TRATAMIENTO DE SOMBRAS EN FOTOGRAFIAS DE DOCUMENTOS

```
# importamos librerias utilizadas
import cv2
import numpy as np
import matplotlib.pyplot as plt
from scipy import ndimage, misc
import matplotlib.pyplot as plt

# definimos unafuncion para graficar las imagenes
def imprimir_pic(pic,etiqueta):
    plt.figure()
    plt.imshow(pic, cmap = 'gray')
    plt.title(etiqueta)
    plt.axis('off')
```

Seleccionamos la imagen con la cual se va a trabajar

```
imagen_entrada = "input7"
input_pic = cv2.imread(imagen_entrada+".jpeg")
```

METODO BASE

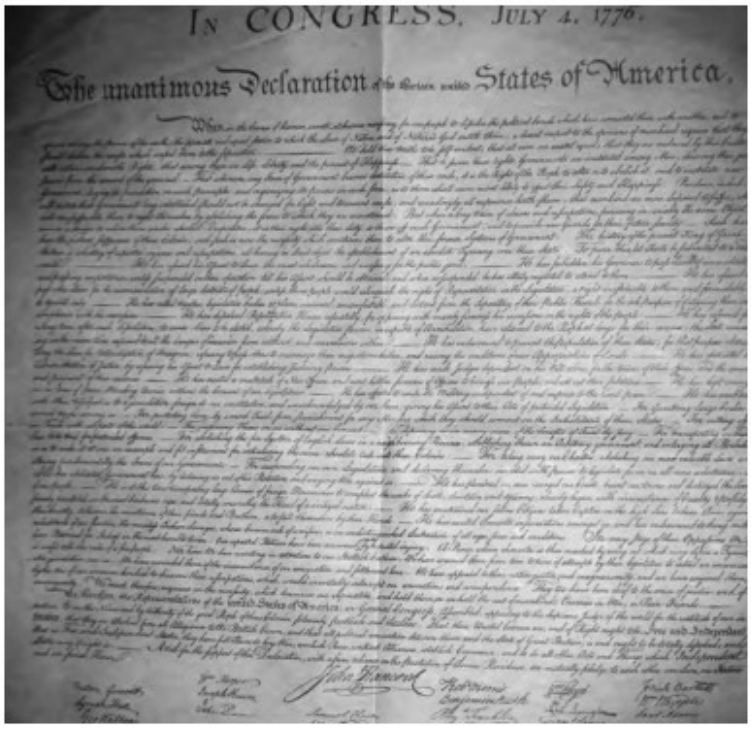
Generamos la mascara o "perfil de sombra"

```
# Paquetes necesarios para la morfología matemática
from skimage.morphology import erosion, dilation, opening, closing
# Elementos estructurales
from skimage.morphology import disk, diamond, ball, rectangle, star
from scipy import ndimage as ndi
#reducimos la pic a grises
input_pic = cv2.cvtColor(input_pic, cv2.COLOR_BGR2GRAY)

#realizamos una copia de la pic recibida para poder modificarla en un
espacio de memoria diferente
mask = np.copy(input_pic)
#las sisguientes 3 lineas se encargar de normalizar la pic de 0 a 255
mask = mask - mask.min()
mask = mask/mask.max()
mask = mask*255


#Creamos la mascara con un filtro de mediana, consideramos las letras
como ruido

for i in range(3):
```

```
    mask = ndimage.median_filter(mask, size=18,mode='reflect')

mask_gris = np.copy(mask)


imprimir_pic(mask,'Máscara en grises')



#la maskara debe estar en blanco y negro y no en escala de grises, asi
que se realiza un if:
promedio = np.mean(mask)
for (cor_y,cor_x), value in np.ndenumerate(mask):
    if mask[cor_y,cor_x]<promedio: #Good Pixel
        mask[cor_y,cor_x] = 0.1
    elif mask[cor_y,cor_x]>promedio: #Bad Pixel
        mask[cor_y,cor_x] = 254.9


imprimir_pic(mask,'Máscara')
imprimir_pic(input_pic,'original')
```

Máscara

original



Definimos la funcion de contraste que apartir de un percentil permite

```
def funcion_de_contraste(pic,percentil):
    limite = np.percentile(pic,percentil)
    blancos = pic >= limite
    pic = pic + 255*blancos
    negros_saturados = pic<limite
    blancos_saturados = pic>=limite
    pic[negros_saturados] = 0
    pic[blancos_saturados] = 255
    return pic
```

Definimos el array "Zona Oscura"

```
zona_oscura = np.full(input_pic.shape,np.nan)
limite = np.nanmean(input_pic)
for (coor_y,coor_x), value in np.ndenumerate(input_pic):
    aux = mask[coor_y:coor_y+1,coor_x:coor_x+1]
    if aux<limite: #Good Pixel
        zona_oscura[coor_y,coor_x] =  input_pic[coor_y,coor_x]
    elif aux>limite: #Bad Pixel
        None
imprimir_pic(zona_oscura,"zona_oscura")
```

