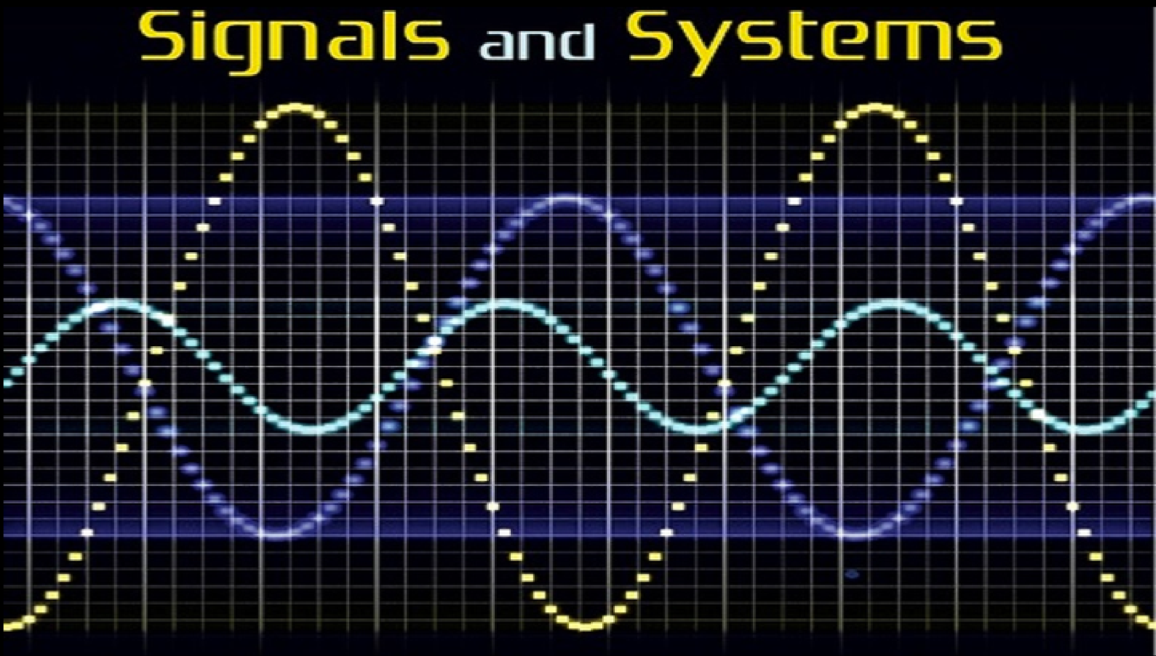
Phase of Sinusoids
in Machine Learning



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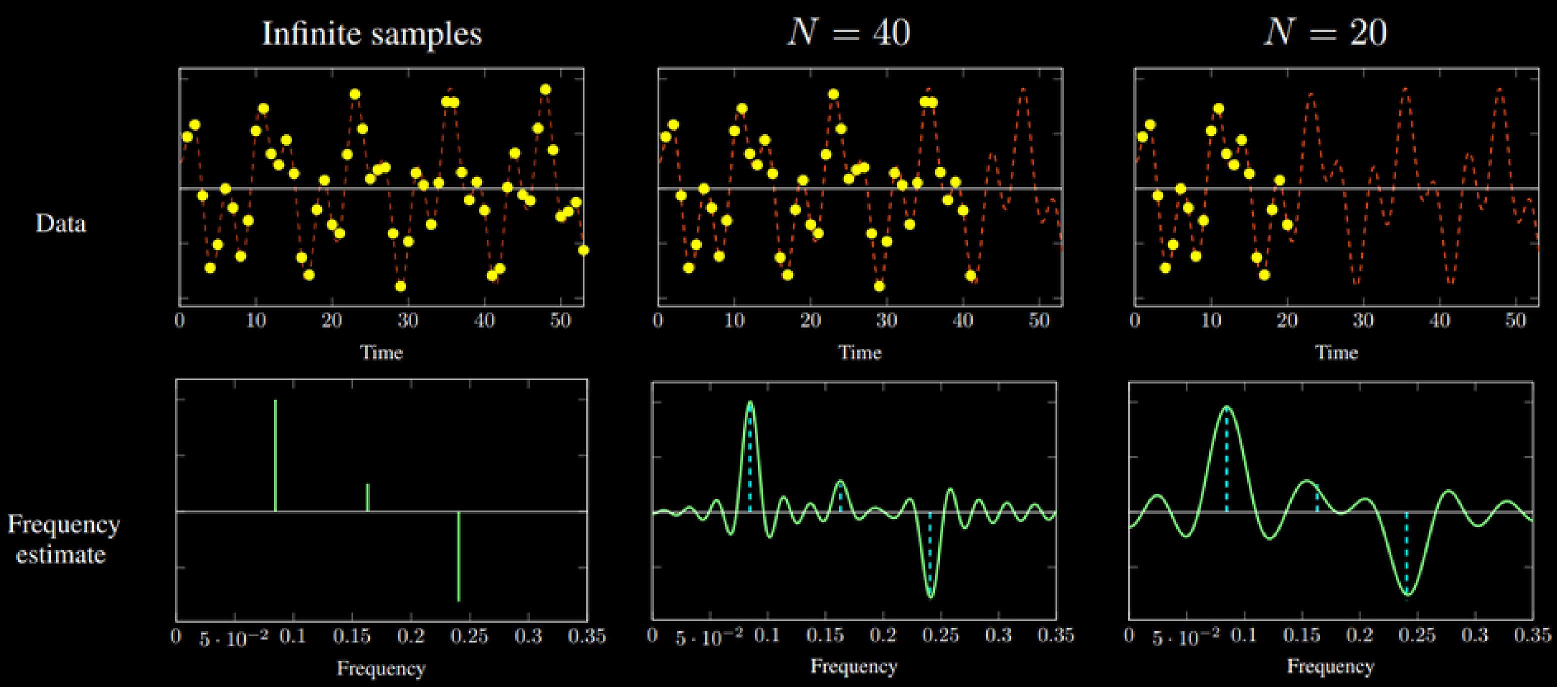
Application

- Estimating the frequencies of multi sinusoidal signals from a finite number of samples is a fundamental problem in signal processing. Examples of applications include underwater acoustics, seismic imaging, target identification, digital filter design, nuclear-magnetic-resonance spectroscopy, and power electronics. In radar and sonar systems, the frequencies encode, the direction of electromagnetic or acoustic waves arriving at a linear array of antennae or microphones.

- The below diagram of the frequency-estimation problem represents a multi sinusoidal signal given by equation 1 (dashed blue line) and its Nyquist-rate samples (blue circles) are depicted on the top row. The bottom row shows that the resolution of the frequency estimate obtained by computing the discrete-time Fourier transform from N samples decreases as we reduce N. The signal is real-valued,
- so its Fourier transform is even; only half of it is shown.



Code Explanation

The phase spectrum specifies the phase of signal components as a function of. component frequency

To describe seismic trace in the frequency domain requires both an amplitude spectrum and a phase spectrum. The amplitude spectrum simply gives amplitude at each frequency. The phase spectrum simply gives the phase at each frequency

Using the Fourier transform, you can also extract the phase spectrum of the original signal. For example, create a signal that consists of two sinusoids of frequencies 10 Hz and 25 Hz. The first sinusoid is a cosine wave with phase $-\pi/4$, and the second is a cosine wave with phase $\pi/2$. Sample the signal at 100 Hz for 1 second.

