

CAP 5415: Lecture 3 Worksheet

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Basic Equations

Assumptions: 1D image with N pixels. Use circular boundary handling.

Convolution of image $f[x]$ with kernel $k[x]$:

$$f[x] * k[x] = \sum_{n=0}^{N-1} f[n]k[n-x] \quad (1)$$

Discrete Fourier Transform:

$$F[u] = \sum_{x=0}^{N-1} f[x]e^{-2\pi j \frac{ux}{N}} \quad (2)$$

Inverse Transform:

$$f[x] = \frac{1}{N} \sum_{u=0}^{N-1} F[u]e^{2\pi j \frac{ux}{N}} \quad (3)$$

Euler's Equation:

$$e^{j\theta} = \cos \theta + j \sin \theta \quad (4)$$

Trig:

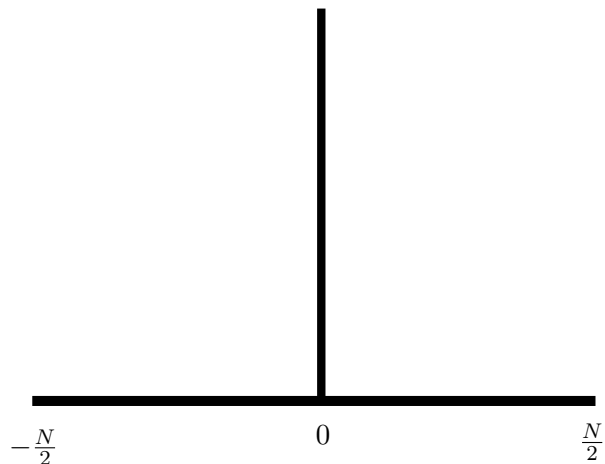
$$\cos(-\theta) = \cos(\theta) \quad (5)$$

$$\sin(-\theta) = -\sin(\theta) \quad (6)$$

$$(7)$$

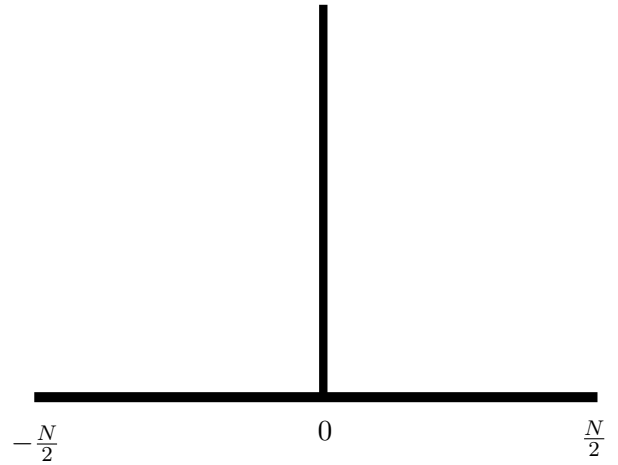
Problem 1:

Calculate the DFT of a signal of length, f , N , with $f[0] = 1$ and the $f[1 \dots N-1] = 0$. Sketch the magnitude on the axes. The magnitude will be a discrete function, but you can sketch it as a continuous function if you would like.



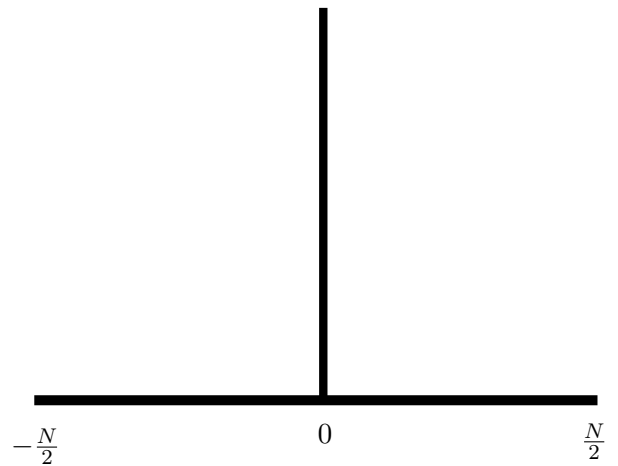
Problem 2:

Calculate the DFT of a signal, f , of length N , with $f[0 \dots N - 1] = 1$. Sketch the magnitude on the axes. The magnitude will be a discrete function, but you can sketch it as a continuous function if you would like.



