Trabalho2

September 30, 2019

0.1 Dependencias do Projeto

0.2 Imports

[87]:
```
import cv2
import numpy as np
from math import exp
from timeit import default_timer
import matplotlib.pyplot as plt
from skimage.util.shape import view_as_windows
```

0.3 Leitura da Imagem Base em formato PGM

[97]:
```
img = cv2.imread('/home/andressa/Documentos/mestrado/pythreshold/pythreshold/
 ↪imagens/baboon.pgm',0)
#orig = img.copy()
```

0.4 FUNÇÃO (apply_threshold)

0.4.1 Função que obtem uma imagem binária com base em um determinado limite global ou um conjunto de limites locais.

Parametros passados para a Função: **1. img**: A imagem de entrada no formato .pgm * type(img): ndarray

2. threshold: Os limites globais ou locais correspondentes para cada pixel da imagem. Por padrão seu valor é 128. * type(threshold): Union[int, ndarray]

3. wp_val: O valor atribuído aos pixels do foreground(pixels brancos). 0 Equivale aos Pixels Pretos e 255 aos Pixels brancos. * type(wp_val): int

4. neighbor: Valor default da vizinhança.

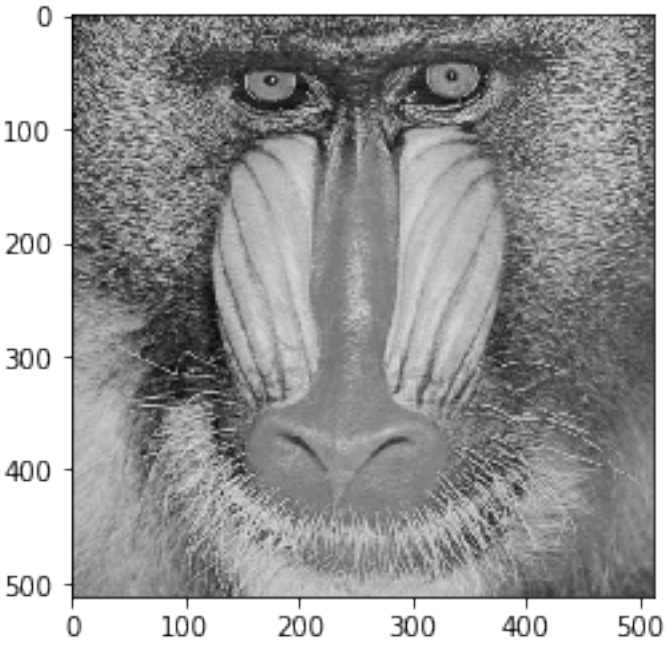
5. return da função: Uma imagem binária. * return type: ndarray

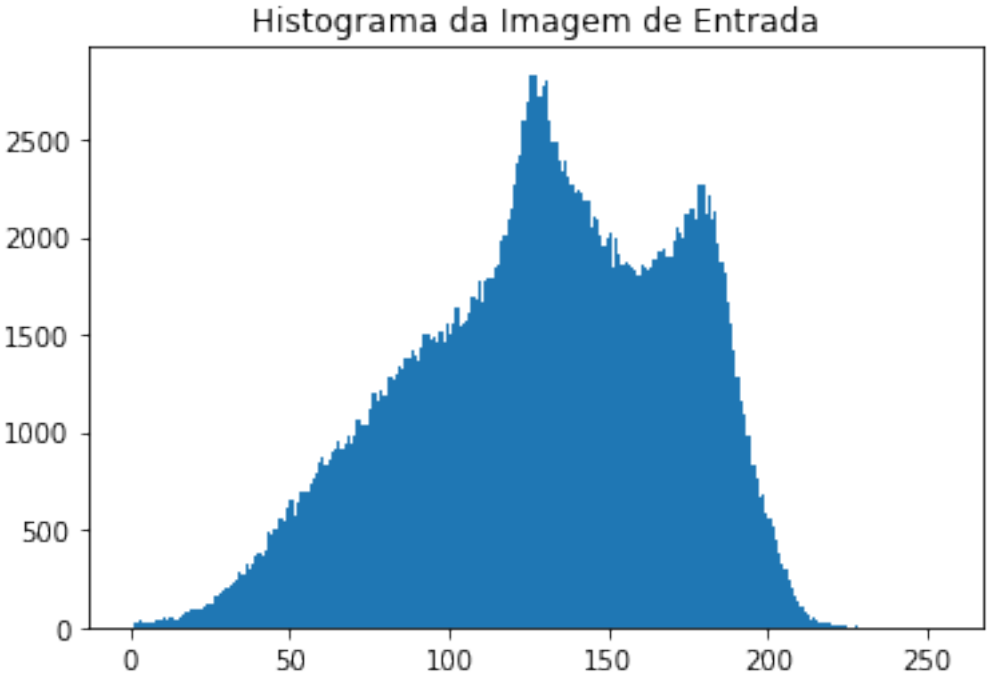
[89]:
```
def apply_threshold(img, threshold=128, wp_val=255, neighbor=9):
    return ((img >= threshold) * wp_val).astype(np.uint8)
```

[90]:
```
# Loading image if needed
if img is None:
    img = face(gray=True)

# Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting test image histogram
plt.figure('Histograma')
plt.title('Histograma da Imagem de Entrada')
plt.hist(img.ravel(), range=(0, 255), bins=255)
```

