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Neural Network-Based Methods in Information Retrieval

Vahideh Reshadat
Department of Computer, Shabestar Branch
Islamic Azad University, Shabestar, Iran
E-mail: v_reshadat@yahoo.com

Mohammad-Reza Feizi-Derakhshi
Department of Computer, University of Tabriz, Tabriz, Iran
E-mail: mfeizi@tabrizu.ac.ir

Abstract

Information retrieval is a wide research area mainly in the World Wide Web. Existing of so many text pages in the World Wide Web cause results which search engines provide, contain a lot of irrelevant information. Consequently, finding the information which user needs has become difficult and complicated and proper retrieval of information has become more important. Facing with these challenges, using of new techniques such as artificial neural networks can be a suitable method to solve these problems. Several kind of neural networks such as Kohonen's Self-Organizing Map, Hopfield net, etc. have been applied to information retrieval models. In this paper we will investigate the possibility of using neural networks in information retrieval and explore the advantages of applying several neural networks models for solving different problems existing in the information retrieval field.

Keywords: Information Retrieval, Neural Network, Kohonen's Self-Organizing Map, Hopfield Net, Multi-Layer Perceptron, Semantic Net

1. Introduction

Information retrieval is a wide research area mainly on the Internet. It is concerned with the analysis, representation and retrieval of texts. With an increasing amount of information available, users find it difficult to obtain the most relevant Web pages from the large number returned by search engines. As the amount of documents become more and more higher, the chance to find the proper information is more and more lower. Therefore, retrieving the proper information in little time is a necessity. The Internet requires new techniques, or extensions to existing methods, to address gathering information, making index structures scalable and efficiently updateable. Therefore it can improve the ability of search engines to discriminate useful from useless information. In recent years researchers have explored many different directions trying to use results achieved in other areas, like Artificial Intelligence, Neural Networks, and expert systems. One alternative architecture for information retrieval involves the use of a neural network. Neural networks in particular seem to have the properties needed for more intelligent information retrieval.

Neural network is one of the important components in Artificial Intelligence (AI). It has been studied for many years in the hope of achieving human-like performance in many fields, such as

classification, clustering, and pattern recognition, speech and image recognition as well as information retrieval by modeling the human neural system.

Neural networks are well suited for information retrieval from large text to multimedia databases. They have been widely used in the area of information retrieval and text mining, such as text classification, text clustering, and collaborative filtering. In recent years, with the fast growth of the World Wide Web and the Internet, these algorithms have also been used in Web-related applications such as Web searching, Web page clustering, Web mining, etc. Their capacity for tolerant and intuitive processing offers new perspectives in information retrieval [3].

This is a review on neural networks and related algorithms and their application in information retrieval. It is aimed to describe the possible applications of some neural networks models for solving different problems existing in information retrieval systems. The rest of this paper is organized as follows. In Section 2, applications of some neural network models and related algorithms in information retrieval systems are investigated. A comparison of various similarity computation methods is discussed and finally the paper is concluded with a summary of the discussed issues in section 3.

2. Neural Network and Information Retrieval

With the exponential growth in the number of Web pages, information retrieval becomes more difficult for users. World Wide Web faces with new challenges and current information retrieval system based on search engines and keywords, does not sufficiently take into account users' needs. Therefore search engines use several ways to improve retrieval performance. There are some neural-based approaches for improving the performance of information retrieval systems. In this section, we will study the applications of some neural network models (i.e., SOFM and Hopfield network) and related algorithms in the information retrieval systems.

2.1. Application of Self-Organizing Feature Maps (SOFM)

A self-organizing map (SOM) or self-organizing feature map (SOFM) is a type of artificial neural network that is trained using unsupervised learning to produce a low-dimensional (typically two-dimensional), discretized representation of the input space of the training samples, called a map. Self-organizing maps are different from other artificial neural networks in the sense that they use a neighborhood function to preserve the topological properties of the input space. Kohonen's self-organizing maps consist of one layer of neurons organized in one, two and multi-dimensional arrays. Each neuron has as many input connections as there are number of attributes to be used in the classification. The training procedure consists of finding the neuron with weights closest to the input data vector and declaring that neuron as the winning neuron. It selects the unit whose connection weight vector is closest to the current input vector as the winning unit. Then the weights of all of the neurons in the vicinity of the winning neuron are adjusted, by an amount inversely proportional to the distance. The radius of the accepted vicinity is reduced as the iteration numbers increase. The training process is terminated if a prescribed number of iterations are reached [26].

