Introduction:

Alzheimer's disease is known as mental disorder many people and specially Childs are victim of this disease. This is type of Dementia.

There are many types and classes of Alzheimer's disease. So, in this report analysis and classification of Alzheimer's disease is carried out using deep learning techniques. deep leaning techniques are used using python libraries. MRI images are used to do analysis and classification.

Dementia refers to diseases that cause loss of memory and deterioration in other mental functions. It occurs due to physical changes in the brain, and it is a progressive disease, means to say that it gets worse over time. For some people, dementia grow rapidly, while it takes years to reach an advanced stage for others.

Data Structure and Case Processing

The dataset which is used is Alzheimer MRI Pre-processed Dataset which is available on Kaggle datasets. Dataset contains 6400 MRI images are used in analysis. All MRI images has size of128 x 128 pixels.

There are four classes of MRI's images which are following:

- Class - 1: Mild Demented (896 images)
- Class - 2: Moderate Demented (64 images)
- Class - 3: Non-Demented (3200 images)
- Class - 4: Very Mild Demented (2240 images)

Above four classes are stages or types of Alzheimer's disease.

Pictures are splatted into training and validation data as 20 % of MRI images are used as validation and remaining 80% are used for training purpose.

Classification:

As here the main tasks are to predict MRI images as a class. So that is way to know about which type of Alzheimer's disease a person has? So, lets first know about classification.

Classification is a process of categorizing a given set of data into classes; it can be performed on both structured and unstructured data. The process starts with predicting the class of given data points. The classes are often referred to as target, label, or categories.

Deep learning:

Deep Learning is a subfield of machine learning and Artificial intelligence. it concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Deep learning techniques are used for image classification, text classification and speech recognition etc.

Computer vison

Computer vision is a field of artificial intelligence (AI) which enables computers and systems to derive meaningful information from digital images, videos, and other visual inputs.

transfer learning

transfer learning is a technique which is used in machine learning and deep learning. In this technique a pre-trained model is reused on a new problem is known as transfer learning in machine learning.

Fast AI

fastai is a deep learning library which provides high-level components that can quickly and easily provide state-of-the-art results.

ResNet:

ResNet, which stands for Residual Network is a specific type of neural network that was introduced in 2015 by Kaiming He, Xiangyu Zhang, Shaoqing Ren and Jian Sun in their research paper “Deep Residual Learning for Image Recognition.

ResNet network uses a 34-layer plain network architecture which is inspired by VGG-19 in which then the shortcut connection is added. These shortcut connections then convert the architecture into the residual network.

ResNet18 Vs Resnet34 architecture:

ResNet18 is a 72-layer architecture with 18 deep layers. The architecture of this network aimed at enabling large amounts of convolutional layers to function efficiently.

Resnet34 is a 34-layer convolutional neural network that can be utilized as a state-of-the-art image classification model. This is a model that has been pre-trained on the ImageNet dataset--a dataset that has 100,000+ images across 200 different classes.

Data preparation:

Data preparation is the process of gathering, combining, structuring, and organizing data so it can be used in model building part. Data preparation is very important step in Machine Learning and data Science project life cycle.

So here data is gathered through Kaggle. Date is resized and scaled by dataloaders function which is used in fastai API.

Splitting of data into train and test images:

Data is divided into train and test because training data is used to train model and test data is used to test results of model

So here MRI Images are splatted into training and validation data as 20 % of MRI images are used as validation and remaining 80% are used for training purpose.

