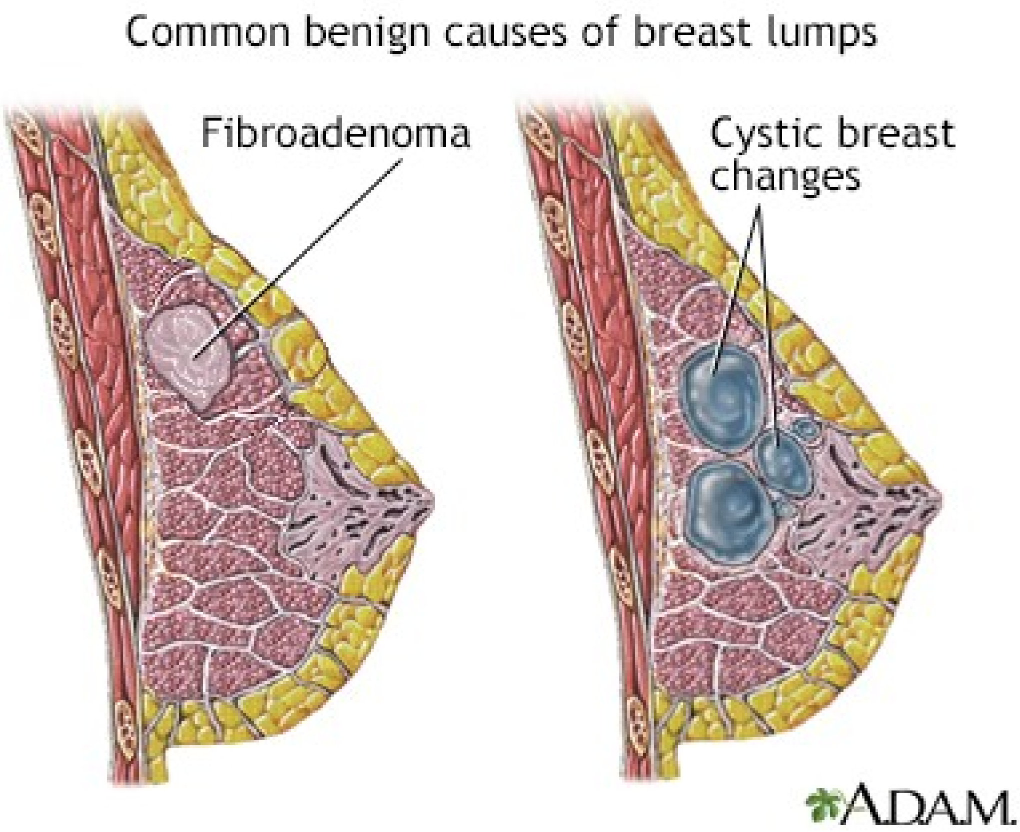
```
>> # ENTRO
```

# Breast Cancer Detection using deep learning

- Breast cancer is the second leading cause of cancer deaths among U.S. women, it is a type of cancer that starts when cells begin to grow out of control
- Most breast cancers begin in the ducts that carry milk to the nipple (ductal cancers),
- Breast cancer can spread when the cancer cells get into the blood or lymph system and are carried to other parts of the body.
- Cancerous breast tumors are detected by a special type of examination, which is screening mammogram



Detection of breast cancer on screening mammography is challenging as an image classification task because the tumors themselves occupy only a small portion of the image of the entire breast. For example, a full-field digital mammography (FFDM) image is typically 4000 × 3000 pixels while a potentially cancerous region of interest (ROI) can be as small as 100 × 100 pixels.

This explains the large number that we have in the data, which is more than **a quarter of a million** images!

Our goal: Given a patient and a patch of a tissue slice predict wheather it contains IDC or not.

```
import os
print(os.getcwd())
```

```
/Users/anikavyas/Desktop
```

CODE

Import Libraries

```
import os
import numpy as np
import shutil
import pandas as pd
from skimage.util import random_noise
from sklearn.model_selection import train_test_split
import tensorflow
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import matplotlib.image as mpimg
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import
Dense,Conv2D,MaxPool2D,Flatten,Dropout
from tensorflow.keras.callbacks import EarlyStopping,ModelCheckpoint
import matplotlib.pyplot as plt
from skimage.filters import gaussian
import seaborn as sns
from sklearn.metrics import confusion_matrix
import itertools
```

Get & Adjust Data

```
# accsess the data files
cancer_rays_dir     =
os.listdir("/Users/anikavyas/Desktop/BC/archive/")
all_rays_dir        = "/Users/anikavyas/Desktop/BC/all_rays_dir/"
cancer_rays_dir_str ="/Users/anikavyas/Desktop/BC/archive/"
```

what is the structure of our data?

```
if not os.path.exists(all_rays_dir):
    os.mkdir(all_rays_dir)

print(cancer_rays_dir)
print(len(cancer_rays_dir))
```

```
['9036', '10268', '10257', '8913', '13613', '8914', '15510', '10259',
'16165', '10292', '12951', '10261', '10295', '9259', '12750', '13020',
'16552', '12905', '9266', '16555', '13018', '9261', '9257', '12934',
'12933', '9250', '10260', '10258', '10293', '9037', '10269', '16531',
'10256', '15516', '12932', '12935', '9256', '16554', '9260', '13019',
'16553', '13021', '8984', '9258', '12751', '9267', '12876', '12882',
'15634', '12871', '14188', '15633', '9324', '12878', '.DS_Store',
'9323', '9383', '8867', '9346', '9174', '12822', '9173', '9322',
'9325', '12879', '14189', '12870', '12884', '12241', '15632', '12883',
'12877', '9126', '13106', '12823', '13591', '9175', '12824', '9347',
'9181', '9382', '10307', '13916', '10300', '14306', '15471', '16896',
'14156', '9135', '12890', '12897', '10308', '10301', '10306', '12896',
'14157', '12891', '12898', '14192', '13458', '9083', '9077', '13460',
'8955', '12910', '9041', '14210', 'IDC_regular_ps50_idx5', '14082',
'10274', '9227', '10273', '13402', '14078', '9023', '12911', '14211',
'13691', '9078', '12929', '13461', '9076', '13459', '16570', '9022',
'10288', '9228', '14079', '10286', '13403', '10272', '10275', '13404',
'9226', '13024', '8975', '16569', '12901', '9262', '13023', '16551',
'9265', '12906', '9291', '12930', '13688', '12908', '9254', '16534',
'8917', '15513', '10253', '9035', '10254', '15514', '16533', '13617',
'10262', '12955', '16166', '10291', '12909', '9255', '14209', '12931',
'13689', '16550', '13022', '12752', '9290', '12907', '13687', '8980',
'8974', '13025', '12900', '16568', '12954', '10264', '16167', '10290',
'8918', '16532', '13616', '15515', '10255', '10299', '15512', '8916',
'8864', '12810', '8863', '12817', '14321', '12821', '12819', '12826',
'9177', '9345', '12886', '9123', '12872', '9124', '12875', '12881',
'9320', '12818', '16014', '9344', '9176', '12820', '9178', '9381',
'15839', '8865', '12811', '9319', '9321', '16085', '12880', '9125',
'12873', '12242', '12626', '16895', '14190', '12869', '12894',
'14155', '12867', '12893', '10303', '10304', '15472', '14305',
'14154', '12892', '14153', '12895', '12868', '14191', '15840',
'14304', '15473', '10305', '10302', '13401', '14081', '9029', '10277',
'12947', '12949', '10279', '12748', '9073', '8956', '8951', '14213',
'13694', '15903', '13693', '12948', '10278', '10276', '10282', '9225',
'10285', '13400', '15902', '9044', '13666', '13692', '9043', '8959',
'14212', '9075', '9081', '8950', '12749', '13462', '8957']
281
```

We can see 279 files for each patient named with their id, and each file contains x-ray images of its owner

To facilitate the process of dealing with screening mammograms images, we will collect all the images in one place, while retaining ownership of each image and its class as well...

```
all_rays_dir_lst = os.listdir(all_rays_dir)

for patient in cancer_rays_dir:
    if patient.startswith('.'):  # skip .DS_Store and hidden files
        continue

    path_0 = os.path.join(cancer_rays_dir_str, str(patient), '0')
    path_1 = os.path.join(cancer_rays_dir_str, str(patient), '1')

    if not os.path.isdir(path_0) or not os.path.isdir(path_1):
        continue  # skip if subfolder doesn't exist

    file_list_0 = os.listdir(path_0)
    file_list_1 = os.listdir(path_1)

    for fname in file_list_0:
        src = os.path.join(path_0, fname)
        dst = os.path.join(all_rays_dir, fname)
        shutil.copyfile(src, dst)

    for fname in file_list_1:
        src = os.path.join(path_1, fname)
        dst = os.path.join(all_rays_dir, fname)
        shutil.copyfile(src, dst)

shutil.copyfile(src, dst)
```

```
'/Users/anikavyas/Desktop/BC/all_rays_dir/
13021_idx5_x351_y901_class0.png'
```

```
len(all_rays_dir_lst)
```

```
29676
```

Now we have 277,524 images, what a number!

