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An Enhanced Semantic Retrieval System of Trademarks using Machine Learning

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Abstract

The objectives of paper are to enhance the conceptual based trademark system. Trademarks are essential and important property of a business. A unique trademark allows a company to make status in the market which products or goods it put up for sale. Infringement causes when two trademarks are similar, because of infringement trademarks need security. The conceptual similarity among trademarks arises when more than one trademark evokes the same or similar content. To retrieve this semantic content, there is need of semantic retrieval system of trademarks. Thus, this paper represents an enhancement in semantic retrieval system to find similarity between trademarks using thesaurus of Microsoft word application and feature extraction technique i.e., Principle Component Analysis (PCA) and classification is performed using machine learning algorithms i.e., Artificial Neural Network (ANN), Support Vector Machine (SVM). This system is validated using real 75 infringement cases of trademarks those are conceptual based. The performance is measured using accuracy, precision and recall.

Keywords: Artificial Neural Network, Conceptual Similarity, Feature Extraction Technique, Semantic Retrieval System, Support Vector Machine

1. Introduction

Intellectual Property (IP) privileges are like other property rights. These rights permit maker, or holder, of copyrights, trademarks or copyrighted workings to benefit from their personal effort. These privileges are shown in Article 27[1] of the Universal Declaration of Human Rights (UDHR), which offer for the right to take benefit for the protection of ethical and material comfort subsequent from composition of technical, mythical or creative manufacturing.

Trademarks are those intellectual property rights which are mainly important and valuable property of a company. An individual trademark allows anindustry to construct public goodwill and brand status in the goods or services it advertise. A trademark is any name, sign or device that identify and differentiates the source of the products of one team from those of others. European Union Intellectual Property Office (EUIPO) registers approximately 120000 trademarks each year. A European Union (EU) trademarks are valid in all 28 nations of the European Union[2]. Example of trademark is shown in Figure 1.

Trademarks are important and valuable business assets irrespective of the size of your business and are relevant at all the levels of the life of a business: From start-up, through general operation, as well as restructure or a business sale or purchase[3].

- Trademarks play an important role in sustaining total financial development.
- Trademarks facilitate customers to make fast and secure purchase choice.
- Trademarks support independence of selection
- Trademarks and related intellectual property promote energetic contest for the profit of customers[4].

Thus trademarks require protection because they are most important part of a business. But if they don't get

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protection then they are getting unauthorized or they may be used by anyone with similar trademark and business goes in loss.

Trademark infringement is the illegal use of a trademark or service sign on or in association with products and services in a method that is probable to cause misunderstanding, cheat, or mistake about the source of the products and services[5].

Due to infringement many situations arise when damages are generally measured like

- Lost sales revenue.
- Lost profits.
- Pay extra cost for security of trademarks to avoid incoming infringement[6].

According to information provided by the U. S. International Trade Commission (ITC), as described by the head of the Joint Economic Committee (JEC) , the amount of investigated infringement cases increased by 23.2% from 2010 to 2011. In 2012, a total of 3400 infringement cases were reported in the U.S. District Courts. In detail between 2002 and 2011, the standard annual rose in trademark court cases was 39.8%. From 2014 to 2015 there is turn down in trademark court cases from 29% to 22% [7].

After the whole analysis it is concluded that there are many elements which are likelihood of confusion: Similarity of goods, Similarity of trademarks, Similarity between profiles of business but similarity of trademarks normally lie because it is root of business to create confusion. Two trademarks need not be same to cause confusion; if they are similar or more likely to each other then they can also create confusion. There are three types of trademark similarity aspects: Visual, Conceptual, and Phonetic

Trademark similarity aspects are shown in Figure 2. From three similarity aspects visual based similarity has been achieved decent success. Many trademark image retrieval systems are working on visual similarity. Phonetic aspect of similarity focuses on the common rhythm and intonation of the trademarks which considers the sound pattern and pitch variations in the syllable that form the trade marks. Phonetic aspect of similarity remains a unique problem. They search only for limited words but in trademarks it is not specific to only one word. A algorithm needs which compares a collection of words.

Figure 1. Example of trademark.

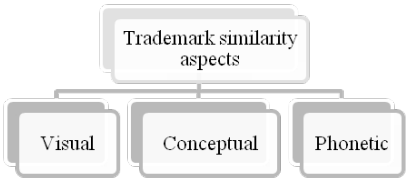

Figure 2. Trademark similarity aspects.