[90]:
```
(array([4.000e+00, 1.800e+01, 2.900e+01, 3.300e+01, 3.000e+01, 2.900e+01,
        2.800e+01, 2.700e+01, 3.700e+01, 3.400e+01, 5.400e+01, 3.800e+01,
        4.700e+01, 4.600e+01, 4.200e+01, 5.100e+01, 7.100e+01, 8.000e+01,
        8.500e+01, 8.800e+01, 9.200e+01, 9.700e+01, 9.100e+01, 1.010e+02,
        1.180e+02, 1.190e+02, 1.560e+02, 1.550e+02, 1.760e+02, 1.950e+02,
        1.980e+02, 2.100e+02, 2.350e+02, 2.440e+02, 2.830e+02, 2.730e+02,
        3.260e+02, 3.030e+02, 3.290e+02, 3.650e+02, 3.790e+02, 3.660e+02,
        3.890e+02, 4.880e+02, 4.760e+02, 4.970e+02, 5.570e+02, 5.530e+02,
        5.490e+02, 6.190e+02, 6.600e+02, 5.730e+02, 6.460e+02, 6.960e+02,
        6.920e+02, 6.940e+02, 7.350e+02, 7.690e+02, 7.910e+02, 8.420e+02,
        8.720e+02, 8.340e+02, 8.650e+02, 8.930e+02, 9.190e+02, 9.600e+02,
        9.180e+02, 9.460e+02, 9.850e+02, 9.370e+02, 9.830e+02, 1.070e+03,
        1.034e+03, 1.038e+03, 1.037e+03, 1.115e+03, 1.194e+03, 1.155e+03,
        1.211e+03, 1.188e+03, 1.191e+03, 1.288e+03, 1.265e+03, 1.294e+03,
        1.333e+03, 1.322e+03, 1.383e+03, 1.375e+03, 1.418e+03, 1.397e+03,
        1.363e+03, 1.426e+03, 1.501e+03, 1.504e+03, 1.479e+03, 1.491e+03,
        1.465e+03, 1.518e+03, 1.458e+03, 1.560e+03, 1.506e+03, 1.559e+03,
        1.644e+03, 1.546e+03, 1.550e+03, 1.572e+03, 1.610e+03, 1.694e+03,
        1.678e+03, 1.774e+03, 1.667e+03, 1.768e+03, 1.786e+03, 1.790e+03,
        1.837e+03, 1.859e+03, 1.986e+03, 2.003e+03, 2.095e+03, 2.146e+03,
        2.264e+03, 2.370e+03, 2.418e+03, 2.592e+03, 2.697e+03, 2.823e+03,
        2.831e+03, 2.821e+03, 2.716e+03, 2.772e+03, 2.795e+03, 2.601e+03,
        2.492e+03, 2.482e+03, 2.395e+03, 2.335e+03, 2.387e+03, 2.312e+03,
        2.262e+03, 2.229e+03, 2.244e+03, 2.220e+03, 2.187e+03, 2.191e+03,
        2.044e+03, 2.109e+03, 2.095e+03, 2.002e+03, 1.947e+03, 1.990e+03,
        2.014e+03, 1.836e+03, 1.998e+03, 1.908e+03, 1.860e+03, 1.873e+03,
        1.857e+03, 1.846e+03, 1.834e+03, 1.798e+03, 1.863e+03, 1.846e+03,
        1.832e+03, 1.839e+03, 1.888e+03, 1.924e+03, 1.931e+03, 1.943e+03,
        1.892e+03, 1.896e+03, 1.982e+03, 2.048e+03, 2.024e+03, 1.999e+03,
        2.118e+03, 2.144e+03, 2.141e+03, 2.090e+03, 2.261e+03, 2.267e+03,
        2.122e+03, 2.207e+03, 2.088e+03, 2.136e+03, 1.963e+03, 1.871e+03,
```

```
       1.809e+03, 1.664e+03, 1.557e+03, 1.415e+03, 1.288e+03, 1.159e+03,
       1.090e+03, 9.850e+02, 9.800e+02, 8.260e+02, 7.650e+02, 6.630e+02,
       6.780e+02, 5.860e+02, 5.520e+02, 5.130e+02, 4.460e+02, 3.800e+02,
       3.240e+02, 3.030e+02, 2.410e+02, 1.980e+02, 1.550e+02, 1.330e+02,
       1.010e+02, 7.700e+01, 6.300e+01, 4.000e+01, 5.700e+01, 3.300e+01,
       1.900e+01, 2.200e+01, 2.100e+01, 1.900e+01, 9.000e+00, 8.000e+00,
       9.000e+00, 6.000e+00, 6.000e+00, 4.000e+00, 1.000e+00, 6.000e+00,
       2.000e+00, 1.000e+00, 0.000e+00, 1.000e+00, 2.000e+00, 0.000e+00,
       0.000e+00, 0.000e+00, 0.000e+00, 1.000e+00, 0.000e+00, 0.000e+00,
       0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
       0.000e+00, 0.000e+00, 1.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
       0.000e+00, 0.000e+00, 0.000e+00]),
array([  0.,   1.,   2.,   3.,   4.,   5.,   6.,   7.,   8.,   9.,  10.,
        11.,  12.,  13.,  14.,  15.,  16.,  17.,  18.,  19.,  20.,  21.,
        22.,  23.,  24.,  25.,  26.,  27.,  28.,  29.,  30.,  31.,  32.,
        33.,  34.,  35.,  36.,  37.,  38.,  39.,  40.,  41.,  42.,  43.,
        44.,  45.,  46.,  47.,  48.,  49.,  50.,  51.,  52.,  53.,  54.,
        55.,  56.,  57.,  58.,  59.,  60.,  61.,  62.,  63.,  64.,  65.,
        66.,  67.,  68.,  69.,  70.,  71.,  72.,  73.,  74.,  75.,  76.,
        77.,  78.,  79.,  80.,  81.,  82.,  83.,  84.,  85.,  86.,  87.,
        88.,  89.,  90.,  91.,  92.,  93.,  94.,  95.,  96.,  97.,  98.,
        99., 100., 101., 102., 103., 104., 105., 106., 107., 108., 109.,
       110., 111., 112., 113., 114., 115., 116., 117., 118., 119., 120.,
       121., 122., 123., 124., 125., 126., 127., 128., 129., 130., 131.,
       132., 133., 134., 135., 136., 137., 138., 139., 140., 141., 142.,
       143., 144., 145., 146., 147., 148., 149., 150., 151., 152., 153.,
       154., 155., 156., 157., 158., 159., 160., 161., 162., 163., 164.,
       165., 166., 167., 168., 169., 170., 171., 172., 173., 174., 175.,
       176., 177., 178., 179., 180., 181., 182., 183., 184., 185., 186.,
       187., 188., 189., 190., 191., 192., 193., 194., 195., 196., 197.,
       198., 199., 200., 201., 202., 203., 204., 205., 206., 207., 208.,
       209., 210., 211., 212., 213., 214., 215., 216., 217., 218., 219.,
       220., 221., 222., 223., 224., 225., 226., 227., 228., 229., 230.,
       231., 232., 233., 234., 235., 236., 237., 238., 239., 240., 241.,
       242., 243., 244., 245., 246., 247., 248., 249., 250., 251., 252.,
       253., 254., 255.]),
<a list of 255 Patch objects>)
```


0
100
200
300
400
500
0
100
200
300
400
500


Histograma da Imagem de Entrada
2500
2000
1500
1000
500
0
0
50
100
150
200
250

0.5 FUNÇÃO (otsu):

0.5.1 Metodo Global Otsu

1. **@param1 image:** Imagem de Entrada

   `@type image: ndarray`

2. **@param2 hist:** Histograma da Imagem

   `@type hist: ndarray`

3. **@return:** Threshold de Otsu

   `@rtype: int`

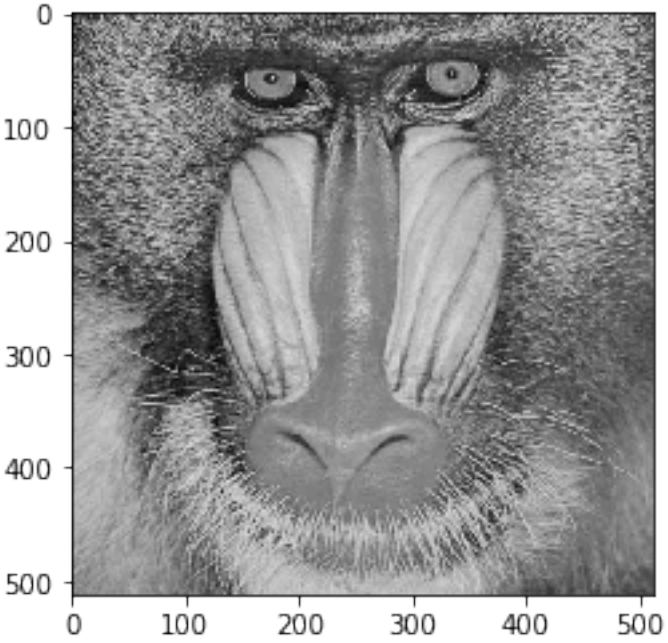
[91]:
```
def otsu_threshold(image=None, hist=None):

    if image is None and hist is None:
        raise ValueError('You must pass as a parameter either'
                         'the input image or its histogram')

    # Calculating histogram
    if not hist:
        hist = np.histogram(image, bins=range(256))[0].astype(np.float)

    cdf_backg = np.cumsum(np.arange(len(hist)) * hist)
    w_backg = np.cumsum(hist)  # The number of background pixels
    w_backg[w_backg == 0] = 1  # To avoid divisions by zero
    m_backg = cdf_backg / w_backg  # The means

    cdf_foreg = cdf_backg[-1] - cdf_backg
    w_foreg = w_backg[-1] - w_backg  # The number of foreground pixels
    w_foreg[w_foreg == 0] = 1  # To avoid divisions by zero
    m_foreg = cdf_foreg / w_foreg  # The means

    var_between_classes = w_backg * w_foreg * (m_backg - m_foreg) ** 2

    return np.argmax(var_between_classes)
```

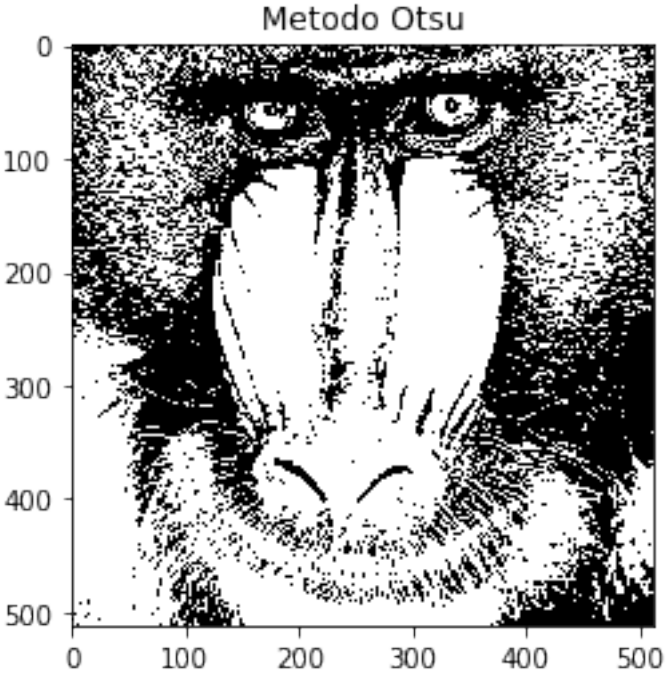
0.5.2 Plot Otsu Method Results

[93]:
```
# Applying Otsu method
start = default_timer()
th = otsu_threshold(img)
stop = default_timer()
print('========Otsuuuu==========')
print('Threshold: {0}'.format(th))
print('Execution time: {0}'.format(stop - start))
```

```
print('====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Otsu method')
plt.title('Metodo Otsu')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Otsuuuu==========
Threshold: 122
Execution time: 0.013375217997236177
====================================
Total de pixels:  262144
========================================
Pixels brancos:  0.9999847412109375
========================================
Pixels pretos:  1.52587890625e-05
```


0
100
200
300
400
500
0
100
200
300
400
500


Metodo Otsu
0
100
200
300
400
500
0
100
200
300
400
500

0.5.3 FUNÇÃO (sauvola_threshold):

1. **@param1 img:** Imagem de Entrada

   @type img: ndarray

2. **@param2 w_size:** O tamanho da janela local para calcular cada limite de pixels. Deve ser um valor ímpar. Em suma será o kernel;

   @type w_size: int

3. **@param3 k:** Controla o valor do limite local. Está no intervalo [0,2, 0,5] ...

   @type k: float

4. **@return:** O limite local estimado para cada pixel.

   @rtype: ndarray

[98]:
```
def sauvola_threshold(img, w_size=15, k=0.2):

    # Obtaining rows and cols
    rows, cols = img.shape
    i_rows, i_cols = rows + 1, cols + 1

    # Computing integral images
    # Leaving first row and column in zero for convenience
    integ = np.zeros((i_rows, i_cols), np.float)
    sqr_integral = np.zeros((i_rows, i_cols), np.float)

    integ[1:, 1:] = np.cumsum(np.cumsum(img.astype(np.float), axis=0), axis=1)
    sqr_img = np.square(img.astype(np.float))
    sqr_integral[1:, 1:] = np.cumsum(np.cumsum(sqr_img, axis=0), axis=1)

    # Defining grid
    x, y = np.meshgrid(np.arange(1, i_cols), np.arange(1, i_rows))

    # Obtaining local coordinates
    hw_size = w_size // 2
    x1 = (x - hw_size).clip(1, cols)
    x2 = (x + hw_size).clip(1, cols)
    y1 = (y - hw_size).clip(1, rows)
    y2 = (y + hw_size).clip(1, rows)

    # Obtaining local areas size
    l_size = (y2 - y1 + 1) * (x2 - x1 + 1)

    # Computing sums
    sums = (integ[y2, x2] - integ[y2, x1 - 1] -
            integ[y1 - 1, x2] + integ[y1 - 1, x1 - 1])
    sqr_sums = (sqr_integral[y2, x2] - sqr_integral[y2, x1 - 1] -
```