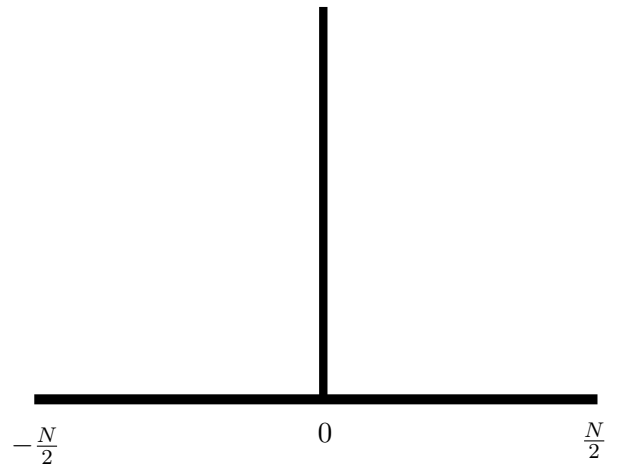
Problem 3:

Calculate the DFT of a signal of length N , with $f[0] = 1$, $f[1] = 1$, and $f[N - 1] = 1$. Sketch the magnitude on the axes. The magnitude will be a discrete function, but you can sketch it as a continuous function if you would like.



Problem 4:

Calculate the DFT of a signal of length N , with $f[0] = -1$ and $f[1] = 1$. Sketch the magnitude on the axes. The magnitude will be a discrete function, but you can sketch it as a continuous function.



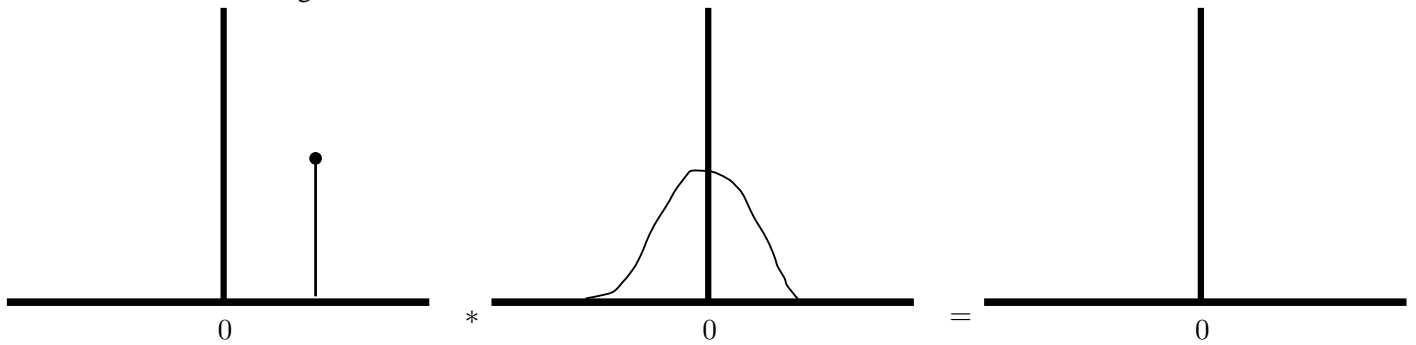
Problem 5:

Calculate the DFT of the signal $f = [1\ 0\ 0\ 0\ 1\ 0\ 0\ 0]$. The resulting DFT will also be length 8.

Sampling

Problem: Shifting

If you convolved these two signals with each other, draw the result:



Problem: Shifting and Replicating

If you convolved these two signals with each other, draw the result:

