

Chapter 3

PROJECT DESCRIPTION

3.1 Existing System

3.1.1 Developmental surveillance

Developmental surveillance is a flexible process whereby knowledgeable clinicians gather relevant information over time from multiple sources (including parents and by direct observation) toward the goal of identifying and addressing developmental concerns, including those related to ASD. Developmental surveillance involves integrating information obtained from inquiry around parental concerns, clinical observations and, possibly, also incorporating standardized measures (e.g., parent questionnaires) to inform clinical impressions and decision making.

3.1.2 Developmental screening

Developmental screening involves a brief assessment using a standardized measure to identify children at increased risk for delay or disorder. Screens vary by format (e.g., parent report versus direct assessment of the child) and scope ('broadband' screens cover multiple developmental domains versus those specific to a particular domain or disorder). Clinicians may use clinical judgement when considering referral for further assessment, even when a child has a 'screen-negative' score. Considerations include clinical observations, parental concerns, and other suggestive factors, such as a positive family history.

3.1.3 Developmental diagnosis

A brief test using a screening tool does not provide a diagnosis, but it can indicate whether a child is on the right development track or if a specialist should take a closer look. If the screening tool identifies an area of concern, a formal developmental evaluation may be needed. This formal evaluation is a more in-depth look at a child's development and is usually done by a trained specialist such as a developmental pe-

diatrician, child psychologist, speech-language pathologist, occupational therapist, or other specialist. The specialist may observe the child give the child a structured test, ask the parents or caregivers questions, or ask them to fill out questionnaires. The results of this formal evaluation highlight your child's strengths and challenges and can inform whether they meet criteria for a developmental diagnosis.

3.2 Proposed System

The idea of our proposed system is to detect markers of Autism Spectrum Disorder (ASD) in young children without the use of heavy machinery and medical expertise. The only machinery that are used in this project are eye tracker and a computer system. Because of the ease of usage, our system can be put to use in any environment. As our system does not include medical machinery, children will feel safe and are thus cooperative and less reluctant with the examination . The spontaneity and speed in which our system produces results make it easier and less time consuming to decide if a child possesses the symptoms of autism. If that is the case , then the child can be put under further examination or tests to confirm the disorder. If a child does not show markers of autism then no further tests are required which saves a lot of time, energy and money.

3.3 Feasibility Study

The feasibility study helps with the project's analysis. This project's feasibility study is divided into three categories.

3.3.1 Economic Feasibility

As our project includes less machinery and decreases the requirement of high expertise, it is safe to say that our project is economically feasible. Since most of the equipment is already used in the beginning to record the raw data of the patient it prevents any additional equipment even if the project is developed further in the future.

3.3.2 Technical Feasibility

Our project requires simple hardware equipment i.e, the eye tracker and a computer system, the rest of the equipment is software based. The software equipment involves usage of classification techniques of deep learning such as 1NN and CNN , which produce accurate results. All the programming is done in python hence it is very simple and easy to understand even if any changes or developments are required in the future it is easy to apply them in python.

3.3.3 Social Feasibility

Since our project does not involve heavy and complicated medical equipment it is easy to collect data from a child at the comfort of their own home, school etc,. Children tend to be more comfortable around people that they know or in an environment familiar to them rather than a hospital. This makes it easy to collect their eye tracking data, thus making it socially feasible.

3.4 System Specification

3.4.1 Hardware Specification

- Processor: Minimum 1 GHz; Recommended 2GHz or more.
- Ethernet connection: (LAN) OR a wireless adapter (Wi-Fi).
- Hard Drive: Minimum 32 GB; Recommended 64 GB or more.
- Memory (RAM): Minimum 1 GB; Recommended 4 GB or above.
- FaceLAB head-free binocular eye-tracking system (60 Hz)

3.4.2 Software Specification

- IDE : Anaconda
- Programming languages:HTML,Python 3.9
- Keras
- Tensorflow
- Numpy
- seaborn
- matplotlib

- pandas
- jupyter

3.5 Data Set

Data is present in multiple excel files. Each file is for each patient and is present with the name format: Class-Patient-ID-Age-Gender-Initials Each file consists of various number of sheets for different images the patient is looking at. Some of the images are: Buffer slide, Black slide, White slide and image slides. An example of few of the images is given in the next slide. Each patient file contains the following data: x, y, Left Diameter, Right Diameter, Time, Look Zone (eyes, nose, head, screen, mouth, object, etc). ‘x’ and ‘y’ are the pixels of the image (with dimensions AKA resolution 1024*768). The data is ‘x’ and ‘y’ columns represents on which pixel the patient gazed his look on. Left diameter and right diameter represent the pupillometric measurements of the patient. They represent the diameters of the left eye pupil and right eye pupil respectively for that particular pixel that is being stared upon. Time – this column represents the amount of time the patient stared at a particular pixel LookZone – this represents the area of an image where the patient looked at. The images consist of either faces of humans (blurred and normal) or objects (blurred and normal). Therefore, the LookZones either represent the facial features of the image (human face) or of the objects.

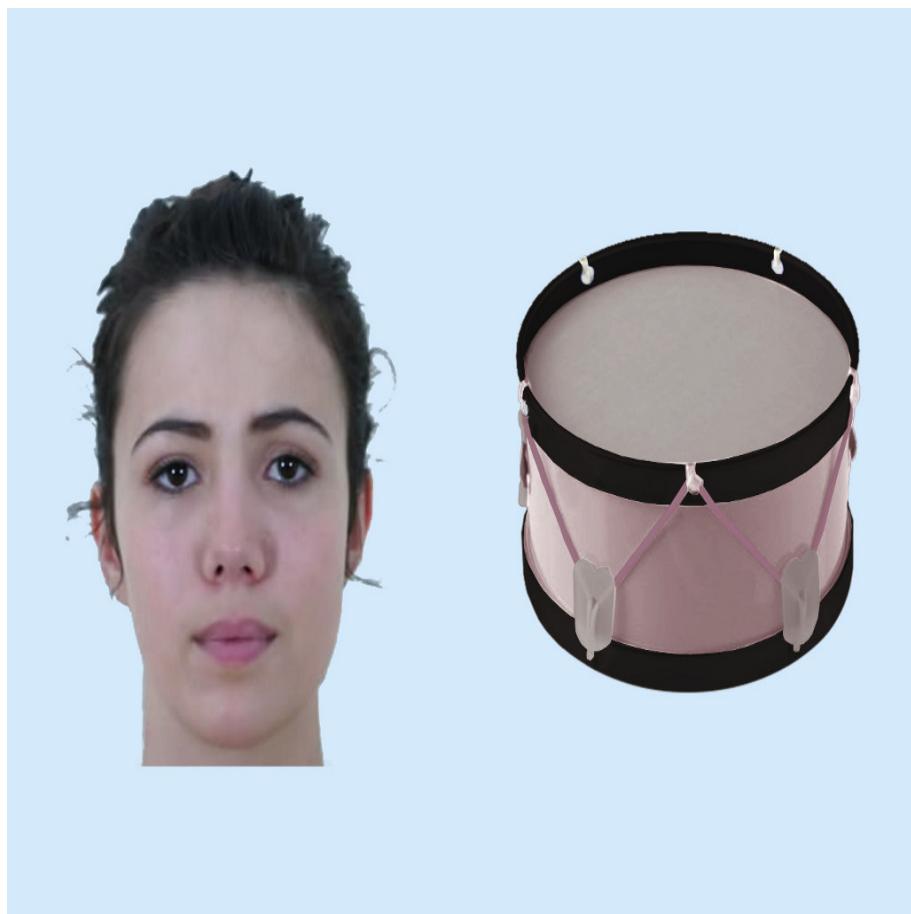


Figure 3.1: An Example of image shown to the patient, Stim - visob04.jpg

Chapter 4

METHODOLOGY

4.1 General Architecture

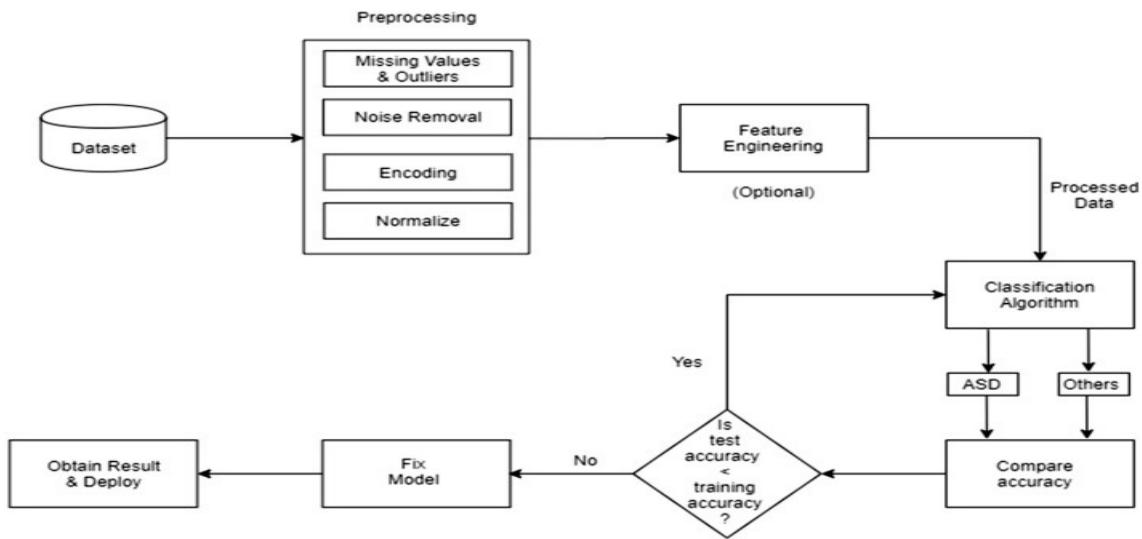


Figure 4.1: General Block Diagram of Machine Learning

The architecture diagram provides the outline of the project. The raw data or dataset of the patients collected has to be preprocessed by including the missing values like patient id ,age, gender,lz zone,class ,etc. and merging all the files into one large all data file for further processes. All data file file is further undergo feature engineering and then the processed data is classified.

4.2 Design Phase

4.2.1 Data Flow Diagram

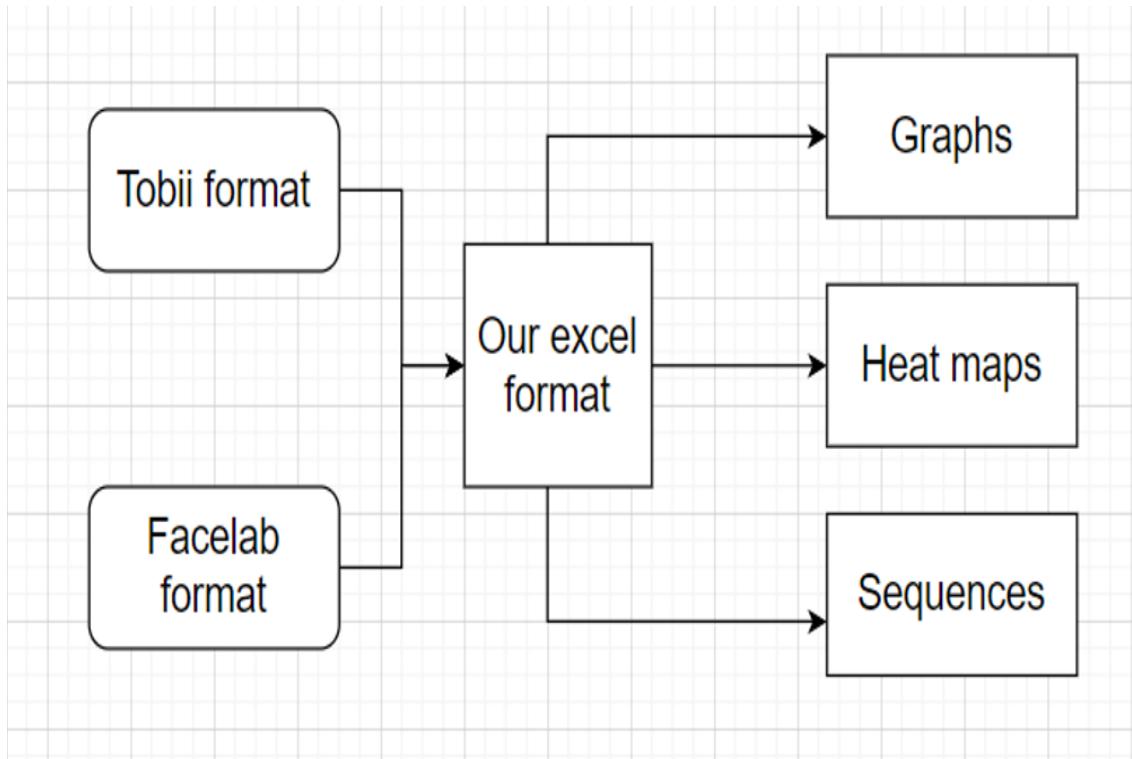


Figure 4.2: **Data Flow Block Diagram**

Data flow diagram is a pictorial or graphical representation. It can be applied to represent the input data to a system and multiple functions carried out on the data and the output is generated by the system. The collected data is pre-processed and the duplicate values are deleted. The raw data collected by using facelab eye tracker is preprocessed and converted into excel format which can be accessed easily. Using that excel data file we have generate matrices and heatmaps for further classification.