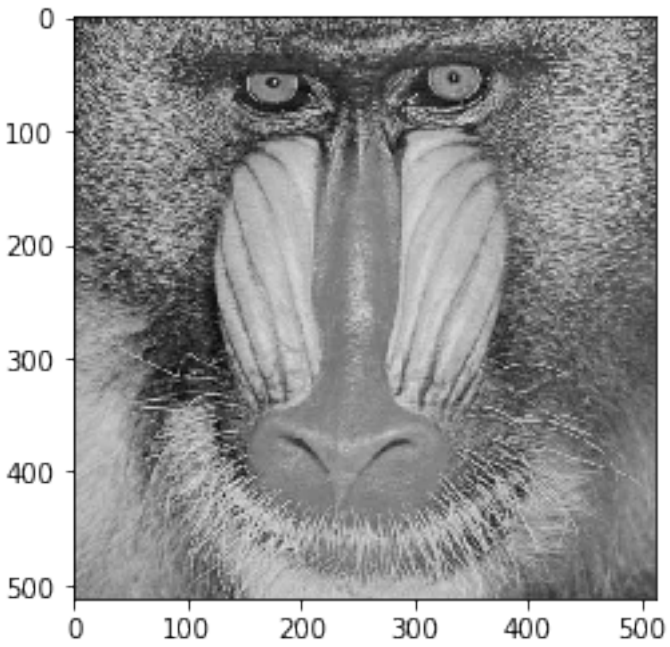
```
                sqr_integral[y1 - 1, x2] + sqr_integral[y1 - 1, x1 - 1])

    # Computing local means
    means = sums / l_size

    # Computing local standard deviation
    stds = np.sqrt(sqr_sums / l_size - np.square(means))

    # Computing thresholds
    thresholds = means * (1.0 + k * (stds / 128 - 1.0))

    return thresholds
```

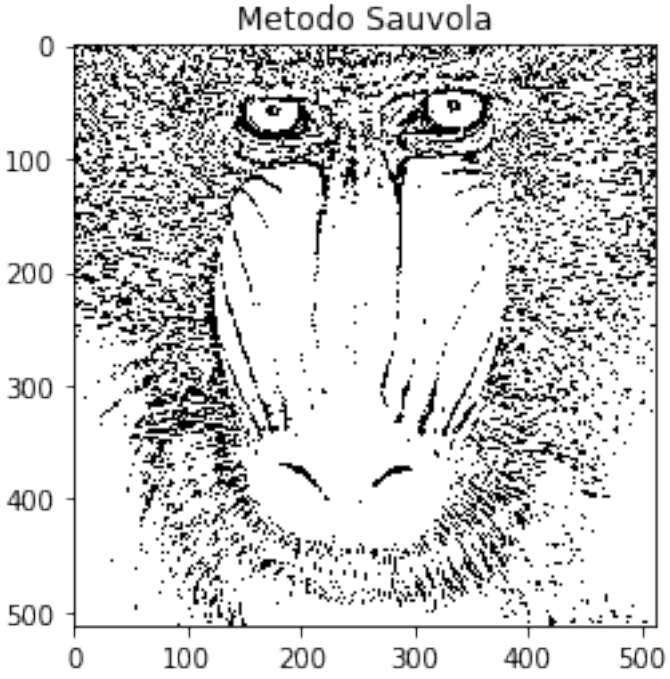
0.5.4 Plot Sauvola Method Results

[108]:
```
# Applying local Sauvola method
start = default_timer()
th = sauvola_threshold(img)
stop = default_timer()
print('========Local Sauvola==========')
print('Execution time: {0}'.format(stop - start))
print('====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local Sauvola method')
plt.title('Metodo Sauvola')
plt.imshow(apply_threshold(img, th), cmap='gray')
plt.show()

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local Sauvola==========
```

```
Execution time: 0.05292540698428638
====================================
```





```
Total de pixels:  262144
========================================
Pixels brancos:  0.9999847412109375
========================================
Pixels pretos:  1.52587890625e-05
```

0.6 FUNÇÃO (niblack_threshold):

1. **@param1 img:** Imagem de Entrada.

   `@type img: ndarray`

2. **@param2 w_size:** O tamanho da janela local para calcular cada limite de pixels. Deve ser valor ímpar.

   `@type w_size: int`

3. **@param3 k:** Controla o valor do limite local. Deve estar no intervalo [-0,2, -0,1].

   `@type k: float`

4. **@return:** O limite local estimado para cada pixel.

   `@rtype: ndarray`

[109]:
```python
def niblack_threshold(img, w_size=15, k=-0.2):
    # Obtaining rows and cols
    rows, cols = img.shape
    i_rows, i_cols = rows + 1, cols + 1

    # Computing integral images
    # Leaving first row and column in zero for convenience
    integ = np.zeros((i_rows, i_cols), np.float)
    sqr_integral = np.zeros((i_rows, i_cols), np.float)

    integ[1:, 1:] = np.cumsum(np.cumsum(img.astype(np.float), axis=0), axis=1)
    sqr_img = np.square(img.astype(np.float))
    sqr_integral[1:, 1:] = np.cumsum(np.cumsum(sqr_img, axis=0), axis=1)

    # Defining grid
    x, y = np.meshgrid(np.arange(1, i_cols), np.arange(1, i_rows))

    # Obtaining local coordinates
    hw_size = w_size // 2
    x1 = (x - hw_size).clip(1, cols)
    x2 = (x + hw_size).clip(1, cols)
    y1 = (y - hw_size).clip(1, rows)
    y2 = (y + hw_size).clip(1, rows)
```

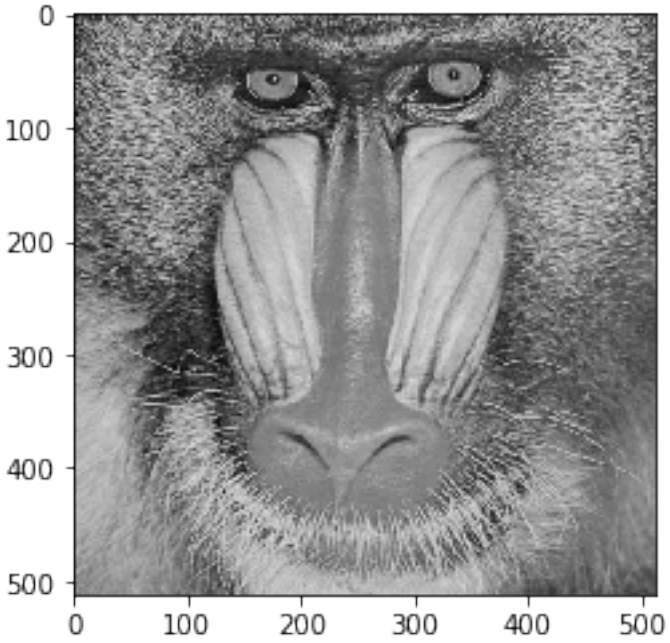
```
    # Obtaining local areas size
    l_size = (y2 - y1 + 1) * (x2 - x1 + 1)

    # Computing sums
    sums = (integ[y2, x2] - integ[y2, x1 - 1] -
            integ[y1 - 1, x2] + integ[y1 - 1, x1 - 1])
    sqr_sums = (sqr_integral[y2, x2] - sqr_integral[y2, x1 - 1] -
                sqr_integral[y1 - 1, x2] + sqr_integral[y1 - 1, x1 - 1])

    # Computing local means
    means = sums / l_size

    # Computing local standard deviation
    stds = np.sqrt(sqr_sums / l_size - np.square(means))

    # Computing thresholds
    thresholds = means + k * stds

    return thresholds
```

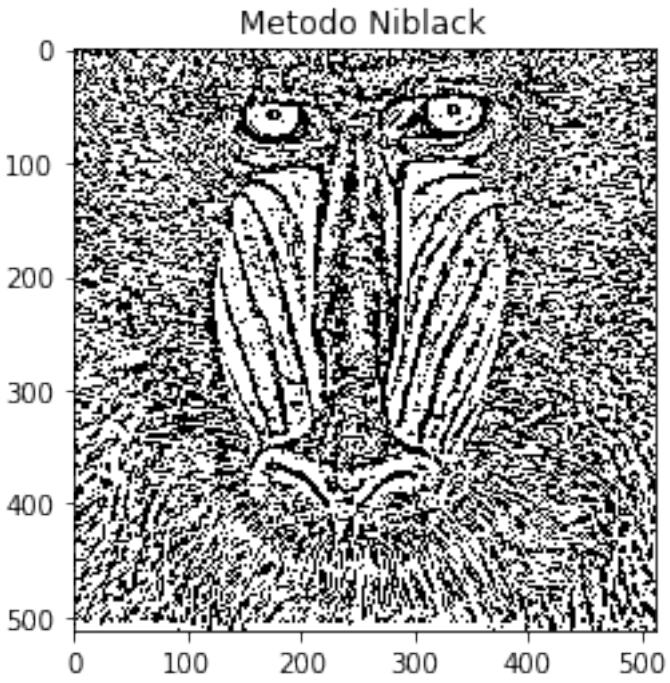
0.6.1 Plot Niblack Method Results

[110]:
```
# Applying local Niblack method
start = default_timer()
th = niblack_threshold(img)
stop = default_timer()
print('========Local Niblack==========')
print('Execution time: {0}'.format(stop - start))
print('==================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local Niblack method')
plt.title('Metodo Niblack')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
```

```
print("Pixels brancos: ", white/total)
print('=========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local Niblack==========
Execution time: 0.05599022001842968
====================================
Total de pixels:  262144
=========================================
Pixels brancos:  0.9999847412109375
=========================================
Pixels pretos:  1.52587890625e-05
```





0.7 FUNÇÃO (lmean_threshold):

1. **@param1 img:** The input image

   `@type img: ndarray`

2. **@param2 w_size:** The size of the local window to compute each pixel threshold. Should be and odd value

   `@type w_size: int`

3. **@return:** The estimated local threshold for each pixel

   `@rtype: ndarray`

[111]:
```
def lmean_threshold(img, w_size=15):
    # Obtaining rows and cols
    rows, cols = img.shape
    i_rows, i_cols = rows + 1, cols + 1

    # Computing integral image
    # Leaving first row and column in zero for convenience
    integ = np.zeros((i_rows, i_cols), np.float)

    integ[1:, 1:] = np.cumsum(np.cumsum(img.astype(np.float), axis=0), axis=1)
```

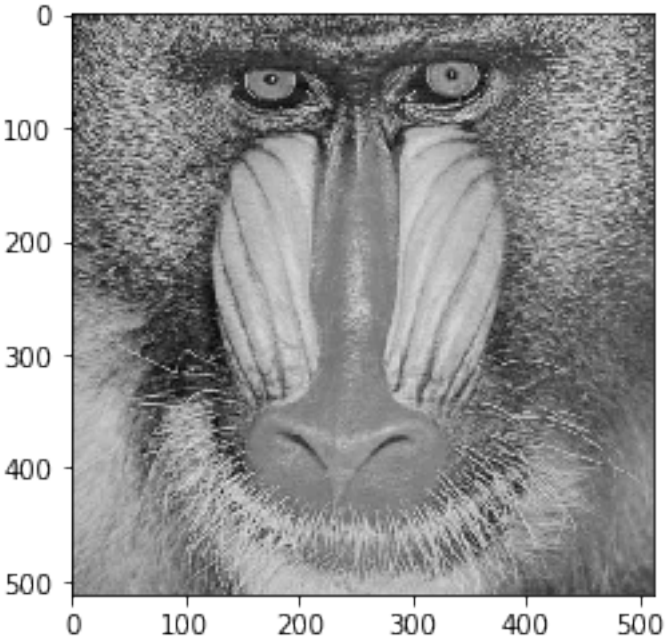
```
    # Defining grid
    x, y = np.meshgrid(np.arange(1, i_cols), np.arange(1, i_rows))

    # Obtaining local coordinates
    hw_size = w_size // 2
    x1 = (x - hw_size).clip(1, cols)
    x2 = (x + hw_size).clip(1, cols)
    y1 = (y - hw_size).clip(1, rows)
    y2 = (y + hw_size).clip(1, rows)

    # Obtaining local areas size
    l_size = (y2 - y1 + 1) * (x2 - x1 + 1)

    # Computing sums
    sums = (integ[y2, x2] - integ[y2, x1 - 1] -
            integ[y1 - 1, x2] + integ[y1 - 1, x1 - 1])

    # Computing local means
    means = sums / l_size

    return means
```

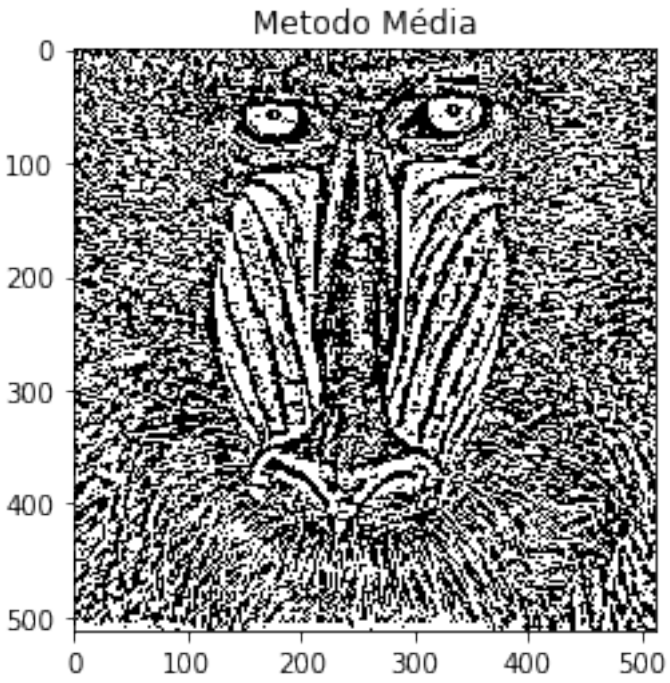
0.7.1 Plot Mean Method Results

[112]:
```
# Applying local mean method
start = default_timer()
th = lmean_threshold(img)
stop = default_timer()
print('========Local mean==========')
print('Execution time: {0}'.format(stop - start))
print('====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local mean method')
plt.title('Metodo Média')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
```

```
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local mean==========
Execution time: 0.02938157698372379
====================================
Total de pixels:  262144
========================================
Pixels brancos:  0.9999847412109375
========================================
Pixels pretos:  1.52587890625e-05
```





0.8 FUNÇÃO (bernsen_threshold):

1. **@param1 img:** The input image. Must be a gray scale image

   `@type img: ndarray`

2. **@param2 w_size:** The size of the local window to compute each pixel threshold. Should be an odd window.

   `@type w_size: int`

3. **@param3 c_thr:** The threshold contrast to determine an homogeneous region

   `@type c_thr: int`

4. **@return:** The estimated local threshold for each pixel

   `@rtype: ndarray`

[113]:
```
def bernsen_threshold(img, w_size=15, c_thr=30):

    thresholds = np.zeros(img.shape, np.uint8)

    # Obtaining windows
    hw_size = w_size // 2
    padded_img = np.ones((img.shape[0] + w_size - 1,
```

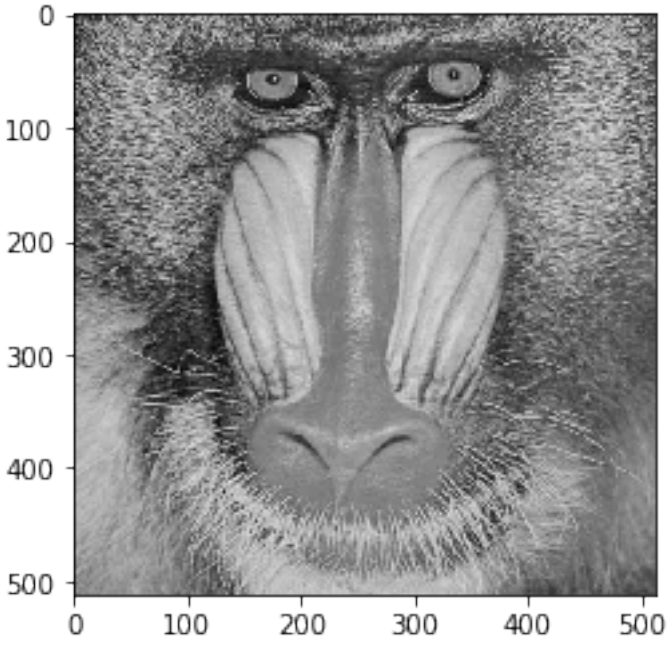
```
                          img.shape[1] + w_size - 1)) * np.nan
    padded_img[hw_size: -hw_size,
               hw_size: -hw_size] = img

    winds = view_as_windows(padded_img, (w_size, w_size))

    mins = np.nanmin(winds, axis=(2, 3))
    maxs = np.nanmax(winds, axis=(2, 3))

    # Calculating contrast and mid values
    contrast = maxs - mins
    mid_vals = (maxs + mins) / 2

    thresholds[contrast <= c_thr] = 128
    thresholds[contrast > c_thr] = mid_vals[contrast > c_thr]

    return thresholds
```

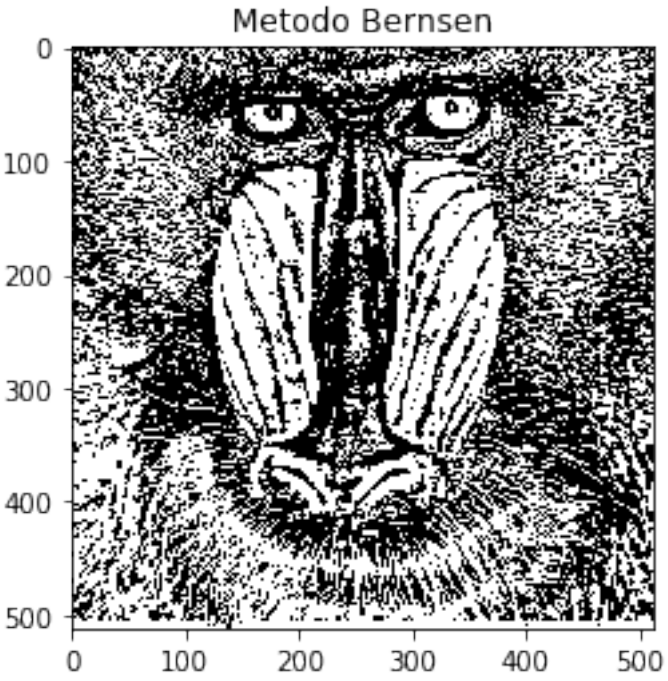
0.8.1 Plot Bernsen Method Results

[114]:
```
# Applying local Bernsen method
start = default_timer()
th = bernsen_threshold(img)
stop = default_timer()
print('========Local Bernsen==========')
print('Execution time: {0}'.format(stop - start))
print('======================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local Bernsen method')
plt.title('Metodo Bernsen')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('========================================')
```

```
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local Bernsen==========
Execution time: 0.27870755598996766
=====================================
Total de pixels:  262144
=========================================
Pixels brancos:  0.9999847412109375
=========================================
Pixels pretos:  1.52587890625e-05
```





0.9 FUNÇÃO (contrast_threshold):

@param1 img: The input image. Must be a gray scale image

`@type img: ndarray`

@param2 w_size: The size of the local window to compute each pixel threshold. Should be an odd window.

`@type w_size: int`

@return: The estimated local threshold for each pixel

`@rtype: ndarray`

[115]:
```
def contrast_threshold(img, w_size=15):

    thresholds = np.zeros(img.shape)

    # Obtaining windows
    hw_size = w_size // 2
    padded_img = np.ones((img.shape[0] + w_size - 1,
                          img.shape[1] + w_size - 1)) * np.nan
    padded_img[hw_size: -hw_size, hw_size: -hw_size] = img
```

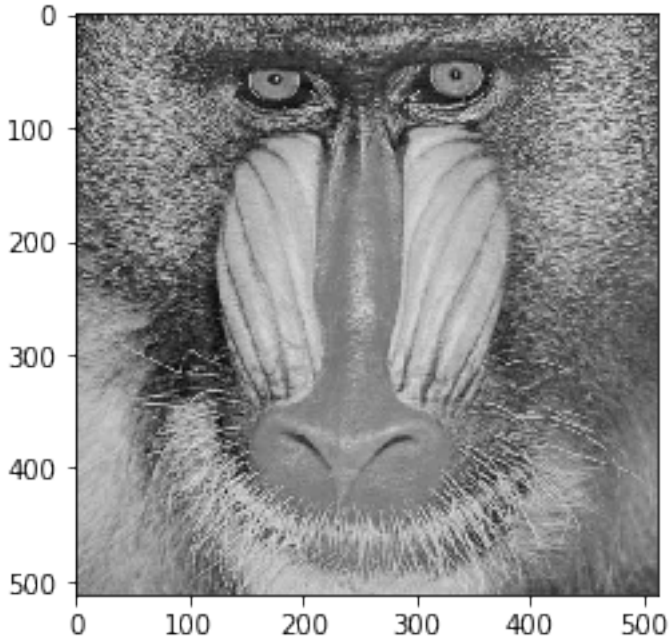
```
    winds = view_as_windows(padded_img, (w_size, w_size))

    # Obtaining maximums and minimums
    mins = np.nanmin(winds, axis=(2, 3))
    maxs = np.nanmax(winds, axis=(2, 3))

    min_dif = img - mins
    max_dif = maxs - img

    thresholds[min_dif <= max_dif] = 256
    thresholds[min_dif > max_dif] = 0

    return thresholds
```

