HOW DO COMPUTERS MAKE SOUND?

Some fundamentals

How Do Computers Make Sound?

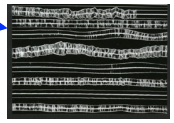
- What is sound?
- What does analog mean?
- Digital audio representation
- Analog-to-Digital conversion
- Digital-to-Analog conversion
- Synthesis example

What Is Sound?

- Sound is a variation in pressure
- Pressure variations travel through air as waves
- Sound travels about 1000 feet/second
- Hz = Hertz = (cycles) per second
- We hear variations from about 20Hz to 20000Hz
- We hear amplitude variations over about 5 orders of magnitude from threshold to pain

What does analog mean?

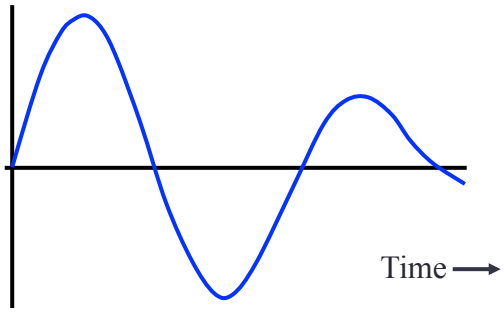
- Pressure variations (sound) can be expressed as:
  - Mechanical displacement (microphone, speaker)
  - Voltage variations
  - Wiggles in vinyl record grooves
  - Degree of magnetization on tape
  - Optical density in film



- These representations are called analog

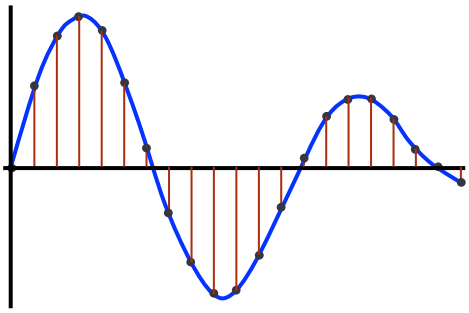
Digital Audio Representation

- Measure an analog signal periodically:



Digital Audio Representation

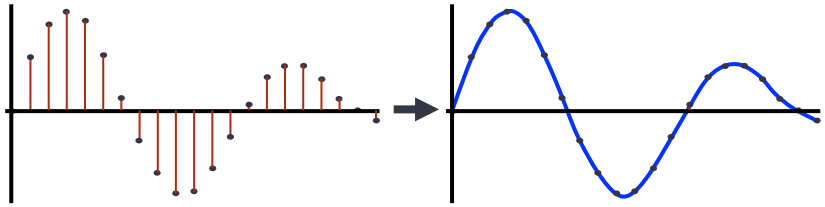
- Measure an analog signal periodically:



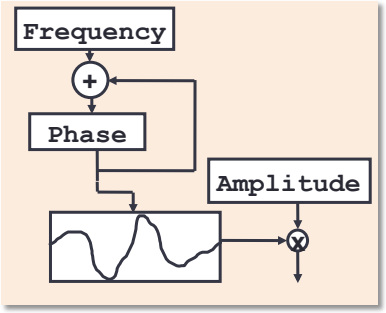
- Store the measurements as a sequence of numbers

Digital to Analog Conversion

- Use the sequence of numbers to control voltage
- Filter the voltage to produce a smooth signal



Synthesis Example



To compute each sample:

```
tlen = 1024 // table length
sr = 44100.0 // sample rate

phase += freq * tlen / sr
// phase wraps around table:
phase = fmod(phase, tlen)
samp = table[floor(phase)]
output = samp * ampl
```