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Deep Learning Based Breast Cancer Classification Using Transfer Learning

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ABSTRACT: Breast cancer is one of the most common causes of cancer-related death in women world wide . In the U.S., breast cancer is diagnosed in about 12% of women during their lifetime and it is the second leading reason for women's death . Since early diagnosis could improve treatment outcomes and longer survival times for breast cancer patients, it is significant to develop breast cancer detection techniques. The Convolutional Neural Network (CNN) can extract features from images automatically and then perform classification. To train the CNN from scratch, however, requires a large number of labeled images, which is infeasible for some kinds of medical image data such as mammographic tumor images. A promising solution is to apply transfer learning in CNN diagnosis of breast cancer may significantly increase the survival rate of patients .Here, we have used Histopathological (microscopic) images to classify the types of tumor and also compared various CNN Transfer Learning Models and concluded with high accuracy model.

KEYWORDS:Convolutional Neural Network (CNN),Histopathological images, Transfer Learning Models

I. INTRODUCTION

Breast cancer is cancer that forms in the cells of the breasts .It will be diagnosed among about 1 in 8 (or 12%)U.S. women during their lifetime and it is the second leading reason for women's death in the U.S.It can occur in both men and women, but it's far more common in women. Typically, the cancer forms in either the lobules or the ducts of the breast. There are different kinds of breast cancer. The kind of breast cancer depends on which cells in the breast turn into cancer. Breast cancer can spread outside the breast through blood vessels and lymph vessels.Tumors can be benign (noncancerous)or malignant (cancerous). Benign tumors tend to grow slowly and do not spread. Malignant tumors can grow rapidly, invade and destroy nearby normal tissues, and spread throughout the body. In its early stages, breast cancer may not cause any symptoms.Inthis model , the input is taken as dataset of histopathology images which is given in to feature extraction which is done by different transfer learning models. Here the bottleneck features of every histopathology images are extracted and convolution and max pooling layers are made by the pre-pretrained model chosen(using trail and error method, the highest accuracy model has been predicted).Depending upon the model's layer the convolution and max pooling layers are continuously constructed and finally the single layer of fully connected layer(FCL) is constructed. After convolution, the final layer is fed into SoftMax classifier to detect the type of cancer when given a input of histopathology image.

II. RELATED WORK

Theconceptof Breast Cancer Detection Using Transfer Learning in Convolutional Neural Networkswasfirstintroduced by Shuyue Guan and Murray Loew[1].In this method, they applied the pre-trained VGG-16 model to extract features from input mammograms and used these features to train a Neural Network (NN)-classifier. They found that this method is ideal for study because the classification accuracy of fine-tuning model was just 0.008 higher than that of feature extraction model but time cost of feature extraction model was only about 5% of that of the fine-tuning model. And used the same method to classify regions: benign vs. normal, malignant vs. normal and abnormal vs. normal from the DDSM database with 10-fold cross validation. Detecting Masses in Mammograms using Convolutional Neural Networks And Transfer Learning proposed by Mor Yemini, Yaniv Zigel and Dror Lederman[2]this method addresses

the problem of mass detection in mammograms. They proposed a Computer-aided diagnosis (CAD) scheme based on convolutional neural networks, using transfer representation learning and the Google Inception-V3 architecture. The performance of the proposed scheme is evaluated based on the receiver operating characteristics (ROC) curve. Areas under the ROC curve of 0.78 and 0.86 were obtained using artificially-generated mammograms and augmentation, respectively. Breast Cancer Detection and Classification by Poonam Kathale and Snehal Thorat [3] presented the method to detect cancer region and classify normal and cancerous patient. They have used Random Forest (RF) classifier for classification of BC patient and normal patient. Classification accuracy of RF is 95% for image of different patient. Processing time of RF classifier is 6.25s. A Study on Convolution Neural Network for Breast Cancer Detection by Oinam Vivek Singh and Dr. Prakash Choudhary [4] reviewed various deep learning concepts applied to breast mammogram analysis and summarizes contributions to this field. They presented a summary of the recent developments and a discussion about the best practices done using CNN in mammogram analysis and improvements that can be done in future research. Breast cancer detection in mammograms using convolutional neural network by Saira Charan, Muhammad Jaleed Khan and Khurram Khurshid [5] used Mammograms-MIAS dataset for breast cancer detection. Promising experimental results have been obtained which depict the efficacy of deep learning for breast cancer detection in mammogram images and further encourage the use of deep learning based modern feature extraction and classification methods in various medical imaging applications especially in breast cancer detection.