Definimos el array "Zona Clara"

```
zona_clara = np.full(input_pic.shape,np.nan)
limite = np.nanmean(input_pic)
```

```
for (coor_y,coor_x), value in np.ndenumerate(input_pic):
    aux = mask[coor_y:coor_y+1,coor_x:coor_x+1]
    if aux>limite: #Good Pixel
        zona_clara[coor_y,coor_x] =  input_pic[coor_y,coor_x]
    elif aux<=limite: #Bad Pixel
        None

imprimir_pic(zona_clara,"zona_clara")
```

Definimos la funcion que nos permite conocer el punto optimo para contrastar la imagen

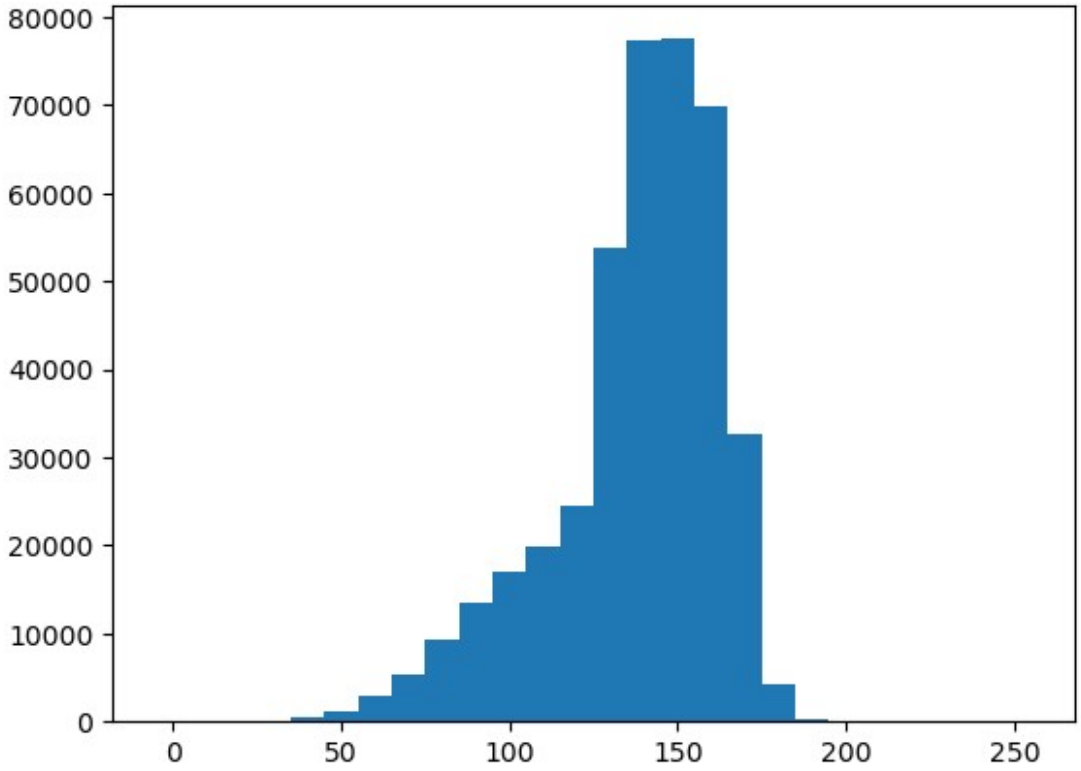
```
def contraste_optimo_por_MSE(segmento,pic):

    output = 255 - np.nan_to_num(segmento,nan=0)

    base = 255 -pic
    errorlist = []
    for i in range(30):

        f = funcion_de_contraste(output,i)
        error = np.sum((base-f)**2)
        errorlist.append(error)

    m = np.arange(30)
    #plt.scatter( m,errorlist)
    #plt.title("Error vs intensidad (por percentile)")
```

```
    #plt.show()
    return (m[np.argmin(errorlist)]+1)
```

