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Digital poetry production using neural networks

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Abstract
intelligence has influenced on everything and faced the social reaction with the modern phenomena. Function of artificial intelligence in human life is increasingly developing in a range of industrial and medical technologies to communicational networks, human sciences and even art. Digital poetry genre along with the digital art has found its fans a few years and its different branches are appearing. Performance of poem in the digital environment and use of software facilities for producing the aesthetics in the language are of achievements of this genre. In this paper, using the neural networks and genetic algorithm, we have designed an artificial poet who enables to compose the Persian harmonic and classic poetry with the extraction of words from the database. Hence, we first make a database from words and extract them by designing a program, then we produce the rhythmic hemistich and rhymed verses by using the genetic algorithm, then we classify our poetic products in the varied rhythms using the neural networks.

Keywords
Artificial Poet, Digital poetry, Genetic Algorithm, Neural Networks.

1. Introduction

A Digital poetry is increasingly developing as a modern approach and a modern artistic genre along with the technical developments. In this type of poetry, poet is programmed who generates a poem by integration of machine and human language. This genre has attained to a considerable development in the recent years at the same time with the issues posed in the Computational Linguistics. Computational linguistics is of interdisciplinary sciences in which it is focused on the machine modeling of natural language. Artificial intelligence is further appeared in the digital poem by processing the natural language and it is started a new discourse in the text. In the programming of this unusual type of poetry, it is used the varied algorithm in the textual game. This algorithms integrate strategy of search in the artificial intelligence by post-modern philosophical theories and post-constructional and create a new aesthetics in the art philosophy. In this paper, constructing a database of words as well as using a synthetic method of genetic algorithm and artificial neural networks which both are of the most effective tools and machine learning algorithms, we design an artificial poet who automatically composes a poem. Generation of automatic poetry has been already regarded by those are interested in the digital poetry and researchers of artificial intelligence. Researches which have conducted in this field are: Abdali Carry out solutions in the generation of poetry in Persian and English language [1]. Also, S. Hassan(2016) uses a learning technique for generation of Bangla Poetry [10]. Diaz-Agudo(2002), Erica Greene (2010)and Hisar Manurung(2003) points out methods to poetry generation[3], [4], [6]. Zhe Wangy(2016) will be focused on the examination of a solution for the generation of poetry in Chinese language using the neural networks[11]. Fam Rashel(2013) is focused on the generation of poetry of Bahasa Indonesia[5]. Also Miroslava Hroncová (2015) is examined the ways of artificial intelligence in the generation of Haiku [7]. Ruli Manurunga (2012) is presented a method using genetic algorithm for producing significant poetic texts. Similarly, Sarjoun Doumit(2013) and David M. Kaplan (2007) is presented the methods in the computational models and the ways of thinking in the poem and prose[2], [8], [9]. In most of these methods are generated the texts close to the poetry in the different languages and on its special grammar that are dependent on only either internal music or grammatical techniques. In this paper, using artificial intelligence techniques, we have designed an artificial poet who composes rhythmic poetry in Persian language just as poems are generated by the human poets. Due to difficulties and fundamental differences of Persian poem from English and others languages; we have presented a method based on a combined method using genetic algorithms and neural networks which can generate rhythmic Persian poetry. Accordingly, in section II we generate a database of words and a string of words using a program, then, in section III by genetic algorithm, we turn a series of words using learning strength and optimization of genetic algorithm into a rhythmic hemistich. Then, in section IV we design a pattern recognition by neural networks in order to classify hemistiches generated by genetic algorithms.

2. Formation of Database from Words

Classical Persian poem follows special rhythms which are based on setting long and short syllables beside each other in particular rhythms. Each word in Persian language has given number of syllables. For designing artificial poet in Persian language, we stored words with their syllables in the form of a matrix in a database.

2.1 Matrix of Words

For normalizing words, long syllables are represented and stored with 1 and short syllables with zero. In this way, any word on the long and short syllables turns into a string of 0 and 1. For producing rhythmic meaningful poems like poetry of a human poet, we classified the words based on their grammatical role such as adverb, verb, subject, object, noun and pronoun etc. from one side, for establishing rhythmical poems with rhyme; one should carry out a classification of words based on rhyme. As in Persian poem classical meters, number of syllables of hemistiches are equal. For complying with hemistich meter, we should store the information on numbers of syllables of each world in database. For doing so, we designed a three dimensional matrix in which m, n, L stand for a feature of stored word. In m dimensions, words with the same rhyme are set, and in dimension n words based on numbers of their syllables are placed, so that words with one syllable are set in row n1 and those with two syllables in row n2 etc. in L dimension words are stored based on their grammatical role so that L1 is subject, L2 verbs, L3pronouns, L4 adverb, L5 objects, L6 infinitive, L7 preposition etc. This kind of classification causes that the practice of extracting words from database is carried out properly and in making a poem, the required grammatical structures for the hemistiches being meaningful in produced poem is taken into account. From other side, number of syllables also is not less or more than certain limit and the produced verses would be of the same rhymes.

