Announcements

- Readings (Week 5 due Sunday 2/9)
  - Bias on Artificial Intelligence algorithms
  - How do we fix it?
  - Can we apply AI to medicine?

- **Today**:
  - 1:1 discussion on Text Processing project
    - What question do you want to answer
    - What issues are you encountering
  - A new type of data

Audio is Data!

Sound

Sound

- a vibration that propagates as an audible longitudinal wave of pressure
- through a transmission medium such as a gas, liquid or solid.

- How hard you shake: loudness

- how fast you shake: frequency.

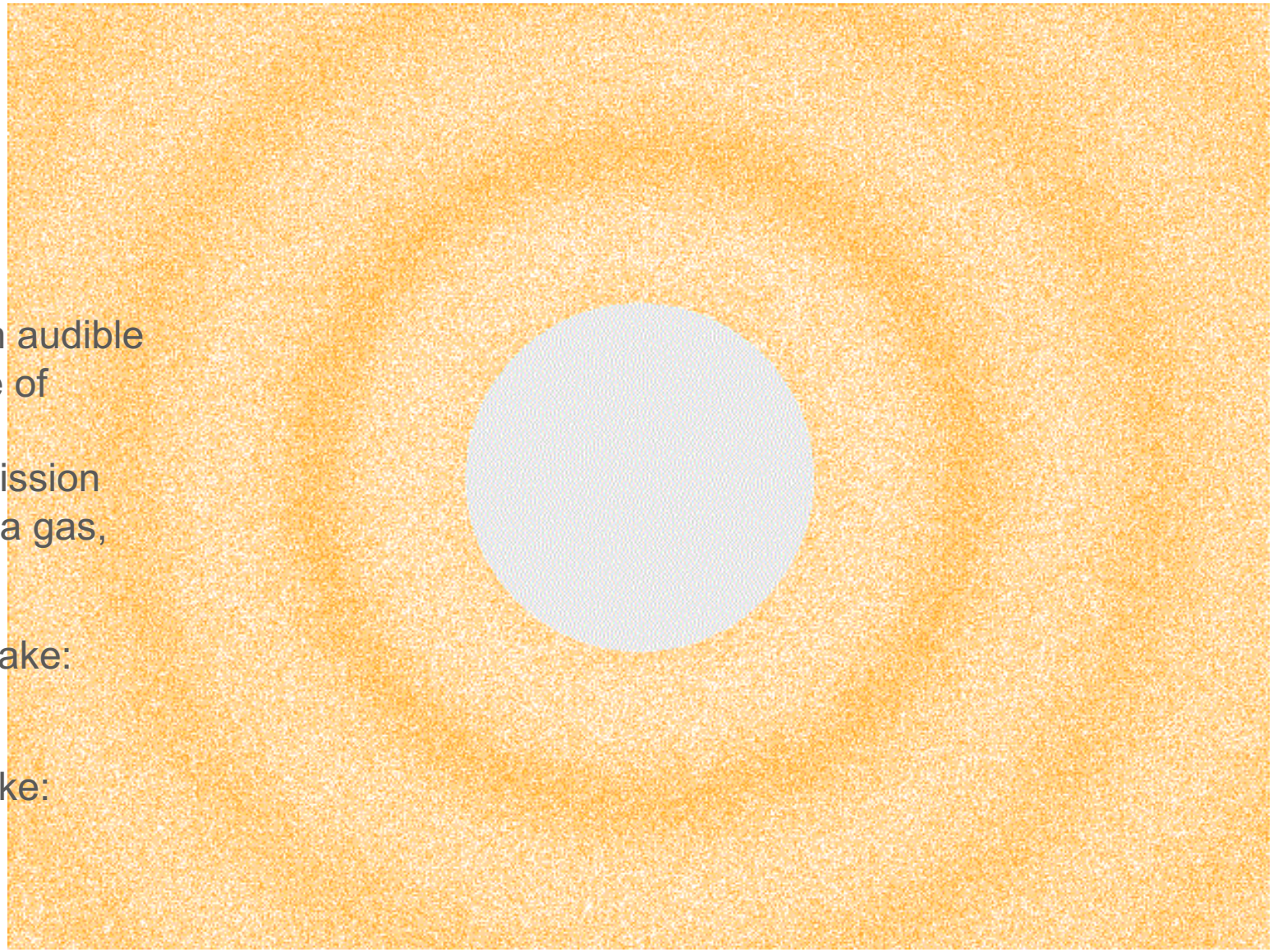
Sound

Sound

- a vibration that propagates as an audible longitudinal wave of pressure
- through a transmission medium such as a gas, liquid or solid.

- How hard you shake: loudness

- how fast you shake: frequency.



