Configuration Manual

Intracranial Haemorrhage Detection using Machine Learning Models

MSc. Research Project

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MSc Project Submission Sheet

School of Computing

Student Name:	BELLANA TIRUPATI PATRO
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Programme:	MSc in Data Analytics
Year:	2019-2020
Module:	MSc Research Project
Lecturer:	Dr Rashmi Gupta
Submission Due Date:	17/08/2020
Project Title:	Intracranial Haemorrhage Detection using Deep Learning Models
Word Count:	1037
Page Count:	………………………………….……….………

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Configuration Manual

Bellana Tirupati Patro
Student ID: 18196551

1 Hardware/Software Requirements

1.1 Hardware Requirements

Laptop	Lenovo Ideapad 330
RAM	8GB
Graphics Processing Unit(GPU)	Nvidia GTX 960 -2GB

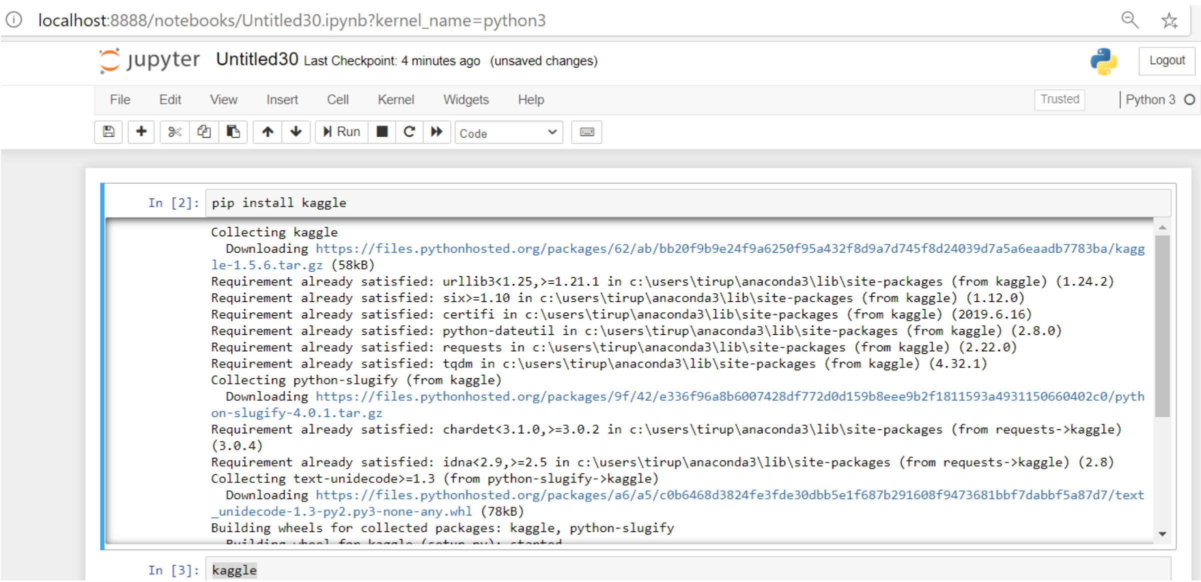
1.2 Software Requirements

Operating System	Windows 10
Programming Tools	Jupyter Notebook, Python Version 3, Anaconda
Graphics Processing Unit(GPU)	Nvidia GTX 960 -2GB

2 Data Gathering

Data Gathering is done for this research project using Kaggle API.

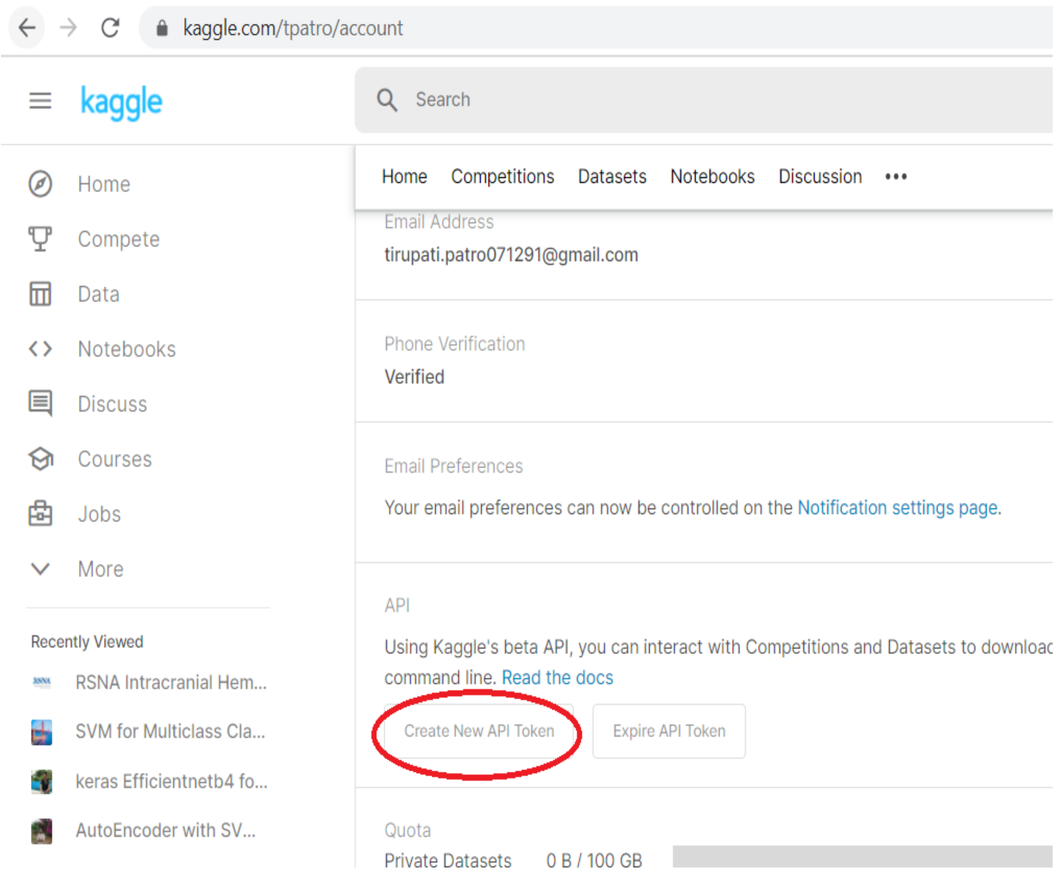
Step 1: Install the Kaggle in Jupyter Notebook.



