Exercises for
Introduction to Pattern Recognition (IntroPR)
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Fourier Series and SNR

Exercise 8 We examine the function $\mathrm{g}(x)$, by comparing the exact solution to the approximation by a bandlimited Fourier series. $\mathrm{g}(x)$ is given as

$$\mathrm{g}(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \tag{1}$$

(a) Determine the Fourier transform $\mathrm{G}(x)$ of $\mathrm{g}(x)$ analytically.

(b) Plot $\mathrm{g}(x)$ and $\mathrm{G}(x)$ in the interval $[-5; 5]$.

(c) Use NumPy to compute the coefficients of the Fourier Series approximating the Fourier Transform. Reconstruct the signal $\mathrm{g}(x)$ using the coefficients and compare the output to the analytical solution.

Exercise 9 How does the *Signal to Noise Ratio (SNR)* change if the quantization changes from B to $B + 1$ bits with

$$f_{\min} = -k\sigma_{f'} \text{ and } f_{\max} = k\sigma_{f'} \ ?$$

Here, $f_{\min}$ and $f_{\max}$ are the minimum and maximum quantized amplitude/function values, as defined as in the lecture. $\sigma_{f'}$ denotes the standard deviation of the original signal f', and k denotes a constant.

Exercise 10 **Programming Task:** Download the audio signal 'sample.wav' from the exercise website. Use NumPy and the Fourier Transform to determine the frequencies contained in this signal, and the appropriate weights of the individual components.
Hint: To read in the signal, use `f` (documentation: `https://docs.python.org/3/library/wave.html`).