Implementation of Neural Network Approach Integrated With Phonetic Identification Algorithms for Correcting and Suggesting English Spelled Word

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Abstract- Neural networks are widely used in computer science in various research applications specifically for pattern recognition. Neural network can solve complex problems by nature and implements solution as being similar to be performed by human being. It is possible to incorporate such a neural network concept with phonetic algorithms that try to identify phonetic similarity among the words that will result in improvement of overall result. Phonetic algorithm based programs are used to identify phonetic similarity in which pronunciation of the different words with different meaning in English language are similar. There exists number of such algorithms with advantages and disadvantages which are introduced here and then after author has derived, designed and developed new algorithm. Each algorithm provides certain result at some extent but by integrating these algorithms in form of neural network results in improvement over any individual algorithm implementation. Neural networks are familiar as a solution for pattern recognition and here efforts are being made to identify similar patterns based on pronunciation of the English words to correct the misspelled English word as well as to suggest number of alternative English words as a result which have similar phonetic identity.

Index Terms- Neural Network, Phonetic, Matching, Soundex, Metaphone, Comparison, Pattern matching, Pronunciation, Match Rating, Spelling Correction and Suggestion

I. INTRODUCTION

Automatic correction of misspelled English words is commonly available in word processing applications, editors as well as number of search applications. For such kind of automatic correction and generating alternative solution of misspelled English words, numbers of solution are available using computer systems. One of such efforts is being made here by integrating more than one phonetic identification algorithms and conceptually preparing a neural network to produce the result with one or more alternatives as a spelling corrector or generator which is nearer to the given word. Neural network consists of a set of neurons each is capable of some unique functionality and passing the result to its nearer another neuron. Each neuron passes some of the data as well as weight associated with them. Here each algorithm that we use for experiment will be treated as neuron and based on the experiments performed weights are calculated. By using cumulative weight decision can be made whether to accept a word as a solution or to reject the word. Instead of applying individual algorithm for such English spell checker, if we apply more algorithms at once resulting in efficient solution. By studying existing algorithms designed for English language to identify phonetic similarity between words another simplified solution is derived which consists of phonetic replacement rules for similarity determination. The prime goal of the proposed paper is to integrate such algorithms in a form of neural network and then the word is passed to the network and expecting a set of words as output from network. By using sample input data as misspelled or typographical error to the neural network test has been performed for the correctness. All such phonetic algorithms have limitations at some extent but as a whole weaved together as a single model of neural network provide better improvement over individual performance.

Neural Network Introduction

In computer science field artificial intelligence is one of the most widely used research area that tries to solve complex problems similar to as being solved by human being. Human mind consists of complex neural structure capable of solving any kind of complex problem far better than any powerful computer. Computer is better for solving numerical and textual processing as well as storing and recalling operations but it is difficult for a computer to recognize and identify a face from thousands of faces compare to a human brain. It requires tremendous computing of image processing for such complex problem. But for human mind it is easier to recall a face due to its inbuilt complex natural neural network as it is a parallel processor and can solve such complex problems very naturally.

Following depicted figure[7] describes the natural neural network. Each neuron consists of a nucleus with a cell body or soma and connected with other neurons through axon. Dendrite is the fiber treated as input to neuron. When biochemical signal moves from one neuron to another weight sum of all the input must met with some threshold value which is determined by synapse. From this position whether the signal is exhibited or inhibited to the next neuron.

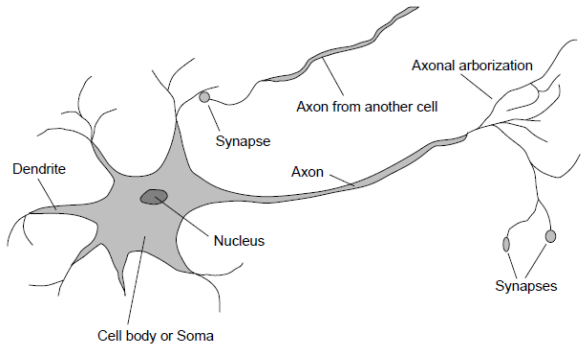

Figure 1 : Biological neural network

Following are the key components of neural network.

Soma / Cell Body

Soma is the cell body of nucleus of an individual neuron.

Dendrite

Dendrite is connected with a neuron and is treated as the input to the neuron. A neuron may have multiple input dendrites.

Axon

Axon is treated as output from neuron as an electrical impulse. This axon is connected with synapses via boutons.

Synapse

Synapses are connected with axons and are processing element which determines the activation of the signal to the next neuron. Synapses connect all the neurons as network and responsible to pass or stop signal for processing.

The processing power of neural network lies in the connections among the neurons. If signal propagation is disturbed then it reflects to the processing power of neural network.