METODO BASE

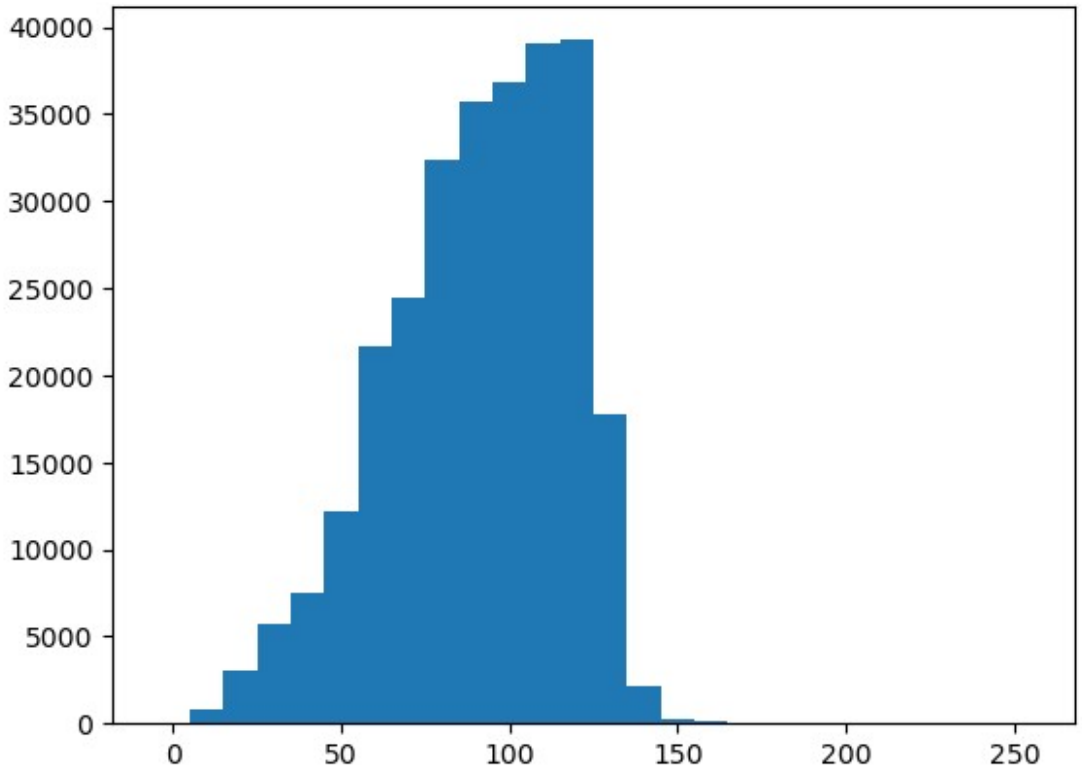
Obtenemos el histograma de la zona clara con el fin de obtener su moda

```
a,b = np.histogram(zona_clara,bins=np.arange(0,270,10))
plt.bar( b[0:26],a[0:26],width=10)
moda_zona_clara = b[np.argmax(a)+1]
```



Obtenemos el histograma de la zona oscura con el fin de obtener su moda

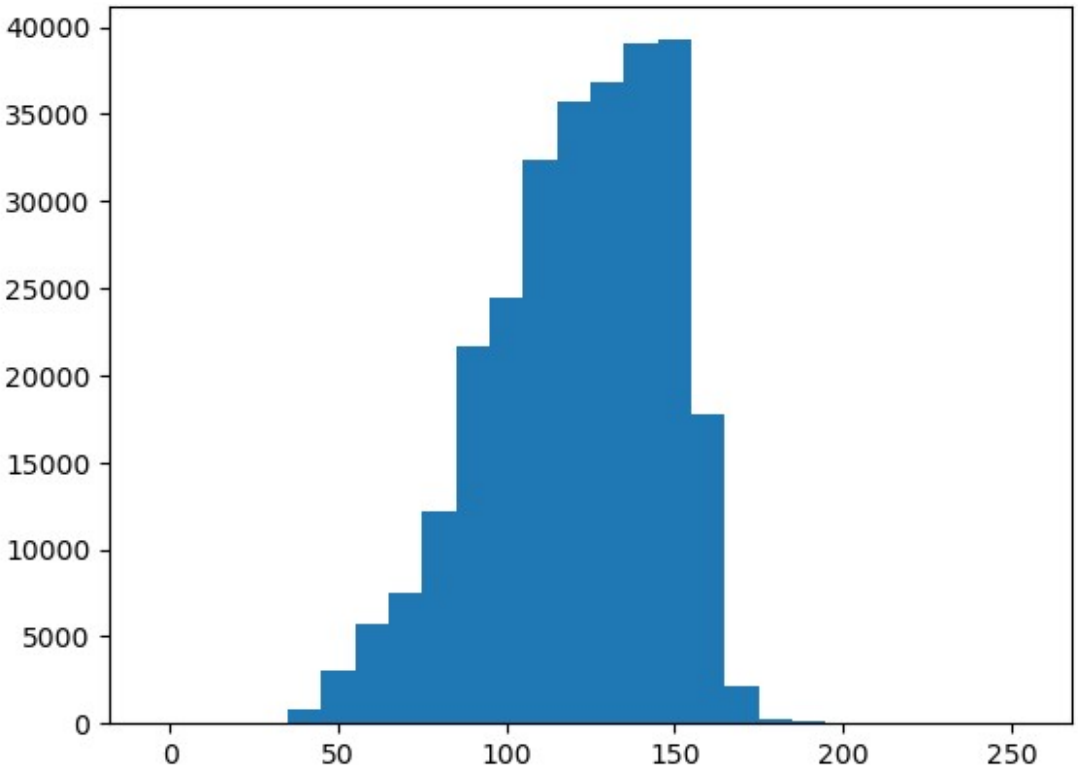
```
a,b = np.histogram(zona_oscura,bins=np.arange(0,270,10))
plt.bar( b[0:26],a[0:26],width=10)
moda_zona_oscura = b[np.argmax(a)+1]
```