With the increase of the volume of information, the deficiency of traditional algorithms for fast information retrieval becomes more clear. When large amount of data are to be handled, the use of a neural network as an Artificial Intelligent technique is a suitable method to increase information retrieval speed. For solving these shortages, Use of SOM neural network for data clustering is shown in [19]. A model of SOM neural network for a sample information retrieval from INIS database was implemented. The results were promising.

Most of the applications of SOFM in information retrieval systems are base on the fact that SOFM is a topographic map and can do mappings from a multidimensional space to a two- or three-dimensional space. Kohonen [16] has shown that his self-organizing feature map "is able to represent rather complicated hierarchical relations of high-dimensional space in a two-dimensional display". He

gives two examples related to information retrieval. In the first example, he uses his feature map and a conventional hierarchical clustering analysis to process some artificial data that can be viewed as a matrix of 32 documents and 5 indexing terms. Both methods resulted in similar minimal spanning trees that maintained the same topological relationships between neighbors. In his second example, he showed that the self-organizing mapping could also display, two dimensionally, topological and similarity relations between phonemes from continuous speech. He had concluded that "the self-organized mappings might be used to visualize topologies and hierarchical structures of high-dimensional pattern spaces". Document space is certainly such a high-dimensional space.

Hatano and his colleagues [11] have proposed an information organizer for effective clustering and similarity-based retrieval of text and video data using Kohonen's self-organizing map. In their model, a vector space model and DCT (Discrete Cosine Transform) image coding is used to extract characteristics of data and SOFM is used to cluster data. There are two notable feature of this organizer: content-based clustering by SOFM and retrieval and navigation on 3D overview map. A comparison between the word-frequency based algorithms of SOFM and algorithms based on Salton's measurement shows the former seems to be more suitable to cluster documents and to generate a global overview map while the latter seems to be more effective to perceive each document's distinction which is useful to information retrieval.

2.1. Application of Hopfield Net

A network in which every unit is connected to every other unit and the connections are symmetric, is called a Hopfield network. The way in which the Hopfield network is used is as follows. A pattern is entered in the network by setting all nodes to a specific value, or by setting only part of the nodes. The network is then subject to a number of iterations using asynchronous or synchronous updating. This is stopped after a while. The network neurons are then read out to see which pattern is in the network.

Hopfield net was introduced as a neural net that can be used as a content addressable memory. Knowledge and information can be stored in single-layered interconnected neurons (nodes) and weighted synapses (links) can be retrieved based on the network's parallel relaxation method. It had been used for various classification tasks and global optimization.

In Chung and her colleagues' study [7] the Hopfield network has been adapted for the special needs of information retrieval. The network is an asymmetric, continuous network in which the neurons are updated synchronously. The major steps of the algorithm are:

1) Assigning synapic weights: The Concept space generated by similarity analysis serves as a trained network in the system. The concepts in the Concept space represent nodes in the network and the similarities, computed based on co-occurrence analysis, represent synapic weights between nodes (concepts).
2) Initialization: An initial set of concept (noun phrases) extracted from a document serves as the input pattern.
3) Activation: Nodes in the concept space Hopfield net are activated in parallel, and activated values from neighboring nodes are combined for each individual node.
4) Convergence: The above process is repeated until the network reaches a stable state, i.e., there is no significant change in the value of the output states between two time steps.

A variant of Hopfield network is developed by Chen and his colleagues [5] to create a network of related keywords. It uses an asymmetric similarity function to produce thesauri (or knowledge bases) for different domain-specific databases. These automatic thesauri are then integrated with some existing manually created thesauri for assisting concept exploration and query refinement. In addition, a variant of the Hopfield parallel relaxation procedure for network search and concept clustering is also implemented by Chen [4].

