

6.003: Signal Processing

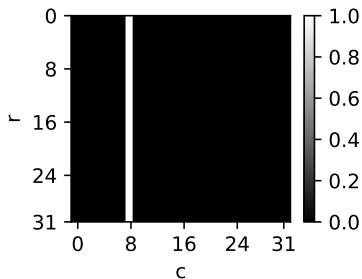
Two-Dimensional DFT

$$F[k_r, k_c] = \frac{1}{RC} \sum_{r=0}^{R-1} \sum_{c=0}^{C-1} f[r, c] e^{-j\left(\frac{2\pi k_r}{R}r + \frac{2\pi k_c}{C}c\right)}$$

$$f[r, c] = \sum_{k_r=0}^{R-1} \sum_{k_c=0}^{C-1} F[k_r, k_c] e^{j\left(\frac{2\pi k_r}{R}r + \frac{2\pi k_c}{C}c\right)}$$

Shapes

Find the 2D DFT of the following vertical bar.

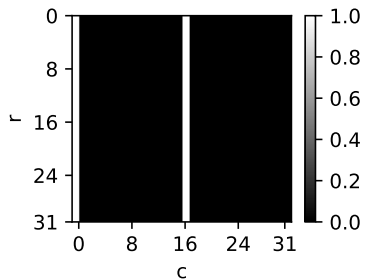


Array indices in numpy are $[r,c]$, where r is row and c is column.

The image is 32×32 pixels. The bar is at $c = 8$.

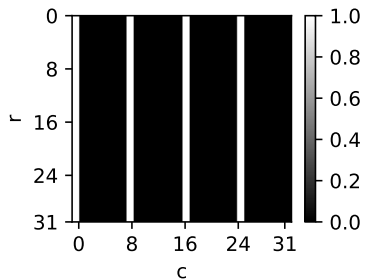
Shapes

Find the 2D DFT of this image, where bars are at $c=0$ and $c=16$.



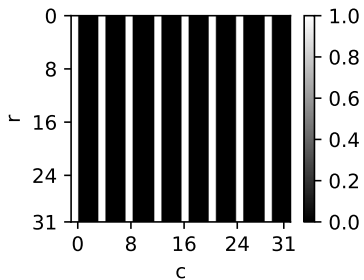
Shapes

Find the 2D DFT of the following image.



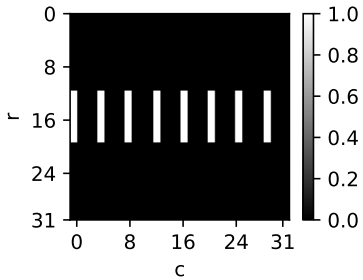
Shapes

Find the 2D DFT of the following image.



Shapes

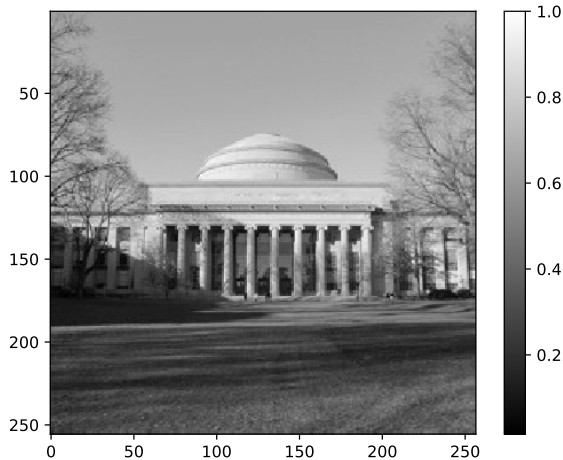
Find the 2D DFT of the following image.



What is the effect of the height of the bars?

Columns

Design a filter to erase the columns from building 10.

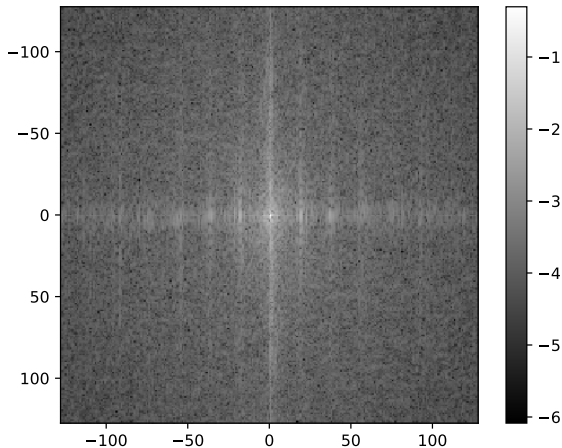


What are the distinguishing feature(s) of the columns?

Columns

The columns are periodic, with period of about 13.9 pixels.

The columns give rise to vertical stripes in the DFT (shown below).



What is the corresponding spacing of the lines in the DFT?