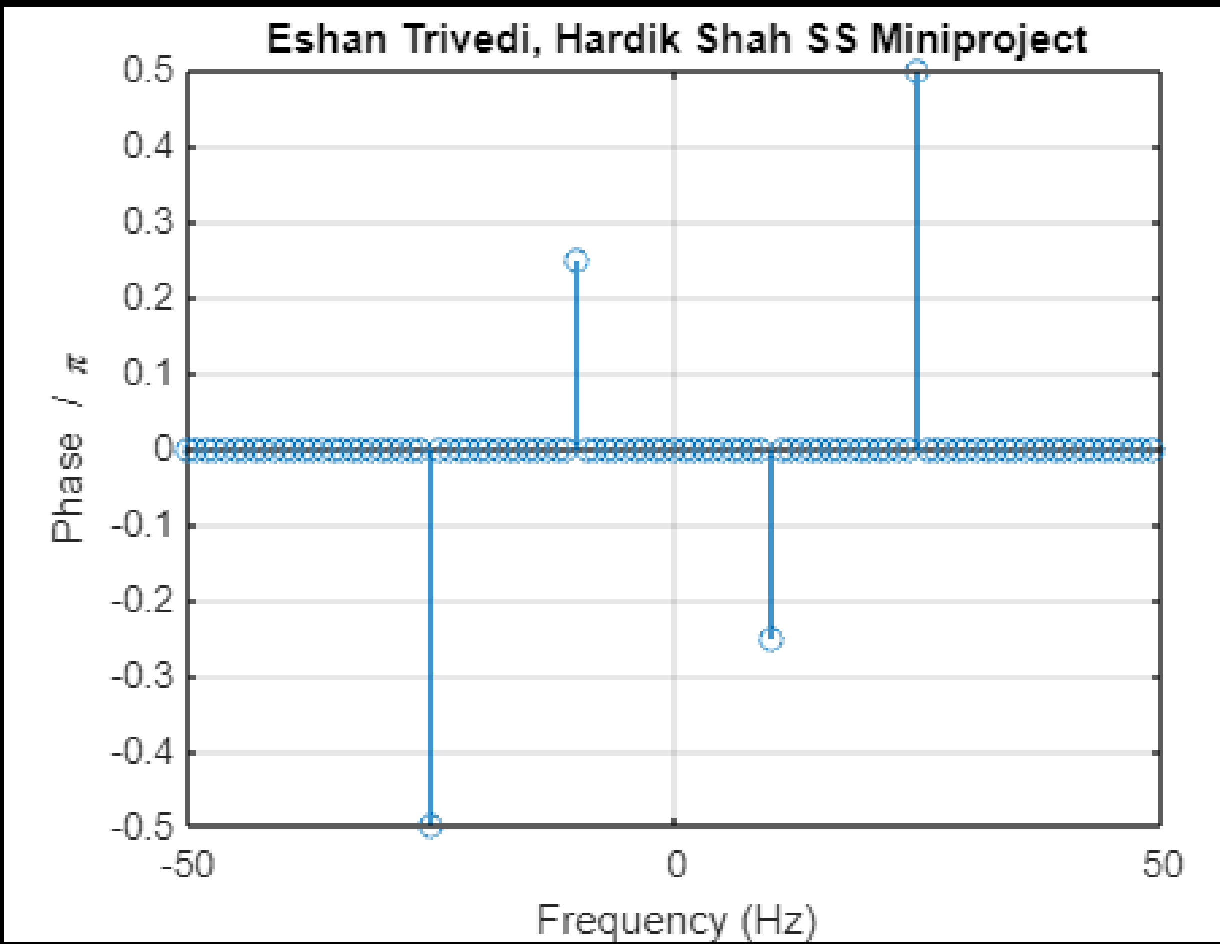
Compute the Fourier transform of the signal. Plot the magnitude of the transform as a function of frequency.

