

MEDICAL IMAGE CLASSIFICATION FOR DISEASE DIAGNOSIS BY DBN METHODS

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ABSTRACT:

A radical deep learning-based feature extraction approach for disease diagnosis is discussed in this paper. This approach focusses on the development of automatic screening system which is capable of diagnosing diseases such as collateral disease, retinal disease, drain, heart diseases etc. Some of these diseases shares common characteristics, which makes their classification difficult. In an effort to subdue the aforementioned problem, DBN (Deep Belief network) in association with a multi class SVM classifier is utilized. The main contribution of this work is the reduction of complexity in the process of finding the significant features and thus reducing its dimensions to classify the nature of the disease. The paper depicts efficient feature extraction methods for diagnosis of retinal diseases.

Key words: DBN, Medical image diagnosis, deep learning.

INTRODUCTION

The retinal images are widely used by manuscripts for analyzing and explaining the nature of DBN. Retinal based diseases are common among all age groups of humans which cause blurred visualization and in some extreme case a complete vision loss explained by Mullins, et al., [2000]. Retina appears to be a thin nerve layer that borders the interior section of the eye and is responsible for sensing light and creating electrical impulses that travel through the optic nerve to the brain. Retina interfaces and maps the real world visual of object to the brain. Its functioning resembles that of a camera. The retina is an essential component of the eye and any disorders tend to be serious and can result even in vision loss. The recognition of an object by retina is as quoted below.

The scattered light reflected by the object enters into the cornea and then retina from where it is send to the brain for converting it into the corresponding chemical as well as electrical signals. Succeeding the conversion, these signals are transported to the different centers. This conversion is achieved with help of rods and cones, which are Photoreceptors present in the retina. A rod being highly sensitive does not possess color perception property. Cones are 6 to 8 million in numbers and can percept colors. There are varieties of ailments affecting retina which includes age related molecular degeneration (AMD), diabetic retinopathy, and macular bunker retinoblastoma, retinal detachment and retinitis pigmentosa. AMD is one of the most common reasons for blindness around the world, which usually emerges with aging. The enigma of blindness due to AMD is hastily growing. This was proposed by Kong et al., [2012]. The root cause of AMD is the Drusen, which is a fatty protein deposited i n

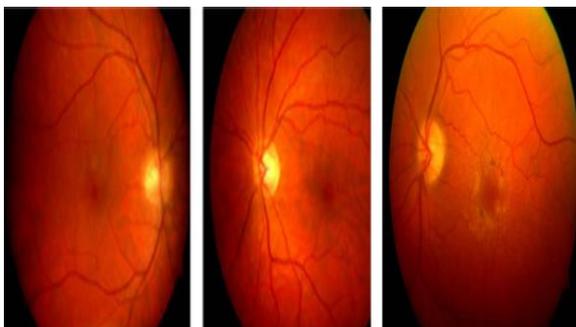
the retina where the light sensitivity tissue is located. The accumulation of Drusen reduces the

sensitivity of light sensitivity tissue resulting in a blockage which increases the risk of visual system which further leads to curtailed sharpness and detailed view. AMD is categorized into Dry macular Degeneration and Wet macular degeneration. Early Detection of these diseases may help to cure it. A diabetic person is prone to diabetic retinopathy. As per survey on people with diabetic retinopathy, it was found that 50 percent of people suffering from diabetics also suffer from diabetic retinopathy. The longer and uncontrolled blood sugar is the main reason for this disease to affect the vision. This was proposed by Gillies et al., [2011]. Diabetic macular edema and proliferative diabetic retinopathy are the main cause of this condition. Diabetic macular edema is a term used to represent the swelling in the central region of retina resulting in the damage of blood vessels which further leads to reduced vision. Diabetics affect the small blood vessels by damaging them and hence resulting in poor blood circulation which ravages the retina tissues. Unlike other tissues, the retinal tissue will not re-grow when damaged. The risk of having diabetic macular edema increases with the time span for which he/she has been suffering from diabetics. The severity varies with the time span for which he suffers from diabetics. Diabetic macular edema results in impaired vision and sometimes complete loss of vision known as proliferative diabetic retinopathy. This was proposed by Faust et al. [2012]. The fine and detailed vision is provided by the functional region of retina - macula or macula lutea. Macula is known as the region of keenest vision and is located in the central region of retina. Gandorfer et al., [2012] explained a macular puc-