Then, it's time to put images in a data_frame for easy access:

```
data = pd.DataFrame(all_rays_dir_lst, columns=['image_id'])
data.head()
```

```
                              image_id
0    9266_idx5_x1901_y701_class0.png
1  15510_idx5_x1801_y1001_class0.png
2    10295_idx5_x801_y951_class0.png
3   9036_idx5_x1051_y2401_class0.png
4    8914_idx5_x651_y1251_class0.png
```

```
def extract_target(x):
    a = x.split('_')
    b = a[4]
    target = b[5]
    return target

data['target'] = data['image_id'].apply(extract_target)
```

```
data.head(10)
```

```
                             image_id  target
0    9266_idx5_x1901_y701_class0.png      0
1  15510_idx5_x1801_y1001_class0.png      0
2    10295_idx5_x801_y951_class0.png      0
3   9036_idx5_x1051_y2401_class0.png      0
4    8914_idx5_x651_y1251_class0.png      0
5    12934_idx5_x701_y701_class0.png      0
6    9257_idx5_x1451_y601_class1.png      1
7   13613_idx5_x501_y1301_class0.png      0
8  15510_idx5_x2651_y1051_class0.png      0
9    9261_idx5_x1101_y501_class1.png      1
```

```
def extract_patient_id(x):
    # split into a list
    a = x.split('_')
    patient_id = a[0]

    return patient_id
data['patient_id'] = data['image_id'].apply(extract_patient_id)
data.head()
```

```
                             image_id  target patient_id
0    9266_idx5_x1901_y701_class0.png      0       9266
1  15510_idx5_x1801_y1001_class0.png      0      15510
2    10295_idx5_x801_y951_class0.png      0      10295
3   9036_idx5_x1051_y2401_class0.png      0       9036
4    8914_idx5_x651_y1251_class0.png      0       8914
```

```
data['target'].value_counts()
```

```
target
0    23384
1     6292
Name: count, dtype: int64
```

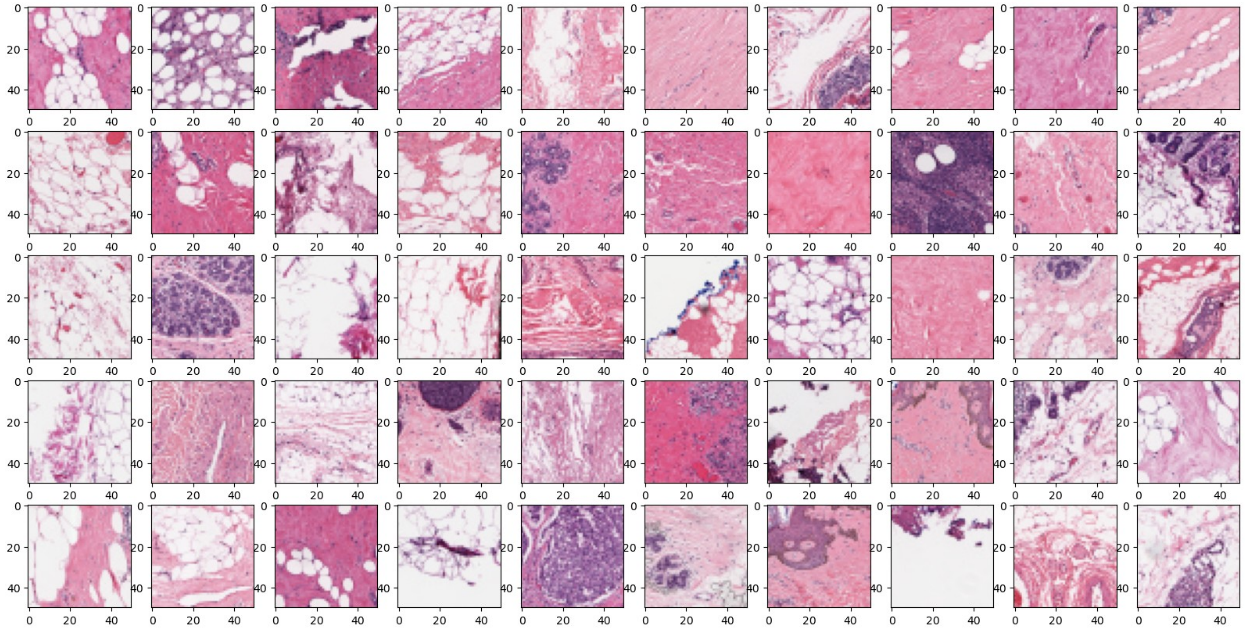
It also seems that the number of healthy rays is greater than the number of infected rays, good news!

Exploratory Data Analysis

First of all, let's take a look at the nature of the mammograms...

Healthy patches:

```
data.target = data.target.astype(int)
fig, ax = plt.subplots(5,10,figsize=(20,10))
pos_selection = np.random.choice(data[data.target ==1].index, size=50,
replace=False,)
neg_selection = np.random.choice(data[data.target ==0].index, size=50,
replace=False,)
for n in range(5):
    for m in range(10):
        idx = neg_selection[m + 10*n]
        path =os.path.join(all_rays_dir,data.loc[idx, 'image_id'])
        image = mpimg.imread(path)
        ax[n,m].imshow(image)
        ax[n,m].grid(False)
```

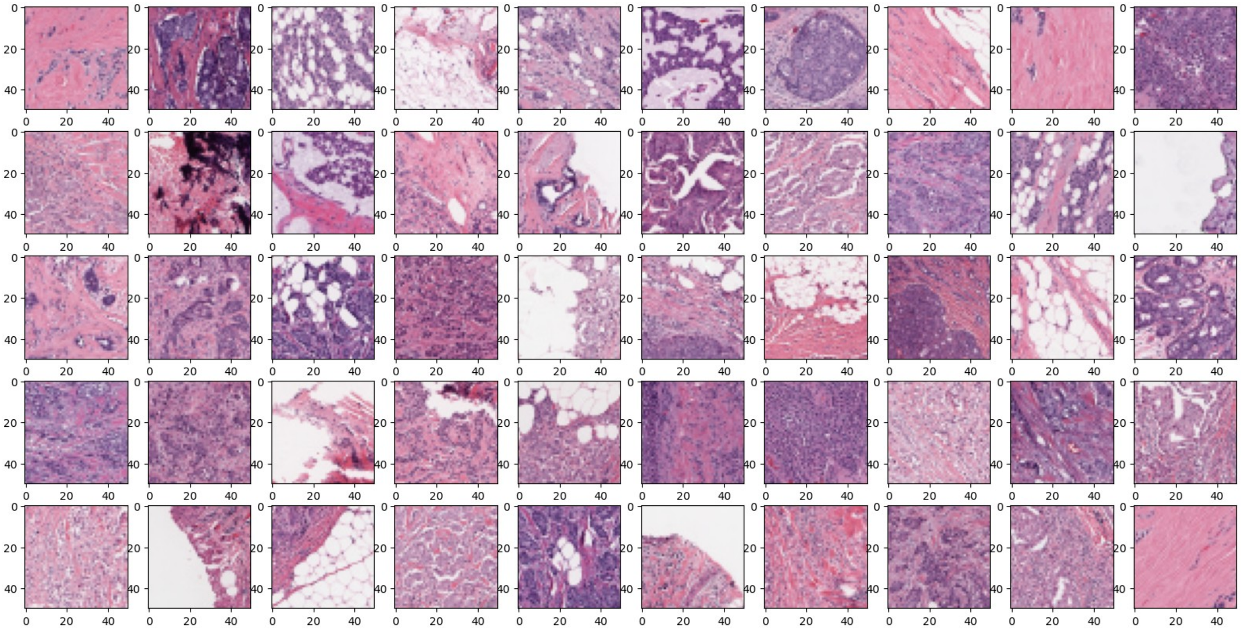


Insights

- Most of the mammograms are light pink, but there are some dark ones too

Cancer patches:

```
fig, ax = plt.subplots(5,10,figsize=(20,10))
for n in range(5):
    for m in range(10):
        idx = pos_selection[m + 10*n]
        path =os.path.join(all_rays_dir,data.loc[idx, 'image_id'])
        image = mpimg.imread(path)
        ax[n,m].imshow(image)
        ax[n,m].grid(False)
```



Insights

- Patches with cancer look more violet and crowded than healthy ones.
- In fact, we could not determine the actual difference between the two types with the naked eye, but I think that the model is able to detect hidden patterns in these images that enable us to determine the state of each image.

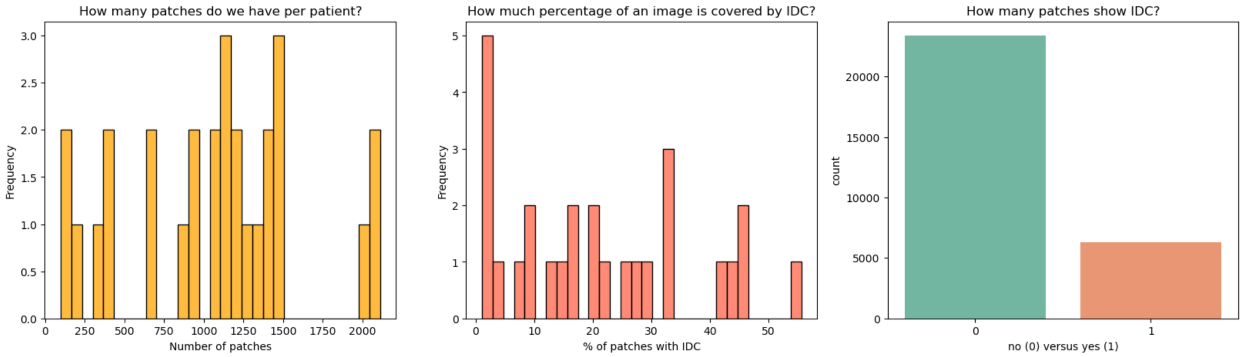
Let's ask some questions that will help us get to know more our data:

- do all patients have the same number of mammograms?
- what is the percentage of cancer (IDC) that each mammogram shows?
- how many healthy and cancered mammograms are in the data?

```
# Calculate cancer percentage per patient
cancer_perc = data.groupby("patient_id").target.value_counts() /
data.groupby("patient_id").target.size()
cancer_perc = cancer_perc.unstack()

# Setup subplot grid
fig, ax = plt.subplots(1, 3, figsize=(20, 5))
```

```
# Histogram: patches per patient
sns.histplot(data.groupby("patient_id").size(), ax=ax[0],
color="orange", bins=30)
ax[0].set_xlabel("Number of patches")
ax[0].set_ylabel("Frequency")
ax[0].set_title("How many patches do we have per patient?")

# Histogram: IDC percentage per image
sns.histplot(cancer_perc.loc[:, 1] * 100, ax=ax[1], color="tomato",
bins=30)
ax[1].set_title("How much percentage of an image is covered by IDC?")
ax[1].set_ylabel("Frequency")
ax[1].set_xlabel("% of patches with IDC")

# Count plot: Target 0 vs 1
sns.countplot(x=data.target, ax=ax[2], palette="Set2")
ax[2].set_xlabel("no (0) versus yes (1)")
ax[2].set_title("How many patches show IDC?")
```

```
/var/folders/g1/rrz63fkj39gbw4qx5mt6rs0w0000gn/T/
ipykernel_68920/2648437307.py:21: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be
removed in v0.14.0. Assign the `x` variable to `hue` and set
`legend=False` for the same effect.

  sns.countplot(x=data.target, ax=ax[2], palette="Set2")

Text(0.5, 1.0, 'How many patches show IDC?')
```



Insights:

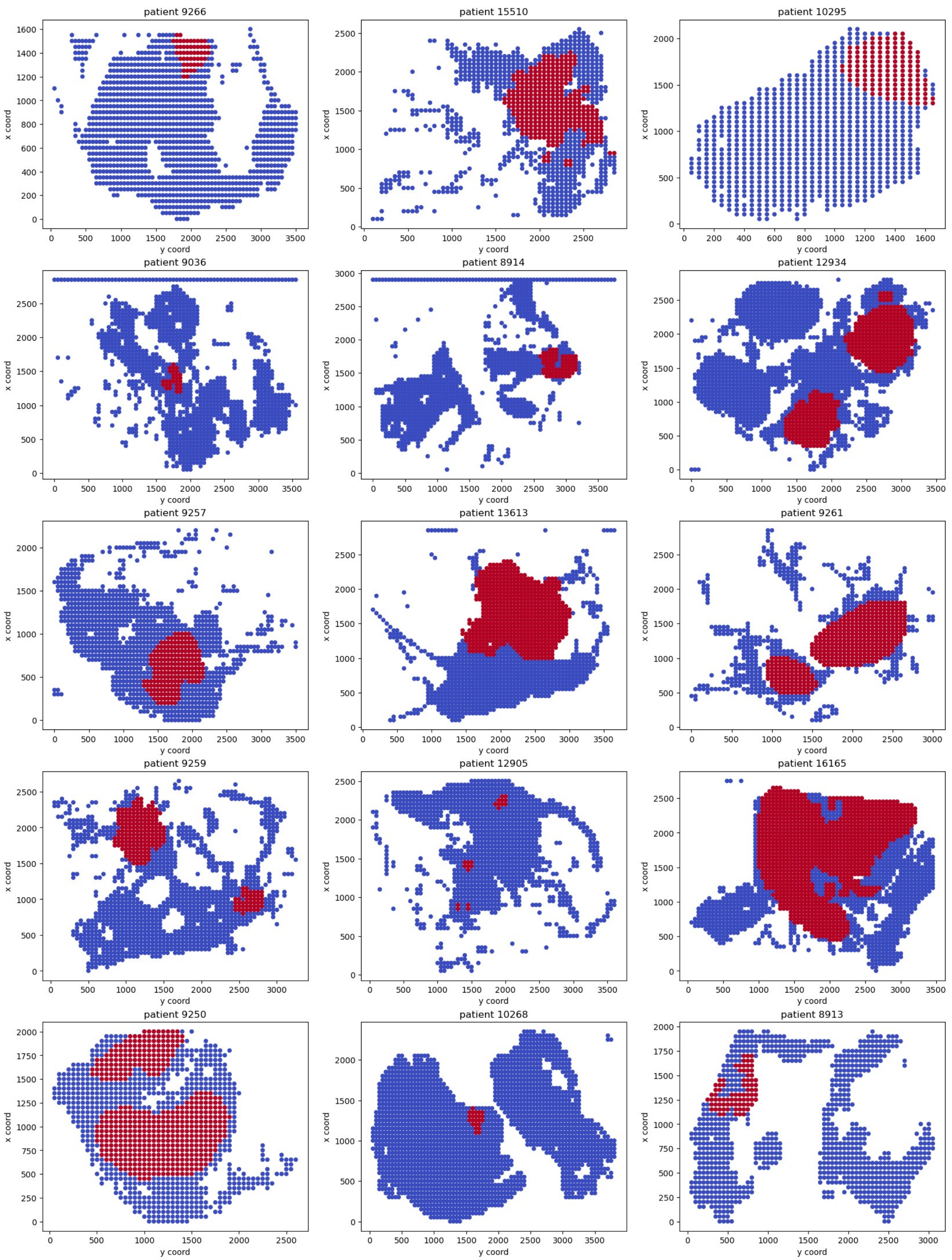
- The number of image patches per patient varies a lot
- Most of the photos have a percentage that is not large, but there are other photos that have a percentage of up to 80%
- the smaller number of mammograms had cancer

```
def extract_coords(df):
    coord = df.path.str.rsplit("_", n=4, expand=True)
    coord = coord.drop([0, 1, 4], axis=1)
    coord = coord.rename({2: "x", 3: "y"}, axis=1)
    coord["x"] = coord["x"].str.replace("x", "",
case=False).astype(int)
    coord["y"] = coord["y"].str.replace("y", "",
case=False).astype(int)
    df["x"] = coord["x"].values
    df["y"] = coord["y"].values
    return df

def get_cancer_dataframe(patient_id, cancer_id):
    path = cancer_rays_dir_str + patient_id + "/" + cancer_id
    files = os.listdir(path)
    dataframe = pd.DataFrame(files, columns=["filename"])
    path_names = path + "/" + dataframe["filename"].values
    dataframe = dataframe["filename"].str.rsplit("_", n=4,
expand=True)
    dataframe["target"] = int(cancer_id)
    dataframe["path"] = path_names
    dataframe = dataframe.drop([0, 1, 4], axis=1)
    dataframe = dataframe.rename({2: "x", 3: "y"}, axis=1)
    dataframe["x"] = dataframe["x"].str.replace("x", "",
case=False).astype(int)
    dataframe["y"] = dataframe["y"].str.replace("y", "",
case=False).astype(int)
    return dataframe

def get_patient_dataframe(patient_id):
    df_0 = get_cancer_dataframe(patient_id, "0")
    df_1 = get_cancer_dataframe(patient_id, "1")
    patient_df = pd.concat([df_0, df_1], ignore_index=True)
    return patient_df

example = get_patient_dataframe(data.patient_id.values[0])
example.head()
```

```
      x     y  target
path
0  1901   701       0
/Users/anikavyas/Desktop/BC/archive/9266/0/926...
1  2251  1251       0
/Users/anikavyas/Desktop/BC/archive/9266/0/926...
2   751   401       0
/Users/anikavyas/Desktop/BC/archive/9266/0/926...
3  2251   451       0
/Users/anikavyas/Desktop/BC/archive/9266/0/926...
4   351  1501       0
/Users/anikavyas/Desktop/BC/archive/9266/0/926...
```

Well let's take a closer look at the shape of the patches and their distribution in each mammogram using Binary objective visualization for each tissue slice:

```
fig, ax = plt.subplots(5,3,figsize=(20, 27))

patient_ids = data.patient_id.unique()

for n in range(5):
    for m in range(3):
        patient_id = patient_ids[m + 3*n]
        example_df = get_patient_dataframe(patient_id)

        ax[n,m].scatter(example_df.x.values, example_df.y.values,
c=example_df.target.values, cmap="coolwarm", s=20);
        ax[n,m].set_title("patient " + patient_id)
        ax[n,m].set_xlabel("y coord")
        ax[n,m].set_ylabel("x coord")
```


patient 9266
patient 15510
patient 10295
patient 9036
patient 8914
patient 12934
patient 9257
patient 13613
patient 9261
patient 9259
patient 12905
patient 16165
patient 9250
patient 10268
patient 8913
x coord
y coord
0
500
1000
1500
2000
2500
3000
3500
200
400
600
800
1200
1400
1600
250
750
1250
1750

Insights:

- We see a large variation in the concentration of cells
- Sometimes we don't have the full tissue information. It seems that tissue patches have been discarded or lost during preparation.

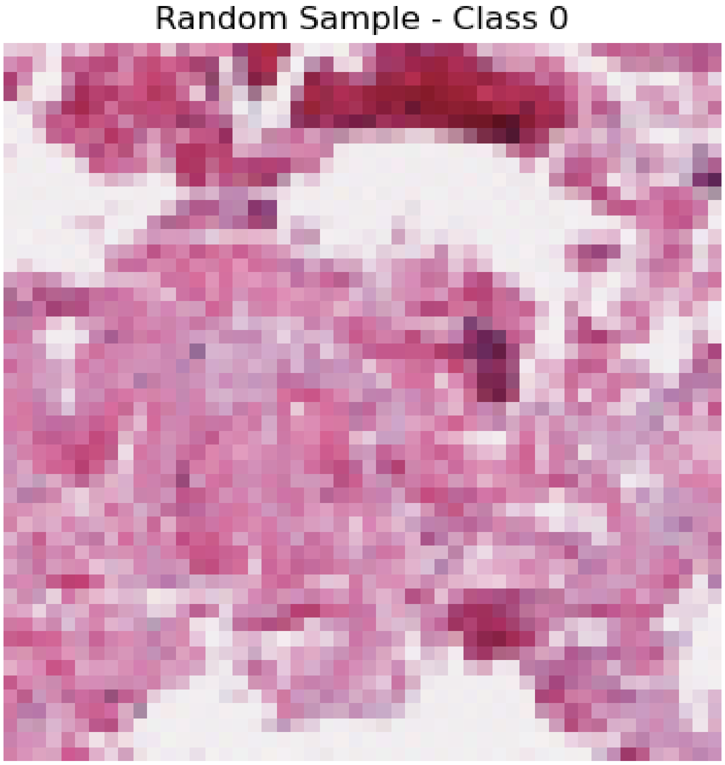
Processing and selection

it's time to work on our data..