Time-based Sampling

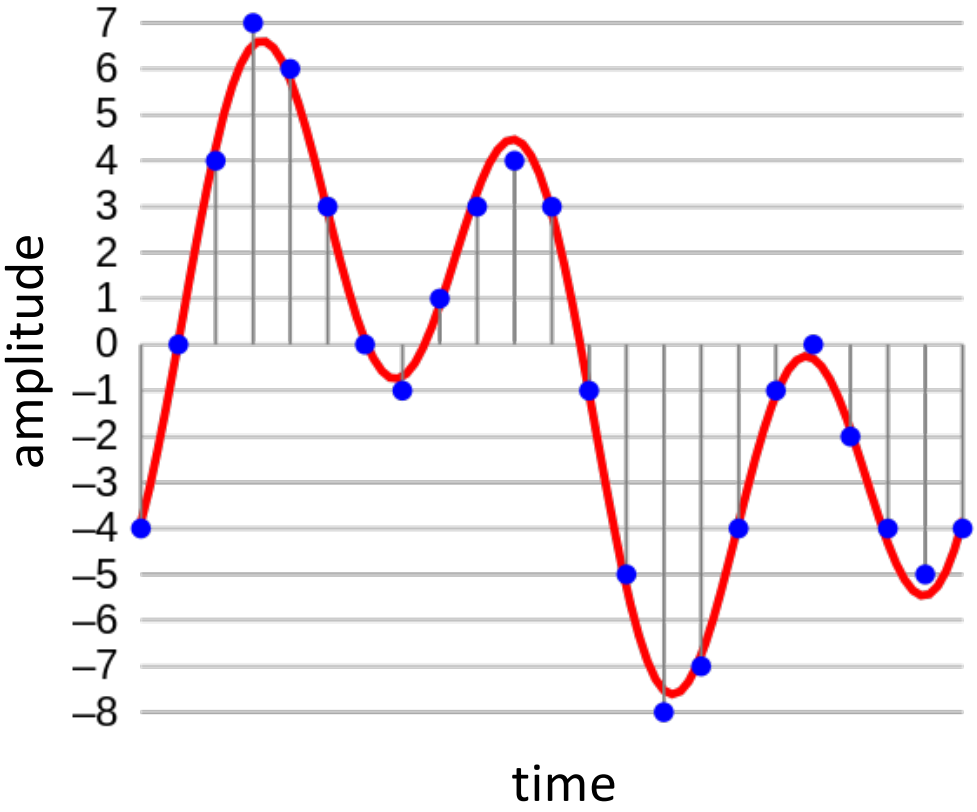
Sound is continuous in time and amplitude (“analog”): red signal

Recording is transducing and storing sound waves.
From the red curve to the blue dots:

Sampling: record values at discrete time (equally spaced time, as in the figure)

Quantizing: record discrete values (e.g., integers, as in the figure)

Nyquist-Shannon sampling theorem: sample at more than twice the bandwidth and you can make a perfect reconstruction.



Noise

Audio is linear:
when two signals coexist,
they just add.

Noise is unwanted sound:

It add up the desired sound

It is often measured as a
power ratio called Signal
to Noise Ratio (SNR)

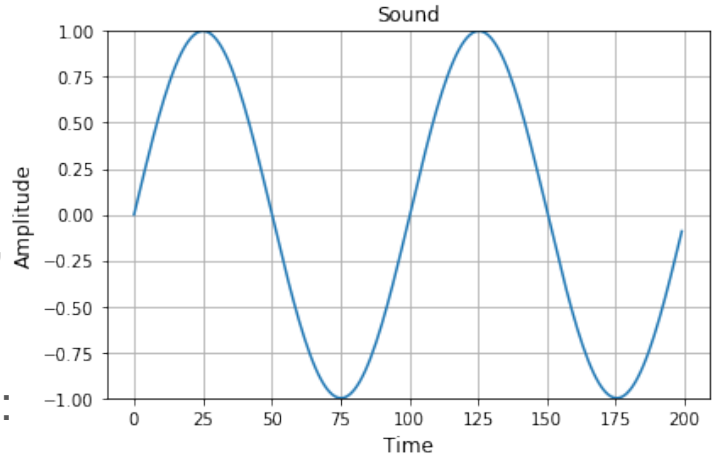
Noise

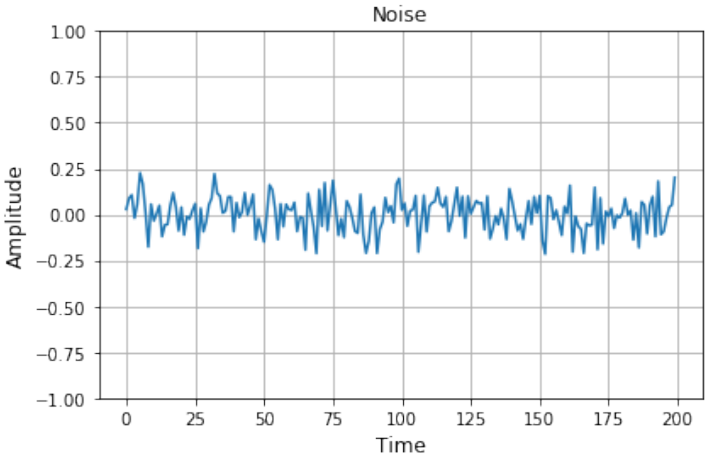
Audio is linear:
when two signals coexist,
they just add.

