# ECE 485 - Digital Audio Processing

Introduction

Henry D. Pfister

Department of Electrical and Computer Engineering
Duke University

**e-mail**: henry.pfister@duke.edu
**homepage**: http://ee.pfister.duke.edu/
**phone**: 919-660-5288

# Digital Audio Processing

- **Digital Signal Processing (DSP)**
  - "is the automatic manipulation of a quantized discrete-time information signal to modify or improve it in some way."
- **Audio Processing**
  - "is the intentional alteration of audio signals through an audio effects unit."
- DSP theory was introduced in the 1950s with the advent of sampling. The first DSP chip was proposed in 1976 for the "Speak & Spell" children's toy.
- Audio processing began with radio transmission and was used to mitigate overmodulation and non-linearities in the system. Now, it is used in the production of high-quality sound and music for stage, radio, television, and movies.

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# Example

**What is the difference between these two audio clips?**

# The Big Question

**Why should I take this class?**

# Philosophy of Learning for Engineering

- "Engineering Maturity" is not a simple thing to define or achieve
  - One develops the basic concepts (e.g., mathematics, physics, linear systems) in introductory classes
  - And a few more advanced topics in senior level classes
  - Maturity occurs when one can follow new topics in engineering on their own by filling in the gaps
- For some of you
  - This class could be central to your future work as engineers
- For others
  - It will add only to the breadth of your engineering knowledge

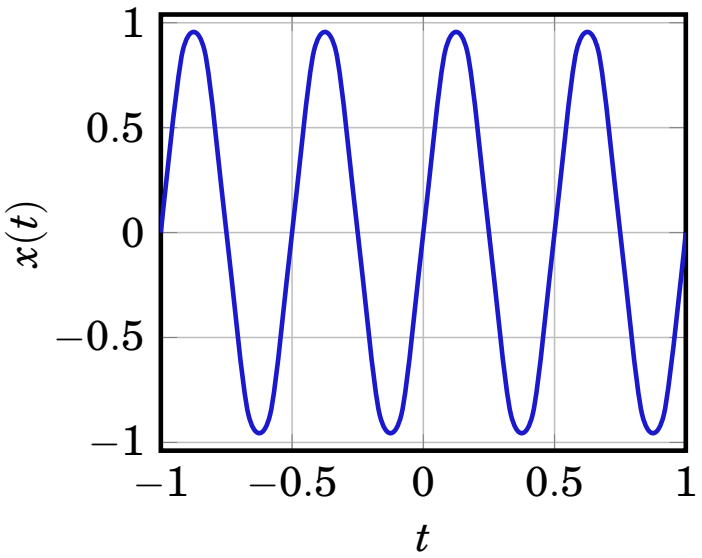
# My Answer

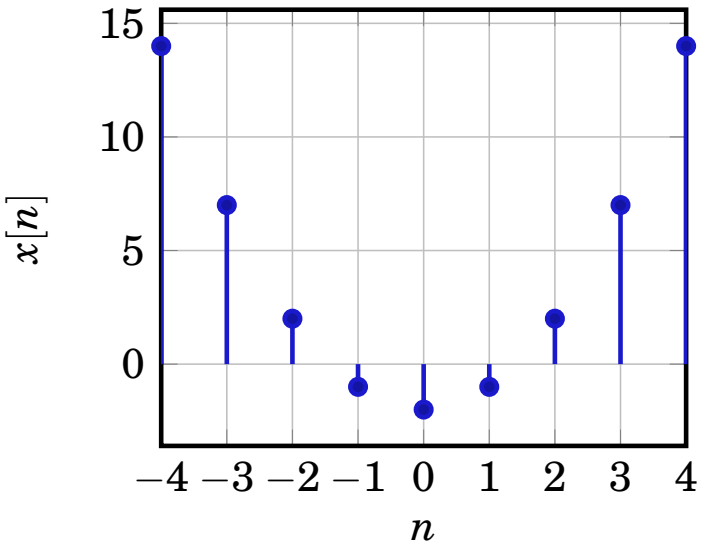
**Learning DSP with practical audio examples is more fun!**

# Questions?

1. What are you hoping to get out of this class?
2. Do you like to listen to or play music?
3. What is your major?
4. Have you taken ECE 280? ECE 381?
5. How familiar are you with MATLAB? Do you have it installed?
6. Do you prefer slide-based lectures of board-based lectures?
7. What are good days and times for make-up classes?