Since different users tend to use diverse terms to seek identical information (polysemy). Because of these discrepancies, an exact match between user's terms and an indexer's terms is unlikely, resulting in poor document recall and precision. One way to overcome vocabulary problem is to index documents semantically and permitting users to search by concept meanings as opposed to

keywords. In order to this, Chen and his colleagues [6] presented another framework for semantic indexing in a large-scale knowledge network using a Hopfield net. Using initial keywords generated by the automatic indexing program for a given document, the Hopfield net for concept exploration can improve the quality of machine information processing and substantially enrich an indexing vocabulary, thereby representing the knowledge incorporated in a database more accurately. The results indicate that using a Hopfield net to automatically traverse over direct thesaurus in parallel is an improvement over direct thesaurus checking for semantic indexing. Another series of benchmark tests was performed to determine the effectiveness of various filtering techniques in reducing the negative impact of noisy input terms. Experiments confirmed that Hopfield net algorithm is potentially useful as an association memory technique to improve document recall and precision by solving discrepancies between indexer vocabulary and end-user vocabularies.

The Hopfield net parallel relaxation procedure which is developed by Chen is shown in fig.1.

Figure 1: Hopfield net parallel relaxation formulas [6].

$$\mu_i(t) = x_i \quad 0 \le i \le n-1$$

$u_i(t)$ is the output of node i at time t. x_i (which has a value between 0 and 1) indicates the input pattern for node i.

$$\mu_j(t+1) = f_s\left[\sum_{i=0}^{n-1} t_{ij}\mu_i(t)\right] \quad 0 \le j \le n-1$$

Where f_s is the continuous SIGMOID transformation function as shown below:

$$f_s(net_j) = \frac{1}{1+\exp\left[\frac{-(net_j - \theta_j)}{\theta_0}\right]}$$

Where $net_j = \sum_{i=0}^{n-1} t_{ij}\mu_i(t)$, θ_j serves as a threshold or bias, and θ_0 is used to modify the shape of the SIGMOID function.

Based on Chen's proposed model, Sheng and Jiung [24] suggested a new model called LCA-ANN. Local Context Analysis (LCA) is one of the most successful and well established query expansion methods in which the n-top concepts which co-occurrence with more query terms and have higher co-occurrence degree are used as expansion terms. Adding these terms into user's query improve the retrieval results. LCA-ANN model combines the merits of LCA model [14] and Hopfield network. It initializes the network by the calculation of terms in LCA model and expands terms by network activation and convergence. With the heuristic function of Hopfield network, the new model is more precise in query expansion.

Chau and Chen [3] proposed another approach in which the Web is modeled as an asymmetric Hopfield Net. They used the Hopfield net model for the Web and applied its algorithm over the network to search for Web pages that are relevant to a given domain. Each neuron in the network represents a Web page, and the connections between neurons represent the hyperlinks between Web pages. Web content analysis and Web link analysis are also incorporated into the model by adding a page content score function and a link score function into the weights of the neurons and the synapses, respectively. The performance of the system was compared with two other Web search algorithms namely, a breadth-first search and a best-first search using PageRank. The results showed that the proposed model performed more efficiently and effectively in searching for domain-specific Web pages. Authors believe that the model can also be useful in other Web applications such as Web page clustering and search result ranking.

2.2. Multi-Layer Perceptron (MLP) Network and Semantic Network

A typical multi-layer feed forward network consists of a set of sensory units that constitute the input layer, one or more hidden layers of computation nodes, and an output layer of computation nodes. The input signal propagates through the network in a forward direction on a layer-by-layer basis. These neural networks are also commonly referred to as multi-layer perceptrons (MLPs) [12]. A multi-layer perceptron has three distinctive characteristics: 1. The model of each neuron in the network includes a nonlinear activation function. 2. The network contains one or more layers of hidden neurons that are not part of the input or output of the network. 3. The network exhibits a high degree of connectivity, determined by the synapses of the network. Multi-layer feed forward networks are always trained in supervised manner with a highly popular algorithm known as the error back propagation algorithm.

