Handwritten Signature Verifier using Image Processing

Tejas Jadhav - B002

Under the guidance of Mentor
Prof. Abhay Kolhe

Contents

- Problem definition
- Literature Review
- Proposed Work
- Implementation tool & setup
- Implementation Work done
- Gantt chart
- References

Problem definition

- As said earlier, Signature Recognition is the procedure of determining to whom a particular signature belongs to.

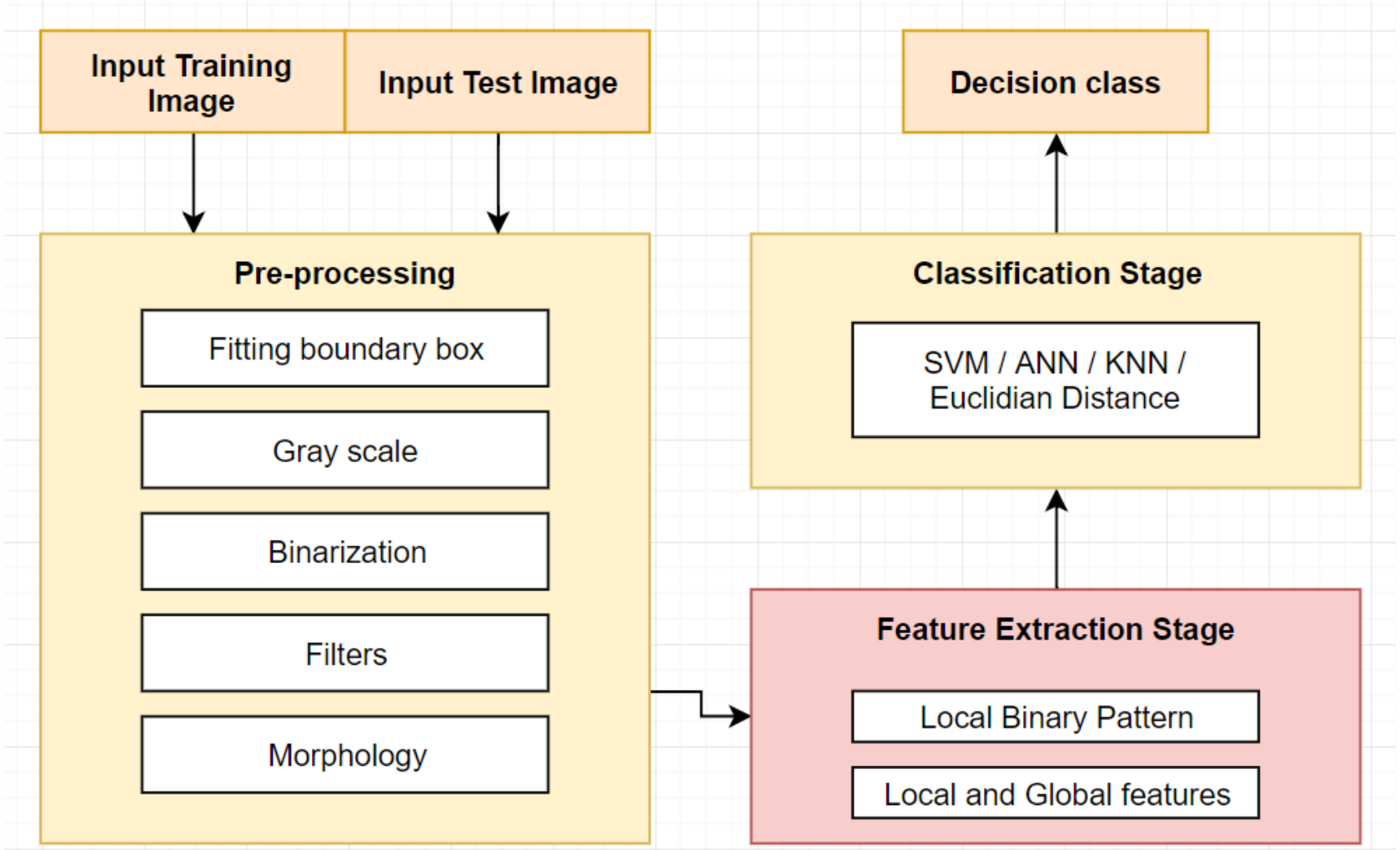
- System would take as input signature images and tell us
  - To whom the signature belongs to (Author Identification)
  - If the signature is forged or genuine (Signature Verification)

Literature Review

- An excel sheet of all the Literature Review has been prepared and is been attached with this slide.
- The literature review contains total of 40 research papers based on the topic Signature Recognition
- Most of the papers make use of 3 stages:
  - Preprocessing stage
  - Feature extraction stage
  - Classification stage


Microsoft Excel Worksheet

Proposed Work



Proposed Work

- Local Binary Pattern

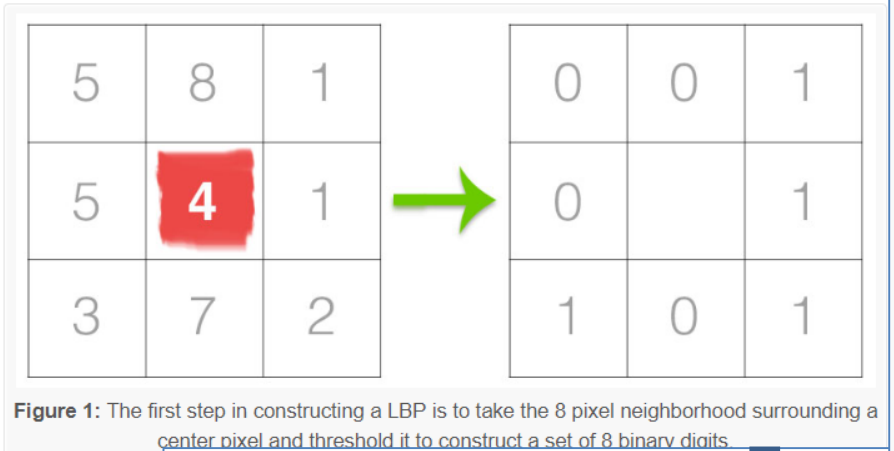


Figure 1: The first step in constructing a LBP is to take the 8 pixel neighborhood surrounding a center pixel and threshold it to construct a set of 8 binary digits.

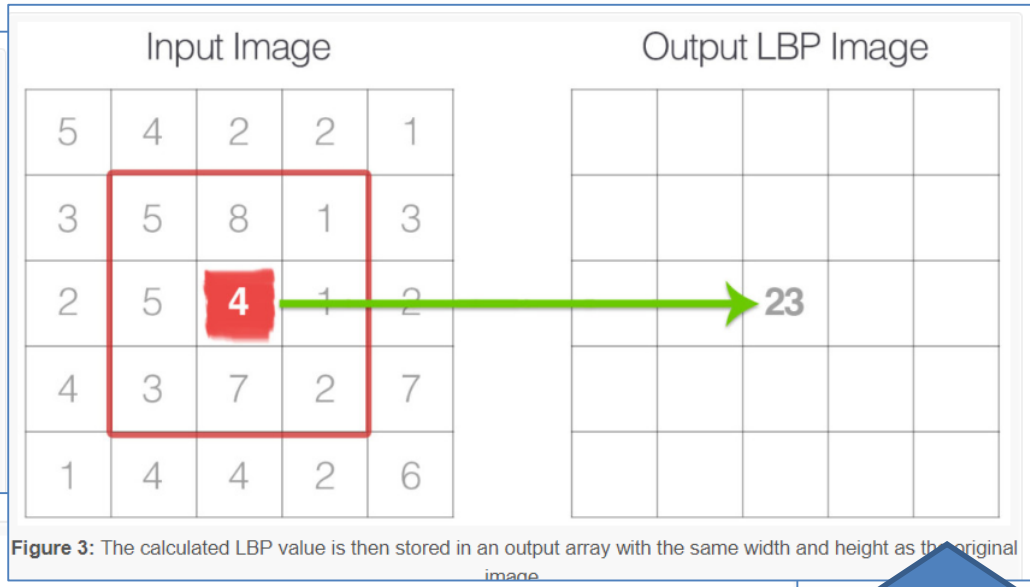


Figure 3: The calculated LBP value is then stored in an output array with the same width and height as the original image.

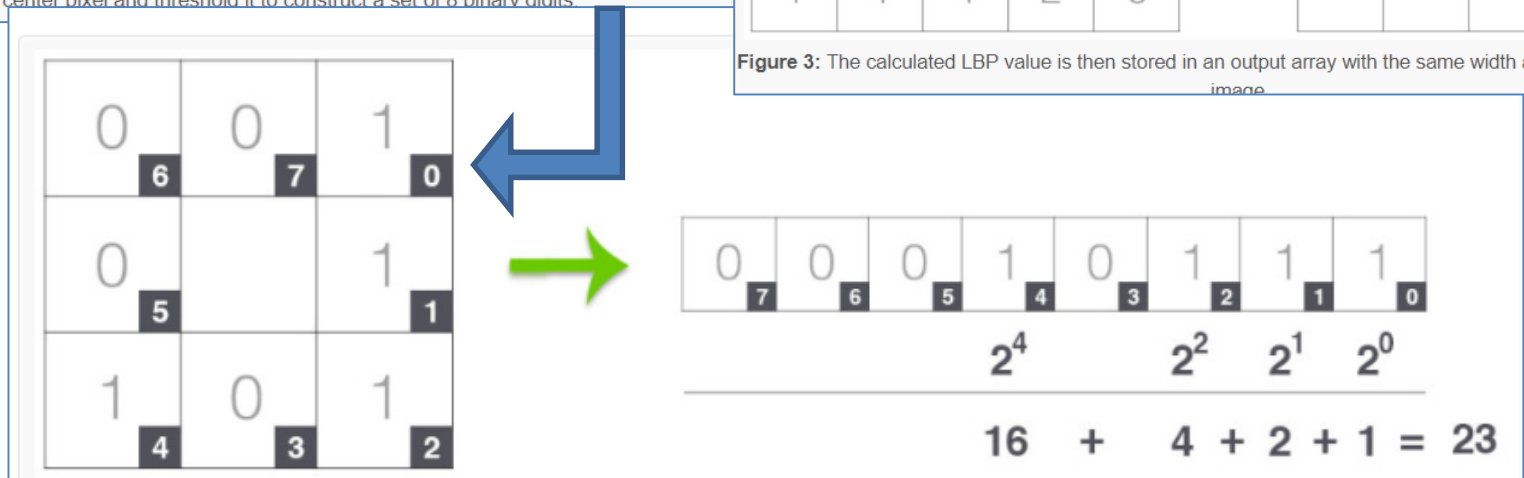


Figure 2: Taking the 8-bit binary neighborhood of the center pixel and converting it into a decimal representation. (Thanks to Bikramjot of Hanzra Tech for the inspiration on this visualization!)

Implementation tool & setup

❑ Python using PyCharm

- Python is a popular programming language used in web & software development, mathematics, system scripting
- PyCharm is a python editor and compiler allows intelligent code completion, on-the-fly error checking and quick-fixes, easy project navigation, and much more.

Implementation tool & setup

❑ Python libraries

- Using number of libraries, which are easy to install & import..
  - OpenCV : *Computer vision and machine learning software library.*
  - NumPy : *Scientific computing & array-processing*
  - Imutils : *Functions to make basic image processing functions easier*
  - Math : *Provides access to the mathematical functions*
  - MatplotLib : *Python 2D plotting library*
  - Pymysql : A simple database interface for Python
  - OS : allows easy file handling
  - Scipy : rovides many user-friendly and efficient numerical routines

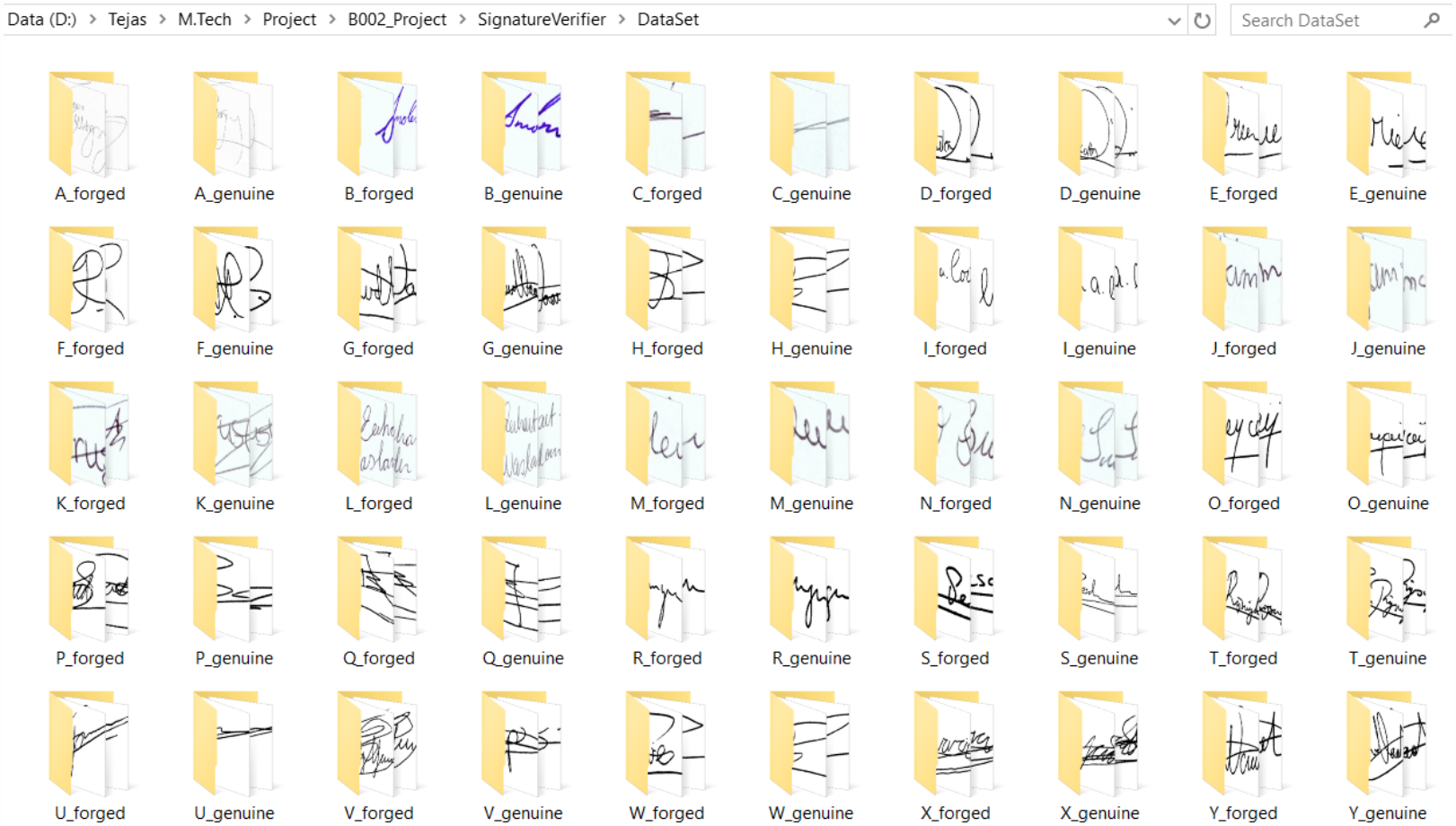
Implementation tool & setup

❑ SQL using MySQL

- SQL is a standard language for storing, manipulating and retrieving data in databases.
- MySQL is an open source relational database management system, very easy to establish, use and manage

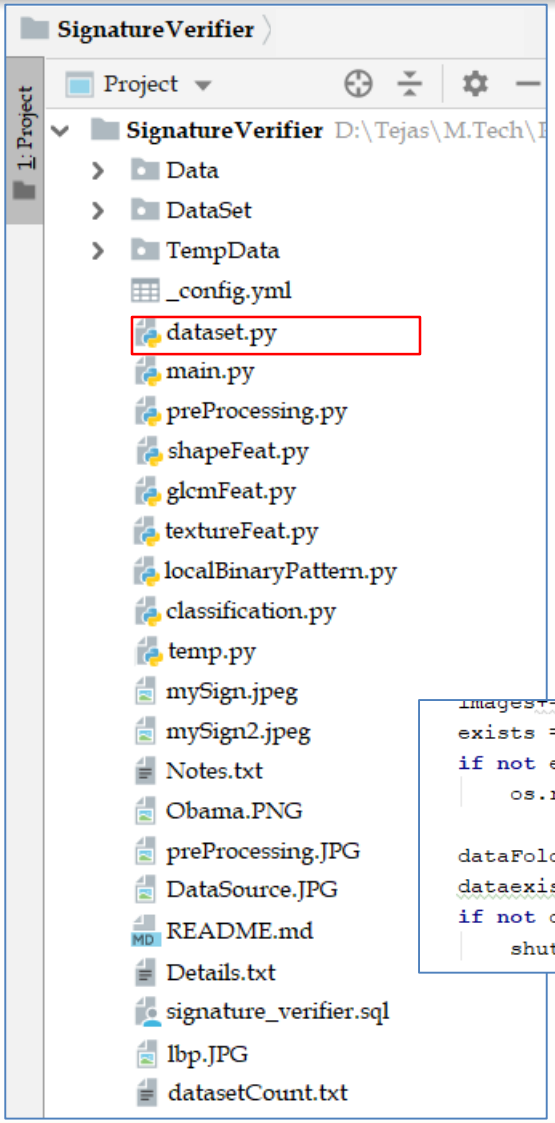
Dataset

25 Authors, 50 Classes, **826 Images**
637 Training images (77.12%)
189 Testing images (22.88%)



Implementation Work done

Implementation

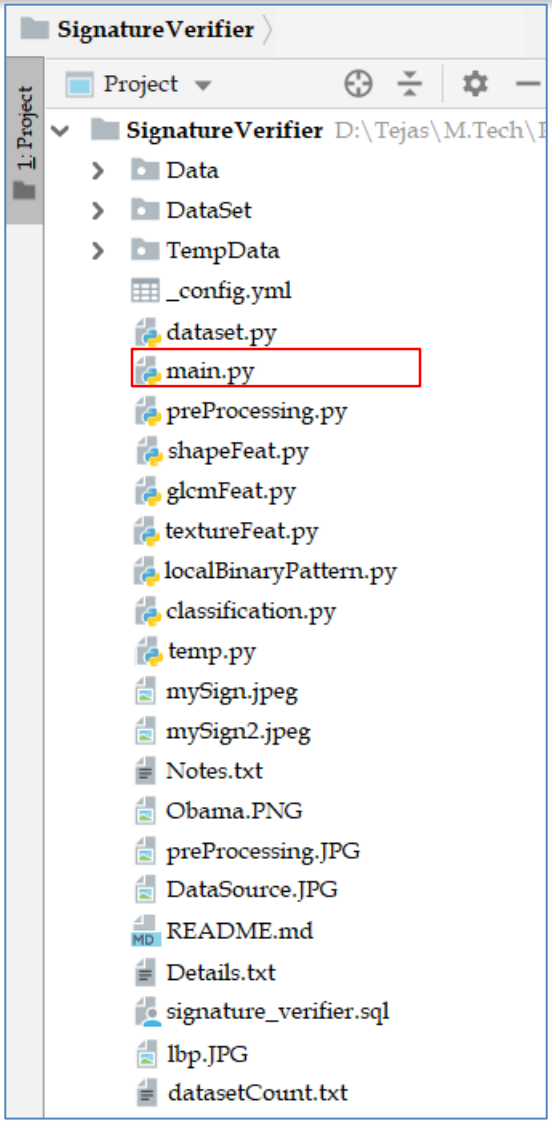


❑ Dataset.py

- Our dataset is read, renamed, copied and organized in the correct naming convention to a different folder, from where out system will use
- xyz.png → A_genuine_7.png
- Also gives an analysis of the count of dataset

```
exists = os.path.isfile("DataSet/"+folder+"/"+folder+"_"+str(j)+".png")
if not exists:
    os.rename("DataSet/" + folder + "/" + file, "DataSet/" + folder + "/" + folder + "_" + str(j) + ".png")

dataFolder = training_folder if (j < (4*total/5)) else testing_folder
dataexists = os.path.isfile(dataFolder + "/" + folder + "_" + str(j) + ".png")
if not dataexists:
    shutil.copy("DataSet/" + folder + "/" + folder + "_" + str(j) + ".png", dataFolder)
```

Implementation

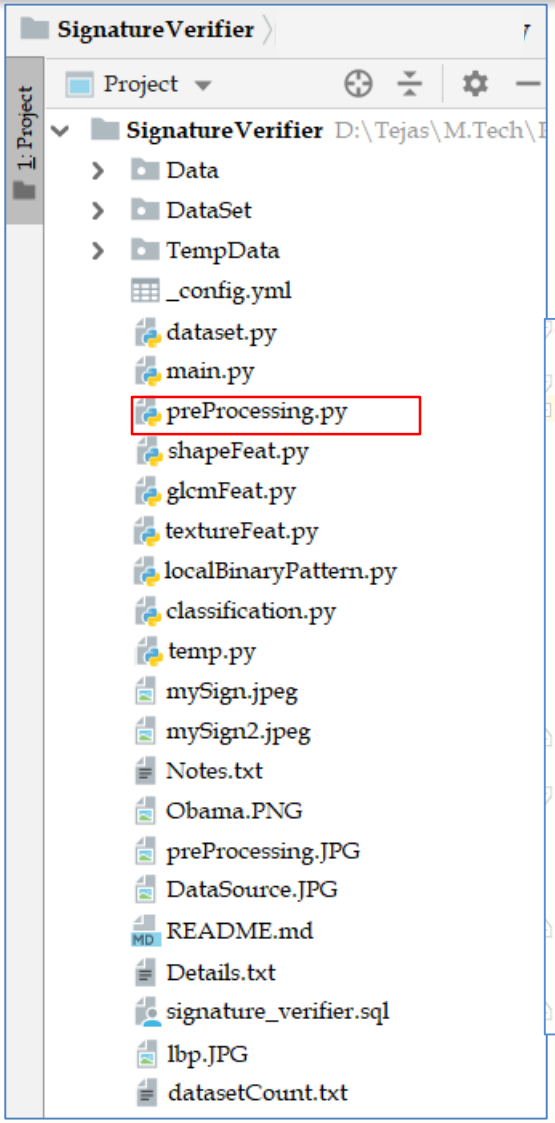


Main.py

- This is the main python file where the system working starts, calls the other functions, gives the appropriate results and ends.

