	Naive Bayes	Bayesian Network	SVM
Accuracy	78.43%	74.97%	86.54 %

Table 4.2 shows the descriptive statistics of the different line's categories based on SVM, which represents frequency and relative frequency (percent) of the different line's categories. Also, Figure 4.1 shows the bar chart for the different line's categories.

Table 4.2: Descriptive statistics of the different line's categories

Type of Line	Frequency	Percent
Mystical	1544	18.93
Non- mystical	6341	77.75
Borderline	271	3.32
Total	8156	100.0

As can be seen, 1544 (18.93%) of lines are mystical, 6341 (77.75%) lines are non-mystical, and 271 (3.32%) lines are Borderline.

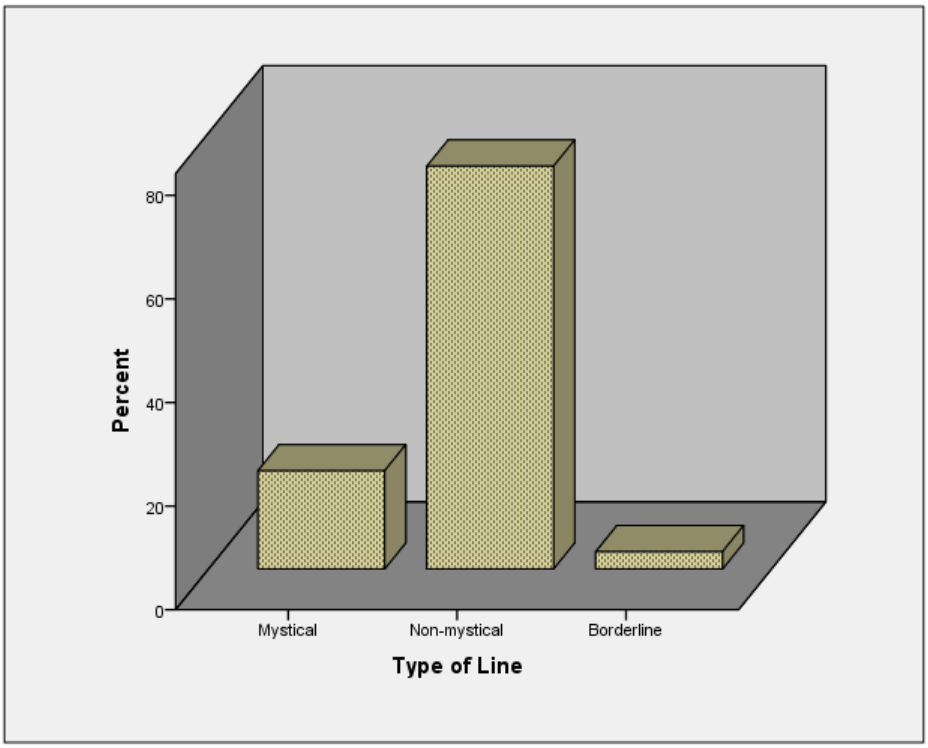

Figure 4.1: Bar chart of different line's categories

Table 4.4 shows the descriptive statistics of the different ode's categories based on SVM which represents frequency and relative frequency (percent) of the different ode's categories. Also, Figure 4.2 shows the bar chart for the different ode's categories.

Table 4.4: Descriptive statistics of the different ode's categories

Type of Ode	Frequency	Percent
Mystical	21	15.9
Non- mystical	100	75.8
Borderline	11	8.3
Total	132	100.0

As can be seen, 21 (15.9%) of odes are mystical, 100 (75.8%) of odes are non-mystical, and 11 (8.3%) of odes are borderline.

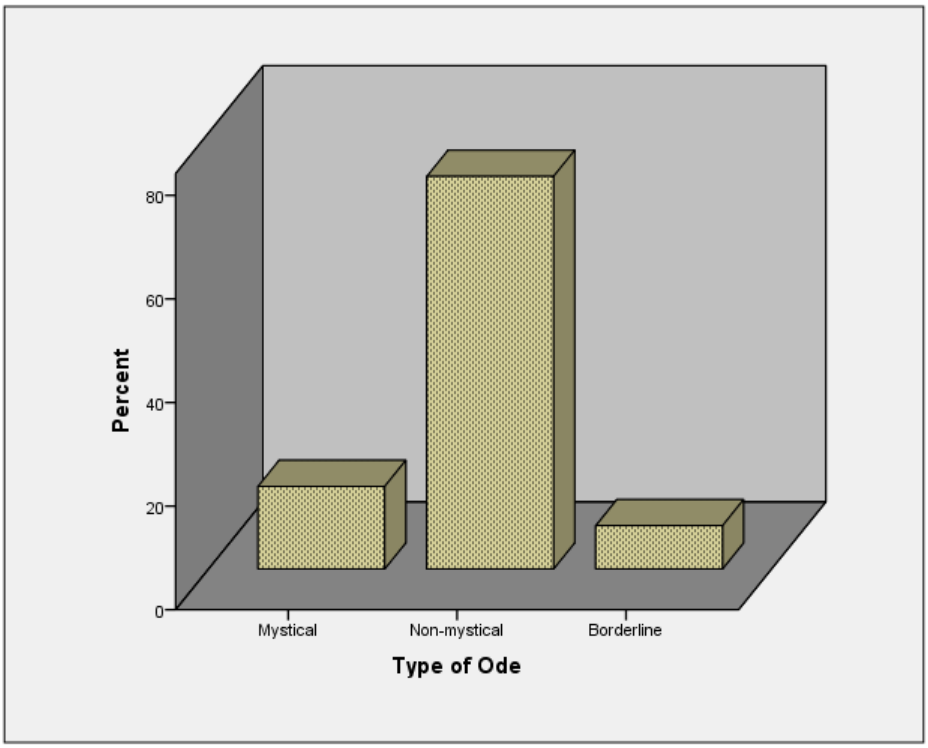

Figure 4.2: Bar chart of different ode's categories

5. Discussion

In this study it was demonstrated that how text mining and machine learning techniques can be useful to literary researches. First CRISP-DM was developed according to SA for analysis of the lines of Khaghani's Divan using text mining and sentiment analysis. Then we compared the sentiment analysis over three machine learning text classifier algorithm. Naive Bayes, Bayesian Network and SVM were utilized to compare and choose the best classifier.

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