Semantic networks emerged in cognitive psychology during the 1960s and 1970s. They have similar architectures as neural networks and they work in a similar way to neural networks. Semantic networks typically have nodes that represent concepts and connections that represent semantically meaningful associations between these concepts. Thus, they are better characterized as associative network models than as neural/brain models. In semantic networks, the conceptual units represented by nodes are semantic entities (e.g., lamp, attic, liver disease, jaundice), and the relationships represented by connections are semantic associations (e.g., the propositions "location (lamp, attic)" and "causes (liver disease, jaundice)" might each be represented by a link between the appropriate nodes. Semantic networks have been used widely in traditional Artificial Intelligence problem solving systems. Many systems for representing knowledge can be considered semantic networks largely because they feature the notion of an explicit taxonomic hierarchy, a tree or lattice-like structure for categorizing classes of things in the world being represented. There are some kinds of "inheritance" links between the representational objects and these links called "IS-A" have been perhaps the most stable element of semantic nets as they have evolved over the years [13].

2.2.1. Application of Multi Layer Perceptron Networks and Semantic Networks

It is hard to distinguish the applications of MLP and the applications of semantic networks with spreading activation methods in information retrieval. In most cases, the applications of semantic networks in information retrieval are making use of spreading activation models while having a feed-forward network structure similar to that of MLP networks. Spreading activation shows how related nodes can be activated based on an initial excitation of nodes in a weighted or labeled graph.

One of the first tasks in this area was done by Kwok [18]. He represented an information retrieval system into a 3-layer network (queries connected to index terms to documents). He attempted to employ the neural network paradigm to reformulate the probabilistic model of information retrieval with single term as document components. A probabilistic retrieval system is aimed to provide an optimal ranking of a document collection with respect to a query. This is based on a decision function, which maybe a variant of Bayes' Theorem. In this 3-layer network, the discrimination function between neurons is still based on Inverse Document Frequency (IDF), but there are learning algorithms. It is proved that the activation through network can provide much better results than the traditional, document-mode IDF weighting.

Wikinson and Hingston [27] implemented a document retrieval system based on a neural network model. Since neural networks can perform very well at matching a given pattern against a large number of possible templates. They used this organization for selecting relevant documents. There is a 3-layer network in this system. One layer for query terms, one layer for terms in all documents and one layer for all the documents. Based on term frequency and document frequency, query terms activate terms in document and rank the relevant documents. This ranking system includes some advantages. It allows for standard document ranking, as determined by cosine measure. It allows the system to find words that appear to be relevant on the basis of initial ranking, and use those words to refine the document ranking. It was shown that a neural net structure can be used for ranking documents in a flexible fashion that allows for a variety of inputs to influence the final ranking and many of the standard strategies of information retrieval are applicable in a neural network model.

Wong and his colleagues [28] have developed a method for computing term associations using a three-layer feed-forward network with linear threshold functions. Each document is represented as a node in input layer. The nodes in the hidden layer represent query terms and the output layer consists of just one node, which pools the input from all the query terms. Term associations are modeled by weighted links connecting different neurons, and are derived by the perceptron learning algorithm without the need for introducing any ad hoc parameters. The preliminary results indicate the usefulness of neural networks in the design of adaptive information retrieval systems.

In [9] an adaptive clustering technique for information retrieval was suggested. This technique is based on the interaction information retrieval method using neural networks. The complexity of the computations involved is polynomial, hence this method is tractable. Two applications based on the Adaptive Interaction Information Retrieval (AI2R) method were also designed and presented briefly. The results of experiments show that both applications meet very well users' satisfaction. It is proved that retrieval technique based on adaptive clustering using a connectionist approach is useful when retrieving from homogeneous documents, and when emphasis is on high precision.