Step 2: Login to Kaggle.com using your credentials.

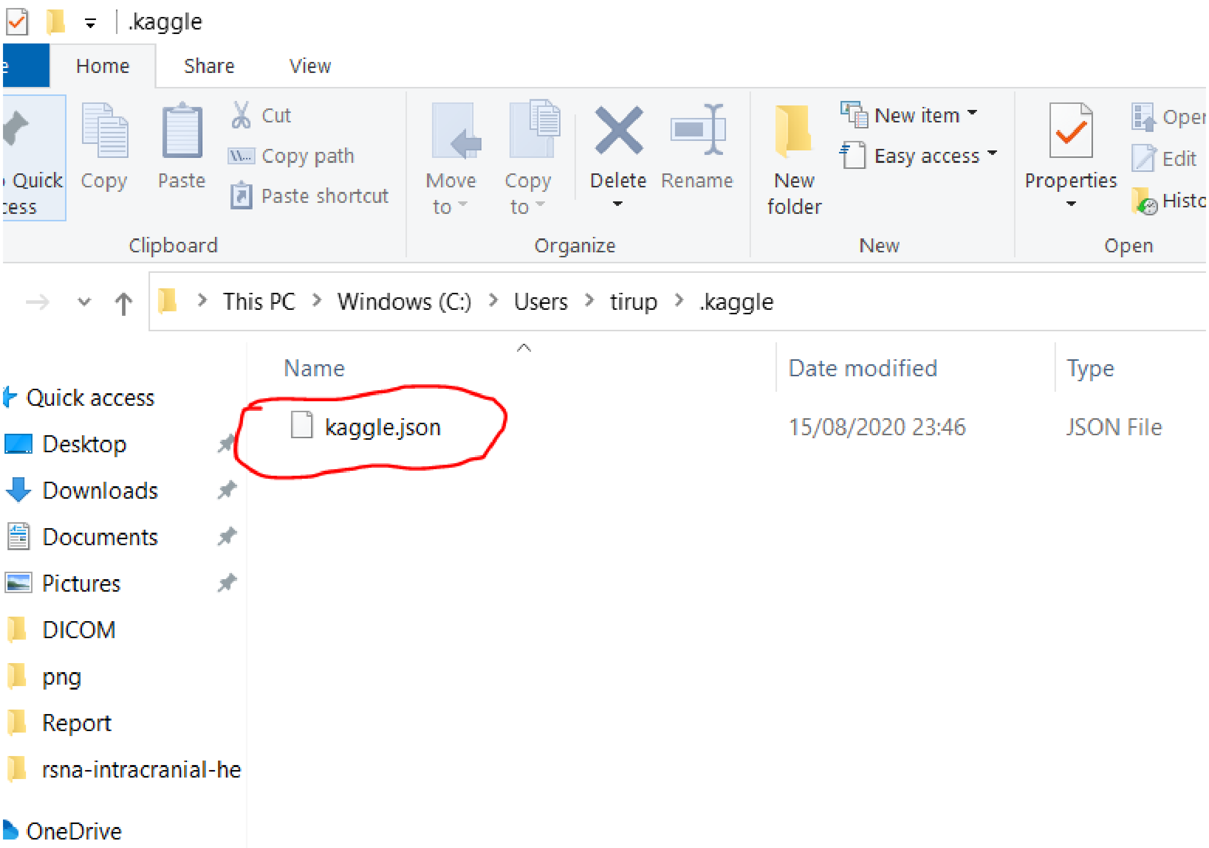
Step 3: Goto My Account page.

