What is the difference between numpy.fft.fft and numpy.fft.fftfreq

Asked 1 year, 7 months ago Active 1 year, 7 months ago Viewed 11k times

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I am analysing time series data and would like to extract the 5 main frequency components and use as features for training machine learning model. My dataset is `921 x 10080`. Each row is a time series and there are 921 of them in total.

While exploring possible ways to do this, I came across various functions including `numpy.fft.fft`, `numpy.fft.fftfreq` and `DFT` ... My question is, what do these functions do to the dataset and what is the difference between these functions?

For `Numpy.fft.fft`, Numpy docs state:

```
Compute the one-dimensional discrete Fourier Transform.

This function computes the one-dimensional n-point discrete Fourier Transform
(DFT) with the efficient Fast Fourier Transform (FFT) algorithm [CT].
```

While for `numpy.fft.fftfreq`:

```
numpy.fft.fftfreq(n, d=1.0)
Return the Discrete Fourier Transform sample frequencies.

The returned float array f contains the frequency bin centers in cycles per
unit of the sample spacing (with zero at the start). For instance, if the
sample spacing is in seconds, then the frequency unit is cycles/second.
```

But this doesn't really talk to me probably because I don't have background knowledge for signal processing. Which function should I use for my case, ie. extracting the first 5 main frequency and amplitude components for each row of the dataset? Thanks

Update:

Using `fft` returned result below. My intention was to obtain the first 5 frequency and amplitude values for each time series, but are they the frequency components?

Here's the code:

```
def get_fft_values(y_values, T, N, f_s):
    f_values = np.linspace(0.0, 1.0/(2.0*T), N//2)
    fft_values_ = rfft(y_values)
    fft_values = 2.0/N * np.abs(fft_values_[0:N//2])
    return f_values[0:5], fft_values[0:5]  #f_values - frequency(length = 5040)
; fft_values - amplitude (length = 5040)

t_n = 1
N = 10080
```

```
T = t_n / N
f_s = 1/T

result = pd.DataFrame(df.apply(lambda x: get_fft_values(x, T, N, f_s), axis
=1))
result
```

and output

```
0   ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [52.91299603174603, 1.2744877093061115, 2.47064631896607,
1.4657299825335832, 1.9362280837538701])
1   ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [57.50430555555556, 4.126212552498241, 2.045294347349226,
0.7878668631936439, 2.6093502232989976])
2   ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [52.05765873015873, 0.7214089616631307, 1.8547819994826562,
1.3859749465142301, 1.1848485830307878])
3   ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [53.68928571428572, 0.44281647644149114,
0.3880646059685434, 2.3932194091895043, 0.22048418335196407])
4   ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [52.049007936507934, 0.08026717757664162,
1.122163085234073, 1.2300320578011028, 0.011097276168966 63])
... ...
916 ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [74.39303571428572, 2.7956204803382096, 1.788360577194303,
0.8660509272194551, 0.530400826933975])
917 ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [51.88751984126984, 1.5768804453161231, 0.9932384706239461,
0.7803585797514547, 1.6151532436755451])
918 ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [52.16263888888889, 1.8672674706267687, 0.9955183554654834,
1.0993971449470716, 1.6476405255363171])
919 ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [59.22579365079365, 2.1082518972190183, 3.686245044113031,
1.6247500816133893, 1.9790245755039324])
920 ([0.0, 1.000198452073824, 2.000396904147648, 3.0005953562214724,
4.000793808295296], [59.32333333333333, 4.374568790482763, 1.3313693716184536,
0.21391538068483704, 1.414774377287436])
```

python numpy time-series fft

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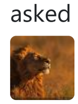
edited Jan 30 '20 at 5:29

asked Jan 30 '20 at 4:59



nilsinelabore
2,397 5 19 54

2 Answers

Active Oldest Votes

6

First one needs to understand that there are time domain and frequency domain representations of signals. The graphic below shows a few common fundamental signal types and their time domain and frequency domain representations.

