Çağdaş Güven 2738938

ME 536

Find and count characters and their elements in strings

Check if you can see the hidden ***SVD flavor*** somewhere in the requirements!

In [1]:
```
# only importing from following libraries are allowed. You can add more i
from skimage import io
from skimage.filters import threshold_otsu as otsu
import numpy as np
from scipy.linalg import orth
from numpy.linalg import matrix_rank as rank
import matplotlib.pyplot as plt
import plotly.graph_objects as go
from sklearn.cluster import KMeans # just for demo purposes, you can impo

# also import the matrix printing function
!rm bug_numpy_utils.py 2> dump.me ## change these to ! when uploading the
!wget https://raw.githubusercontent.com/bugrakoku/bug_python_utils/main/b
from bug_numpy_utils import CData as CMe
from bug_numpy_utils import GenerateDataforImage as GenImMat
from bug_numpy_utils import text2mat
```

```
--2024-12-06 18:04:11--  https://raw.githubusercontent.com/bugrakoku/bug_p
ython_utils/main/bug_numpy_utils.py
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199
.110.133, 185.199.109.133, 185.199.108.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.19
9.110.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 18456 (18K) [text/plain]
Saving to: ‘bug_numpy_utils.py’

bug_numpy_utils.py  100%[===================>]  18.02K  --.-KB/s    in 0.0
05s

2024-12-06 18:04:11 (3.26 MB/s) - ‘bug_numpy_utils.py’ saved [18456/18456]
```

Intro to Basics: Assignment has not started yet!

This is the warm up

Generate and plot reference text

Generate data matrix from a string.

Columns of this matrix are data points, which when plotted is read as the given string.

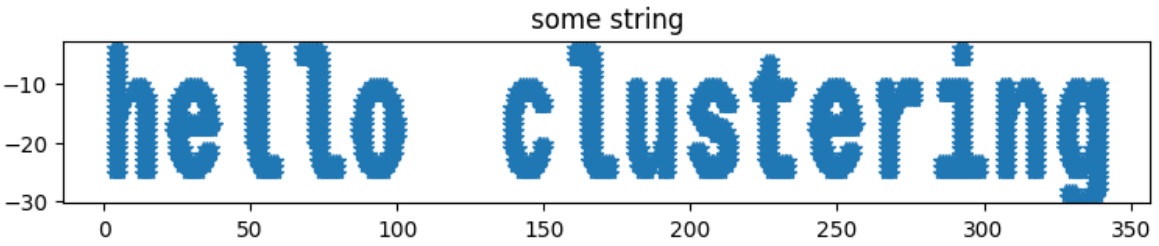
Using pyplot display the data points to make sure that they are readable.

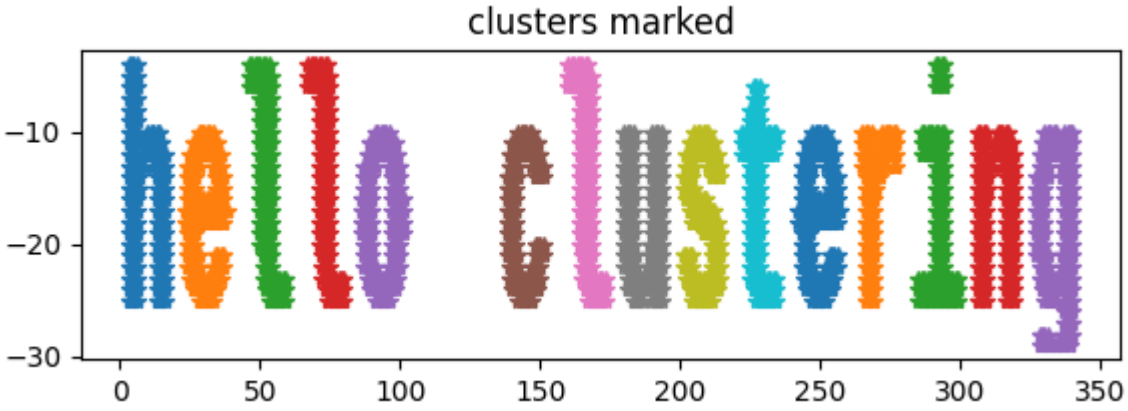
The problem is given in 2D below, play with the `NoiseLevel` and observe how data points mere into each other.