But this paper addresses the problem of conceptual similarity, because it is a unique problem and new in this domain. A few attempts made on conceptual similarity. Like existing trademark systems that focus on text element match partial or entire words in a query text. Keyword search system search for same matches from predefined databases. This is the reason why so we focus on conceptual similarity of trademarks in this paper.

Conceptual similarity means similar or identical content. For Example a trademark "luggage" is similar to another trademark "baggage". Both evoke similar meanings and they cause confusion because they are synonyms of each other. Cycle and Vehicle are two words in which conceptual similarity exsits. These two words also semantically related with each other. This similarity relationship needs an information source in form of dictionary to find synonyms or semantically related word. Example of conceptual similarity is shown in Figure 3.

The conceptual similarity is a unique problem in case of trademarks because many approaches are applied on trademarks to find conceptual similarity but they are focusing on text size so that they are not applicable.

Thus there is need to improve the system to retrieve the semantic words and find similarity between conceptual trademarks. This paper is based on conceptual similarity of trademarks that can find similar words and help in finding similar trademarks which cause infringement. These similar trademarks help in automatic classification of trademark infringement cases.

The remaining paper is structured as follows. Section 2 provides Literature Survey. The problem formulation and methodology for semantic retrieval system is explained in Section 3. Section 4 provides Results and Discussions.

Figure 3. Example of conceptual similar[8].

Section 5 explains the conclusion of the research and future scope.

Similarity helps in finding infringement cases of trademarks. Due to many infringement cases there are many trademark image retrieval systems are available. Many researchers have made an attempt on visual similarity and a great success they have been achieved. A few researches made an attempt on conceptual similarity but they are not successful at a specific level. Overview of literature survey is given in Appendix 1. (Table 1 Overview of Literature Survey). Firstly in this paper literature survey of visual similarity is described, and then description of phonetic similarity and conceptual similarity in literature survey is given.

2. Literature Survey

2.1 Visual Similarity

First attempt on finding visual similarity among trademarks was made by[9] to develop an automatic trademark management system. Author used statistical features of mesh image to develop an automatic trademark management system.

In[10] introduce the relationships between contours of trademark objects by a contours tree with chain code strings. String distance using dynamic programming technique is calculated to measure shape similarity.

In[11] author proposed a semi-automatic trademark retrieval system. This method randomly choose many pairs of trademarks from the database. Then each pair of trademarks manually generate a new distinguishing feature present in one trademark but not in the other trademark.

In[12] employed a System for Trademark Archival and Registration (STAR). The reason being to employ STAR was multiplicity and difficulty of image patterns exist in trademarks; there was no successful automated trademark registration system.

In[13] present a similar approach like STAR which was Automatic Retrieval of Trademark Images by Shape Analysis (ARTISAN) and it provide automatic retrieval of abstract trademark images by shape feature. This system was designed after examine each image and distinguish key shape components, grouping image section into families. This system allowed users to select another sets of shape features and similarity matching pattern.

In[14] used the most salient features based on Zernike moments to describe the global view of trademarks.

In[15] suggested a retrieval system which was capable to retrieve trademark images by similarity from patent and trademark offices, digital libraries.

In[16] propose trademark image retrieval using an integrated shape descriptor. The Zernike Moment Edge Gradient technique (ZMEG) was used and in that shape features and descriptor matching stage were employed.

2.2 Phonetic Similarity

In[17] proposed an algorithm which was designed to search actual English word, which has similar pronunciation but different meaning.

In[18] proposed an algorithm to retrieve phonetically similar trademarks that can be used as a means for supporting trademark examination during the registration process. This algorithm deploys a phonology based string similarity algorithm together with a typography mapping and token rearrangement to compute a phonetic similarity between trademarks.

2.3 Conceptual Similarity

Author in[19] described a proposal of semantic knowledge to an information retrieval system with the help of wordnet.

In[20] presented a new method to evaluate semantic similarity between words and concepts. Edge based approach and node based approach were combined to calculate information content.

In[21] present a new method to determine semantic similarity between words and hierarchical structure which was used to represent information content. Synonyms were found out using wordnet.

