Write a program to examine the effect of quantizing the DCT coefficients. For each 8 x 8 block in the image, your program should first calculate the DCT of the block, quantize the coefficients, and then take the inverse DCT. For quantization, use a scaled version of the JPEG quantization matrix as the stepsizes. You only need to do this for a gray scale image or the luminance component of a color image. Furthermore, the program should compute the PSNR of the reconstructed image from quantized DCT coefficients and also count the total number of non-zero coefficients after quantization and derive the average number of non-zero coefficients per block. Your program should show the original and reconstructed image. Examine the resulting image quality with the following values for the scaling factor: 0.5, 1, 2, 4, 8. What is the largest value of the scaling factor at which the reconstructed image quality is very close to the original image? Please also plot PSNR vs. the quantization scaling factor, the number of non-zero coefficients/block vs. the quantization scaling factors, and finally the PSNR vs. the number of non-zero coefficients. Interpret these plots, to comment on the effect of the quantization factor on the image quality and bit rate. Note that you may roughly consider the number of non-zero coefficients to be proportional to the required bits to represent the quantized image. Hint: you may want to make use of the ”blockproc” function in MATLAB to speed up your program. You can use the dct2( ) and idct2( ) functions in MATLAB.

```
close all
clear all
clc
I=imread('lena_gray.bmp');
Qmatrix=[16 11 10 16 24 40 51 61;
    12 12 14 19 26 58 60 55;
    14 13 16 24 40 57 69 56;
    14 17 22 29 51 87 80 62;
    18 22 37 56 68 109 103 77;
    24 35 55 64 81 104 113 92;
    49 64 78 87 103 121 120 101;
    72 92 95 98 112 100 103 99];

A=mycompress1(I,Qmatrix,0.5);
B=mycompress1(I,Qmatrix,1);
C=mycompress1(I,Qmatrix,2);
D=mycompress1(I,Qmatrix,4);
E=mycompress1(I,Qmatrix,8);
F=mycompress1(I,Qmatrix,16);

fun = @(block_struct) dct2(block_struct.data);
dctImg = blockproc(modeErr, [8 8], fun);
PSNRa = zeros(1,100);
ka = zeros(1,100);
for q = 1:100
    dctImgq = round(dctImg/q)*q + q/2;
```

```
    ka(q) = sum(dctImgq(:) ~= q/2);
    fun = @(block_struct) idct2(block_struct.data);
modeErrq = blockproc(dctImgq, [8 8], fun);
img2q = modePre + modeErrq;
PSNRa(q) = 10*log10((255*255)/mean((img2(:) - img2q(:)).^2));
end
figure(3);
plot(ka, PSNRa);
xlabel('K');
ylabel('PSNR');

figure
imshow(I,[])
title('original')
figure
subplot(1,2,1)
imshow(A,[])
title('QP=0.5')
subplot(1,2,2)
imshow(B,[])
title('QP=1')
figure
subplot(1,2,1)
imshow(C,[])
title('QP=2')
subplot(1,2,2)
imshow(D,[])
title('QP=4')
figure
subplot(1,2,1)
imshow(E,[])
title('QP=8')
subplot(1,2,2)
imshow(F,[])
title('QP=16')


function [ Y ] = mycompress1( I,Qmatrix,QP )
QM=Qmatrix*QP;
fun=@dct2;
A=blkproc(I,[8 8],fun);
fun=@(x)(floor((x+QM/2)./(QM)));
B1=blkproc(A,[8 8],fun);
B2=blkproc(B1,[8 8],'x.*P1',QM);
fun=@(x)(round(idct2(x)));
B3=blkproc(B2,[8 8],fun);
Y=B3;
end
```

original

QP=0.5

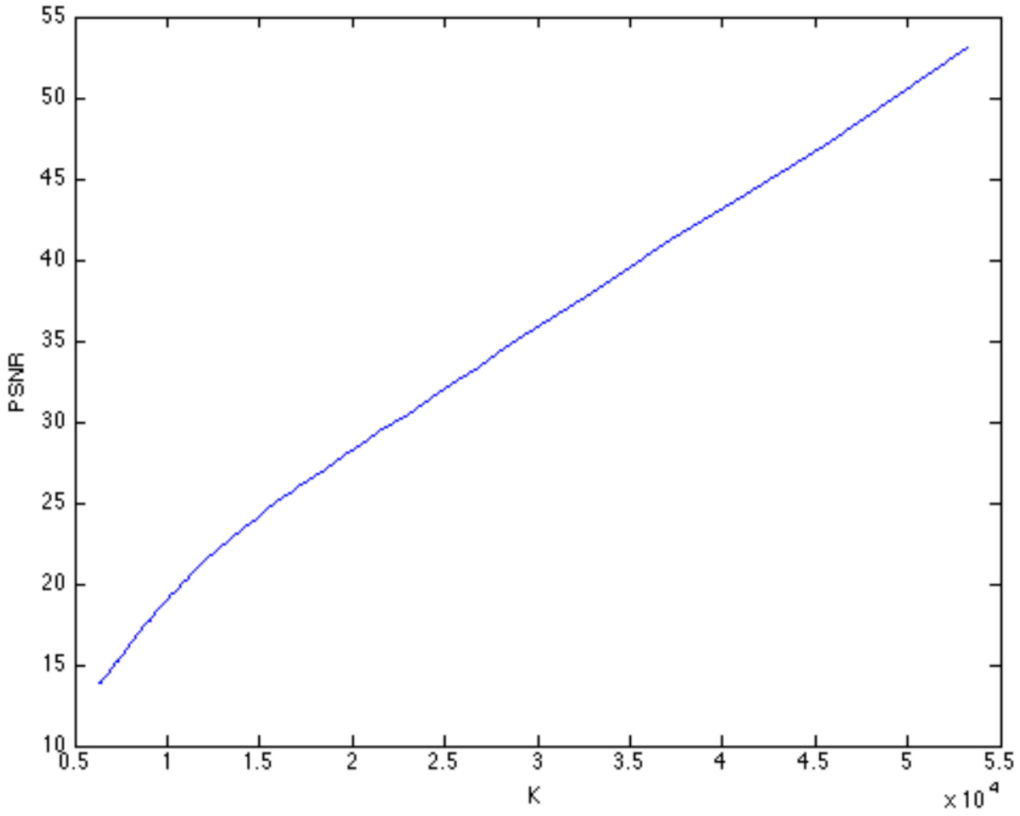
QP=1

QP=2

QP=4

QP=8

QP=16



Therefore, the largest value of the scaling factor is 2 at which the reconstructed image quality is very close to the original image.