In [2]:
```
# this is a support function to see the result of clustering better

def ColorizeChars(M, Mnum = [], Title='some string', figSize = (9, 3),  a
    Indicies = np.hstack((np.array([0]), np.cumsum(Mnum)))
    fig, ax = plt.subplots(figsize= figSize) # Increased figure size
    # absence of Mnum is that we do not want to colorize the plot
    if Mnum is None or Mnum is [] or len(Mnum) == 0:
        ax.plot(M[0,:],M[1,:], '*')
    else:
        for i, uLim in enumerate(Indicies):
            if i < len(Indicies)-1:
                X = M[0, uLim:Indicies[i+1]]
                Y = M[1, uLim:Indicies[i+1]]
                #plt.plot(X,Y, '*')
                ax.plot(X,Y, '*')
    ax.set_aspect(aspectR) # Set the aspect ratio to aspectR:1
    ax.set_title(Title)
    plt.show()
```

In [3]:
```
S1 = 'hello clustering'
T1, T1num = text2mat(S1)

# just that we get to understand ```text2mat``` function let's print the
print(f'Shape of T1 = {T1.shape}, where letters of "{S1}" has {T1num} dat

NoiseLevel = 0.0

T1 += NoiseLevel * np.random.randn(*T1.shape)


ColorizeChars(T1) # just plot the data as a single chunk
ColorizeChars(T1, T1num, Title='clusters marked', figSize=(7,2), aspectR=
```

```
Shape of T1 = (3, 2062), where letters of "hello clustering" has [166, 153
, 128, 128, 148, 119, 128, 141, 137, 119, 153, 95, 124, 142, 181] data poi
nts in each corresponding letter
```





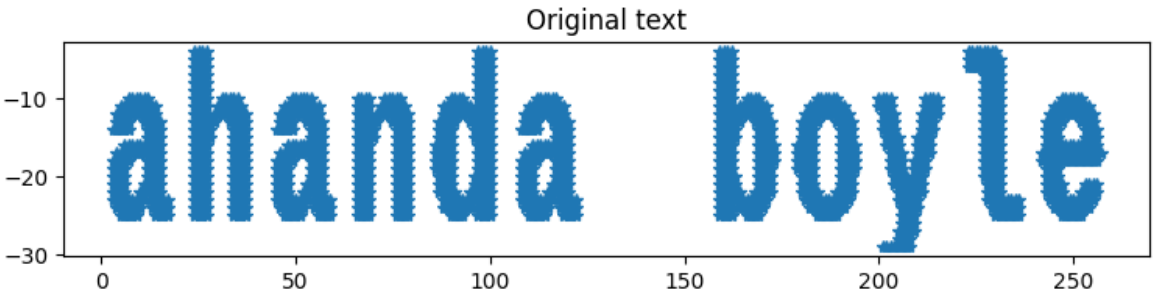
WARNING: Testing conditions is not Vanilla

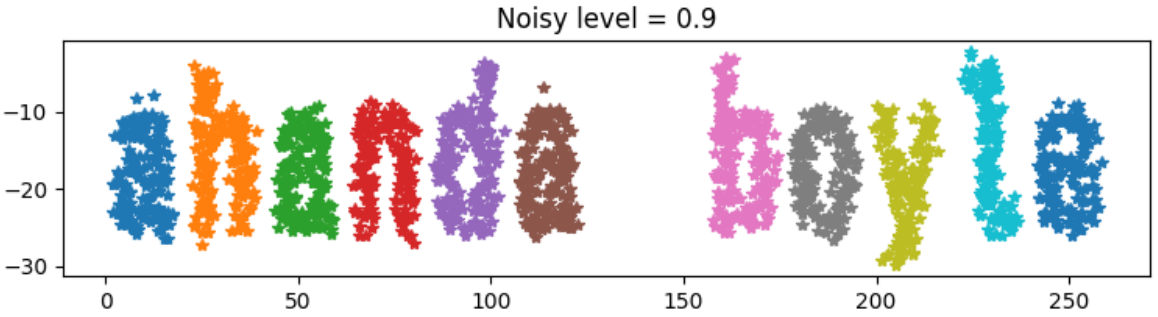
Note that data matrix that will be sent might slightly be manipulated after it is generated with `text2mat` , way beyond adding noise.
Check out the following to give you an idea.