2.2 Extraction of Words

Before production of a metered poem, we should extract the words from database and by setting a string along each other, we should make some prose so that the words with the same rhyme comes at the end of string for both produced strings. For doing so, we have written a program with several (Loop For) which in addition to setting words with the same rhyme at the end of both produced string, it sets the words so that the number of syllables of total string is equal to number of syllables of one of desired meters of Persian classical poem which we want produce the poem based on that meter. However, as the grammatical structure is given in matrix of word storage, we write the program so that each string enjoys the minimum grammatical structure including verb, subject and objects and so on and wouldn't be afflicted in repetition loop. However, as in Persian classical poem, the order of placement of words is not important, poet can change the common grammatical structure for granting harmony to the poem and aesthetic creation, so we used this benefit in programming and we changed the arrangement of words in produced strings given the meter limitations. To this point, we managed to produce the strings with words which are equal in length in terms of number of syllables so that they are rhymed two by two. For rendering this string of words to harmonic poems, we use techniques of artificial intelligence which is discussed in the following.

3. Generation of Rhythmic Poem Using Genetic Algorithm

Genetic algorithm is one of the most effective methods for machine learning and optimization of problems. In this stage, chromosomes which form the initial population of our problem are same rhyme strings of equal lengths in the prior section that we intend to turn them into a classic rhythmic poem by genetic algorithm which has a special order in the long and short syllables.

3.1 Encoding

There are the different encoding methods due to the structure of problem. In this study, we apply binary coding. In this way of encoding, on the Figure 1, every chromosome is involved a strings of bits of 1 and 0. In this problem, we indicate long syllables by 1 and short syllables by 0.

3.2 Evaluation of Fitness

Producing the chromosomes, Fitness of subsets generated is evaluated by chromosomes so that larger the accuracy of classification of that chromosomes and lower the difference of the chromosome in terms of arrangement of 0 and 1 indicating long and short syllables from current and standard rhythms of Persian poem, the higher-quality has that chromosome. Error related to the generated solution by ith chromosome according to relations (1) , (2).

$$Cost_i = Error_i^{\varphi 1} * Num_i^{\varphi 2} \quad (1)$$

$$Error_i = 1 - Accuracy_i \quad (2)$$

Whereas, $\mathrm{Cost_i}$is an amount of error of ith chromosome. $\mathrm{Error_i}$is an amount of classified error and $\mathrm{Num_i}$ is a number of features related to the corresponding solution of ith chromosome.

0	1	1	0	0	1	0	1	1	0	1

Fig. 1.Binary coding of one chromosome from initial population

3.3 Selection Operator

In this stage, the best chromosomes are selected as parents for generating the next generation. The most current method for selection of parents is to use Roulette Wheel model. In this model, the probability of selection of each chromosome is directly proportional to the amount of fitness. Elitism selection model is same of Roulette Wheel expect that, in this model, contribution of any member of population is related to the exponent of fitness of that chromosome. Larger the exponents from 1 are selected the more fitness chromosomes. In this research, it has used elitism selection model. Similarly, it is always added a fixed solution to the parents which it is, in fact, same reply of innovative algorithm in the optimal situation.

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3.4 Crossover Operator

The most important operator in the genetic algorithm is Crossover Operator. Crossover is a process in which old generation is combined together to generate a new generation of chromosomes in the hope that a new generation is improved than the old. Crossover operator operates with the probability P_c on the parent chromosomes. It means that P_c % of next generation is generated by combination of parents; e.g., if population of chromosomes is 50 and P_c is 90%, 45 chromosomes are generated by combination of parents and 5 better chromosomes are just also transformed into the next generation. In this study, it has been applied a dispersed (integrated) combination. In this method, each of gene of the chromosome for child is randomly and separately selected by one of the parents. This method has been indicated in Figure 2.

