# Python exercises

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1. Create a numpy array of numbers which starts at 0 and increments in 8000 equal steps until it reaches $2\pi$.

2. Use the numpy's sin function to make a sine wave from this array and plot it. Now make a sine wave which repeats 200 times in the 8000 samples.

3. Try applying frequency modulation by implementing this equation:

$$y = \cos\left(\omega_c t + \frac{\Delta f}{f_m}\sin(\omega_m t)\right)$$

   where $f_m$ is the base signal frequency, $f_c$ is the carrier frequency and $\Delta f = |f_c - f_m|$

   Try various different values for $f_c$ and $f_m$ so you can see the changing frequency when you plot $y$.

4. Until now you have been using numpy arrays and ufuncs (universal functions, i.e. a function which is applied to every element in the array). Repeat steps 1–3, but this time allocate an empty array (look at the documentation for numpy.empty and numpy.zeros) and fill it element-by-element using a `for` loop (as you would if you were programming in C).

5. Put your `for` loop implementation of FM modulation into its own function. The arguments to this function should be the base signal frequency, carrier frequency and an array to be filled with output values (plus anything else you think is necessary). Comment your code, not just with inline comments (beginning '#'), but write a docstring comment (one which is enclosed in triple quotes[1]) for the function, detailing what arguments the function takes and what it returns. (If you're using the Spyder IDE, pressing ctrl + i when the cursor is in the function name will display your docstring in the help pane.)

6. Write another function which half-wave rectifies a FM modulated signal. Again, do this C-style, using an `if` statement to set all negative values of y to zero one by one.

[1] For more information on writing docstring comments, `https://github.com/numpy/numpy/blob/master/doc/HOWTO_DOCUMENT.rst.txt` explains the numpy docstring convention. Also, in the IPython console, typing '??' after a function will display the source code, including any docstrings.