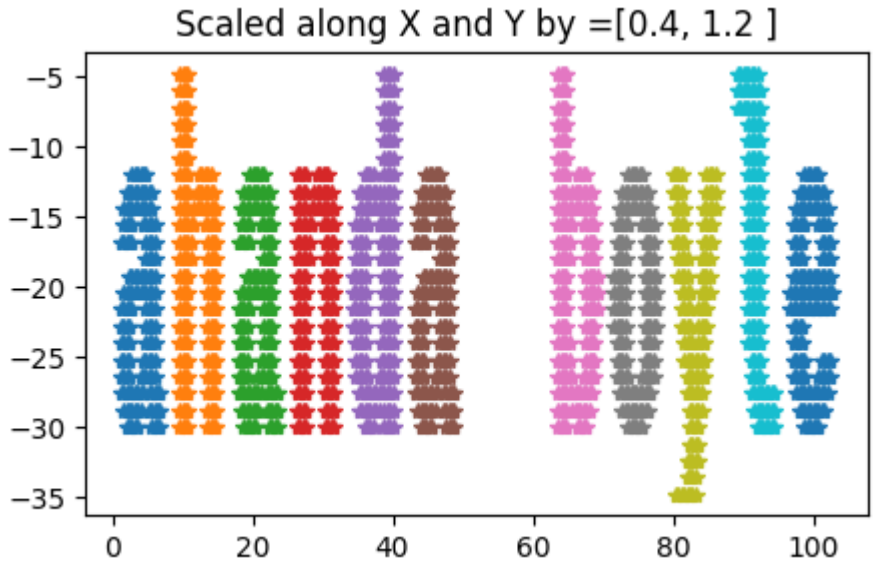
Note that when data matrix is shuffled, color printing makes no sense, because the columns are no more sorted, hence values returned by text2mat does not make sense.

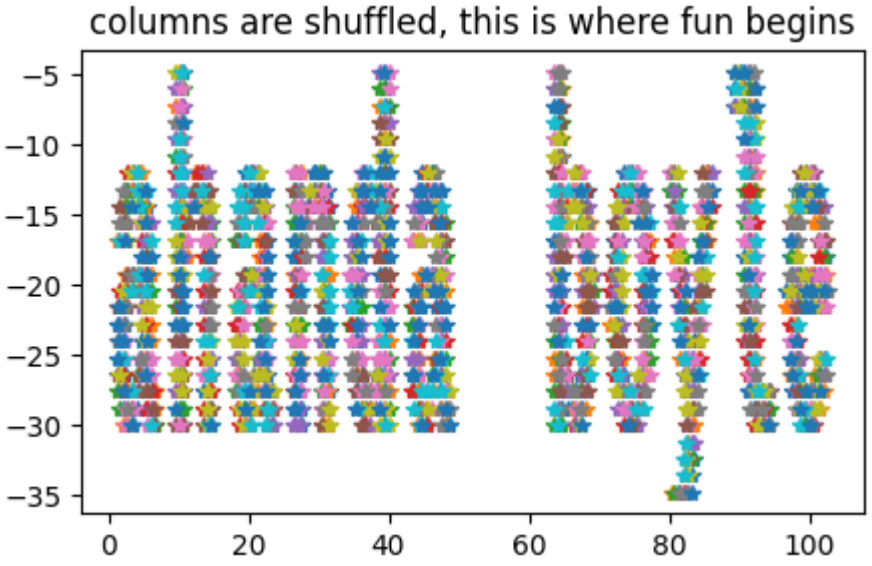
In [4]:
```
# CELL 1
Stest = 'ahanda boyle'
Ttest, Tnum = text2mat(Stest)
noiseLevel = 0.9

#'''
# original text
V1 = Ttest[0:2, :]
ColorizeChars(V1, Title='Original text')
#'''

#'''
# contaminated ... play with noise levels
V2 = V1 + noiseLevel * np.random.randn(*V1.shape)
ColorizeChars(V2, Tnum, Title=f'Noisy level = {noiseLevel}')
#'''

#'''
# extended or shrung along X-Y axis
V3 = np.copy(V1)
Xscale = 0.4
Yscale = 1.2
V3[0,:] *= Xscale
V3[1,:] *= Yscale
ColorizeChars(V3, Tnum, Title=f'Scaled along X and Y by =[{Xscale}, {Ysca
#'''

#'''
V4 = np.copy(V3)
V4 = V4[:, np.random.permutation(V4.shape[1])]
ColorizeChars(V4, Tnum, Title='columns are shuffled, this is where fun be
#'''

#'''
V5 = orth(np.random.rand(2,2)) @ V2
```