Modificamos el histograma de la zona oscura con el fin de igualar la moda de ambas zonas

```
osc = np.copy(zona_oscura) + ( -moda_zona_oscura + moda_zona_clara)
#osc = zona_oscura
lessThen0 = osc<0
moreThen255 = osc>255
osc[lessThen0] = 0
osc[moreThen255] = 255
#imprimir_pic(osc,"osc")
a,b = np.histogram(osc,bins=np.arange(0,270,10))
plt.bar( b[0:26],a[0:26],width=10)
#moda_zona_oscura = b[np.argmax(a)+1]
```

```
<BarContainer object of 26 artists>
```

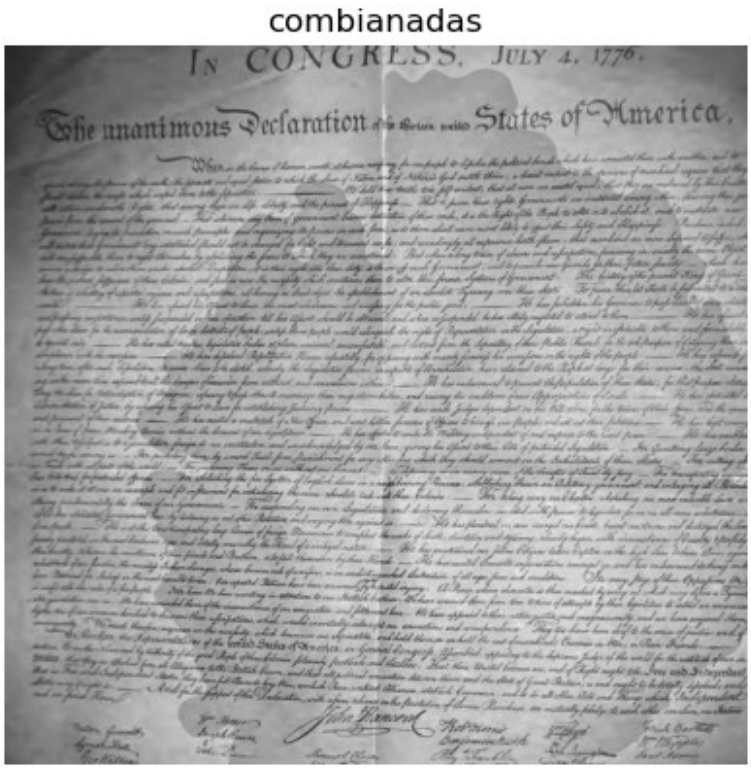



```
imprimir_pic(osc,"Zona oscura con histograma modificado")
```

```
imprimir_pic(zona_clara,"zona_clara")
```

Combinamos ambas zonas: la zona clara y la zona oscura modificada

```
z1 =  np.nan_to_num(zona_clara,0)
z2 = np.nan_to_num(osc,0)

suma_parcial = (z1 + z2)
imprimir_pic(suma_parcial,"combianadas")
```

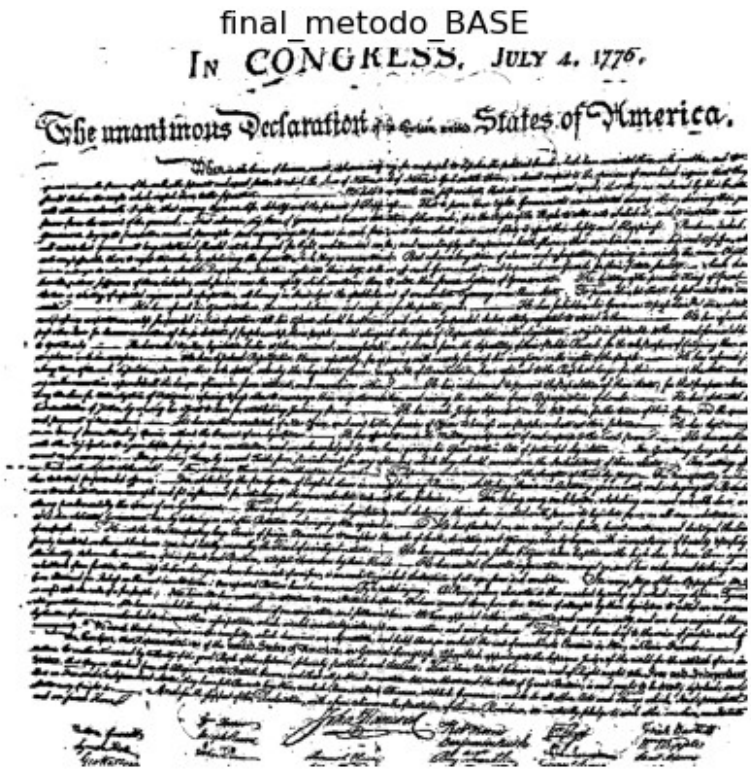


Restamos las mascara (en tonos de gris) de la imagen original

```
resta_parcial = np.copy(suma_parcial)

mask_gris = ndimage.median_filter(suma_parcial,
size=15,mode='reflect')


resta_parcial = ((suma_parcial - mask_gris)+255)/(2)
lessThen0 = resta_parcial<0
moreThen255 = resta_parcial>255
resta_parcial[lessThen0] = 0
resta_parcial[moreThen255] = 255


imprimir_pic(resta_parcial,"resta")
```

