Pre-class assignment #14

PHY-905-005
Computational Astrophysics and Astrostatistics
Spring 2023

This assignment is due the evening of Sunday March 21, 2021. Turn in all materials via the GitHub Classroom.

Reading:

1. Chapter 7 of *Computational Physics*, by M. Newman **(required)** – read Sections 7.1, 7.2, and 7.4, but focus on general conceptual understanding rather than diving into the details regarding derivations.
2. An intuitive guide to the discrete Fourier transform **(required)** – short but helps to build intuition.
3. `scipy.fft` tutorial **(required)**
4. NumPy FFT routines (reference)
5. An Interactive Introduction to Fourier Transforms (optional, but highly recommended – it's useful for building intuition!)
6. Understanding the FFT algorithm (optional, but useful for building intuition)

Your assignment: After you read the appropriate chapter of Wilson and the "Intuitive guide to the discrete Fourier transform," work through the examples in the `scipy.fft` tutorial and use those to examine the spectral properties of the functions defined in the file `functions.py` (included with this assignment). Please note that we're going to use this code in class, so you may wish to make sure that your code is well-commented!

1. Plot both the function `fx` and `fx_noisy` as a function of time (you may have to zoom in on a small window of time to see what's going on).
2. Calculate the 1D FFT of both functions for $N = 10,000$. Does the result in frequency space like what you expected for these two functions? Why or why not? And, how are the results for the two functions different?
3. Calculate the 1D FFT of both functions for $N = 5000, 2000, 1000, 500, 250, 100$. As you decrease the number of samples, what happens? Given what you know about how a discrete Fourier transform is calculated, why do you think you see this behavior?
4. Do you have any questions or things you'd like us to discuss in class?

Handing it in: Include your code, your plots, and your answers to the questions about FFTs (in the file `ANSWERS.md`) in your assignment.