Image Processing

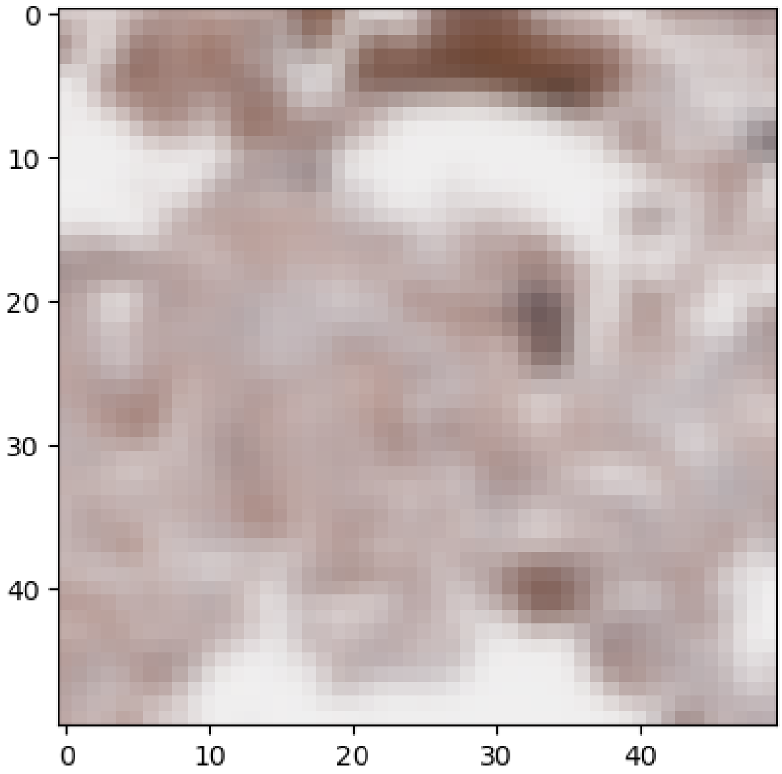
- Apply some processing properties

```
data["target"] = data["target"].astype(int)

# Select a random image index from the negative class (target == 0)
random_index = np.random.choice(data[data["target"] == 0].index,
size=1, replace=False)

# Build the image path
path = os.path.join(all_rays_dir, data.loc[random_index[0],
'image_id'])

# Load and display the image
image = mpimg.imread(path)
plt.imshow(image)
plt.axis('off')  # Optional: makes the display cleaner
plt.title("Random Sample - Class 0")
plt.show()
```

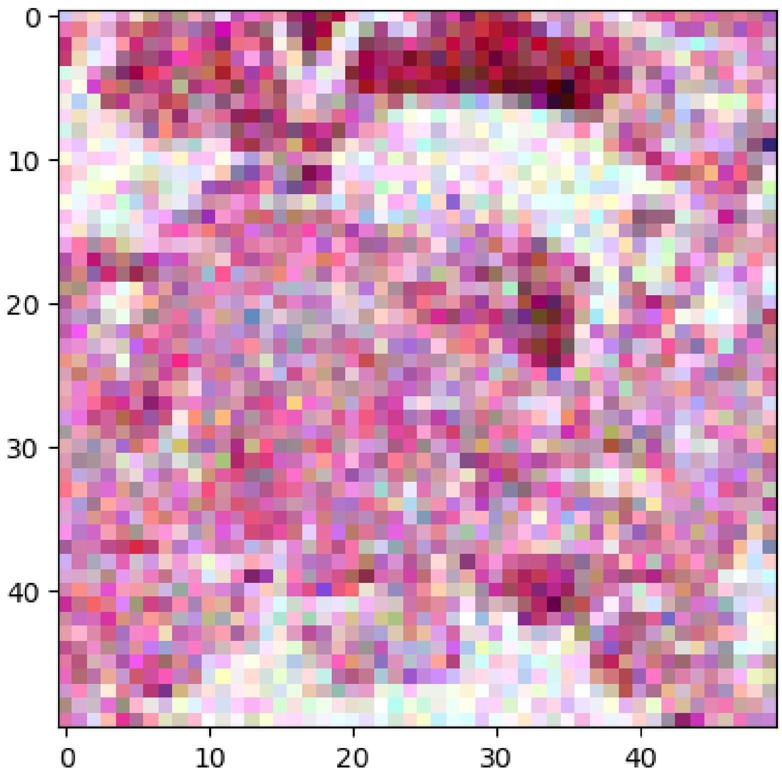


Random Sample - Class 0

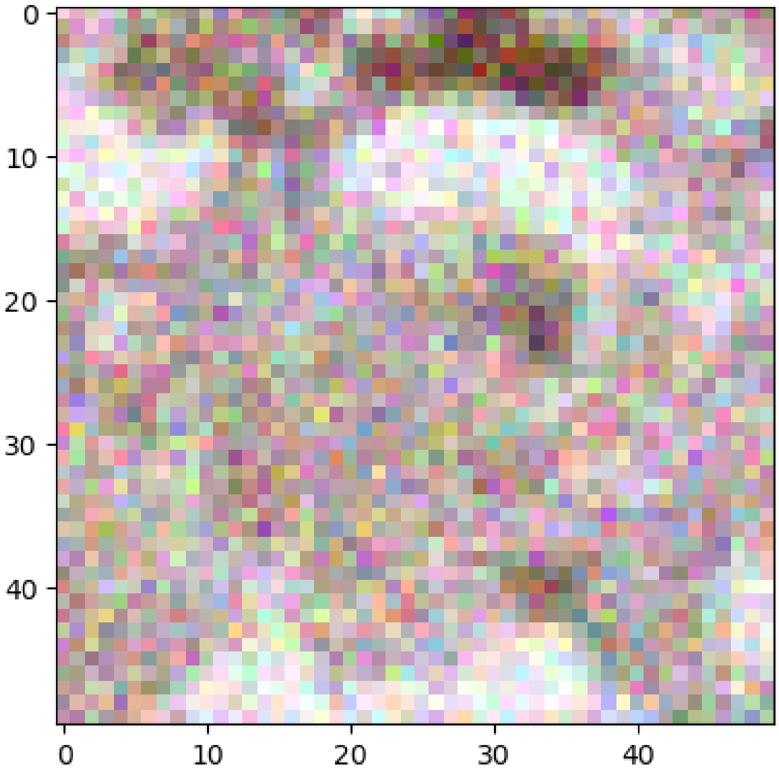
```
gaussian_image = gaussian(image)
plt.imshow(gaussian_image)

<matplotlib.image.AxesImage at 0x30bb29130>
```



```
noise_image = random_noise(image)
plt.imshow(noise_image)

<matplotlib.image.AxesImage at 0x36a3b83b0>
```



```
noise_gaussian_image = random_noise(gaussian_image)
plt.imshow(noise_gaussian_image)

<matplotlib.image.AxesImage at 0x30d7a85c0>
```



