1 Combinations

Consider the following 2-D signals (labeled A through D) with the following properties:
• black represents a value of 0, and white represents a value of 1
• the origin \((n_x = 0, n_y = 0)\) is in the lower-left corner
• the image is 63 pixels wide and 63 pixels tall
• all lines are white and one pixel wide

For each of the combinations of signals below (where \(+\) denotes element-wise addition, \(\times\) denotes element-wise multiplication, and \(\bigcirc\) denotes circular convolution), indicate which of the numbered images at the bottom of this page best matches the DFT coefficient magnitudes of that combination.

Each plot below shows the magnitude of the DFT coefficients associated with some 2-D signal. In each, \((k_x = 0, k_y = 0)\) is in the center of the image. Black represents 0, and pure white represents the highest value in the image (not necessarily 1).
2 Filtering

Consider the following image, which we’ll refer to as $x[n_x, n_y]$. This image has height $N_y$ and width $N_x$. The origin is in the center of the image, with $x$ pointing to the right and $y$ pointing down.

In addition, consider several other signals:

$$H_1[k_x, k_y] = j \sin \left( \frac{10\pi k_y}{N_y} \right)$$

$$h_2[n_x, n_y] = \sin \left( \frac{10\pi n_y}{N_y} \right)$$

For each of the expressions below, indicate which of the images on the following page is represented by that expression. In each of those images, black represents the lowest value (not necessarily 0), and white represents the highest value (not necessarily 1).

$$(x \times h_1)[n_x, n_y]$$

$$(x \times h_2)[n_x, n_y]$$

$$(x \odot h_1)[n_x, n_y]$$

$$(x \odot h_2)[n_x, n_y]$$