Another work is done in [20]. It describes the development of the information retrieval system, which retrieves the information from the text documents in Slovak language by neural networks. it comes from the information retrieval system using statistical, conceptual, and linguistic model. This approach shows the possibility to simplify the computational complexity of the information retrieval process for documents by neural networks. The neural network model, based on multilayer perceptron and spreading activation network type, accepts the structure of conceptually and linguistically oriented model, where problems of document database creation and document indexing for keyword determination are solved. Proposed structure of the neural network model solves the problem of the document retrieval on the base of user’s question. However, learning algorithm and neural network invariance, come from utilization of the neural networks, enable the decrease of the computational complexity of the language analysis algorithm.

Since most existing neural network information retrieval systems are based on some type of classical artificial neural network model. There are other variations on the neural network concept that could also be considered. For example, a modern type of neural network, known as a Morphological Neural Network (MNN), differs from most other neural networks in the way computation occurs at the nodes. Morphological neural networks are the lattice algebra-based version of classical artificial neural networks. Just like the classical model, MNNs can be single-layer or multilayer and are capable of solving various types of classification problems [21]. The computation that occurs at each dendrite is based on morphological operations using lattice algebra. In [22] an information retrieval system based on this model was examined. Their goal was to show that these networks have a variety of valuable uses in the information retrieval field by creating a query engine that transforms user queries into an MNN capable of filtering document vectors in a latent semantic space.

The Morphological Neural Network Information Retrieval (MNNIR) Model is built on top of a standard Vector Model design for representing the terms and documents in a collection. In the MNNIR engine the query vector is used to dynamically construct a morphological neural network to rank the documents in the collection. The query network is a single-layer morphological perceptron with a single positive dendrite designed to input a document vector and return a measure of relevance for the examined query. For each non-zero term in the query vector, an excitatory connection is made to the dendrite, and the connection weight is determined by the term weight of the query vector. At query time, a network is constructed from the provided query and each document in the collection is run through the network. Once the relevance scores for the collection have been obtained, the system then ranks the documents in decreasing order of relevance and returns the results to the user. Because of the speed of the morphological neural network, the information retrieval system can quickly and efficiently determine the relevance of the documents and filter out any unwanted parts of the collection. Overall the simple MNNIR system performed very well when compared to the established information retrieval models [22].

The text collections may be very large as the number of textual documents on the web increases rapidly. Furthermore, the execution time of some learning processes can be prohibitive when applying the algorithms to large volumes of textual data generated in real world applications and also the text data can be physically distributed at different sites, which makes some traditional search technologies in a single platform impractical. A new approach is introduced in [29] to cope with these challenges. It is a neural network based metalearning technique to perform parallel text information extraction. Metalearning [2], which is defined as learning from learned knowledge, provides a novel and very promising solution to the mentioned challenges by applying parallel architectures. Different from individual learning method, metalearning technique aims to compute a number of independent information retrieval models by applying some individual learning algorithms to a collection of independent and inherently distributed text collections in a parallel way.

The main motivation of this study was to take full advantage of the inherent parallelism and distributed nature of metalearning and to design a powerful and practical parallel information retrieval system for the large scale text collections. In this method, a triple-phase neural network metalearning technique is proposed to perform parallel textual information retrieval tasks. In the first phase, the massive textual data collections with the terabyte scale are first partitioned into various relatively small textual data subsets. Then these small data subsets are moved to different computational agents. In the second phase, the single neural network model as the intelligent learning agent is applied to the different textual data subsets so as to retrieve some relevant text documents responding to a query. For a given query, the neural network learning agent, which is sufficiently trained by back-propagation learning algorithm on underlying text documents, can produce a relevance score between 0 and 1 for a certain text document. In the third phase, based on the different relevance scores produced by the previous phase, a neural-network-based metamodel by integrating the relevance results is generated to provide a proactive information extraction model that can be used on unseen query to determine the relevance degree between the query and textual documents (out of many candidates). For illustration and testing purposes, a practical web textual information retrieval experiment is performed to verify the effectiveness and efficiency of the proposed neural-network-based metalearning technique [29].

A new method was proposed in [25]. It deals with text document retrieval from the given document collection by using neural networks, namely cascade neural network, linear and nonlinear Hebbian neural networks and linear autoassociative neural network. All of these neural networks can be used not only for the dimension reduction but also for the document clustering. With using neural networks it is possible to reduce the dimension of the document search space with preserving the highest retrieval accuracy. When the number of documents is large, the amount of the data in the text document space can be reduced by various methods. One possibility to reduce the document space is to divide the documents into groups - clusters, with similar documents in each cluster. This method deals with text document space dimension reduction and their clustering by neural networks. This approach uses the VSM matrix. T representation of VSM matrix is done by the spreading activation neural network. The text document retrieval part of system has three main subsystems, and they are the query subsystem, indexing subsystem and the administrator subsystem. The transitions between these subsystems can be replaced by the neural networks, where input of the first neural network represents the user query subsystem and the output of the first neural network represents the indexing subsystem. The output of the first neural network represents also the input to the second neural network (spreading activation neural network). The output of the second neural network represents the relevance of documents (the administrator subsystem). Such a model is called cascade neural network model.

The VSM matrix represented by a spreading activation neural network is too large for large collections, reducing the dimension of the document space can be solved by Latent Semantic Indexing (LSI) model, The main contribution of this work is the analysis and synthesis of described algorithms for dimension reduction and clustering the text documents and for text document retrieval by means of neural networks in comparison with LSI and SVD [25].

2.2.2.1. Relevance Feedback-based Approaches

Relevance Feedback (RF) is a technique that allows a user to express his information requirement in a better way by adapting his original query formulation with further information provided by indicating some relevant documents. When a document is marked as relevant the RF device analyses the document text, picking out terms that are statistically significant to the document, and adds these terms to the query. RF is a very good technique of specifying an information requirement, because it releases the user from the burden of having to think up lots of terms for the query. Instead the user deals with the ideas and concepts contained in the documents [8]. There are some retrieval methods which incorporate Relevance Feedback data into neural network.

In his article, Belew [1] talked about Adaptive Information Retrieval (AIR) which represents a connectionist approach to the task of information retrieval. The system uses relevance feedback from its users to change its representation of authors, index terms and documents so that, over time, it improves at its task. Belew argued that connectionist representations are particularly appropriate for information retrieval for two reasons. First these networks naturally perform a type of spreading activation search that is shown to be a natural extension of techniques used in information retrieval systems. Second, powerful learning algorithms have been developed for connectionist systems that allow these representations to improve over time. This offers the potential of information retrieval systems that automatically modify their indices to improve the probability of relevant retrievals. Generalized representation, generalized retrieval, and generalized input and output are the distinguish features on AIR systems. Strictly speaking, these networks are semantic networks and work in the spreading activation models. This example shows the potential of spreading activation for information retrieval. In theory, because of its inherent associative approach, spreading activation is believed to have the potential to outperform "exact-match" techniques. However, experimental verification and comparative evaluation are still needed. In fact, the comparison done by Salton & Buckley [23] of a spreading activation model and vector processing methods questions this belief. These authors compared four variants of the spreading activation model of Jones & Furnas with four variants of vector processing methods in six different databases. The results indicate that vector processing methods produce better results than the spreading activation methods. Thus, these authors concluded that the simple spreading activation model they considered "may not be sufficiently powerful to produce acceptable retrieval output". Perhaps one insight from Salton & Buckley's comparison is that successful spreading activation may need to be based on a well-learned network. An obvious disadvantage of spreading activation is that control of spreading activation relies on parameter selection [10].

In another work Kwok [17] showed how probabilistic information retrieval based on document components may be implemented as a feedforward (feedbackward) artificial neural network. The network supports adaptation of connection weights as well as the growing of new edges between queries and terms based on user relevance feedback data for training, and it reflects query modification and expansion in information retrieval. A learning rule is applied that can also be viewed as supporting sequential learning using a harmonic sequence learning rate. Experimental results with four standard small collections and a large collection (173,219 documents) show that performance of feedback improves substantially over no feedback, and further gains are obtained when queries are expanded with terms from the feedback documents.

Probabilistic Relevance Feedback (PRF) is one of the most advance techniques for performing RF in operative information retrieval systems. Briefly, the technique consists in adding a few other terms to those already present in the original query. The terms added are chosen by taking the first m terms in a list where all the terms present in relevant documents are ranked according to a weighting function. An approach in [8] presents the results of an experimental investigation into the use of neural networks for implementing Relevance Feedback in an interactive information retrieval system. They investigated the possible use of neural network in designing and implementing Relevance Feedback.

Neural Relevance Feedback (NRF) can be performed using a Relevance Feedback device based upon a neural network. This device learns from training examples to associate new terms to the

original query formulation. The NRF device acts in a way similar to the classical Relevance Feedback. The main difference is that the weights used to order and select the terms are obtained from the output of a 3-layer feedforward neural network trained using the Back Propagation (BP) learning algorithm. Authors used as many input nodes as the terms that can be used to formulate queries, and as many output nodes as terms that can be used to represent all the documents in the collection. Each node in the neural network input layer represents a query term and each node in the output layer represents a document term.

The results of this investigation, demonstrate that a Relevance Feedback device based on neural network (NRF) acts in a similar way to classical information Relevance Feedback techniques. However, a comparison with one of the most advance Relevance Feedback techniques (PRF) shows that for low levels of training, which is the most common case in information retrieval, NRF does not perform as well as PRF [8].

There is considerable interest in bridging the gap between the terminology used in defining queries and the terminology used in representing documents. Some approaches use rules to capture user query concepts. The rules are usually weighted and expressed by AND/OR logical connectives. One difficulty with these approaches is that the resulting performance is quite sensitive to the weight assignments. A neural network model in which the rule weights can be adjusted is developed by users' relevance feedback was suggested by Kim and Raghavan [15]. They suggested a multi-layered perceptron neural network in which a back-propagation learning rule (relevance feedback) was used to adjust the weights of an AND/OR tree which represented query concepts (in the RUBRIC system). He reported on experiments which showed higher performance (in terms of precision and recall) than in the original RUBRIC approach.

3. Discussion

Neural networks have been applied to information retrieval in different manners. Various problems of the text document retrieval can also be solved by neural networks. Generally, we can divide neural networks for text document retrieval into some main approaches based on feed-forward neural networks, Kohonen neural networks and recurrent neural networks (such as Hopfield neural network). Some highlights are summarized as follow:

- Most of the applications of self-organizing feature map in information retrieval systems are base on the fact that it is a topographic map and can do mappings from a multidimensional space to a two- or three- dimensional space. Document space is such a multi-dimensional space.
- Hopfield Network has been used mostly in search and optimization applications. Its convergence property is used to search appropriate nodes from an initial set of nodes that are related to the given nodes. These nodes can be as documents or terms.
- Multi-layer perceptron networks are used for many purposes in information retrieval such as ranking of documents, clustering, etc. Some models utilize back propagation for the match between query and document representation.
- Spreading activation is a method to search associative networks, neural networks, or semantic networks. Spreading activation shows how related nodes can be activated based on an initial excitation of nodes in a weighted or labeled graph such as semantic nets. Spreading activation models are customarily used with nodes for query terms and document nodes to retrieve the most activated documents.
- Some neural networks use statistic information and training data needs to be collected from a large amount of relevance judgments from users. Some of them have been suggested for query optimization and query expansion. They incorporate query expansion methods such as Relevance feedback, Local Context Analysis and etc into information retrieval systems.

All models use specific properties of neural networks to have an information retrieval system with better performance.

4. Conclusion

Researches show that neural network gives encouraging results and can be effectively used in information retrieval at the current state of the neural network technology. These results prove that it may be possible to use neural network in information retrieval for specific tasks. However, the results sometimes show that a neural device is not effective in real world's applications, where it doesn't perform better than traditional techniques. The literature review above shows neural network models have many attractive properties and some of them could be applied into an information system well. It is expected the research on the application of neural network models into information retrieval will grow rapidly in the future along with the development of its technological. However, there are still some unsolved questions and we cannot envision that neural network models will soon replace traditional approaches. However, we believe the application of neural network models can make an information retrieval system more powerful.

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