European Harmonization of Internal Market (OHIM) launched a system[22] which provides three match options those are word prefix, full expression, and correct match. Intellectual property office looks for a system that gives similar strings.

Trademark manual of OHIM[23] explained conceptual similarity of trademarks that include words or expression.

In[24] proposed a semantic algorithm to evaluate trademarks in terms of conceptual similarity. This algorithm brought forward a fully new similarity comparison concept in the field of trademark retrieval.

In[25] proposed hypothetic similarities among trademarks, in which more than two or more trademark return equal or related semantic words. An algorithm was proposed semantic reflow by using similarity of trademarks.

Table 1. Overview of literature survey

Sl. No.	Paper name	Author name	Work done
Visual Similarity			
1.	TRADEMARK multimedia image database system with intelligent human interface[8]	Kato, Toshikazu and Koreaki Fujimura	Author develop an automatic trademark management system by using statistical features of mesh image
2.	Trademark shapes description by string matching techniques[9]	Cortelazzo, et al.	Author introduce the relationships between contours of trademark objects by a contours tree with chain code string
3.	The retrieval of images from image databases :trademarks[10]	Whalen, Thomas, Eric S. Lee and Frank Safayeni	Author propose a semi automatic trademark retrieval system
4.	Content based retrieval for trademark registration[11]	Wu, Jian-kang, et al.	Author employed a system for trademark archival and registration
5.	Retrieval of trademark images by shape feature- The artisan project[12]	Eakins JP, Boardman JM and Shields K.	Paper present a similar approach like STAR which was Automatic Retrieval of trademark images by shape analysis
6.	Content based trademark retrieval system using a visually salient feature[13]	Kim, Yong-Sung and Whoi-Yul kim	Paper describe global view of trademarks by using salient features based on Zernike moments
7.	Interactive trademark image retrieval by fusing semantic and visual content[14]	Rusinol Marcal, Aldavert david, Dimosthenis Karatzas	Author suggested a retrieval system of trademarks which was able to retrieve trademark images by similarity from trademark offices
8.	Trademark image retrieval using an integrated shape descriptor[15]	Anuar, Fatahiyah Mohd, Rossitza Setchi and yu-kun Lai	Author propose trademark I age retrieval using an integrated shape descriptor
Conceptual Similarity			
9.	Using wordnet as a knowledge base for measuring semantic similarity between words[16]	Richardson, Ray, A. Smeaton and John Murphy	Paper described a proposal of semantic knowledge to an information retrieval system with the help of wordnet
10.	Semantic similarity based on corpus statistics and lexical taxonomy[17]	Jiang, jay J and David W. Conarth	Paper present combination of edge based approach and node based approach to calculate information content
11.	Information retrieval based on semantic based on semantic similarity using information content[18]	Wagh, Kishore and Satish Kolhe	Author present a new approach to measure semantic similarity between words and hierarchical structure
12.	News on patent, trademark and design databases on the internet[19]	P. Eagle	European harmonization of internal market(OHIM) launched a system which provides three match option :word prefix, full phrase, exact match
13.	Semantic retrieval of trademarks based on conceptual similarity[21]	F. M. Anuar, R. Setchi and Y. K. Lai	Author proposed a semantic algorithm to compare trademarks in terms of conceptual similarity
14.	Study of semantic retrieval by data similarity of trademarks[22]	Mali, Deepak and P. D. Lambate	Author propose hypothetic similarities among trademarks in which more than two or more trademark return equal or related semantic words

From this literature survey it is concluded that most of researches made on visual similarity because from ancient time trademarks starts from visual. So, most of the infringement cases arise in figurative trademarks firstly and from that time trademark image retrieval system are proposed. But with time trademarks infringement cases are also arise where two trademarks are having conceptual similarity[26]. So, there are also many researchers carried out to find conceptual based similarity but till no approach has been proposed to automate the work done to automate the process of finding conceptual similarity among trademarks. Thus this paper presents an approach

to automate semantic retrieval system of trademarks to find conceptual similarity.

3. Problem Formulation and Methodology

3.1 Problem Formulation

From literature survey it is observed that many research conducted on trademark image retrieval system which tells about visual similarity of trademarks. But now a day's conceptual based infringement cases are also increased. A few researches are presented on conceptual infringement cases.

