Introduction to Julia – exercises

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Exercise 1: Find a *short* Julia expression to build the matrix

$$B = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 9 & 7 & 5 & 3 & 1 & -1 & -3 \\ 4 & 8 & 16 & 32 & 64 & 128 & 256 \end{pmatrix}$$

Exercise 2: Give a Julia expression that uses only a single matrix multiplication with B to obtain

(a) the sum of columns 5 and 7 of B

(b) the last row of B

(c) a version of B with rows 2 and 3 swapped

Exercise 3: Give a Julia expression that multiplies two vectors to obtain

(a) the matrix $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 1 & 2 & 3 & 4 & 5 \\ 1 & 2 & 3 & 4 & 5 \end{pmatrix}$

(b) the matrix $\begin{pmatrix} 0 & 0 & 0 \\ 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \\ 4 & 4 & 4 \end{pmatrix}$

Exercise 4: Modify slide 35 to produce tones of falling frequency instead.

Exercise 5:

(a) Write down the function $g(t)$ that has the shape of a sine wave that increases linearly in frequency from 0 Hz at $t = 0$ s to 5 Hz at $t = 10$ s.

(b) Plot the graph of this function using `Plot.jl`'s `plot` command.

(c) Add to the same figure (this can be achieved using the `plot!` or `sticks!` command) in a different colour a "sticks" plot of the same function sampled at 5 Hz, with circle markers.

(d) [Extra credit] Plot the graph from (c) separately. Can you explain its symmetry? [*Hints:* sampling theorem, aliasing].

<u>Exercise 6:</u> Use Julia to write an audio waveform (8 kHz sampling frequency) that contains a sequence of nine tones with frequencies 659, 622, 659, 622, 659, 494, 587, 523, and 440 Hz. Append to this waveform a copy of itself in which every other sample has been multiplied by -1. Play the waveform, write it to a WAV file, and use the `spectrogram` command to plot its spectrogram with correctly labelled time and frequency axis.