A COMPREHENSIVE STUDY OF ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

- Artificial Neural Networks are basically a concept, known from the field of biology where a neural network plays a principal and key role in the human body. A neuron is a unique and special biological cell that has the responsibility of information processing from one neuron to another with the assistance of chemical change and some electrical change also. It is comprised and composed of a cell body. And outreaching branches (tree-like) of two types.
- A nucleus which contains some information regarding hereditary traits and plasma neurons that has a hold of the molecular instruments for supplying the important materials required by the neurons, are the constituents of the cell body. Artificial neuron is primarily an engineering approach of a biological neural network or neuron.
- Artificial Neural Networks are rapidly developing since they have been introduced to the world in the mid of the 20th century and according to science in our present time, we have explored the advantages of the neural networks and the problems which have occurred in the course of their creation. Also, the way the disadvantages and limitations of the artificial neural networks, although it being a developing branch of science and technology, are being eliminated and their advantages are being increased as per time, shouldn't be ignored. Soon, they'll become an indispensable part of our daily lives.

KEYWORDS- ARTIFICIAL INTELLIGENCE, ARTIFICIAL NEURAL NETWORKS, CONVOLUTIONAL NEURAL NETWORKS, BREAST CANCER.

INTRODUCTION

- **Artificial Neural Networks-** A part of a computer system which is used to simulate the same way to analyse and process information, the human brain does the task. It has the ability to solve problems that are deemed impossible or certainly very difficult by the standards of human statistics and thus it is the foundation of artificial intelligence. The more the data becomes available, the better results are produced by these artificial neural networks because they have self-learning capabilities enabling them to perform these tasks.
- An artificial neural network is that component of AI that is supposed to simulate how a human brain basically functions.
- It consists of inputs and outputs, of processing units, which make up the artificial neural networks. It learns from the inputs about how to produce the perfect required output, which is desired.
- The set of learning rules are called backpropagation, which are used to guide the ANN.
- The practical applications of artificial neural networks surpass far and wide, comprised of medicine, education, business and personal communication.

ANN AND BREAST CANCER

- With the advancement of new technologies, AI is now the talk of the town in the field of medicine and research and the interest of various developers and clinicians have been drawn towards it. One such evolutionary branch of Artificial Intelligence are Artificial neural networks, without a doubt. Nowadays also a lot of research is being done extensively on this topic.
- Artificial Neural Networks are becoming a powerful weapon used by the clinicians to analyse, make a model of and decode complex information of medical data across a massive length of medical approaches. Its task is mostly to perform classification that means it has to put the patients in one of the many small classes based on the features which are studied and measured.
- Now, the prediction of what will be the clinical result of the patients suffering from breast cancer and who have undergone surgery plays an important part in the medical field such as the planning of further treatment and the accurate diagnosis of the disease and its progression. Currently survival predictions are estimated by the doctors using techniques which are non-numeral.
- Artificial neural networks have been proven that they are a powerful tool for dataset analyzation and evaluation where there are complications regarding interactions which are non-linear between the input data and the statistics to be predicted or information. Some studies also say that extensive experience is required to accurately interpret and analyse the images of breast and artificial intelligence assists in finding breast cancer with minor recalls and it can detect cancers in its early stage of progression. Hence in this paper we demonstrate the use of artificial neural networks in the diagnosis and prediction of breast cancer by moving headway into the various types of neural networks and their applications.

LITERATURE REVIEW

- “Breast Cancer Detection using Artificial Neural Networks”, Nadeem Tariq, 2017, Journal of Molecular Biomarkers & Diagnosis, in this paper overall research is of 4 stages, quite simply explained, first stage is of image acquisition, second stage is the extraction from mammograms of features, selection of features which are more optimal and classifier to determine the correct section of the mammogram and its class. A database has also been taken.

- The paper “Computer aided breast cancer analysis and detection using statistical features and neural networks” compiled by the authors Roopa Ashok Thorat and Ruchira Ajay Jadhav,2009, ACM, takes up mammography, which is known as the single most constructive way for breast cancer screening. They have used a feature extraction method which is statistical with the help of an analysis through a sliding window analysis for detecting small masses in the mammograms for effectively finding out the exact tumor position.

- “Fast Modular Artificial Neural Network for the Classification of Breast Cancer Data” by Doreswamy and M Umme Salma, 2015,ACM, interestingly comes up with an idea of using FM-ANN, a fast modular artificial neural network. They came to produce the highest classification results in comparison of other types of networks used before. A modular neural network is actually formed using four types of different feed forward neural networks and the selected input which is refined are sent to each of the four where they perform their respective tasks and later the final result is inculcated using their sum.

METHODOLOGY

Objective- Creating a breast cancer classification model using an IDC dataset. To accurately detect an image from the histology (study of the microscopic structure of cells and tissues) - as benign or malignant.

- What is Deep Learning- An initiative of Machine Learning, this term is an approach towards the working of the human mind and its neural networks(biological). Deep neural networks, convolutional neural networks, etc are architectures which are consisting multiple layers, through which the data has to pass through, so that it can give us an output. It serves for the better performance of AI and make its few applications a possibility. Applied to many fields like computer vision and speech recognition, deep learning is an intensive approach.
- What is Keras -An open-source library of the artificial neural networks, which is written in Python. An API of a high-level. It can run much better than others like TensorFlow. Its main application is to make the experimentation run fast and prototyping as it runs without any halt on the GPU and the CPU. It is user-friendly. And it is extensible.