4.2.2 Activity Diagram

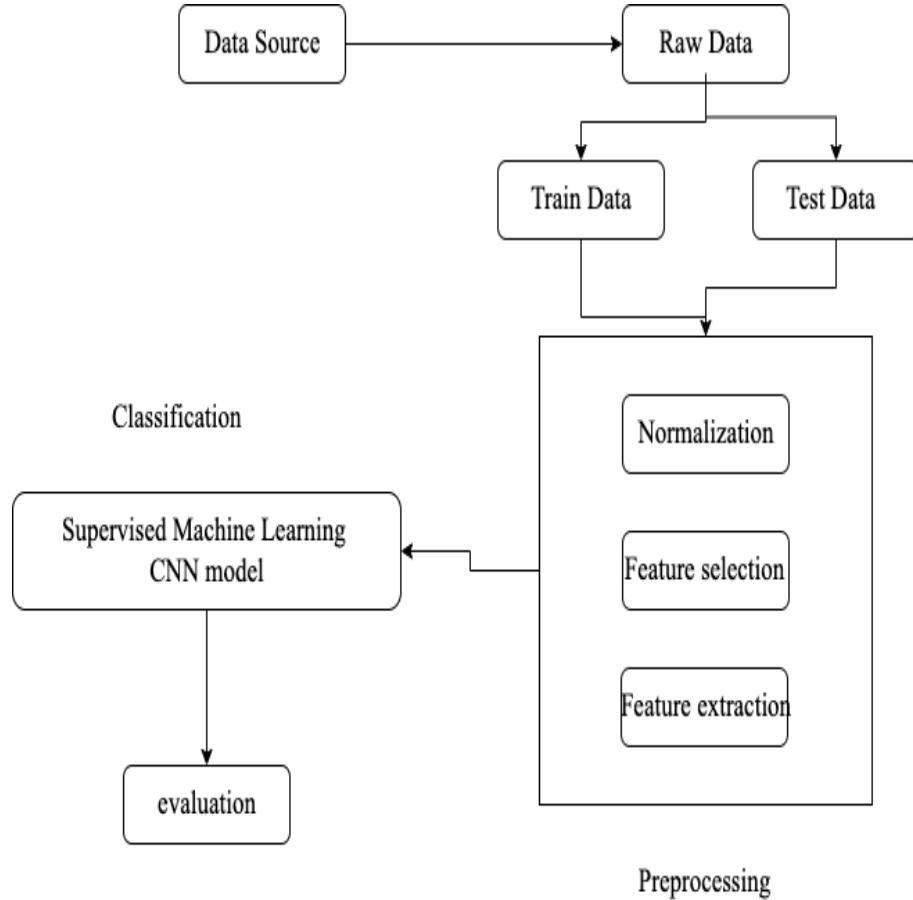


Figure 4.3: **Activity Diagram**

Activity diagram is made to understand the flow of activities in the project. In the above diagram there are 3 major activities they are data collection, feature extraction and prediction . After collecting the data the raw data is preprocessed and the duplicate values are removed from the data set .if there are no duplicate values then the data is sent to feature extraction where the features of data are extracted and the data with similar features are assigned to near. then the data is sent for ML training and the Autism markers are predicted . Figure 4.6 shows about the Activity diagram.

4.3 Algorithm & Pseudo Code

4.3.1 Algorithm

Algorithm For Adding Sheet Name Column :

- Step 1 : Import requuired libraries
- Step 2 : Read the folder of data set
- Step 3 : Read each file in the folder
- Step 4 : Read file as pandas dataframe
- Step 5 : Get the sheetnames in each file
- Step 6 : Adding sheet name column to the file
- Step 7 : Save the files with sheetname column in excel format

```
In [1]: #import required libraries

import pandas as pd
import os

In [ ]: # read the folder of data set

folder = "/Users/dhanu/Desktop/Patients/"

In [ ]: #read each file in the folder

for file in listdir.os(folder):
    df = pd.read_excel(file) #read file as pandas dataframe
    sheets = df.sheet_names #get the sheetnames in each file
    #adding sheet name column to the file
    df1 = pd.concat([pd.read_excel(df, sheet_name=s).assign(sheet_name=s) for s in sheets])
    # save the files with sheetname column in excel format
    df1.to_excel("/Users/dhanu/Desktop/c_out/" + file + ".xlsx")
```

Figure 4.4: code for adding sheet name column in excel file

Algorithm For Adding File Name Column :

- Step 1 : Import requuired libraries
- Step 2 : Read the folder of files with sheetnames added

Step 3 : Create an empty dataframe

Step 4 : Read each file in folder and add filename column

Step 5 : Append all the files with filename column to the empty dataframe

Step 6 : Save the dataframe as excel file

```
In [4]: #import required libraries

import pandas as pd
import os
import numpy as np

In [24]: # read the folder
path = r'/Users/dhanu/Desktop/c2/'
output_loc = "/Users/dhanu/Desktop/cp all/"
files = os.listdir(path)

In [27]: #create an empty dataframe
df_total = pd.DataFrame()

for file in files:
    #read each file in folder and add filename column
    df_temp = pd.read_excel(path + "" + file)
    df_temp['filename'] = file
    #append all the files with filename column to the empty dataframe
    df_total = df_total.append(df_temp)
#save the dataframe as excel file
df_total.to_excel("/Users/dhanu/Desktop/cp all/c2final.xlsx")

In [ ]:
```

Figure 4.5: code for adding filename column in excel file

Algorithm for removing unwanted data and nodata updation:

Step 1 : Import required libraries

Step 2 : Read the sheetname column and filename column added file

Step 3 : Remove the unwanted data by column filtering

Step 4 : Dealing with the nodata cells

Step 5 : Save the dataframe as excel file

```

In [57]: #import required libraries
import pandas as pd
import numpy as np
import os
import openpyxl

In [58]: #read the excel file with both sheetname column and filename column
DF = pd.read_excel('/Users/dhanu/Desktop/final/finalp.xlsx')

In [59]: #remove unwanted data
f1 = DF[(DF['sheet_name']!= 'Black Slide - F')
& (DF['sheet_name']!= 'Black Slide - STAT')
& (DF['sheet_name']!= 'Black Slide - F 2')
& (DF['sheet_name']!= 'White Slide - F')
& (DF['sheet_name']!= 'White Slide - STAT')
& (DF['sheet_name']!= 'Buffer Slide - F')
& (DF['sheet_name']!= 'Buffer Slide - F 2')
& (DF['sheet_name']!= 'Buffer Slide - F 3')
& (DF['sheet_name']!= 'Buffer Slide - F 4')
& (DF['sheet_name']!= 'Buffer Slide - F 5')
& (DF['sheet_name']!= 'Buffer Slide - F 6')
& (DF['sheet_name']!= 'Buffer Slide - F 7')
& (DF['sheet_name']!= 'Buffer Slide - F 8')
& (DF['sheet_name']!= 'Buffer Slide - F 9')
& (DF['sheet_name']!= 'Buffer Slide - F 10')
& (DF['sheet_name']!= 'Buffer Slide - F 11')
& (DF['sheet_name']!= 'Buffer Slide - F 12')
& (DF['sheet_name']!= 'Buffer Slide - F 13')
& (DF['sheet_name']!= 'Buffer Slide - F 14')
& (DF['sheet_name']!= 'Buffer Slide - F 15')
& (DF['sheet_name']!= 'Buffer Slide - F 16')
& (DF['sheet_name']!= 'Buffer Slide - F 17')
& (DF['sheet_name']!= 'Buffer Slide - F 18')
& (DF['sheet_name']!= 'Buffer Slide - F 19')
& (DF['sheet_name']!= 'Buffer Slide - F 20')
& (DF['sheet_name']!= 'Buffer Slide - F 21')
& (DF['sheet_name']!= 'Buffer Slide - F 22')
& (DF['sheet_name']!= 'Buffer Slide - F 23')
& (DF['sheet_name']!= 'Buffer Slide - F 24')

```

```

& (DF[ 'sheet_name' ]!= 'mosob03.jpg - F')
& (DF[ 'sheet_name' ]!= 'mosob04.jpg - F')
& (DF[ 'sheet_name' ]!= 'mosob04.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'ob01.jpg - F')
& (DF[ 'sheet_name' ]!= 'ob01.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'ob02.jpg - F')
& (DF[ 'sheet_name' ]!= 'ob02.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'ob03.jpg - F')
& (DF[ 'sheet_name' ]!= 'ob03.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'ob04.jpg - F')
& (DF[ 'sheet_name' ]!= 'ob04.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vis01.jpg - F')
& (DF[ 'sheet_name' ]!= 'vis01.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vis02.jpg - F')
& (DF[ 'sheet_name' ]!= 'vis02.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vis03.jpg - F')
& (DF[ 'sheet_name' ]!= 'vis03.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vis04.jpg - F')
& (DF[ 'sheet_name' ]!= 'vis04.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vismos01.jpg - F')
& (DF[ 'sheet_name' ]!= 'vismos01.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vismos02.jpg - F')
& (DF[ 'sheet_name' ]!= 'vismos02.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vismos03.jpg - F')
& (DF[ 'sheet_name' ]!= 'vismos03.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'vismos04.jpg - F')
& (DF[ 'sheet_name' ]!= 'vismos04.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'visob01.jpg - F')
& (DF[ 'sheet_name' ]!= 'visob01.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'visob02.jpg - F')
& (DF[ 'sheet_name' ]!= 'visob02.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'visob03.jpg - F')
& (DF[ 'sheet_name' ]!= 'visob03.jpg - STAT')
& (DF[ 'sheet_name' ]!= 'visob04.jpg - F')
& (DF[ 'sheet_name' ]!= 'visob04.jpg - STAT')
]
#save it as the excel file
f1.to_excel( "/Users/dhanu/Desktop/finally/p.xlsx", index = False)

```

In []:

Figure 4.6: code for removing unwanted data

```

In [30]:
import pandas as pd
import os
import numpy as np

In [31]:
df = pd.read_excel("/Users/dhanu/Desktop/final1/f1.xlsx")

In [33]:
new_df = df['X'].fillna('nodata', inplace = True)

In [35]:
new_df = df['Y'].fillna('nodata', inplace = True)

In [37]:
new_df = df['Left Diam'].fillna('nodata', inplace = True)

In [38]:
new_df = df['Right Diam'].fillna('nodata', inplace = True)

In [40]:
new_df = df['TIme'].fillna('nodata', inplace = True)

In []:
df.to_excel("/Users/dhanu/Desktop/final1/f2.xlsx", index = False)

```

Figure 4.7: code for updating nodata cells

Algorithm for Splitting Filename Column:

- Step 1 : import required libraries.
- Step 2 : read the excelfile as dataframe.
- Step 3 : remove the extension in filename column.
- Step 4 : split the filename column into seprate columns.
- Step 5 : give names to the split columns.
- Step 6 : save the dataframe as an excel file.

```

In [2]: #import the required libraries
import pandas as pd
import os

In [3]: #read the excel file as dataframe
df = pd.read_excel("/Users/dhanu/Desktop/final1/g3.xlsx")

In [4]: #remove the extension in filename column
df['File Name'] = df['File Name'].str.replace('.xlsx','')

/var/folders/02/k754q_hn7kvdlvjfl_vyr79m000gn/T/ipykernel_8695/591001716.py:2: FutureWarning: The default value of expand is deprecated. Use expand=True instead.
df['File Name'] = df['File Name'].str.replace('.xlsx','')

In [11]: #split the filename column into separate columns
split_d = df['File Name'].str.split('_',n = -1,expand = True)

In [41]: #give names to the split columns
df[['Class','Patient ID','Age(in months)','Gender','Initials']] = df['File Name'].str.split('_',expand = True)

In [43]: #save the dataframe as excel file
df.to_excel("/Users/dhanu/Desktop/final1/f1.xlsx",index = False)

```

Figure 4.8: **code for splitting filename column**

Algorithm for Splitting LZ Name Column:

Step 1 : import required libraries.

Step 2 : read the excelfile as dataframe.

Step 3 : split the LZ name column by reading the column from right to left.

Step 4 : give names to the split columns.

Step 5 : save the updated dataframe as an excel file.

```

In [90]: #import the required libraries
          import pandas as pd
          import os
          import openpyxl

In [92]: #read the excel file as dataframe
          df = pd.read_excel("/Users/dhanu/Desktop/final1/dhanu.xlsx")

In [103...]: #split the LZ name column by reading the column from right to left
            df["Lz3"] = df["LZ Name"].str.split().str[-1]
            df["Lz2"] = df["LZ Name"].str.split().str[-2]
            df["Lz1"] = df["LZ Name"].str.split().str[-3]

In [102...]: #save the updated dataframe as excel file
            df.to_excel("/Users/dhanu/Desktop/final1/dhanu2.xlsx")

```

Figure 4.9: code for splitting LZ Name column

Algorithm for Splitting excelfile into multiple excelfiles based on Column values:

Step 1 : Import required libraries.

Step 2 : Read the excelfile as dataframe.

Step 3 : Split the file into multiple files based on column value using unique() function.

Step 4 : Repeat the same code for multiiple columns until we get the desired files.

Step 5 : Save the dataframes as excel files with names as unique column values.

```

In [1]: #import required libraries
import pandas as pd
import numpy as np
import openpyxl
import os

In [14]: #read the final all data excel file as dataframe
df = pd.read_excel("/Users/dhanu/Desktop/split/p.xlsx")

In [16]: #give output location
output = "/Users/dhanu/Desktop/split/p"

In [18]: # split the all data file into different excel files based on column values
pid = df['Patient ID'].unique()
for ids in pid:
    df1 = df[df['Patient ID'] == ids]
    path = os.path.join(output,str(ids)+".xlsx")
    #read the dataframes into different excel files with names as unique column values
    df1.to_excel(path,index = False)

```

Figure 4.10: code for splitting file into multiple files based on column values

Algorithm For Generating HeatMmaps :

Step 1 : Import required libraries.

Step 2 : Read the folder of matrices.

Step 3 : Read each file from the folder using for loop.

Step 4 : Read that file as dataframe matrix.

Step 5 : Create a zero numpy matrix.

Step 6 : If the cell value in matrix is not zero then increase the cell value by 5.

Step 7 : Convert that updated numpy matrix to datframe matrix.

Step 8 : If the cell value is not equal to zero then covert it into numpy matrix and add ones 7*7 matrix.

Step 9 : Convert that numpy matrix to dataframe matrix by retreiving previous value in non zero cell.

Step 10 : Convert the dataframe matrix to seaborn matrix.