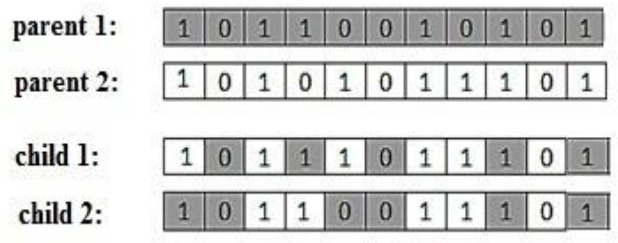

Fig. 2. Dispersed combination operator

3.5 Mutation Operator

Mutation operation is so that some of genes involved in the child chromosome randomly change. Mutation operation is conducted by probability of mutation (P_m) on every gene. In this study, it has been used the Binary Mutation for this problem according to Figure 3. Figure after mutation is one of the current rhythms from right to left (as form of writing and reading in Persian) on which Persian poetry is composed. Here, and in this part, the mutation has occurred on a word of the single-syllable, it may be sometimes optimized our chromosome and harmonized our hemistich by change of a word and replacement of a word with the other short and long syllables. If we can't obtain such a pattern after mutation, so we continue it by repetition of this method and replacement to achieve to the relevant optimization, e.g., generation of rhythmic hemistiches.

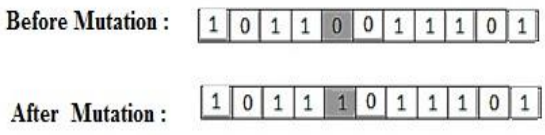

Fig. 3.Binary Mutation Operator

3.6 Replacement

In any stage of genetic algorithm, if algorithm wasn't stopped because of being optimal, children along with the best parents of previous generation is replaced in the new generation after operating the combination and mutation in order to be used as the new generation in the next repetition.

4. Classification Of Harmonic Verses Produced By Neural Network

As the common meters in Persian classical poem are diverse, produced verses (each verse includes two hemistiches with the same rhyme) from fitness function of separate genetic algorithms (for producing poem in various meters, we implement for each meter a separated genetic algorithm according previous part and fitness function of each genetic algorithm is considered as appropriate with a certain meter) can be classified by pattern recognition. Therefore we can have poems automatically in various rhythms. For this purpose, we use multilayer perceptron (MLP) for classification.

4.1 Adjusting The Network

For determining the efficiency of pattern recognition approaches one should single out some of final features obtained from implementation of each algorithm and accuracy of classification as their criteria of evaluation. For this purpose, we use MLP neural network with two hidden layers before pattern identification as well as on features set obtained by each algorithm. MLP neural network, there is input layer, output layer, and one or more hidden layers and in this structure, all of neurons of layer are joined up directly to all of neurons of subsequent layer and for this reason, this structure is named as a network with full connections. Number of nodes of input layer is equal to number of features of each pattern, and number of neurons of output layer is equal with number of possible modes for output (number of classes). Number of hidden layers and number of neurons of hidden layer(s) are adjusted by designer. We assign 5 to number of our hidden layers in this network and we train the network by giving inputs and outputs. Each connection between neurons has a weight, therefore, output of each neuron is considered by a weight factor in the form of input for neuron of subsequent layer. Sum of input signals of each neuron after passing from a transfer function produces the neuron output. Various transfer functions are suggested for producing output of neurons based on sum of input signals in MLP network, in this paper, according to relation (3), one uses Tangent hyperbolic transfer function.

$$tanh(x) = \frac{1-e^{-2x}}{1+e^{-2x}} \quad (3)$$

4.2 Training The Network by Error Back Propagation Algorithm

For training the weights of MLP neural network one uses error back propagation algorithm. Error back propagation algorithm is widely used approach of supervisor training based on gradient reduction. In this algorithm, firstly, primary parameters of network are selected randomly. In each step, output of network is calculated and the weight is improved according to direction and value of error slope, so that finally this error would be minimized. In error back propagation algorithm based on gradient reduction, it is attempted to attain network optimal weights with movement in the opposite direction of error diagram slope based on weights of network, so that in each repetition, magnitude of error would be smaller than previous repetition. This diagram

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is obtained through chain derivation from error function with respect to each one of weights of network. The major snag of this algorithm is moving on the error diagram path. In error back propagation algorithm, if the learning coefficient is considered small, definitively it would approach to closest relative optimum, yet the algorithm would be stuck in local minimum, while if the great learning coefficient is assumed, it is able to pass from local minimums and causes relative increase of convergence speed, yet when it finds the local minimum proximity, it oscillates around it and in fact it fails to reach the general optimum value. This shows that error back propagation algorithm hinges substantially on changes of learning coefficient. A solution for improving above problem is selection of value of variable based on repetition of algorithm for learning coefficient. Minimum value considered for η, is 0.001 and maximum value is 0.1. According to mentioned discussions, the value of η is obtained with relation (4).