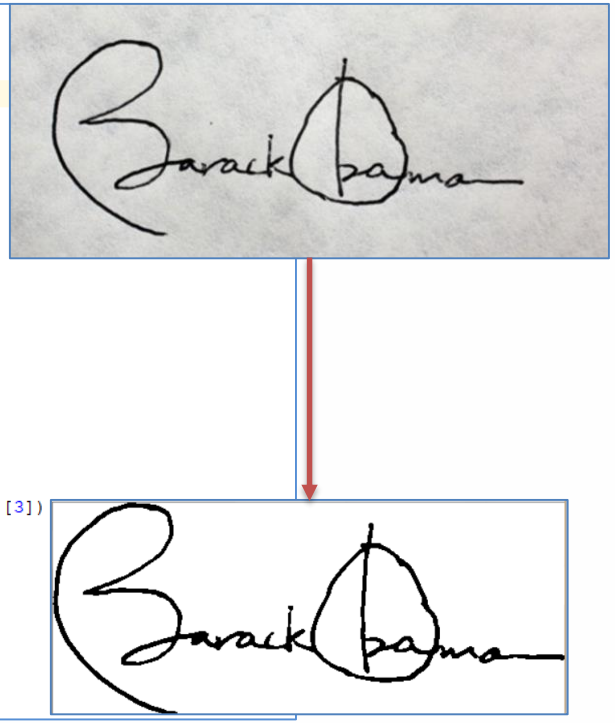
```
for filename in os.listdir(testing_folder):
    img = cv.imread(os.path.join(testing_folder, filename), 0)
    if img is not None:
        isLBP = False
        f = open("Data/" + datafile, "a")
        print("\n~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~")
        f.write("\n~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~\n")
        print("Image file : ", filename)
        f.write("\nImage file : "+ str(filename) +"\n")
        f.close()
        orgImg = img
        # cv.imshow(filename, img)
        proImg = pr.preprocess(orgImg, datafile)
        # cv.imshow(filename, myImg)

        sf.shapeFeat(proImg, testingFeatures, isLBP, datafile, filename)
        gf.glcm(proImg, testingFeatures, datafile)
        tf.textFeat(proImg, testingFeatures, datafile)

        isLBP = True
        lbpImg = lbp.lbp(orgImg, datafile)
        sf.shapeFeat(lbpImg, testingFeatures, isLBP, datafile, filename)
        gf.glcm(lbpImg, testingFeatures, datafile)
        tf.textFeat(lbpImg, testingFeatures, datafile)
        cl.actualclass(filename, testingClasses, datafile)

        cl.knn(trainingFeatures,testingFeatures,trainingClasses,decisionClasses, datafile)
```

Implementation

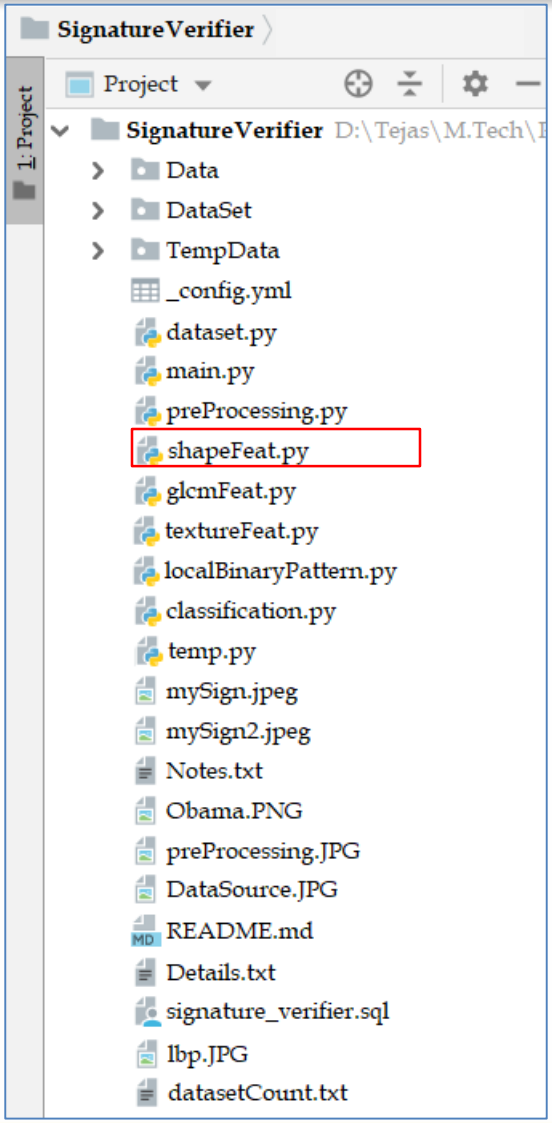


- **Preprocessing.py**
  - This function takes the image in the raw format and converts into a pre-processed format.
  - Resize, RGB to Grey , Otsu thresholding, boundary Box cropping

```
def preprocess(img, datafile):

    try:
        """..."""

        print()
        if(len(img.shape)>2):
            img = cv.cvtColor(img, cv.COLOR_RGB2GRAY)

        img = imutils.resize(img, 720)

        # ~~ Otsu's thresholding after Gaussian filtering ~~
        blur = cv.GaussianBlur(img,(3,3),0)
        ret, img = cv.threshold(blur,0,255,cv.THRESH_OTSU)

        img = boundaryBox(img, datafile)

    except Exception as error:
        print("An exception was thrown in " + inspect.stack()[0][3])
        f = open("Data/"+datafile, "a")
        print("Error: "+ str(error))
        f.write("\nError: "+ str(error))
        f.close()

    finally:
        return img
```



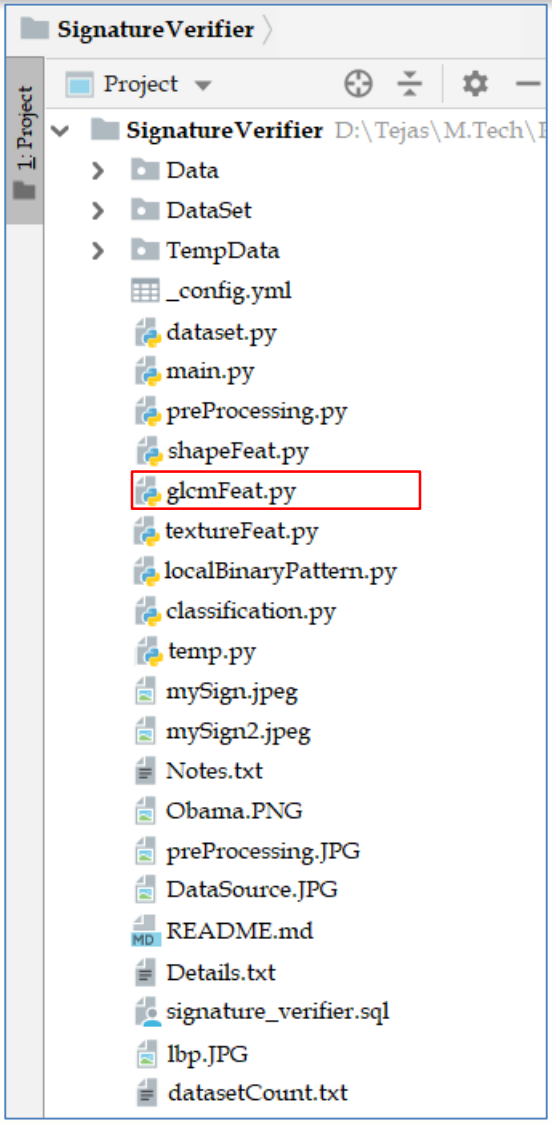
Implementation



- **shapeFeat.py**
  - This function extracts shape based features of the signature from the images.
  - These includes:
    - Aspect Ratio
    - Center of Gravity
    - Normalized Area
    - Baseline Shift
    - Eccentricity
    - HuMoments
    - No of Corners

```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Image file :  Y_genuine_12.png

     ~~~ Shape features ~~~
Aspect Ratio :  1.8882175226586102
X_COG: 314.35614528971786
Y_COG: 160.09018323098957
Normalized area:  0.8808652567975831
Baseline shift:  5.49301214401541
Eccentricity:  0.844747849543066
HuMoments:  13.06358045823279
Corners:  317
```