Aplicamos un contraste optmizado por MSE a la imagen de "resta parcial"

```
p_indicado = contraste_optimo_por_MSE(255 - resta_parcial,255 -
input_pic)
final_metodo_BASE = funcion_de_contraste(resta_parcial,p_indicado)
imprimir_pic(final_metodo_BASE,"final_metodo_BASE")
```



METODO B

```
# Importar las librearias necesarias:

import matplotlib.pyplot as plt
from PIL import Image
import scipy.ndimage as snd
import numpy as np
import cv2
from skimage.filters import threshold_otsu
from cv2 import threshold, adaptiveThreshold

# Declarar metodos para aplicar Clausura y Threshold:

def closing(image_array):

  # Estructurar elemento de clausura:
  huella = np.ones((40, 40))
  # Aplicar clausura de grises:
  fondo = snd.grey_closing(image_array, footprint=huella)
  # Se resta el fondo de la imagen:
  fondo_libre = (image_array.astype(np.float64) -
fondo.astype(np.float64))
  # Se reescala la imagen con el fondo libre de 0 a 255:
  denominador = (fondo_libre.max() - fondo_libre.min())
```

```
  fondo_libre_normalizado = (fondo_libre - fondo_libre.min())*
255/denominador
  # Convertir fondo_libre_normalizado a uint8:
  fondo_libre_normalizado = fondo_libre_normalizado.astype(np.uint8)
  # Convertir fondo_libre_normalizado a imagen:
  fondo_libre_normalizado = Image.fromarray(fondo_libre_normalizado)
  return fondo_libre_normalizado


def threshold(image_array):
  th = cv2.adaptiveThreshold(np.asarray(image_array),
    255,  # Maximo valor assignado al valor de un pixel que excede el
'threshold'.
    cv2.ADAPTIVE_THRESH_MEAN_C,  # suma ponderada "gaussiana" de los
vecinos.
    cv2.THRESH_BINARY,  # Tipo de threshold.
    15,  # Tamaño del bloque (ventana 5x5)
    12)

  # Convertir th a imagen:
  th = Image.fromarray(th)

  return th

# Importar imagen:
input_image = input_pic
# Convertir la imagen en arreglo:
image_array = np.asarray(input_image)
# Aplicar Clausura:
closing_image = closing(image_array)
# Aplicar Threshold:
threshold_image = threshold(closing_image)

input_image

array([[18, 18, 18, ..., 54, 53, 53],
       [16, 17, 17, ..., 54, 54, 54],
       [16, 16, 17, ..., 56, 56, 56],
       ...,
       [53, 52, 52, ..., 75, 75, 74],
       [53, 52, 52, ..., 74, 74, 74],
       [52, 52, 51, ..., 74, 74, 74]], dtype=uint8)

closing_image
```


IN CONGRESS, JULY 4, 1776.

The unanimous Declaration of the thirteen united States of America.

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to

We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator

That to secure these rights, Governments are instituted among Men, deriving their

that among these are Life, Liberty and the pursuit of Happiness.—

whenever any form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute

Prudence, indeed,

and accordingly all experience hath shewn, that mankind are more disposed to suffer,

But when a long train of abuses and usurpations, pursuing invariably the same Object

it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security.— Such

The history of the present King of Great

He has refused his Assent to Laws, the most wholesome and necessary for the public good.— He has forbidden his Governors to pass Laws of immediate

He has refused for

He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them

He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people.— He has refused

He has endeavoured to prevent the population of these States; for that purpose obstructing

He has made Judges dependent on his Will alone, for the tenure of their offices, and the

He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our People, and eat out their substance.— He has kept among

He has affected to render the Military independent of and superior to the Civil power.— He has combined

For quartering large bodies

For cutting off

For depriving us in many cases of the benefits of Trial by jury.— For transporting us

For abolishing the free System of English laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries

For taking away our Charters, abolishing our most valuable Laws, and

For suspending our own Legislatures, and declaring themselves invested with power to legislate for us in all cases whatsoever.

He has abdicated Government here, by declaring us out of his Protection and waging War against us.— He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives

He is at this time transporting large Armies of foreign Mercenaries to compleat the works of death, desolation and tyranny, already begun with circumstances of cruelty & perfidy

He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against

He has excited domestic insurrections amongst us, and has endeavoured to bring

In every stage of these Oppressions We

Our repeated Petitions have been answered only by repeated injury. A Prince, whose character is thus marked by every act which may define a Tyrant,

We have

We have warned them from time to time of attempts by their Legislature to extend an unwarrantable

We have appealed to their native justice and magnanimity, and we have conjured them,

We must, therefore, acquiesce in the necessity, which denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends.—

We, therefore, the Representatives of the united States of America, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our

Solemnly

That these United Colonies are, and of Right ought to be Free and Independent

that they are Absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved; and

that as Free and Independent States, they have full Power to

And for the support of this Declaration, with a firm reliance on the protection of divine Providence, we mutually pledge to each other our lives, our Fortunes

