1. Break both images into subimages of size mxm.
2. Mean subtraction from all the subimages.
3. Attach respective sub-images side-by-side.
4. Apply SVD(returns = U, S, V_trans).
5. P = S * V_trans(size = mxn)
6. Divide P into two parts(PR, PD), each of size (mxm)
7. Calculate ds(j) on each column vector of PR and PD
8. Calculate dl(i) for all the subimages' ds(i)
9. Take mean of dl(i)
10. Result is the score we wanted

In [ ]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

In [ ]:

```
from google.colab.patches import cv2_imshow
import pandas as pd
import cv2
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
from skimage.transform import resize
import warnings
warnings.filterwarnings("ignore")
plt.rcParams["figure.figsize"] = [10, 10]
```

In [ ]:

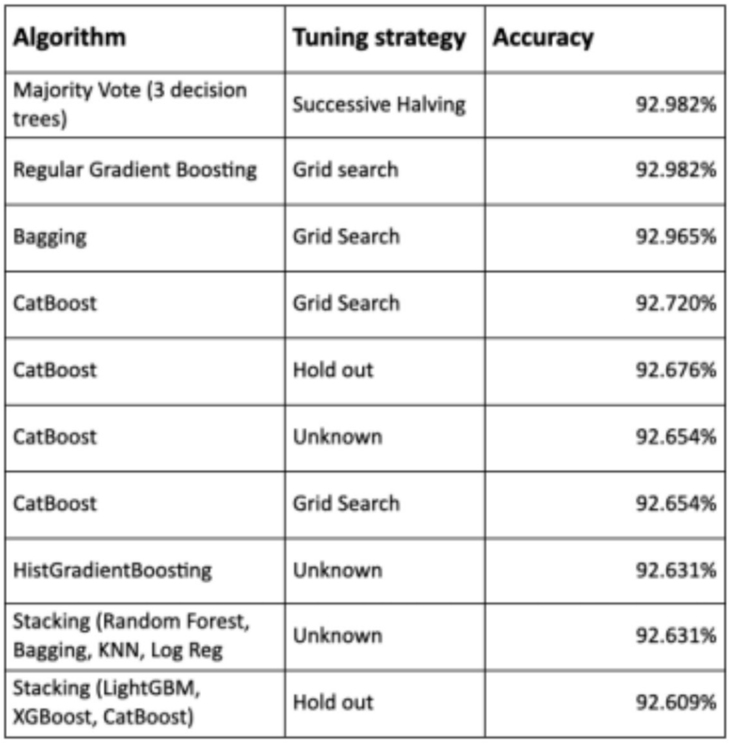
```
org_image = plt.imread("/content/drive/MyDrive/CT_11/lena_gray_512.tif")
plt.imshow(dis_image, "gray")
plt.axis("off")
plt.show()
```

In [ ]:

```
dis_image = plt.imread("/content/drive/MyDrive/CT_11/lena_gray_256.tif")
plt.imshow(org_image, "gray")
plt.axis("off")
plt.show()
```

In [ ]:

```
diff_image = plt.imread("/content/drive/MyDrive/CT_11/FEVUbLjXwAQDcMj.png")
diff_image = diff_image[: , :, 0]
plt.imshow(diff_image, "gray")
plt.axis("off")
plt.show()
```



Algorithm	Tuning strategy	Accuracy
Majority Vote (3 decision trees)	Successive Halving	92.982%
Regular Gradient Boosting	Grid search	92.982%
Bagging	Grid Search	92.965%
CatBoost	Grid Search	92.720%
CatBoost	Hold out	92.676%
CatBoost	Unknown	92.654%
CatBoost	Grid Search	92.654%
HistGradientBoosting	Unknown	92.631%
Stacking (Random Forest, Bagging, KNN, Log Reg	Unknown	92.631%
Stacking (LightGBM, XGBoost, CatBoost)	Hold out	92.609%

In [ ]:

```
im = cv2.imread("/content/drive/MyDrive/CT_11/lena_gray_512.tif")
im = cv2.resize(im,(1000,500))

imgheight = im.shape[0]
imgwidth = im.shape[1]

y1 = 0
M = imgheight//20
N = imgwidth//20

for y in range(0,imgheight,M):
    for x in range(0, imgwidth, N):
        y1 = y + M
        x1 = x + N
        tiles = im[y:y+M,x:x+N]

        cv2.rectangle(im, (x, y), (x1, y1), (0, 255, 0))
        cv2.imwrite("save/" + str(x) + '_' + str(y)+".png",tiles)

cv2_imshow(im)
```

In [ ]:

```
print(org_image.shape, dis_image.shape)
org_image = np.array(resize(org_image, (256, 256)))
dis_image = np.array(resize(dis_image, (256, 256)))
diff_image = np.array(resize(diff_image, (256, 256)))
print(org_image.shape, dis_image.shape)
```

```
(512, 512) (256, 256)
(256, 256) (256, 256)
```

In [ ]:

```
def break_image(image1 = org_image, image2 = dis_image, m = 4):
    ds_main = np.array([])
    subimage_count = int(len(image1)//m)*2
    for i in range(len(image1)//m):
        for j in range(len(image1)//m):
            subimage1 = image1[i:i+m, j:j+m]
            subimage2 = image2[i:i+m, j:j+m]

            def subtract_mean(image):
                image = image - image.mean()
                return image

            org_image = subtract_mean(subimage1)
            dis_image = subtract_mean(subimage2)

            def attach_images(image1, image2):
                new_image = np.concatenate((image1, image2), axis = 1)
                return new_image

            attached_image = attach_images(org_image, dis_image)

            _, S, V_trans = np.linalg.svd(attached_image, full_matrices = Fals
            P = np.diag(S) @ V_trans
            PR, PD = np.split(P, 2, axis = 1)

            def calculate_ds(mat1 = PR, mat2 = PD):
                ds = []
                for i in range(len(mat1)):
                    l3_1 = sum(mat1[:, i]**2)**(1/3)
                    l3_2 = sum(mat2[:, i]**2)**(1/3)
                    ds += (l3_1 - l3_2),
                return ds
            ds_main = np.append(ds_main, np.array(calculate_ds()))
    return ds_main, subimage_count
```

In [ ]:

```
def calculate_dl(ds):
    dl = []
    for i in range(subimage_count):
        ds_sub = np.split(ds, subimage_count)[i]
        mds = sum(ds_sub)/len(ds_sub)
        dl += ((sum((ds_sub-mds)**2))/len(ds_sub))**0.5,
    return np.array(dl)
```

In [ ]:

```
ds_main_mid, subimage_count = break_image()
dl_mid = calculate_dl(ds_main_mid)
score_mid = sum(dl_mid)/len(dl_mid)
print("Score for Reference and distorted images: ", score_mid)
```

```
Score for Reference and distorted images:  0.02202721881638776
```

In [ ]:

```
ds_main_same, subimage_count = break_image(org_image, org_image, 16)
dl_same = calculate_dl(ds_main_same)
score_same = sum(dl_same)/len(dl_same)
print("Score for same images: ", score_same)
```

```
Score for same images:  4.1591374695965026e-17
```

In [ ]:

```
ds_main_diff, subimage_count = break_image(org_image, diff_image, 16)
dl_diff = calculate_dl(ds_main_diff)
score_diff = sum(dl_diff)/len(dl_diff)
print("Score for totally different images: ", score_diff)
```

```
Score for totally different images:  0.0676286731789097
```