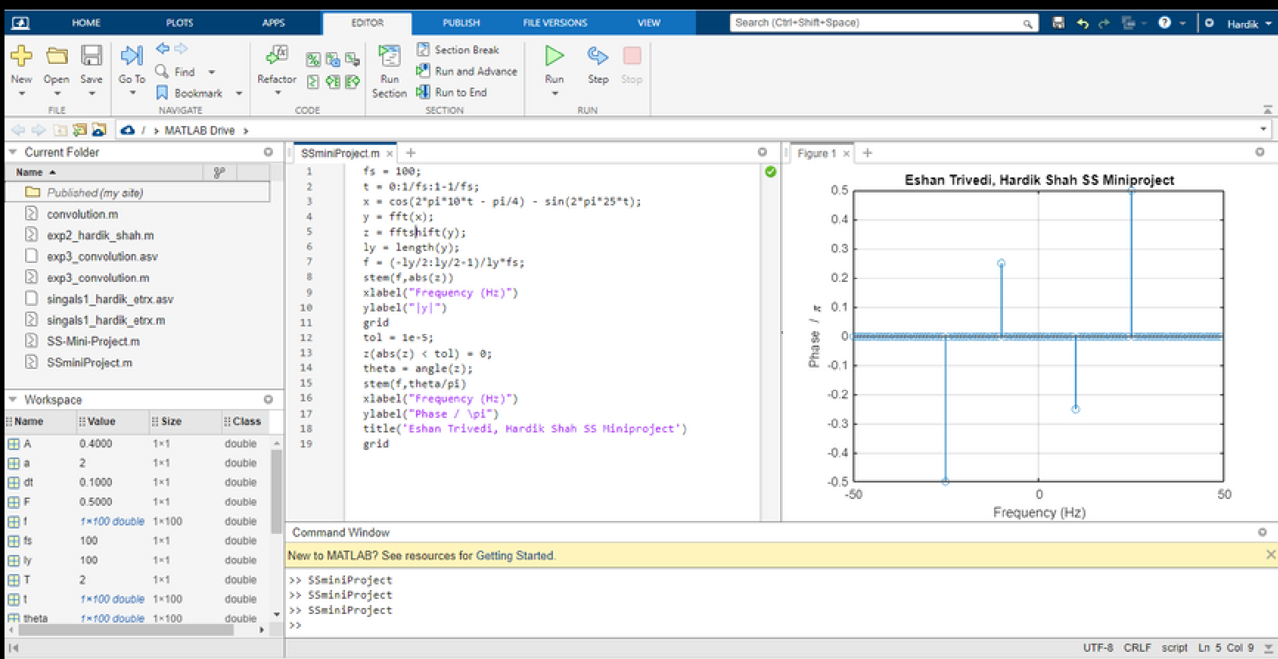
Compute the phase of the transform, removing small-magnitude transform values. Plot the phase as a function of frequency.

Matlab Code

```
fs = 100;
t = 0:1/fs:1-1/fs;
x = cos(2*pi*10*t - pi/4) - sin(2*pi*25*t);
y = fft(x);
z = fftshift(y);
ly = length(y);
f = (-ly/2:ly/2-1)/ly*fs;
stem(f,abs(z))
xlabel("Frequency (Hz)")
ylabel("|y|")
grid
tol = 1e-5;
z(abs(z) < tol) = 0;
theta = angle(z);
stem(f,theta/pi)
xlabel("Frequency (Hz)")
ylabel("Phase / \pi")
title('Eshan Trivedi, Hardik Shah SS
Miniproject')
grid
```

Output


Eshan Trivedi, Hardik Shah SS Miniproject
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
Phase / π
-50
0
50
Frequency (Hz)


HOME
PLOTS
APPS
EDITOR
PUBLISH
FILE VERSIONS
VIEW
Search (Ctrl+Shift+Space)
Hardik
New
Open
Save
Go To
Find
Bookmark
Refactor
Run Section
Section Break
Run and Advance
Run to End
Run
Step
Stop
FILE
NAVIGATE
CODE
SECTION
RUN
MATLAB Drive
Current Folder
Name
Published (my site)
convolution.m
exp2_hardik_shah.m
exp3_convolution.asv
exp3_convolution.m
singals1_hardik_etrx.asv
singals1_hardik_etrx.m
SS-Mini-Project.m
SSminiProject.m
Workspace
Name
Value
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Class
A
0.4000
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dt
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t
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double
theta
1×100 double
1×100
double
SSminiProject.m
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stem(f,abs(z))
xlabel("Frequency (Hz)")
ylabel("|y|")
grid
tol = 1e-5;
z(abs(z) < tol) = 0;
theta = angle(z);
stem(f,theta/pi)
xlabel("Frequency (Hz)")
ylabel("Phase / \pi")
title('Eshan Trivedi, Hardik Shah SS Miniproject')
grid
Figure 1
Eshan Trivedi, Hardik Shah SS Miniproject
Phase / π
Frequency (Hz)
Command Window
New to MATLAB? See resources for Getting Started.
>> SSminiProject
>> SSminiProject
>> SSminiProject
>>
UTF-8
CRLF
script
Ln 5 Col 9

Conclusion

Hence, we conclude that Fourier transform is a powerful concept that’s used in a variety of fields, from pure math to audio engineering and even finance.

We are now familiar with the Fast Fourier transform and are well equipped to apply it for computational efficiency and execute problems using MATLAB.

References

Medium https://towardsdatascience.com/laplace-smoothing-in-na%C3%AFve-bayes-algorithm-9c237a8bdece

LinkedIn Articles

NEURAL INFORMATION PROCESSING SYSTEMS