Therefore, there is need to research in semantic retrieval of conceptual based similarity of trademarks which automatically classify similar and non-similar trademarks based on their infringement.

Thus the problem statement for this research is "An Enhanced Semantic Retrieval System of Trademarks using Machine Learning".

The objectives of the research are as follows:

- Extraction of trademark infringement cases.
- Preprocessing of infringement cases by using text mining approach.
- Use word document application server to find synonyms.
- Calculate similarity between real trademark and synonym.
- Use principle component analysis for dimensionality reduction.
- Classification of cases by training the dataset using ANN and SVM Classifier.
- Test the performance in form of precision, accuracy and recall.

3.2 Methodology

The methodology of semantic retrieval system is presented and explained in Figure 4.

3.2.1 Trademarks Dataset

The experiment considers dataset of real trademark infringement cases[26] to apply the proposed approach. Infringement cases of trademarks are those cases which cause confusion, deception or mistake about the sources of the goods and services.

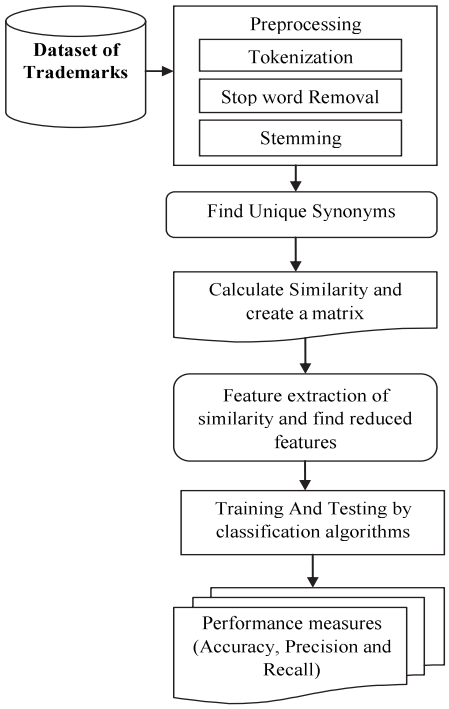

Figure 4. Methodology of semantic retrieval system.

3.2.2 Pre-Processing

Pre-processing steps are applied on trademark infringement dataset. It includes tokenization, stop word removal and stemming. These are explained as below:

- Stop word removal**:** In stop word removal process all stop words are removed because these words are rarely contain any important information. Stop words are like a, an, the, and etc. After removing stop words system performance is increased.
- Tokenization: Tokenization split the whole text into separate tokens to expand the words in document. For example what is data mining then tokens are "What", "is", "data", and "Mining".
- Stemming: Stemming process is used to reduce the words to their core words. For example words like "Testing", "Tested" and "Tester" reduced to core word "Test".

3.2.3 Find Unique Synonyms

Semantic meanings of words are needed to find conceptual similarity of trademarks. These synonyms are found with the help of word application document server. This server helps in finding synonyms offline with the help of thesaurus. As a lexical ontology we use

thesaurus. A matrix is created between real trademark and synonym of that trademark. Matrix is created of zero and one where word found synonym then there value is one otherwise zero.

3.2.4 Calculate Similarity

Similarity is computed between real trademark and synonym of that trademark with the help of Tversky's theory. To estimate the similarity between two words, set based methods usually compare the common and/or different features that two objects have. In Tversky's theory similarity is a function of common features and unique features. Similarity rises by computing the common features and reduces by computing the unique features. The Tversky's theory is an asymmetric similarity measure. The Tversky's index is a number between 0 and 1 given by:

$$Sim(a,b) = \frac{|A \cap B|}{|A \cap B| + \alpha |A - B| + \beta |B - A|} \quad (1)$$

Where α, β ≥ 0 are parameters. Setting α = β = 1 produces the Tanimono coefficient and α = β = 0.5 produces Dice's coefficient[27].

A matrix is created with their similarity values, where word and synonym is found then similarity value is shown that how much it is similar and if no word similar then zero is shown in matrix.

3.2.5 Feature Extraction

Feature extraction helps in conversion of original feature matrix into a more compress matrix. All the original features are changed into the new reduced space without eliminating them but replacing the original features by a smaller representative set. In this thesis feature extraction is used to extract important features using PCA technique. So a reduced matrix is created with top 100 features[28].

