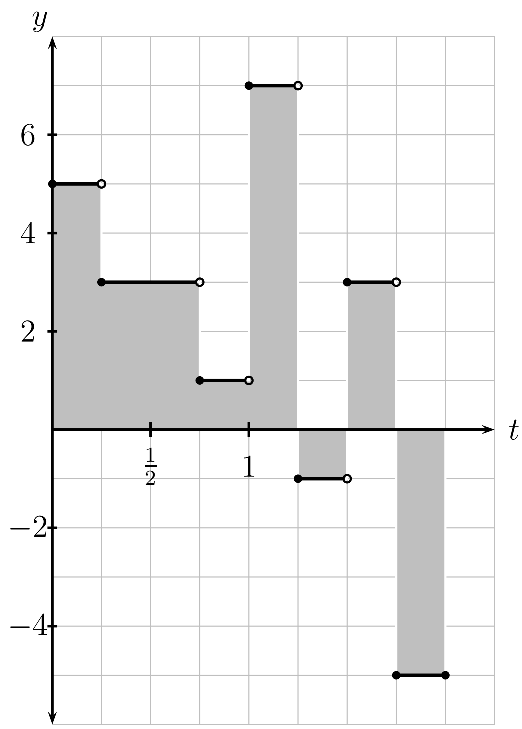
Math 342 SIGNAL PROCESSING EXERCISES 2 **Spring 2016**

When someone talks about a "signal," they simply mean a function. If it is an audio signal, the function will be of just one variable, time. If the signal is a picture, it will be a function of two space variables. Suppose that we have the audio signal shown to the right. What you are going to do is "analyze" the signal by finding its coordinate vector with respect to two orthogonal bases, the Walsh functions $\mathcal{W}$ and the Haar wavelets $\mathcal{H}$. The coordinate vector with respect to $\mathcal{W}$ is analogous to the **Fourier transform**, and the coordinate vector with respect to the Haar basis is an example of what is called a **wavelet transform**. As you will see, the reason for transforming to another basis is that we can get information from the transformation that we can't get from the signal itself, or its coordinate vector with respect to the standard basis.



1. The standard basis for a step function like the one shown (let's call if f) is the same as the one you used for step functions on $[0,1]$ but with four additional functions taking the value one on the intervals $[1, \frac{5}{4})$, $[\frac{5}{4}, \frac{3}{2})$, and so on. Give the coordinate vector for f with respect to the standard basis.

2. Find the change of basis matrices $[P]_{\mathcal{E},\mathcal{W}}$ and $[P]_{\mathcal{E},\mathcal{H}}$ for the Walsh and Haar bases given on the additional page. Then apply them to $[f]_{\mathcal{E}}$ to find $[f]_{\mathcal{W}}$ and $[f]_{\mathcal{H}}$.

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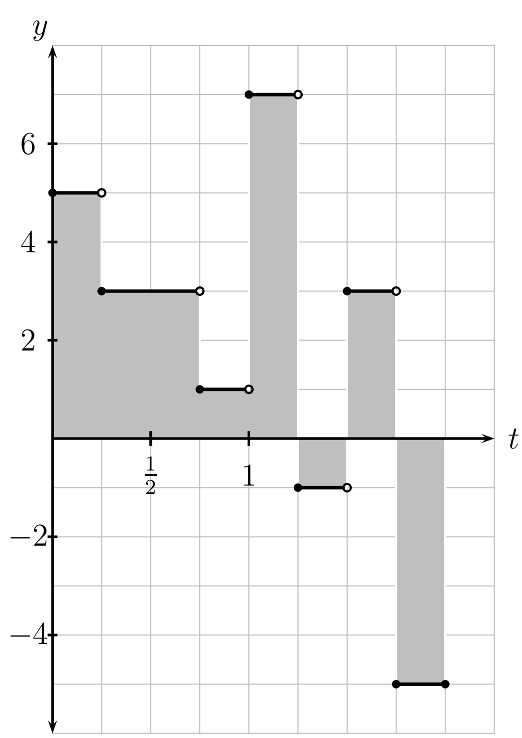

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