The work in this paper is divided in two stages. 1) Comparing various CNN Transfer Learning Models 2) Classification of breast cancer tumours. By comparing various Transfer Learning Models we could get to know the best model suited for breast cancer classification based on their classification accuracy. For classifying the types of breast cancer tumours is done by applying SoftMax classifier which gives a slightly more intuitive output (normalized class probabilities) and also has a probabilistic interpretation.

III. METHODOLOGY

In breast cancer classification using Transfer Learning model we used Histopathology images as dataset which is given into feature extraction module to extract important features, which is done by different transfer learning models. The bottleneck features of every histopathology images are extracted and convolution and max pooling layers are continuously constructed by the pre-trained model chosen. Finally the single layer of fully connected layer (FCL) is constructed. Then this final layer is fed into SoftMax classifier to detect the type of cancer when given as an input of histopathology image.

The block diagram for our model is given below:

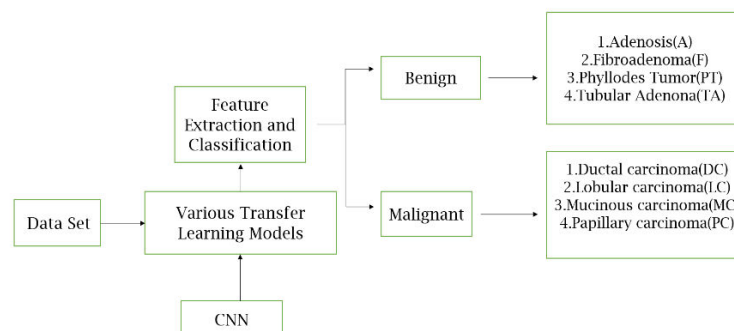


Figure 1: Block diagram for breast cancer classification using Transfer Learning

The description of each block is explained below:

1. Dataset: Here we have used Histopathological images for classifying the breast cancer tumours. Histopathology is the study of the signs of the disease using the microscopic examination of a biopsy or surgical specimen that is processed and fixed onto glass slides. The most commonly used stain in histology is a combination of hematoxylin and eosin (often abbreviated H&E).
2. CNN Transfer Learning Models: Transfer learning is the reuse of a pre-trained model on a new problem. It's currently very popular in deep learning because it can train deep neural networks with comparatively little

data. Here, we have compared six different Transfer Learning models (VGG-16, Inception-v3, ResNet-50, MobileNet-v2, Xception, NASNet mobile) and concluded with high accuracy model.

3. Feature extraction and classification : Feature extraction is a process of dimensionality reduction by which an initial set of raw data is reduced to more manageable groups for processing. A classifier is an algorithm that automatically orders or categorizes data into one or more of a set of "classes."
4. Classification of breast cancer tumours: In this method we have classified the breast cancer tumours into 8 types. The Benign type tumour consist of four categories such as, Adenosis(A), Fibroadenoma(F), Phyllodes tumour(PT), Tubular adenoma(TA) and the Malignant type tumour consist of four categories such as, Ductal carcinoma(DC), Lobular carcinoma(LC), Mucinous carcinoma(MC), Papillary carcinoma(PC).

IV. EXPERIMENTAL RESULTS

The final results of comparison between six different Transfer Learning Models is shown in Table 1. From the below table we get to know, that MobileNet-v2 model has given the best and high accuracy of 93.8% accuracy. Figure 2 shows the Training accuracy Vs Validation accuracy plot of MobileNet-v2 where the Training accuracy is 99.6% and Validation accuracy is 88.7% . Figure 3 shows the Training loss Vs Validation loss plot of MobileNet-v2 where the Training loss is 1.01% and Validation loss is 27.9% .

S.NO	TRANSFER LEARNING MODEL	TRAINING		VALIDATION		MODEL PREDICTION ACCURACY
		ACCURACY	LOSS	ACCURACY	LOSS	
1	VGG16	0.9984	0.0308	0.8625	0.5158	0.838
2	Xception	0.9875	0.1278	0.7125	0.7902	0.725
3	ResNet50	0.9953	0.0916	0.7125	0.826	0.713
4	InceptionV3	0.9937	0.097	0.7	0.8205	0.688
5	NASNet Mobile	0.9984	0.0868	0.7	0.7875	0.675
6	MobileNetV2	0.9969	0.0101	0.8875	0.2792	0.938

Table 1: Comparison between various Transfer Learning Models



Figure 2: Training accuracy VS Validation Accuracy of MobileNet-v2 model

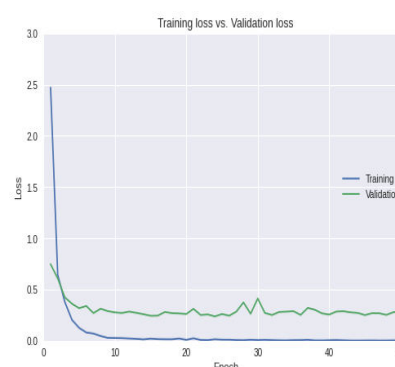


Figure 3: Training loss VS Validation loss of MobileNet-v2 model

Now the final results for Classification of Breast cancer tumours is shown below :

Figures 4 and 5 shows the classification results of Benign and Malignant type breast cancer tumour .



```

classfify('/content/data/flow/test/malignant type ductal carcinoma/S08_M_DC-14-2523-40-014.png')

[ ]

WARNING:tensorflow:5 out of the last 11 calls to <function Model.make_predict_function.<locals>.predict_function at 0x7f40c12aa7b0> triggered tf.function retracing.
[[1.0368091e-04 3.1601633e-03 9.6569323e-08 1.1919678e-04 9.9656785e-01
 1.8883535e-05 2.4230928e-08 3.0013303e-05]]

[4]
Its a malignant type ductal carcinoma

```

Figure 4: Classification of Malignant type tumour-Ductal carcinoma(DC)



```

[26] classfify('/content/drive/MyDrive/breakhisdataset/benign type fibroadenoma/S08_B_F-14-14134-40-006.png')

[[2.3330202e-16 1.0000000e+00 1.4080426e-09 4.4611398e-13 4.2695489e-10
 2.2207295e-16 4.2731454e-16 5.2444045e-15]]

[1]
Its a benign type fibroadenoma

```

Figure 5: Classification of Benign type tumor- Fibroadenoma(F)

V. CONCLUSION

In our project, we applied the SoftMax Classifier to classify the types of breast cancer using histopathological images and also used six different types of Transfer Learning Models and compared the classification accuracy of each model. Our result show that the pretrained CNN model (MobileNet-v2) has the accuracy of 93.8% which is the highest among the six. It should be also noted that this is the only preliminary work, in which the dataset of histopathological images are used and the subtypes of benign and malignant tumors are classified. Therefore, this work shows that applying transfer learning in CNN can detect breast cancer from microscopic images which gives more accuracy than training the CNN from scratch or using mammograms. For our future work, we could try to find out which stage (Stage 0 to stage 5) and which grade (Grade 1 to Grade 3) the tumor comes under. We could also use Efficient Net architecture, which is known for its uniform scaling of different dimensions like depth, width, resolution etc... to further improve our accuracy.

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