Noise is unwanted sound:

It add up the desired sound

It is often measured as a power ratio called Signal to Noise Ratio (SNR)





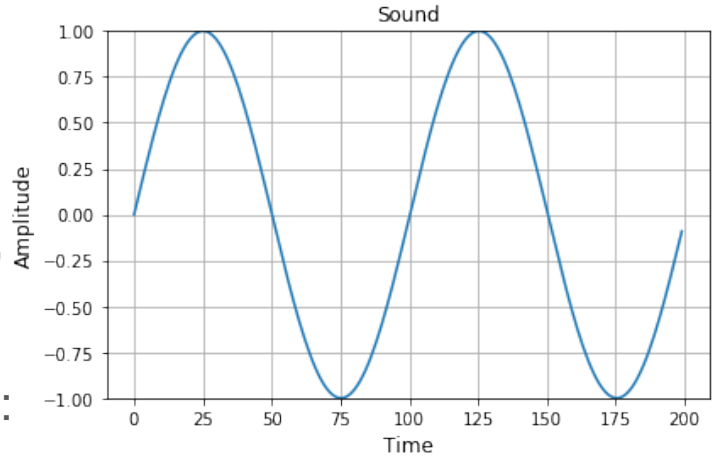
Noise

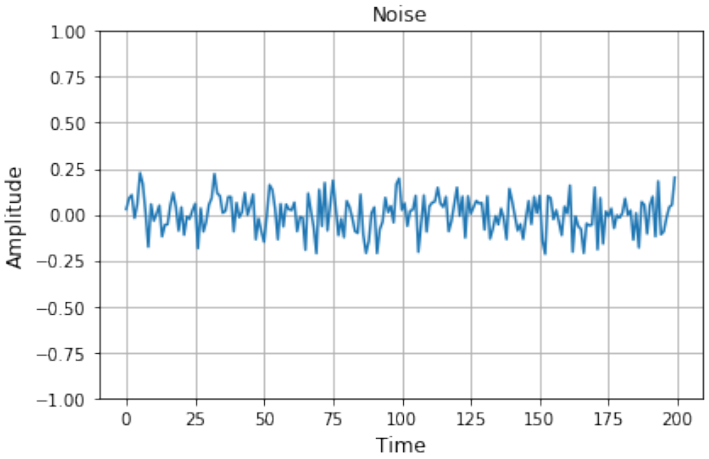
Audio is linear:
when two signals coexist,
they just add.

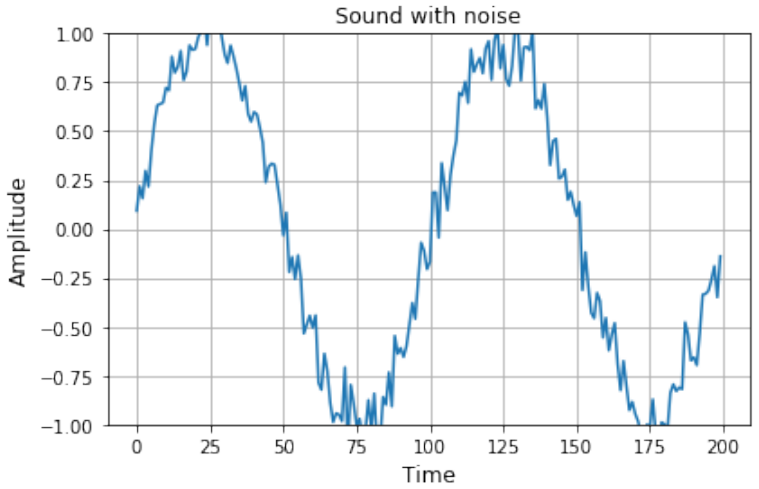
Noise is unwanted sound:

It add up the desired sound

It is often measured as a power ratio called Signal to Noise Ratio (SNR)







