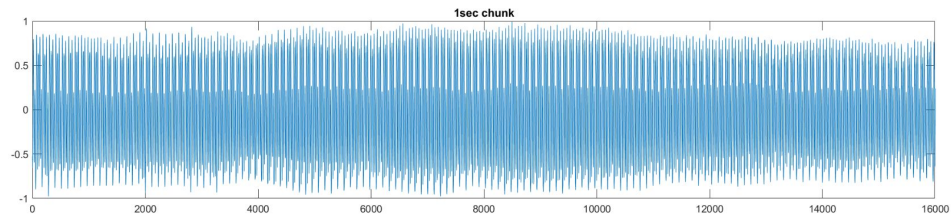


# **Assignment - 2 Tutorial**

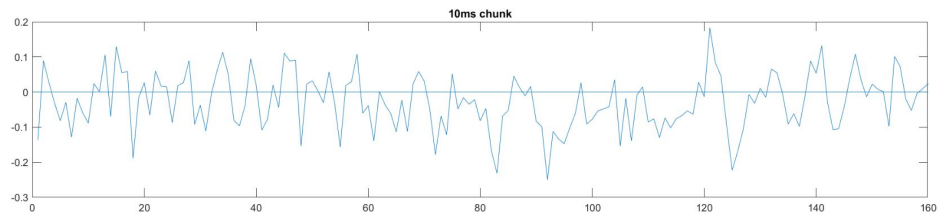
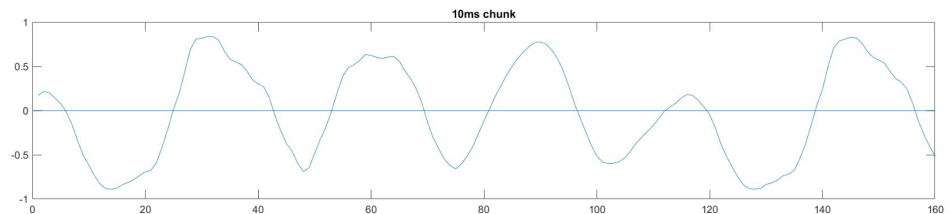
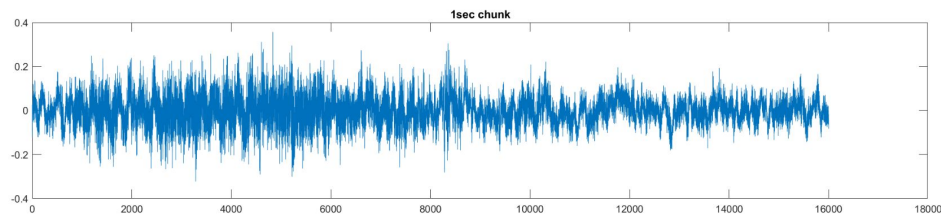
1. Zero Crossing
2. Energy
3. Autocorrelation

# Zero Crossing

A



F



$$ZCR = \frac{1}{2} \sum_{i=2}^n |\text{sign}(x[i]) - \text{sign}(x[i-1])|$$

## Zero Crossing

$$ZCR = \frac{1}{2} \sum_{i=2}^n |\text{sign}(x[i]) - \text{sign}(x[i-1])|$$

## Energy

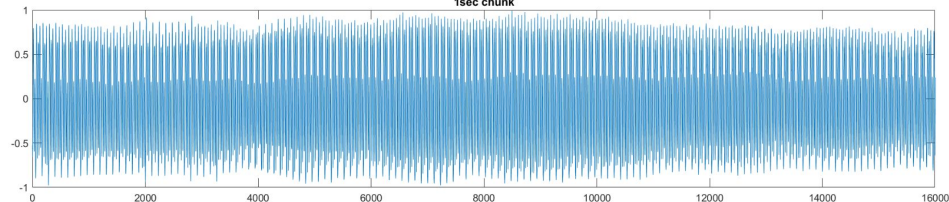
$$E = \sum_{n=a}^b |x[n]|^2$$

## Autocorrelation

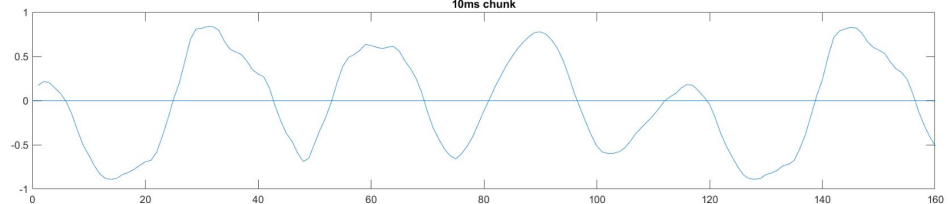
$$R_{xx}[m] = \sum_{n=-\infty}^{+\infty} x[n] \cdot x[n-m]$$

A

1sec chunk



10ms chunk



**A - Voiced**

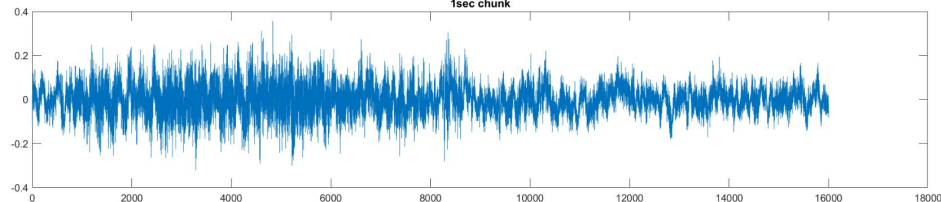
ZCR = 11

Energy = 45.57

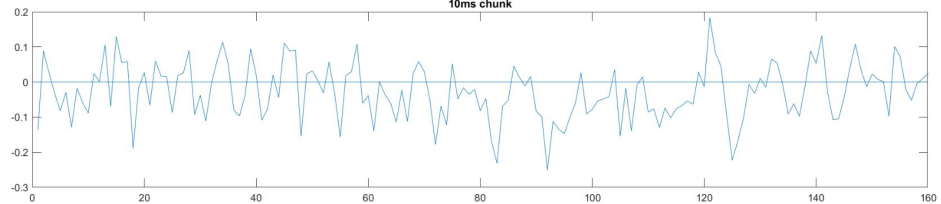
Autocorr = 44.43

F

1sec chunk



10ms chunk



**F - Unvoiced**

ZCR = 60

Energy = 1.11

Autocorr = 0.42

# Sampling Rate

Sampling rate = Number of samples per second

Q) Let  $fs=16000$ , How many samples for 10ms?

Ans) Number of samples for 10ms =  $0.01 \times 16000 = 160$

Q) Let a signal has  $fs=48,000$  and total number of samples = 2,40,000.  
What is the duration of signal?

Ans) Duration =  $2,40,000 / 48,000 = 5$  sec

Python: `s, fs = librosa.load(filename)`

MATLAB: `[s,fs] = audioread(filename);`