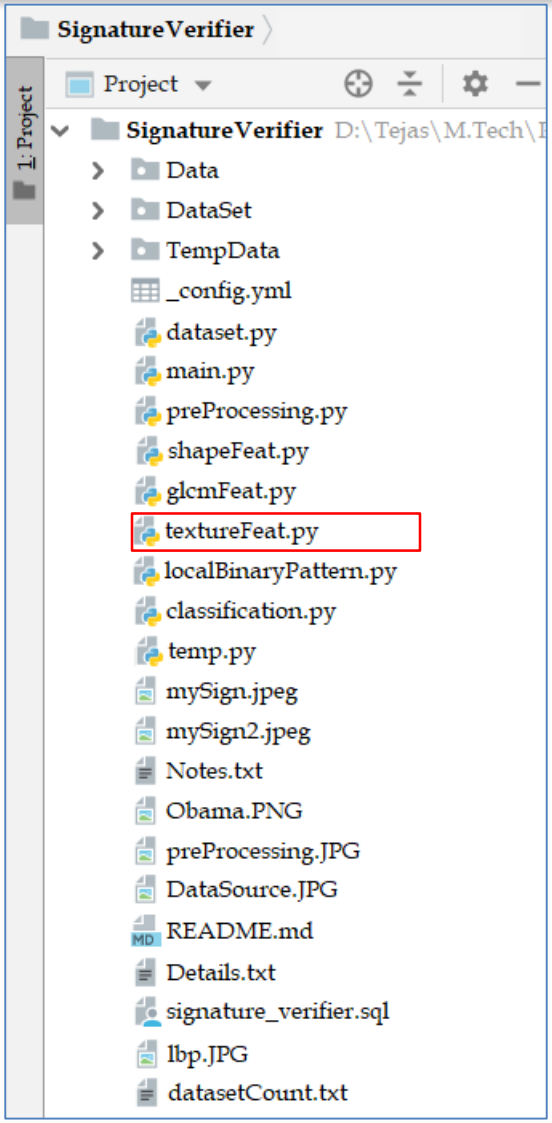
Implementation



- **glcmFeat.py**
  - This function extracts glcm based features of the signature from the images.
  - Gray Level Coherence Matrix
  - These includes:
    - Contrast
    - Dissimilarity
    - Homogeneity
    - Energy
    - Correlation
    - ASM

```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Image file :  Y_genuine_12.png

      ~~~ GLCM features ~~~
Contrast:  1619.1396264234256
Dissimilarity:  6.3495671624448065
Homogeneity:  0.9751001195456674
Energy:  0.8751210985740953
Correlation:  0.8813611181808606
ASM:  0.7658369371695313
```

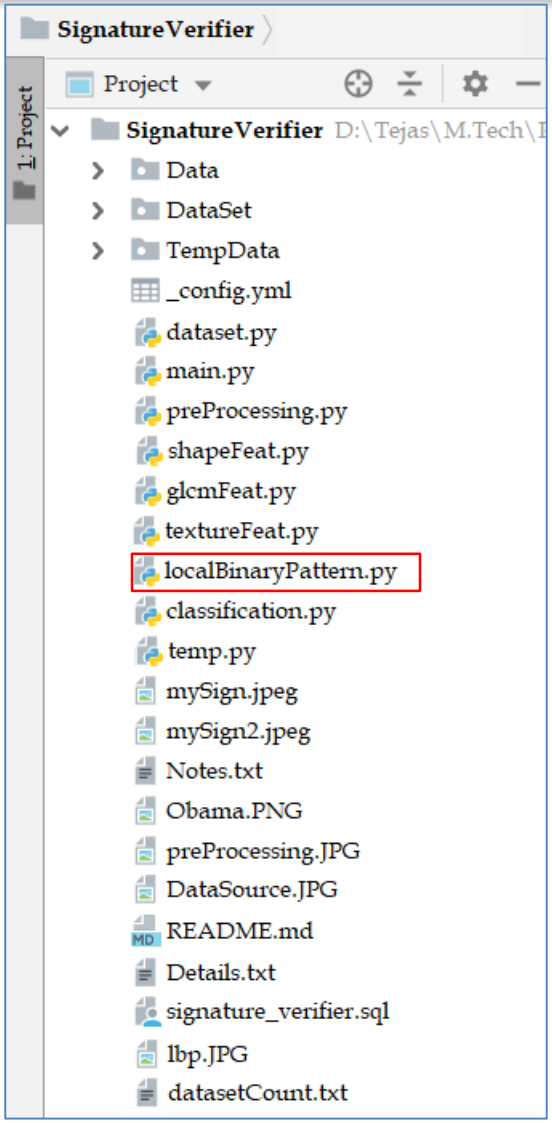
Implementation



- **textureFeat.py**
  - This function extracts texture based features of the signature from the images.
  - These includes:
    - Mean
    - Variance
    - Skewness
    - Kurtosis
    - Energy
    - Haralick

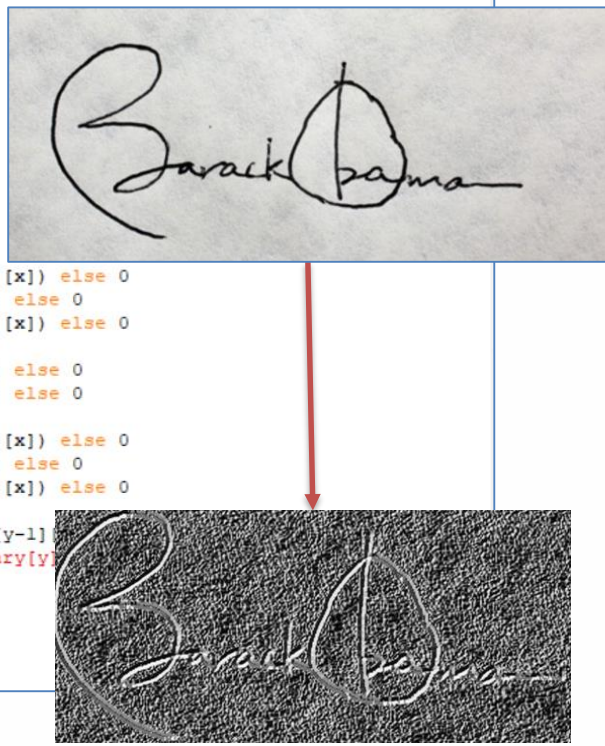
```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Image file :  Y_genuine_12.png

      ~~~ Texture features ~~~
 Mean:  224.62064048338368
 Variance:  132.49999999976717
 Skewness:  -2.67989282143756
 Kurtosis:  6.181647412206975
 Entropy:  5.672146449324859
 Haralick:  2663.808568037615
```

Implementation

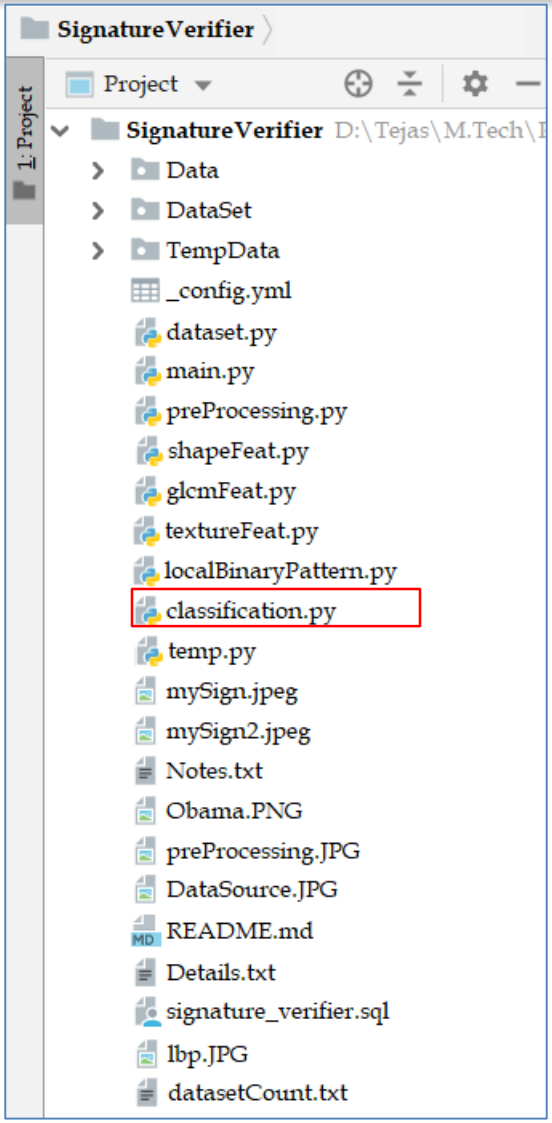


- **localBinaryPattern.py**
  - This python file contains function that converts the image to an LBP image.
  - Local Binary Pattern

```
def lbp(img):
    if(len(img.shape)>2):
        img = cv.cvtColor(img, cv.COLOR_RGB2GRAY)

    binary = img.copy()
    lbpImg = img.copy()
    height = img.shape[0]
    width = img.shape[1]

    y=1
    while(y<height-1):
        x=1
        while(x < width-1):
            binary[y-1][x-1] = 1 if(img[y-1][x-1] < img[y][x]) else 0
            binary[y-1][x] = 1 if(img[y-1][x] < img[y][x]) else 0
            binary[y-1][x+1] = 1 if(img[y-1][x+1] < img[y][x]) else 0

            binary[y][x-1] = 1 if(img[y][x-1] < img[y][x]) else 0
            binary[y][x+1] = 1 if(img[y][x+1] < img[y][x]) else 0

            binary[y+1][x-1] = 1 if(img[y+1][x-1] < img[y][x]) else 0
            binary[y+1][x] = 1 if(img[y+1][x] < img[y][x]) else 0
            binary[y+1][x+1] = 1 if(img[y+1][x+1] < img[y][x]) else 0

            lbpImg[y][x] = (binary[y][x-1]*128) + (binary[y-1]
            #lbpImg[y][x] = (binary[y-1][x+1]*128) + (binary[y
            x+=1
        y+=1

    return lbpImg
```



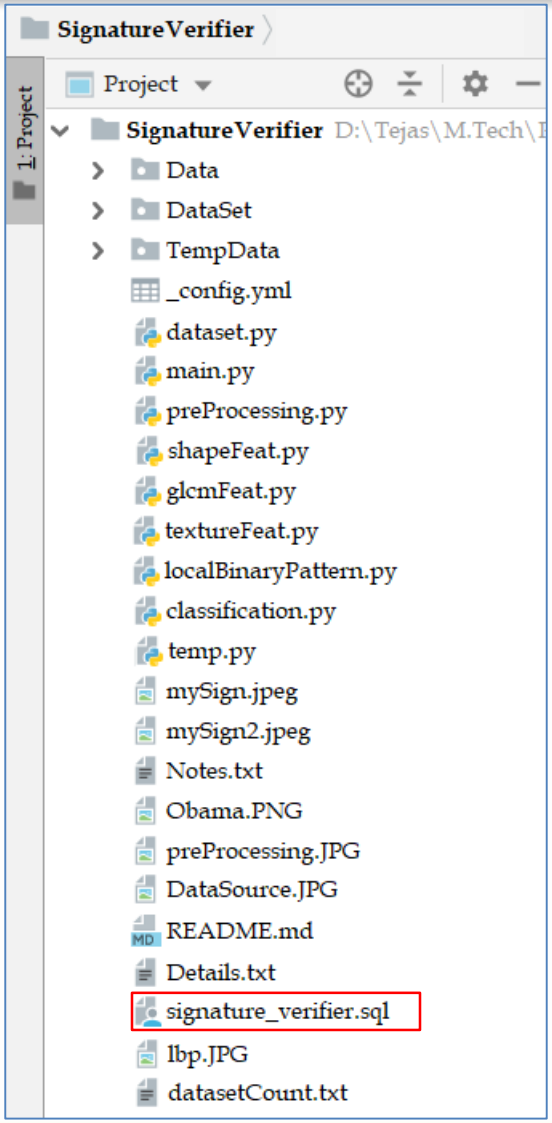
Implementation



- **classification.py**
  - This python file contains KNN classification function which classifies the given test data to a particular class.
  - There are two functions one that gets the actual class of the function by merely the name of the file and other is the KNN classifier.