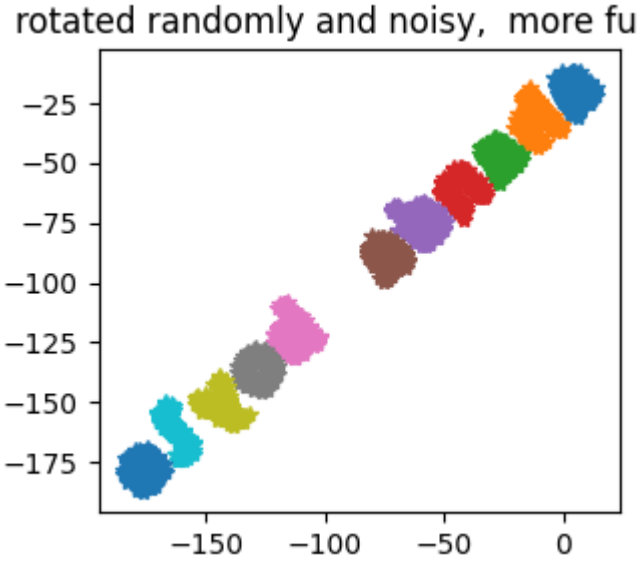
```
ColorizeChars(V5, Tnum, Title='rotated randomly and noisy,  more fun :) '
#'''


#'''
V6 = V5[:, np.random.permutation(V5.shape[1])]
ColorizeChars(V6, Tnum, Title='shuffled and rotated and contaminated, alm
#'''
```