ker is a scar tissue formed on the macula, because of the damaged blood vessels as well as obstructed blood flow. The shrinking of this wrinkled tissue causes loss of sharp vision due to macular edema i.e swelling. A form of retinal cancer, usually found in infants is Retinoblastoma. The core factor that leads to this disorder is the mutation resulting from cell division during fetus formation. This disease is not hereditary and is independent of ageing factor. The eyes develop very early as babies grow in the womb. At the early development stages, the eyes have retinoblasts, a type of cell which divides into a number of new cells and forms the mature retinal cells at a particular stage. In some rare cases, these cells continue to divide and grow out of control, and results in a cancerous situation known as retinoblastoma. A pupil looking red or white instead of a normal black, a crossed eye, poor vision, a red painful looking eye, enlarged different colored irises etc are some of the regular symptoms exhibited by retinoblastoma patients. Retinal Detachment is usually found in people of age group of 40 and is characterized by the detachment of retina from the layer underneath it. Retinal detachment is mostly affected in males when compared to females. This was proposed by Etminan et al., [2012]. This occurs as a result of shifting of retina from its actual position. Retinitis Pigmentosa affects the photoreceptors and is a hereditary disease characterized by night blindness, loss of peripheral vision and blurred visualization. Since it is genetic disease the symptoms of this disease will be seen from the childhood.

PROBLEM STATEMENT

In age related macular degeneration, Drusen, and yellowish pigment gets spread all over the retinal region. The crucial stage of this disease is characterized by the advancement of Drusen all over the retina. A person is concluded to have Diabetic retinopathy if his iris image includes abnormal blood vessels, extrudes, hemorrhages and cotton wool spots.



Deep Belief neural network

Deep learning a radical version of Artificial Neural Network was developed for easing the machine

learning process to different level of frontier. This sophisticated technique focuses on high level abstraction methodology. This deep learning algorithm is composed of multistage nonlinear transformers resembling numerous cascaded neural networks. For data abstraction in higher order, distributed data representation is adopted. In distributed representation, data will be analyzed with different dimensions and parameters. Each abstraction is carried out on the basis of hierarchical explanatory factors which involves the generation of several sub-level information from single previous level of generated information. Conventional artificial neural networks lack the capability to process the unlabeled data whereas all deep learning algorithms are successful in efficient processing of untagged data. Unsupervised manipulation of data is efficiently achieved by the deep belief network (DBN) a version of deep learning algorithm. Unsupervised data processing involves description of a hidden structure from an unlabeled data. The invariant data having divergence of ranges which includes noise, displacement, smoothness etc can be classified using this algorithm. Conventional neural networks turn out to be inefficient due to their inability to label dataset, inadequate parameter selection, and slow learning process. The deep belief networks prove to be an efficient optimal resolution for all these problems. Enhanced high-tech CPUs and GPUs, big data, enhanced learning algorithms etc contributed to the remarkable success of deep learning algorithms. Several multistage non-linear transforms constitute a deep belief network. A deep belief network has several layers which is comprised of stacked multi staged Restricted Boltzmann Machine(RBM), in which a single hidden layer is confined to each stage of RBM for the purpose of making the learning process faster. This was proposed by Hinton et al., [2006]. The design of RBM is in accordance with the log-linear MRF (Markov Random Field) in which the energy function is linear in its free parameters and as a result, learning characteristics of one RBM will be confined as input for the next RBM.