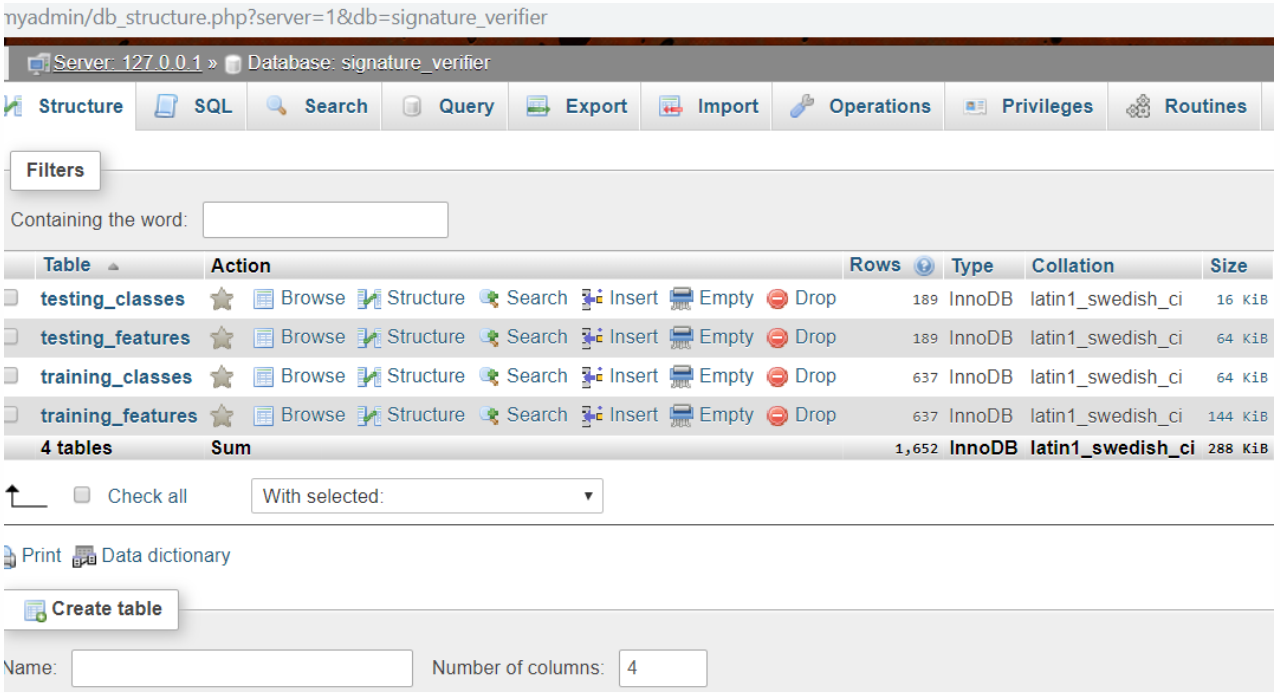
```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Image file :  A_forged_21.png
                    ■
                    ■
                    ■

Actual Class:  A_forged
Decision:  A_forged
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Implementation



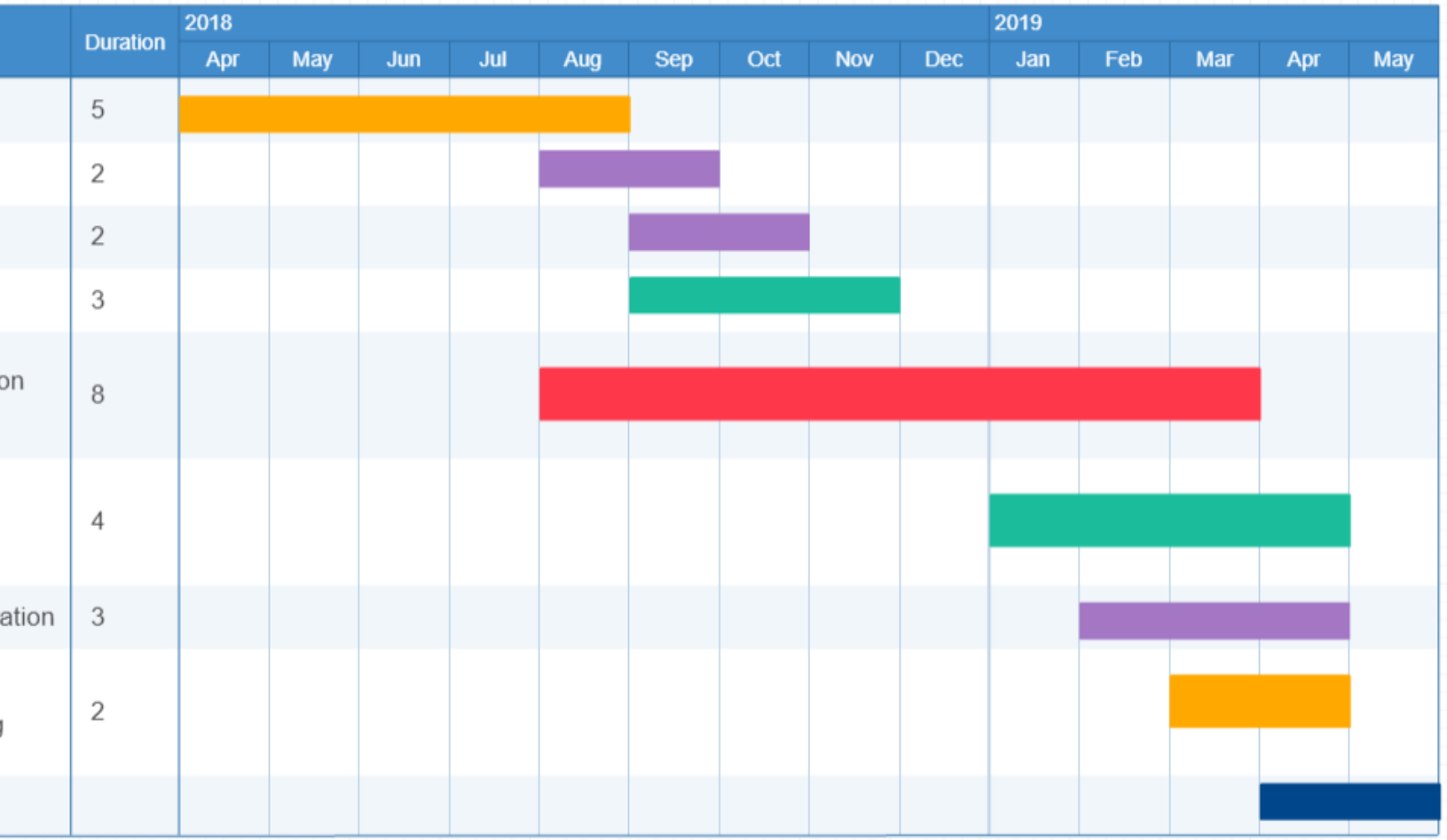
❑ DATABASE

- This has SQL queries for creating database, creating tables, inserting entries into the tables.
- Main.py also inserts and reads each feature vector into the database



Gantt Chart

ID	Task Name	Duration
1	Research	5
2	Planning	2
3	Analysis	2
4	Design	3
5	Implementation and Support	8
7	Testing and Evaluation	4
8	Report generation	3
9	Technical Paper Writing	2
9	Future Work	



References

[1] S. F. A. Zaidi and S. Mohammed, "Biometric Handwritten Signature Recognition," 2007.

[2] D. Morocho, A. Morales, J. Fierrez, and R. Vera-Rodriguez, "Towards human-assisted signature recognition: Improving biometric systems through attribute-based recognition," *ISBA 2016 - IEEE Int. Conf. Identity, Secur. Behav. Anal.*, 2016.

[3] S. A. Angadi, S. Gour, and G. Bhajantri, "Offline Signature Recognition System Using Radon Transform," *2014 Fifth Int. Conf. Signal Image Process.*, pp. 56–61, 2014.

[4] S. Hangai, S. Yamanaka, and T. Hammamoto, "ON-LINE SIGNATURE VERIFICATION BASED ON ALTITUDE AND DIRECTION OF PEN MOVEMENT," *Proc. 15th Int. Conf. Pattern Recognition. ICPR-2000*, vol. 3, no. l, pp. 479–482, 2000.

[5] I. V Anikin and E. S. Anisimova, "Handwritten signature recognition method based on fuzzy logic," *2016 Dyn. Syst. Mech. Mach.*, 2016.

[6] E. Ozgunduz, T. Senturk, and M. E. Karsligil, "Off-line signature verification and recognition by support vector machine," *13th Eur. Signal Process. Conf.*, no. 90, pp. 1–4, 2005.

[7] S. A. Angadi and S. Gour, "Euclidean Distance Based Offline Signature Recognition System Using Global and Local Wavelet Features," *2014 Fifth Int. Conf. Signal Image Process.*, pp. 87–91, 2014.

[8] Ruangroj Sa-Ardship and K. Woraratpanya, "Offline Handwritten Signature Recognition Using Adaptive Variance Reduction," *7th Int. Conf. Inf. Technol. Electr. Eng. (ICITEE), Chiang Mai, Thail. Offline*, pp. 258–262, 2015.

[9] M. A. Djoudjai, Y. Chibani, and N. Abbas, "Offline signature identification using the histogram of symbolic representation," *5th Int. Conf. Electr. Eng. - Boumerdes*, pp. 1–5, 2017.

[10] A. B. Jagtap and R. S. Hegadi, "Offline Handwritten Signature Recognition Based on Upper and Lower Envelope Using Eigen Values," *Proc. - 2nd World Congr. Comput. Commun. Technol. WCCCT 2017*, pp. 223–226, 2017.

References

[11] T. Marušić, Ž. Marušić, and Ž. Šeremet, "Identification of authors of documents based on offline signature recognition," *MIPRO*, no. May, pp. 25–29, 2015.

[12] S. L. Karanjkar and P. N. Vasambekar, "Signature Recognition on Bank cheques using ANN," *IEEE Int. WIE Conf. Electr. Comput. Eng.*, no. December, 2016.

[13] G. S. Prakash and S. Sharma, "Computer Vision & Fuzzy Logic based Offline Signature Verification and Forgery Detection," *IEEE Int. Conf. Comput. Intell. Comput. Res.*, 2014.

[14] M. S. Shirdhonkar and M. B. Kokare, "Document image retrieval using signature as query," *2011 2nd Int. Conf. Comput. Commun. Technol. ICCCT-2011*, pp. 66–70, 2011.

[15] R. Sa-Ardship and K. Woraratpanya, "Offline Handwritten Signature Recognition Using Polar-Scale Normalization," *8th Int. Conf. Inf. Technol. Electr. Eng. (ICITEE), Yogyakarta, Indones.*, pp. 3–7, 2016.

[16] A. Piyush Shanker and A. N. Rajagopalan, "Off-line signature verification using DTW," *Pattern Recognit. Lett.*, vol. 28, no. 12, pp. 1407–1414, 2007.

[17] Nancy and P. G. Goyal, "Signature Processing in Handwritten Bank Cheque Images," *Int. J. Recent Innov. Trends Comput. Commun.*, vol. 2, no. 5, pp. 1239–1243, 2014.

[18] A. T. Nasser and N. Dogru, "Signature recognition by using SIFT and SURF with SVM basic on RBF for voting online," *Proc. 2017 Int. Conf. Eng. Technol. ICET 2017*, vol. 2018–Janua, pp. 1–5, 2017.

[19] A. Kumar and K. Bhatia, "A Robust Offline Handwritten Signature Verification System Using Writer Independent Approach," *3rd Int. Conf. Adv. Comput. Autom.*, 2017.