# Signals



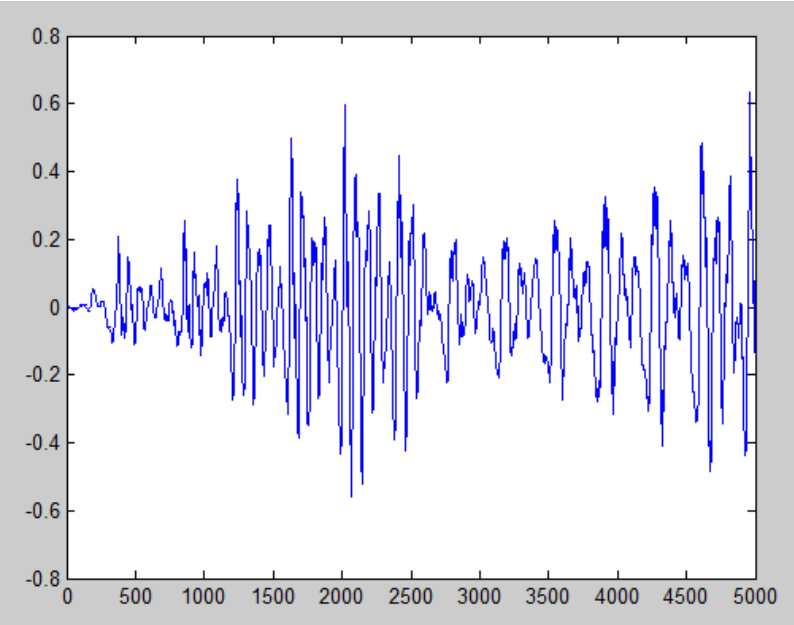

A *signal* is a function of an independent variable (e.g., time) that carries some information or describes some physical phenomenon.

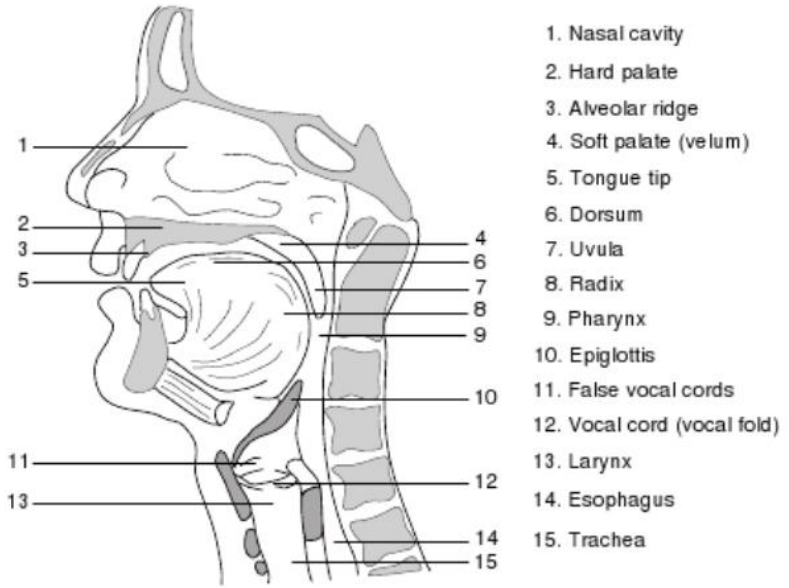
- Continuous-time (CT) $x(t)$ where $t$ takes continuous values
- Discrete-time (DT) $x[n]$ where $n$ takes integer values
- Note: $x(t)$ is used to denote both the "signal" and "the signal "value at time $t$"

# Signals

- Types of Signals
  - Electrical signals: Voltages and currents in a circuit
  - Acoustic signals: Audio and speech signals
  - Biological signals: ECG, EEG, medical images
  - Financial signals: Dow Jones indices
  - Can be continuous: Time and location
  - Can be discrete: Digital image pixels, DNA sequence
  - Can be 1-D, 2-D, ..., $N$-D
- Most signals are CT signals and DT signals are often formed by sampling a CT signal
- DT signals can be directly processed by the powerful digital computers and digital signal processors (DSPs)

