Data and Signal Analysis
Problem Sheet 4

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1 The Message

The ciphertext message gained from the signal reads “Caesar says: LZLVKBRXDPHUUBFKULVWPDVDQGDKDSSBQHZBHDU”. The plaintext can be recovered by a Caesar cipher shift by three characters, reading “IWISHYOUAMERRYCHRISTMASANDAHAPPYNEWYEAR”.

2 Method

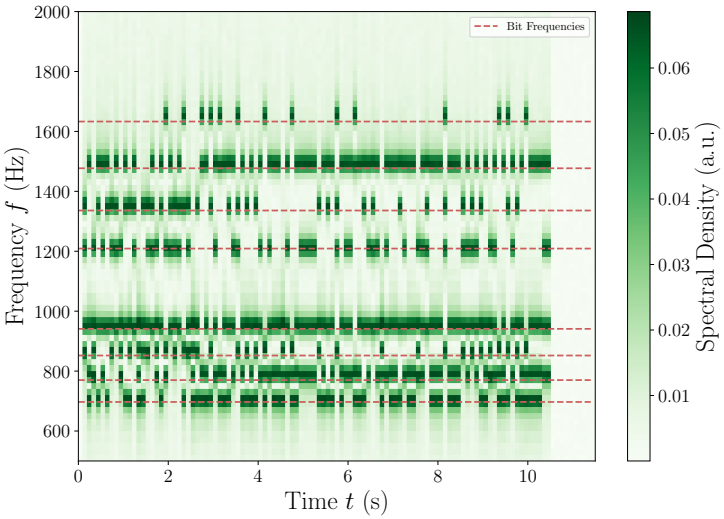

Figure 1: Short-time spectral density of the truncated signal.

First, we truncate the first second of the signal because it does not contain any information. Then, we get the short time FT, using a 400 step, i.e. 50 ms, hamming window and a hop of 50 ms. This ensures that one FT is taken per symbol. We use `fft_mode="onesided2X"` and `scale_to="psd"` in `scipy`’s `ShortTimeFFT` class to get the spectral density. The results are shown in figure 1 and one can clearly see the structure of the signal. To decode it, we get

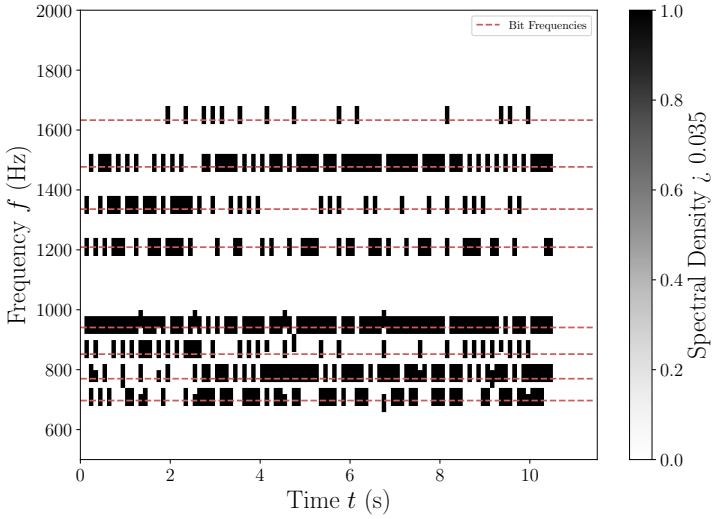

Figure 2: Binary mask of the spectral density compared to the arbitrary threshold 0.35.

a binary mask by extracting all elements where the spectral density is greater than 0.35, see figure 2. We can then iterate through the columns of the mask at the indices corresponding to the signal frequencies, setting the bits of a zero-initialised integer according to the rules given in the exercise. Combining all characters into a string yields the ciphertext message.