- Processing using [random_noise] function

```
import os
from skimage.util import random_noise
import matplotlib.image as mpimg

# Make sure the directories exist
os.makedirs('Desktop/final_proj/image_processing/noise_images',
exist_ok=True)

# Loop over the image filenames
for normal_image in all_rays_dir_lst:
    path = os.path.join(all_rays_dir, normal_image)

    # Read the image
    img = mpimg.imread(path)

    # Add noise to the image
    noise_image = random_noise(img)

    # Save the noisy image
    new_path =
os.path.join('Desktop/final_proj/image_processing/noise_images',
normal_image)
    mpimg.imsave(new_path, noise_image)
```

```python
os.makedirs('Desktop/final_proj/image_processing/
processed_data_train/zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/processed_data_train/
ones', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/processed_data_test/
zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/processed_data_test/
ones', exist_ok=True)

# List the processed image files
processed_lst =
os.listdir('Desktop/final_proj/image_processing/noise_images')

# Construct path to noise images
processed_lst_str = 'Desktop/final_proj/image_processing/noise_images'

# Convert to DataFrame
processed_data = pd.DataFrame(processed_lst, columns=['image_id'])

# Preview the data
processed_data.head()
```

```
                             image_id
0    9266_idx5_x1901_y701_class0.png
1  15510_idx5_x1801_y1001_class0.png
2    10295_idx5_x801_y951_class0.png
3   9036_idx5_x1051_y2401_class0.png
4    8914_idx5_x651_y1251_class0.png
```

```python
def extract_target(x):
    a = x.split('_')
    b = a[4]
    target = b[5]  # Get the 6th character of the string at index 5
    return target

# Ensure `processed_data` is the DataFrame you're working with (not
`processd_data`)
processed_data['target'] =
processed_data['image_id'].apply(extract_target)

processed_data.head(10)
```

```
                             image_id target
0    9266_idx5_x1901_y701_class0.png      0
1  15510_idx5_x1801_y1001_class0.png      0
2    10295_idx5_x801_y951_class0.png      0
3   9036_idx5_x1051_y2401_class0.png      0
4    8914_idx5_x651_y1251_class0.png      0
5    12934_idx5_x701_y701_class0.png      0
6    9257_idx5_x1451_y601_class1.png      1
7   13613_idx5_x501_y1301_class0.png      0
```

```
8  15510_idx5_x2651_y1051_class0.png      0
9    9261_idx5_x1101_y501_class1.png      1
```

```
processed_data['target'].value_counts()
```

```
target
0    23384
1     6292
Name: count, dtype: int64
```

```
import shutil
import os

# Assuming `processd_test` is a list of image filenames from processed
data for the test set
for image in processed_data['image_id']:
    fname = image
    target = processed_data.loc[processed_data['image_id'] == image,
'target'].values[0]

    if target == '0':
        label = 'zeros'
    elif target == '1':
        label = 'ones'
    else:
        continue  # Skip if the target is neither '0' nor '1'

    src = os.path.join(processed_lst_str, fname)
    dst =
os.path.join("Desktop/final_proj/image_processing/processed_data_test"
, label, fname)

    # Ensure the destination folder exists
    os.makedirs(os.path.dirname(dst), exist_ok=True)

    # Copy file
    shutil.copyfile(src, dst)

# Ensure `processed_data` is defined correctly and set the index
processed_data.set_index('image_id', inplace=True)

# Assuming `processd_train` is a list of image filenames or the train
data subset from `processed_data`
# If you haven't defined `processd_train`, you can use processed_data
directly, filtering for train data
processd_train = processed_data.index  # or
processed_data[processed_data['set'] == 'train'].index

# Iterate over the training set and copy files
for image in processd_train:
    fname = image
    target = processed_data.loc[image, 'target']

    if target == '0':
        label = 'zeros'
    elif target == '1':
        label = 'ones'
    else:
        continue  # Skip if the target is neither '0' nor '1'

    # Source and destination paths
    src = os.path.join(processed_lst_str, fname)
    dst =
os.path.join('Desktop/final_proj/image_processing/processed_data_train
', label, fname)

    # Ensure the destination folder exists
    os.makedirs(os.path.dirname(dst), exist_ok=True)

    # Copy file to the destination
    shutil.copyfile(src, dst)

print(len(os.listdir('Desktop/final_proj/image_processing/
processed_data_train/zeros')))
print(len(os.listdir('Desktop/final_proj/image_processing/processed_da
ta_train/ones')))
print(len(os.listdir('Desktop/final_proj/image_processing/processed_da
ta_test/zeros')))
print(len(os.listdir('Desktop/final_proj/image_processing/processed_da
ta_test/ones')))
```

```
23384
6292
23384
6292
```

Processing and Normal test

- the images we processed and the noraml are tested on the same model to see which the best in the accuracy
- A small sample is taken for testing (20,000) images

First: the processed images

```
os.makedirs('Desktop/final_proj/image_processing/model_tst/training/
zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/model_tst/training/
ones', exist_ok=True)
```

```
os.makedirs('Desktop/final_proj/image_processing/model_tst/testing/zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/model_tst/testing/ones', exist_ok=True)

import pandas as pd
from sklearn.model_selection import train_test_split
import shutil
import os

# Ensure `processd_data` is loaded correctly
# This assumes `processd_data` is a DataFrame, make sure you have it from previous steps
# If it's not loaded, load it from a file (e.g., CSV or other formats)
# processd_data = pd.read_csv("your_data.csv")  # Example for CSV loading

# Sample 10000 entries for each target class '0' and '1'
df_0 = processd_data[processd_data['target'] == '0'].sample(10000, random_state=101)
df_1 = processd_data[processd_data['target'] == '1'].sample(10000, random_state=101)

# Combine the two DataFrames for testing
test_data = pd.concat([df_0, df_1], axis=0).reset_index(drop=True)
test_y = test_data['target']

# Split into training and test sets
test_data_train, test_data_test = train_test_split(test_data, test_size=0.10, random_state=101, stratify=test_y)

# Get image IDs for training and testing
sts_train = test_data_train.image_id
tst_test = test_data_test.image_id

# Set the index to image_id
test_data.set_index('image_id', inplace=True)

# Ensure destination directories exist
os.makedirs('Desktop/final_proj/image_processing/model_tst/training/zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/model_tst/training/ones', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/model_tst/testing/zeros', exist_ok=True)
os.makedirs('Desktop/final_proj/image_processing/model_tst/testing/ones', exist_ok=True)

# Copy files for training set
for image in sts_train:
    fname = image
    target = test_data.loc[image, 'target']

    if target == '0':
        label = 'zeros'
    elif target == '1':
        label = 'ones'

    # Source and destination paths
    src = os.path.join(all_rays_dir, fname)
    dst = 
os.path.join('Desktop/final_proj/image_processing/model_tst/training',
label, fname)

    # Copy the file
    shutil.copyfile(src, dst)

# Copy files for testing set
for image in tst_test:
    fname = image
    target = test_data.loc[image, 'target']

    if target == '0':
        label = 'zeros'
    elif target == '1':
        label = 'ones'

    # Source and destination paths
    src = os.path.join(all_rays_dir, fname)
    dst = 
os.path.join('Desktop/final_proj/image_processing/model_tst/testing',
label, fname)

    # Copy the file
    shutil.copyfile(src, dst)
```

```
----------------------------------------------------------------------
-----
NameError                                 Traceback (most recent call
last)
Cell In[113], line 12
      4 import os
      6 # Ensure `processd_data` is loaded correctly
      7 # This assumes `processd_data` is a DataFrame, make sure you
have it from previous steps
      8 # If it's not loaded, load it from a file (e.g., CSV or other
formats)
      9 # processd_data = pd.read_csv("your_data.csv")  # Example for
CSV loading
     10
     11 # Sample 10000 entries for each target class '0' and '1'
---> 12 df_0 = processd_data[processd_data['target'] ==
'0'].sample(10000, random_state=101)
     13 df_1 = processd_data[processd_data['target'] ==
'1'].sample(10000, random_state=101)
     15 # Combine the two DataFrames for testing

NameError: name 'processd_data' is not defined
```

