6.300: Signal Processing

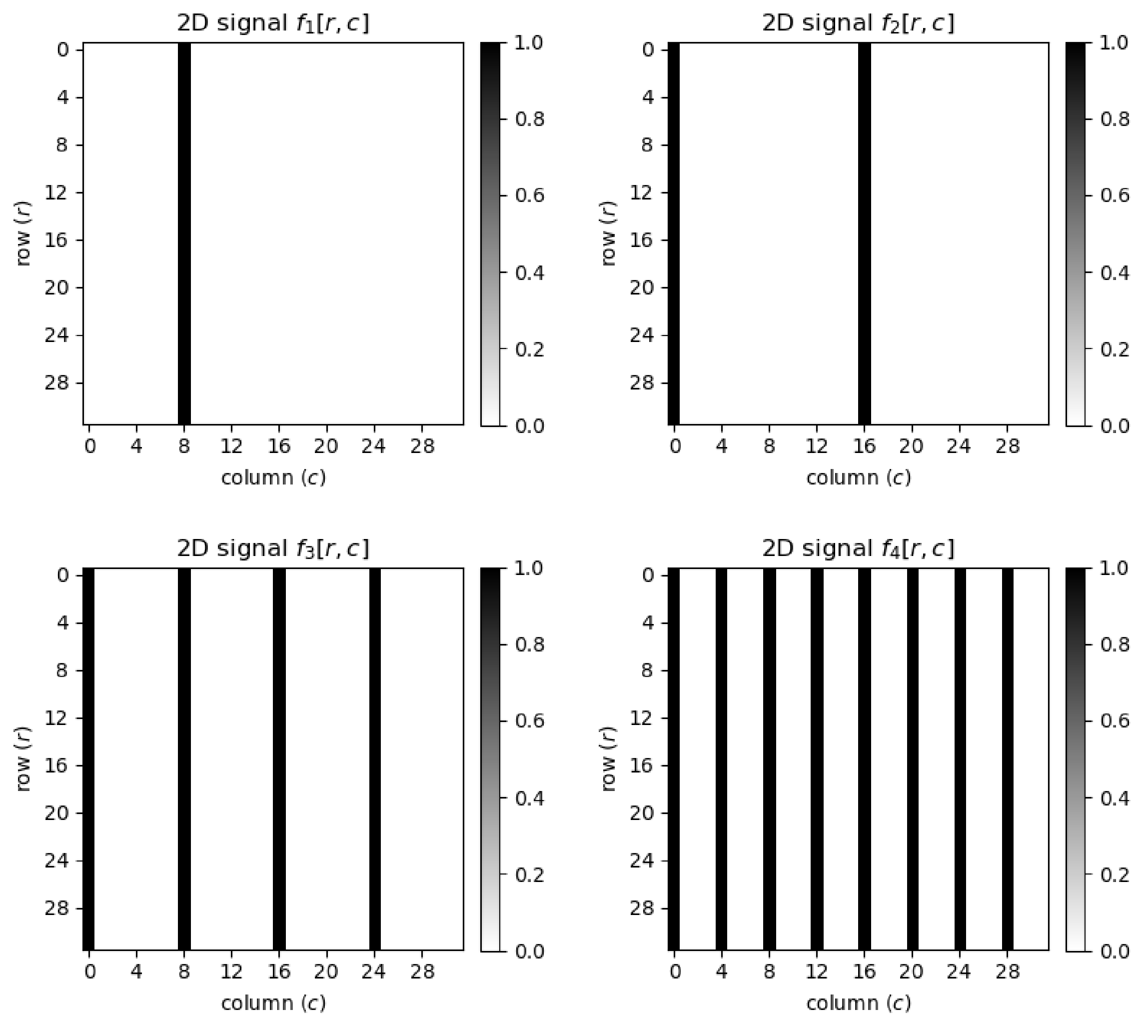
Tutorial Topic 2D Fourier Transforms
Author Titus K. Roesler (tkr@mit.edu)

2D Discrete Fourier Transform

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

Computing 2D Fourier Transforms

Compute the 2D DFT for each image shown below, where $R = C = 32$.
Solutions are given on the next page. Don't look until you've finalized your answer for each problem.



Solutions: 2D Discrete Fourier Transform Expressions

$$f_1[r,c] = \delta[c-8] \qquad F_1[k_r,k_c] = \tfrac{1}{32}\delta[k_r]e^{-jk_c\frac{2\pi}{32}8}$$

$$f_2[r,c] = \delta[c] + \delta[c-16] \qquad F_2[k_r,k_c] = \tfrac{1}{32}(1+(-1)^{k_c})\delta[k_r]$$

$$f_3[r,c] = \sum_{m=0}^{3}\delta[c-8m] \qquad F_3[k_r,k_c] = \tfrac{1}{8}\delta[k_r]\delta[k_c \bmod 4]$$

$$f_4[r,c] = \sum_{m=0}^{7}\delta[c-4m] \qquad F_4[k_r,k_c] = \tfrac{1}{4}\delta[k_r]\delta[k_c \bmod 8]$$

Solutions: 2D Discrete Fourier Transform Plots