John Hancock

Josiah Bartlett
Wm Whipple
Saml Adams

threshold_image

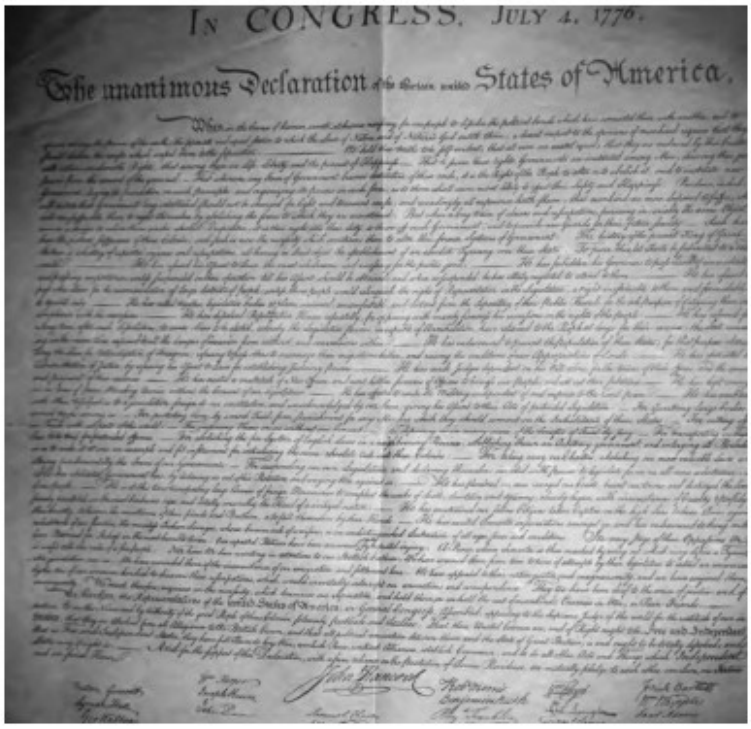
METODO A

```
mask = dilation(image=mask, selem=disk(40))

imprimir_pic(mask,'Máscara')
imprimir_pic(input_pic,'original')
```

```
/tmp/ipykernel_12094/2346952556.py:1: FutureWarning: `selem` is a
deprecated argument name for `dilation`. It will be removed in version
1.0. Please use `footprint` instead.
  mask = dilation(image=mask, selem=disk(40))
```