II. Artificial Neural Network

Artificial neural network is developed based on the human brain nervous system. Artificial neural network architecture is a layered architecture in which input layer consists neurons receiving inputs and sends the result to its next layer called hidden layer. Hidden layer depending on the network consist one or more layers. At last output layer contains the possible outcome. Input is processed by the neuron based on the weight sum of all inputs and propagates the result to next neuron. A simplest form of neural network is feed forward neural network. Following neural network is an example of feed forward neural network.

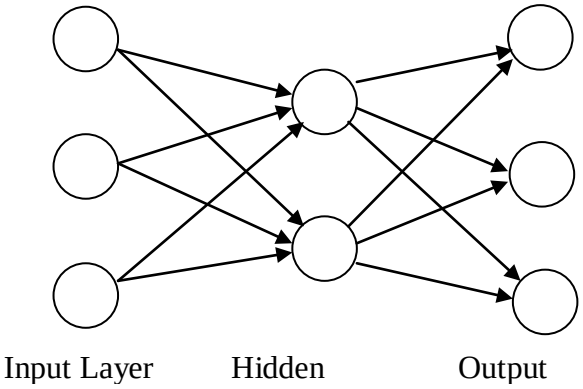

Figure 2 : Feed forward neural network

Each layer has incoming and outgoing connections. Based on the total effect of all the input signals to a neuron, it can pass the signal to its nearest neuron. In natural brain neural network signals are of biochemical electrical signals whereas in artificial neural network signals are described as weight sum of real value. Each arc is assigned a specific weight. If sum satisfies the expected threshold value it is referred to as activated neuron.

Following figure shows[12] the working mechanism of a single neuron.

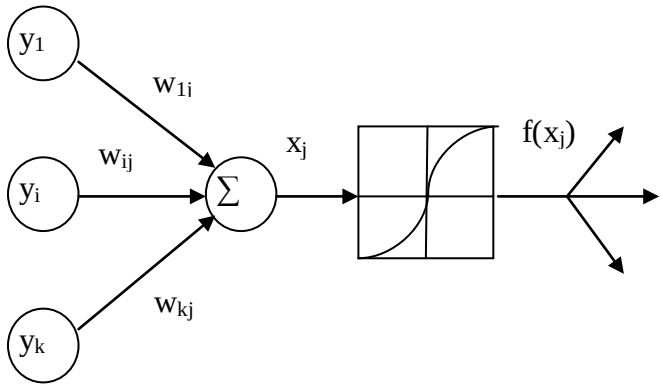

Figure 3 : Single neuron functionality

A neuron takes input from other neurons with different weights and summation is performed to calculate cumulative effect of its input using $x_j = \sum w_{ij}\ y_i$. Then using a suitable nonlinear function $f(x_j)$ is calculated and forwarded to the next layer of neural network. The threshold value of a neuron determines the activation of a neuron that means whether the value is accepted or rejected based on threshold value. During neural network processing this threshold value might be changed to achieve the desired performance.

III. Existing Phonetic Algorithms

Number of phonetic algorithms to determine similar pronunciation is developed. Some of the widely used popular algorithms are listed below.

Soundex

The soundex algorithm is one of the oldest algorithm and was developed by Robert C. Russell and Margaret K. Odell in 1918[2]. The soundex algorithm returns a four character encoded string for the given word. The first character in output is the starting alphabet of the given input word and remaining three characters are digits representing the phonetic string.

Daitch-mokotoff soundex

A variation of original soundex is D-M soundex which was designed in 1985 by Gary mokotoff and later improved by Randy Daitch to match surnames of Slavic and German languages and returns the six digit numeric code for the given word[1,5].

Kolner phonetic

This algorithm works similar to soundex algorithm but was designed for German words instead of English words[1].

Metaphone, Double metaphone and Metaphone 3

Initially metaphone algorithm was developed by Lawrence Phillips in 1990 which returns three characters encoded string. Later variation of metaphone by him was the double metaphone supporting other languages too. In 2009 he released the third version of metaphone which achieves accuracy up to 99% of English words. Thus metaphone algorithms family is suitable for most of the English words and forms the basis for many English spell checkers and dictionaries.

NYSIIS

New York state Identification and Intelligence System also known as NYSIIS phonetic algorithms developed in 1970 which has achieved improved accuracy over soundex algorithm.

Match Rating Approach

The match rating Approach MRA is a phonetic algorithm based on the distance among words developed by Western Airlines in 1977 for indexing and comparing homophonous names[1].

Caverphone

The Caverphone phonetic algorithm was developed in 2002 by David Hood at the University of Otago in New Zealand and later revised in 2004 and was created for data matching between late 19th century and early 20th century electoral rolls to commonly recognize the names[1].

By studying various above algorithms researcher has developed a new algorithm[4]. The algorithm takes an English word as input text and produces the output text based on the pronunciation of the word. The output pattern is somehow similar to which of metaphone algorithm.

These algorithms can be used for spell checkers and spell generators which are phonetically nearer to the given misspelled English words. But no single algorithm produces the desired output. For some set of words one algorithm is better while for other set of words another algorithm proves better. So here an effort is being made to obtained the combined effect of multiple algorithms in form of neural network that proves better performance over any individual algorithm.

Here three algorithms soundex, metaphone and user developed algorithms are used to form a neural network and implemented it in Java programming language to test the approach.

IV. Integration of Artificial Neural Network With Phonetic Algorithms

A neural network of phonetic algorithms can be formed to realize the effect in spell checking. Instead of using single phonetic algorithm if more than one algorithm are used to determine phonetic similarity the result is more accurate. Neural network can be constructed where input layer received an input word that may be correct or misspelled. This input word is passed to different neurons with some initial weight which represent processing of different algorithms. Here we will use three different algorithms as three neurons. Each algorithm will produce set of similar pronunciation words. Here we can have number of alternatives as to select which words as output from different algorithms. Weight can be calculated based on the performance of each algorithm that can identify two similar pronunciation words from given set of homophone words. The simplest solution is to take boolean AND operation for which if the word matches with the given word using more than one algorithm and so the word in current context is the candidate word for the output word in output layer.

V. Neural Network For Spell Corrector and Spell Generator

Neural network approach can be integrated with phonetic algorithms to determine correct spelling or generating similar pronunciation word as depicted in following diagram.

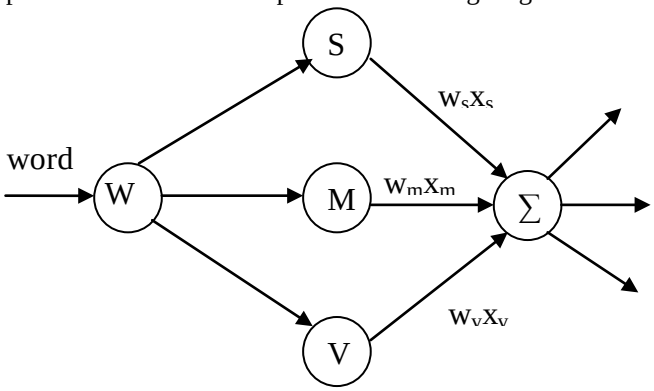

Figure 4 : Neural network of phonetic algorithms

The neural network represented consists three layers. Input layer takes an input English word. This word is passed to hidden layer consisting of three neurons namely S representing soundex, M representing metaphone and V representing user's developed algorithm to determine phonetic similarity. Initially weights can be set equally or based on the experimented set of data. The outcome of these neurons are sent to output layer which is responsible for displaying a set of words based on cumulative effect of three algorithms. Thus it is possible to correct or generate a set of words which are phonetically nearer to the given word. So the input to the neural network is just a single

word but the output may be a single word, set of words or no word mean empty output.

VI. Neural Network Working Mechanism

Input layer takes an English word as input may be correct or misspelled.

This word passes through all the three neurons representing separate processing by different algorithms.

A dictionary of the English word is required to find similar words. First word is fetched from dictionary and compared with input word by all three neurons at hidden layer representing different algorithms. The result is passed to the output layer neuron.

The output layer is responsible to select or reject the current word. One solution is if the current word of the dictionary matches with input word by all the algortihms then this word must be select as an outcome. But here not only the criteria of all three algortihms is taken but if word is passed from either two neurons is also accepted. Separate weight can also be incorporated.

Then second word is taken from the dictionary and the process is repeated for all the words in dictionary of merely english words without meaning for the efficient performance.

At last output layer neuron displays all the suggestive English words which are generated from three different algorithms as output.

The output layer neuron $\sum$ calcuates summation of all three input layers. If it reaches at thresold value that may be 2 or 3 the word is selected as output otherwise it is rejected. For this the output of hidden layer neurons must be 1 or 0 with constant weight. If match found then it is 1 otherwise it is 0. If weights are taken in calculation then based on the experimental data, for each algorithm separate weight is calculated and it shold be multiplied with 1 or 0 depending on the matching and passed over to the output layer.

Thus the proposed neural network consisting of massive processing of textual comparison proves better performance compared to performing the same task using any individual algorithm.

Testing and Experimenting Using Sample Data

Following table represents the test experiments performed on sample data set. Here the effort is to output as many English word suggestions which are phonetically nearer to given input English word.

Table 1

Testing and Evaluation of model with sample data set			
Sr. No.	***English Input Word***	***Generated Output***	
1.	Wather	WEATHER	WETHER
		WITHER	WUTHER
2.	Marning	MORNING	MORNING(A)
		MOURNING	
3.	Paralal	PARALLEL	
4.	Intrnet	INTERNET	
5.	Simbol	SYMBOL	
6.	Langage	LANGUAGE	LINKAGE
		LONG-AGO	
7.	Exparimant	EXPERIMENT	
8.	Friquansy	FOREIGNNESS	
		FREQUENCY	
9.	Quoliti	QUALITY	QUILLET
		QUELLED	QUILT
10.	Compilation	COMPELLATION	COMPILATION
		COMPLETION	COMPULSION
11.	DISCRIT	DISCORD	DISCREET
		DISCRETE	
12.	Auspisius	ASEPSIS	AUSPICES
		AUSPICIOUS	
13.	Mixure	MIXER	
14.	Nervas	NERVES	NERVOS
		NERVOUS	
15.	Acsidant	ACCIDENT	
16.	Accomodat	ACCOMMODATE	
17.	Adventurous	ADVENTURES	ADVENTUROUS
		ADVENTURESS	
18.	Advice	ADVICE	ADVISE
		ADVISEE	
19.	Bordcast	BROADCAST	
20.	Bisnes	BASENESS	BUSINESS
		BUSYNESS	
21.	Correspondans	CORRESPONDANCE	
22.	DEOXIDYZASION	DEOXIDIZATION	
23.	Disipline	DISCIPLINE	
24.	Raciprocal	RECIPROCAL	RECIPROCALLY
25.	Program	PARAGRAM	PROGRAM
		PROGRAMMA	PROGRAMME

Table – 1 (Sample Data Test)

VII. Conclusion

From the testing result of table – 1, the model gives some reasonable result for sample data set of English words. Implementation of the neural network model requires massive text data processing. Performance can be improved by incorporating other phonetic algorithms with the cost of

increased processing. Optimization can be applied over such text processing of accessing dictionary. If the core dictionary of English words changes, it reflects to processing also. The model described here is the idea to combine neural network with phonetic algorithm but require improvement for better performance. Neural network require much processing similar to mind but today we have more powerful computers that are able to mirror the processing of mind. Further, the neural network can be trained by experimenting on more data reflecting the weight of joining arcs. Further here entire processing is performed on word by word bases but it can be processed character by character requires more efforts. Intelligent dictionary can also be built with improved neuron architecture.

REFERENCES

[1] Phonetic Comparison Algorithms By BRETT KESSLER Washington University in St. Louis Volume 103:2 (2005) 243–260

[2] Analysis and Comparative Study on Phonetic Matching Techniques, Rima Shah, Dheeraj Kumar Singh, IJCA Volume 87 – No.9, February 2014

[3] Name and address matching strategy – White Paper December 2010

[4] Vimal P Parmar and C K Kumbharana. Article: Study Existing Various Phonetic Algorithms and Designing and Development of a working model for the New Developed Algorithm and Comparison by implementing it with Existing Algorithm(s). International Journal of Computer Applications 98(19):45-49, July 2014

[5] Vimal P Parmar , C K Kumbharana and Apurva K Pandya - Determining the Character Replacement Rules and Implementing Them for Phonetic Identification of Given Words to Identify Similar Pronunciation Words. Futuristic Trends on Computation Analysis and Knowledge Management (ABLAZE) 2015 International Conference at Greater Noida, India Pages : 272-277 Print ISBN : 978-1-4799-8432-9 DOI : 10.1109/ABLAZE.2015.7155010

[6] http://www.massey.ac.nz/~wwpapajl/evolution/assign2/BC/ANN.htm

[7] http://www.ent.mrt.ac.lk/~ekulasek/ami/PartA.pdf

[8] http://www.theprojectspot.com/tutorial-post/introduction-to-artificial-neural-networks-part-1/7

[9] Multi layer neural network and soundex algorithms fortext recognition model. - Mandeep Kaur, Sheetal Mahajan

[10] Neural Network recognition of spelling errors. Mark Lewellen Computational Linguistics Georgetown university WashingtonDC 20057 0 105

[11] Basics of Artificial Neural Network - Sakshi Kohli, Surbhi Miglani, Rahul Rapariya IJCSMC, Vol. 3, Issue. 9, September 2014, pg.745 – 751

[12] Artificial neural network and its application Girishkumar Jha I.A.R.I. New Delhi.

[13] A neural network based solution for automatic typing errors correction. Article in Neural Computing and Applications • September 2011 Impact Factor: 1.76 • DOI: 10.1007/s00521-010-0492-3 • Source: DBLP

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