Step 4: Click on "Create New API Token"



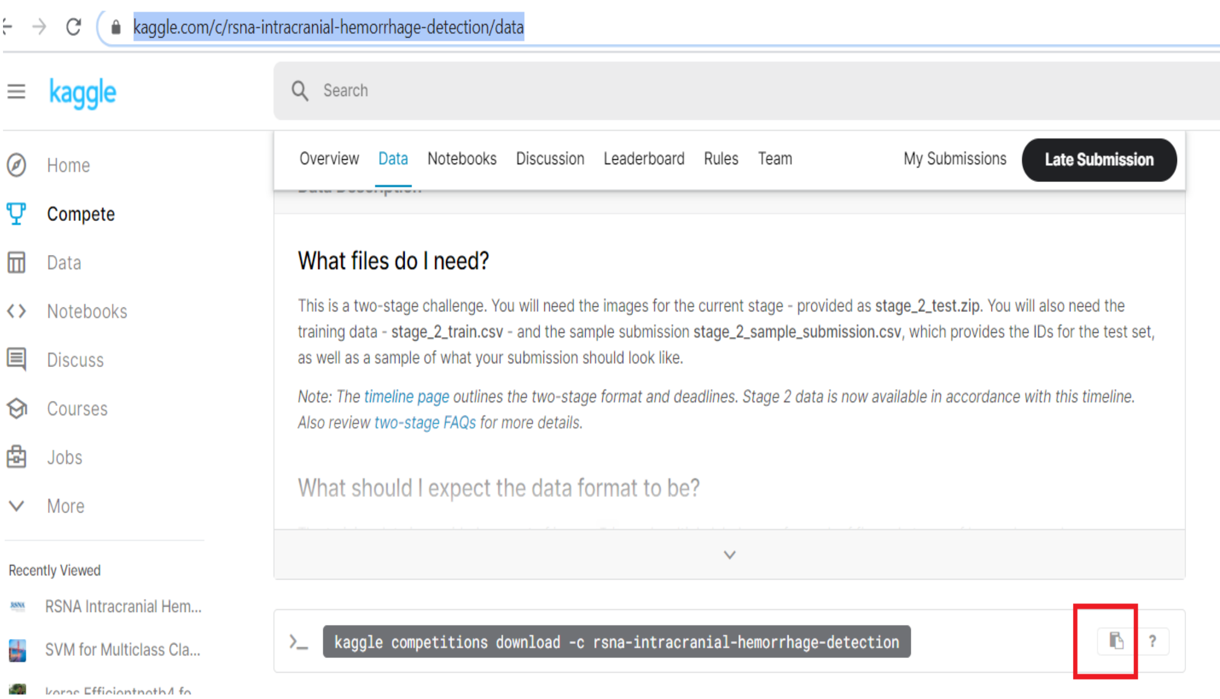
Step 5: The kaggle.json file is downloaded in Downloads folder of local machine.

Step 6: Copy this kaggle.json file from Dowloads folder to .kaggle folder present in Users folder inside C: drive of your local machine.

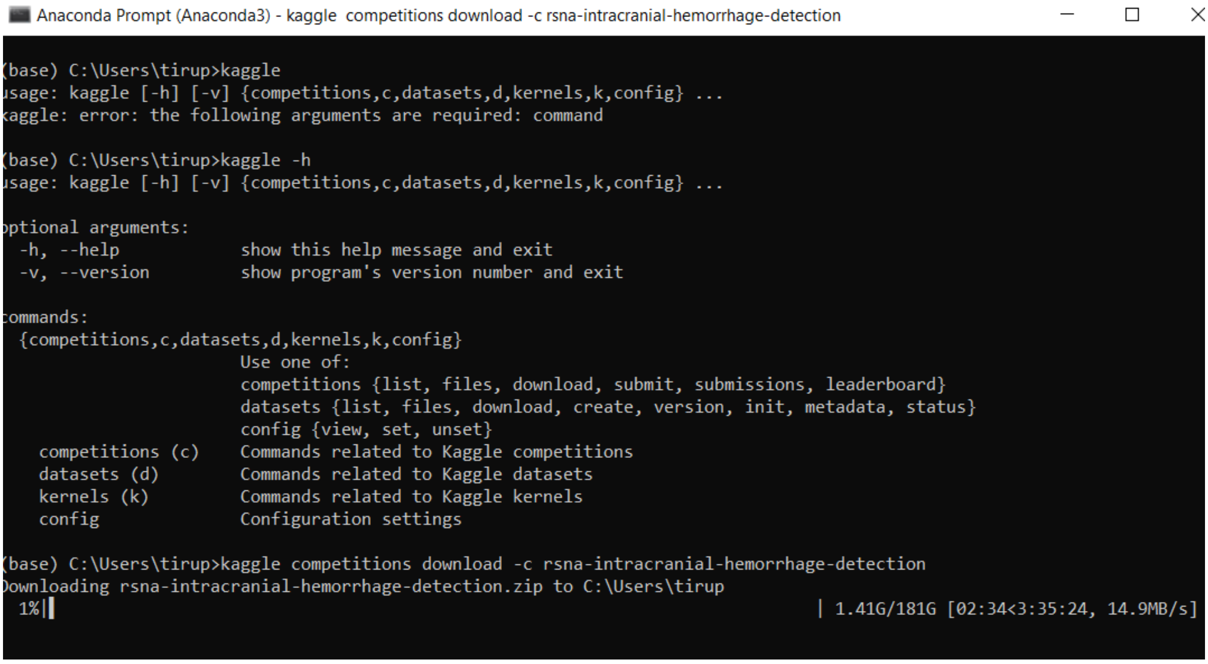


Step 7: Goto dataset page by clicking on this link https://www.kaggle.com/c/rsna-intracranial-hemorrhage-detection/data