3.3.6 Training and Testing of Classification Algorithms

The reduced matrix of similarity values is created and given to machine learning algorithms those are ANN and SVM for its training. Training and Testing is done with 70–30 ratio. 70% part of data is given to training and 30% part of data is given to testing. 2-fold cross validation is done for classification which is called hold out method. This method used to validate the error rate. Performance of each classifier is analyzed and compared on basis of performance parameters those are accuracy, precision and recall.

Table 2. Results of ANN and SVM with Tversky's theory in case of accuracy

Techniques	Accuracy
Tversky's Theory with ANN	73.895 %
Tversky's Theory with SVM	82.446 %

4. Results and Discussions

Experiment is performed on real trademarks with the help of MATLAB (2013a) and Microsoft Word used to find Synonyms.

4.1 Results

In this paper, results are calculated on basis of Tversky's theory. By applying this similarity algorithm on dataset similarity is calculated and then classification is performed using ANN and SVM. Performance is measured with the help of accuracy, precision and recall. The results are shown below.

The results obtained after using classifiers with Tversky's theory is shown in Table 2. Accuracy varies from 73% to 82%. But precision varies from 84%-89% and recall varies from 73%-89%.

- Table 2 shows accuracy results of ANN and SVM with Tversky's Theory.
- In this Table accuracy varies from 73.895% to 82.446%.
- Table 3 shows precision results of ANN and SVM with Tversky's Theory.
- In this table precision varies from 84.437% to 89.421%.
- Table 4. shows recall results of ANN and SVM with Tversky's Theory.
- In this Table recall varies from 89.524% to 73.025%.

Table 3. Results of ANN and SVM with Tversky's theory in case of precision

Techniques	Precision
Tversky's Theory with ANN	84.437 %
Tversky's Theory with SVM	89.421 %

Table 4. Results of ANN and SVM with Tversky's theory in case of recall

Techniques	Recall
Tversky's Theory with ANN	89.524 %
Tversky's Theory with SVM	73.025 %

4.2 Comparisons

From experimental results it is analyzed that accuracy obtained by SVM and ANN with Tversky's theory is 82% and 73% respectively. Figure 5 shows that accuracy of SVM is better than ANN.

SVM performs better because it is fast algorithm. They are highly accurate, owing to their ability to model complex nonlinear decision boundaries. They are much less prone to over fitting than other methods. SVM has mean error rate is less in comparison to ANN.

Figure 6 shows precision rate. Precision is defined as the Percentage of correct predicted results from the set of input terms. The precision value should be more in SVM than ANN for the better system performance.

Figure 7 shows recall rate. The recall or True Positive rate (TP) is the proportion of positive cases that were correctly identified.

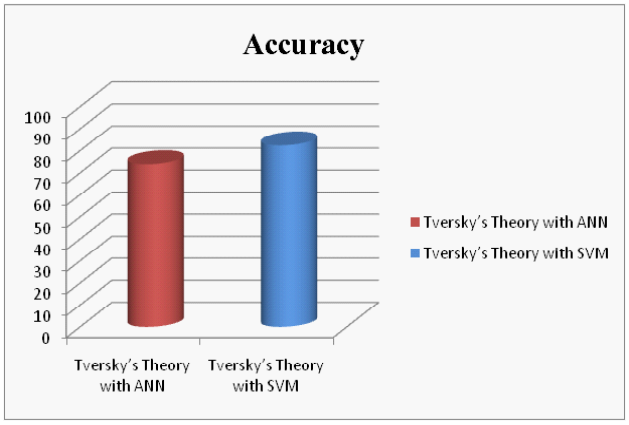

Figure 5. Comparison of SVM and ANN in case of accuracy.

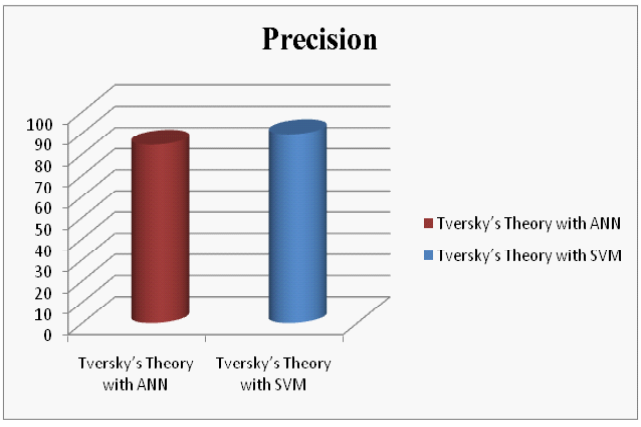

Figure 6. Comparison of SVM and ANN in case of precision.