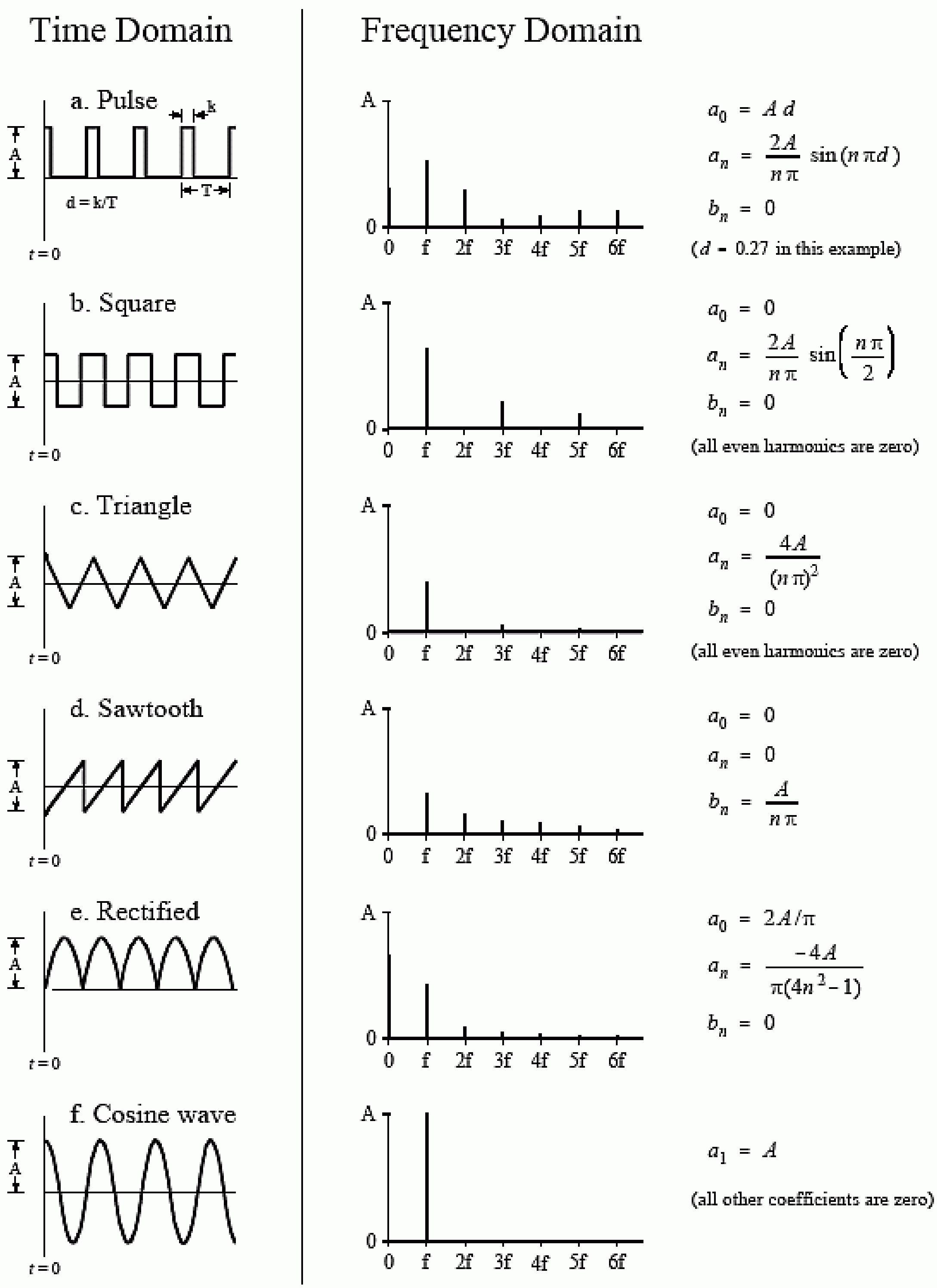


FIGURE 13-10
Examples of the Fourier series. Six common time domain waveforms are shown, along with the equations to calculate their "a" and "b" coefficients.

Pay close attention to the sine curve which I will use to illustrate the difference between fft and fftfreq.

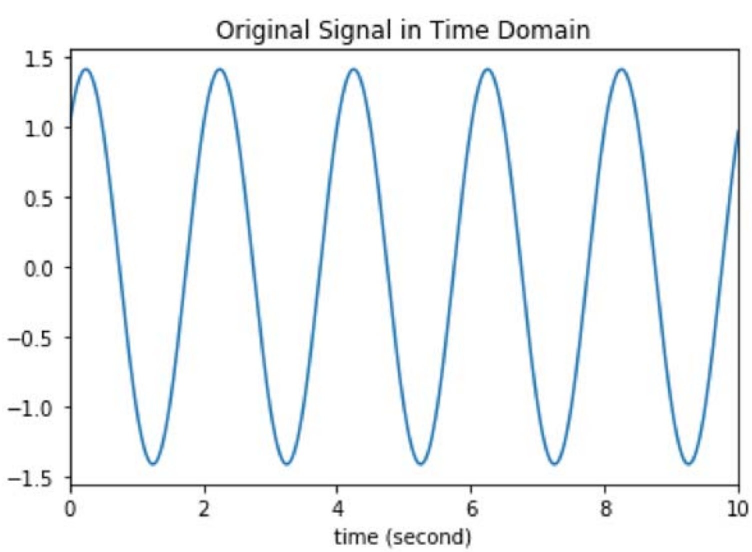
The Fourier transformation is the portal between your time domain and frequency domain representation. Hence `numpy.fft.fft()` - returns the fourier transform. this will have both real and imaginary parts. The real and imaginary parts, on their own, are not particularly useful, unless you are interested in symmetry properties around the data window's center (even vs. odd).