Máscara

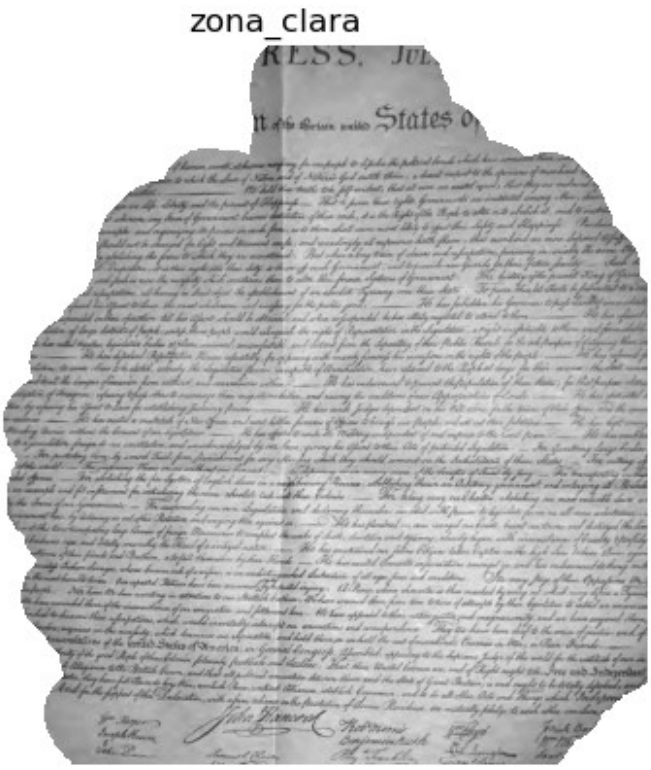
original



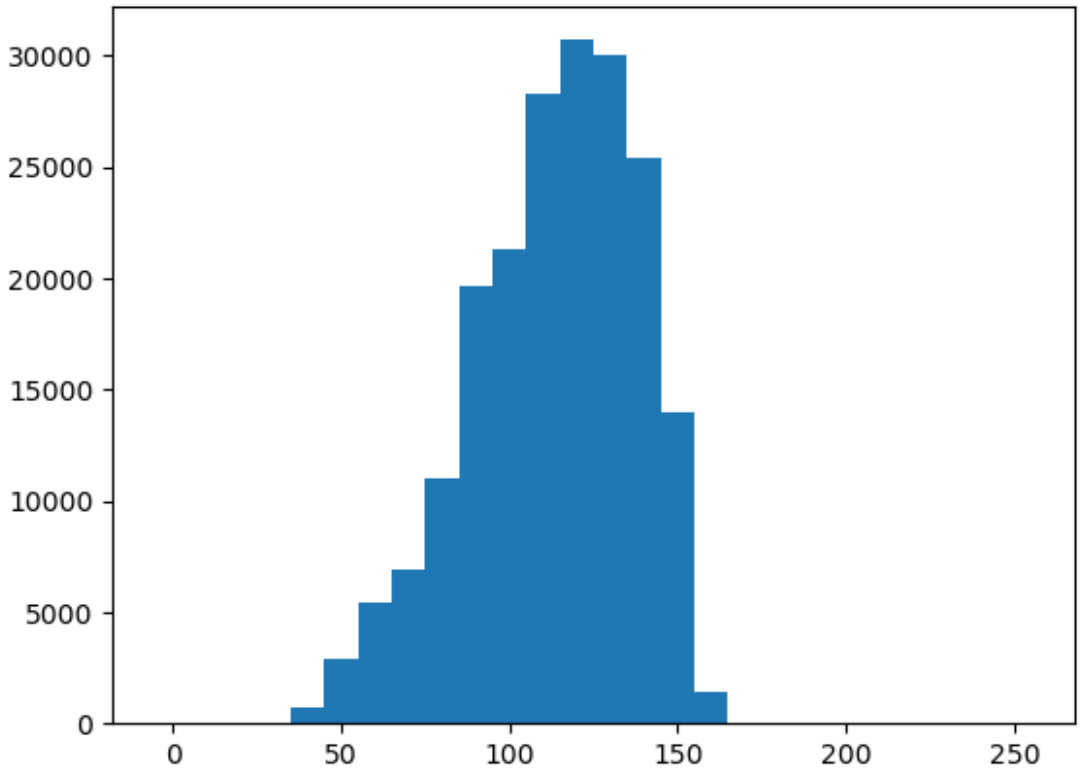

```
zona_oscura = np.full(input_pic.shape,np.nan)
limite = np.nanmean(input_pic)
```

```
for (coor_y,coor_x), value in np.ndenumerate(input_pic):
    aux = mask[coor_y:coor_y+1,coor_x:coor_x+1]
    if aux<limite: #Good Pixel
        zona_oscura[coor_y,coor_x] =  input_pic[coor_y,coor_x]
    elif aux>limite: #Bad Pixel
        None
imprimir_pic(zona_oscura,"zona_oscura")
```

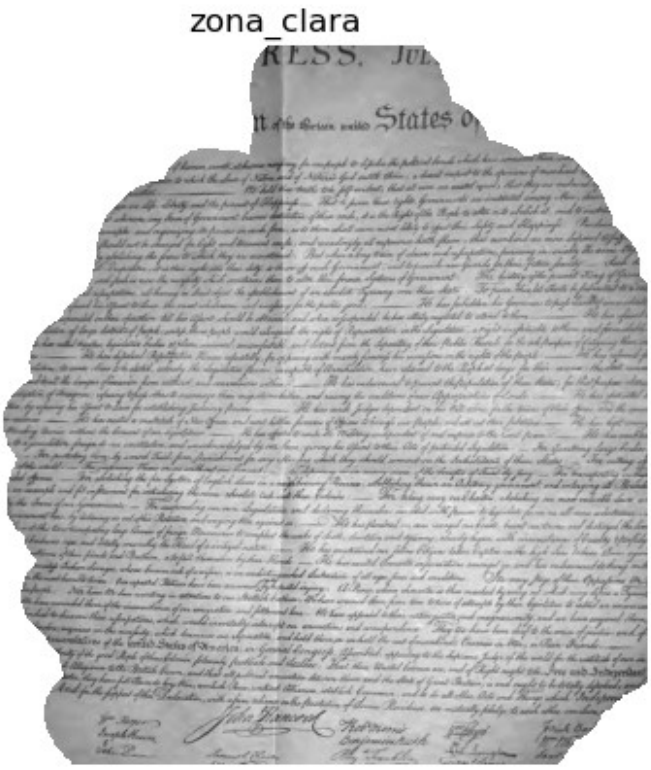

```
zona_clara = np.full(input_pic.shape,np.nan)
limite = np.nanmean(input_pic)

for (coor_y,coor_x), value in np.ndenumerate(input_pic):
    aux = mask[coor_y:coor_y+1,coor_x:coor_x+1]
    if aux>limite: #Good Pixel
        zona_clara[coor_y,coor_x] =  input_pic[coor_y,coor_x]
    elif aux<=limite: #Bad Pixel
        None

imprimir_pic(zona_clara,"zona_clara")
```




```
#a,b = np.histogram(zona_clara,bins=np.arange(0,270,10))
#plt.bar( b[0:26],a[0:26],width=10)
#moda_zona_clara = b[np.argmax(a)+1]
#
#a,b = np.histogram(zona_oscura,bins=np.arange(0,270,10))
#plt.bar( b[0:26],a[0:26],width=10)
#moda_zona_oscura = b[np.argmax(a)+1]

osc = np.copy(zona_oscura) + ( -moda_zona_oscura + moda_zona_clara)
#osc = zona_oscura
lessThen0 = osc<0
moreThen255 = osc>255
osc[lessThen0] = 0
osc[moreThen255] = 255
#imprimir_pic(osc,"osc")
a,b = np.histogram(osc,bins=np.arange(0,270,10))
plt.bar( b[0:26],a[0:26],width=10)
#moda_zona_oscura = b[np.argmax(a)+1]
imprimir_pic(osc,"Zona oscura con histograma modificado")
imprimir_pic(zona_clara,"zona_clara")
```