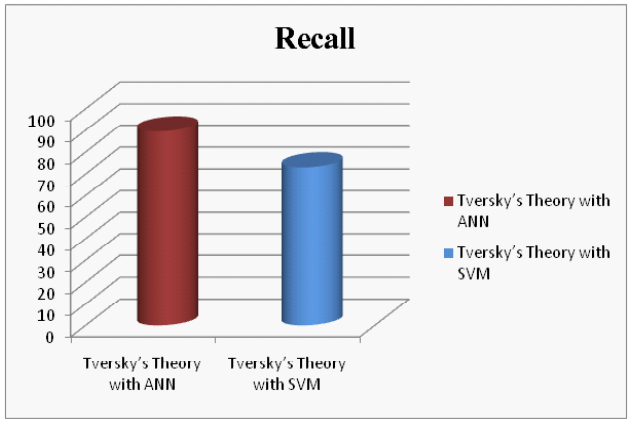

Figure 7. Comparison of SVM and ANN in case of recall.

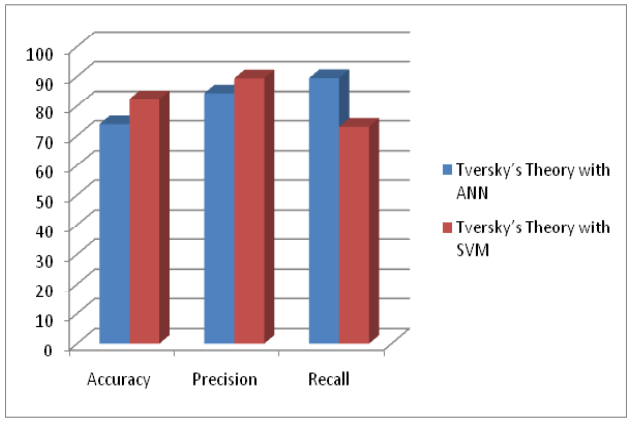

Figure 8. Comparison of ANN and SVM.

From Figure 8 it is concluded that performance of SVM is better than ANN because SVM is performed better in case of text classification. SVM constantly attain good performance on text categorization tasks, outperforming existing methods significantly and extensively. With their capability to simplify well in high dimensional feature spaces, SVM reduce the need for feature selection, making the application of text categorization significantly easier. Another advantage of SVM over the traditional methods is their strength. SVM show good performance in all experiments.

In some cases ANN also performs better because ANN is used for classification or regression. It tolerates the noisy inputs. Accuracy of ANN depends on number of input classes but ANN Produce good results in complex domains.

Hence it can be concluded that after using machine learning semantic retrieval system performs better in case of SVM. SVM algorithm works on kernel functions which differentiates the similar and non similar terms. When

training data is small, SVM performs best than traditional classifiers while ANN works on target values.

5. Conclusion and Future Scope

Trademarks are valuable assets of business. Without trademarks business does not grow well. So if there is similarity between trademarks it causes infringement. From that infringement many cases are realized in court. In those court cases many cases are of visual similarity and some are of conceptual similarity and other are on phonetic similarity. Many attempts made on visual similarity. So this paper work represented conceptual similarity of trademarks. Generally, information retrieval systems do not deal with this specific problem in a good way. So, this work contributes a method by proposing a semantic algorithm to evaluate trademarks in terms of conceptual similarity.

This paper takes forward an enhanced trademark retrieval system. It uses NLP techniques, combined with outer information source in the form of lexical ontology like dictionary. Extract features with PCA algorithm and classify the dataset using two famous algorithms like ANN and SVM in machine learning method. The evaluation using their similarity computation and classification by machine learning algorithms offers better outcome than the conventional standard method.

The work in this paper implements with one linguistic source but in future other linguistic sources can also be used. Other machine learning algorithms can also be used for classification. It combines visual similarity with conceptual similarity and phonetic similarity.

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