[20] H. Anand, "Enhanced Signature Verification and RECOGNITION USING MATLAB," *Int. J. Innov. Res. Adv. Eng.*, vol. 1, no. 4, pp. 88–94, 2014.

[21] B. H. Shekar and R. K. Bharathi, "Eigen-signature: A robust and an efficient offline signature verification algorithm," *Int. Conf. Recent Trends Inf. Technol. ICRTIT 2011*, pp. 134–138, 2011.

[22] A. R. Rahardika, "Global Features Selection for Dynamic Signature Verification," *Int. Conf. Inf. Commun. Technol. Glob.*, pp. 348–354, 2018.

[23] T. Handhayani, A. R. Yohannis, and Lely Hiryanto, "Hand Signature and Handwriting Recognition as Identification of the Writer using Gray Level Co- Occurrence Matrix and Bootstrap," *Intell. Syst. Conf.*, no. September, pp. 1103–1110, 2017.

References

[24] A. Beresneva, A. Epishkina, and D. Shingalova, "Handwritten Signature Attributes for its Verification," pp. 1477–1480, 2018.

[25] M. P. Patil, Bryan Almeida, Niketa Chettiar, and Joyal Babu, "Offline Signature Recognition System using Histogram of Oriented Gradients," *Int. Conf. Adv. Comput. Commun. Control*, 2017.

[26] M. M. Kumar and N. B. Puhan, "Offline signature verification using the trace transform," *2014 IEEE Int. Adv. Comput. Conf.*, pp. 1066–1070, 2014.

[27] O. Miguel-Hurtado, L. Mengibar-Pozo, M. G. Lorenz, and J. Liu-Jimenez, "On-Line Signature Verification by Dynamic Time Warping and Gaussian Mixture Models," *2007 41st Annu. IEEE Int. Carnahan Conf. Secur. Technol.*, pp. 23–29, 2007.

[28] M. Ferrer and J. Vargas, "Robustness of offline signature verification based on gray level features," *IEEE Trans. Inf. FORENSICS Secur.*, vol. 7, no. 3, pp. 966–977, 2012.

[29] B. Erkmen, N. Kahraman, R. A. Vural, and T. Yildirim, "Conic section function neural network circuitry for offline signature recognition," *IEEE Trans. Neural Networks*, vol. 21, no. 4, pp. 667–672, 2010.

[30] M. A. Ferrer, A. Morales, and J. F. Vargas, "Off-line signature verification using local patterns," *2nd Natl. Conf. Telecommun.*, pp. 1–6, 2011.

[31] M. Tahir and M. U. Akram, "Online Signature Verification using Hybrid Features," *Conf. Inf. Commun. Technol. Soc. Online*, pp. 11–16, 2018.

[32] M. Pal, S. Bhattacharyya, and T. Sarkar, "Euler number based feature extraction technique for Gender Discrimination from offline Hindi signature using SVM & BPNN classifier," *2018 Emerg. Trends Electron. Devices Comput. Tech.*, pp. 1–6, 2004.

[33] W. Pan and G. Chen, "A Method of Off-line Signature Verification for Digital Forensics," *12th Int. Conf. Nat. Comput. Fuzzy Syst. Knowl. Discov.*, pp. 488–493, 2016.

References

[34] M. A. Ferrer, J. B. Alonso, and C. M. Travieso, "Offline geometric parameters for automatic signature verification using fixed-point arithmetic," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 27, no. 6, pp. 993–997, 2005.

[35] S. A. Farimani and M. V. Jahan, "An HMM for Online Signature Verification Based on Velocity and Hand Movement Directions," *Iran. Jt. Congr. Fuzzy Intell. Syst.*, pp. 205–209, 2018.

[36] G. Pirlo and D. Impedovo, "Verification of static signatures by optical flow analysis," *IEEE Trans. Human-Machine Syst.*, vol. 43, no. 5, pp. 499–505, 2013.

[37] A. Alaei, S. Pal, U. Pal, and M. Blumenstein, "An Efficient Signature Verification Method Based on an Interval Symbolic Representation and a Fuzzy Similarity Measure," *IEEE Trans. Inf. Forensics Secur.*, vol. 12, no. 10, pp. 2360–2372, 2017.

[38] D. S. Guru and H. N. Prakash, "Online Signature Verification and Recognition: An Approach based on Symbolic Representation.," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 31, no. 6, pp. 1059–73, 2009.

[39] A. Sharma and S. Sundaram, "On the Exploration of Information from the DTW Cost Matrix for Online Signature Verification," *IEEE Trans. Cybern.*, vol. 48, no. 2, pp. 611–624, 2018.

[40] G. Pirlo, V. Cuccovillo, M. Diaz-Cabrera, D. Impedovo, and P. Mignone, "Multidomain Verification of Dynamic Signatures Using Local Stability Analysis," *IEEE Trans. Human-Machine Syst.*, vol. 45, no. 6, pp. 805–810, 2015.

[41] Python : https://www.python.org/

[42] Dataset source :- http://www.iapr-tc11.org/mediawiki/index.php?title=Datasets_List#Handwritten%20Documents

Thank You ☺

Any Questions?