Step 11 : Save the heatmap as jpg file.

```

In [1]: #import required libraries
import pandas as pd
import numpy as np
import os
from scipy.ndimage import gaussian_filter
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.ndimage.morphology import binary_dilation
from scipy.signal import convolve2d

In [3]: #read the folder of matrices
folder = "/Users/dhanu/heatmaps from matrix"
plt.rcParams.update({'figure.max_open_warning': 0})

In [4]: #read eachfile from the folder
for file in os.listdir(folder):
    if file.startswith("mos01"):
        #read each file as dataframe matrix
        df = pd.read_excel(file)
        df = df.to_numpy()
        #create a zero numpy matrix
        df_inc = np.zeros((1023, 768), dtype=int)
        for i in range(1023):
            for j in range(768):
                if df[i][j] != 0:
                    #if the cell value in matrix is not zero then increase the cell value by 5
                    df_inc = np.where(df, df+5, df)
        #convert that updated numpy matrix to dataframe matrix
        df1 = pd.DataFrame(df_inc)
        #if the cell value is not equal to zero then covert it into numpy matrix and add ones 7*7 matrix
        a = df1.ne(0).to_numpy()
        b = np.ones((7,7))
        #convert that numpy matrix to dataframe matrix by retreiving previous value in non zero cell.
        df1 = pd.DataFrame(np.where(binary_dilation(a,b)^a,3, df1))
        plt.figure(figsize=(14.236, 10.67))
        #convert the dataframe matrix to seaborn matrix
        ax = sns.heatmap(df1,cmap ="Greys_r",cbar = False)
        ax.invert_yaxis()
        plt.axis('off')
        #save the heatmap as jpg file
        output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mos01", file + '.jpg')
        plt.savefig(output)

```

Figure 4.11: code for generating heatmaps

4.3.2 Pseudo Code

4.4 Module Description

4.4.1 Module1: Data Preprocessing

Data is present in multiple excel files. Each file is for each patient and is present with the name format: Class-Patient-ID-Age-Gender-Initials Each file consists of various number of sheets for different images the patient is looking at. Some of the images are: Buffer slide, Black slide, White slide and image slides. An example of few of the images is given in the next slide. Each patient file contains the following data: x, y, Left Diameter, Right Diameter, Time, Look Zone (eyes, nose, head, screen, mouth, object, etc). ‘x’ and ‘y’ are the pixels of the image (with dimensions AKA resolution 1024*768). The data is ‘x’ and ‘y’ columns represents on which pixel the patient gazed his look on. Left diameter and right diameter represent the pupillometric measurements of the patient. They represent the diameters of the left eye pupil

and right eye pupil respectively for that particular pixel that is being stared upon. Time – this column represents the amount of time the patient stared at a particular pixel LookZone – this represents the area of an image where the patient looked at. The images consist of either faces of humans (blurred and normal) or objects (blurred and normal). Therefore, the LookZones either represent the facial features of the image (human face) or of the objects.

A	B	C	D	E	F	G	H	I	J	K	L	M	N
visob04.jpg - G	Number	X	Y	Left Diam	Right Diam	Time	LZ Name						
F:\Protocoles\SEOP	1	556	552	3.6	0	0.014	Droite						
F:\Protocoles\SEOP	2	513	377	3.7	3.6	0.031	Droite						
F:\Protocoles\SEOP	3	526	493	3.8	3.6	0.047	Droite						
F:\Protocoles\SEOP	4	512	484	3.8	3.7	0.064	Droite						
F:\Protocoles\SEOP	5	521	527	3.7	0	0.081	Droite						
F:\Protocoles\SEOP	6	546	353	4	0	0.114	Droite						
F:\Protocoles\SEOP	7	348	428	3.7	0	0.364	Gauche						
F:\Protocoles\SEOP	8	271	405	3.7	3.4	0.381	Gauche						
F:\Protocoles\SEOP	9	274	395	3.7	3.4	0.397	Gauche						
F:\Protocoles\SEOP	10	282	375	3.7	3.4	0.414	Gauche						
F:\Protocoles\SEOP	11	275	375	3.6	3.4	0.431	Gauche						
F:\Protocoles\SEOP	12	277	392	3.7	3.4	0.447	Gauche						
F:\Protocoles\SEOP	13	254	413	3.7	3.4	0.464	Gauche						
F:\Protocoles\SEOP	14	266	410	3.7	3.5	0.481	Gauche						
F:\Protocoles\SEOP	15	263	403	3.7	3.5	0.497	Gauche						
F:\Protocoles\SEOP	16	335	443	3.7	0	0.514	Gauche						
F:\Protocoles\SEOP	17	279	412	3.7	3.5	0.531	Gauche						
F:\Protocoles\SEOP	18	287	383	3.7	3.6	0.547	Gauche						
F:\Protocoles\SEOP	19	281	359	3.7	3.6	0.564	Gauche						
F:\Protocoles\SEOP	20	281	351	3.7	3.6	0.581	Gauche						
F:\Protocoles\SEOP	21	277	349	3.7	3.9	0.597	Gauche						
F:\Protocoles\SEOP	22	272	350	3.7	3.9	0.614	Gauche						
F:\Protocoles\SEOP	23	267	351	3.7	3.9	0.631	Gauche						
F:\Protocoles\SEOP	24	288	412	3.7	3.5	0.647	Gauche						
F:\Protocoles\SEOP	25	280	436	3.7	3.4	0.664	Gauche						
F:\Protocoles\SEOP	26	271	411	3.7	3.1	0.681	Gauche						

Figure 4.12: An Example Raw Data File of Patient 17, Class - C

We have to combine all the sheets inside each file and then combine all the files to make one large all data file which is easy to access for further processes using python. I have to combine the files by adding columns with patient id ,gender ,class and age and have to remove irrelevant data like sheets which ends with F. there is this no data case in some patients for some images ,it happens when that child is not looking at the image or screen. In that case that sheets has only one no data cell. So while combing all sheets it will give empty cells in remaining columns so to deal with it it should be filled with “nodata” string. And also have to split the LZ column into 3.LZ is look zone at which the patient is seeing it is in French words like tete(head),ecran(screen),bouche(mouth).I have to split it into 3 columns by reading

it from right to left to get the required order.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	X	Y	Left Diam	Right Diam	Time	Sheet Name	Class	Patient ID	Age(in months)	Gender	Initials	Lz1	Lz2	Lz3		
2	978	537	0	0	0.005	Black Slide	C	51	61	M	MC					
3	978	537	0	0	0.022	Black Slide	C	51	61	M	MC					
4	977	537	0	0	0.038	Black Slide	C	51	61	M	MC					
5	977	537	0	0	0.055	Black Slide	C	51	61	M	MC					
6	976	538	0	0	0.070	Black Slide	C	51	61	M	MC					
7	975	538	0	0	0.088	Black Slide	C	51	61	M	MC					
8	973	538	0	0	0.105	Black Slide	C	51	61	M	MC					
9	972	537	0	0	0.122	Black Slide	C	51	61	M	MC					
10	972	535	0	0	0.138	Black Slide	C	51	61	M	MC					
11	972	534	0	0	0.155	Black Slide	C	51	61	M	MC					
12	973	532	0	0	0.171	Black Slide	C	51	61	M	MC					
13	972	531	0	0	0.188	Black Slide	C	51	61	M	MC					
14	971	530	0	0	0.205	Black Slide	C	51	61	M	MC					
15	970	529	0	0	0.222	Black Slide	C	51	61	M	MC					
16	970	529	0	0	0.238	Black Slide	C	51	61	M	MC					
17	970	528	0	0	0.255	Black Slide	C	51	61	M	MC					
18	970	528	0	0	0.271	Black Slide	C	51	61	M	MC					
19	970	528	0	0	0.288	Black Slide	C	51	61	M	MC					
20	972	528	0	0	0.305	Black Slide	C	51	61	M	MC					
21	974	529	0	0	0.321	Black Slide	C	51	61	M	MC					
22	975	530	0	0	0.338	Black Slide	C	51	61	M	MC					
23	973	530	0	0	0.355	Black Slide	C	51	61	M	MC					
24	971	530	0	0	0.371	Black Slide	C	51	61	M	MC					
25	970	530	0	0	0.388	Black Slide	C	51	61	M	MC					
26	971	530	0	0	0.405	Black Slide	C	51	61	M	MC					
27	972	530	0	0	0.421	Black Slide	C	51	61	M	MC					
28	971	530	0	0	0.438	Black Slide	C	51	61	M	MC					
29	967	529	0	0	0.455	Black Slide	C	51	61	M	MC					
30	958	527	0	0	0.471	Black Slide	C	51	61	M	MC					
31	952	526	0	0	0.488	Black Slide	C	51	61	M	MC					
32	946	524	0	0	0.505	Black Slide	C	51	61	M	MC					
33	941	523	0	0	0.521	Black Slide	C	51	61	M	MC					
34	937	521	0	0	0.538	Black Slide	C	51	61	M	MC					
35	932	519	0	0	0.555	Black Slide	C	51	61	M	MC					
36	926	517	0	0	0.571	Black Slide	C	51	61	M	MC					
37	923	517	0	0	0.588	Black Slide	C	51	61	M	MC					
38	920	517	0	0	0.605	Black Slide	C	51	61	M	MC					
39	915	515	0	0	0.621	Black Slide	C	51	61	M	MC					
40	907	515	0	0	0.638	Black Slide	C	51	61	M	MC					
41	732	470	0	0	0.655	Black Slide	C	51	61	M	MC					
42	630	428	0	0	0.671	Black Slide	C	51	61	M	MC					
43	631	426	0	0	0.688	Black Slide	C	51	61	M	MC					
44	632	426	0	0	0.705	Black Slide	C	51	61	M	MC					

Figure 4.13: All Data File after Preprocessing

4.4.2 Module2:Generation of Matrices

To generate the matrix we need to split that all data file into different files based on image name, patient id, class. After splitting I got around 4455 excel files and have to generate matrices (using x and y values) for all those files separately. A matrix was created for each file (for X and Y values) using ‘Crosstab’ function [6]. The values in the matrix shows the number of occurrences of intersection of a particular X Y value. The dimensions of each matrix were 1024*768.

	JP	JQ	JR	JS	JT	JU	JV	JW	JX	JY	JZ	KA
460	0	0	0	0	0	0	0	0	0	0	0	0
461	0	0	0	0	0	0	0	1	0	0	0	0
462	0	0	0	0	0	0	0	0	1	1	0	0
463	0	0	0	0	0	0	0	0	0	0	1	0
464	0	0	0	0	0	0	0	0	0	0	0	1
465	0	0	0	0	0	0	0	0	0	0	1	0
466	0	0	0	0	0	0	0	0	1	0	0	0
467	0	0	0	0	0	0	0	0	0	0	0	0
468	0	0	0	0	0	0	0	0	2	1	0	0
469	0	0	0	0	0	0	0	1	0	0	1	0
470	0	0	0	0	0	0	0	0	0	1	0	2
471	2	0	0	0	0	0	0	0	0	0	0	0
472	0	1	0	0	0	0	0	0	0	0	0	0
473	0	0	1	0	0	0	0	1	0	0	0	0
474	0	0	0	0	1	0	1	0	0	0	0	0
475	0	0	0	0	0	0	0	0	0	0	0	0
476	0	0	0	0	0	0	0	0	0	0	0	0
477	0	0	0	0	0	0	0	0	0	0	0	0
478	0	0	0	0	0	0	0	0	0	0	0	0
479	0	0	0	0	0	0	0	0	0	0	0	0
480	0	0	0	0	0	0	0	0	0	0	0	0
481	0	0	0	0	0	0	0	0	0	0	0	0

Figure 4.14: Example of Matrix

4.4.3 Module3: Generation of Heatmaps

Heatmaps are the representation of data in the form of a map in which the data values are represented in colours. Heatmaps can be easily accessed by machine learning than matrices..heatmaps transforms the correlation matrix into color coding. the heatmaps produced with the original matrices are hardly visible and it is hard for the classification method to work on such sparse data, so to increase the visibility a gaussian filter is used. Gaussian distribution is a probability distribution about mean, showing the data near the mean is occurred more frequently than the data away from the mean. first I tried using the 5*5 gaussian matrix but then I found out that results are still very sparse to be well enough to be detected in the classification. so I applied the 7*7 gaussian matrix.

	JO	JP	JQ	JR	JS	JT	JU	JV	JW	JX	JY	JZ	KA	KB	KC	K
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
446	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
447	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
449	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
451	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
452	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
453	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
454	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
456	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
457	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0
458	0	0	0	0	0	3	13	23	16	6	1	0	0	0	0	0
459	0	0	0	0	1	13	62	113	94	49	19	4	0	0	0	0
460	0	0	0	0	2	23	111	231	256	191	97	29	5	0	0	0
461	0	0	0	0	1	15	83	217	328	332	232	106	29	6	1	1
462	0	0	0	0	0	4	27	96	196	284	313	224	98	37	14	14
463	0	0	0	0	0	0	4	23	77	197	321	296	182	121	61	61
464	1	0	0	0	0	0	1	17	91	226	303	242	182	174	98	98
465	13	3	0	0	0	0	6	41	146	258	228	121	87	101	59	59
466	59	13	1	0	0	4	28	107	235	284	178	60	23	22	13	13
467	99	23	2	0	1	15	83	223	354	376	258	112	29	6	1	1
468	82	28	5	0	2	23	112	246	336	387	352	221	83	15	1	1
469	123	85	28	5	1	13	65	138	207	288	308	243	113	25	3	3
470	222	207	103	29	6	8	29	59	92	132	141	126	76	36	16	16
471	207	277	210	95	41	40	85	115	76	39	30	39	75	113	81	81
472	103	208	234	170	135	142	207	219	111	25	6	25	111	218	195	195
473	28	84	132	161	195	208	240	196	81	15	2	15	81	197	231	231
474	4	16	36	73	113	121	123	82	26	4	0	4	27	94	172	172
475	0	1	5	14	25	26	26	15	4	0	0	0	6	38	133	133
476	0	0	0	1	2	2	2	1	0	0	0	0	1	16	83	83
477	0	0	0	0	0	0	0	0	0	0	0	0	0	4	26	26
478	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
479	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
481	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
482	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
484	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 4.15: Example of Matrix after Gaussian filter

Heatmaps are generated for all the files using these gaussian filtered matrices. All those heatmaps are then sorted to different files based on image id for all patients.i.e, all patients for one stim(image) id.

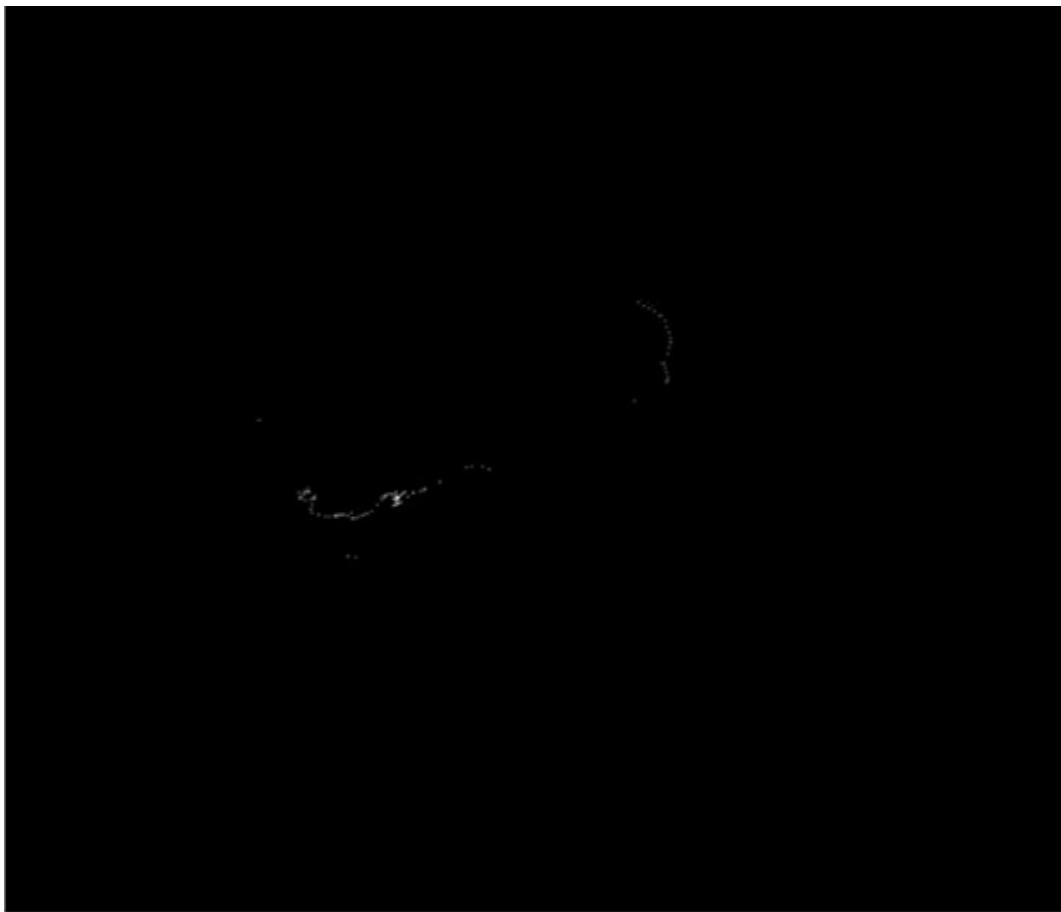


Figure 4.16: Example of heatmap

4.4.4 Module4: CNN classification

Convolutional neural networks (CNNs) are deep neural networks that have the capability to classify and segment images. CNN classification is used to classify the heatmaps by training the CNN model by assigning train data set. The training dataset contains heatmaps of both children with and without autism. The model recognizes the pattern of both class C and P and that pattern is used to classify the test data. The main advantage of CNN compared to its neural networks is that it automatically detects the important features without any human supervision. For example, given many pictures of cats and dogs, it can learn the key features for each class by itself. The class mode will be using is binary as there are only two classes with and without autism.

```
In [40]: validation_dataset.classes

Out[40]: array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1], dtype=int32)

In [41]: model = tf.keras.models.Sequential([
    tf.keras.layers.Conv2D(16,(3,3),activation = 'relu',input_shape = (200,200,3)),
    tf.keras.layers.MaxPool2D(2,2),
    #
    tf.keras.layers.Conv2D(32,(3,3),activation = 'relu',input_shape = (200,200,3)),
    tf.keras.layers.MaxPool2D(2,2),
    #
    tf.keras.layers.Conv2D(64,(3,3),activation = 'relu',input_shape = (200,200,3)),
    tf.keras.layers.MaxPool2D(2,2),
    ##
    tf.keras.layers.Flatten(),
    ##
    tf.keras.layers.Dense(512,activation= 'relu'),
    ##
    tf.keras.layers.Dense(1,activation= 'sigmoid')
])

In [42]: model.compile(loss = 'binary_crossentropy',
                      optimizer = RMSprop(lr=0.001),
                      metrics =['accuracy'])

In [45]: model_fit = model.fit(train_dataset,
                           steps_per_epoch = 3,
                           epochs= 20,
                           validation_data = validation_dataset)

Train for 3 steps, validate for 8 steps
Epoch 1/20
3/3 [=====] - 2s 700ms/step - loss: 0.4524 - accuracy: 0.8889 - val_loss: 0.3664 - val_accuracy: 0.9167
Epoch 2/20
3/3 [=====] - 2s 641ms/step - loss: 0.7067 - accuracy: 0.6667 - val_loss: 0.4593 - val_accuracy: 0.8750
Epoch 3/20
```

Figure 4.17: **CNN model**

4.5 Steps to execute/run/implement the project

4.5.1 Step1

Open Jupyter notebook in anaconda and import required libraries

4.5.2 Step2

Type code to generate heatmaps

4.5.3 Step3

Save the heatmaps in a folder which can be accessed through keras library.

4.5.4 Step4

Import the test data into jupyter notebook through keras.

4.5.5 Step5

classify the test data using CNN model

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output

5.1.1 Input Design

In order to predict the presence of markers of autism spectrum disorder the data collected from the patient should be preprocessed and converted in to heatmap. Then the heatmap of the patient is imported through tensorflow library, further passed through trained CNN model.

5.1.2 Output Design

The heat map of the Patient is passed through already trained Convolutional Neural Network model and it predicts whether the child is autistic or not by using the patterns of the heatmap.

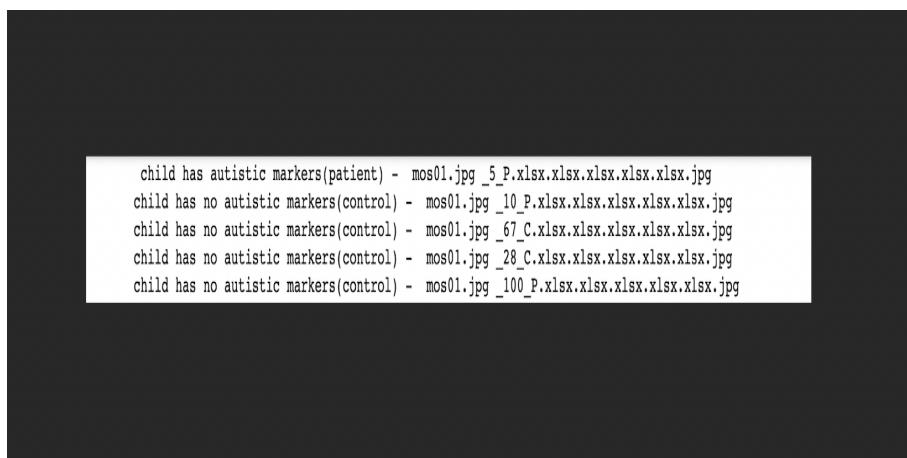


Figure 5.1: Example of Output

5.2 Testing

Testing is the process of assessing a system or its component(s) in order to determine whether it complies with the required specifications. It is the process of thoroughly

inspecting a framework to identify any errors, gaps, or missing pieces.

The true precondition versus necessity.

5.3 Types of Testing

5.3.1 Unit Testing

Designing test cases for unit testing ensures that the internal program logic is working correctly and that program inputs result in legitimate outputs. It is important to verify the internal code flow and all decision branches. It is the testing of the application's separate software components. Before integration, it is done following the completion of each individual unit. Unit tests carry out fundamental tests at the component level and examine a particular configuration of a system, application, or business process. As soon as the input was given to the system, it successfully completed the training. It requests that you resend the valid inputs when you send values that are outside the allowed range.

```
Last login: Tue Jul 12 11:51:05 on ttys001
/Users/dhanu/opt/anaconda3/bin/jupyter_mac.command ; exit;
(base) dhanu@Dhanunjais-MacBook-Air ~ % /Users/dhanu/opt/anaconda3/bin/jupyter_mac.command ; exit;
[I 2022-07-12 11:55:29.813 LabApp] JupyterLab extension loaded from /Users/dhanu/opt/anaconda3/lib/python3.9/site-packages/jupyterlab
[I 2022-07-12 11:55:29.813 LabApp] JupyterLab application directory is /Users/dhanu/opt/anaconda3/share/jupyter/lab
[I 11:55:29.816 NotebookApp] The port 8888 is already in use, trying another port.
[I 11:55:29.816 NotebookApp] The port 8889 is already in use, trying another port.
[I 11:55:29.816 NotebookApp] Serving notebooks from local directory: /Users/dhanu
[I 11:55:29.816 NotebookApp] Jupyter Notebook 6.4.5 is running at:
[I 11:55:29.816 NotebookApp] http://localhost:8890/?token=9886f70820c3a39e7db1c727c43fc5b8b311355421344044
[I 11:55:29.816 NotebookApp] or http://127.0.0.1:8890/?token=9886f70820c3a39e7db1c727c43fc5b8b311355421344044
[I 11:55:29.816 NotebookApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmation).
[IC 11:55:29.820 NotebookApp]

To access the notebook, open this file in a browser:
  file:///Users/dhanu/Library/Jupyter/runtime/nbserver-89251-open.html
Or copy and paste one of these URLs:
  http://localhost:8890/?token=9886f70820c3a39e7db1c727c43fc5b8b311355421344044
  or http://127.0.0.1:8890/?token=9886f70820c3a39e7db1c727c43fc5b8b311355421344044
[W 11:55:46.989 NotebookApp] Notebook Desktop/correct/heatmaps for 7x7 matrices.ipynb is not trusted
[I 11:55:47.131 NotebookApp] Kernel started: 178b17a6-cdae-4ab6-a0f6-fbc6a62949e, name: python3
[I 11:57:48.089 NotebookApp] Saving file at /Desktop/correct/heatmaps for 7x7 matrices.ipynb
[I 11:59:47.888 NotebookApp] Saving file at /Desktop/correct/heatmaps for 7x7 matrices.ipynb
[I 12:22:54.844 NotebookApp] Kernel started: a1ebab35f-66bf-4d21-a1eb-040db83274f, name: python3
[IC 12:32:48.142 NotebookApp] Kernel interrupted: 178b17a6-cdae-4ab6-a0f6-fbc6a62949e
```

Figure 5.2: unit testing of single class

5.3.2 Integration Testing

Software components that have been merged are tested in integration tests to see if they genuinely operate as a single program. Testing is event-driven and focuses more on the fundamental result of screens or fields. Even though the individual components were successful in unit testing, integration tests indicate that the combination of the components is accurate and consistent. Integration testing is especially designed to highlight issues that result from combining components.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Efficiency of the Proposed System

The complete system is designed using Python and the data was handled using MS Excel. For the image classification I used Convolutional Neural Network Model (CNN) as it is more accurate while recognising the data patterns than any other neural network model as it can automatically detect the important features of the image without any human intervention. The accuracy after processing the training data is around 70 percent, so we can assume that the accuracy when we process the test data will also be considerably good. The classification is done for each image for all patients to increase the accuracy even more.

6.2 Comparison of Existing and Proposed System

The diagnosis of Autism SPectrum Disorder is very cumbersome and time taking. Even with the methods that are used now, a lot of experience is required to examine a child for ASD and come to conclusion. Our project aims to solve this issue. By using machine learning and eye tracking, the children can easily be classified into two classes - with ASD symptoms and with typical growth. Hence, only the children classified under the former class need to be taken under examination to be diagnosed properly instead of examining each and every child individually in a traditional method.

6.3 Sample Code

```
1 import tensorflow as tf
2 import matplotlib.pyplot as plt
3 import cv2
4 import os
5 import numpy as np
6 from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```

7 from tensorflow.keras.preprocessing import image
8 from tensorflow.keras.optimizers import RMSprop
9 import PIL
10
11 train = ImageDataGenerator(rescale = 1/255)
12 validation = ImageDataGenerator(rescale = 1/255)
13 train_dataset = train.flow_from_directory("/Users/dhanu/Desktop/cnn/train/",
14                                         target_size = (200,200),
15                                         batch_size = 3,
16                                         class_mode = 'binary')
17 validation_dataset = validation.flow_from_directory("/Users/dhanu/Desktop/cnn/valid/",
18                                         target_size = (200,200),
19                                         batch_size = 3,
20                                         class_mode = 'binary')
21 model = tf.keras.models.Sequential([
22     tf.keras.layers.Conv2D(16,(3,3),activation = 'relu',input_shape
23     = (200,200,3)),
24     tf.keras.layers.MaxPool2D(2,2),
25     #
26     tf.keras.layers.Conv2D(32,(3,3),activation = 'relu',input_shape =
27     (200,200,3)),
28     tf.keras.layers.MaxPool2D(2,2),
29     #
30     tf.keras.layers.Conv2D(64,(3,3),activation = 'relu',input_shape =
31     (200,200,3)),
32     tf.keras.layers.MaxPool2D(2,2),
33     ##
34     tf.keras.layers.Flatten(),
35     ##
36     tf.keras.layers.Dense(512,activation= 'relu'),
37     ##
38     tf.keras.layers.Dense(1,activation= 'sigmoid')
39 ])
40
41 model.compile(loss = 'binary_crossentropy',
42                 optimizer = RMSprop(lr=0.001),
43                 metrics =['accuracy'])
44
45 model_fit = model.fit(train_dataset,
46                         steps_per_epoch = 3,
47                         epochs= 20,
48                         validation_data = validation_dataset)
49
50 path = '/Users/dhanu/Desktop/cnn/test'
51
52 for i in os.listdir(path):
53     img = image.load_img(path +'//'+ i ,target_size = (200,200))
54
55     X = image.img_to_array(img)
56     X = np.expand_dims(X, axis = 0)
57     images = np.vstack([X])
58
59     val = model.predict(images)
60     if val ==0:

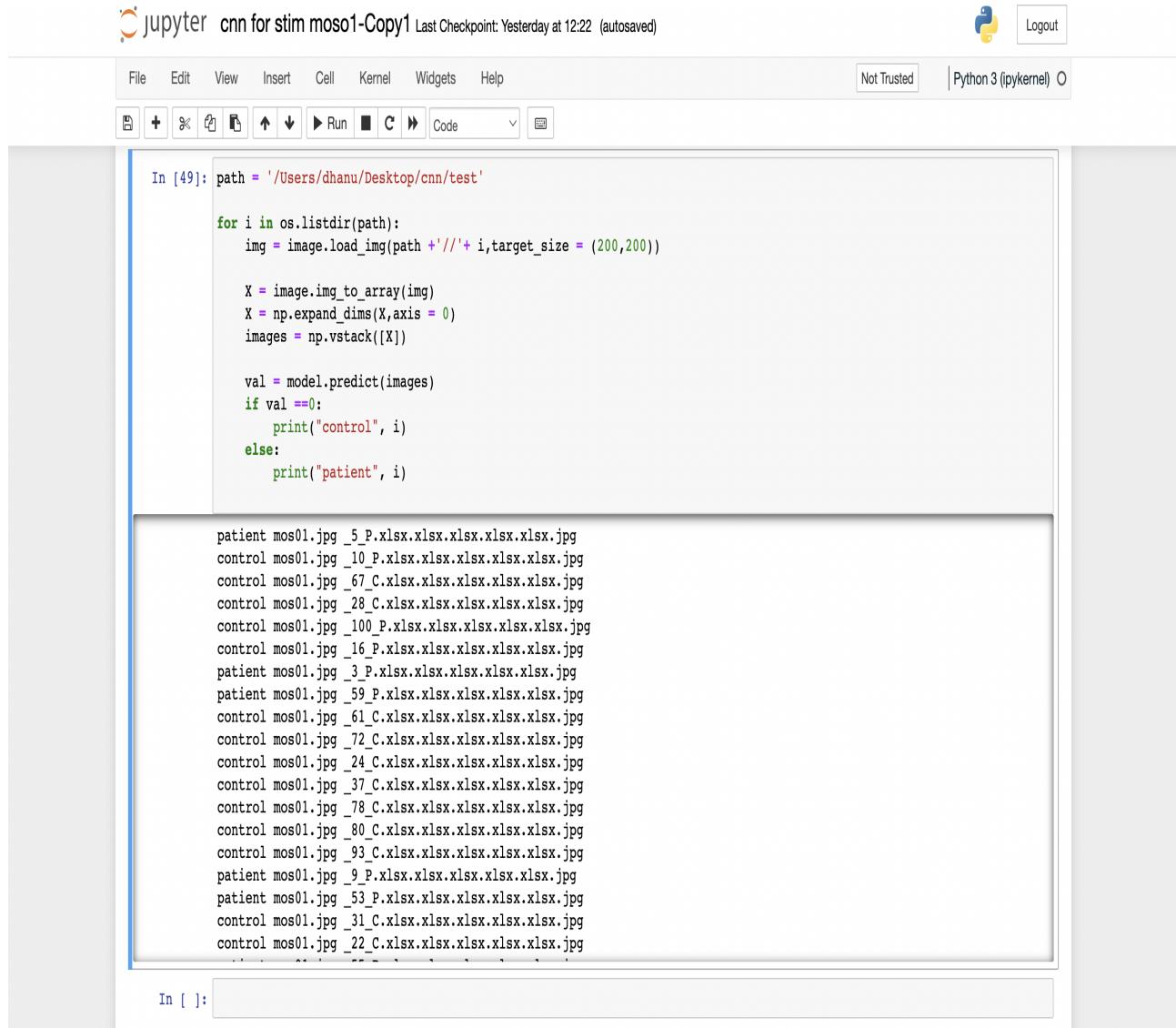
```

```

54     print("child has no autistic markers(control) - ", i)
55 else:
56     print(" child has autistic markers(patient) - ", i)

```

Output



The screenshot shows a Jupyter Notebook interface with the following details:

- Header:** jupyter cnn for stim moso1-Copy1 Last Checkpoint: Yesterday at 12:22 (autosaved)
- Toolbar:** File, Edit, View, Insert, Cell, Kernel, Widgets, Help, Not Trusted, Python 3 (ipykernel), Logout.
- Code Cell (In [49]):**

```

path = '/Users/dhanu/Desktop/cnn/test'

for i in os.listdir(path):
    img = image.load_img(path +'//'+ i,target_size = (200,200))

    X = image.img_to_array(img)
    X = np.expand_dims(X,axis = 0)
    images = np.vstack([X])

    val = model.predict(images)
    if val ==0:
        print("control", i)
    else:
        print("patient", i)

```
- Output Cell (In [49]):**

```

patient mos01.jpg _5_P.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _10_F.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _67_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _28_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _100_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _16_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
patient mos01.jpg _3_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
patient mos01.jpg _59_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _61_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _72_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _24_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _37_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _78_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _80_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _93_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
patient mos01.jpg _9_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
patient mos01.jpg _53_P.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _31_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg
control mos01.jpg _22_C.xlsx.xlsx.xlsx.xlsx.xlsx.xlsx.jpg

```
- Bottom Cell (In []):** An empty input field.

Figure 6.1: Output 1

Chapter 7

CONCLUSION

7.1 Conclusion

In this project, we have effectively proposed and implemented a system to detect Autism Spectrum Disorder trackers in a child through machine learning. This system helps in diagnosis of ASD in a way that is less time-taking and more effective. This project is a great addition, in many ways, to the whole process of diagnosis of ASD but is never a replacement for it. Eliminating children with no markers of autism can save up time and effort for the family, child and even the doctors since it is a very cumbersome process. With successful implementation of this project, the children with ASD and typical growth can be easily separated from each other. Hence, only the children with the ASD markers can go further for an ASD examination. After an expert examining the child, a proper diagnosis can be made.

Chapter 8

EXCHANGE PROGRAM DETAILS

8.1 Industry name : Polytech Tours (University of Tours

8.1.1 Duration of Internship (April 2022 - To July 2022)

8.1.2 4 months

8.1.3 University Address : Polytech Tours, Universite de Tour ,Tours , France - 37200

8.2 Internship offer letter



Tours, February 22, 2022

Object: Confirmation of admission at the Graduate School of Engineering Polytech Tours - Academic Year 2021-2022.

Dear Dhanunjai Sai Kumar ANDEY,

The file for the scholarship will be established upon the student's arrival only.

I am pleased to announce you that the committee has decided to accept you as an exchange student in our graduate school of engineering of the University of Tours for the Academic Year 2021-2022 (until the end from March until the beginning of July 2022).

The teaching program will start at **1rst of March, 2022 to beginning on July 2022**. We advise you to be in Tours at least ten days before the beginning of the classes

According to your home country, you will have to initiate in advance the visa request (VISA VLS-TS "Visa de long séjour pour études- Titre de Séjour") by registering via the **mandatory online Campus France procedure** (please follow the link : <http://www.campusfrance.org/fr/page/a-partir-dun-pays-a-procedure-cef>)

For all administrative procedures, you are invited to keep in touch with Mrs. Annabelle NOUR (annabelle.nour@univ-tours.fr) who is the administrative manager for I <http://www.campusfrance.org/fr/page/a-partir-dun-pays-a-procedure-cef>urs you will have to proceed to the administrative registration. Once you confirm you participate in the program, we will inform you about this process.

For organization and teaching details, please contact Pr. Jean-Paul Chemla (jean-paul.chemla@univ-tours.fr) who is in charge of the international relations at the engineering school. He will help you to choose your pedagogic program.

Looking forward to seeing you in Tours in March,

Best wishes,

Jean Paul Chemla

A handwritten signature in black ink, appearing to read "Jean Paul Chemla".

Jean Paul Chemla
Assistant Professor
Graduate School of Engineering of the University of Tours.
Vice director in charge of International Relations
7 Avenue Marcel Dassault - 37200 Tours
Tel: +33 6 82 34 59 29

<http://polytech.univ-tours>

Figure 8.1: Offer Letter

8.3 Internship Completion certificate

Chapter 9

PLAGIARISM REPORT

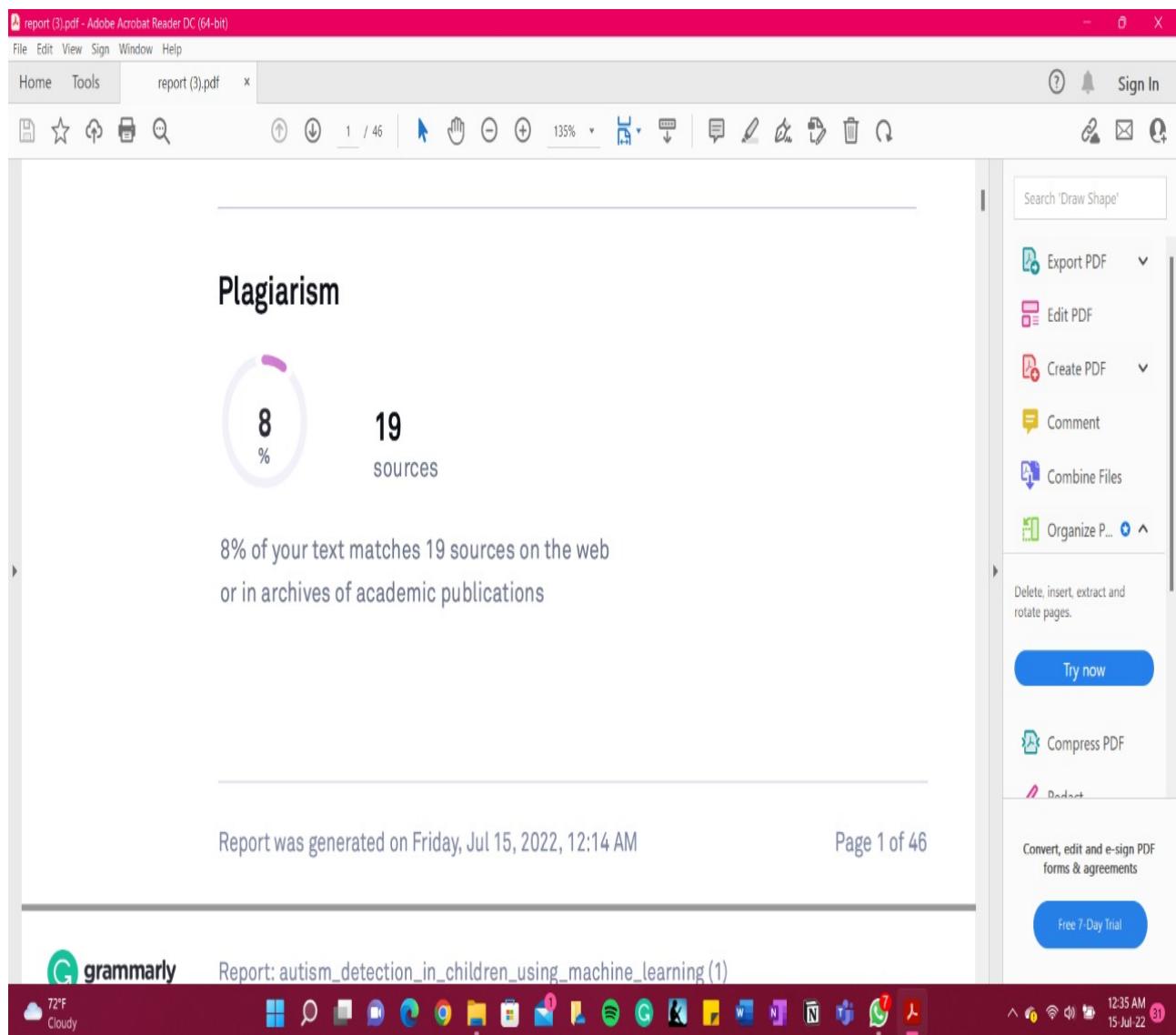


Figure 9.1: plagiarism report

Chapter 10

SOURCE CODE & POSTER

PRESENTATION

10.1 Source Code

```
1 import tensorflow as tf
2 import matplotlib.pyplot as plt
3 import cv2
4 import os
5 import numpy as np
6 from tensorflow.keras.preprocessing.image import ImageDataGenerator
7 from tensorflow.keras.preprocessing import image
8 from tensorflow.keras.optimizers import RMSprop
9 import PIL
10 for file in os.listdir(folder):
11     if file.endswith(".xlsx"):
12         df = pd.read_excel(file, header = None)
13         df = df.to_numpy()
14         df2 = np.zeros((1024, 768), dtype=int)
15         for i in range(1024):
16             for j in range(768):
17                 if df[i][j] != 0:
18                     if i > 2 and i < 1021:
19                         if j > 2 and j < 765:
20                             df2[i-3][j-3] = df2[i-3][j-3] + gaussian[0][0]
21                             df2[i-2][j-3] = df2[i-2][j-3] + gaussian[1][0]
22                             df2[i-1][j-3] = df2[i-1][j-3] + gaussian[2][0]
23                             df2[i][j-3] = df2[i][j-3] + gaussian[3][0]
24                             df2[i+1][j-3] = df2[i+1][j-3] + gaussian[4][0]
25                             df2[i+2][j-3] = df2[i+2][j-3] + gaussian[5][0]
26                             df2[i+3][j-3] = df2[i+3][j-3] + gaussian[6][0]
27                             df2[i-3][j-2] = df2[i-3][j-2] + gaussian[0][1]
28                             df2[i-2][j-2] = df2[i-2][j-2] + gaussian[1][1]
29                             df2[i-1][j-2] = df2[i-1][j-2] + gaussian[2][1]
30                             df2[i][j-2] = df2[i][j-2] + gaussian[3][1]
31                             df2[i+1][j-2] = df2[i+1][j-2] + gaussian[4][1]
32                             df2[i+2][j-2] = df2[i+2][j-2] + gaussian[5][1]
33                             df2[i+3][j-2] = df2[i+3][j-2] + gaussian[6][1]
34                             df2[i-3][j-1] = df2[i-3][j-1] + gaussian[0][2]
35                             df2[i-2][j-1] = df2[i-2][j-1] + gaussian[1][2]
```

```

36         df2[i-1][j-1] = df2[i-1][j-1] + gaussian[2][2]
37         df2[i][j-1]   = df2[i][j-1]   + gaussian[3][2]
38         df2[i+1][j-1] = df2[i+1][j-1] + gaussian[4][2]
39         df2[i+2][j-1] = df2[i+2][j-1] + gaussian[5][2]
40         df2[i+3][j-1] = df2[i+3][j-1] + gaussian[6][2]
41         df2[i-3][j]  = df2[i-3][j]  + gaussian[0][3]
42         df2[i-2][j]  = df2[i-2][j]  + gaussian[1][3]
43         df2[i-1][j]  = df2[i-1][j]  + gaussian[2][3]
44         df2[i][j]    = df2[i][j]    + gaussian[3][3]
45         df2[i+1][j] = df2[i+1][j] + gaussian[4][3]
46         df2[i+2][j] = df2[i+2][j] + gaussian[5][3]
47         df2[i+3][j] = df2[i+3][j] + gaussian[6][3]
48         df2[i-3][j+1] = df2[i-3][j+1] + gaussian[0][4]
49         df2[i-2][j+1] = df2[i-2][j+1] + gaussian[1][4]
50         df2[i-1][j+1] = df2[i-1][j+1] + gaussian[2][4]
51         df2[i][j+1]   = df2[i][j+1]   + gaussian[3][4]
52         df2[i+1][j+1] = df2[i+1][j+1] + gaussian[4][4]
53         df2[i+2][j+1] = df2[i+2][j+1] + gaussian[5][4]
54         df2[i+3][j+1] = df2[i+3][j+1] + gaussian[6][4]
55         df2[i-3][j+2] = df2[i-3][j+2] + gaussian[0][5]
56         df2[i-2][j+2] = df2[i-2][j+2] + gaussian[1][5]
57         df2[i-1][j+2] = df2[i-1][j+2] + gaussian[2][5]
58         df2[i][j+2]   = df2[i][j+2]   + gaussian[3][5]
59         df2[i+1][j+2] = df2[i+1][j+2] + gaussian[4][5]
60         df2[i+2][j+2] = df2[i+2][j+2] + gaussian[5][5]
61         df2[i+3][j+2] = df2[i+3][j+2] + gaussian[6][5]
62         df2[i-3][j+3] = df2[i-3][j+3] + gaussian[0][6]
63         df2[i-2][j+3] = df2[i-2][j+3] + gaussian[1][6]
64         df2[i-1][j+3] = df2[i-1][j+3] + gaussian[2][6]
65         df2[i][j+3]   = df2[i][j+3]   + gaussian[3][6]
66         df2[i+1][j+3] = df2[i+1][j+3] + gaussian[4][6]
67         df2[i+2][j+3] = df2[i+2][j+3] + gaussian[5][6]
68         df2[i+3][j+3] = df2[i+3][j+3] + gaussian[6][6]
69         df3 = pd.DataFrame(df2)
70         output = os.path.join("/Users/dhanu/Desktop/correct_1/", file + '.xlsx')
71         df3.to_excel(output, header = None, index = False)
72         for file in os.listdir(folder):
73             if file.startswith("mos01"):
74                 df = pd.read_excel(file)
75                 plt.figure(figsize=(14.236, 10.67))
76                 ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
77                 ax.invert_yaxis()
78                 plt.axis('off')
79                 output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mos01", file + '.jpg')
80                 plt.savefig(output)
81             elif file.startswith("mos02"):
82                 df = pd.read_excel(file)
83                 plt.figure(figsize=(14.236, 10.67))
84                 ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
85                 ax.invert_yaxis()

```

```

86     plt.axis('off')
87     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mos02", file + '.jpg')
88     plt.savefig(output)
89 elif file.startswith("mos03"):
90     df = pd.read_excel(file)
91     plt.figure(figsize=(14.236, 10.67))
92     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
93     ax.invert_yaxis()
94     plt.axis('off')
95     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mos03", file + '.jpg')
96     plt.savefig(output)
97 elif file.startswith("mos04"):
98     df = pd.read_excel(file)
99     plt.figure(figsize=(14.236, 10.67))
100    ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
101    ax.invert_yaxis()
102    plt.axis('off')
103    output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mos04", file + '.jpg')
104    plt.savefig(output)
105 elif file.startswith("mosob01"):
106     df = pd.read_excel(file)
107     plt.figure(figsize=(14.236, 10.67))
108     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
109     ax.invert_yaxis()
110     plt.axis('off')
111     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mosob01", file + '.jpg')
112     plt.savefig(output)
113 elif file.startswith("mosob02"):
114     df = pd.read_excel(file)
115     plt.figure(figsize=(14.236, 10.67))
116     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
117     ax.invert_yaxis()
118     plt.axis('off')
119     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mosob02", file + '.jpg')
120     plt.savefig(output)
121 elif file.startswith("mosob03"):
122     df = pd.read_excel(file)
123     plt.figure(figsize=(14.236, 10.67))
124     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
125     ax.invert_yaxis()
126     plt.axis('off')
127     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mosob03", file + '.jpg')
128     plt.savefig(output)
129 elif file.startswith("mosob04"):
130     df = pd.read_excel(file)
131     plt.figure(figsize=(14.236, 10.67))
132     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
133     ax.invert_yaxis()
134     plt.axis('off')
135     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/mosob04", file + '.jpg')

```

```

136     plt.savefig(output)
137 elif file.startswith("ob01"):
138     df = pd.read_excel(file)
139     plt.figure(figsize=(14.236, 10.67))
140     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
141     ax.invert_yaxis()
142     plt.axis('off')
143     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/ob01", file + '.jpg')
144     plt.savefig(output)
145 elif file.startswith("ob02"):
146     df = pd.read_excel(file)
147     plt.figure(figsize=(14.236, 10.67))
148     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
149     ax.invert_yaxis()
150     plt.axis('off')
151     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/ob02", file + '.jpg')
152     plt.savefig(output)
153 elif file.startswith("ob03"):
154     df = pd.read_excel(file)
155     plt.figure(figsize=(14.236, 10.67))
156     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
157     ax.invert_yaxis()
158     plt.axis('off')
159     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/ob03", file + '.jpg')
160     plt.savefig(output)
161 elif file.startswith("ob04"):
162     df = pd.read_excel(file)
163     plt.figure(figsize=(14.236, 10.67))
164     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
165     ax.invert_yaxis()
166     plt.axis('off')
167     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/ob04", file + '.jpg')
168     plt.savefig(output)
169 elif file.startswith("visob01"):
170     df = pd.read_excel(file)
171     plt.figure(figsize=(14.236, 10.67))
172     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
173     ax.invert_yaxis()
174     plt.axis('off')
175     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/visob01", file + '.jpg')
176     plt.savefig(output)
177 elif file.startswith("visob02"):
178     df = pd.read_excel(file)
179     plt.figure(figsize=(14.236, 10.67))
180     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
181     ax.invert_yaxis()
182     plt.axis('off')
183     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/visob02", file + '.jpg')
184     plt.savefig(output)
185 elif file.startswith("visob03"):

```

```

186     df = pd.read_excel(file)
187     plt.figure(figsize=(14.236, 10.67))
188     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
189     ax.invert_yaxis()
190     plt.axis('off')
191     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/visob03", file + '.jpg')
192     plt.savefig(output)
193 elif file.startswith("visob04"):
194     df = pd.read_excel(file)
195     plt.figure(figsize=(14.236, 10.67))
196     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
197     ax.invert_yaxis()
198     plt.axis('off')
199     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/visob04", file + '.jpg')
200     plt.savefig(output)
201 elif file.startswith("vis01"):
202     df = pd.read_excel(file)
203     plt.figure(figsize=(14.236, 10.67))
204     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
205     ax.invert_yaxis()
206     plt.axis('off')
207     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vis01", file + '.jpg')
208     plt.savefig(output)
209 elif file.startswith("vis02"):
210     df = pd.read_excel(file)
211     plt.figure(figsize=(14.236, 10.67))
212     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
213     ax.invert_yaxis()
214     plt.axis('off')
215     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vis02", file + '.jpg')
216     plt.savefig(output)
217 elif file.startswith("vis03"):
218     df = pd.read_excel(file)
219     plt.figure(figsize=(14.236, 10.67))
220     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
221     ax.invert_yaxis()
222     plt.axis('off')
223     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vis03", file + '.jpg')
224     plt.savefig(output)
225 elif file.startswith("vis04"):
226     df = pd.read_excel(file)
227     plt.figure(figsize=(14.236, 10.67))
228     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
229     ax.invert_yaxis()
230     plt.axis('off')
231     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vis04", file + '.jpg')
232     plt.savefig(output)
233 elif file.startswith("vismos01"):
234     df = pd.read_excel(file)
235     plt.figure(figsize=(14.236, 10.67))

```

```

236     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
237     ax.invert_yaxis()
238     plt.axis('off')
239     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vismos01", file + '.jpg')
240     plt.savefig(output)
241 elif file.startswith("vismos02"):
242     df = pd.read_excel(file)
243     plt.figure(figsize=(14.236, 10.67))
244     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
245     ax.invert_yaxis()
246     plt.axis('off')
247     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vismos02", file + '.jpg')
248     plt.savefig(output)
249 elif file.startswith("vismos03"):
250     df = pd.read_excel(file)
251     plt.figure(figsize=(14.236, 10.67))
252     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
253     ax.invert_yaxis()
254     plt.axis('off')
255     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vismos03", file + '.jpg')
256     plt.savefig(output)
257 elif file.startswith("vismos04"):
258     df = pd.read_excel(file)
259     plt.figure(figsize=(14.236, 10.67))
260     ax = sns.heatmap(df,cmap ="Greys_r",cbar = False)
261     ax.invert_yaxis()
262     plt.axis('off')
263     output = os.path.join("/Users/dhanu/Desktop/heatmaps (mat)/vismos04", file + '.jpg')
264     plt.savefig(output)
265
266 train = ImageDataGenerator(rescale = 1/255)
267 validation = ImageDataGenerator(rescale = 1/255)
268 train_dataset = train.flow_from_directory("/Users/dhanu/Desktop/cnn/train/",
269                                         target_size = (200,200),
270                                         batch_size = 3,
271                                         class_mode = 'binary')
272 validation_dataset = validation.flow_from_directory("/Users/dhanu/Desktop/cnn/valid/",
273                                         target_size = (200,200),
274                                         batch_size = 3,
275                                         class_mode = 'binary')
276 model = tf.keras.models.Sequential([
277     tf.keras.layers.Conv2D(16,(3,3),activation = 'relu',input_shape =
278     (200,200,3)),
279     tf.keras.layers.MaxPool2D(2,2),
280     #
281     tf.keras.layers.Conv2D(32,(3,3),activation = 'relu',input_shape =
282     (200,200,3)),
283     tf.keras.layers.MaxPool2D(2,2),
284     #
285     tf.keras.layers.Conv2D(64,(3,3),activation = 'relu',input_shape =
286     (200,200,3)),
287     tf.keras.layers.MaxPool2D(2,2),
288     #
289     tf.keras.layers.Conv2D(128,(3,3),activation = 'relu',input_shape =
290     (200,200,3)),
291     tf.keras.layers.MaxPool2D(2,2),
292     #
293     tf.keras.layers.Conv2D(256,(3,3),activation = 'relu',input_shape =
294     (200,200,3)),
295     tf.keras.layers.MaxPool2D(2,2),
296     #
297     tf.keras.layers.Conv2D(512,(3,3),activation = 'relu',input_shape =
298     (200,200,3)),
299     tf.keras.layers.MaxPool2D(2,2),
300     #
301     tf.keras.layers.Conv2D(1024,(3,3),activation = 'relu',input_shape =
302     (200,200,3)),
303     tf.keras.layers.MaxPool2D(2,2),
304     #
305     tf.keras.layers.Conv2D(2048,(3,3),activation = 'relu',input_shape =
306     (200,200,3)),
307     tf.keras.layers.MaxPool2D(2,2),
308     #
309     tf.keras.layers.Conv2D(4096,(3,3),activation = 'relu',input_shape =
310     (200,200,3)),
311     tf.keras.layers.MaxPool2D(2,2),
312     #
313     tf.keras.layers.Conv2D(8192,(3,3),activation = 'relu',input_shape =
314     (200,200,3)),
315     tf.keras.layers.MaxPool2D(2,2),
316     #
317     tf.keras.layers.Conv2D(16384,(3,3),activation = 'relu',input_shape =
318     (200,200,3)),
319     tf.keras.layers.MaxPool2D(2,2),
320     #
321     tf.keras.layers.Conv2D(32768,(3,3),activation = 'relu',input_shape =
322     (200,200,3)),
323     tf.keras.layers.MaxPool2D(2,2),
324     #
325     tf.keras.layers.Conv2D(65536,(3,3),activation = 'relu',input_shape =
326     (200,200,3)),
327     tf.keras.layers.MaxPool2D(2,2),
328     #
329     tf.keras.layers.Conv2D(131072,(3,3),activation = 'relu',input_shape =
330     (200,200,3)),
331     tf.keras.layers.MaxPool2D(2,2),
332     #
333     tf.keras.layers.Conv2D(262144,(3,3),activation = 'relu',input_shape =
334     (200,200,3)),
335     tf.keras.layers.MaxPool2D(2,2),
336     #
337     tf.keras.layers.Conv2D(524288,(3,3),activation = 'relu',input_shape =
338     (200,200,3)),
339     tf.keras.layers.MaxPool2D(2,2),
340     #
341     tf.keras.layers.Conv2D(1048576,(3,3),activation = 'relu',input_shape =
342     (200,200,3)),
343     tf.keras.layers.MaxPool2D(2,2),
344     #
345     tf.keras.layers.Conv2D(2097152,(3,3),activation = 'relu',input_shape =
346     (200,200,3)),
347     tf.keras.layers.MaxPool2D(2,2),
348     #
349     tf.keras.layers.Conv2D(4194304,(3,3),activation = 'relu',input_shape =
350     (200,200,3)),
351     tf.keras.layers.MaxPool2D(2,2),
352     #
353     tf.keras.layers.Conv2D(8388608,(3,3),activation = 'relu',input_shape =
354     (200,200,3)),
355     tf.keras.layers.MaxPool2D(2,2),
356     #
357     tf.keras.layers.Conv2D(16777216,(3,3),activation = 'relu',input_shape =
358     (200,200,3)),
359     tf.keras.layers.MaxPool2D(2,2),
360     #
361     tf.keras.layers.Conv2D(33554432,(3,3),activation = 'relu',input_shape =
362     (200,200,3)),
363     tf.keras.layers.MaxPool2D(2,2),
364     #
365     tf.keras.layers.Conv2D(67108864,(3,3),activation = 'relu',input_shape =
366     (200,200,3)),
367     tf.keras.layers.MaxPool2D(2,2),
368     #
369     tf.keras.layers.Conv2D(134217728,(3,3),activation = 'relu',input_shape =
370     (200,200,3)),
371     tf.keras.layers.MaxPool2D(2,2),
372     #
373     tf.keras.layers.Conv2D(268435456,(3,3),activation = 'relu',input_shape =
374     (200,200,3)),
375     tf.keras.layers.MaxPool2D(2,2),
376     #
377     tf.keras.layers.Conv2D(536870912,(3,3),activation = 'relu',input_shape =
378     (200,200,3)),
379     tf.keras.layers.MaxPool2D(2,2),
380     #
381     tf.keras.layers.Conv2D(1073741824,(3,3),activation = 'relu',input_shape =
382     (200,200,3)),
383     tf.keras.layers.MaxPool2D(2,2),
384     #
385     tf.keras.layers.Conv2D(2147483648,(3,3),activation = 'relu',input_shape =
386     (200,200,3)),
387     tf.keras.layers.MaxPool2D(2,2),
388     #
389     tf.keras.layers.Conv2D(4294967296,(3,3),activation = 'relu',input_shape =
390     (200,200,3)),
391     tf.keras.layers.MaxPool2D(2,2),
392     #
393     tf.keras.layers.Conv2D(8589934592,(3,3),activation = 'relu',input_shape =
394     (200,200,3)),
395     tf.keras.layers.MaxPool2D(2,2),
396     #
397     tf.keras.layers.Conv2D(17179869184,(3,3),activation = 'relu',input_shape =
398     (200,200,3)),
399     tf.keras.layers.MaxPool2D(2,2),
400     #
401     tf.keras.layers.Conv2D(34359738368,(3,3),activation = 'relu',input_shape =
402     (200,200,3)),
403     tf.keras.layers.MaxPool2D(2,2),
404     #
405     tf.keras.layers.Conv2D(68719476736,(3,3),activation = 'relu',input_shape =
406     (200,200,3)),
407     tf.keras.layers.MaxPool2D(2,2),
408     #
409     tf.keras.layers.Conv2D(137438953472,(3,3),activation = 'relu',input_shape =
410     (200,200,3)),
411     tf.keras.layers.MaxPool2D(2,2),
412     #
413     tf.keras.layers.Conv2D(274877906944,(3,3),activation = 'relu',input_shape =
414     (200,200,3)),
415     tf.keras.layers.MaxPool2D(2,2),
416     #
417     tf.keras.layers.Conv2D(549755813888,(3,3),activation = 'relu',input_shape =
418     (200,200,3)),
419     tf.keras.layers.MaxPool2D(2,2),
420     #
421     tf.keras.layers.Conv2D(1099511627776,(3,3),activation = 'relu',input_shape =
422     (200,200,3)),
423     tf.keras.layers.MaxPool2D(2,2),
424     #
425     tf.keras.layers.Conv2D(2199023255552,(3,3),activation = 'relu',input_shape =
426     (200,200,3)),
427     tf.keras.layers.MaxPool2D(2,2),
428     #
429     tf.keras.layers.Conv2D(4398046511104,(3,3),activation = 'relu',input_shape =
430     (200,200,3)),
431     tf.keras.layers.MaxPool2D(2,2),
432     #
433     tf.keras.layers.Conv2D(8796093022208,(3,3),activation = 'relu',input_shape =
434     (200,200,3)),
435     tf.keras.layers.MaxPool2D(2,2),
436     #
437     tf.keras.layers.Conv2D(17592186044416,(3,3),activation = 'relu',input_shape =
438     (200,200,3)),
439     tf.keras.layers.MaxPool2D(2,2),
440     #
441     tf.keras.layers.Conv2D(35184372088832,(3,3),activation = 'relu',input_shape =
442     (200,200,3)),
443     tf.keras.layers.MaxPool2D(2,2),
444     #
445     tf.keras.layers.Conv2D(70368744177664,(3,3),activation = 'relu',input_shape =
446     (200,200,3)),
447     tf.keras.layers.MaxPool2D(2,2),
448     #
449     tf.keras.layers.Conv2D(140737488355328,(3,3),activation = 'relu',input_shape =
450     (200,200,3)),
451     tf.keras.layers.MaxPool2D(2,2),
452     #
453     tf.keras.layers.Conv2D(281474976710656,(3,3),activation = 'relu',input_shape =
454     (200,200,3)),
455     tf.keras.layers.MaxPool2D(2,2),
456     #
457     tf.keras.layers.Conv2D(562949953421312,(3,3),activation = 'relu',input_shape =
458     (200,200,3)),
459     tf.keras.layers.MaxPool2D(2,2),
460     #
461     tf.keras.layers.Conv2D(1125899906842624,(3,3),activation = 'relu',input_shape =
462     (200,200,3)),
463     tf.keras.layers.MaxPool2D(2,2),
464     #
465     tf.keras.layers.Conv2D(2251799813685248,(3,3),activation = 'relu',input_shape =
466     (200,200,3)),
467     tf.keras.layers.MaxPool2D(2,2),
468     #
469     tf.keras.layers.Conv2D(4503599627370496,(3,3),activation = 'relu',input_shape =
470     (200,200,3)),
471     tf.keras.layers.MaxPool2D(2,2),
472     #
473     tf.keras.layers.Conv2D(9007199254740992,(3,3),activation = 'relu',input_shape =
474     (200,200,3)),
475     tf.keras.layers.MaxPool2D(2,2),
476     #
477     tf.keras.layers.Conv2D(18014398509481984,(3,3),activation = 'relu',input_shape =
478     (200,200,3)),
479     tf.keras.layers.MaxPool2D(2,2),
480     #
481     tf.keras.layers.Conv2D(36028797018963968,(3,3),activation = 'relu',input_shape =
482     (200,200,3)),
483     tf.keras.layers.MaxPool2D(2,2),
484     #
485     tf.keras.layers.Conv2D(72057594037927936,(3,3),activation = 'relu',input_shape =
486     (200,200,3)),
487     tf.keras.layers.MaxPool2D(2,2),
488     #
489     tf.keras.layers.Conv2D(144115188075859872,(3,3),activation = 'relu',input_shape =
490     (200,200,3)),
491     tf.keras.layers.MaxPool2D(2,2),
492     #
493     tf.keras.layers.Conv2D(288230376151719744,(3,3),activation = 'relu',input_shape =
494     (200,200,3)),
495     tf.keras.layers.MaxPool2D(2,2),
496     #
497     tf.keras.layers.Conv2D(576460752303439488,(3,3),activation = 'relu',input_shape =
498     (200,200,3)),
499     tf.keras.layers.MaxPool2D(2,2),
500     #
501     tf.keras.layers.Conv2D(1152921504606878976,(3,3),activation = 'relu',input_shape =
502     (200,200,3)),
503     tf.keras.layers.MaxPool2D(2,2),
504     #
505     tf.keras.layers.Conv2D(2305843009213757952,(3,3),activation = 'relu',input_shape =
506     (200,200,3)),
507     tf.keras.layers.MaxPool2D(2,2),
508     #
509     tf.keras.layers.Conv2D(4611686018427515904,(3,3),activation = 'relu',input_shape =
510     (200,200,3)),
511     tf.keras.layers.MaxPool2D(2,2),
512     #
513     tf.keras.layers.Conv2D(9223372036855031808,(3,3),activation = 'relu',input_shape =
514     (200,200,3)),
515     tf.keras.layers.MaxPool2D(2,2),
516     #
517     tf.keras.layers.Conv2D(18446744073700063616,(3,3),activation = 'relu',input_shape =
518     (200,200,3)),
519     tf.keras.layers.MaxPool2D(2,2),
520     #
521     tf.keras.layers.Conv2D(36893488147400127232,(3,3),activation = 'relu',input_shape =
522     (200,200,3)),
523     tf.keras.layers.MaxPool2D(2,2),
524     #
525     tf.keras.layers.Conv2D(73786976294800254464,(3,3),activation = 'relu',input_shape =
526     (200,200,3)),
527     tf.keras.layers.MaxPool2D(2,2),
528     #
529     tf.keras.layers.Conv2D(147573952589600508928,(3,3),activation = 'relu',input_shape =
530     (200,200,3)),
531     tf.keras.layers.MaxPool2D(2,2),
532     #
533     tf.keras.layers.Conv2D(295147905179201017856,(3,3),activation = 'relu',input_shape =
534     (200,200,3)),
535     tf.keras.layers.MaxPool2D(2,2),
536     #
537     tf.keras.layers.Conv2D(590295810358402035712,(3,3),activation = 'relu',input_shape =
538     (200,200,3)),
539     tf.keras.layers.MaxPool2D(2,2),
540     #
541     tf.keras.layers.Conv2D(1180591620716804071424,(3,3),activation = 'relu',input_shape =
542     (200,200,3)),
543     tf.keras.layers.MaxPool2D(2,2),
544     #
545     tf.keras.layers.Conv2D(2361183241433608142848,(3,3),activation = 'relu',input_shape =
546     (200,200,3)),
547     tf.keras.layers.MaxPool2D(2,2),
548     #
549     tf.keras.layers.Conv2D(4722366482867216285696,(3,3),activation = 'relu',input_shape =
550     (200,200,3)),
551     tf.keras.layers.MaxPool2D(2,2),
552     #
553     tf.keras.layers.Conv2D(9444732965734432571392,(3,3),activation = 'relu',input_shape =
554     (200,200,3)),
555     tf.keras.layers.MaxPool2D(2,2),
556     #
557     tf.keras.layers.Conv2D(18889465931468865142784,(3,3),activation = 'relu',input_shape =
558     (200,200,3)),
559     tf.keras.layers.MaxPool2D(2,2),
560     #
561     tf.keras.layers.Conv2D(37778931862937725285568,(3,3),activation = 'relu',input_shape =
562     (200,200,3)),
563     tf.keras.layers.MaxPool2D(2,2),
564     #
565     tf.keras.layers.Conv2D(75557863725875450571136,(3,3),activation = 'relu',input_shape =
566     (200,200,3)),
567     tf.keras.layers.MaxPool2D(2,2),
568     #
569     tf.keras.layers.Conv2D(151115727451750901542272,(3,3),activation = 'relu',input_shape =
570     (200,200,3)),
571     tf.keras.layers.MaxPool2D(2,2),
572     #
573     tf.keras.layers.Conv2D(302231454903501803084544,(3,3),activation = 'relu',input_shape =
574     (200,200,3)),
575     tf.keras.layers.MaxPool2D(2,2),
576     #
577     tf.keras.layers.Conv2D(604462909807003606169088,(3,3),activation = 'relu',input_shape =
578     (200,200,3)),
579     tf.keras.layers.MaxPool2D(2,2),
580     #
581     tf.keras.layers.Conv2D(1208925819614007212338176,(3,3),activation = 'relu',input_shape =
582     (200,200,3)),
583     tf.keras.layers.MaxPool2D(2,2),
584     #
585     tf.keras.layers.Conv2D(2417851639228014424676352,(3,3),activation = 'relu',input_shape =
586     (200,200,3)),
587     tf.keras.layers.MaxPool2D(2,2),
588     #
589     tf.keras.layers.Conv2D(4835703278456028849352704,(3,3),activation = 'relu',input_shape =
590     (200,200,3)),
591     tf.keras.layers.MaxPool2D(2,2),
592     #
593     tf.keras.layers.Conv2D(9671406556912057698705408,(3,3),activation = 'relu',input_shape =
594     (200,200,3)),
595     tf.keras.layers.MaxPool2D(2,2),
596     #
597     tf.keras.layers.Conv2D(19342813113824115397410816,(3,3),activation = 'relu',input_shape =
598     (200,200,3)),
599     tf.keras.layers.MaxPool2D(2,2),
600     #
601     tf.keras.layers.Conv2D(38685626227648230794821632,(3,3),activation = 'relu',input_shape =
602     (200,200,3)),
603     tf.keras.layers.MaxPool2D(2,2),
604     #
605     tf.keras.layers.Conv2D(77371252455296461589643264,(3,3),activation = 'relu',input_shape =
606     (200,200,3)),
607     tf.keras.layers.MaxPool2D(2,2),
608     #
609     tf.keras.layers.Conv2D(15474250491059292317928652,(3,3),activation = 'relu',input_shape =
610     (200,200,3)),
611     tf.keras.layers.MaxPool2D(2,2),
612     #
613     tf.keras.layers.Conv2D(30948500982118584635857304,(3,3),activation = 'relu',input_shape =
614     (200,200,3)),
615     tf.keras.layers.MaxPool2D(2,2),
616     #
617     tf.keras.layers.Conv2D(61897001964237169271714608,(3,3),activation = 'relu',input_shape =
618     (200,200,3)),
619     tf.keras.layers.MaxPool2D(2,2),
620     #
621     tf.keras.layers.Conv2D(123794003928474338543429216,(3,3),activation = 'relu',input_shape =
622     (200,200,3)),
623     tf.keras.layers.MaxPool2D(2,2),
624     #
625     tf.keras.layers.Conv2D(247588007856948677086858432,(3,3),activation = 'relu',input_shape =
626     (200,200,3)),
627     tf.keras.layers.MaxPool2D(2,2),
628     #
629     tf.keras.layers.Conv2D(495176015713897354173716864,(3,3),activation = 'relu',input_shape =
630     (200,200,3)),
631     tf.keras.layers.MaxPool2D(2,2),
632     #
633     tf.keras.layers.Conv2D(990352031427794708347433728,(3,3),activation = 'relu',input_shape =
634     (200,200,3)),
635     tf.keras.layers.MaxPool2D(2,2),
636     #
637     tf.keras.layers.Conv2D(1980704062855589416694867456,(3,3),activation = 'relu',input_shape =
638     (200,200,3)),
639     tf.keras.layers.MaxPool2D(2,2),
640     #
641     tf.keras.layers.Conv2D(3961408125711178833389734912,(3,3),activation = 'relu',input_shape =
642     (200,200,3)),
643     tf.keras.layers.MaxPool2D(2,2),
644     #
645     tf.keras.layers.Conv2D(7922816251422357666779469824,(3,3),activation = 'relu',input_shape =
646     (200,200,3)),
647     tf.keras.layers.MaxPool2D(2,2),
648     #
649     tf.keras.layers.Conv2D(1584563252284471533355893968,(3,3),activation = 'relu',input_shape =
650     (200,200,3)),
651     tf.keras.layers.MaxPool2D(2,2),
652     #
653     tf.keras.layers.Conv2D(3169126504568943066711787936,(3,3),activation = 'relu',input_shape =
654     (200,200,3)),
655     tf.keras.layers.MaxPool2D(2,2),
656     #
657     tf.keras.layers.Conv2D(6338253009137886133423575872,(3,3),activation = 'relu',input_shape =
658     (200,200,3)),
659     tf.keras.layers.MaxPool2D(2,2),
660     #
661     tf.keras.layers.Conv2D(1267650601827577226684715176,(3,3),activation = 'relu',input_shape =
662     (200,200,3)),
663     tf.keras.layers.MaxPool2D(2,2),
664     #
665     tf.keras.layers.Conv2D(2535301203655154453369430352,(3,3),activation = 'relu',input_shape =
666     (200,200,3)),
667     tf.keras.layers.MaxPool2D(2,2),
668     #
669     tf.keras.layers.Conv2D(5070602407300308906738860704,(3,3),activation = 'relu',input_shape =
670     (200,200,3)),
671     tf.keras.layers.MaxPool2D(2,2),
672     #
673     tf.keras.layers.Conv2D(10141204814600617813477721408,(3,3),activation = 'relu',input_shape =
674     (200,200,3)),
675     tf.keras.layers.MaxPool2D(2,2),
676     #
677     tf.keras.layers.Conv2D(20282409629201235626955442816,(3,3),activation = 'relu',input_shape =
678     (200,200,3)),
679     tf.keras.layers.MaxPool2D(2,2),
680     #
681     tf.keras.layers.Conv2D(40564819258402471253910885632,(3,3),activation = 'relu',input_shape =
682     (200,200,3)),
683     tf.keras.layers.MaxPool2D(2,2),
684     #
685     tf.keras.layers.Conv2D(81129638516804942507821761264,(3,3),activation = 'relu',input_shape =
686     (200,200,3)),
687     tf.keras.layers.MaxPool2D(2,2),
688     #
689     tf.keras.layers.Conv2D(162259277033609885015643522528,(3,3),activation = 'relu',input_shape =
690     (200,200,3)),
691     tf.keras.layers.MaxPool2D(2,2),
692     #
693     tf.keras.layers.Conv2D(324518554067219770031287045056,(3,3),activation = 'relu',input_shape =
694     (200,200,3)),
695     tf.keras.layers.MaxPool2D(2,2),
696     #
697     tf.keras.layers.Conv2D(649037108134439540062574090112,(3,3),activation = 'relu',input_shape =
698     (200,200,3)),
699     tf.keras.layers.MaxPool2D(2,2),
700     #
701     tf.keras.layers.Conv2D(1298074216268879080125488180224,(3,3),activation = 'relu',input_shape =
702     (200,200,3)),
703     tf.keras.layers.MaxPool2D(2,2),
704     #
705     tf.keras.layers.Conv2D(2596148432537758160250976360448,(3,3),activation = 'relu',input_shape =
706     (200,200,3)),
707     tf.keras.layers.MaxPool2D(2,2),
708     #
709     tf.keras.layers.Conv2D(5192296865075516320501952720896,(3,3),activation = 'relu',input_shape =
710     (200,200,3)),
711     tf.keras.layers.MaxPool2D(2,2),
712     #
713     tf.keras.layers.Conv2D(10384593730151032641003905441792,(3,3),activation = 'relu',input_shape =
714     (200,200,3)),
715     tf.keras.layers.MaxPool2D(2,2),
716     #
717     tf.keras.layers.Conv2D(20769187460302065282007810883584,(3,3),activation = 'relu',input_shape =
718     (200,200,3)),
719     tf.keras.layers.MaxPool2D(2,2),
720     #
721     tf.keras.layers.Conv2D(41538374920604130564015621767168,(3,3),activation = 'relu',input_shape =
722     (200,200,3)),
723     tf.keras.layers.MaxPool2D(2,2),
724     #
725     tf.keras.layers.Conv2D(83076749841208261128031243534336,(3,3),activation = 'relu',input_shape =
726     (200,200,3)),
727     tf.keras.layers.MaxPool2D(2,2),
728     #
729     tf.keras.layers.Conv2D(166153499682416522256062487068672,(3,3),activation = 'relu',input_shape =
730     (200,200,3)),
731     tf.keras.layers.MaxPool2D(2,2),
732     #
733     tf.keras.layers.Conv2D(332306999364833044512124974137344,(3,3),activation = 'relu',input_shape =
734     (200,200,3)),
735     tf.keras.layers.MaxPool2D(2,2),
736     #
737     tf.keras.layers.Conv2D(664613998729666089024249948274688,(3,3),activation = 'relu',input_shape =
738     (200,200,3)),
739     tf.keras.layers.MaxPool2D(2,2),
740     #
741     tf.keras.layers.Conv2D(1329227997459332178048499896549376,(3,3),activation = 'relu',input_shape =
742     (200,200,3)),
743     tf.keras.layers.MaxPool2D(2,2),
744     #
745     tf.keras.layers.Conv2D(2658455994918664356096999793098752,(3,3),activation = 'relu',input_shape =
746     (200,200,3)),
747     tf.keras.layers.MaxPool2D(2,2),
748     #
749     tf.keras.layers.Conv2D(5316911989837328712193999586197504,(3,3),activation = 'relu',input_shape =
750     (200,200,3)),
751     tf.keras.layers.MaxPool2D(2,2),
752     #
753     tf.keras.layers.Conv2D(1063382397967465742438799917239508,(3,3),activation = 'relu',input_shape =
754     (200,200,3)),
755     tf.keras.layers.MaxPool2D(2,2),
756     #
757     tf.keras.layers.Conv2D(2126764795934931484877599834479016,(3,3),activation = 'relu',input_shape =
758     (200,200,3)),
759     tf.keras.layers.MaxPool2D(2,2),
760     #
761     tf.keras.layers.Conv2D(4253529591869862969755199668958032,(3,3),activation = 'relu',input_shape =
762     (200,200,3)),
763     tf.keras.layers.MaxPool2D(2,2),
764     #
765     tf.keras.layers.Conv2D(8507059183739725939510399337916064,(3,3),activation = 'relu',input_shape =
766     (200,200,3)),
767     tf.keras.layers.MaxPool2D(2,2),
768     #
769     tf.keras.layers.Conv2D(17014118367479451879020798675832128,(3,3),activation = 'relu',input_shape =
770     (200,200,3)),
771     tf.keras.layers.MaxPool2D(2,2),
772     #
773     tf.keras.layers.Conv2D(34028236734958903758041597351664256,(3,3),activation = 'relu',input_shape =
774     (200,200,3)),
775     tf.keras.layers.MaxPool2D(2,2),
776     #
777     tf.keras.layers.Conv2D(68056473469917807516083194703328512,(3,3),activation = 'relu',input_shape =
778     (200,200,3)),
779     tf.keras.layers.MaxPool2D(2,2),
780     #
781     tf.keras.layers.Conv2D(136112946939835615032166389406656024,(3,3),activation = 'relu',input_shape =
782     (200,200,3)),
783     tf.keras.layers.MaxPool2D(2,2),
784     #
785     tf.keras.layers.Conv2D(272225893879671230064332778813312048,(3,3),activation = 'relu',input_shape =
786     (200,200,3)),
787     tf.keras.layers.MaxPool2D(2,2),
788     #
789     tf.keras.layers.Conv2D(544451787759342460128665557626624096,(3,3),activation = 'relu',input_shape =
790     (200,200,3)),
791     tf.keras.layers.MaxPool2D(2,2),
792     #
793     tf.keras.layers.Conv2D(1088903575518848920257331115253280192,(3,3),activation = 'relu',input_shape =
794     (200,200,3)),
795     tf.keras.layers.MaxPool2D(2,2),
796     #
797     tf.keras.layers.Conv2D(2177807151037697840514662230506560384,(3,3),activation = 'relu',input_shape =
798     (200,200,3)),
799     tf.keras.layers.MaxPool2D(2,2),
800     #
801     tf.keras.layers.Conv2D(43556
```

```

283         tf.keras.layers.MaxPool2D(2,2),
284         ##
285         tf.keras.layers.Flatten(),
286         ##
287         tf.keras.layers.Dense(512,activation= 'relu'),
288         ##
289         tf.keras.layers.Dense(1,activation= 'sigmoid')
290     ])
291 model.compile(loss = 'binary_crossentropy',
292                 optimizer = RMSprop(lr=0.001),
293                 metrics =[ 'accuracy'])
294 model_fit = model.fit(train_dataset,
295                         steps_per_epoch = 3,
296                         epochs= 20,
297                         validation_data = validation_dataset)
298 path = '/Users/dhanu/Desktop/cnn/test'
299
300 for i in os.listdir(path):
301     img = image.load_img(path + '/' + i, target_size = (200,200))
302
303     X = image.img_to_array(img)
304     X = np.expand_dims(X, axis = 0)
305     images = np.vstack([X])
306
307     val = model.predict(images)
308     if val ==0:
309         print("child has no autistic markers(control) - ", i)
310     else:
311         print(" child has autistic markers(patient) - ", i)

```

10.2 Poster Presentation

Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
Approved by University Board, AICTE & USCI Act, 1994

Diagnosis of autism spectrum disorders in children: data preprocessing and first models.

Department of Computer Science & Engineering
School of Computing
1156CS701 – MAJOR PROJECT
WINTER SEMESTER 21-22

ABSTRACT

Autism spectrum disorder (ASD) is a developmental disorder, affecting about 1% of the global population. Currently, the only clinical method for diagnosing ASD are prolonged diagnostic time and increased medical costs. This project is part of a larger one that consists in developing a data mining and artificial intelligence method to detect the presence of markers related to autism spectrum disorders (ASD) in children. Data is collected from children using an eye-tracking system under different visual stimulation conditions (images and videos of objects, faces, etc.). From these data, the main problem will be to automatically extract discriminating descriptors, and then to explain them to experts in the field. This work will use convolutional neural networks. The training will produce a classifier that will be trained to assess the presence of markers of autism in a subject with an unknown diagnosis. The method produced will have to be operational and integrated into a nomadic device to assess the risk of ASD in very young children.

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INTRODUCTION

Autism Spectrum Disorder occurs in the developmental stages of an individual and is a serious disorder which can impair the ability to interact or communicate with others. Generally caused by genetics or environmental factors, it impacts the nervous system, as a result of which the overall cognitive, social, emotional, and physical health of the individual is affected. There is a wide variance in the range as well as the severity of its symptoms. A few of the common symptoms the individual faces are difficulties in communication, especially in social settings, obsessive interests, and mannerisms, which take a repetitive form. To identify ASD, an extensive examination is required. The conventional methods such as Autism Diagnostic Interview Revised (ADI-R) and Autism Diagnostic Observation Schedule Revised (ADOS-R) are lengthy and cumbersome, taking up a large amount of time as well as effort.

METHODOLOGIES & IMPLEMENTATION

➤ MODULE 1: Data Preprocessing : combine all the files to make one large all data file, and combine the files by adding columns.
➤ MODULE 2: Generation of Matrices: A matrix was created for each file (for X and Y values) using Crosstab function for each file.
➤ MODULE 3: Generation of Heatmaps: A presentation of data in the form of a map or diagram in which data values are represented as color. Heatmaps are generated for every matrix.
➤ MODULE 4: CNN classification: Convolutional neural networks (CNNs) are deep neural networks that have the capability to classify and segment images.
➤ IMPLEMENTATION:
➤ The Datasets are imported to Jupyter notebook using Keras library .They are divided as training set and testing set.
➤ The CNN model is trained using training set to recognise the pattern.
➤ Then the by using those patterns it classifies the test set whether they were autistic or not.

RESULTS

When the test data sets are classified through the CNN model the results are produced like this.

```
child has autistic markers(patient) - nosl.jpg 3 3 also.also.also.also.jpg  
child has autistic markers(control) - nosl.jpg 10 also.also.also.also.jpg  
child has autistic markers(control) - nosl.jpg 17 also.also.also.also.jpg  
child has autistic markers(control) - nosl.jpg 20 also.also.also.also.jpg  
child has autistic markers(control) - nosl.jpg 30 also.also.also.also.jpg
```

Table 1. Datasets imported from Keras library

```
train_dataset = train.flow_from_directory('/Users/dhanu/Desktop/cnn/train/',  
                                         target_size=(200,200),  
                                         batch_size=3,  
                                         class_mode='binary')  
  
validation_dataset = validation.flow_from_directory('/Users/dhanu/Desktop/cnn/valid/',  
                                         target_size=(200,200),  
                                         batch_size=3,  
                                         class_mode='binary')  
  
Found 135 images belonging to 2 classes.  
Found 24 images belonging to 2 classes.  
  
validation_dataset.class_indices  
{'control': 0, 'patient': 1}
```

Figure 1. Heatmap image

STANDARDS AND POLICIES

- "Technical Framework and Requirements of Shared Machine Learning". This standard defines a framework and architectures for machine learning in which a model is trained using encrypted data that has been aggregated from multiple sources and is processed by a trusted third party.
- Safety. Machine learning (ML) algorithms allow computers to learn without being explicitly programmed. Their utilization is spreading to highly sophisticated tasks across multiple domains, like medical diagnostics or fully autonomous vehicles. Whereas this presents a great potential, it also raises new safety concerns as ML has many specificities that make its behaviour prediction and assessment much different from explicitly programmed software systems. A good number of relevant questions are open topics of research.

Figure 2. image of a matrix

Figure 2. image of a matrix

CONCLUSIONS

- The dataset has been preprocessed and cleaned
- Then it is trained with a few heatmaps to recognize the pattern to classify.
- Then the CNN model is made to predict the Autism.

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Figure 10.1: Poster Presentation

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