ELEC 221 Lecture 14
Hands-on: twice the fun with the 2D Fourier transform

Tuesday 25 October 2022

- Quiz 6 today
- Assignment 4 due on Saturday at 23:59

We defined the discrete Fourier transform, which corresponds to equally-spaced samples of the discrete-time Fourier transform.
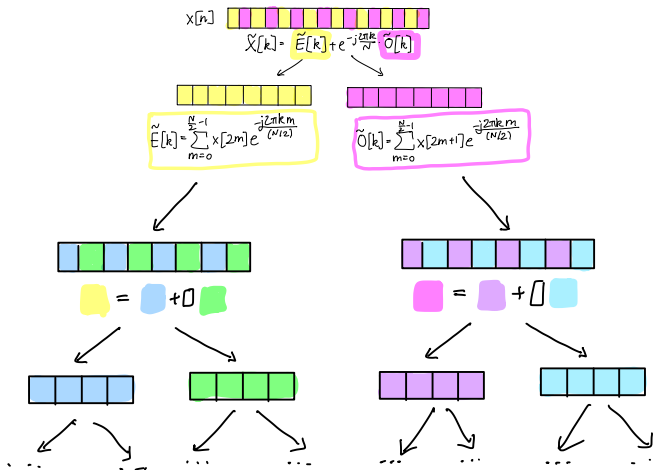
$$\tilde{X}[k] = \frac{1}{N} \sum_{n=0}^{N-1} x[n] e^{-jk2\pi n/N}$$

$$x[n] = \sum_{k=0}^{N-1} \tilde{X}[k] e^{jk2\pi n/N}$$

These are equivalent (up to normalization) to

```
>>> X_k = np.fft.fft(xn)
>>> xn = np.fft.ifft(X_k)
```

We saw how the DFT can be computed efficiently using the Fast Fourier Transform (FFT).

$x[n]$

$$\tilde{X}[k] = \tilde{E}[k] + e^{-j\frac{2\pi k}{N}} \tilde{O}[k]$$

$$\tilde{E}[k] = \sum_{m=0}^{\frac{N}{2}-1} x[2m] e^{-j\frac{2\pi k m}{(N/2)}}$$

$$\tilde{O}[k] = \sum_{m=0}^{\frac{N}{2}-1} x[2m+1] e^{-j\frac{2\pi k m}{(N/2)}}$$

Hands-on activity! See Homework 4.5 in PrairieLearn.

Learning outcomes:

- define and compute the Fourier transform of two-dimensional signals
- describe the role of a spectrum's magnitude and phase in image processing
- apply simple filters to modify images in Python

Today

This activity is *not graded* and not part of the assignments and quizzes. However, your group is welcome to submit the completed worksheet for up to 2 bonus *points* (not percent) that can be banked for future assignments and exams.

Point bank:

- Points can be applied to quizzes, assignments, or exams
- Points cannot be used to increase your score beyond the maximum during the term
- All unused points at the end of the term will go towards your final exam.

Example: you get 16/17 on an assignment, and have 2 points banked. You may apply one of these points to that assignment to improve your score to 17/17, with one point still banked.

For next time

Content:

- Time/frequency domain analysis of systems
- Frequency response of non-ideal filters

Action items:

1. Assignment 4 due Saturday 23:59
2. Bonus activity due Saturday 23:59

Recommended reading:

- For next class: Oppenheim 6.0-6.4