$$\eta = (\eta_{min} - \eta_{max}) * \frac{Iter_{\text{current}}}{Iter_{max}} + \eta_{max} \qquad (4)$$

for improving the weights of network based on gradient approach, firstly, using chain derivation, slope of error with respect to each weight is calculated, and at its opposite direction, a small change appropriate with learning rate value in weights are made. Degree of change in each parameter of network is calculated according to relation (5).

$$\Delta W_{ji} = -\eta \frac{\partial E}{\partial w_i} \qquad (5)$$

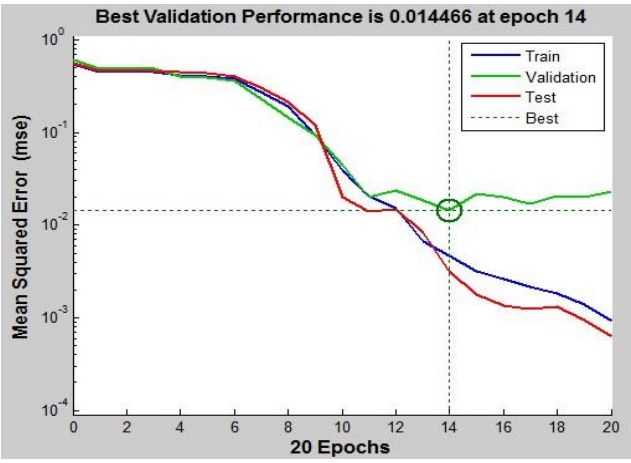

Fig. 4. Performance of neural network

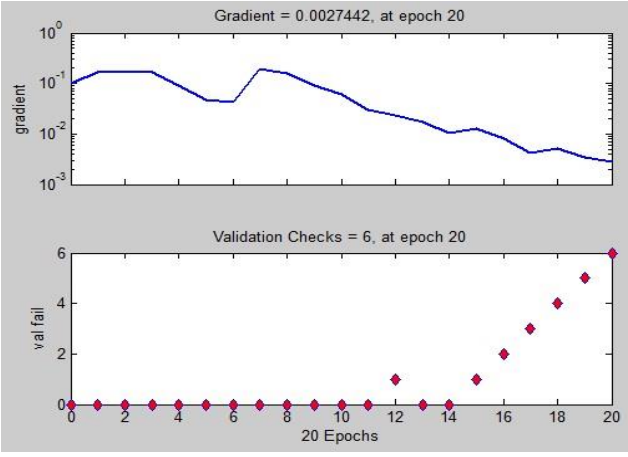

Fig. 5. Training State

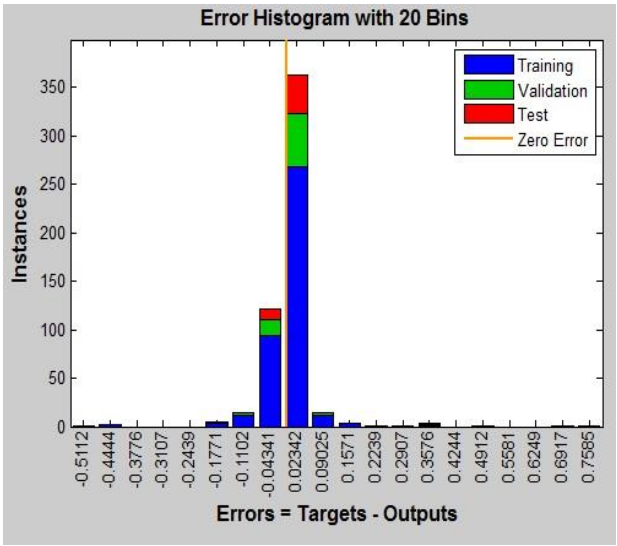

Fig. 6. Error Histogram

4.3 Results Of Simulation

Performance of neural network has been indicated in Figure 4, best validation performance is 0.014466 at epoch 14. Training state has been indicated in Figure 5 and error histogram has been indicated in Figure 6.

5. Conclusion

In this project, the poetry is generated using a synthetic method of genetic algorithm and neural networks and game in language is expanded using digital equipment. The use of artificial intelligence algorithms to generate poetry causes opening up new horizons in aesthetics. What made generating poetries of the artificial poet as a non-human author special is the text being generation by artificial mind that is void of history, memory, and also human experience. Then it encounters a difficulty to criticize generating poem psychologically. What is not doubtful is that we should be an eye witness to the beautiful and interesting display by entry of computational linguistics and artificial intelligence in the generation of poetry that this category can play a role in philosophy and literature.

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