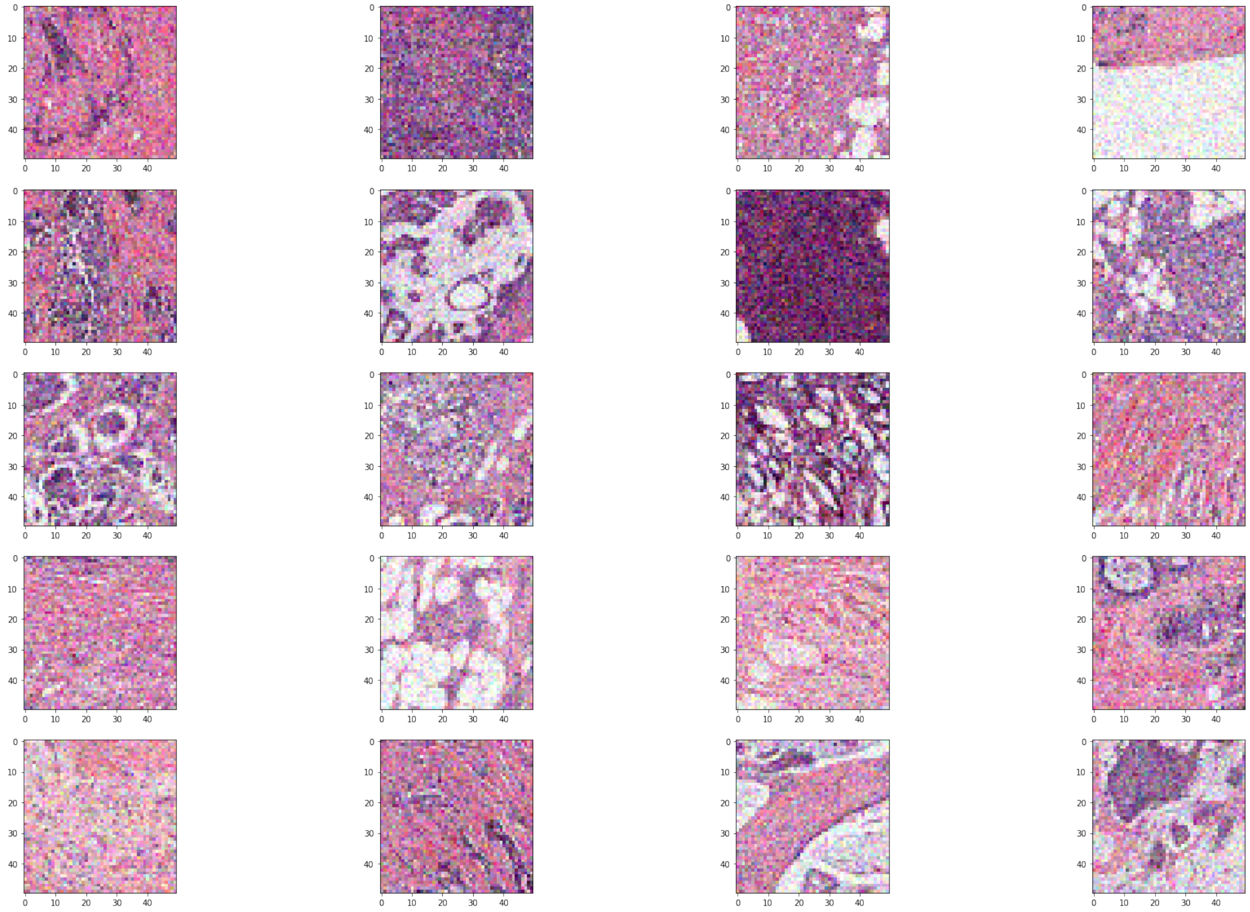
```python
import pandas as pd

# Load the data (update with the actual file path)
processd_data = pd.read_csv('path_to_your_file.csv')

# Check if data is loaded correctly
print(processd_data.head())
```

```
----------------------------------------------------------------------
-----
FileNotFoundError                         Traceback (most recent call
last)
Cell In[117], line 4
      1 import pandas as pd
      3 # Load the data (update with the actual file path)
----> 4 processd_data = pd.read_csv('path_to_your_file.csv')
      6 # Check if data is loaded correctly
      7 print(processd_data.head())

File
/opt/anaconda3/lib/python3.12/site-packages/pandas/io/parsers/readers.
py:1026, in read_csv(filepath_or_buffer, sep, delimiter, header,
names, index_col, usecols, dtype, engine, converters, true_values,
false_values, skipinitialspace, skiprows, skipfooter, nrows,
na_values, keep_default_na, na_filter, verbose, skip_blank_lines,
parse_dates, infer_datetime_format, keep_date_col, date_parser,
date_format, dayfirst, cache_dates, iterator, chunksize, compression,
thousands, decimal, lineterminator, quotechar, quoting, doublequote,
escapechar, comment, encoding, encoding_errors, dialect, on_bad_lines,
delim_whitespace, low_memory, memory_map, float_precision,
storage_options, dtype_backend)
   1013 kwds_defaults = _refine_defaults_read(
   1014     dialect,
   1015     delimiter,
   (...)
   1022     dtype_backend=dtype_backend,
   1023 )
   1024 kwds.update(kwds_defaults)
-> 1026 return _read(filepath_or_buffer, kwds)

File
/opt/anaconda3/lib/python3.12/site-packages/pandas/io/parsers/readers.
py:620, in _read(filepath_or_buffer, kwds)
    617 _validate_names(kwds.get("names", None))
    619 # Create the parser.
--> 620 parser = TextFileReader(filepath_or_buffer, **kwds)
    622 if chunksize or iterator:
    623     return parser

File
/opt/anaconda3/lib/python3.12/site-packages/pandas/io/parsers/readers.
py:1620, in TextFileReader.__init__(self, f, engine, **kwds)
   1617     self.options["has_index_names"] = kwds["has_index_names"]
   1619 self.handles: IOHandles | None = None
-> 1620 self._engine = self._make_engine(f, self.engine)

File
/opt/anaconda3/lib/python3.12/site-packages/pandas/io/parsers/readers.
py:1880, in TextFileReader._make_engine(self, f, engine)
   1878     if "b" not in mode:
   1879         mode += "b"
-> 1880 self.handles = get_handle(
   1881     f,
   1882     mode,
   1883     encoding=self.options.get("encoding", None),
   1884     compression=self.options.get("compression", None),
   1885     memory_map=self.options.get("memory_map", False),
   1886     is_text=is_text,
   1887     errors=self.options.get("encoding_errors", "strict"),
   1888     storage_options=self.options.get("storage_options", None),
   1889 )
   1890 assert self.handles is not None
   1891 f = self.handles.handle

File
/opt/anaconda3/lib/python3.12/site-packages/pandas/io/common.py:873,
in get_handle(path_or_buf, mode, encoding, compression, memory_map,
is_text, errors, storage_options)
    868 elif isinstance(handle, str):
    869     # Check whether the filename is to be opened in binary
mode.
    870     # Binary mode does not support 'encoding' and 'newline'.
    871     if ioargs.encoding and "b" not in ioargs.mode:
    872         # Encoding
--> 873         handle = open(
    874             handle,
    875                 ioargs.mode,
    876                 encoding=ioargs.encoding,
    877                 errors=errors,
    878                 newline="",
    879             )
    880         else:
    881             # Binary mode
    882             handle = open(handle, ioargs.mode)

FileNotFoundError: [Errno 2] No such file or directory:
'path_to_your_file.csv'
```

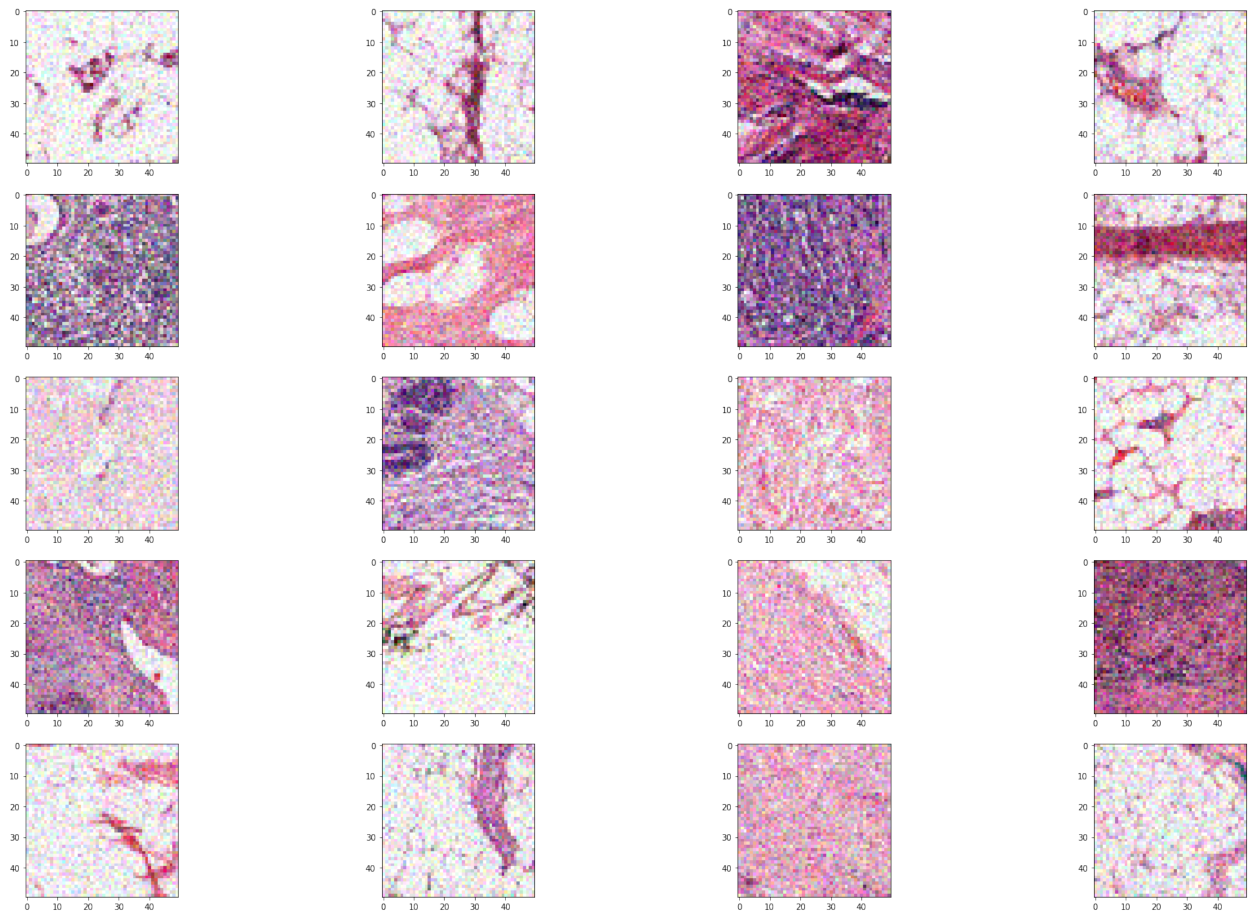
```
print(processd_data.columns)
```

```
----------------------------------------------------------------------
-----
NameError                                 Traceback (most recent call
last)
Cell In[115], line 1
----> 1 print(processd_data.columns)

NameError: name 'processd_data' is not defined
```

```
processd_data.target = processd_data.target.astype(np.int)
fig, ax = plt.subplots(5,4,figsize=(30,20))
pos_selection =
np.random.choice(processd_data[processd_data.target==1].index.values,
size=20, replace=False)
neg_selection =
np.random.choice(processd_data[processd_data.target==0].index.values,
size=20, replace=False)
for n in range(5):
    for m in range(4):
        idx = pos_selection[m + 4*n]
        path =os.path.join(processd_lst_str,processd_data.loc[idx,
'image_id'])
        image = mpimg.imread(path)
        ax[n,m].imshow(image)
        ax[n,m].grid(False)
```



```
fig, ax = plt.subplots(5,4,figsize=(30,20))
for n in range(5):
    for m in range(4):
        idx = neg_selection[m + 4*n]
        path =os.path.join(processd_lst_str,processd_data.loc[idx,
'image_id'])
        image = mpimg.imread(path)
        ax[n,m].imshow(image)
        ax[n,m].grid(False)
```



```
data_processd_test_generation = ImageDataGenerator(rescale=1.0/255)
train_generation_processd =
data_processd_test_generation.flow_from_directory("Desktop\\
final_proj\\image_processing\\model_tst\\trainig",
target_size=(50,50), batch_size=10,class_mode='categorical')
test_generation_processd =
data_processd_test_generation.flow_from_directory("Desktop\\
final_proj\\image_processing\\model_tst\\
testing",target_size=(50,50),batch_size=10,class_mode='categorical')
```

```
Found 18000 images belonging to 2 classes.
Found 2000 images belonging to 2 classes.
```

```
my_model_im_processd =Sequential()
my_model_im_processd.add(Conv2D(filters=32,kernel_size=(4,4),input_sha
pe=(50,50,3),activation='relu'))
my_model_im_processd.add(MaxPool2D(pool_size=(2,2)))


my_model_im_processd.add(Flatten())

my_model_im_processd.add(Dense(128,activation='relu'))
my_model_im_processd.add(Dense(2,activation='softmax'))

my_model_im_processd.compile(loss = 'categorical_crossentropy',
optimizer ='adam', metrics= ['accuracy'])

early_stop = EarlyStopping(monitor='val_loss',patience=2)
my_model_im_processd.fit_generator(train_generation_processd,validatio
n_data=test_generation_processd,epochs=60,
verbose=1,callbacks=early_stop)

C:\Users\zeado\anaconda3\lib\site-packages\keras\engine\
training.py:1972: UserWarning: `Model.fit_generator` is deprecated and
will be removed in a future version. Please use `Model.fit`, which
supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '

Epoch 1/60
1800/1800 [==============================] - 344s 190ms/step - loss:
0.5252 - accuracy: 0.7552 - val_loss: 0.5818 - val_accuracy: 0.7180
Epoch 2/60
1800/1800 [==============================] - 100s 55ms/step - loss:
0.4949 - accuracy: 0.7704 - val_loss: 0.4938 - val_accuracy: 0.7660
Epoch 3/60
1800/1800 [==============================] - 102s 57ms/step - loss:
0.4715 - accuracy: 0.7891 - val_loss: 0.4551 - val_accuracy: 0.7985
Epoch 4/60
1800/1800 [==============================] - 102s 57ms/step - loss:
0.4558 - accuracy: 0.7974 - val_loss: 0.4683 - val_accuracy: 0.7950
Epoch 5/60
1800/1800 [==============================] - 100s 56ms/step - loss:
0.4391 - accuracy: 0.8053 - val_loss: 0.5133 - val_accuracy: 0.7670

<keras.callbacks.History at 0x1e75d3cc520>
```