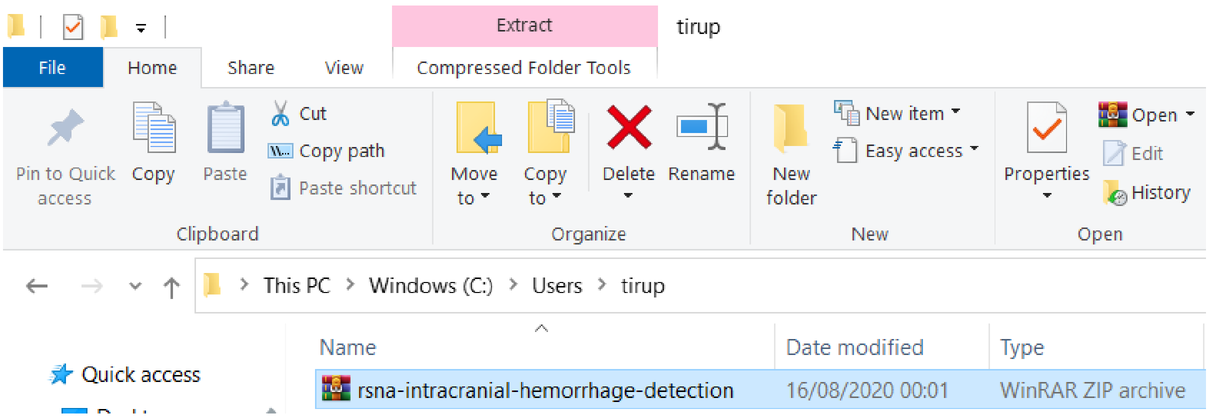
Step 8: Scroll down a bit and click on the link as per screenshot below.



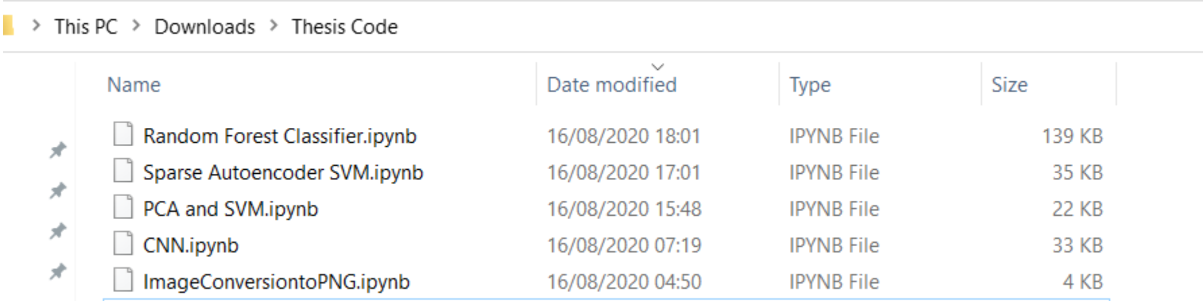
Step 9: Goto Anaconda Prompt and paste the command: **kaggle competitions download -c rsna-intracranial-hemorrhage-detection and click enter .**(refer the screenshot below).



Step 10: The dataset starts downloading in Zip folder inside Windows folder in C drive. (refer the screenshot below).



3 Code Structure

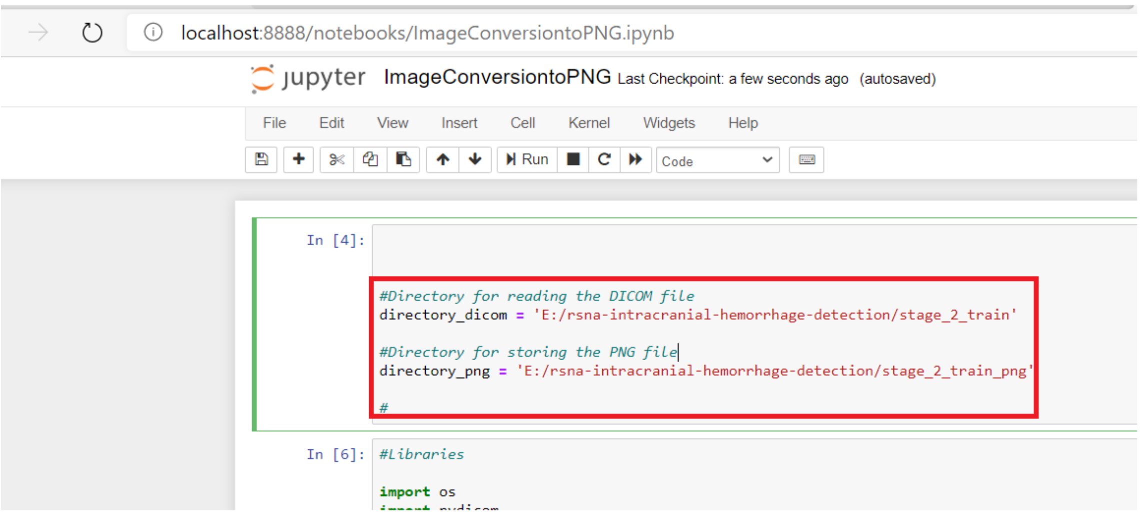


4 Data Conversion

Step 1: Unzip the data set downloaded to any specific folder you need.

Step 2: Upload the thesis code folder to jupyter notebook and open ImageConversiontoPNG.ipynb to jupyter notebook.

Step 3: Change the path for reading the DICOM file and change the path for storing the PNG file in ImageConversiontoPNG.ipynb.(Refer the screenshot below)



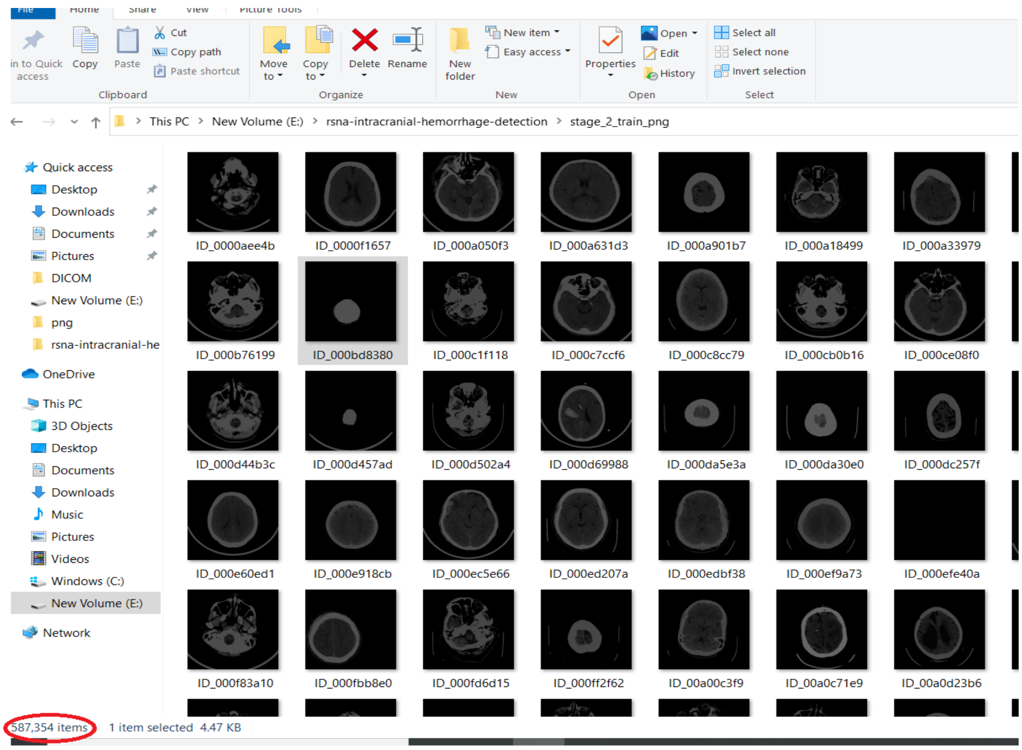
Step 4: After replacing the directory paths, import the necessary libraries.

```
In [8]: #Libraries

import os
import pydicom
import cv2
import glob
import multiprocessing as mp
import numpy as np
```

Step 5: Run the remaining part of the code.

```
In [ ]: # Functions

def window_image(img, window_center, window_width, intercept, slope):
    img = (img * slope + intercept)
    img_min = window_center - window_width // 2
    img_max = window_center + window_width // 2
    img[img < img_min] = img_min
    img[img > img_max] = img_max

    return img


def get_first_of_dicom_field_as_int(x):
    if type(x) == pydicom.multival.MultiValue:
        return int(x[0])
    else:
        return int(x)


def get_windowing(data):
    dicom_fields = [data[('0028', '1050')].value,  # window center
                    data[('0028', '1051')].value,  # window width
                    data[('0028', '1052')].value,  # intercept
                    data[('0028', '1053')].value]  # slope
    return [get_first_of_dicom_field_as_int(x) for x in dicom_fields]

def convert_to_png(dcm_in):

    dicomimage = pydicom.dcmread(dcm_in)
    window_center, window_width, intercept, slope = get_windowing(dicomimage)
    img = pydicom.read_file(dcm_in).pixel_array
    img = window_image(img, window_center, window_width, intercept, slope)
    cv2.imwrite(os.path.join(directory_png, os.path.basename(dcm_in)[:-3] + 'png'), img)

# Extract images in parallel
dicom = glob.glob(os.path.join(directory_dicom, '*.dcm'))
type(dicom)
print(dicom)
len(dicom)
import dask as dd
all_images = [dd.delayed(convert_to_png)(dicom[x]) for x in range(len(dicom))]
dd.compute(all_images)
```

Step 5: The image starts getting converted to PNG in the corresponding folder. (Refer Screenshot below)



5 Executing Sparse autoencoder and SVM Model

Step 1: Open the sparseautoencoder and SVM.ipynb from Thesis code folder.

Step 2: Set the path in the code from where data labels and PNG images are read.

```
In [2]:
#Set the path where the csv file is located
csv_path = ("E:/rsna-intracranial-hemorrhage-detection/stage_1_train.csv")

# Set the directory where converted PNG images are stored
imgpath = ("C:/Users/tirup/Downloads/trainimagespng/stage_1_train_png_224x/")
```

Step 3: Reading the train label file and creating a dataframe.

```
n [4]: import pandas as pd
import numpy as np
train_df = pd.read_csv(csv_path)
train_df['filename'] = train_df['ID'].apply(lambda st: "ID_" + st.split('_')[1] + ".png")
train_df['type'] = train_df['ID'].apply(lambda st: st.split('_')[2])
train_df.head()
```

Step 4: Creating a dataframe by checking the filename from labels dataframe and checking if the file exists for 50,000 images in the Image folder

```
In [39]: # Creating a dataframe by checking  the filename from labels dataframe and checking if the file exists in the Image folder

import os
Total_images=50000
sample_files = np.random.choice(os.listdir(imgpath), Total_images)
print(len(sample_files))
sample_df = train_df[train_df.filename.apply(lambda x: x.replace('.png', '.png')).isin(sample_files)]
sample_df = sample_df[['Label', 'filename', 'type']].drop_duplicates().pivot(
    index='filename', columns='type', values='Label').reset_index()
#sample_df = train_df[train_df.filename.apply(lambda x: x.replace('.png', '.png')).isin(sample_files)]
#sample_df = sample_df[['Label', 'filename', 'type']].drop_duplicates()
print(sample_df.shape)
sample_df.head()

sample_df = sample_df[sample_df["filename"].isin(os.listdir(imgpath))]
print(sample_df.shape)
sample_df.head()
```

Step 5: Splitting the label data frame created into test and train labels data frame.

```
In [93]: from sklearn.model_selection import train_test_split

train_label, test_label = train_test_split(sample_df, test_size=0.2)
print(train_label.shape)
print(test_label.shape)
arraylist1=list(train_label.index.values)
print(len(arraylist1))
arraylist2=list(test_label.index.values)
print(len(arraylist2))
```

Step 6: Import libraries for loading training image and convert to numpy array

```
: from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, load_img
import PIL
```

Step 6: After splitting the label dataframe, read filename and from numpy array for training images.

```
In [95]: from keras.preprocessing import image
all_images=[]
for i in arraylist1:
    file = train_label.loc[i]["filename"]
    if(os.path.isfile(imgpath+file)):
      img = image.load_img(imgpath+file, target_size=(128,128))
      img = image.img_to_array(img)
      all_images.append(img)
print(len(all_images))
print(len(train_label))
```

```
Trainimagearray=np.array(all_images)
```

Step 7: Loading image for testing data and converting to numpy array

```
5]: test_images=[]
    for j in arraylist2:
      file =test_label.loc[j]["filename"]
      if(os.path.isfile(imgpath+ file)):
          img = image.load_img(imgpath+file, target_size=(128,128))
          img = image.img_to_array(img)
          test_images.append(img)
    print(len(test_images))
    print(len(test_label))
```

```
In [99]: Testimagearray=np.array(test_images)
```

Step 8: One hot encoding for train and test labels

```
#converting encoded data to categories, one hot encoded data provided in the datas

def label_img(label_arr):
    labels=[]
    for i in range(len(label_arr)):
        if (label_arr[i][0]==0):
            labels.append("Normal")
        elif (label_arr[i][1]==1):
            labels.append("Epidural")
        elif (label_arr[i][2]==1):
            labels.append("Intraparenchymal")

        elif (label_arr[i][3]==1):
            labels.append("Intraventricular")

        elif (label_arr[i][4]==1):
            labels.append("Subarachnoid")
        else:
            labels.append("Subdural")
    return labels
```

```
train_label=np.array(train_label)
train_label= label_img(train_label)
```

```
test_label=np.array(test_label)
test_label= label_img(test_label)
test_label
```

Step 9: Normalize the pixel values of training and testing image numpy arrays

```
In [30]: # Normalize the pixels
Trainimagearray = Trainimagearray/255.
Testimagearray = Testimagearray/255.
```

Step 10: Building the encoder part of the auto encoder

```
|: # Modelling the autoencoder with keras library
from keras import regularizers
from keras.layers import Dense, Activation, Embedding, concatenate, Flatten, Input
from keras.models import Model

# the encoder part
encoder_input = Input(shape=(2352,))
encoded = Dense(2000, activation='relu')(encoder_input)
encoded = Dense(500, activation='relu',
                activity_regularizer=regularizers.l1(10e-10))(encoded)
encoded = Dense(500, activation='relu',
                activity_regularizer=regularizers.l1(10e-10))(encoded)
encoded = Dense(300, activation='sigmoid',
                activity_regularizer=regularizers.l1(10e-10))(encoded)
```

Step 11: Building the decoder part of autoencoder

```
In [33]:
# Decoder Part of the autoencoder
decoded = Dense(500, activation='relu')(encoded)
decoded = Dense(500, activation='relu')(decoded)
decoded = Dense(2000, activation='relu')(decoded)
decoded = Dense(2352,)(decoded)

# this model maps an input to its reconstruction
autoencoder = Model(encoder_input, decoded)
```

Step 12. Fitting the autoencoder

```
]: # Fitting the model
autoencoder.compile(optimizer='adam', loss='mse')

autoencoder.fit(X_train, X_train, epochs=50, batch_size=28, validation_data=(X_test, X_test))
```

Step 13: Retrieving the encoded image from autoencoder.

```
39]: # retrieving the encoded training image from auto encoder
Encodeimagetrain=encoder.predict(X_train)
```

```
2]: # retrieving encoded image for testing images
Encodeimagetest=encoder.predict(X_test)
```

Step 14: Training the SVM classifier and predicting for training set of images.

```
4]: # Training the SVM classifier with encoder training images
from sklearn.svm import SVC
svm = SVC(kernel='rbf', probability=True, random_state=0, gamma=.01, C=1)

# fit model
SVMmodel=svm.fit(Encodeimagetrain, train_label)
```

```
5]: # Testing the SVM classifier with encoded image of test image array
SVMPredict=SVMmodel.predict(Encodeimagetest)
```

Step 15. Accuracy of the Model

```
]: # Accuracy of the model
from sklearn.metrics import accuracy_score
# calculate accuracy
accuracy = accuracy_score(test_label, SVMPredict)
print('Model accuracy is: ', accuracy)
```

Step 16: Generating the confusion matrix.

```
: from sklearn.metrics import confusion_matrix,classification_report
matrix=confusion_matrix(test_label,SVMPredict, labels=['Any','Normal','Epidural','Subdural','Intraparenchyma
print(matrix)
```

Step 17. Classification report for precision, recall and f1 score

```
[48]: report = classification_report(test_label,SVMPredict,labels=['Any','Normal','Epidural','Subdural','Intraparenchymal','Intraventr
print('Classification report : \n',report)
```

6 Executing the PCA and SVM Model

Step 1: Open the PCA and SVM.ipynb from Thesis code folder.

Step 2: Set the path in the code from where data labels and PNG images are read.

```
In [2]:
#Set the path where the csv file is located
csv_path = ("E:/rsna-intracranial-hemorrhage-detection/stage_1_train.csv")

# Set the directory where converted PNG images are stored
imgpath = ("C:/Users/tirup/Downloads/trainimagespng/stage_1_train_png_224x/")
```

Step 3: Reading the train label file and creating a dataframe.

```
n [4]: import pandas as pd
import numpy as np
train_df = pd.read_csv(csv_path)
train_df['filename'] = train_df['ID'].apply(lambda st: "ID_" + st.split('_')[1] + ".png")
train_df['type'] = train_df['ID'].apply(lambda st: st.split('_')[2])
train_df.head()
```

Step 4: Creating a dataframe by checking the filename from labels dataframe and checking if the file exists for 50,000 images in the Image folder

```
In [39]: # Creating a dataframe by checking  the filename from labels dataframe and checking if the file exists in the Image folder

import os
Total_images=50000
sample_files = np.random.choice(os.listdir(imgpath), Total_images)
print(len(sample_files))
sample_df = train_df[train_df.filename.apply(lambda x: x.replace('.png', '.png')).isin(sample_files)]
sample_df = sample_df[['Label', 'filename', 'type']].drop_duplicates().pivot(
    index='filename', columns='type', values='Label').reset_index()
#sample_df = train_df[train_df.filename.apply(lambda x: x.replace('.png', '.png')).isin(sample_files)]
#sample_df = sample_df[['Label', 'filename', 'type']].drop_duplicates()
print(sample_df.shape)
sample_df.head()

sample_df = sample_df[sample_df["filename"].isin(os.listdir(imgpath))]
print(sample_df.shape)
sample_df.head()
```

Step 5: Splitting the label data frame created into test and train labels data frame.

```
In [93]: from sklearn.model_selection import train_test_split

train_label, test_label = train_test_split(sample_df, test_size=0.2)
print(train_label.shape)
print(test_label.shape)
arraylist1=list(train_label.index.values)
print(len(arraylist1))
arraylist2=list(test_label.index.values)
print(len(arraylist2))
```

Step 6: Import libraries for loading training image and convert to numpy array

```
: from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, load_img
import PIL
```

Step 6: After splitting the label dataframe, read filename and from numpy array for training images.

```
In [95]: from keras.preprocessing import image
all_images=[]
for i in arraylist1:
    file = train_label.loc[i]["filename"]
    if(os.path.isfile(imgpath+file)):
      img = image.load_img(imgpath+file, target_size=(128,128))
      img = image.img_to_array(img)
      all_images.append(img)
print(len(all_images))
print(len(train_label))
```

```
Trainimagearray=np.array(all_images)
```

Step 7: Loading image for testing data and converting to numpy array

```
5]: test_images=[]
for j in arraylist2:
  file =test_label.loc[j]["filename"]
  if(os.path.isfile(imgpath+ file)):
      img = image.load_img(imgpath+file, target_size=(128,128))
      img = image.img_to_array(img)
      test_images.append(img)
print(len(test_images))
print(len(test_label))
```

```
In [99]: Testimagearray=np.array(test_images)
```

Step 8: One hot encoding for train and test labels

```
#converting encoded data to categories, one hot encoded data provided in the datas

def label_img(label_arr):
    labels=[]
    for i in range(len(label_arr)):
        if (label_arr[i][0]==0):
            labels.append("Normal")
        elif (label_arr[i][1]==1):
            labels.append("Epidural")
        elif (label_arr[i][2]==1):
            labels.append("Intraparenchymal")

        elif (label_arr[i][3]==1):
            labels.append("Intraventricular")

        elif (label_arr[i][4]==1):
            labels.append("Subarachnoid")
        else:
            labels.append("Subdural")
    return labels
```

```
train_label=np.array(train_label)
train_label= label_img(train_label)
```

Step 9: Reshaping to one dimension vector for 128*128*3= 49152

```
Trainimagearray=Trainimagearray.reshape(len(Trainimagearray),49152)
Testimagearray=Testimagearray.reshape(len(Testimagearray),49152)
Trainimagearray.shape
```

Step 10:

Applying the model:

```
from sklearn.decomposition import PCA
pca = PCA(n_components=300)
pca.fit(Trainimagearray)
```

```
data_pca = pca.transform(Trainimagearray)
test_pca=pca.transform(Testimagearray)
```

```
test_label=np.array(test_label)
train_label=np.array(train_label)
```

```
train_label
from sklearn.svm import SVC
svm = SVC(kernel='linear', probability=True, random_state=42)

# fit model
SVMmodel=svm.fit(data_pca, train_label)
```

```
SVMPredict=SVMmodel.predict(test_pca)
```

Step 11: Accuracy,confusion matrix and classification report:

```
SVMPredict=SVMmodel.predict(test_pca)
```

```
from sklearn.metrics import accuracy_score
# calculate accuracy
accuracy = accuracy_score(test_label, SVMPredict)
print('Model accuracy is: ', accuracy)
```

```
from sklearn.metrics import confusion_matrix,classification_report
matrix=confusion_matrix(test_label,SVMPredict, labels=['Normal','Epidural','Subdural','Intraparenchymal','Intraventricular','Sub
print(matrix)
```

```
report = classification_report(test_label,SVMPredict,labels=['Normal','Epidural','Subdural','Intraparenchymal','Intraventricular
print('Classification report : \n',report)
```

7 Executing CNN Model

Step 1: Repeat step 1 to step 7 from previous section 5.

Step 2: Perform one hot encoding for labels.

```
In [11]: #converting encoded data to categories, one hot encoded data provided in the dataset
         import pdb
         def label_img(label_arr):
             labels=[]
             for i in range(len(label_arr)):
                 if (label_arr[i][0]==0):
                     labels.append(0)
                 elif (label_arr[i][1]==1):
                     labels.append(1)
                 elif (label_arr[i][2]==1):
                     labels.append(2)

                 elif (label_arr[i][3]==1):
                     labels.append(3)

                 elif (label_arr[i][4]==1):
                     labels.append(4)
                 else:
                     labels.append(5)
             return labels
```

```
In [12]: import sys
         test_label= label_img(np.array(test_label))
         train_label= label_img(np.array(train_label))
         train_label=np.array(train_label)
         test_label=np.array(test_label)
```

Step 3: Normalize the pixels in an image.

```
]: # Normalize the pixels in an image
   Trainimagearray = Trainimagearray/255.
   Testimagearray = Testimagearray/255.
```

Step 4: import libraries for CNN model

```
# import libraries for CNN model
from keras.layers import MaxPool2D
import keras
from keras.layers import MaxPooling2D
from keras.models import Sequential
from tensorflow import keras
from keras.layers import Conv2D
```

Step 5: Building the CNN Model.

```
#Building the model
model = Sequential([
    Conv2D(16, (3, 3), activation='sigmoid', input_shape=(224,224, 3)),
    MaxPooling2D(2, 2),

    Conv2D(32, (3, 3), activation='sigmoid'),
    MaxPooling2D(2, 2),

    Conv2D(64, (3, 3), activation='sigmoid'),
    Conv2D(64, (3, 3), activation='sigmoid'),
    MaxPooling2D(2, 2),

    Conv2D(128, (3, 3), activation='sigmoid'),
    Conv2D(128, (3, 3), activation='relu'),
    MaxPooling2D(2, 2),
    Dropout(0.50),

    Flatten(),
    Dense(512, activation='relu'),
    Dense(6, activation='softmax')
])

model.compile(optimizer='sgd', loss='sparse_categorical_crossentropy', metrics =['accuracy'])
```

Step 6: Fitting the model.

```
# fitting the model
Model=model.fit(Trainimagearray, train_label, epochs=50,verbose=1, batch_size=28, validation_data=(Testimagearray, test_label))
```

8 Executing the Random Forest Classifier.

Step 1: Follow the steps from 1 to 9 used in Section 5.
Step 2: Generate the random forest classifier

```
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier(n_estimators=10)
rf.fit(Trainimagearray,train_label)
# Predictions on training and validation
y_pred_train = rf.predict(Testimagearray)

# training metrics
from sklearn.metrics import accuracy_score
# calculate accuracy
accuracy = accuracy_score(test_label, y_pred_train)
print('Model accuracy is: ', accuracy)
```

Step 4. Generate the confusion matrix using sk learn library

```
from sklearn.metrics import confusion_matrix,classification_report
matrix=confusion_matrix(test_label,y_pred, labels=['Normal','Epidural','Subdural','Intraparenchymal','Intraventricular','Subarac
print(matrix)
```

Step 4. Create the classification report for evaluation metrics like precision, recall, f1score.

```
from sklearn.metrics import classification_report
report = classification_report(test_label,y_pred_train,labels=['Any','Normal','Epidural','Subdural','Intraparenchymal','Intraven
print('Classification report : \n',report)
```