Time and Frequency

Frequency is measured in Hertz, units 1/s

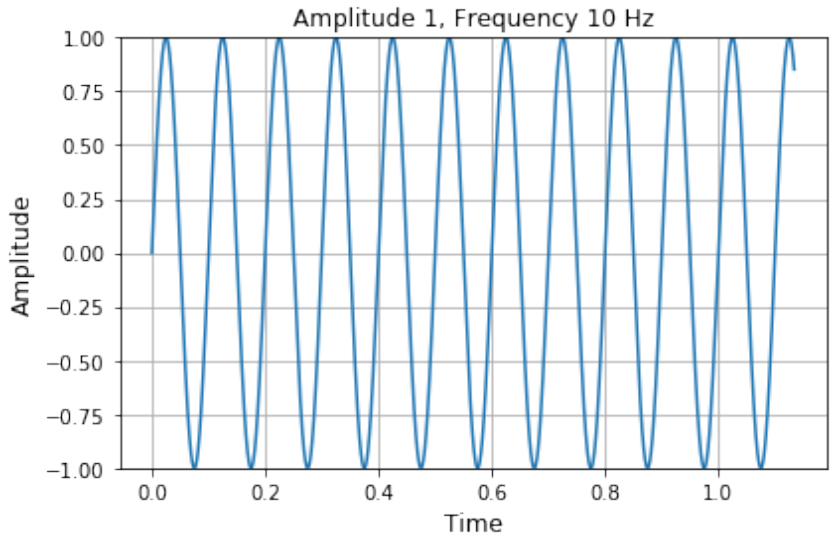
Humans generally hear from 20 Hz to 20 kHz

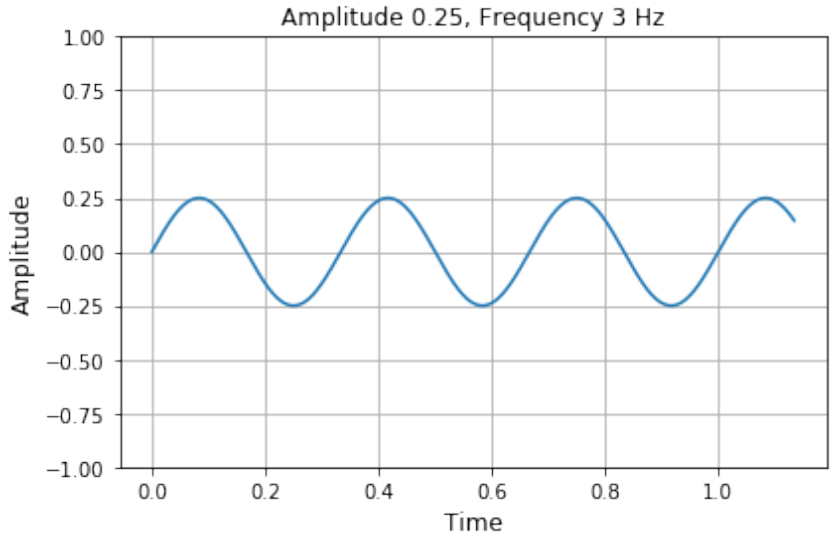
Frequency is generally perceived as pitch.

Amplitude and pitch are independent.

Tones have distinct frequencies, while noise and impulses have broad frequencies.

Average male voice is 120 Hz, average female voice is 210 Hz. Middle A on a piano is 440 Hz.



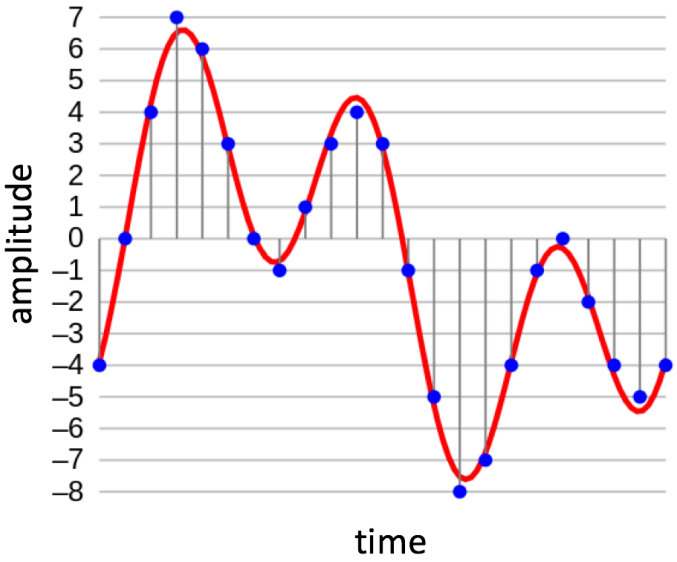


Formats

Examples: WAV, FLAC, mp3, AAC, ...

Differences:

Compression (lossy versus lossless)
Streamable
Decode vs encode difficulty
Proprietary



Today's Exercise

Making sounds from scratch!

Using Python you will make:

A simple tone
An amplitude modulated tone
Noise
A short song!
(can you make one?)