Second: the normal images

```
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
trainig')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
testing')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
trainig\\zeros')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
trainig\\ones')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
testing\\zeros')
os.mkdir( 'Desktop\\final_proj\\image_processing\\normal\\model_tst\\
testing\\ones')
```

```
df_0 = data[data['target'] == '0'].sample(10000, random_state=101)
df_1 = data[data['target'] == '1'].sample(10000, random_state=101)
test_data =pd.DataFrame(data)
test_data = pd.concat([df_0, df_1], axis=0).reset_index(drop=True)
test_y = test_data['target']
test_data_train, test_data_test = train_test_split(test_data,
test_size=0.10, random_state=101, stratify=test_y)
sts_train = test_data_train.image_id
tst_test  = test_data_test.image_id
test_data.set_index('image_id', inplace=True)
for image in sts_train:
    fname  = image
    target = test_data.loc[image,'target']

    if target == '0':
        label = 'zeros'
    if target == '1':
        label = 'ones'
    src = os.path.join(all_rays_dir, fname)
    dst = os.path.join('Desktop\\final_proj\\image_processing\\
normal\\model_tst\\trainig', label, fname)
    shutil.copyfile(src, dst)
for image in tst_test:
    fname  = image
    target = test_data.loc[image,'target']

    if target == '0':
        label = 'zeros'
    if target == '1':
        label = 'ones'
    src = os.path.join(all_rays_dir, fname)
    dst = os.path.join('Desktop\\final_proj\\image_processing\\
normal\\model_tst\\testing', label, fname)
    shutil.copyfile(src, dst)
```

```
data_normal_test_generation = ImageDataGenerator(rescale=1.0/255)
train_generation_normal =
data_normal_test_generation.flow_from_directory("Desktop\\final_proj\\
image_processing\\normal\\model_tst\\trainig", target_size=(50,50),
batch_size=10,class_mode='categorical')
test_generation_normal =
data_normal_test_generation.flow_from_directory("Desktop\\final_proj\\
image_processing\\normal\\model_tst\\
testing",target_size=(50,50),batch_size=10,class_mode='categorical')
```

```
Found 18000 images belonging to 2 classes.
Found 2000 images belonging to 2 classes.
```

```
my_model_im_norm =Sequential()
my_model_im_norm.add(Conv2D(filters=32,kernel_size=(4,4),input_shape=(
50,50,3),activation='relu'))
my_model_im_norm.add(MaxPool2D(pool_size=(2,2)))


my_model_im_norm.add(Flatten())

my_model_im_norm.add(Dense(128,activation='relu'))
my_model_im_norm.add(Dense(2,activation='softmax'))

my_model_im_norm.compile(loss = 'categorical_crossentropy', optimizer
='adam', metrics= ['accuracy'])

early_stop = EarlyStopping(monitor='val_loss',patience=2)
my_model_im_processd.fit_generator(train_generation_normal,validation_
data=test_generation_normal,epochs=60, verbose=1,callbacks=early_stop)
```

```
C:\Users\zeado\anaconda3\lib\site-packages\keras\engine\
training.py:1972: UserWarning: `Model.fit_generator` is deprecated and
will be removed in a future version. Please use `Model.fit`, which
supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '

Epoch 1/60
1800/1800 [==============================] - 332s 184ms/step - loss:
0.4209 - accuracy: 0.8166 - val_loss: 0.5193 - val_accuracy: 0.7650
Epoch 2/60
1800/1800 [==============================] - 92s 51ms/step - loss:
0.4273 - accuracy: 0.8151 - val_loss: 0.4623 - val_accuracy: 0.7905
Epoch 3/60
1800/1800 [==============================] - 93s 52ms/step - loss:
0.3895 - accuracy: 0.8341 - val_loss: 0.4769 - val_accuracy: 0.7850
Epoch 4/60
1800/1800 [==============================] - 95s 53ms/step - loss:
0.3602 - accuracy: 0.8439 - val_loss: 0.5446 - val_accuracy: 0.7935

<keras.callbacks.History at 0x1e761f6b160>
```

conclusion : Normal images are the best in modeling

Modeling

Data Spliting & Generation

```
y = data['target']
data_train, data_test = train_test_split(data, test_size=0.10,
random_state=101, stratify=y)
```

```
print(data_train.shape)
print(data_test.shape)
```

```
(222019, 2)
(55505, 2)
```

```
os.mkdir( 'Desktop\\final_proj\\train_dir')
os.mkdir('Desktop\\final_proj\\test_dir')

os.mkdir( 'Desktop\\final_proj\\train_dir\\zeros')
os.mkdir( 'Desktop\\final_proj\\train_dir\\ones')

os.mkdir( 'Desktop\\final_proj\\test_dir\\zeros')
os.mkdir( 'Desktop\\final_proj\\test_dir\\ones')

train = data_train.image_id
test  = data_test.image_id

data.set_index('image_id', inplace=True)
for image in train:
    fname  = image
    target = data.loc[image,'target']

    if target == '0':
        label = 'zeros'
    if target == '1':
        label = 'ones'
    src = os.path.join(all_rays_dir, fname)
    dst = os.path.join('Desktop\\final_proj\\train_dir', label, fname)
    shutil.copyfile(src, dst)

for image in test:
    fname = image
    target = data.loc[image,'target']
    if target == '0':
        label = 'zeros'
    if target == '1':
        label = 'ones'
    src = os.path.join(all_rays_dir, fname)
    dst = os.path.join("Desktop\\final_proj\\test_dir", label, fname)
    shutil.copyfile(src, dst)

print('non-IDC train      =',len(os.listdir('Desktop\\final_proj\\
train_dir\\zeros')))
print('IDC train          =',len(os.listdir('Desktop\\final_proj\\
train_dir\\ones')))
print('non-IDC validation =',len(os.listdir('Desktop\\final_proj\\
test_dir\\zeros')))
print('IDC validation     =',len(os.listdir('Desktop\\final_proj\\
test_dir\\ones')))
```

```
non-IDC train      = 178864
IDC train          = 70907
non-IDC validation = 19874
IDC validation     = 7879

data_generation = ImageDataGenerator(rescale=1.0/255)

train_generation = data_generation.flow_from_directory(
                                        "Desktop\\final_proj\\
train_dir",
                                        target_size=(25,25),
                                        batch_size=10,
                                        class_mode='categorical')
test_generation = data_generation.flow_from_directory(
                                        "Desktop\\final_proj\\
test_dir",
                                        target_size=(25,25),
                                        batch_size=10,
                                        class_mode='categorical')


Found 249771 images belonging to 2 classes.
Found 27753 images belonging to 2 classes.
```

Model design

```
my_model =Sequential()
my_model.add(Conv2D(filters=32,kernel_size=(4,4),input_shape=(25,25,3)
,activation='relu'))
my_model.add(Conv2D(filters=32,kernel_size=(4,4),input_shape=(25,25,3)
,activation='relu'))
my_model.add(MaxPool2D(pool_size=(2,2)))
my_model.add(Dropout(.3))

my_model.add(Flatten())

my_model.add(Dense(256,activation='relu'))

my_model.add(Dense(2,activation='softmax'))

my_model.compile(loss = 'categorical_crossentropy', optimizer ='adam',
metrics= ['accuracy'])

my_model.summary()

Model: "sequential_12"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_18 (Conv2D)           (None, 22, 22, 32)        1568      
_________________________________________________________________
conv2d_19 (Conv2D)           (None, 19, 19, 32)        16416     
_________________________________________________________________
max_pooling2d_12 (MaxPooling (None, 9, 9, 32)          0         
_________________________________________________________________
dropout_3 (Dropout)          (None, 9, 9, 32)          0         
_________________________________________________________________
flatten_7 (Flatten)          (None, 2592)              0         
_________________________________________________________________
dense_14 (Dense)             (None, 256)               663808    
_________________________________________________________________
dense_15 (Dense)             (None, 2)                 514       
=================================================================
Total params: 682,306
Trainable params: 682,306
Non-trainable params: 0
_________________________________________________________________
```

