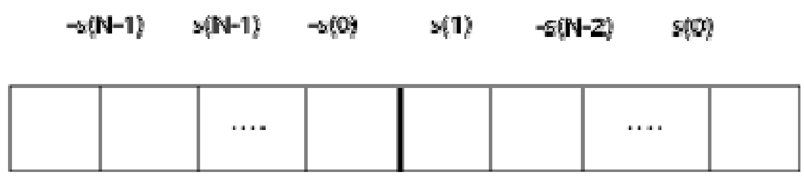
Supplement to Chapter 4 of *The Science of Digital Media* – Digital Audio Representation

Worksheet – Digital Audio > Comparison of Discrete Cosine Transform and Discrete Fourier Transform[1]

Before completing this worksheet, you should view the on-line interactive tutorial “Comparison of DFT and DCT.” This tutorial can be accessed at the website for *The Science of Digital Media*.

1. Explain what the terms "even" and odd” means with respect to functions. When applied to sine and cosine functions, what does this tell us about the mathematical difference between the DCT and the DFT?

2. Fill in the following array with the array elements given below. This array represents the expanded array used by the DCT in its computations. Then explain what this array means. Does the DCT *actually* form this array?



3. Explain what “periodic” means in reference to the discrete Fourier transform and the discrete cosine transform. In what sense does each transform treat a wave as periodic?

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4. By combining the DFT with the Nyquist theorem, you have learned that only some of the frequency components that result from the transform are guaranteed to be free from aliasing. Solve the following equation for *k* and find what portion of the *N* values in the result array are valid according to the Nyquist theorem.

$$\frac{k}{T} = \frac{f}{2}$$ where *f* is the sampling rate

$k =$

5. Consider a 150 Hz wave that is sampled at *f* = 1000 samples/second. The Fourier transform will be applied to a window of *N* = 1024 samples. Calculate the total period of the wave (*T*) and 1/*T*, which is the frequency range for each frequency component. Apply the formula that you derived in the previous problem to calculate the cutoff value of *k*. Multiply this value by the 1/*T* value and compare this to the Nyquist frequency as 1/2 of the sampling frequency.

   T =

   1/*T* =

   k =

   (1/*T*)**k* =

   Nyquist frequency =

6. Explain the relationship between the DCT and the DFT with regards to phase. Which of the transforms captures phase information?

7. Explain how the following equation – the magnitude/phase form of the DFT – helps to understand how the DFT captures phase information. Identify what part of the equation represents magnitude and what part represents phase.

$$\boldsymbol{f}_k = \sum_{n=0}^{N-1} \boldsymbol{A}_n \cos(2\pi nk + \phi_n)$$