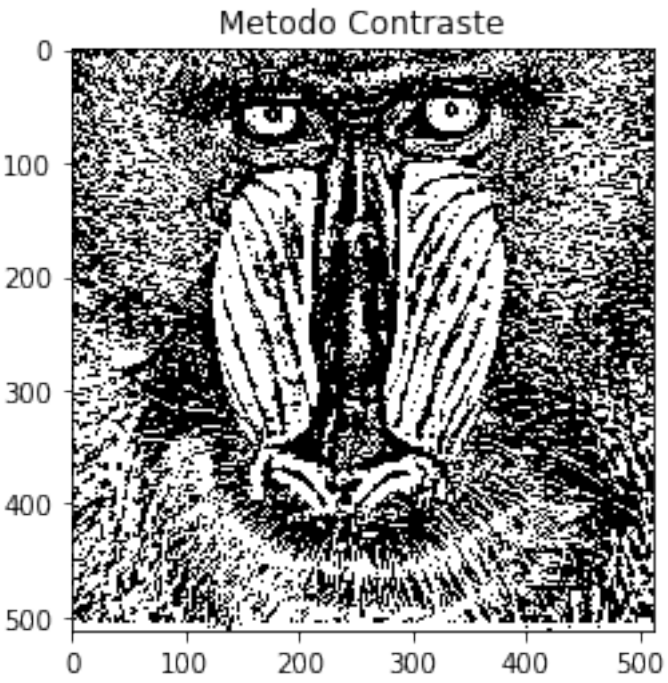
0.10 Plot Contrast Method Result:

[116]:
```
# Applying local contrast method
start = default_timer()
th = contrast_threshold(img)
stop = default_timer()
print('========Local contrast==========')
print('Execution time: {0}'.format(stop - start))
print('=====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local contrast method')
plt.title('Metodo Contraste')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('=========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('=========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local contrast==========
```

```
Execution time: 0.27732080200803466
====================================
Total de pixels:  262144
========================================
Pixels brancos:  0.9999847412109375
========================================
Pixels pretos:  1.52587890625e-05
```





0.10.1 Local thresholding method building on Sauvola/Pietaksinen.

0.10.2 Deals with low contrast images.

0.10.3 k, R, p, q are adjustment parameters. Suggested k=0,25, R=0,5, p=2 and q=10.

0.10.4 R is different from Sauvola because it uses normalized intensity.

0.11 Font: https://imagej.net/Auto_Local_Threshold#Phansalkar

0.12 Função Phansalskar, Sabale e More

Esta é uma modificação do método de limiar de Sauvola para lidar com imagens de baixo contraste.

Phansalskar, N; Mais, S & Sabale, A et al. (2011), " Limiar local adaptativo para detecção de núcleos em imagens citológicas manchadas de diversidade. ", Conferência Internacional sobre Comunicações e Processamento de Sinais (ICCSP) : 218-220, doi: 10.1109 / ICCSP.2011.5739305 Nesse método, o limite t é calculado como:

t = média * (1 + p * exp (-q * média) + k * ((stdev / r) - 1))

onde média e stdev são a média local e o desvio padrão, respectivamente.

Phansalkar recomenda k = 0,25, r = 0,5, p = 2 e q = 10.

k e r são os parâmetros 1 e 2 respectivamente, mas os valores de p e q são fixos.

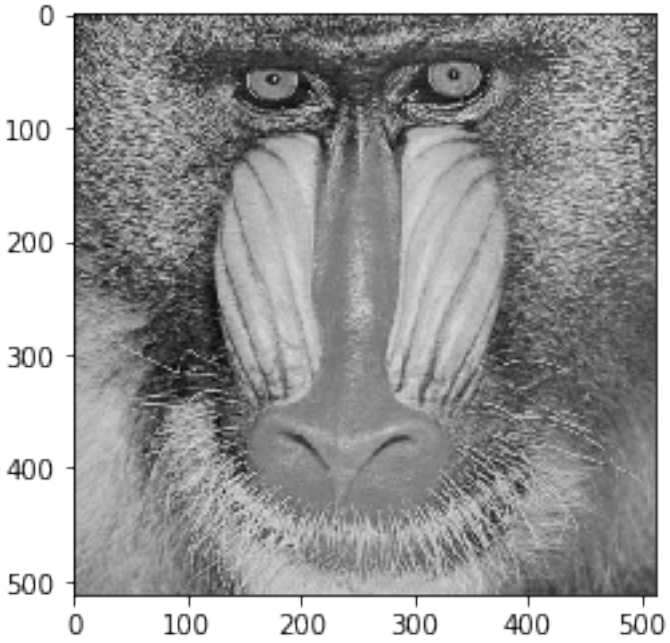
1. **Parâmetro 1 : é o valor k . O valor padrão é 0,25. Qualquer outro número que não 0 alterará seu valor.**
2. **Parâmetro 2 : é o valor r . O valor padrão é 0,5. Este valor é diferente do de Sauvola porque usa a intensidade normalizada da imagem. Qualquer outro número que não 0 alterará seu valor.**