Model Structure:

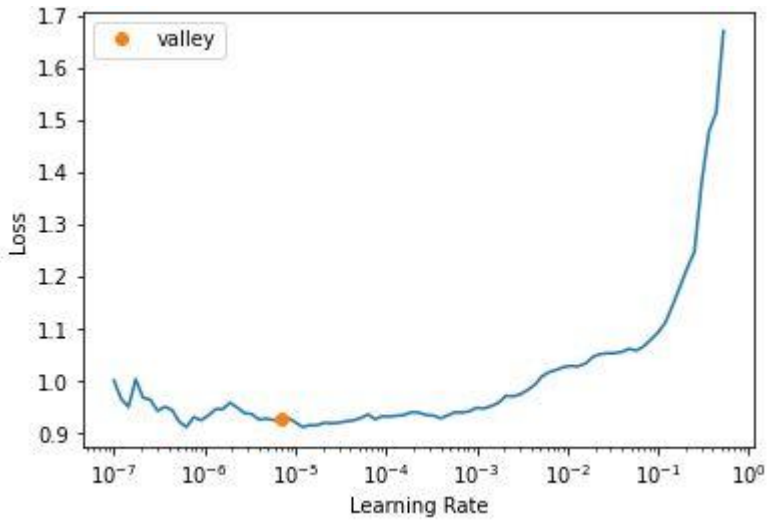
Machine learning model is built using transfer learning technique. vision learner API is used to add model and data.

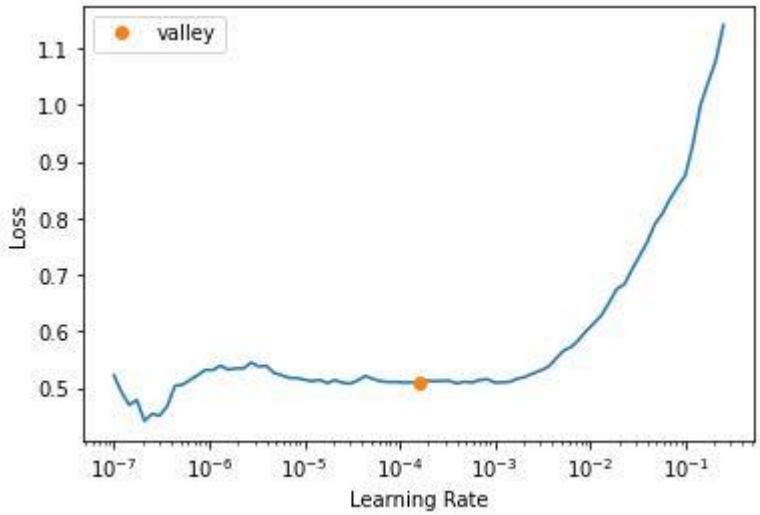
Resnet18, Resnet34 and xresnet34 pretrained model are downloaded and then used in model. Our provided data is trained to build prediction.

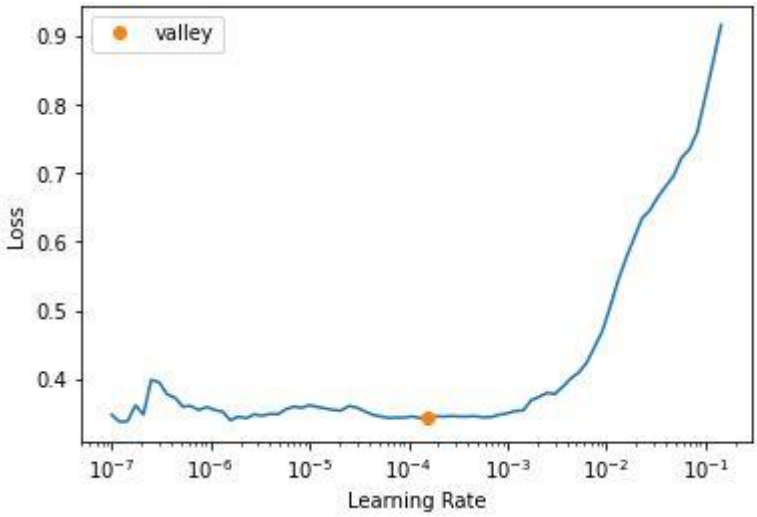
Pre-processed MRI images are used to train model.