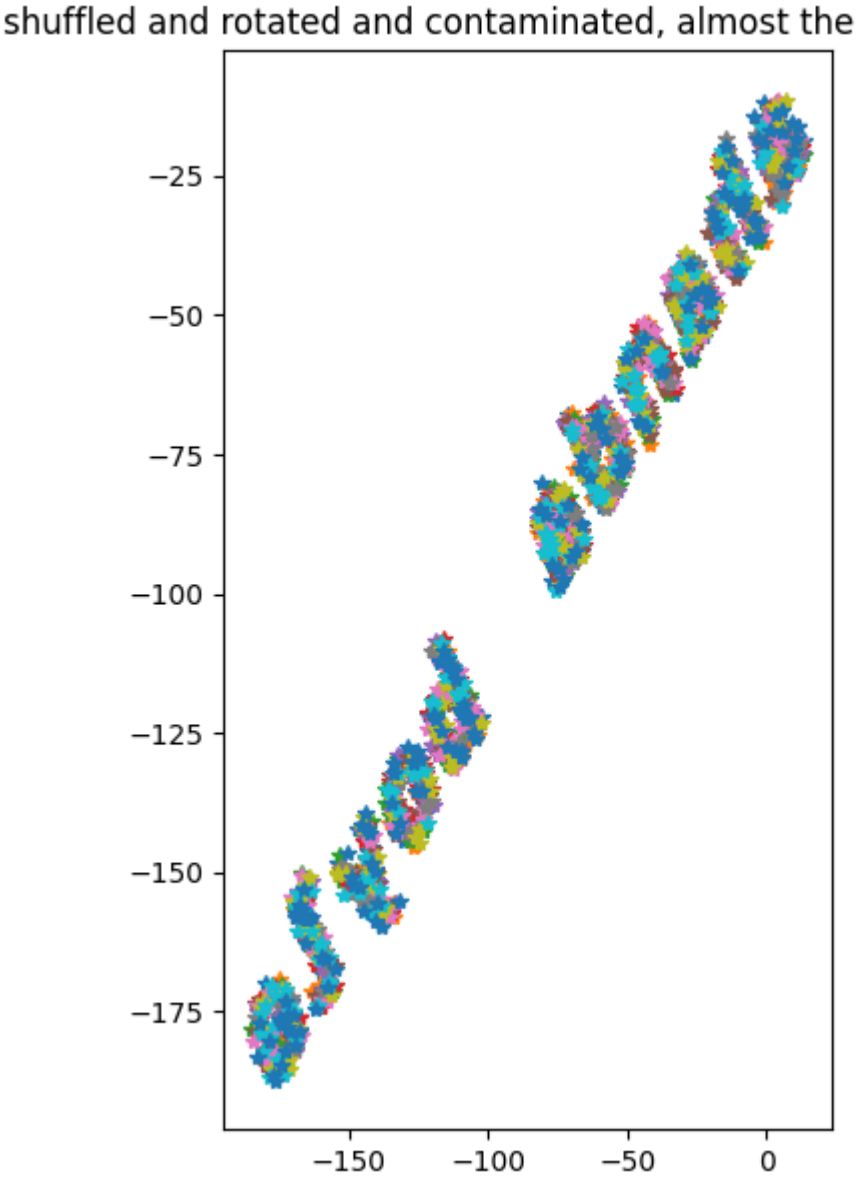







columns are shuffled, this is where fun begins
−5
−10
−15
−20
−25
−30
−35
0
20
40
60
80
100


rotated randomly and noisy, more fun :)
−25
−50
−75
−100
−125
−150
−175
−150
−100
−50
0



Assignment starts here

Read the following cells carefully and respond by filling in the code and text cells. Your explanations brief yet clear.

This assignment will hopefully make you better in clustering simple cases :)
For harder cases, we will talk about artificial neural networks...

Let's start with a show case

Note that `text2mat` function returns a data matrix and a list.
Also note that the data matrix is sorted, so that the first groups of points belong to the first letter, second group to the second letter and so on.
The list contains the number of points in each groups that correspond to the letters in the text that is sent to the function.

So your objective indeed is to recover clusters, sort them, so that when we print, it plot

them using what is returned from your function, it plots properly.

However, note that your sorting algorithm is not necessarily expected to find the order of clusters (i.e. letters), it is possible that you read the string from the end to beginning. By running the following you will see that the text might even be mirrorred. Under any circumstance, you should be able to find the alignment of the text, it does not matter wheter it is backwards or mirrorred, cluster it and return the sorted matrix along with the number of elements in each cluster, similar to what `text2mat` does. When we plot it using `ColorizeChars` it should look meaningful.

In other words, your element count list should either be similar to what text2sum returns or to the inverse of the list.

Run the following cell for different noise levels and observe the changes.

Clustering time:

Using any approach you like sort points in the given data matrix. You can use hence import other sub-libraries in already imported libraries above.
No new libraries...

Objective is to see if you can find letters indiviually.
In other words, after we shuffle everything, objective is to check if you can

Implemet the sorting function: i.e. `SortPoints()`

If you would like to seperate this function into smaller other functions, write them in the support functions cell

In [5]:
```
# support functions goes in here so that I run them before SortPoints()
# write as many as needed
#
```

In [6]:
```
def SortPoints(M, K = -1):
    '''
    Columns of M are the data points
    K is the number of clusters, if K = -1, this function is to find the

    returns Ms, MsNum
    Ms: the column sorted version of M, similar to what is given by text2
    MsNum: element count list --> the number of points in each cluster, s
    Note that len(MsNum) = number of letters in the original string
    '''
    # fill in the function so that...
    Ms = None
    MsNum = []


    Ms, MsNum
```

Let's test the sorting function

If you have implemented `SortPints` properly, following should work. I will only call `SortPints` to test your work.

In [7]:
```
# let's generate test data
St = 'Test Data'
Tt, Ttsum = text2mat(St)
#in my case I will generate variations of Tt as I did above but for simpl

#I will run one of the following
R, Rsum = SortPoints(Tt) # case when k- number of clusters is given -
# also check for fun what happens when k is given to be something differe

R, Rsum = SortPoints(Tt, len(Ttsum)) # case when it is not given

# finally see the result
ColorizeChars(R, Rsum)
```

```
---------------------------------------------------------------------------
-
TypeError                                 Traceback (most recent call las
t)
Cell In[7], line 7
      3 Tt, Ttsum = text2mat(St)
      4 #in my case I will generate variations of Tt as I did above but fo
r simplicty here I will stick with Tt
      5
      6 #I will run one of the following
----> 7 R, Rsum = SortPoints(Tt) # case when k- number of clusters is give
n -
      8 # also check for fun what happens when k is given to be something
different then the correct value
     10 R, Rsum = SortPoints(Tt, len(Ttsum)) # case when it is not given

TypeError: cannot unpack non-iterable NoneType object
```

In [ ]: