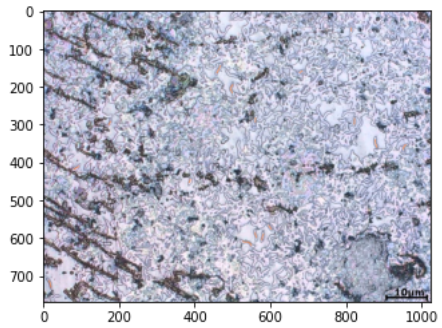
```
import numpy as np
import cv2
import csv
import matplotlib.pyplot as plt
from matplotlib.pyplot import imshow
import random
import os



img_path='/content/Graphene_DAY3_9.png'
img = cv2.imread(img_path)


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

```
Mounted at /content/drive
```

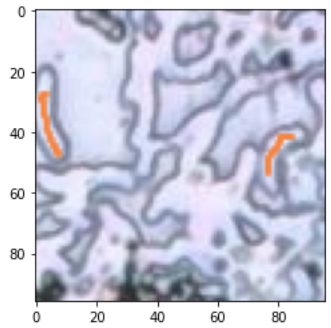
```
print(img.shape)
imshow(np.asarray(img))
```

```
(768, 1023, 3)
<matplotlib.image.AxesImage at 0x7fa15c4eda90>
```




```
i,j,s,st=329,922,64,16
cropped_image = img[i-32+st:i+s+st, j-32-st:j+s-st]
imshow(np.asarray(cropped_image))
```

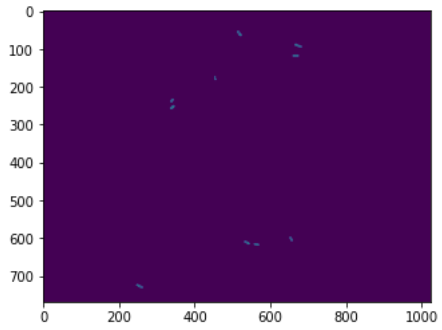
```
<matplotlib.image.AxesImage at 0x7fa15c53d310>
```



Generating_Patches

```
def find_contour(img_path):
  img = cv2.imread(img_path)
  dim=(1024,768)
  img=cv2.resize(img, dim, interpolation = cv2.INTER_AREA)
  gray= cv2.cvtColor(img,cv2.COLOR_RGB2GRAY)
  thresh=0
  ret,thresh = cv2.threshold(gray,thresh,255,cv2.THRESH_BINARY)
  thresh = cv2.Canny(thresh, 30, 150)
  contours,hierarchy = cv2.findContours(thresh,cv2.RETR_TREE,cv2.CHAIN_APPROX_SIMPLE)
  imshow(np.asarray(thresh))
  #print(contours)
  return contours

def extract_patch(img_path,des,contours,s):
```

```
        c=0
        img = cv2.imread(img_path)
        dic={}
        for k in range(len(contours)):
          cnt = contours[k]
          (x,y),radius = cv2.minEnclosingCircle(cnt)
          if x>42 and x<980 and y>42 and y<726:
            #print(x,y)
            j=int(x-s/2)
            i=int(y-s/2)
            if (i,j) not in dic:
              dic[(i,j)]=1
              #print(i,j)
              img = cv2.imread(img_path)
              cropped_image = img[i:i+s, j:j+s]
              c+=1
              save=des+'4_'+str(c)+'.jpg'
              cv2.imwrite(save, cropped_image)
              st=10
              cropped_image = img[i-st:i+s-st, j-st:j+s-st]
              c+=1
              save=des+'4_'+str(c)+'.jpg'
              cv2.imwrite(save, cropped_image)

              cropped_image = img[i-st:i+s-st, j+st:j+s+st]
              c+=1
              save=des+'4_'+str(c)+'.jpg'
              cv2.imwrite(save, cropped_image)

              cropped_image = img[i+st:i+s+st, j+st:j+s+st]
              c+=1
              save=des+'4_'+str(c)+'.jpg'
              cv2.imwrite(save, cropped_image)

              cropped_image = img[i+st:i+s+st, j-st:j+s-st]
              c+=1
              save=des+'4_'+str(c)+'.jpg'
              cv2.imwrite(save, cropped_image)

    def extract_non_patch(img_path,des,contours,s):
        c=0
        img = cv2.imread(img_path)
        dic={}
        for k in range(len(contours)):
          cnt = contours[k]
          (x,y),radius = cv2.minEnclosingCircle(cnt)
          if x>32 and x<990 and y>32 and y<736:
            #print(x,y)
            j=int(x-s/2)
            i=int(y-s/2)
            if (i,j) not in dic:
              dic[(i,j)]=1
        m=len(dic)*5
        c=0

        while c<m:
          flag=0
          i=random.randrange(50,700)
          j=random.randrange(50,700)
          for point in dic:
            if (abs(point[0]-i)<32 or abs(point[1]-j)<32):
              flag=1
              break
          if flag==1:
            continue
          img = cv2.imread(img_path)
          cropped_image = img[i:i+s, j:j+s]
          c+=1
          save=des+'1_'+str(c)+'.jpg'
          cv2.imwrite(save, cropped_image)



    c=find_contour("/content/graphene_Day7_4.png")
    extract_patch("/content/Graphene_DAY7_4.jpg","/content/drive/MyDrive/Research/Single_Cell/",c,64)
    #extract_non_patch("/content/Graphene_DAY3_9.jpg","/content/drive/MyDrive/Research/non_patch/",c,64)
```



CLAHE patching

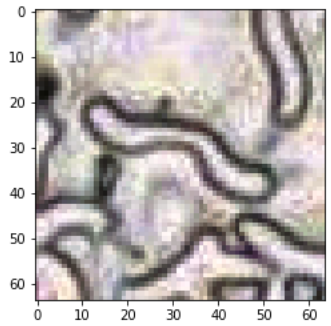
```
pip install tf_clahe
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting tf_clahe
  Downloading tf_clahe-0.1.0-py3-none-any.whl (4.9 kB)
Collecting tensorflow-addons>=0.10
  Downloading tensorflow_addons-0.18.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.1 MB)
     |████████████████████████████████| 1.1 MB 33.8 MB/s
Requirement already satisfied: tensorflow>=2.3 in /usr/local/lib/python3.7/dist-packages (from tf_clahe) (2.9.2)
Requirement already satisfied: termcolor>=1.1.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (2.0.1)
Requirement already satisfied: six>=1.12.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.15.0)
Requirement already satisfied: google-pasta>=0.1.1 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (0.2.0)
Requirement already satisfied: wrapt>=1.11.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.14.1)
Requirement already satisfied: astunparse>=1.6.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.6.3)
Requirement already satisfied: keras<2.10.0,>=2.9.0rc0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (2.9.0
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (57.4.0)
Requirement already satisfied: typing-extensions>=3.6.6 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (4.1.
Requirement already satisfied: h5py>=2.9.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (3.1.0)
Requirement already satisfied: gast<=0.4.0,>=0.2.1 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (0.4.0)
Requirement already satisfied: protobuf<3.20,>=3.9.2 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (3.17.3)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_
Requirement already satisfied: keras-preprocessing>=1.1.1 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.
Requirement already satisfied: opt-einsum>=2.3.2 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (3.3.0)
Requirement already satisfied: tensorflow-estimator<2.10.0,>=2.9.0rc0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->t
Requirement already satisfied: tensorboard<2.10,>=2.9 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (2.9.1)
Requirement already satisfied: numpy>=1.20 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.21.6)
Requirement already satisfied: flatbuffers<2,>=1.12 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.12)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (21.3)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.49.1)
Requirement already satisfied: absl-py>=1.0.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (1.2.0)
Requirement already satisfied: libclang>=13.0.0 in /usr/local/lib/python3.7/dist-packages (from tensorflow>=2.3->tf_clahe) (14.0.6)
Requirement already satisfied: wheel<1.0,>=0.23.0 in /usr/local/lib/python3.7/dist-packages (from astunparse>=1.6.0->tensorflow>=2.3->tf
Requirement already satisfied: cached-property in /usr/local/lib/python3.7/dist-packages (from h5py>=2.9.0->tensorflow>=2.3->tf_clahe) (
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->tensorflow>=2.3->
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->
Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->tensorflow>=2.3->
Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->tensorflow>
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->ten
Requirement already satisfied: requests<3,>=2.21.0 in /usr/local/lib/python3.7/dist-packages (from tensorboard<2.10,>=2.9->tensorflow>=2
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.7/dist-packages (from google-auth<3,>=1.6.3->tensorboard<
Requirement already satisfied: cachetools<5.0,>=2.0.0 in /usr/local/lib/python3.7/dist-packages (from google-auth<3,>=1.6.3->tensorboard
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.7/dist-packages (from google-auth<3,>=1.6.3->tensorboard<2.10,>=2
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.7/dist-packages (from google-auth-oauthlib<0.5,>=0.4.1
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.7/dist-packages (from markdown>=2.6.8->tensorboard<2.10
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata>=4.4->markdown>=2.6.8->tensc
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.7/dist-packages (from pyasn1-modules>=0.2.1->google-auth<3
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-packages (from requests<3,>=2.21.0->tensorboard<2.10,>
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests<3,>=2.21.0->tensorboard<2.10,>=2.9-
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-packages (from requests<3,>=2.21.0->tensorboard<2.10,
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/lib/python3.7/dist-packages (from requests<3,>=2.21
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/dist-packages (from requests-oauthlib>=0.7.0->google-auth-oau
Requirement already satisfied: typeguard>=2.7 in /usr/local/lib/python3.7/dist-packages (from tensorflow-addons>=0.10->tf_clahe) (2.7.1)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging->tensorflow>=2.3->tf_c
Installing collected packages: tensorflow-addons, tf-clahe
Successfully installed tensorflow-addons-0.18.0 tf-clahe-0.1.0
```

```
import tensorflow as tf
import tf_clahe

img = tf.io.decode_image(tf.io.read_file('/content/drive/MyDrive/Research/Single_Cell/1_1.jpg'))
```

```
des=
# With sane defaults (8x8 tiling and 4.0 clip limit)
img_clahe = tf_clahe.clahe(img)
imshow(np.asarray(img_clahe))
```

```
<matplotlib.image.AxesImage at 0x7f2fbda14550>
```




```
import tensorflow as tf
import tf_clahe
des='/content/drive/MyDrive/Research/CLAHE_Single_Cell/'
folder_name='/content/drive/MyDrive/Research/Single_Cell/'
img_names = os.listdir(folder_name)

for name in (img_names):
        path=folder_name+name
        name=name[:name.find('.')]
        img = tf.io.decode_image(tf.io.read_file(path))
        img_clahe = tf_clahe.clahe(img)
        save=des+name+'.jpg'
        cv2.imwrite(save, np.asarray(img_clahe))
```

```
import tensorflow as tf
import tf_clahe
des='/content/drive/MyDrive/Research/CLAHE_Non_Patch/'
folder_name='/content/drive/MyDrive/Research/non_patch/'
img_names = os.listdir(folder_name)

for name in (img_names):
        path=folder_name+name
        name=name[:name.find('.')]
        img = tf.io.decode_image(tf.io.read_file(path))
        img_clahe = tf_clahe.clahe(img)
        save=des+name+'.jpg'
        cv2.imwrite(save, np.asarray(img_clahe))
```