# Applications

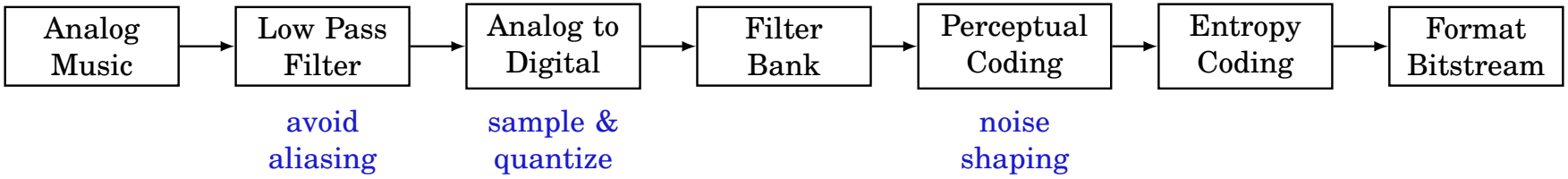


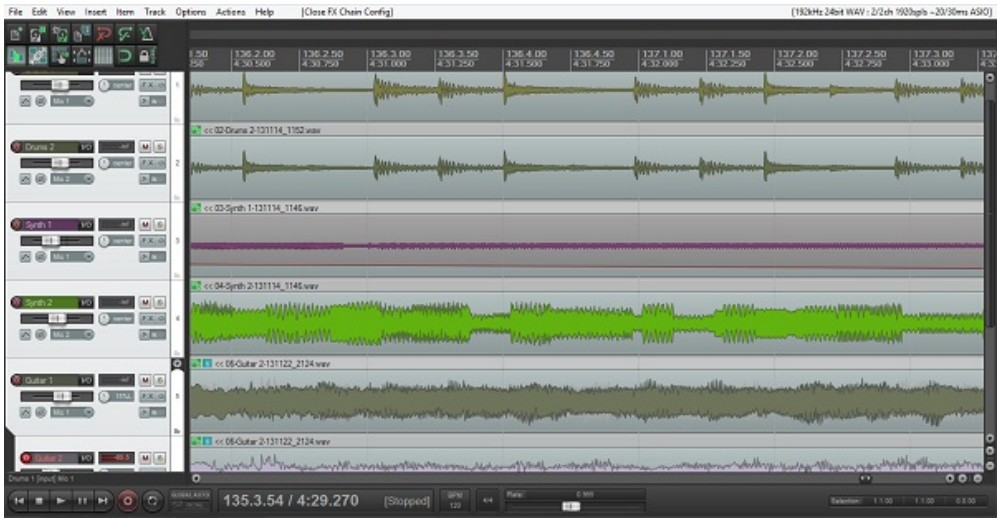




Speech waveform and production

# Applications

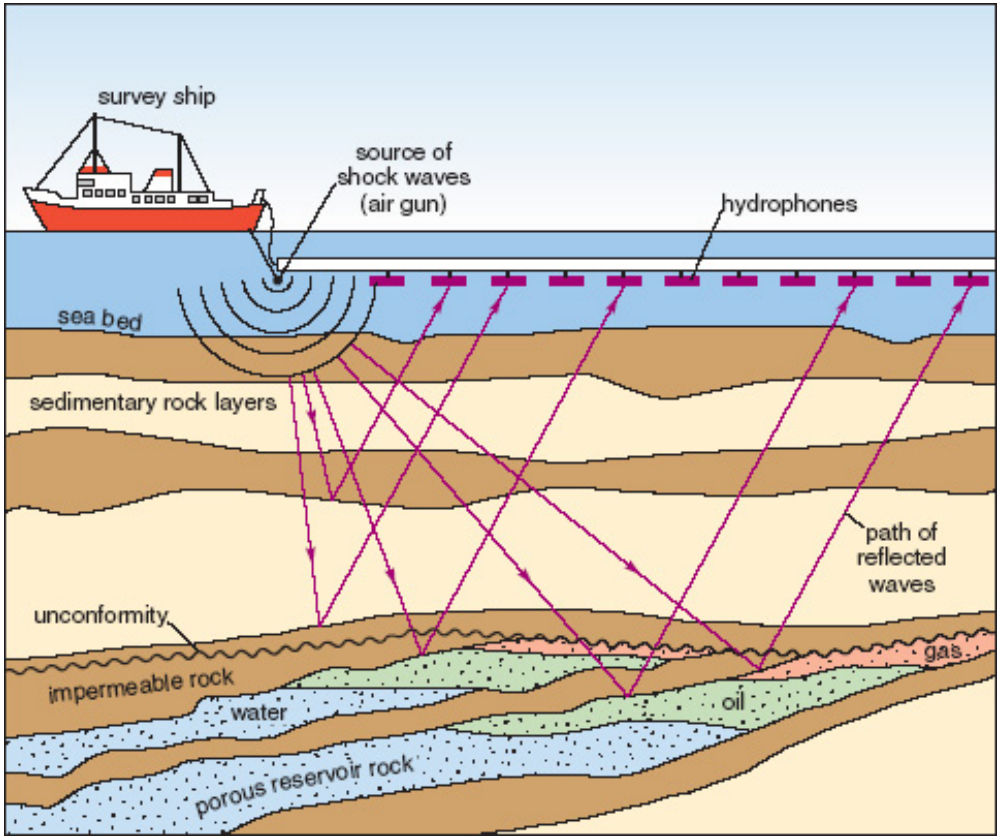
## MP3 Source Encoder Block Diagram




Digital Audio Workstation

# Applications




Marine Reflection Seismology for Oil Exploration

# Learning to Play

- Everyone knows learning to play a sport requires the practice of basic skills
  - For example, consider the catching and throwing a ball
  - It would crazy for me to expect my 5 year old daughter to master this skill without hours of repetitive practice
- Yet, many intelligent students try to:
  - Learn new skills (e.g., DSP) without doing the necessary repetitive practice of basic skills (i.e., homework)
  - Like learning your multiplication tables, repetitive practice of basic skills allows your brain to perform automatically
  - This allows your conscious thought process to focus on more abstract details