- **A CNN, convolutional neural networks, are used mainly for accurate face detection. Even if the provided image is not of a good resolution, this network does its work. Making work of a different kind of MLPs, these have several layers which have the ability to get interconnected fully. Primarily used to decipher a particular part of a given input, their purpose solely is to give accurate output.**

- In this project, we use python, to build a classification model, which will get trained on about 80% histology images from the dataset for breast cancer. The other 10% data will be kept for validation. We will use a convolutional neural network defined by an open-source library called Keras, and we will name it as CancerNet. This network will get trained on the images from the dataset. Then we will analyse the data with the help of a confusion matrix so that we can check the working of our model. IDC which is known as Invasive Ductal Carcinoma, as studied in the types of breast cancer earlier, which gets formed in the milk duct and spreads to the tissues outside of the milk duct, accounts for about 80% of all the breast cancer cases, it is the most common form of it.
- The IDC dataset is downloaded from Kaggle. The packages- matplotlib, imultis, numpy, are downloaded in Python.

STEPS TAKEN-

- The downloaded requirements are unzipped at the required location, after downloading the prerequisites. And inside the breast-cancer-classification directory, we create the datasets folder and then inside this we create, another directory named as original. Using the commands- mkdir datasets, mkdir datasets\originals. The dataset should be unzipped at the original directory.
- The structure of this directory is observed by using the tree command Now, we have a directory for all patient IDs and in each of them we have folders- 0 and 1 for images of the benign and malignant tumours.
- Config.py: Here then we declare the path to the input dataset (datasets/original), that for the new directory (datasets/idc), and the paths for the training, validation, and testing directories using the base path. We also declare that 80% of the entire dataset will be used for training, and of that, 10% will be used for validation.
- build_dataset.py: This will split our dataset into training, validation, and testing sets in the ratio mentioned above- 80% for training (of that, 10% for validation) and 20% for testing. With the ImageDataGenerator from Keras, we will extract batches of images to avoid making space for the entire dataset in memory at once. In this, we'll import from config, imutils, random, shutil, and os. We'll build a list of original paths to the images, then shuffle the list. Then, we calculate an index by multiplying the length of this list by 0.8 so we can slice this list to get sublists for the training and testing datasets. Next, we further calculate an index saving 10% of the list for the training dataset for validation and keeping the rest for training itself. Now, datasets is a list with **tuples** for information about the training, validation, and testing sets. These hold the paths and the base path for each. For each setType, path, and base path in this list, we'll print, say, 'Building testing set'. If the base path does not exist, we'll create the directory. And for each path in originalPaths, we'll extract the filename and the class label. We'll build the path to the label directory(0 or 1)- if it doesn't exist yet, we'll explicitly create this directory. Now, we'll build the path to the resulting image and copy the image here- where it belongs.

SOME HISTOLOGY IMAGES

- cancernet.py: The network we'll build will be a CNN (Convolutional Neural Network) and call it CancerNet. This network performs the following operations: Use 3×3 CONV filters. Stack these filters on top of each other. Perform max-pooling. Use depthwise separable convolution (more efficient, takes up less memory). We use the Sequential API to build CancerNet and SeparableConv2D to implement depthwise convolutions. The class CancerNet has a static method build that takes four parameters- width and height of the image, its depth (the number of color channels in each image), and the number of classes the network will predict between, which, for us, is 2 (0 and 1). In this method, we initialize model and shape. When using channels_first, we update the shape and the channel dimension. Now, we'll define three DEPTHWISE_CONV => RELU => POOL layers; each with a higher stacking and a greater number of filters. The softmax classifier outputs prediction percentages for each class. In the end, we return the model.

- train_model.py: This trains and evaluates our model. Here, we'll import from keras, sklearn, cancernet, config, imutils, matplotlib, numpy, and os. In this script, first, we set initial values for the number of epochs, the learning rate, and the batch size. We'll get the number of paths in the three directories for training, validation, and testing. Then, we'll get the class weight for the training data so we can deal with the imbalance. Now, we initialize the training data augmentation object. This is a process of regularization that helps generalize the model. This is where we slightly modify the training examples to avoid the need for more training data. We'll initialize the validation and testing data augmentation objects. We'll initialize the training, validation, and testing generators so they can generate batches of images of size batch_size. Then, we'll initialize the model using the Adagrad optimizer and compile it with a binary_crossentropy loss function. Now, to fit the model, we make a call to fit_generator(). We have successfully trained our model. Now, let's evaluate the model on our testing data. We'll reset the generator and make predictions on the data. Then, for images from the testing set, we get the indices of the labels with the corresponding largest predicted probability. And we'll display a classification report. Now, we'll compute the confusion matrix and get the raw accuracy, specificity, and sensitivity, and display all values. Finally, we'll plot the training loss and accuracy.

RESULTS-

- The epochs were obtained as-

```
Epoch 38/40
6244/6244 [==============================] - 2384s 382ms/
 0.8513
Epoch 39/40
6244/6244 [==============================] - 2676s 429ms/
 0.8511
Epoch 40/40
6244/6244 [==============================] - 2379s 381ms/
 0.8516
Now evaluating the model
              precision    recall  f1-score   support
```

- The accuracy-

```
   macro avg       0.81      0.83      0.82     55505
weighted avg       0.86      0.85      0.85     55505

[[34757  4979]
 [ 3271 12498]]
Accuracy: 0.8513647419151428
Specificity: 0.792567696112626
Sensitivity: 0.8746980068451782
```

CONCLUSION

In this project we learned about Artificial Neural Networks, their applications in our everyday lives and the its advantages and disadvantages. Then, we ventured upon the field of Breast Cancer and its trends in India, and we built accordingly a classifier using the convolutional neural networks in python. On the IDC dataset, we created the network, trained it and then used Keras to implement the same.

FUTURE WORKS

- The various other types of neural networks could be explored to build a model for the classification and diagnosis of Breast Cancer with a greater accuracy.

Thank You!!!