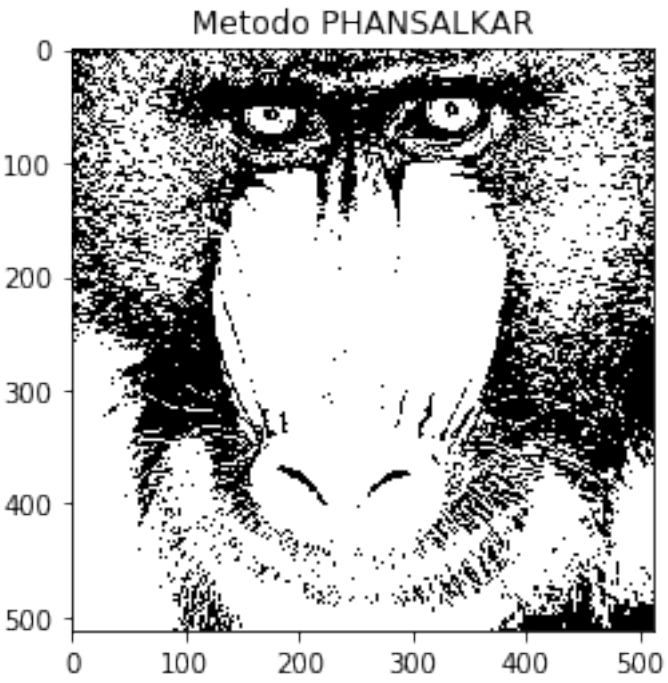
[117]:
```
# thresholds = mean * (1.0 + p * exp(-1*q*mean) + k * (np.std(w_size) / 128 - 1.
↪0))

def phansalskar_more_sabale(w_size=15,k=0.2, p=2.0, q=10.0):
    mean = np.mean(w_size)
    return mean * (1 + p * exp(-1*q*mean) + k * (np.std(w_size)/128 - 1))
```

[118]:
```
# Applying local contrast method
start = default_timer()
th = phansalskar_more_sabale(img)
stop = default_timer()
print('========Local phansalkar==========')
print('Execution time: {0}'.format(stop - start))
print('====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local  PHANSALKAR method')
plt.title('Metodo PHANSALKAR')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local phansalkar==========
Execution time: 0.00231788499513641
```

```
====================================
Total de pixels:  262144
========================================
Pixels brancos:  0.9999847412109375
========================================
Pixels pretos:  1.52587890625e-05
```





0.13 Função median

0.13.1 Metodo Mediana

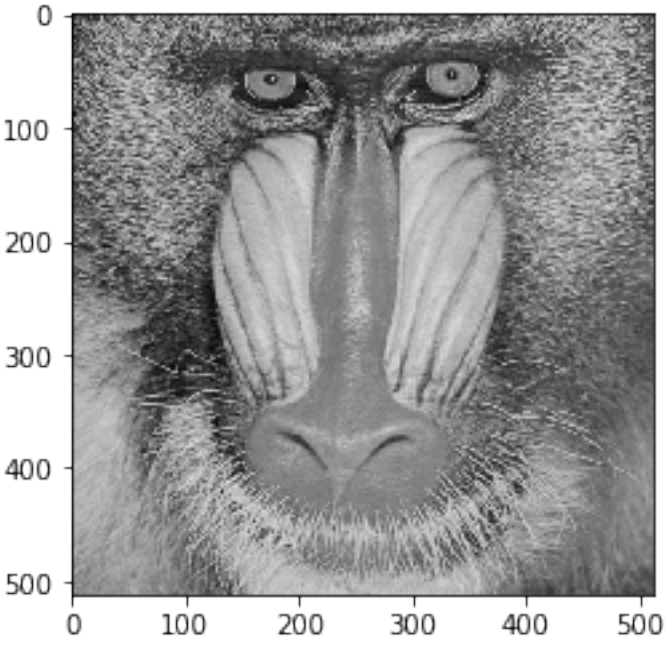
[119]:
```
def lmedian_threshold(img, w_size=15):
    # Obtaining rows and cols
    rows, cols = img.shape
    i_rows, i_cols = rows + 1, cols + 1

    # Computing integral image
    # Leaving first row and column in zero for convenience
    integ = np.zeros((i_rows, i_cols), np.float)

    integ[1:, 1:] = np.cumsum(np.cumsum(img.astype(np.float), axis=0), axis=1)

    # Defining grid
    x, y = np.meshgrid(np.arange(1, i_cols), np.arange(1, i_rows))

    # Obtaining local coordinates
    hw_size = w_size // 2
    x1 = (x - hw_size).clip(1, cols)
    x2 = (x + hw_size).clip(1, cols)
```

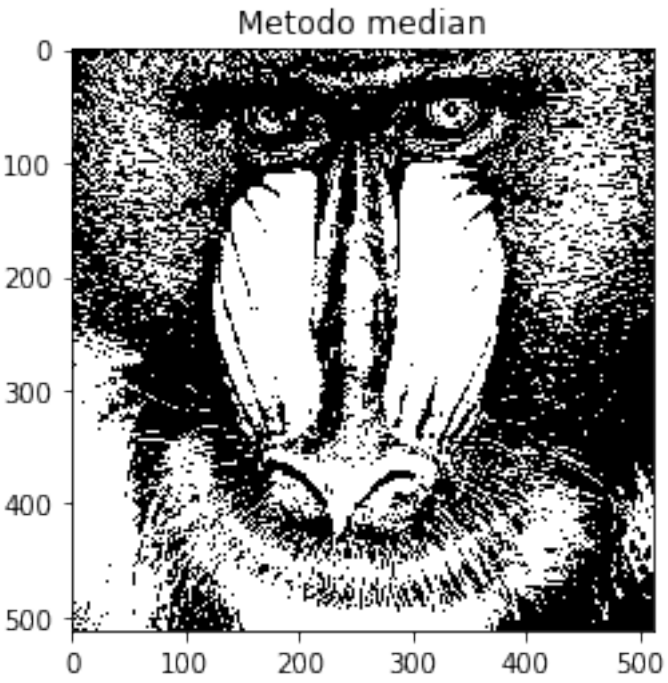
```
    y1 = (y - hw_size).clip(1, rows)
    y2 = (y + hw_size).clip(1, rows)

    # Obtaining local areas size
    l_size = (y2 - y1 + 1) * (x2 - x1 + 1)

    # Computing sums
    sums = (integ[y2, x2] - integ[y2, x1 - 1] - integ[y1 - 1, x2] + integ[y1 -␣
↪1, x1 - 1])

    # Computing local means
    means = sums / l_size
    median = np.median(means)

    return median
```

0.13.2 Plot Median

[120]:
```
# Applying local contrast method
start = default_timer()
th = lmedian_threshold(img)
stop = default_timer()
print('========Local median==========')
print('Execution time: {0}'.format(stop - start))
print('=====================================')

#Plotting test image
plt.figure('Imagem Original')
plt.imshow(img, cmap='gray')

# Plotting results
plt.figure('Local median method')
plt.title('Metodo median')
plt.imshow(apply_threshold(img, th), cmap='gray')

# Fractions pixels
total = img.size
white = np.count_nonzero(img)
black = total - white
print("Total de pixels: ", total)
print('=========================================')
#print("Fraction of white pixels: ", white)
print("Pixels brancos: ", white/total)
print('=========================================')
#print("Fraction of black pixels: ", black)
print("Pixels pretos: ", black/total)
```

```
========Local median==========
Execution time: 0.04416273901006207
====================================
Total de pixels:  262144
==========================================
Pixels brancos:  0.9999847412109375
==========================================
Pixels pretos:  1.52587890625e-05
```




Metodo median
0
100
200
300
400
500
0
100
200
300
400
500