`numpy.fft.fftfreq` - returns a float array of the frequency bin centers in cycles per unit of the sample spacing.

The `numpy.fft.fft()` method is a way to get the right frequency that allows you to separate the fft properly.

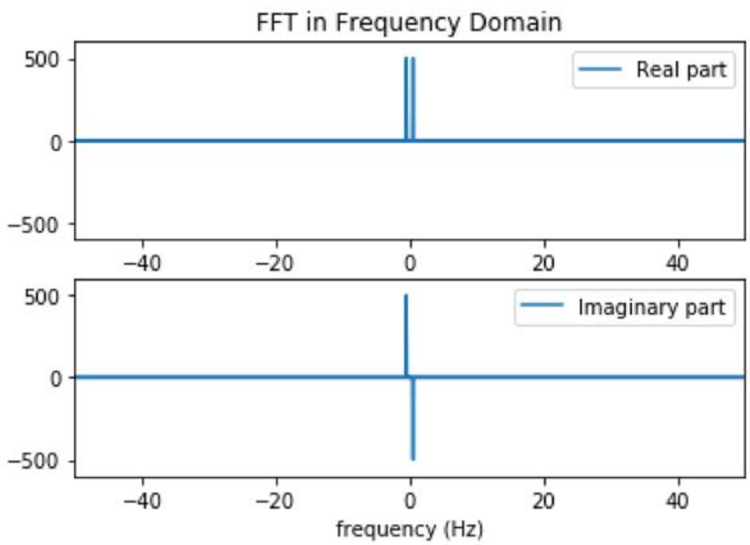
This is best illustrated with an example:

```
import numpy as np
import matplotlib.pyplot as plt

#fs is sampling frequency
fs = 100.0
time = np.linspace(0,10,int(10*fs),endpoint=False)

#wave is the sum of sine wave(1Hz) and cosine wave(10 Hz)
wave = np.sin(np.pi*time)+ np.cos(np.pi*time)
#wave = np.exp(2j * np.pi * time )

plt.plot(time, wave)
plt.xlim(0,10)
plt.xlabel("time (second)")
plt.title('Original Signal in Time Domain')

plt.show()
```




```
# Compute the one-dimensional discrete Fourier Transform.

fft_wave = np.fft.fft(wave)

# Compute the Discrete Fourier Transform sample frequencies.

fft_fre = np.fft.fftfreq(n=wave.size, d=1/fs)
```

```
plt.subplot(211)
plt.plot(fft_fre, fft_wave.real, label="Real part")
plt.xlim(-50,50)
plt.ylim(-600,600)
plt.legend(loc=1)
plt.title("FFT in Frequency Domain")

plt.subplot(212)
plt.plot(fft_fre, fft_wave.imag,label="Imaginary part")
plt.legend(loc=1)
plt.xlim(-50,50)
plt.ylim(-600,600)
plt.xlabel("frequency (Hz)")

plt.show()
```



Share Follow edited Feb 9 '20 at 15:03 answered Jan 30 '20 at 5:09

nav
1,068 10 18

Thanks for your answer. May I ask 1) What should I use to get the main freq and amplitude components? 2) What does it mean by frequency bin centers? Cheers – nilsinelabore Jan 30 '20 at 5:20

@nilsinelabore ok I see your source of confusion. I will illustrate with an example shortly. Please wait. – nav Feb 3 '20 at 23:41

1 @nilsinelabore this should help you. – nav Feb 10 '20 at 4:19

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If by 'main component", you mean the 5 strongest frequencies, you'll search for those values in the result of `np.fft.fft()` . To know which frequencies these values belong to, you'll use `np.fft.fftfreq` . The output of both will be arrays of same length, thus you can feed your indices from `np.fft.fft()` into the array from `np.fft.fftfreq()` to obtain the corresponding frequency.

For example, say the output of `fft` is A and of `fftfreq` is B, suppose A[1] is one of your main components, B[1] = 0Hz will be the frequency of your main component.

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answered Jan 30 '20 at 16:50

Mimakari

341 2 11

Thanks for your answer! Just a couple of questions:1) Could you please show me how I can alter my code to do this? Is `fftfreq` amplitude of corresponding frequency? Cheers – nilsinelabore Jan 30 '20 at 22:29

@nilsinelabore I don't know how else I can tell that `fftfreq` returns you an array of ***frequencies*** not amplitudes. You get the ***amplitudes*** from `fft` . This distinction was explained in both your previous question and twice in this question. You only need to do `frequencies = np.fft.fftfreq(N, 1/f_s)` and then use `frequencies` as your x axis, and `fft_values` as your y axis. Find your "main components" however you want, and when you have their indices from `fft_values` , use those indices to get the corresponding frequencies from `frequencies` . – Mimakari Jan 31 '20 at 1:31

Okay there was a mistake I wanted to say Is fftfreq frequency of corresponding amplitude ... – nilsinelabore Jan 31 '20 at 1:41