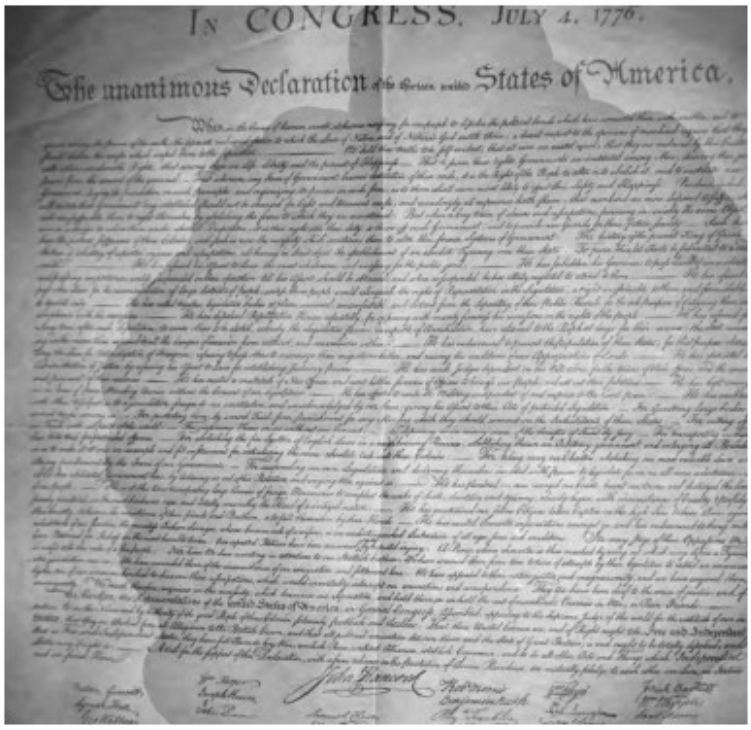


Zona oscura con histograma modificado




```
z1 =  np.nan_to_num(zona_clara,0)
z2 = np.nan_to_num(osc,0)

suma_parcial = (z1 + z2)
imprimir_pic(suma_parcial,"combianadas")
```

combianadas



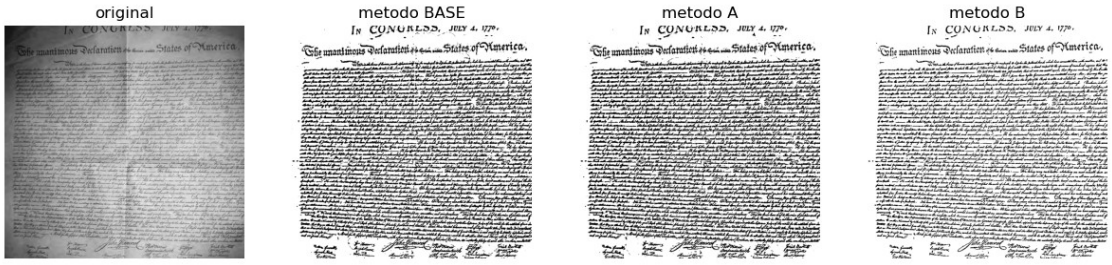

```
resta_parcial = np.copy(suma_parcial)

mask_gris = ndimage.median_filter(suma_parcial,
size=15,mode='reflect')


resta_parcial = ((suma_parcial - mask_gris)+255)/(2)
lessThen0 = resta_parcial<0
moreThen255 = resta_parcial>255
resta_parcial[lessThen0] = 0
resta_parcial[moreThen255] = 255


imprimir_pic(resta_parcial,"resta")
p_indicado = contraste_optimo_por_MSE(255 - resta_parcial,255 -
input_pic)
final_metodo_A = funcion_de_contraste(resta_parcial,p_indicado)
imprimir_pic(final_metodo_A,"final_metodo_A")
```

resta

final_metodo_A


```
plt.figure(figsize=(15,12))
plt.subplot(1,4, 1)
```

```
plt.imshow(input_pic, cmap = 'gray')
plt.title('original')
plt.axis('off')

plt.subplot(1,4, 2)
plt.imshow(final_metodo_BASE, cmap = 'gray')
plt.axis('off')
plt.title('metodo BASE')



plt.subplot(1,4, 3)
plt.imshow(final_metodo_A, cmap = 'gray')
plt.axis('off')
plt.title('metodo A')

plt.subplot(1,4, 4)
plt.imshow(threshold_image, cmap = 'gray')
plt.axis('off')
plt.title('metodo B')
plt.show()
```



Guardamos el mejor resultado como archivo jpeg

```
type(threshold_image)
```

```
PIL.Image.Image
```

```
nombre = imagen_entrada + "_PROCESADA.jpeg"

threshold_image.save(nombre)
```