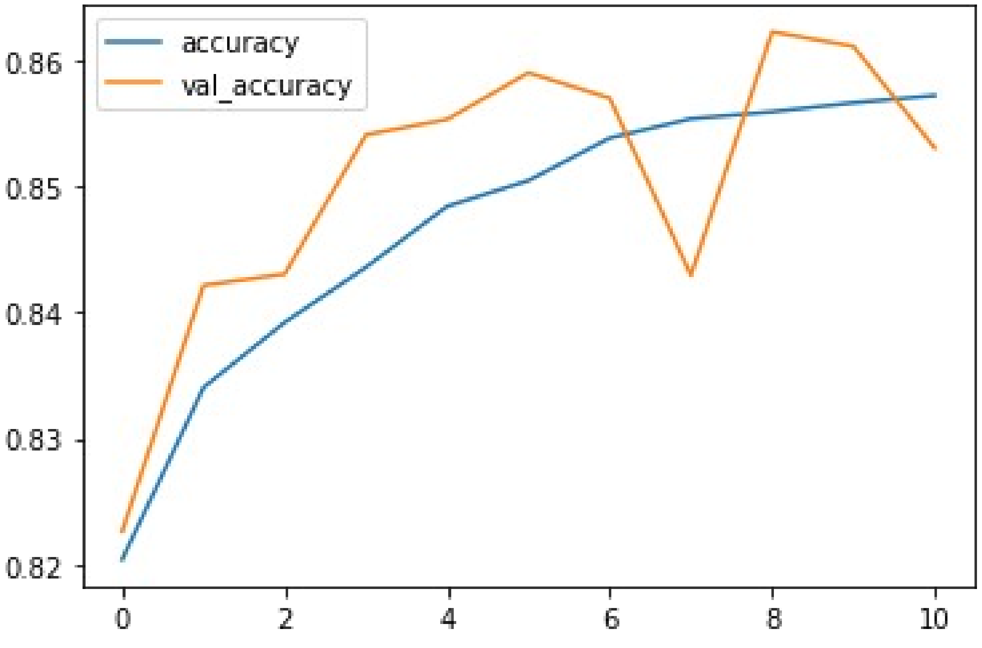
```
my_model.fit_generator(train_generation,validation_data=test_generatio
n,epochs=60, verbose=1,callbacks=early_stop)
```

```
C:\Users\zeado\anaconda3\lib\site-packages\keras\engine\
training.py:1972: UserWarning: `Model.fit_generator` is deprecated and
will be removed in a future version. Please use `Model.fit`, which
supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '

Epoch 1/60
24978/24978 [==============================] - 1335s 53ms/step - loss:
0.4165 - accuracy: 0.8204 - val_loss: 0.4191 - val_accuracy: 0.8226
Epoch 2/60
24978/24978 [==============================] - 1315s 53ms/step - loss:
0.3874 - accuracy: 0.8341 - val_loss: 0.3622 - val_accuracy: 0.8422
Epoch 3/60
24978/24978 [==============================] - 1395s 56ms/step - loss:
0.3748 - accuracy: 0.8392 - val_loss: 0.3814 - val_accuracy: 0.8431
Epoch 4/60
24978/24978 [==============================] - 1420s 57ms/step - loss:
0.3650 - accuracy: 0.8436 - val_loss: 0.3392 - val_accuracy: 0.8541
Epoch 5/60
24978/24978 [==============================] - 1274s 51ms/step - loss:
0.3564 - accuracy: 0.8485 - val_loss: 0.3362 - val_accuracy: 0.8554
Epoch 6/60
24978/24978 [==============================] - 1272s 51ms/step - loss:
0.3508 - accuracy: 0.8505 - val_loss: 0.3341 - val_accuracy: 0.8591
Epoch 7/60
24978/24978 [==============================] - 1293s 52ms/step - loss:
0.3464 - accuracy: 0.8539 - val_loss: 0.3324 - val_accuracy: 0.8571
Epoch 8/60
```

```
24978/24978 [==============================] - 1135s 45ms/step - loss: 
0.3435 - accuracy: 0.8554 - val_loss: 0.3510 - val_accuracy: 0.8430
Epoch 9/60
24978/24978 [==============================] - 1102s 44ms/step - loss: 
0.3419 - accuracy: 0.8560 - val_loss: 0.3292 - val_accuracy: 0.8623
Epoch 10/60
24978/24978 [==============================] - 1102s 44ms/step - loss: 
0.3403 - accuracy: 0.8567 - val_loss: 0.3299 - val_accuracy: 0.8612
Epoch 11/60
24978/24978 [==============================] - 1110s 44ms/step - loss: 
0.3389 - accuracy: 0.8573 - val_loss: 0.3400 - val_accuracy: 0.8531

<keras.callbacks.History at 0x1e771d4e820>
```

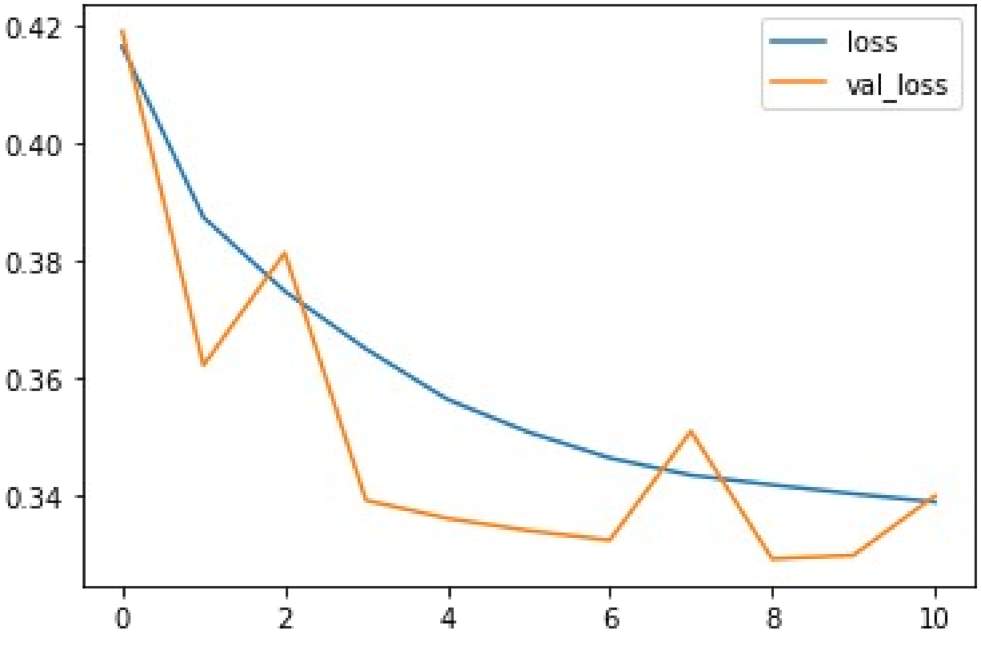
Outputs and Outcomes

```
losse = pd.DataFrame(my_model.history.history)
losse.head()

       loss  accuracy  val_loss  val_accuracy
0  0.416507  0.820387  0.419071      0.822614
1  0.387389  0.834056  0.362227      0.842179
2  0.374838  0.839233  0.381375      0.843080
3  0.365002  0.843617  0.339223      0.854142
4  0.356424  0.848453  0.336158      0.855367

losse[['accuracy','val_accuracy']].plot()

<AxesSubplot:>
```



```
losse[['loss','val_loss']].plot()
```

```
<AxesSubplot:>
```



```
val_loss, val_acc = \
my_model.evaluate_generator(test_generation)

print('val_loss:', val_loss)
print('val_acc:', val_acc)
```

```
C:\Users\zeado\anaconda3\lib\site-packages\keras\engine\
training.py:2006: UserWarning: `Model.evaluate_generator` is
deprecated and will be removed in a future version. Please use
`Model.evaluate`, which supports generators.
  warnings.warn('`Model.evaluate_generator` is deprecated and '

val_loss: 0.33995357155799866
val_acc: 0.8530969619750977
```

model results :

- After several attempts, we made a good model design
- Our model have a good acc = 85.4 %
- over fitting is so small
- We're ready to create APIs

Save &Loaded Model

```
model_json = my_model.to_json()

with open("Desktop\\final_proj\\GUI\\model.json", "w") as json_file:
    json_file.write(model_json)
# serialize weights to HDF5
my_model.save_weights("Desktop\\final_proj\\GUI\\model.h5")
print("Saved model to disk")

Saved model to disk

json_file = open('model.json', 'r')
loaded_model_json = json_file.read()
json_file.close()
loaded_model = model_from_json(loaded_model_json)
loaded_model.load_weights("model.h5")
print("Loaded model from disk")

loaded_model.compile(loss='binary_crossentropy', optimizer='rmsprop',
metrics=['accuracy'])

Loaded model from disk
```

APIs & Web Localization

- we will use this class to connect the web app to the model

```
class Api_service :
    def __init__(self,img_file_path):
        self.img_file_path = img_file_path
    def prediction_function(self) :
        predict_generation = data_generation.flow_from_directory(
                                                       self.img_file_path,
                                                       target_size=(25,25),
                                                       batch_size=10,
                                                       class_mode='categorical')

        prediction =
loaded_model.predict_generator(predict_generation)
        has_cancer = 'The percentage of cancer : '+
str(round(prediction[0][1]*100,2)) + "%"
        has_no_cancer='Percentage of no cancer : ' +
str(round(prediction[0][0]*100,2)) + '%'
        return has_cancer,has_no_cancer

prediction = Api_service("Desktop\\final_proj\\predict")
x,y        = prediction.prediction_function()
print(x)
print(y)

Found 1 images belonging to 1 classes.
The percentage of cancer : 97.91%
Percentage of no cancer : 2.09%
```

Finally we have finished