Learning rate:

The learning rate is a hyperparameter that controls how much to change the model in response to the estimated error each time the model weights are updated. Choosing the learning rate challenging as a value too small may result in a long training process that could get stuck, whereas a value too large may result in learning a sub-optimal set of weights too fast or an unstable training process.







Evolution of model:

After building machine learning model it is very important to know about performance of machine learning model that how accurately a machine learning model is performing?

The function that measures how good or bad the model is during each iteration is called the “loss function”. It is measure of the discrepancy between the desired output and the actual output

Here the training loss calculates training accuracy and validation loss calculates validation or test accuracy.

The accuracy or error rate of a machine learning classification algorithm is one way to measure how often the algorithm classifies a data point correctly. Accuracy is the number of correctly predicted data points out of all the data points.

A full pass over the entire training dataset is called epoch.

Time is measure of seconds by model in training process.

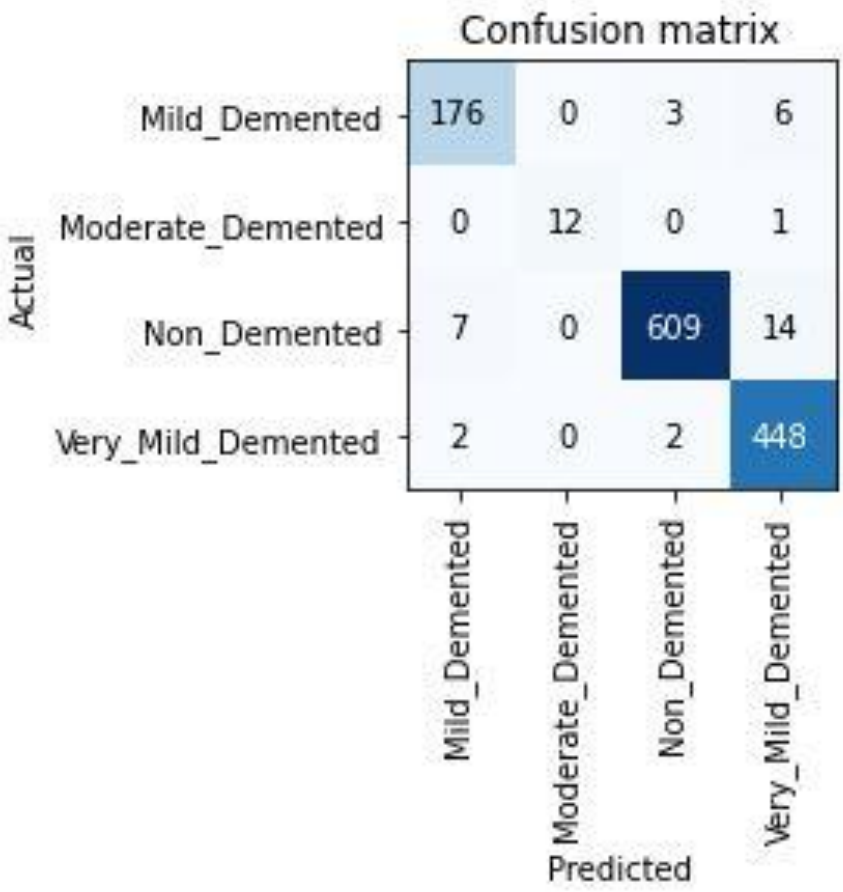
epoch	train_loss	valid_loss	error_rate	time
0	0.351582	0.413762	0.167187	00:23
1	0.333744	0.398213	0.163281	00:22
2	0.326223	0.386159	0.157031	00:23
3	0.303926	0.383317	0.156250	00:23
4	0.285984	0.370231	0.156250	00:23
5	0.258482	0.358815	0.144531	00:23
6	0.252983	0.354212	0.150000	00:23
7	0.253286	0.350551	0.141406	00:22
8	0.237439	0.347917	0.135937	00:24
9	0.232663	0.346824	0.136719	00:23

As on increasing epochs training and validation loss is reduced. so at the result we have loss of 0.23 so this show that our model accuracy is more than 80 percent.

Confusion matrix:

Confusion matrix is an N x N matrix used for evaluating the performance of a classification model, where N is the number of target classes. The matrix compares the actual target values with those

predicted by the machine learning model. This gives us a holistic view of how well our classification model is performing and what kinds of errors it is making.



Classification report:

A classification report is a performance evaluation metric in machine learning. It is used to show the precision, recall, F1 Score. Precision, recall and f1-score can be calculated using confusion matrix.

F1 score is the harmonic mean of precision and recall and is a better measure than accuracy.

	precision	recall	f1-score	support
Mild_Demented	0.95	0.95	0.95	185
Moderate_Demented	1.00	0.92	0.96	13
Non_Demented	0.99	0.97	0.98	630
Very_Mild_Demented	0.96	0.99	0.97	452
accuracy			0.97	1280
macro avg	0.97	0.96	0.97	1280
weighted avg	0.97	0.97	0.97	1280

As all categories are performing well because all has f1-score greater than 95 percent.

Non demented category has highest f1-score that is 98 %.

Model summary:

Transfer learning technique is used in model building so there are three pretrained models are used which are following with loss and error rate.

- ResNet18

epoch	train_loss	valid_loss	error_rate	time
0	0.931734	0.807735	0.364844	00:29
1	0.898243	0.786428	0.345313	00:30
2	0.864088	0.741991	0.334375	00:29
3	0.837051	0.730629	0.321875	00:29
4	0.821890	0.732853	0.331250	00:30
5	0.801448	0.727709	0.318750	00:30
6	0.802242	0.708289	0.316406	00:29
7	0.797584	0.706558	0.314844	00:29
8	0.775077	0.708141	0.314063	00:30
9	0.784347	0.699128	0.312500	00:29

- ResNet34

epoch	train_loss	valid_loss	error_rate	time
0	0.621535	0.653777	0.256250	00:21

epoch	train_loss	valid_loss	error_rate	time
0	0.399932	0.378617	0.142969	00:22
1	0.278153	0.468559	0.160156	00:23
2	0.264099	0.345710	0.119531	00:22
3	0.166097	0.293326	0.102344	00:22
4	0.087191	0.252537	0.087500	00:22
5	0.043106	0.147485	0.045313	00:22
6	0.034414	0.132606	0.035937	00:22
7	0.017030	0.104462	0.031250	00:22
8	0.008655	0.071186	0.023438	00:22
9	0.003471	0.080833	0.027344	00:21

- XResNet34

epoch	train_loss	valid_loss	error_rate	time
0	0.489227	0.499694	0.201562	00:23
1	0.486608	0.485325	0.195312	00:22
2	0.487620	0.466649	0.190625	00:22
3	0.447453	0.453660	0.180469	00:23
4	0.440313	0.438587	0.176563	00:23
5	0.413600	0.432680	0.176563	00:22
6	0.402611	0.428645	0.180469	00:23
7	0.390861	0.422231	0.173438	00:23
8	0.391177	0.423289	0.171875	00:22
9	0.368589	0.422030	0.171094	00:22

Conclusion:

The analysis and classification of Alzheimer's disease is carried out using deep learning technique such as transfer learning. There are 6400 MRI images are used as dataset. Resnet is pretrained model which is used here to train model.

Model has good accuracy on ResNet34 that is F1-score is greater than 95% which clears that this has very good performance.

References:

- Alzheimer's disease explanation:

https://www.mayoclinic.org/diseases-conditions/alzheimers-disease/symptoms-causes/syc-20350447#:~:text=Overview,person's%20ability%20to%20function%20independently.

- A Gentle Introduction to Transfer Learning for Deep Learning on machine learning mastery by *Jason Brownlee*

https://machinelearningmastery.com/transfer-learning-for-deep-learning/#:~:text=Transfer%20learning%20is%20an%20optimization,that%20has%20already%20been%20learned.