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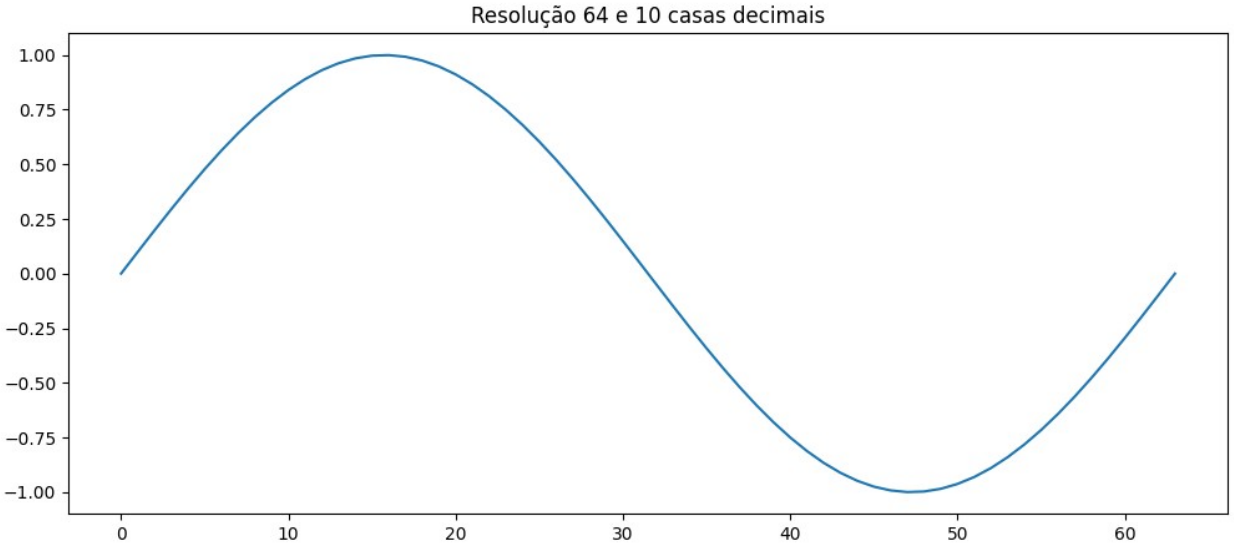
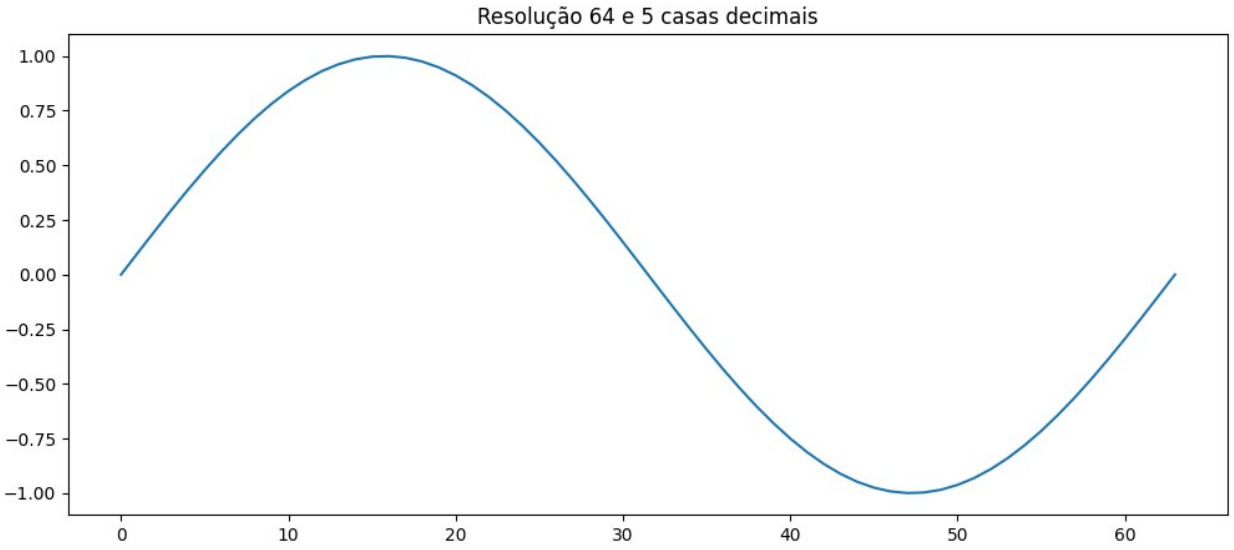
Exercício 2: processos de discretização de sinais, amostragem e quantização

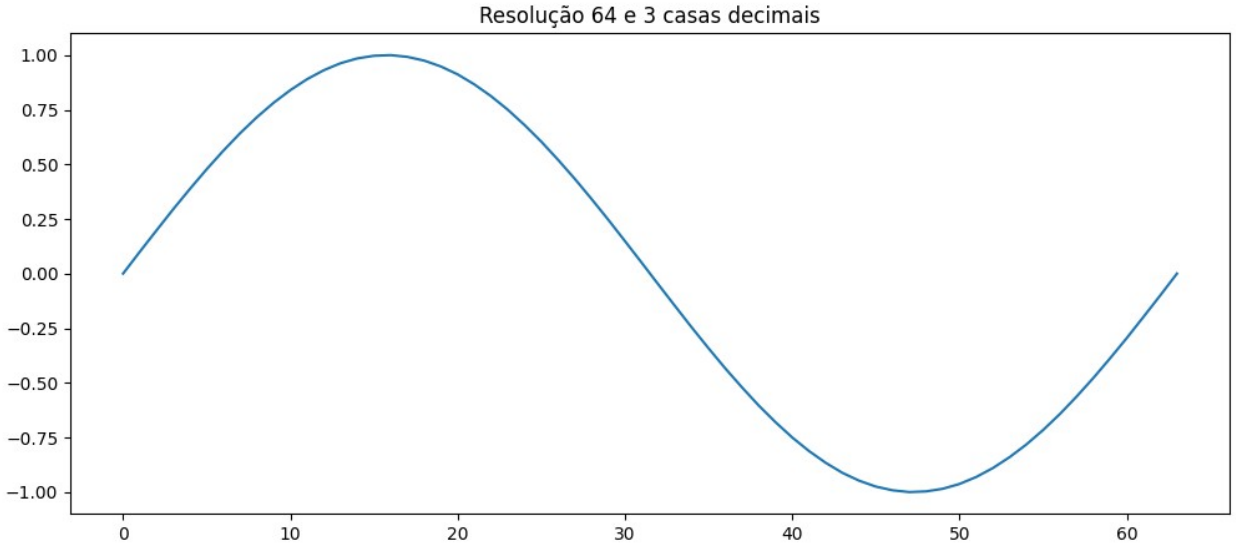
```
import numpy as np
import matplotlib.pyplot as plt
```

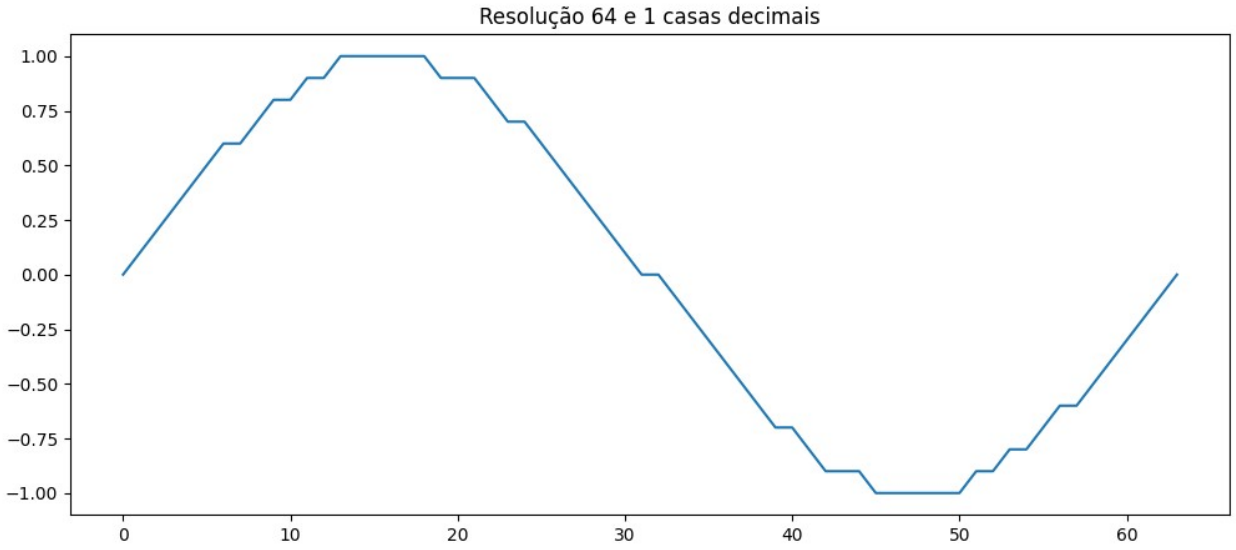
Caso 1D

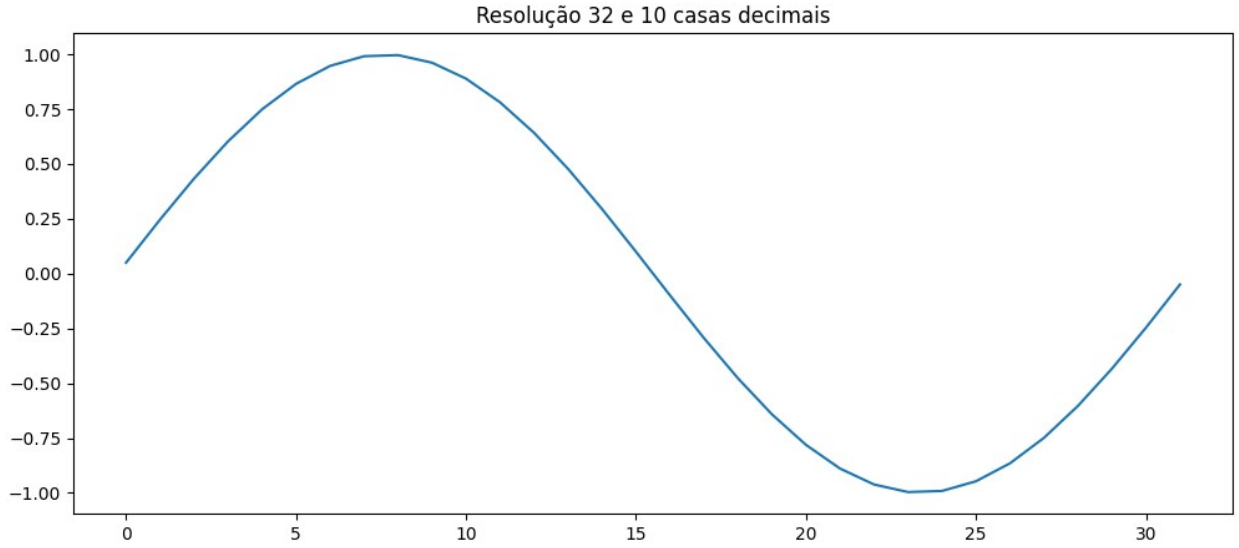
```
def geraSinal(N, w):
    t = np.linspace(0, 2*np.pi, N)
    sinal = np.sin(w*t)
    return sinal

def amostragem(sinal, N, resolucoes):
    amostragens = []
    for resolucao in resolucoes:
        passo = N // resolucao
        amostra = []
        for i in range(0, N, passo):
            media = np.mean(sinal[i:i+passo])
            amostra.append(media)
        amostragens.append(amostra)
    return amostragens

def quantizacao(sinal, casa_decimal):
    sinal_quantizado = np.round(sinal, casa_decimal)
    return sinal_quantizado

N = 64
w = 1.0

resolucoes = [N, N//2, N//4, N//8]
casas_decimais = [10, 5, 3, 1]

sinal = geraSinal(N, w)

amostragens = amostragem(sinal, N, resolucoes)

for amostra, resolucao in zip(amostragens, resolucoes):
  for casa in casas_decimais:
    resultado = quantizacao(amostra, casa)
    plt.figure(figsize=(12, 5))
    plt.plot(resultado)
    plt.title(f"Resolução {resolucao} e {casa} casas decimais")
    plt.show()
```

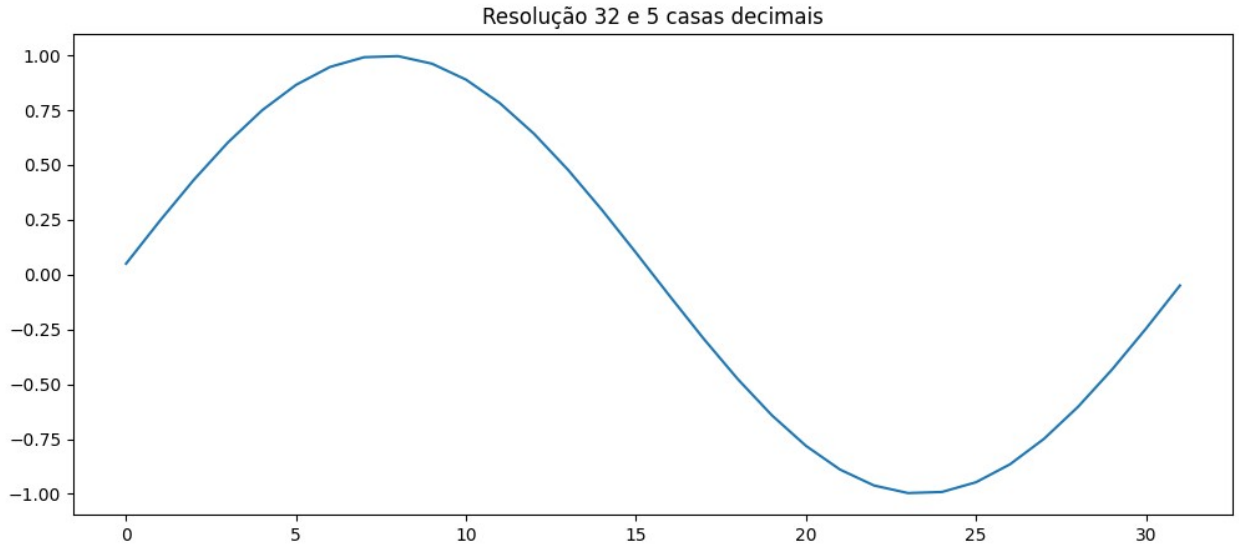

Resolução 64 e 10 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
10
20
30
40
50
60

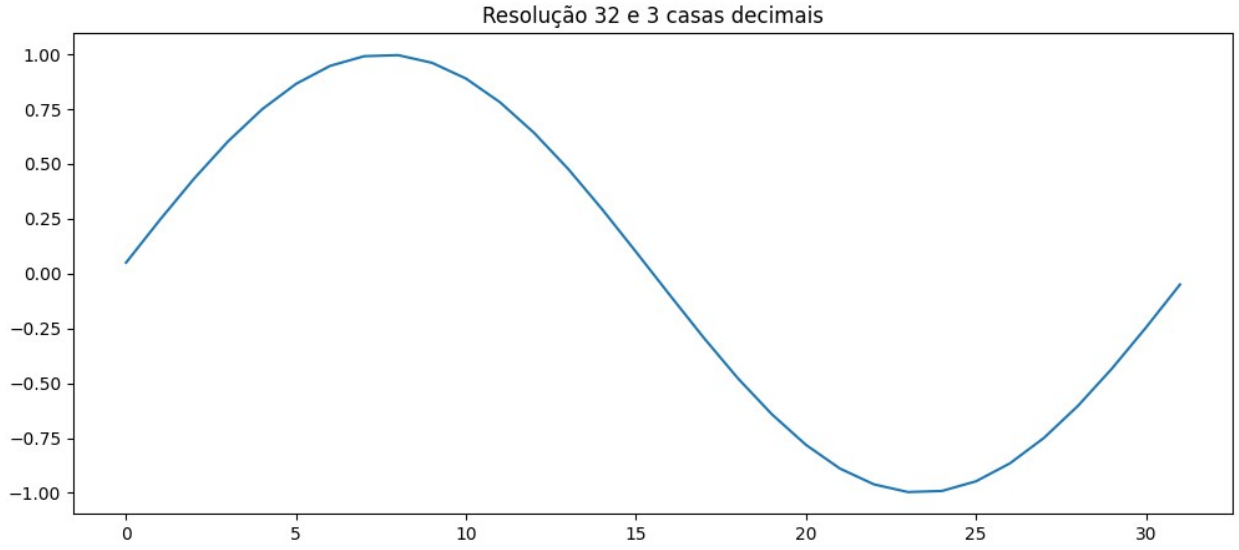

Resolução 64 e 5 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
10
20
30
40
50
60

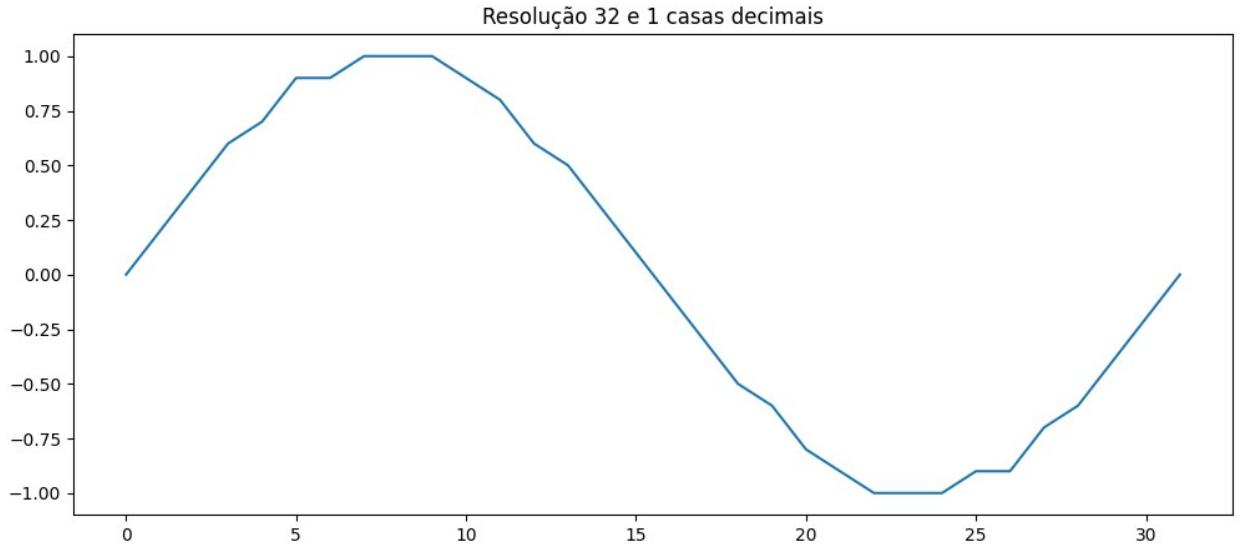

Resolução 64 e 3 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
10
20
30
40
50
60

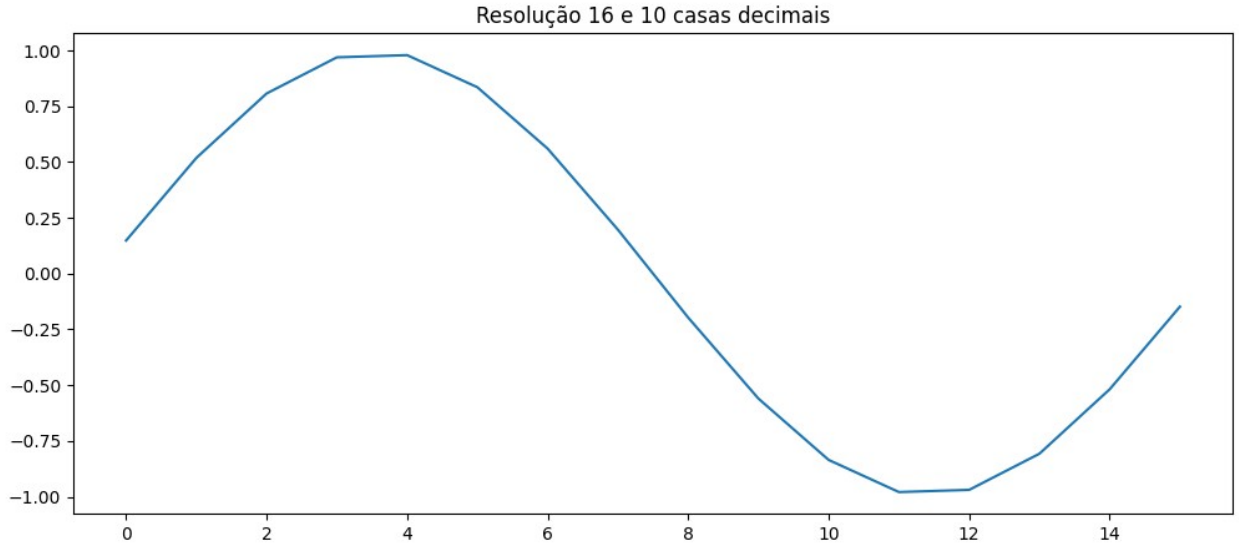

Resolução 64 e 1 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
10
20
30
40
50
60