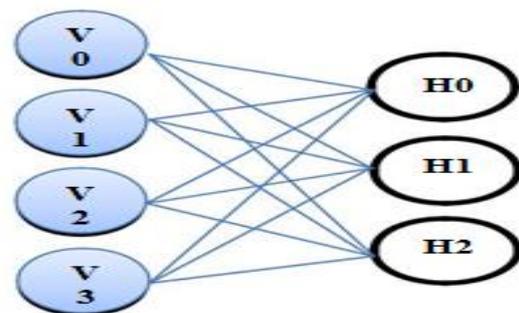


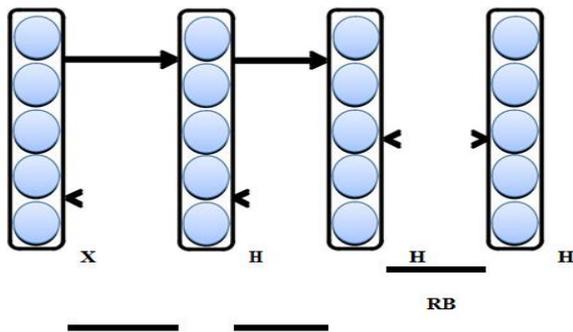
Figure-2: RBM Structure

A restricted Boltzmann machine (RBM), being an artificial neural network have the ability to understand and determine a probability distribution over its set of inputs Probability distribution of visible variable is essential for the efficient processing of RBM. Hidden unit with respect to an energy function is given by

$$E(V, H) = -b'V - c'H - H'WV \tag{1}$$

Through the energy function the free energy formulas are derived is given by,

$$F(V) = -b'V - \sum_i \log \sum_{H_i} e^{H_i(c_i + W_i V)} \tag{2}$$



where W is the weight acting as the intermediate link for hidden layer and visible layer b and c are assigned as the offsets of visible as well as hidden layers respectively.

The visible and hidden units of RBM are interdependent on each other by a certain condition. When the probabilistic version of binary data uses the RBM, the activation function would be sigmoidal in nature which further gives

$$P(H_i = 1|V) = \text{sigm}(c_i + W_i V) \tag{3}$$

$$P(V_j = 1|H) = \text{sigm}(b_j + W'_j H) \tag{4}$$

So that the free energy of an RBM can be further simplified as

$$F(V) = -b'V - \sum_i \log (1 + e^{(c_i + W_i V)}) \tag{5}$$

Higher order analogies including high frequency components, directional information edges of the given data can be acquired by the hidden layers as they operation the basis of energy model. Unsupervised processing of untagged data is made possible by the stacked data learning technique adopted by multistage RBM. Since the DBM is a stack of RBM networks, the training process is handled stage by stage. Initially the one dimensional or two- dimensional inputs from the visible layers are trained. the sequential training process leads to high level extraction of features.

Operational Procedure

- 1) Initial step involves the collection of all datasets (images) of various retinal disorders.
- 2) For the purpose of processing these images in a common system, the collected images are to be normalized. The pre-processing procedure is handled which involves noise removal, histogram equalization, contrast adjustment etc.
- 3) The normalized images are given as input to the DBM as inputs and deep features are extracted from these images i.e. where i varies from 1 to n and the extraction process depends on the network architecture used.
- 4) With the aid of a GRNN module, a dimension reduction strategy is used which selects the predominant features of the image and reduce the dimensions of the selected features.
- 5) These strong features are then trained using a multiclass SVM for the diagnosis of disease through classification.

CONCLUSION

DBN based feature extraction method when utilized for diagnosis of various retinal diseases has shown excellent result. Many ailments affecting retina can be efficiently diagnosed using this automatic screening technique. The main objective focused here is to build an efficient system for the classification of common characteristic datasets. An efficient deep learning algorithm for the classification and diagnosis of various retinal diseases is discussed.

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