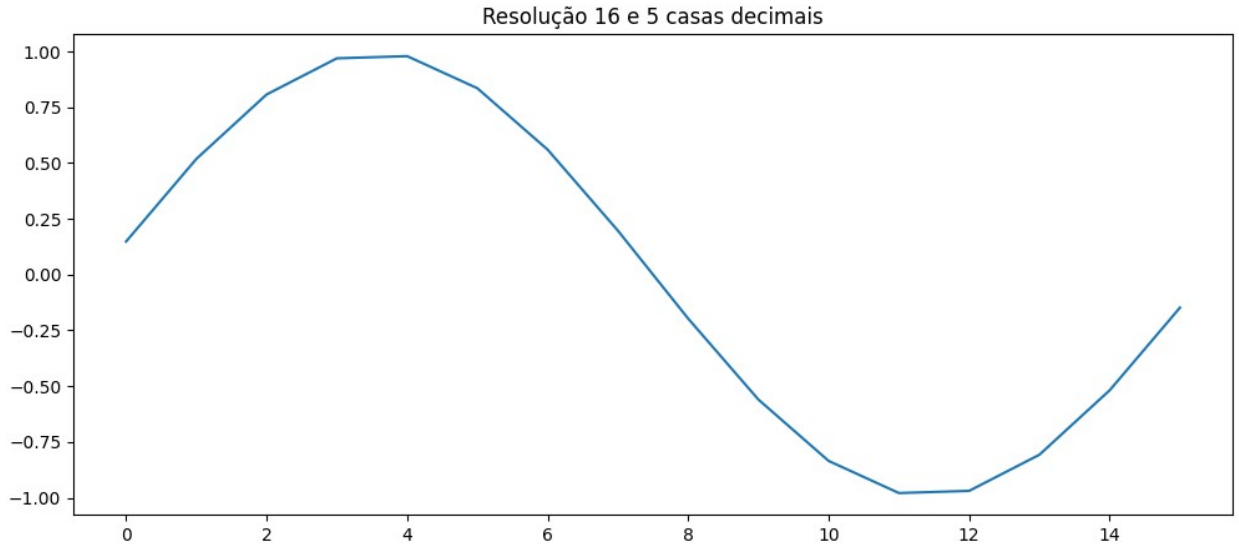

Resolução 32 e 10 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30

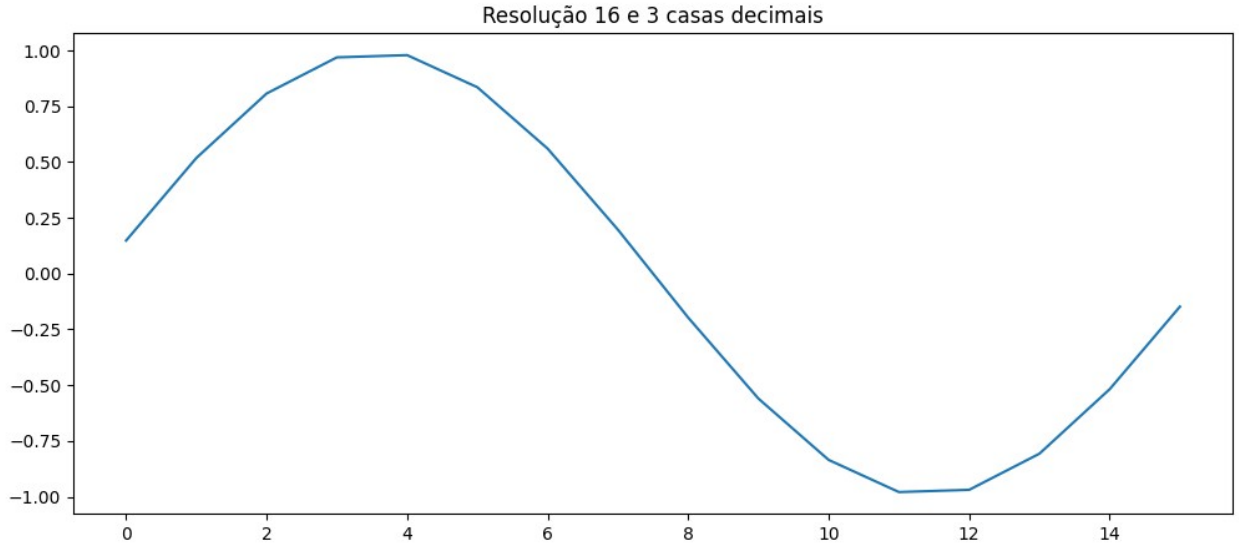

Resolução 32 e 5 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30

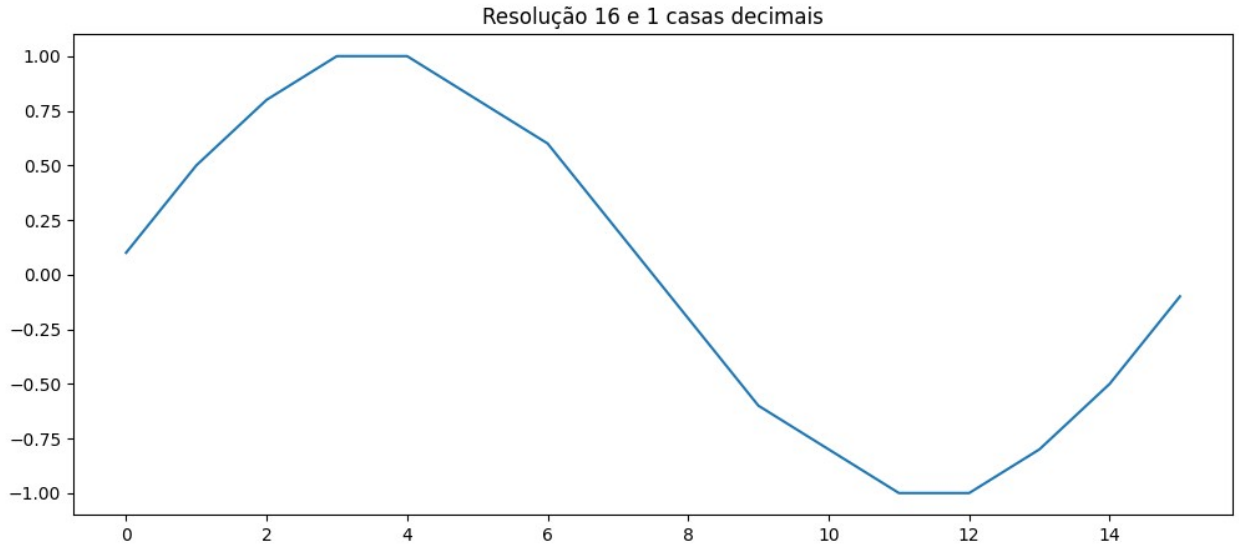

Resolução 32 e 3 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30

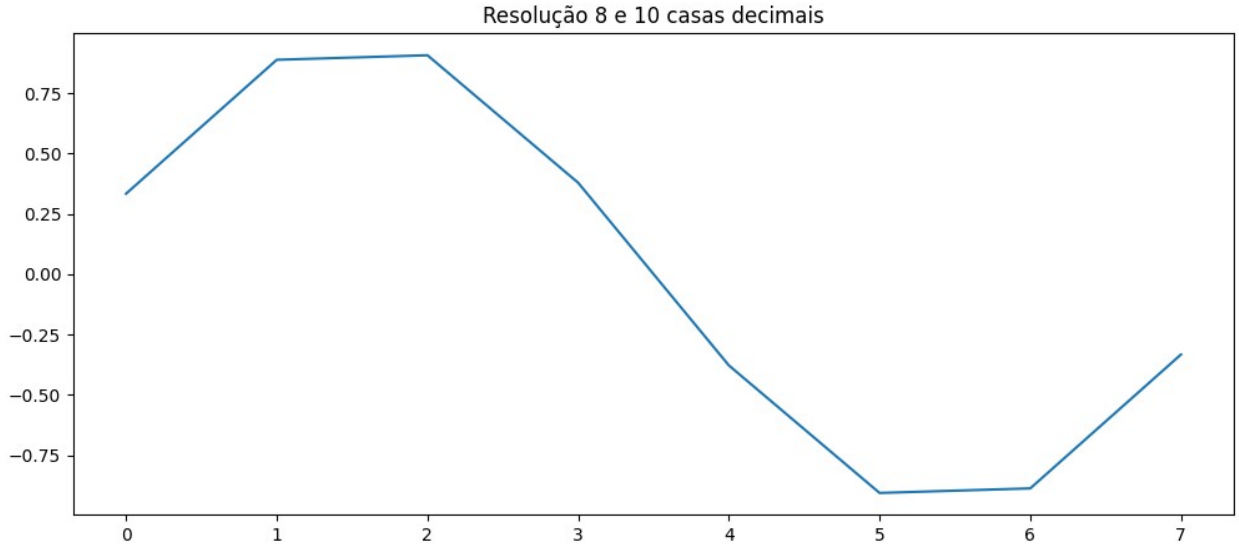

Resolução 32 e 1 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30

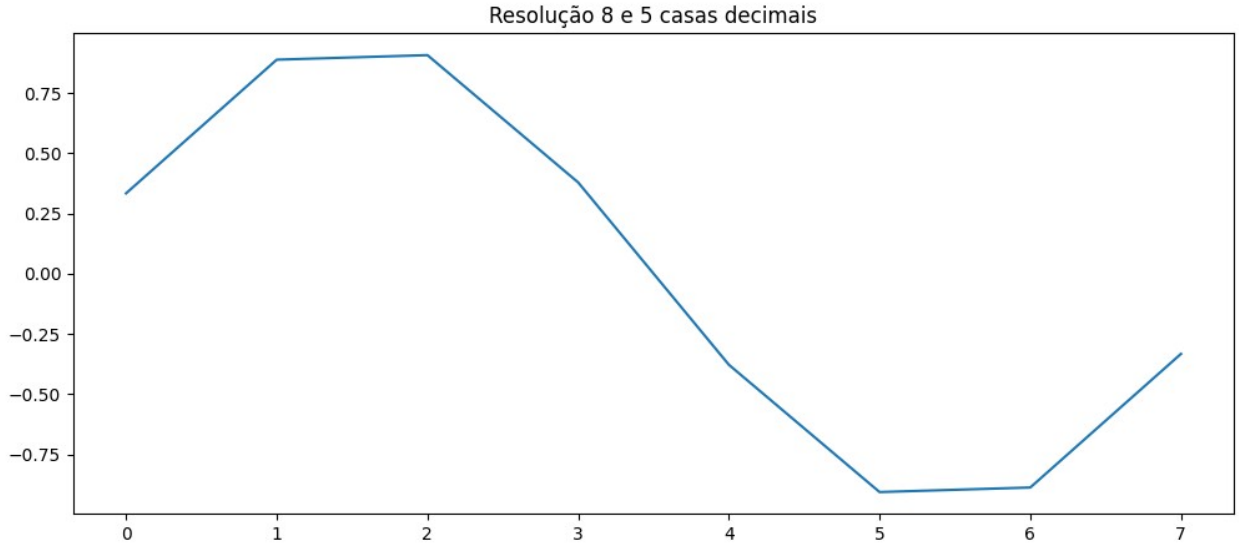

Resolução 16 e 10 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
2
4
6
8
10
12
14

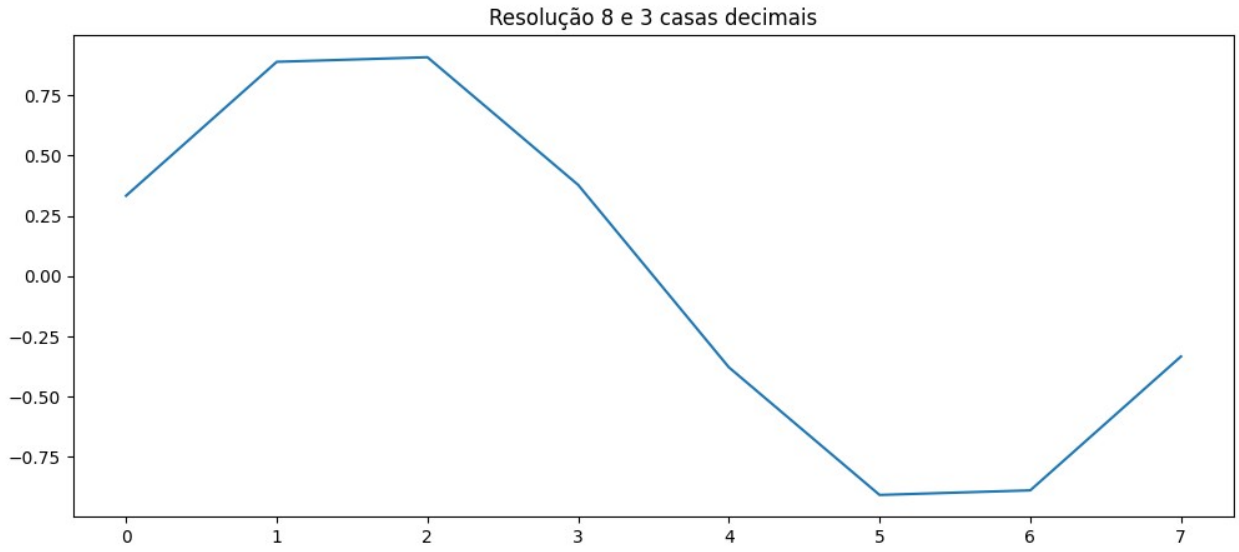

Resolução 16 e 5 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
2
4
6
8
10
12
14

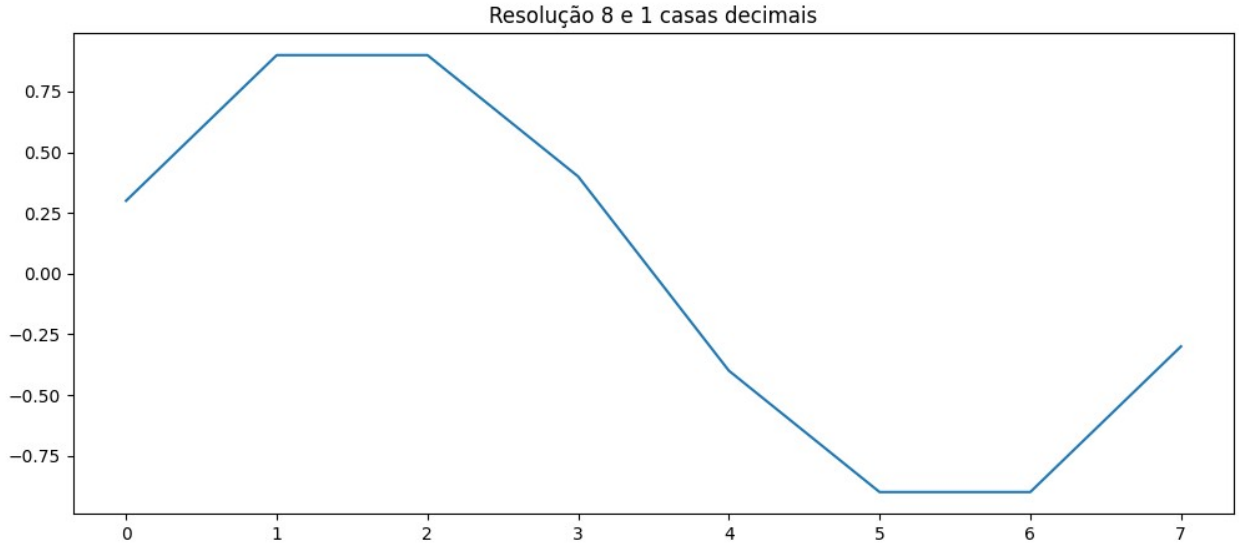

Resolução 16 e 3 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
2
4
6
8
10
12
14


Resolução 16 e 1 casas decimais
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
2
4
6
8
10
12
14


Resolução 8 e 10 casas decimais
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
1
2
3
4
5
6
7


Resolução 8 e 5 casas decimais
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
1
2
3
4
5
6
7

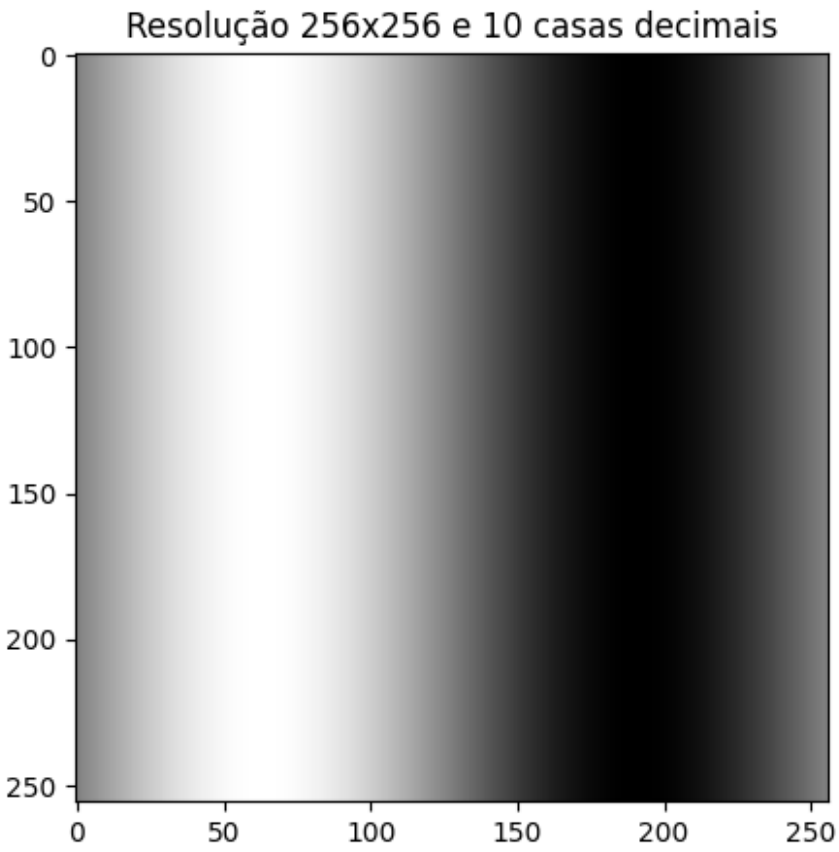


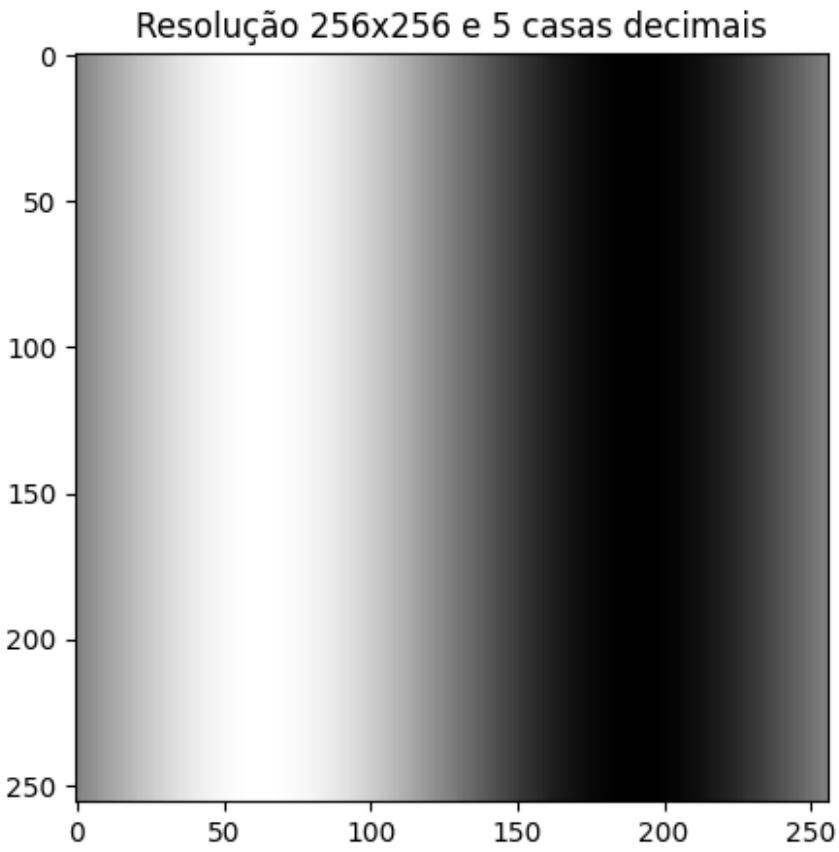


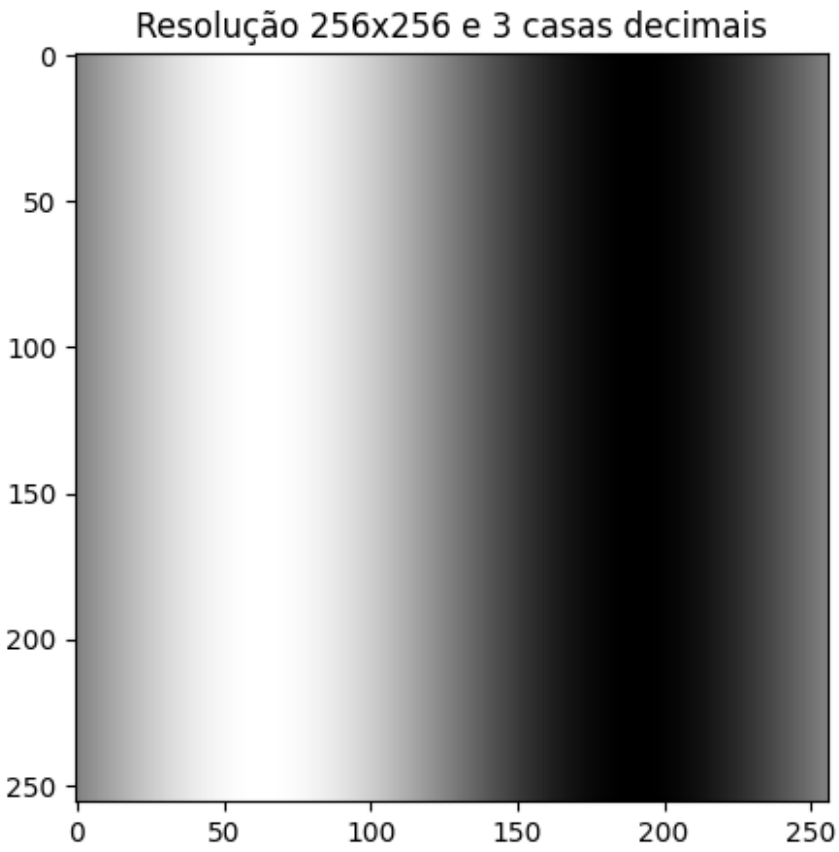
Caso 2D

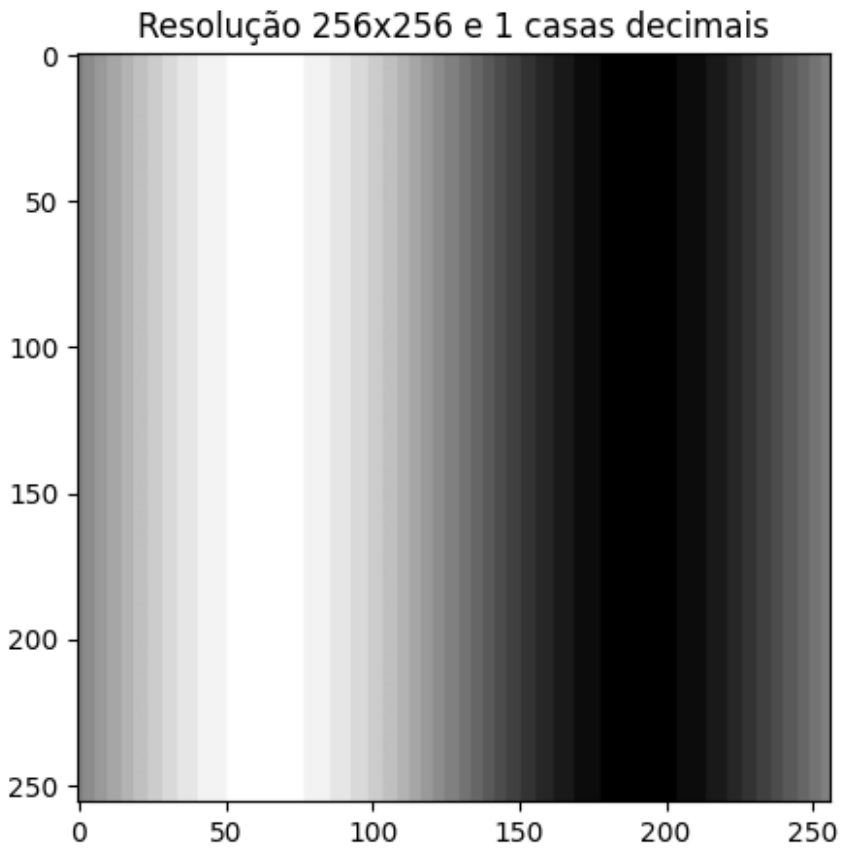
```
def geraSinal(N, w):
    t = np.linspace(0, 2 * np.pi, N)
    senoides = np.sin(w * t)
    sinal = np.tile(senoides, (N, 1))
    return sinal

def amostragem(sinal, resolucoes, N):
    amostragens = []
    for resolucao in resolucoes:
        passo = N // resolucao
        amostra = []
        for i in range(0, N, passo):
            for j in range(0, N, passo):
```

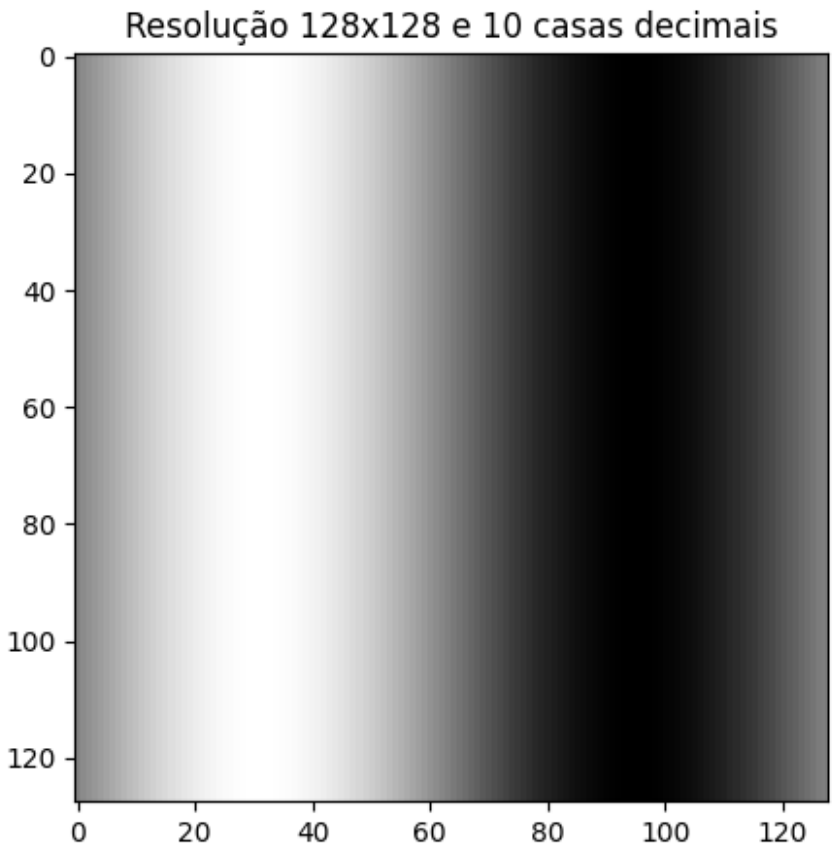
```
                vizinhos = [
                    sinal[i:i+passo, j:j+passo],
                    sinal[i:i+passo, j+passo:j+2*passo],
                    sinal[i+passo:i+2*passo, j:j+passo],
                    sinal[i+passo:i+2*passo, j+passo:j+2*passo]
                ]
                mediaVizinhos = []
                for matriz in vizinhos:
                    if matriz.size > 0:
                        mediaVizinhos.append(matriz)
                if len(mediaVizinhos) > 0:
                    media = np.mean(mediaVizinhos)
                    amostra.append(media)
        amostragens.append(amostra)
    return amostragens

def quantizacao(sinal, casa_decimal):
    sinal_quantizado = np.round(sinal, casa_decimal)
    return sinal_quantizado

N = 256
w = 1.0

resolucoes = [N, N//2, N//4, N//8]
casas_decimais = [10, 5, 3, 1]

sinal = geraSinal(N, w)

amostragens = amostragem(sinal, resolucoes, N)

for amostra, resolucao in zip(amostragens, resolucoes):
    for casa in casas_decimais:
        resultado = quantizacao(amostra, casa)
        resultado_2D = np.array(resultado).reshape(resolucao,
resolucao)
        plt.figure(figsize=(5, 5))
        plt.imshow(resultado_2D, cmap='gray', aspect='auto')
        plt.title(f"Resolução {resolucao}x{resolucao} e {casa} casas
decimais")
        plt.show()
```

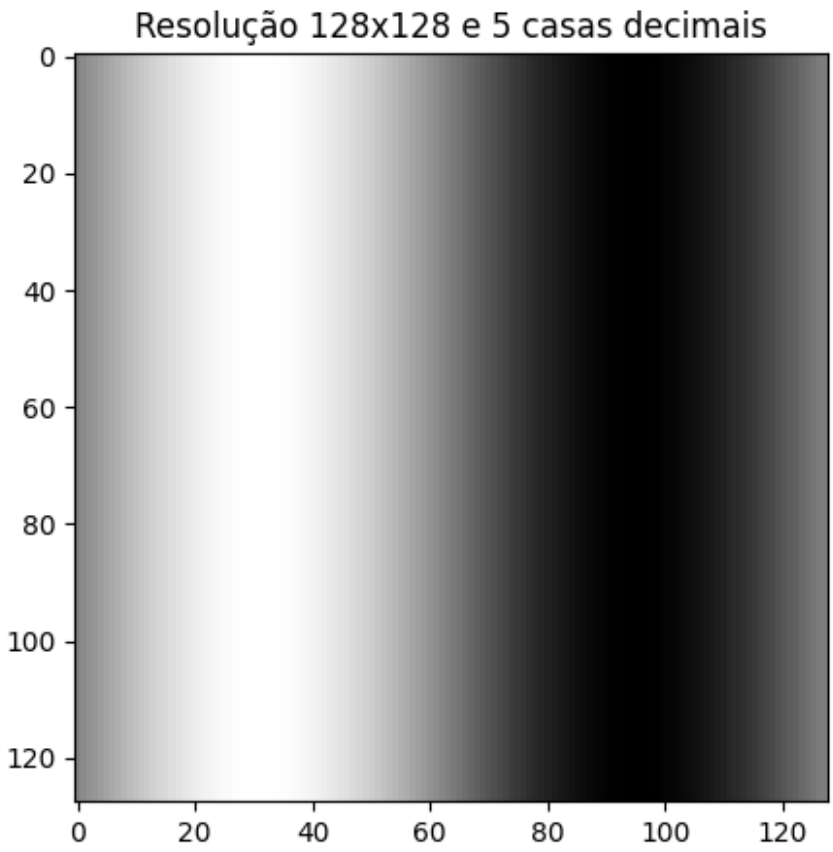

Resolução 256x256 e 10 casas decimais
0
50
100
150
200
250
0
50
100
150
200
250

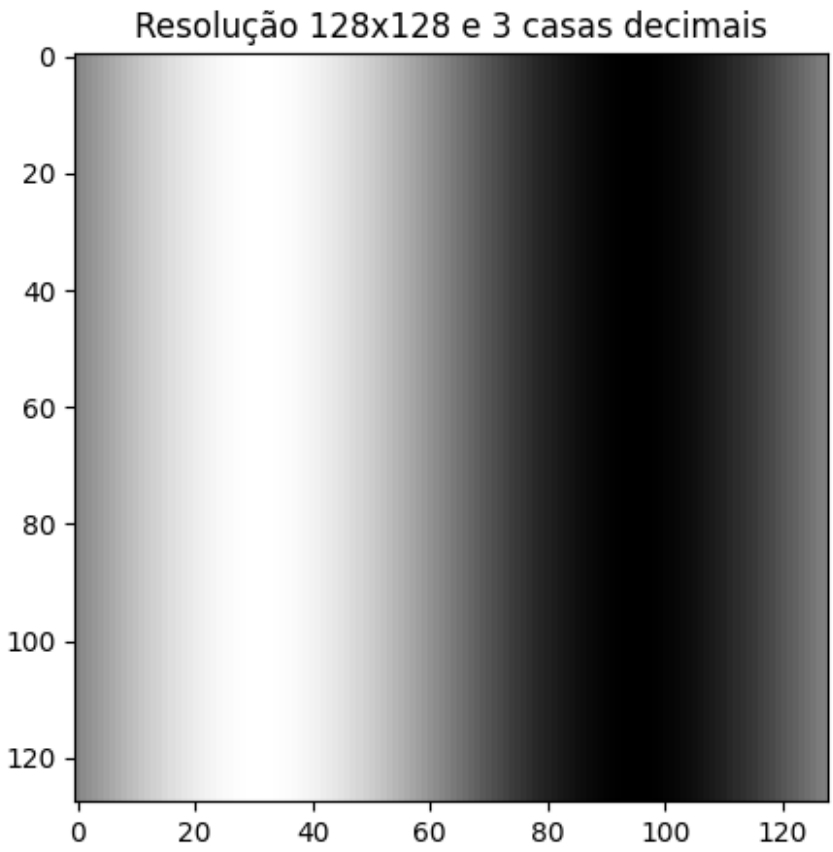

Resolução 256x256 e 5 casas decimais
0
50
100
150
200
250
0
50
100
150
200
250

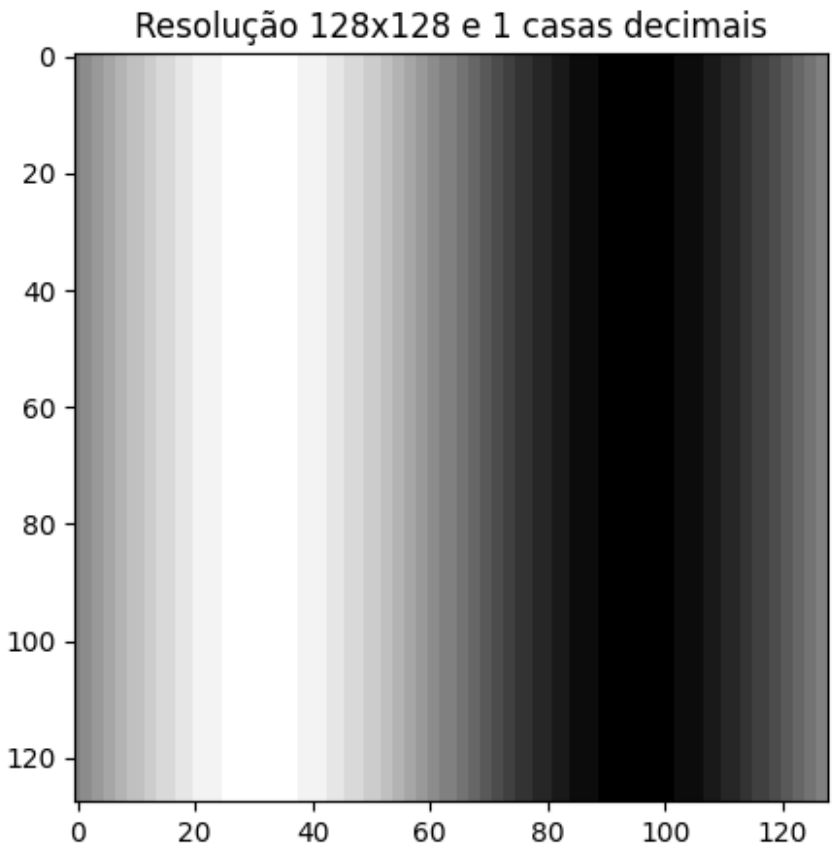

Resolução 256x256 e 3 casas decimais
0
50
100
150
200
250
0
50
100
150
200
250

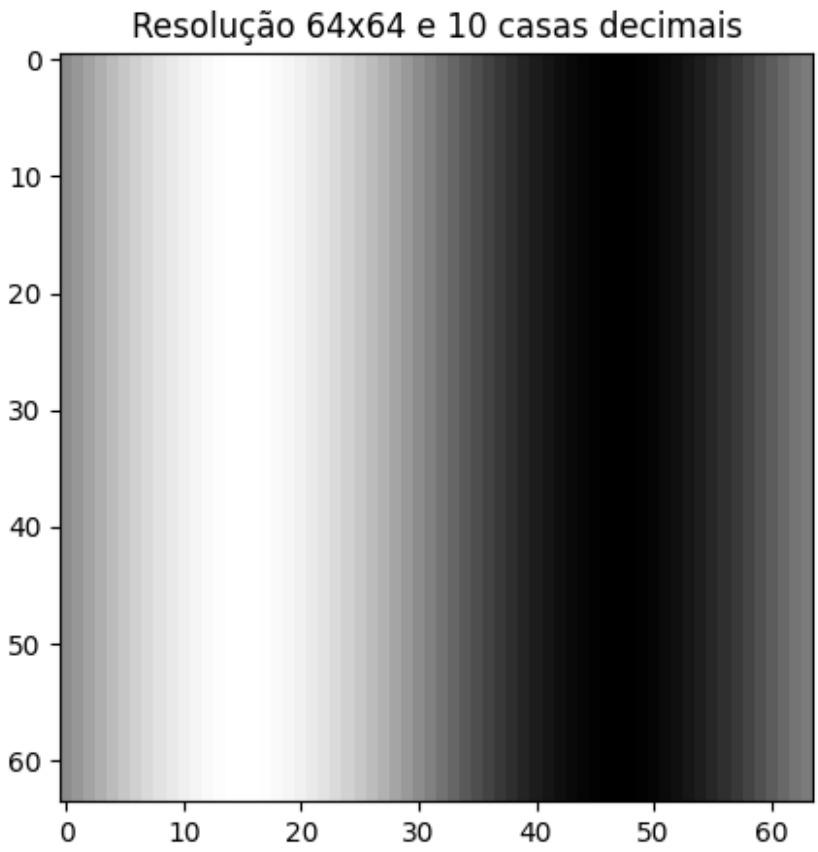

Resolução 256x256 e 1 casas decimais
0
50
100
150
200
250
0
50
100
150
200
250

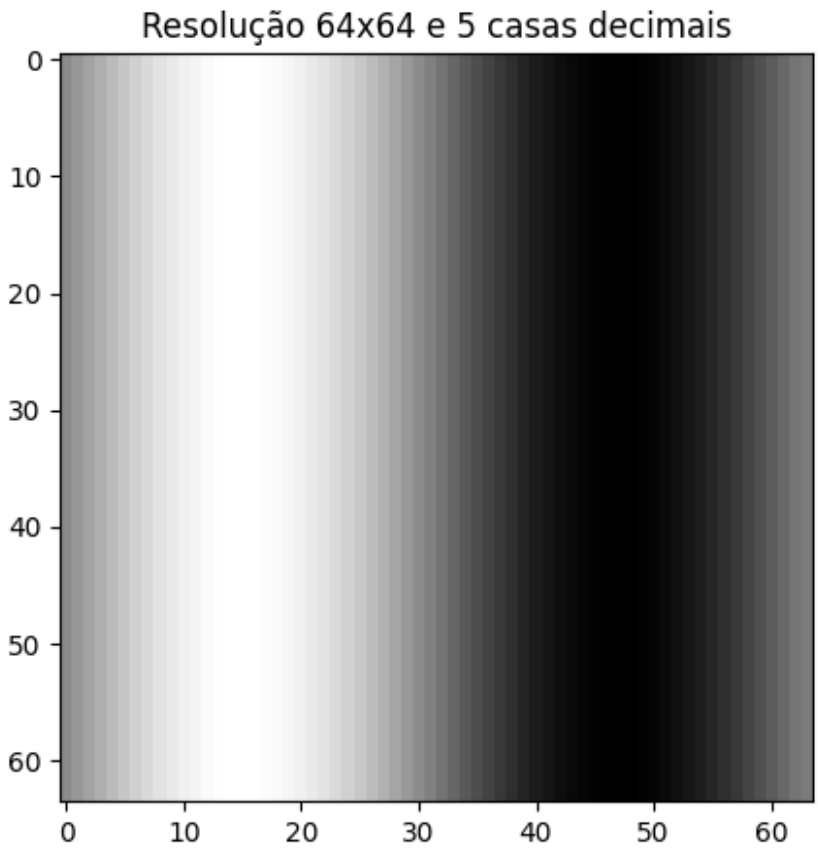

Resolução 128x128 e 10 casas decimais
0
20
40
60
80
100
120
0
20
40
60
80
100
120

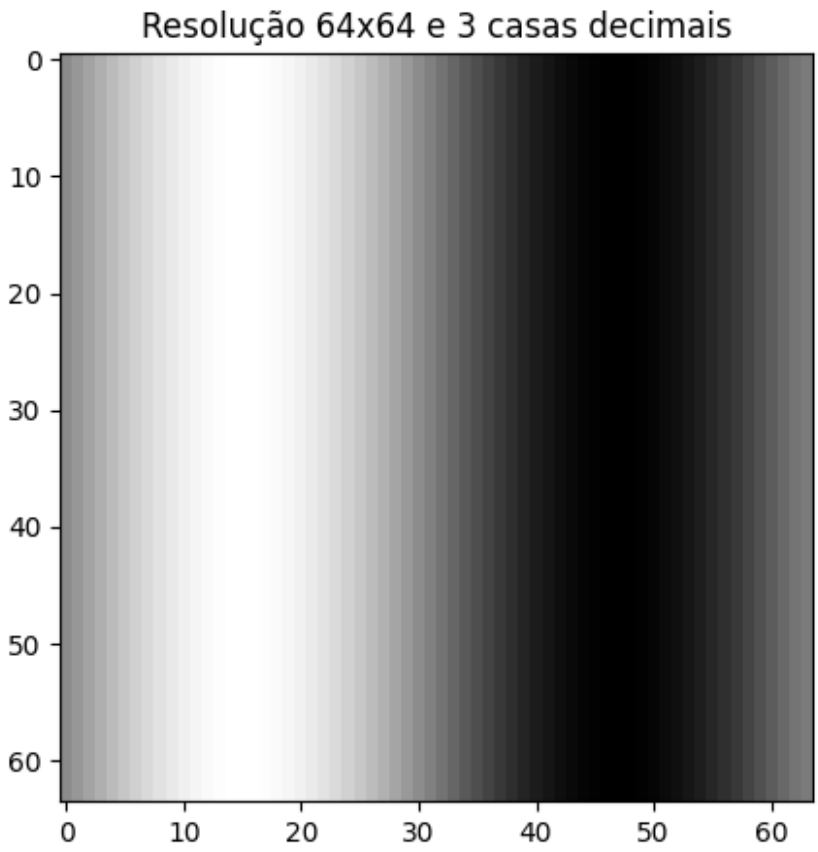

Resolução 128x128 e 5 casas decimais
0
20
40
60
80
100
120
0
20
40
60
80
100
120

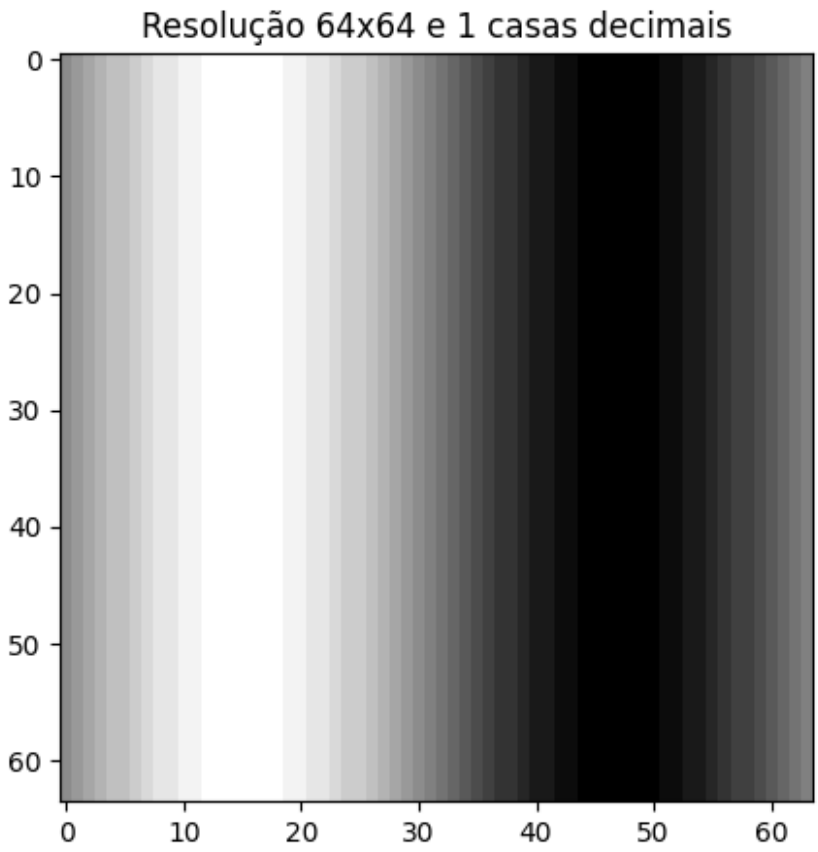

Resolução 128x128 e 3 casas decimais
0
20
40
60
80
100
120
0
20
40
60
80
100
120

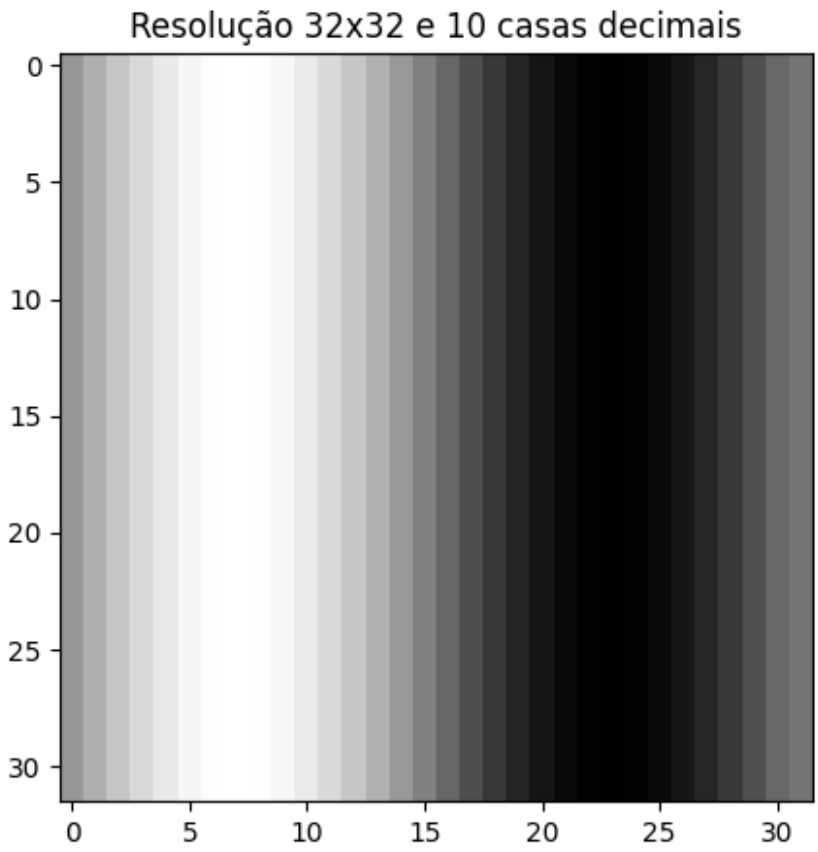

Resolução 128x128 e 1 casas decimais
0
20
40
60
80
100
120
0
20
40
60
80
100
120

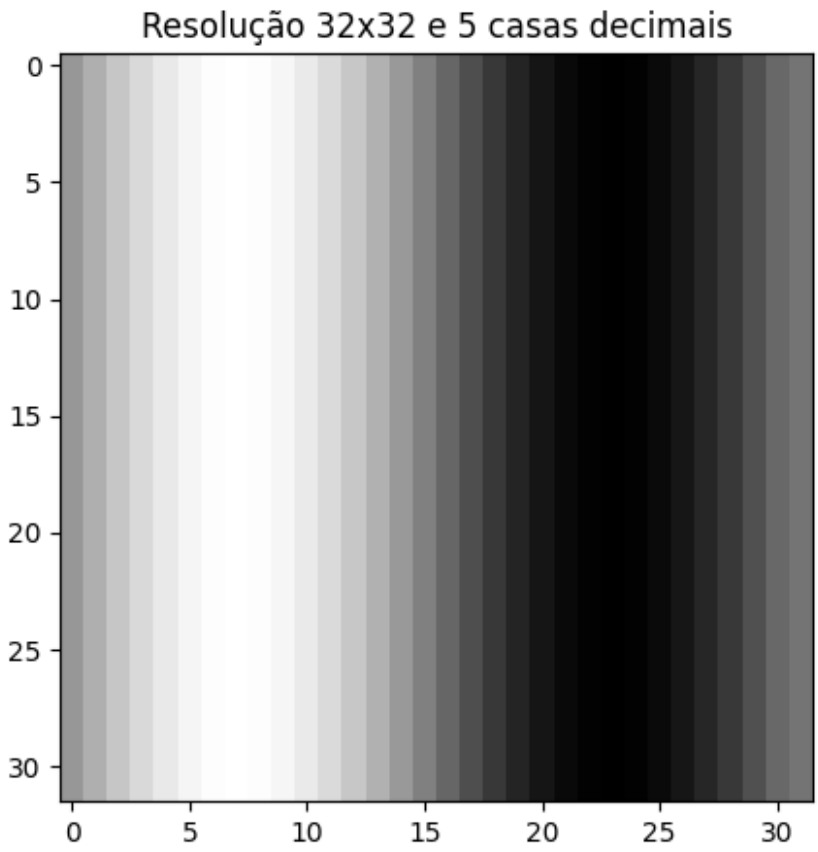

Resolução 64x64 e 10 casas decimais
0
10
20
30
40
50
60
0
10
20
30
40
50
60

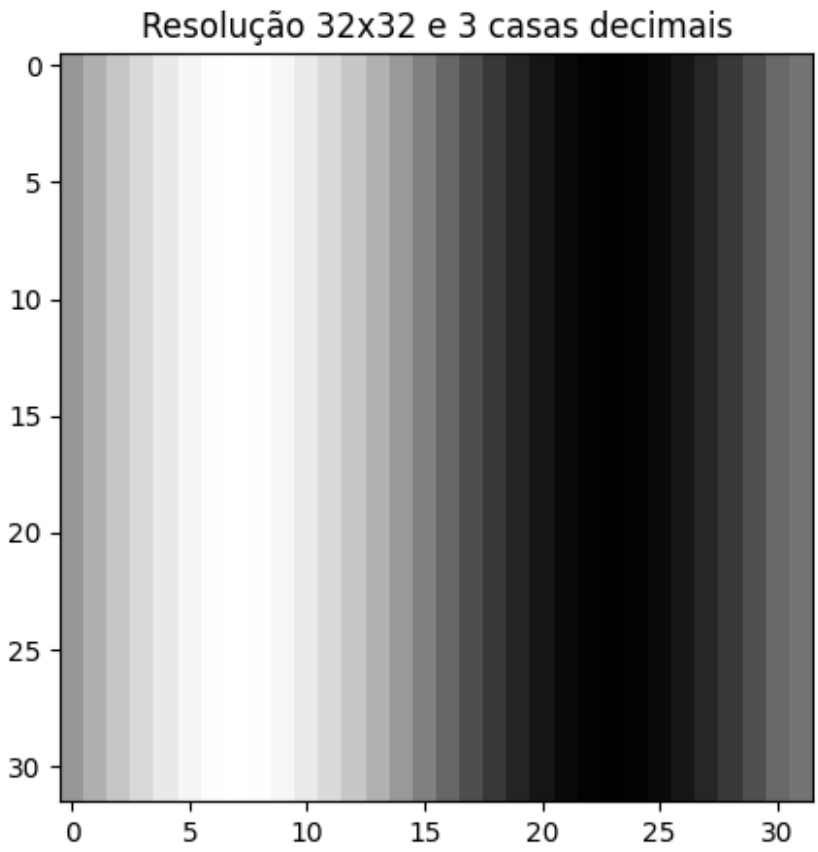

Resolução 64x64 e 5 casas decimais
0
10
20
30
40
50
60
0
10
20
30
40
50
60

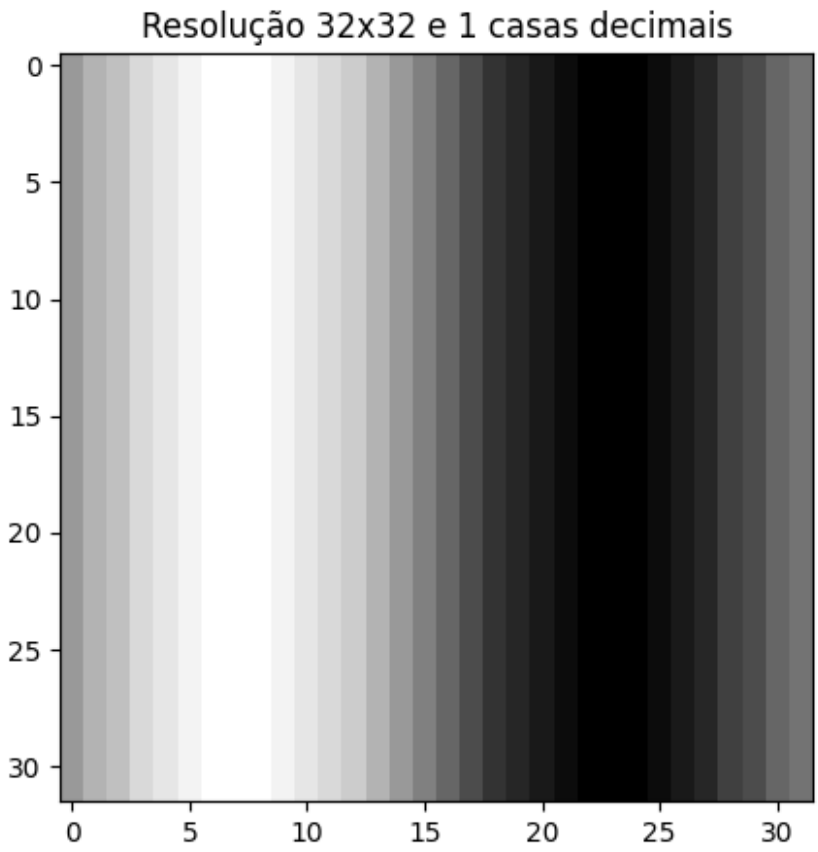

Resolução 64x64 e 3 casas decimais
0
10
20
30
40
50
60
0
10
20
30
40
50
60


Resolução 64x64 e 1 casas decimais
0
10
20
30
40
50
60
0
10
20
30
40
50
60


Resolução 32x32 e 10 casas decimais
0
5
10
15
20
25
30
0
5
10
15
20
25
30


Resolução 32x32 e 5 casas decimais
0
5
10
15
20
25
30
0
5
10
15
20
25
30

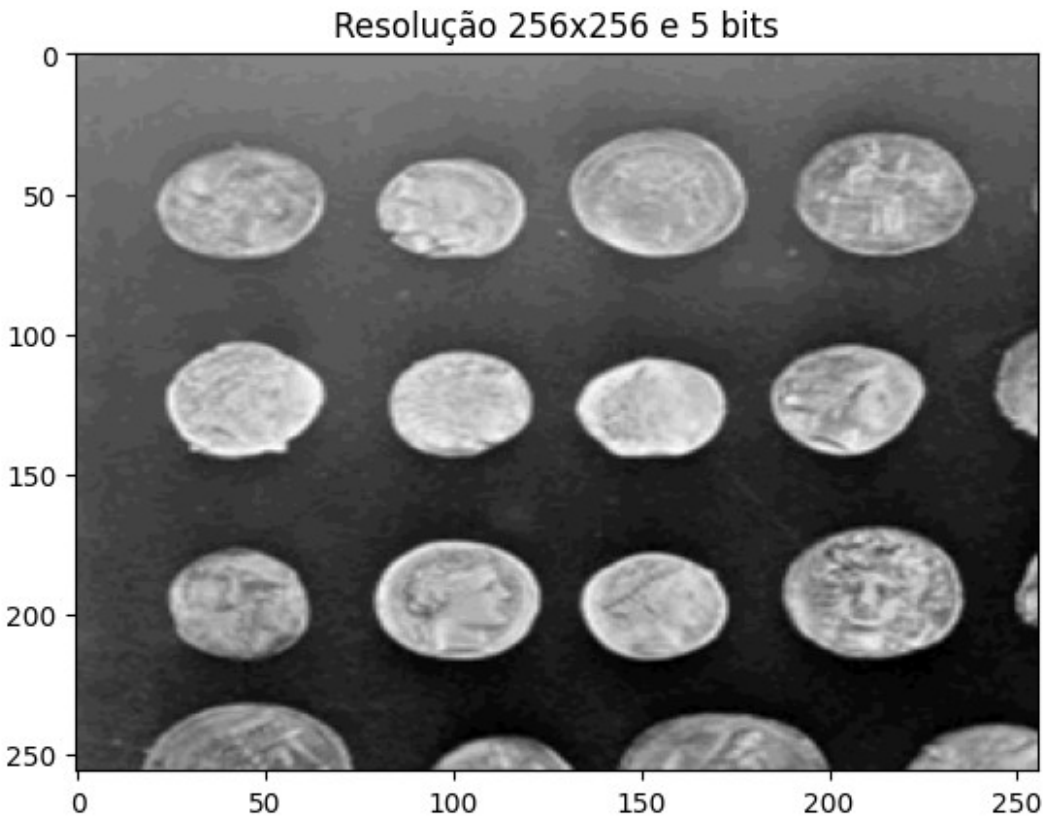

Resolução 32x32 e 3 casas decimais
0
5
10
15
20
25
30
0
5
10
15
20
25
30



Imagens do Scikit

```
from skimage import data

def geraSinal(N, w):
    t = np.linspace(0, 2 * np.pi, N)
    senoides = np.sin(w * t)
    sinal = np.tile(senoides, (N, 1))
    return sinal

def amostragem(sinal, resolucoes, N):
    amostragens = []
    for resolucao in resolucoes:
        passo = N // resolucao
        amostra = []
        for i in range(0, N, passo):
            for j in range(0, N, passo):
                vizinhos = [
                    sinal[i:i+passo, j:j+passo],
                    sinal[i:i+passo, j+passo:j+2*passo],
                    sinal[i+passo:i+2*passo, j:j+passo],
                    sinal[i+passo:i+2*passo, j+passo:j+2*passo]
                ]
```

```
                mediaVizinhos = []
                for matriz in vizinhos:
                    if matriz.size > 0:
                        mediaVizinhos.append(matriz)
                if len(mediaVizinhos) > 0:
                    media = np.mean(mediaVizinhos)
                    amostra.append(media)
        amostragens.append(amostra)
    return amostragens

def quantizacao(sinal, bit):
    sinalBit = np.clip(sinal, 0, 255)
    sinal_quantizado = np.floor(sinalBit / (256 / (2 ** bit))) * (256
// (2 ** bit))
    return sinal_quantizado.astype(np.uint8)

N = 256
w = 1.0

resolucoes = [N, N//2, N//4, N//8]
bits = [5, 3, 2, 1]

imagem = data.coins()

amostragens = amostragem(imagem, resolucoes, N)

for amostra, resolucao in zip(amostragens, resolucoes):
    for bit in bits:
        resultado = quantizacao(amostra, bit)
        resultado_2D = np.array(resultado).reshape(resolucao,
resolucao)
        plt.figure()
        plt.imshow(resultado_2D, cmap='gray', aspect='auto')
        plt.title(f"Resolução {resolucao}x{resolucao} e {bit} bits")
        plt.show()

imagem = data.moon()

amostragens = amostragem(imagem, resolucoes, N)

for amostra, resolucao in zip(amostragens, resolucoes):
    for bit in bits:
        resultado = quantizacao(amostra, bit)
        resultado_2D = np.array(resultado).reshape(resolucao,
resolucao)
        plt.figure()
        plt.imshow(resultado_2D, cmap='gray', aspect='auto')
        plt.title(f"Resolução {resolucao}x{resolucao} e {bit} bits")
        plt.show()
```


Resolução 256x256 e 5 bits
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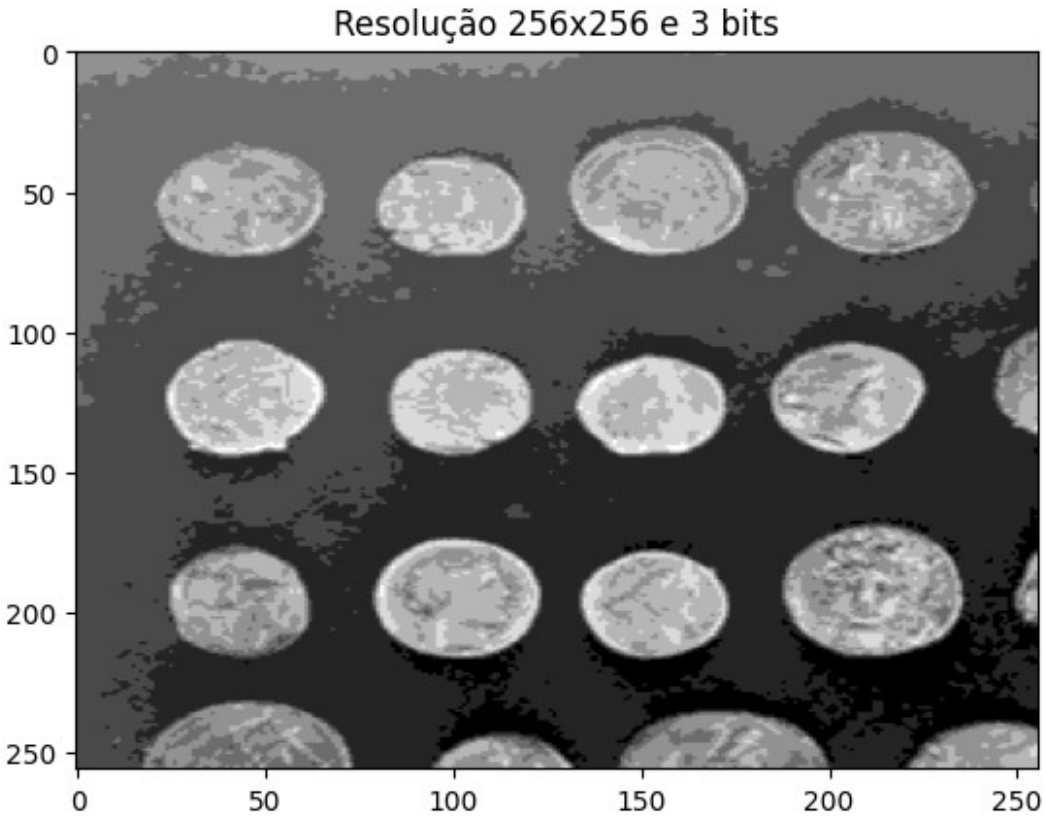
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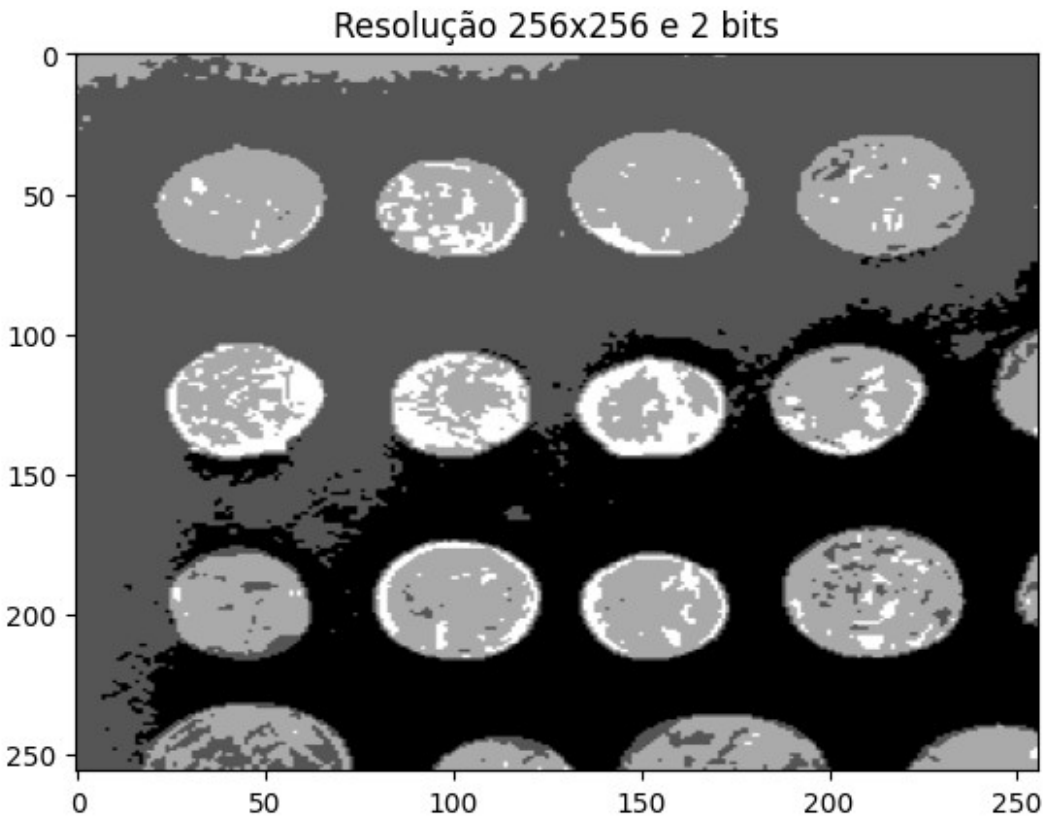
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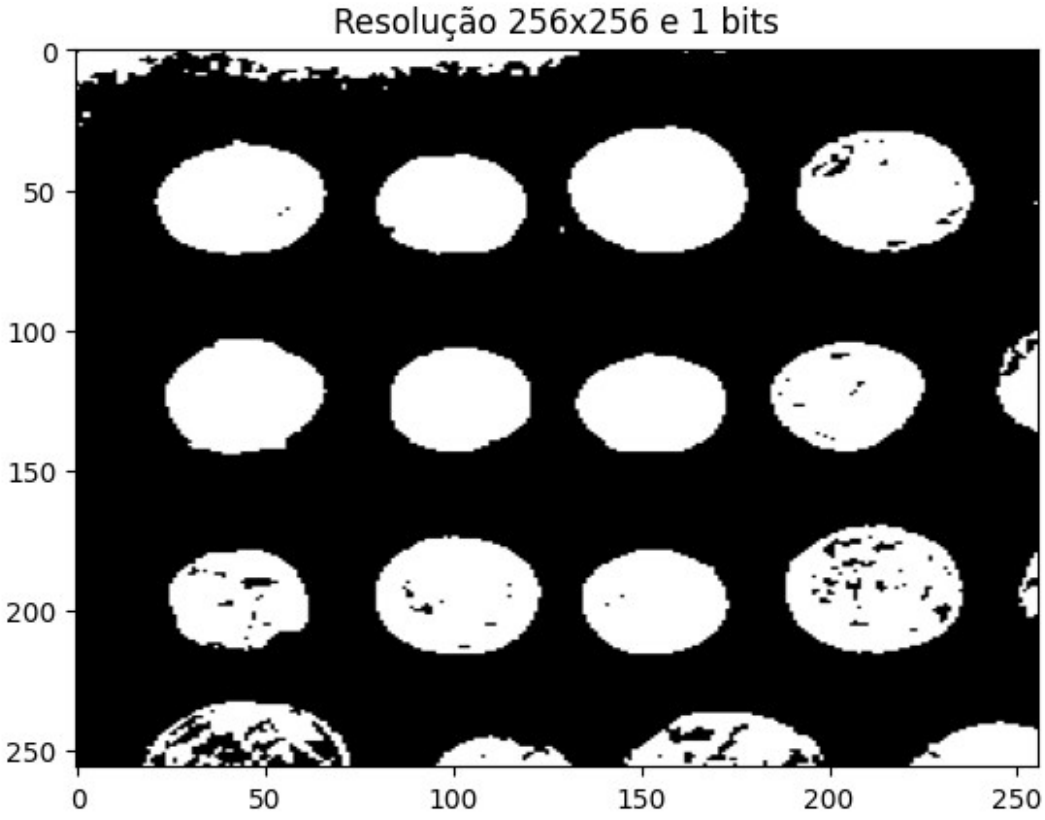
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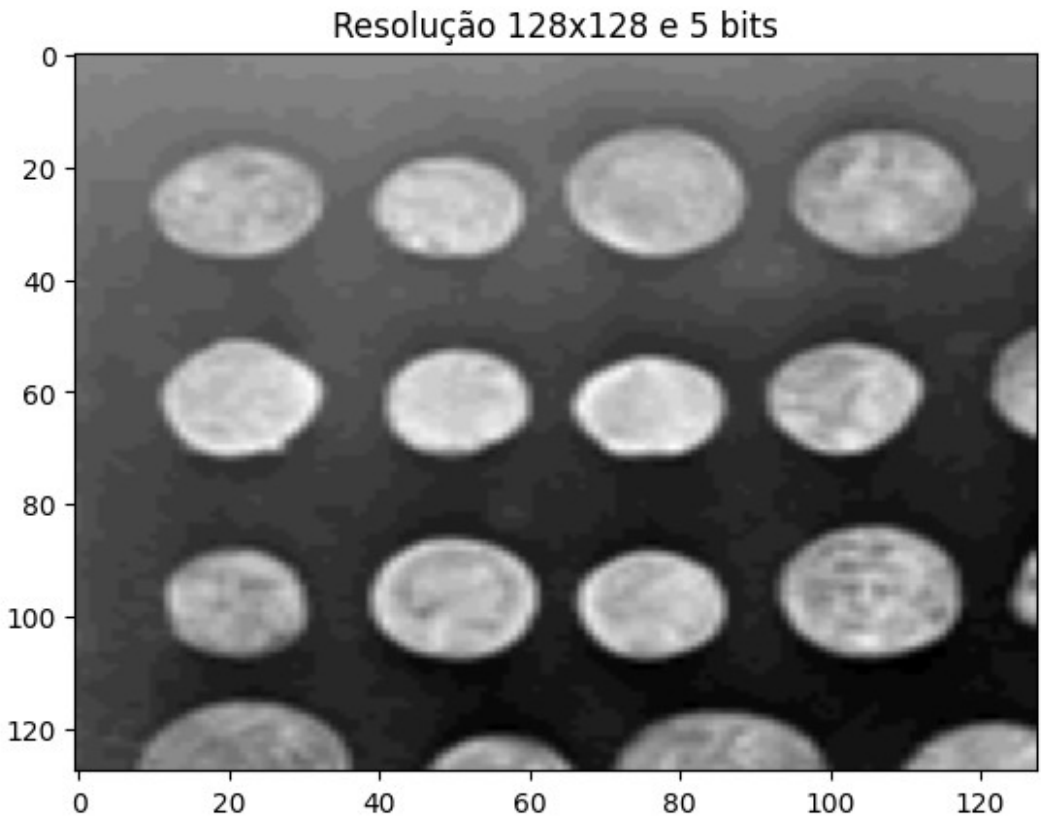
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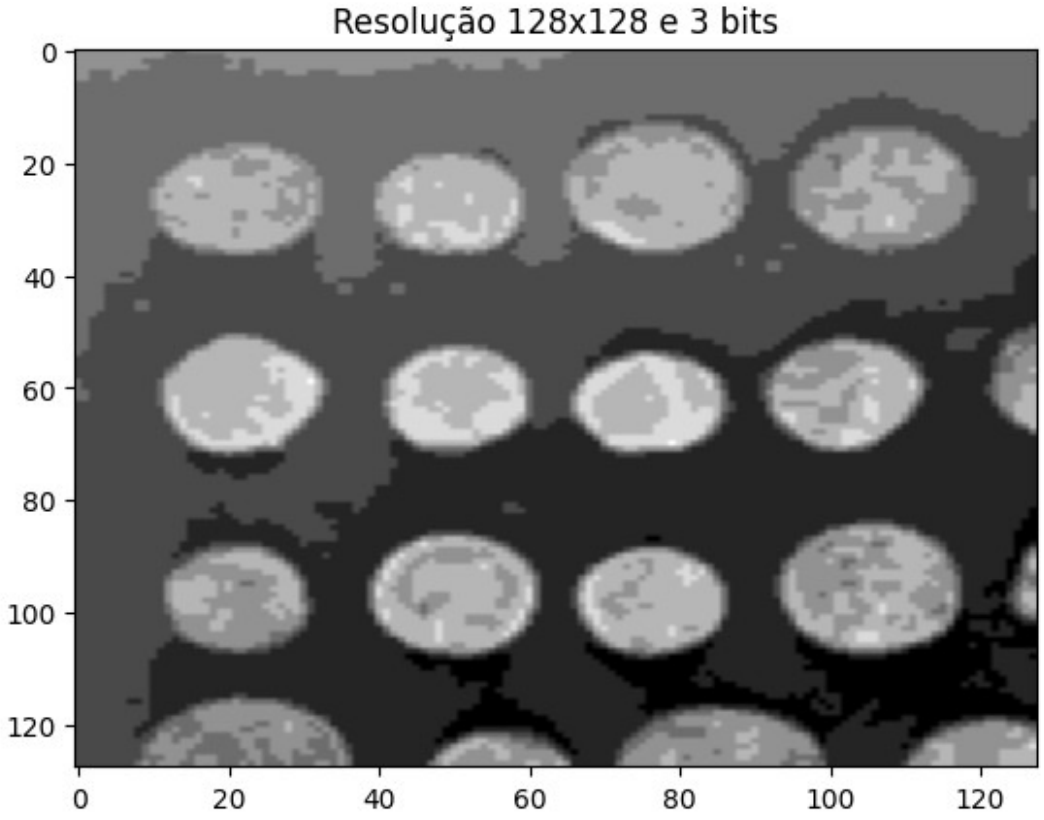
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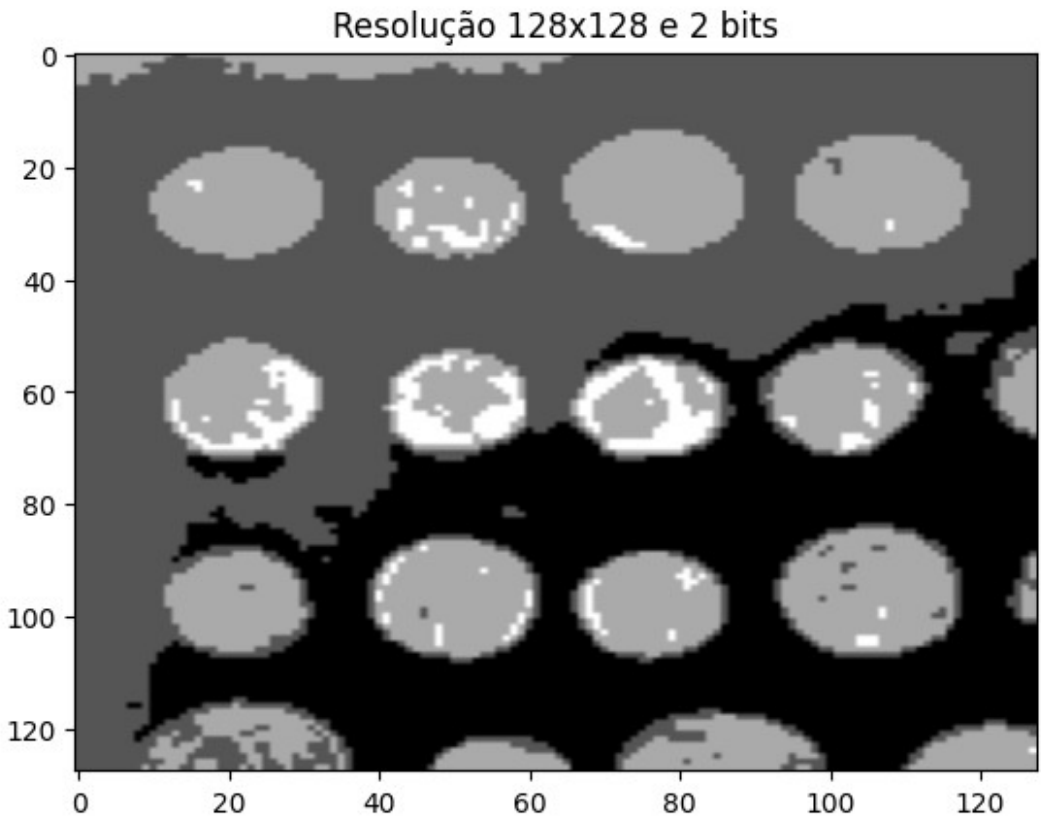
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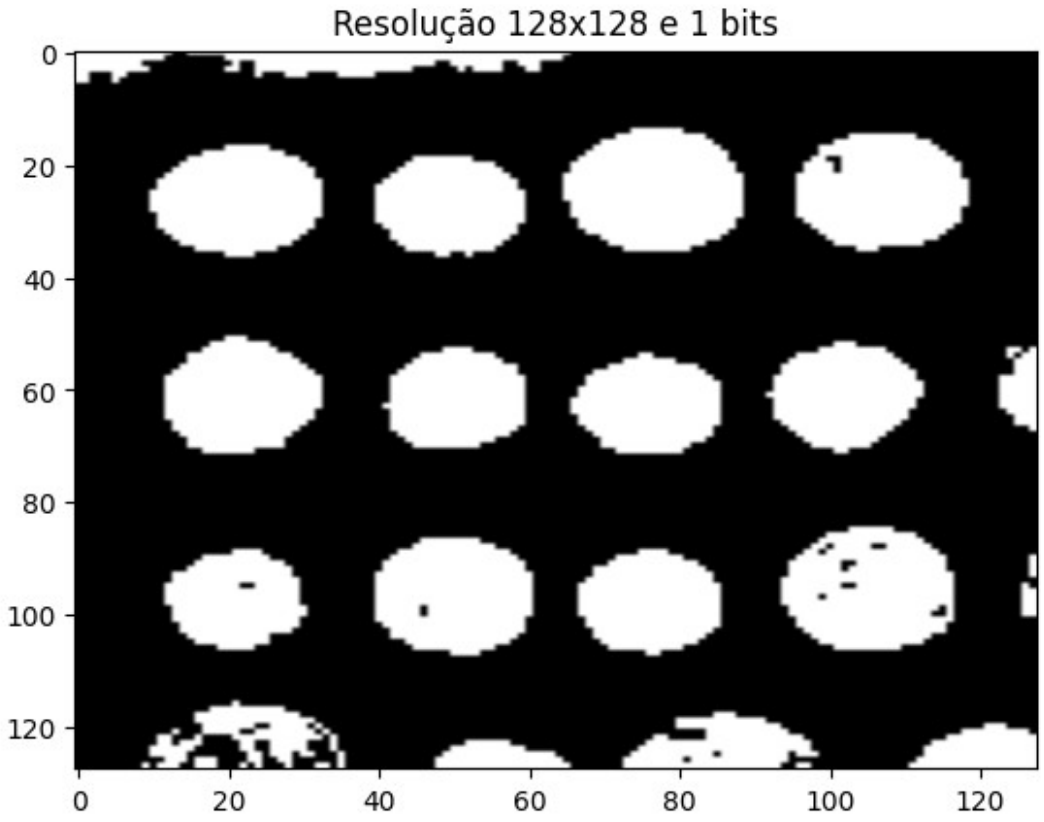
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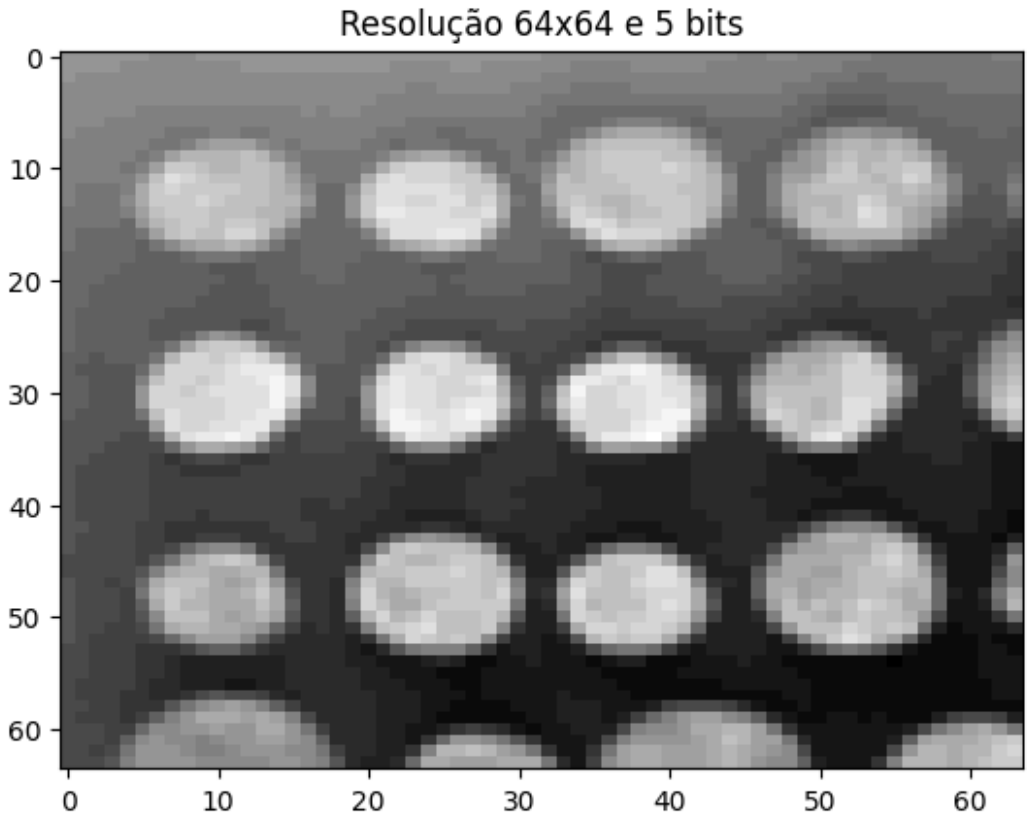
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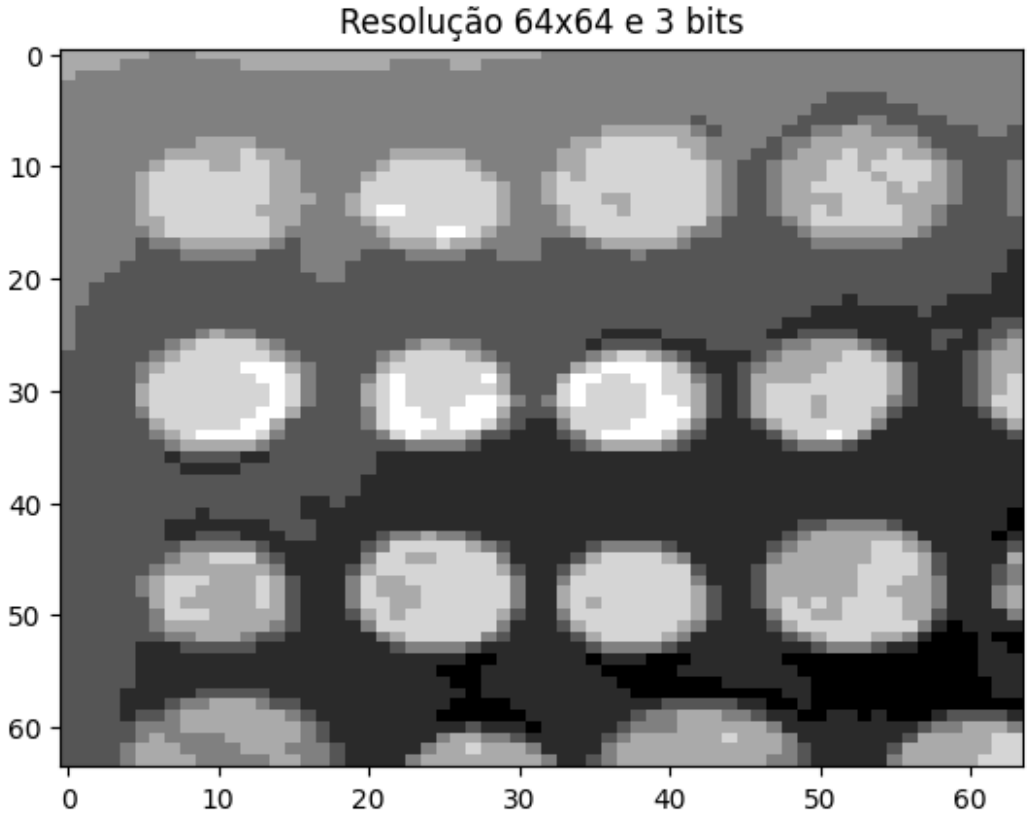
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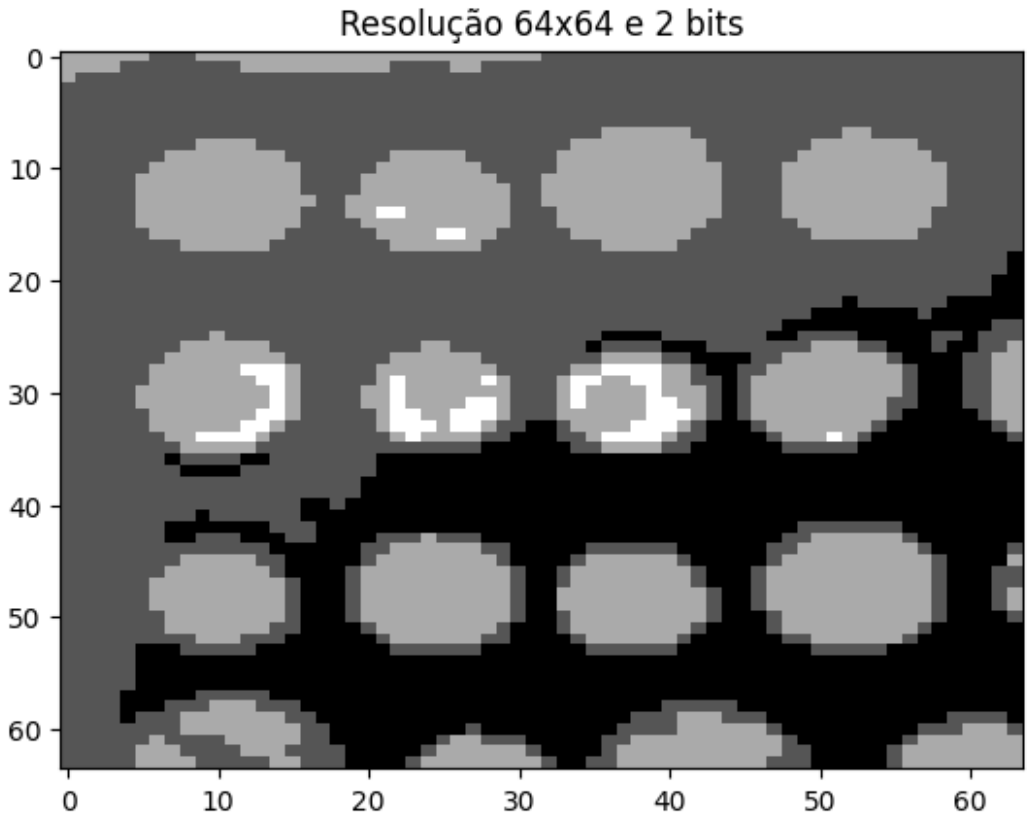
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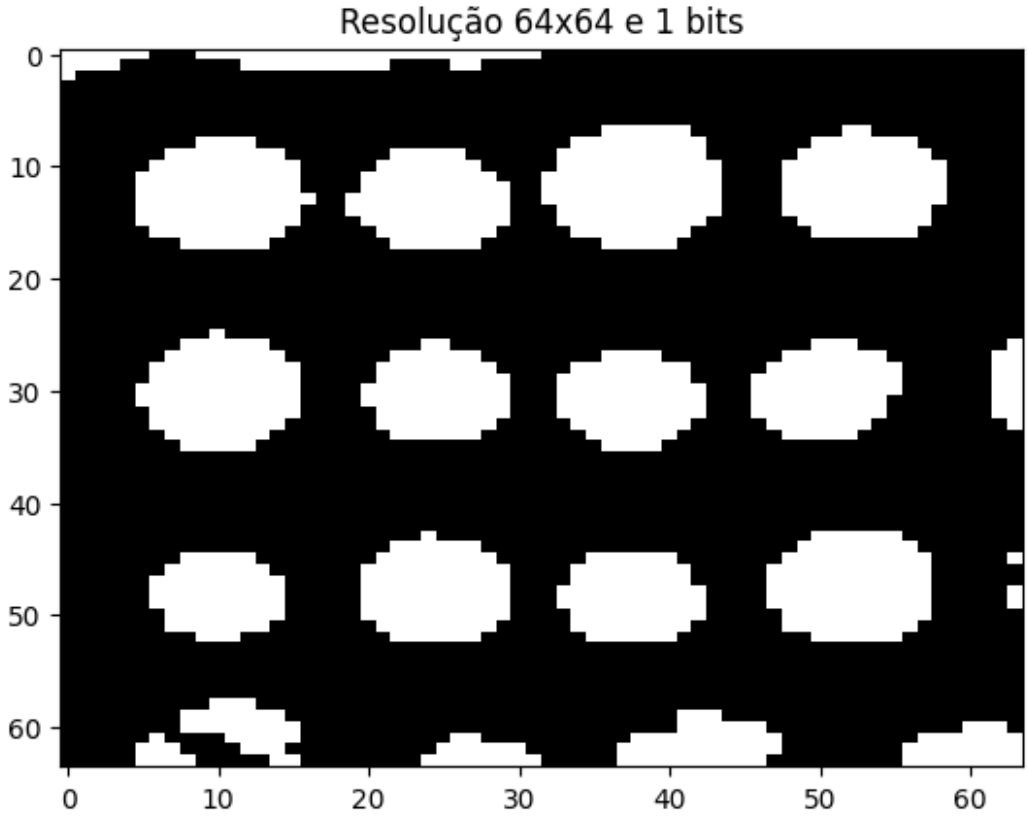
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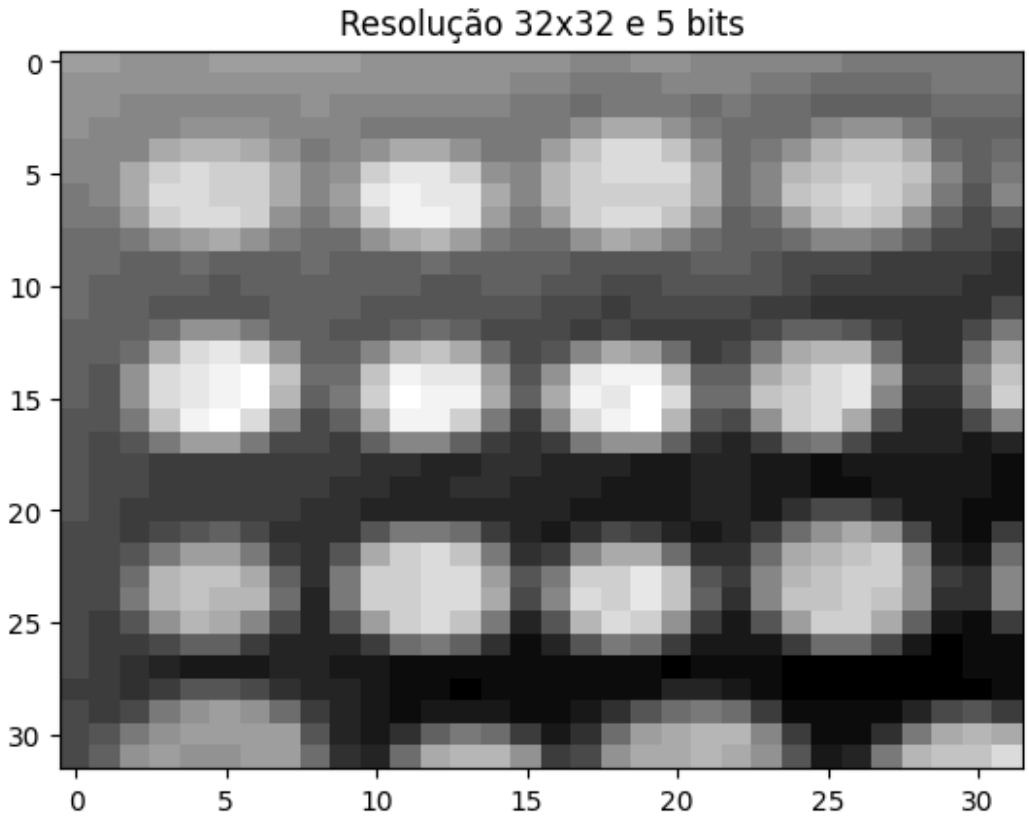
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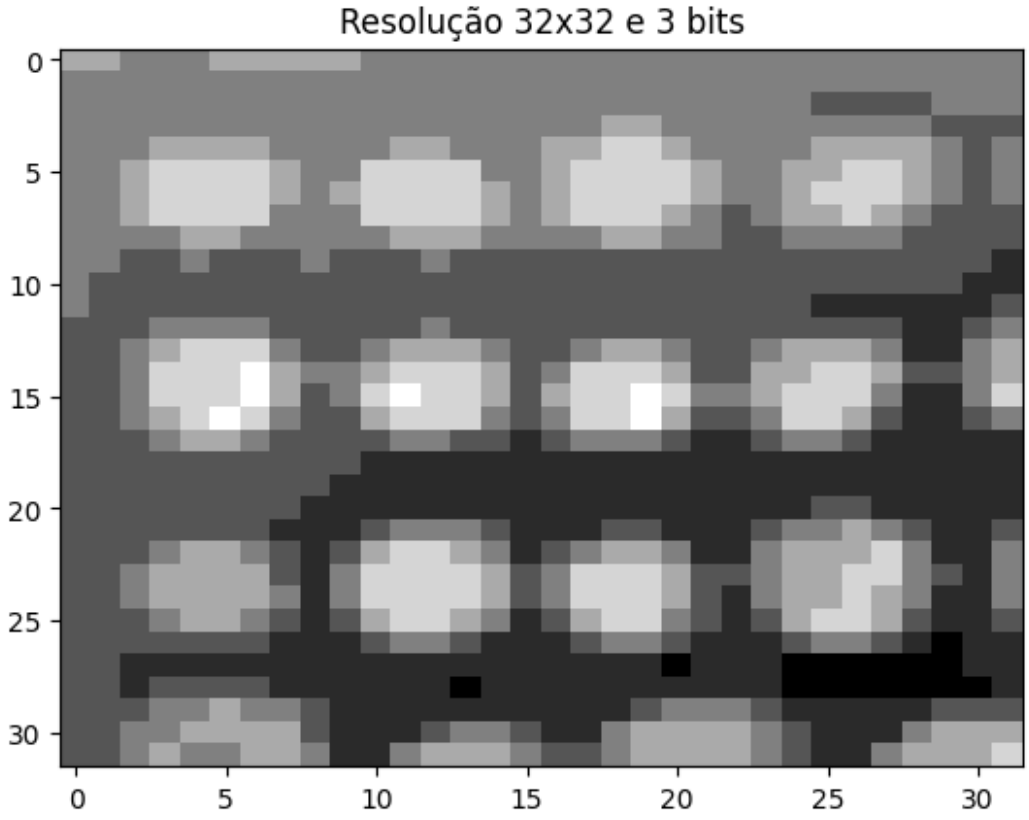
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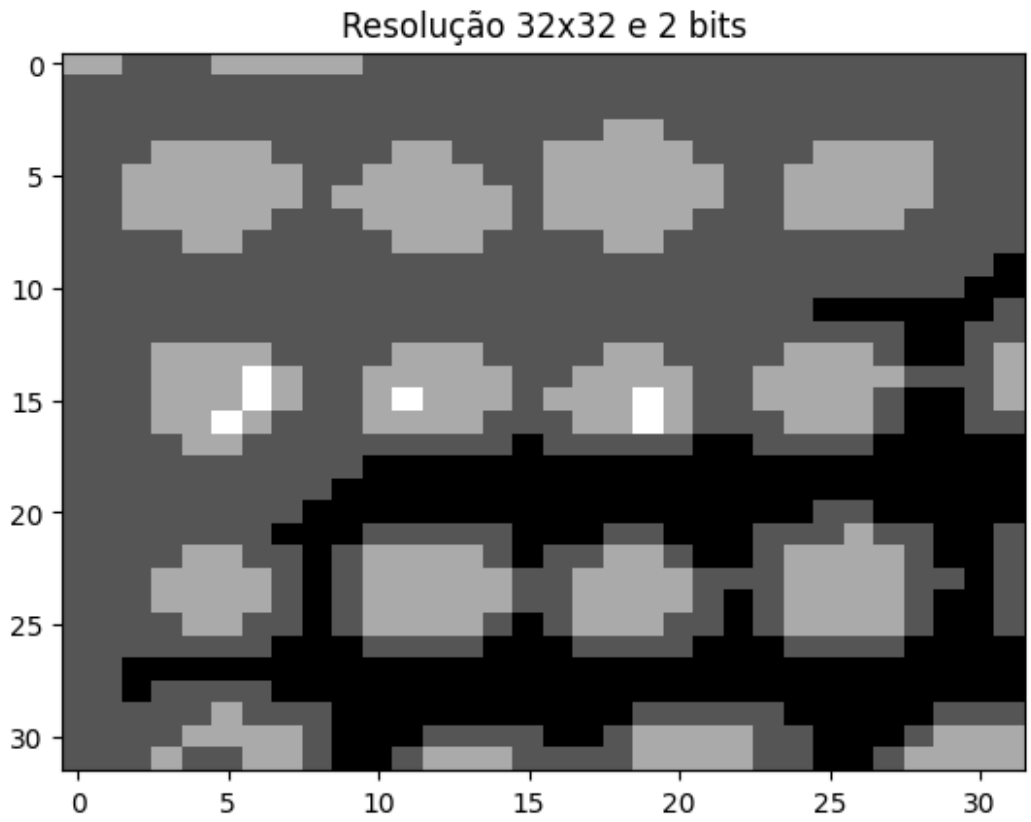
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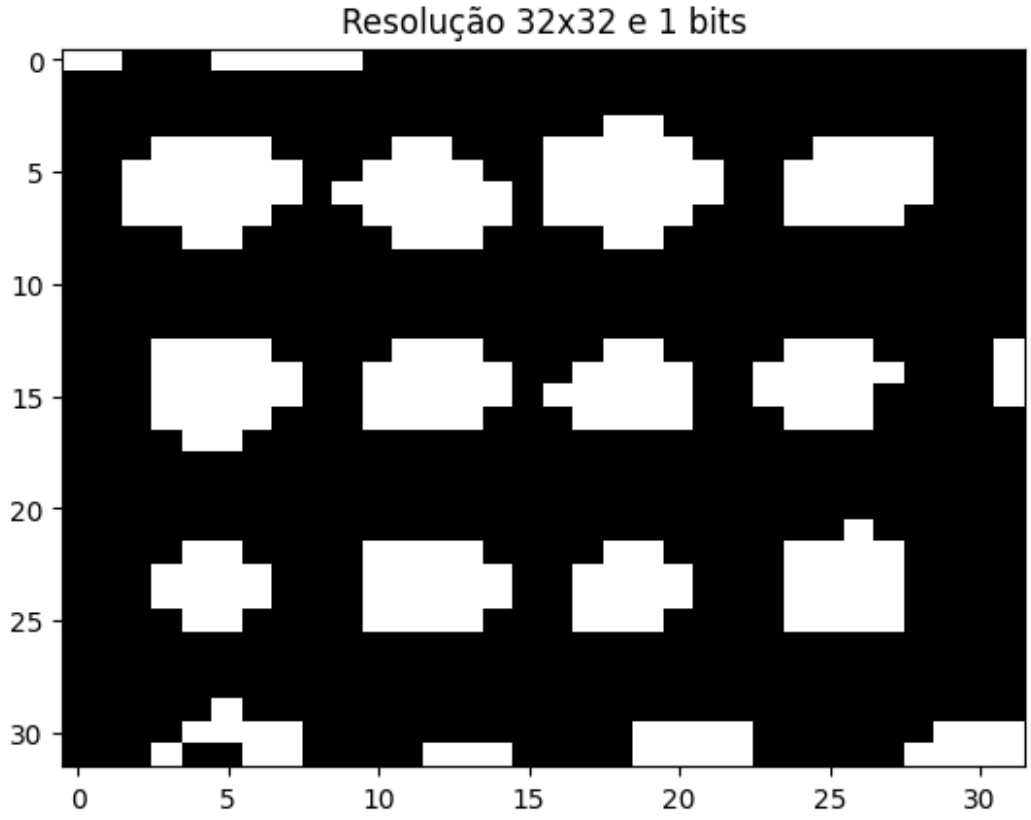
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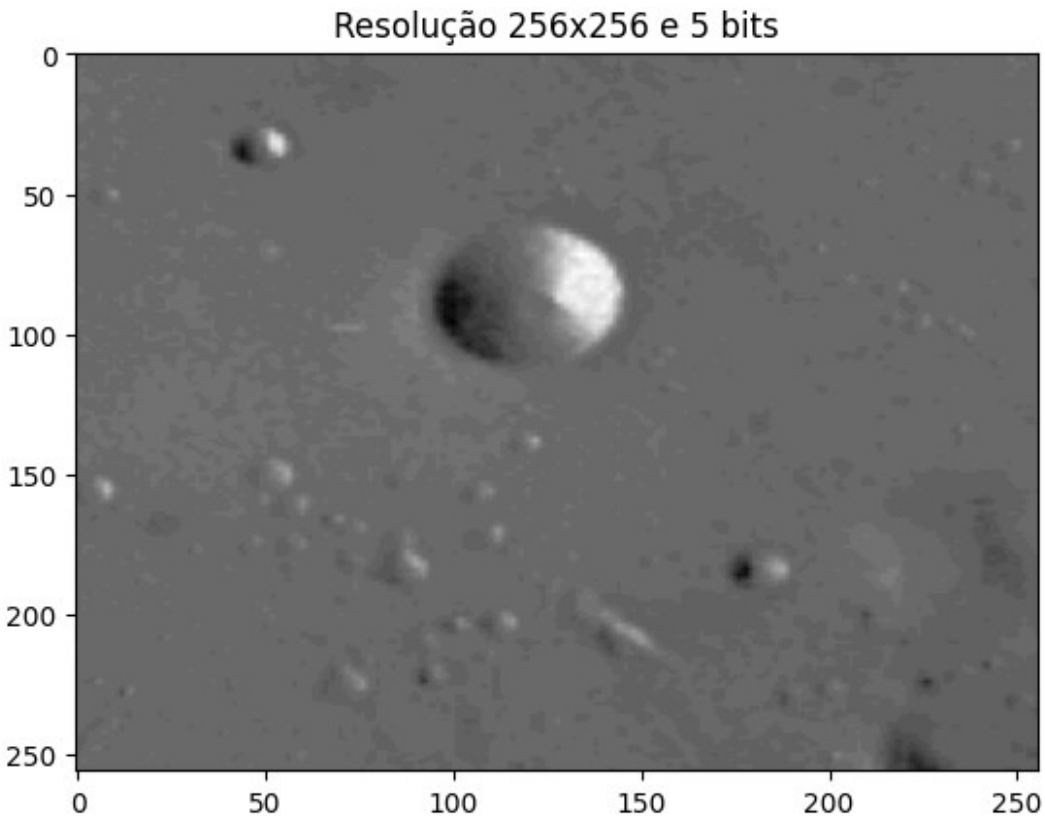
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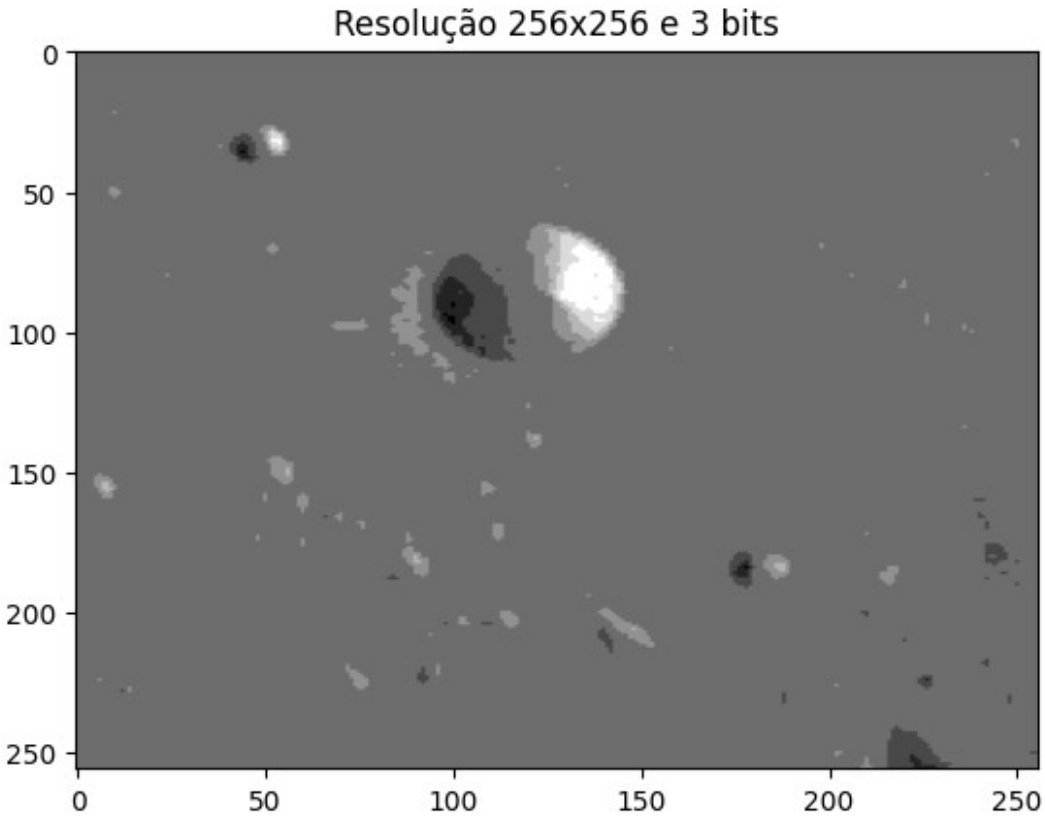
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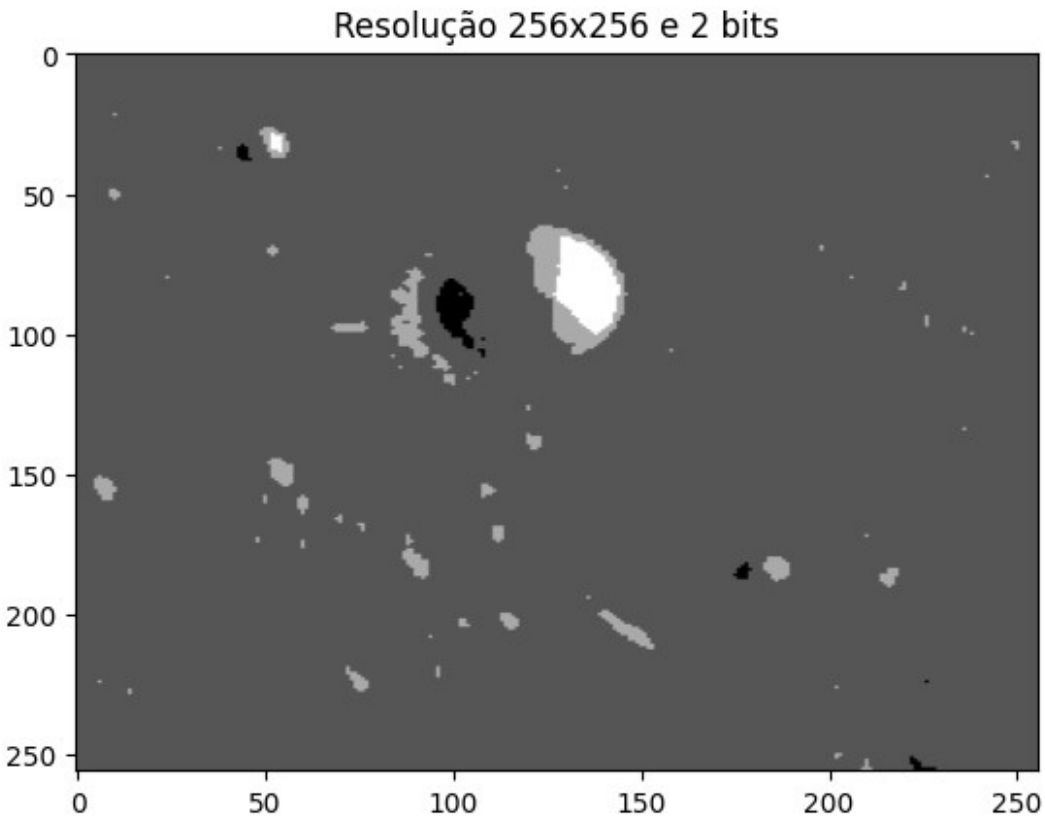
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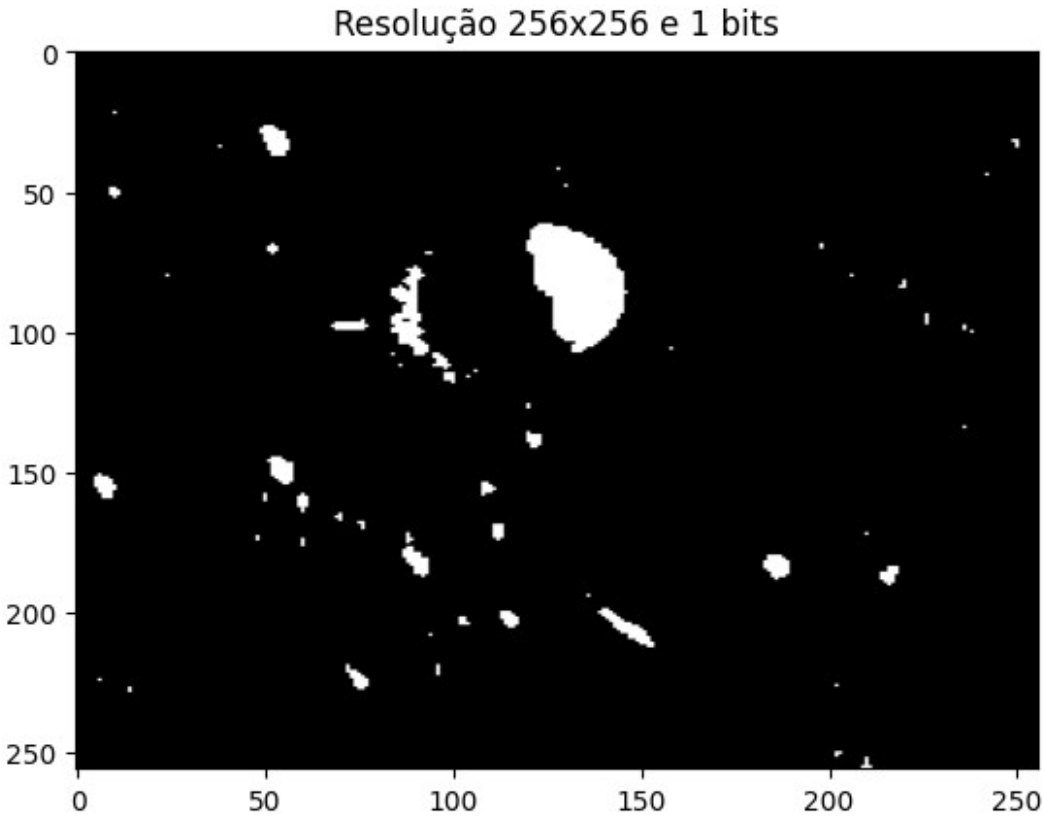
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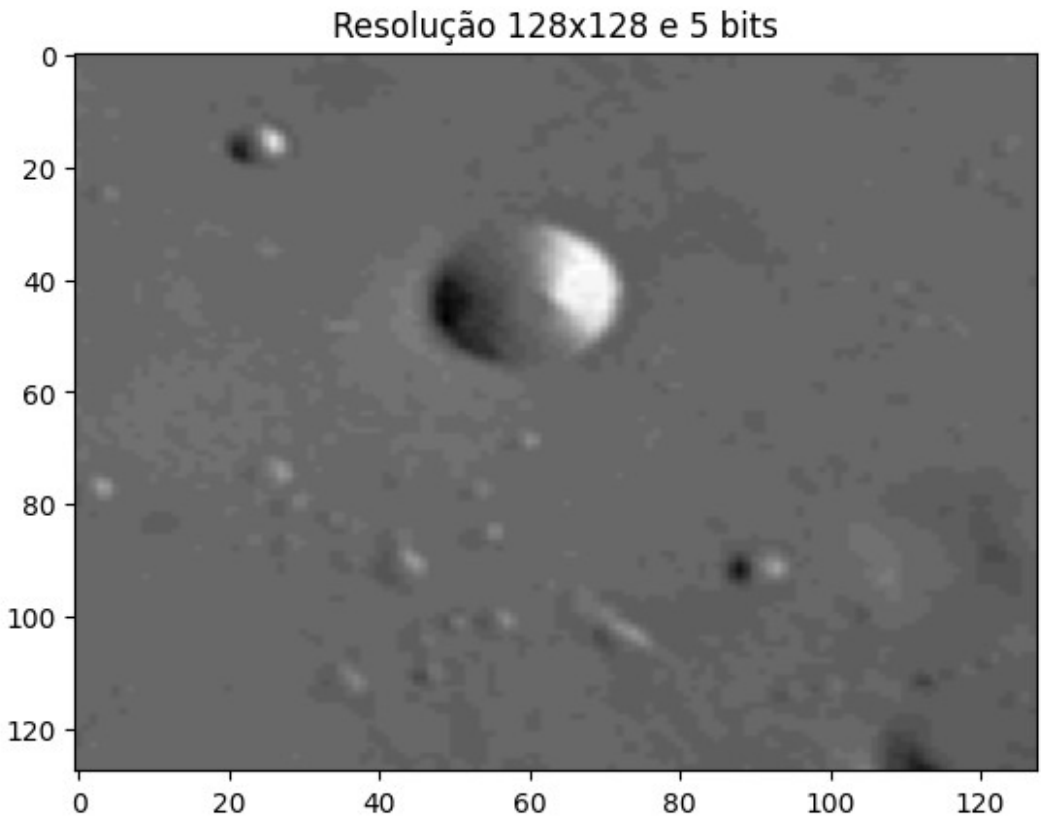
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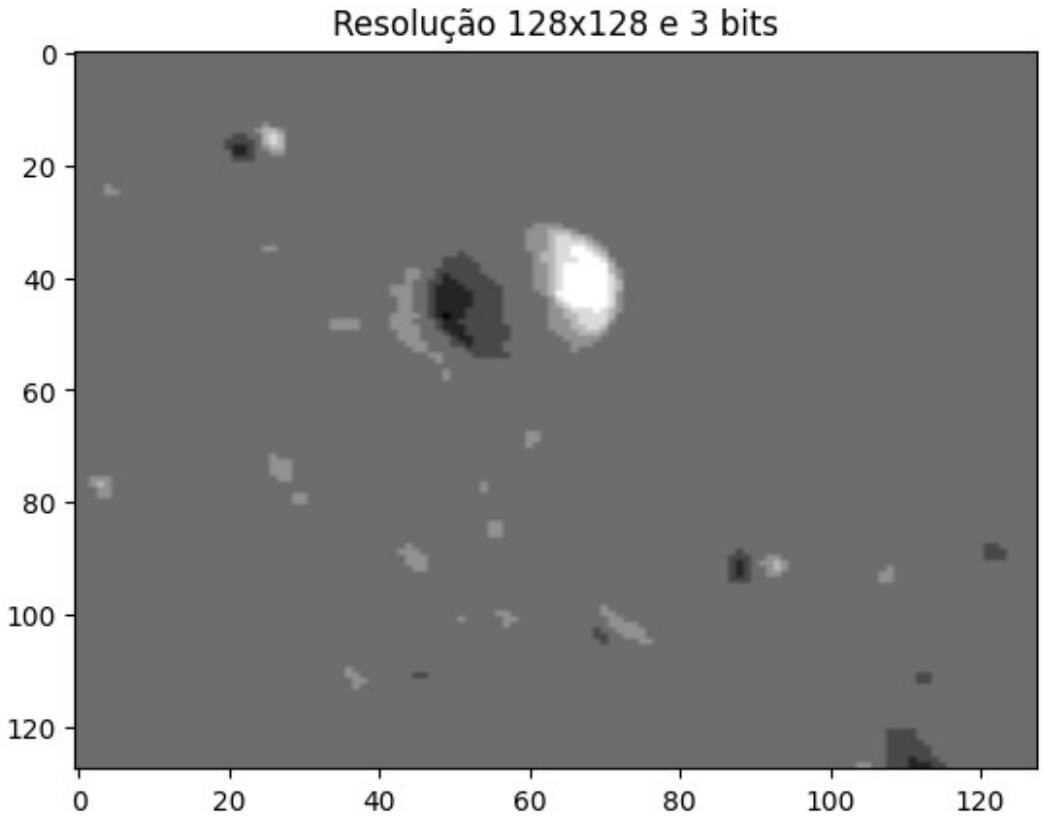
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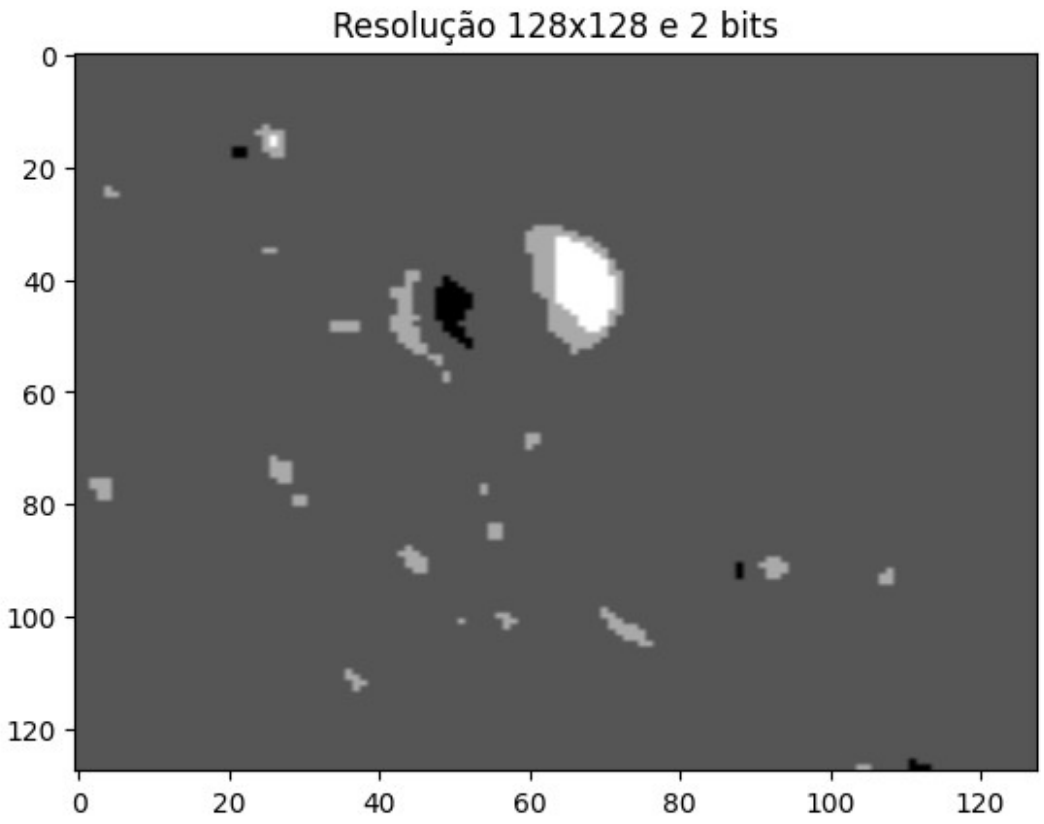
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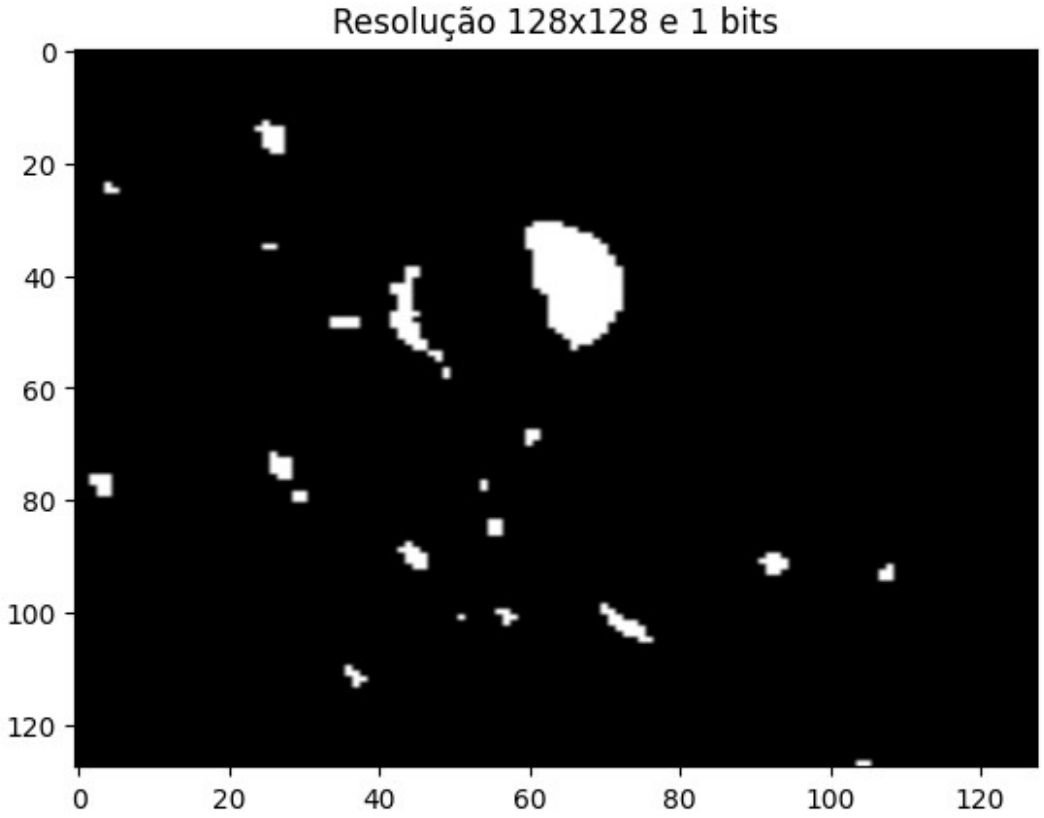
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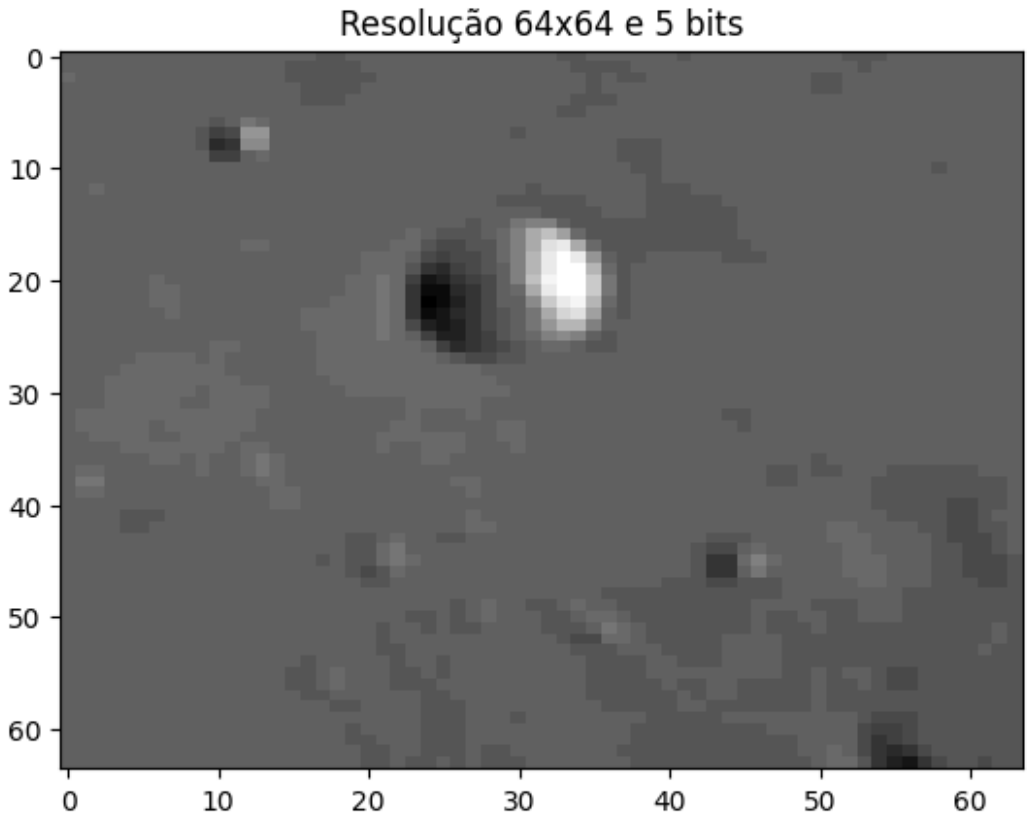
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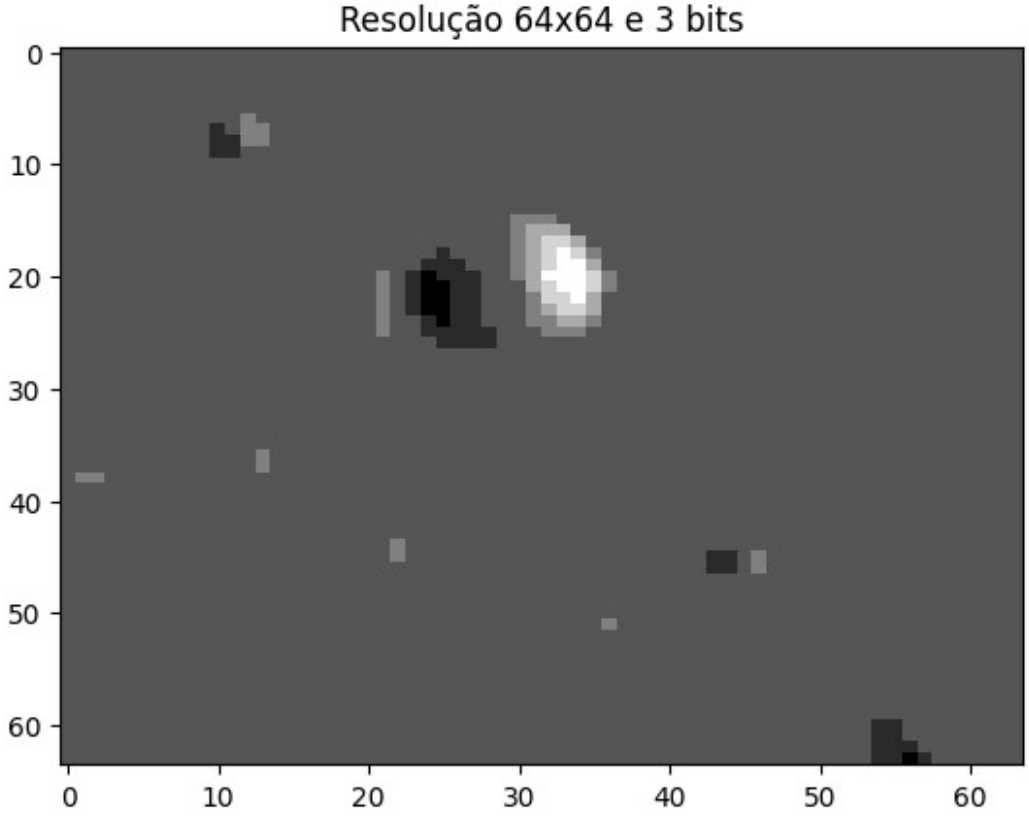
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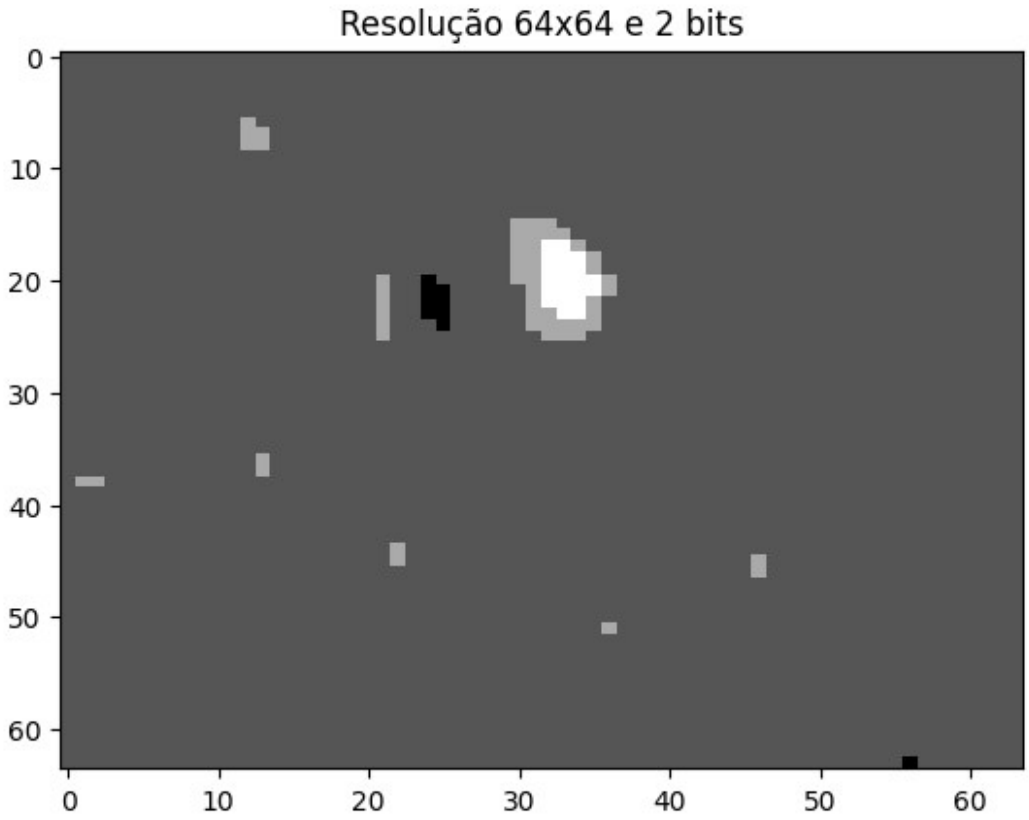
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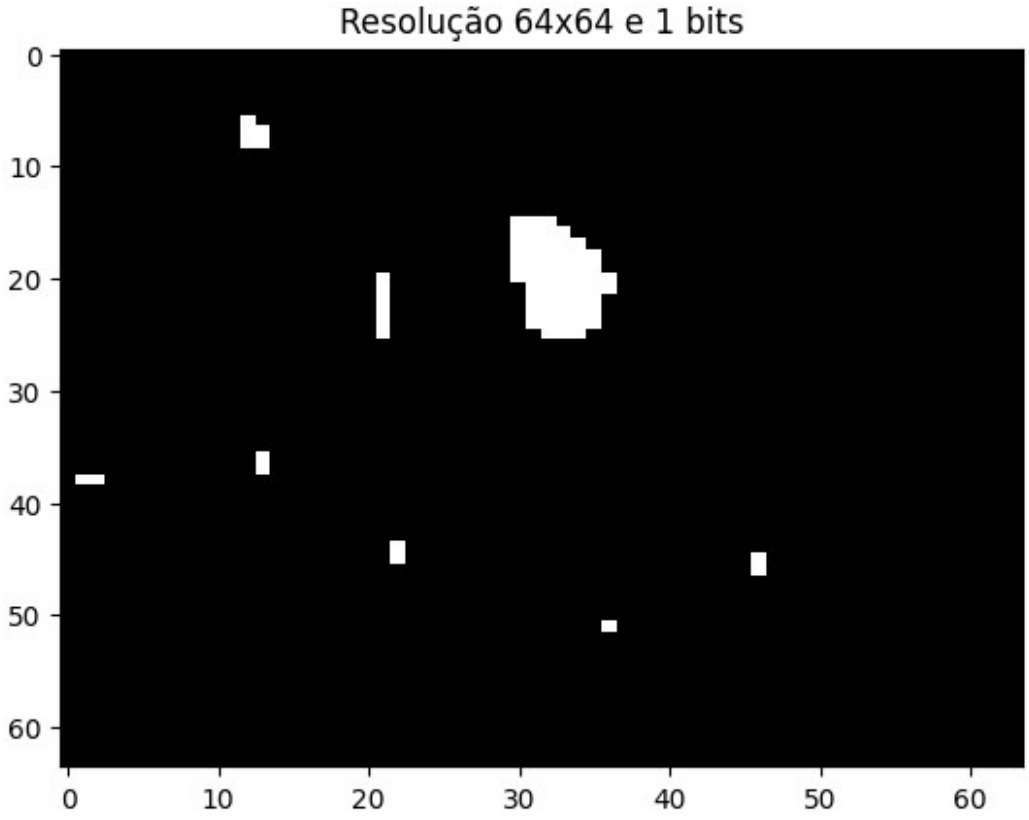
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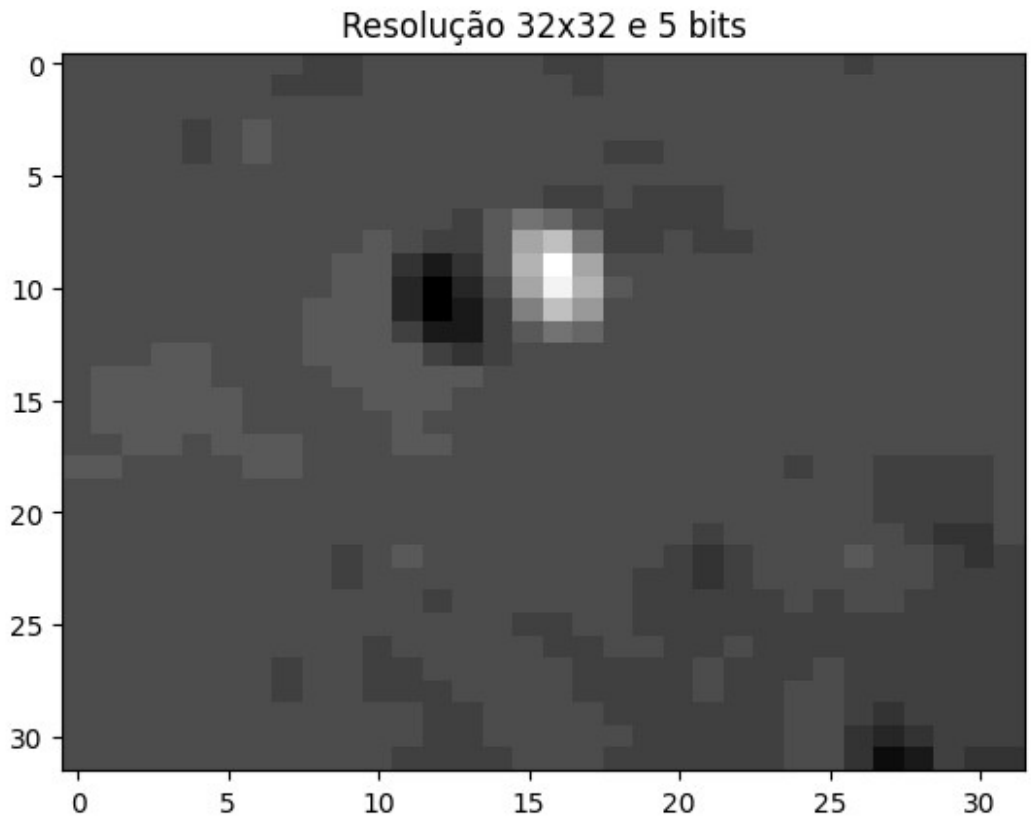
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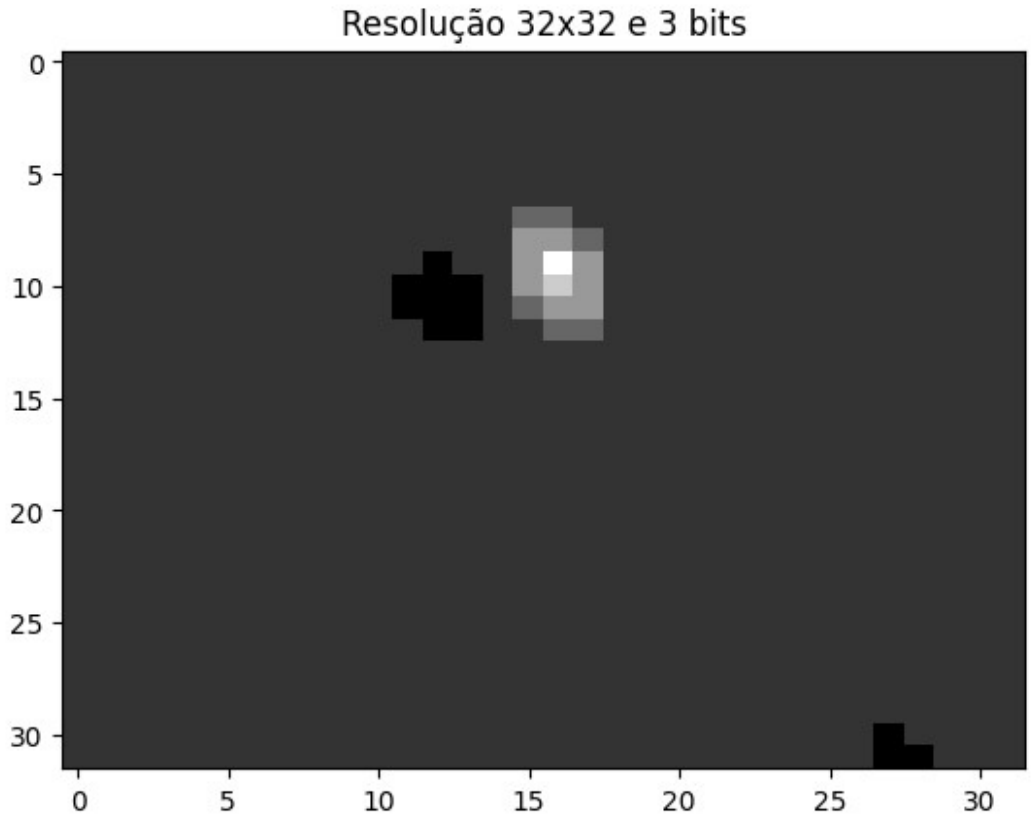
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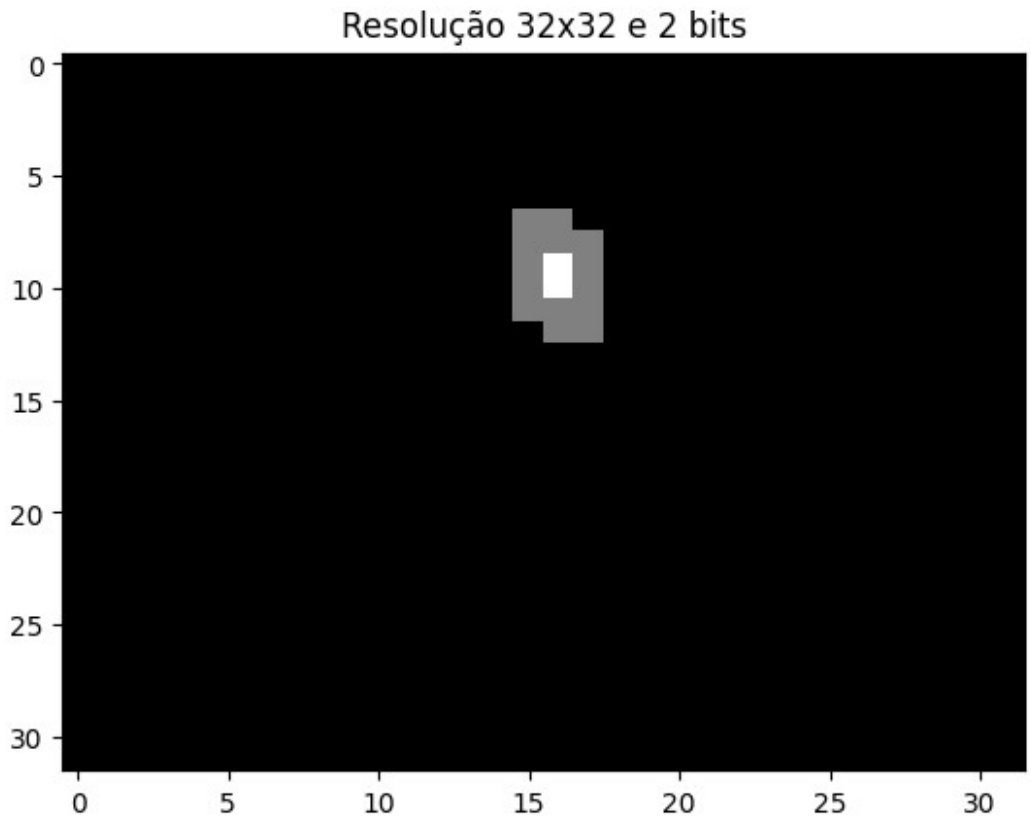
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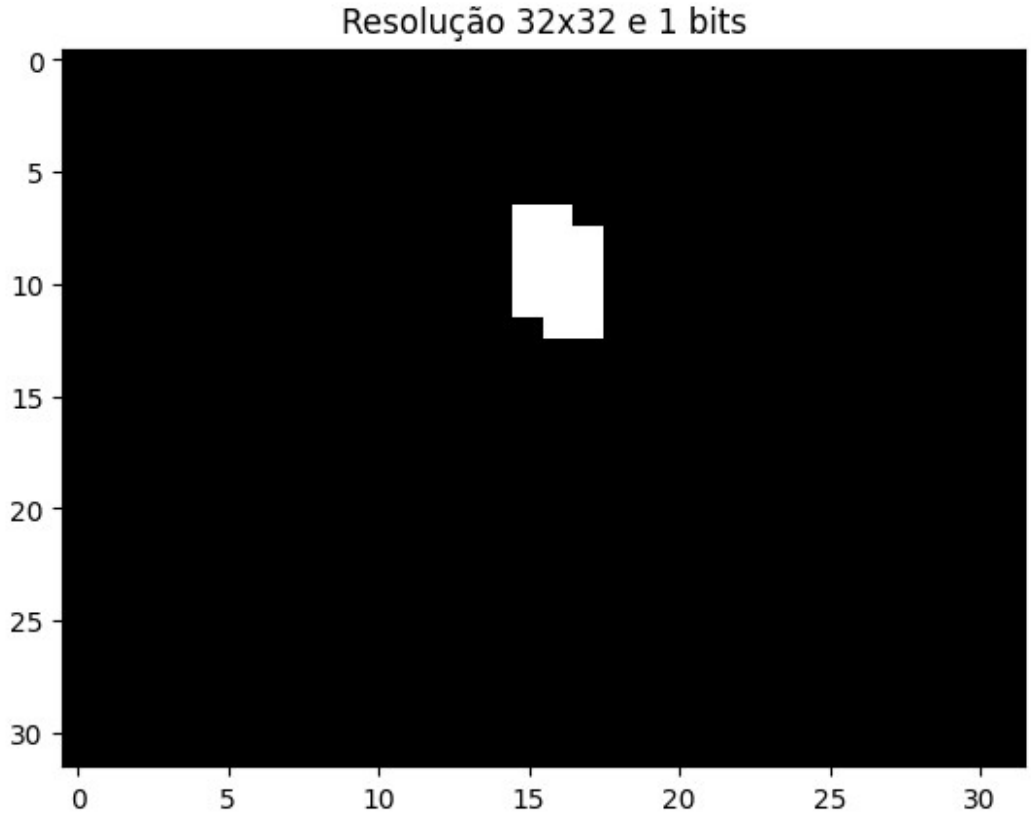
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