PSY-2007S

Labo Auditif

semaine 1 – son numérique

PSY-2007S

Labo Auditif

How this course works:

Each session starts with a 45 min lecture, followed by practical exercises and experiments in groups.
Each week you will prepare one lab report per group during the session.

There will be a 1.5h exam in the last week.

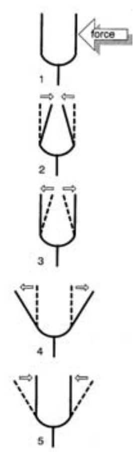
The grade depends 50% on the lab reports and 50% on the test.

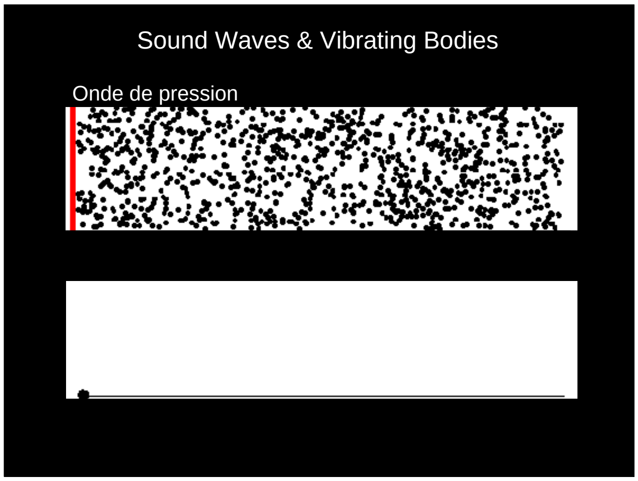
Digital Signals

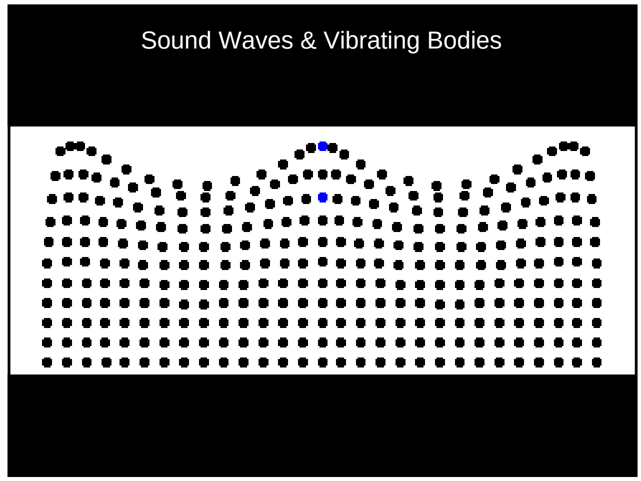
What is Sound
Digital Sound:
Waveform, Spectrum, Spectrogram
Sampling
Filtering

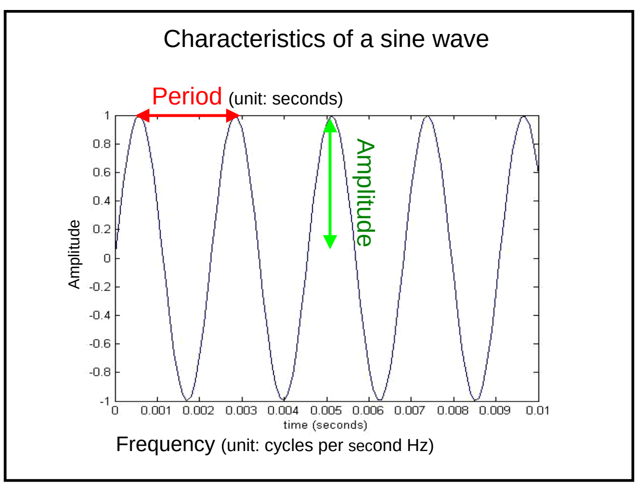
Sound

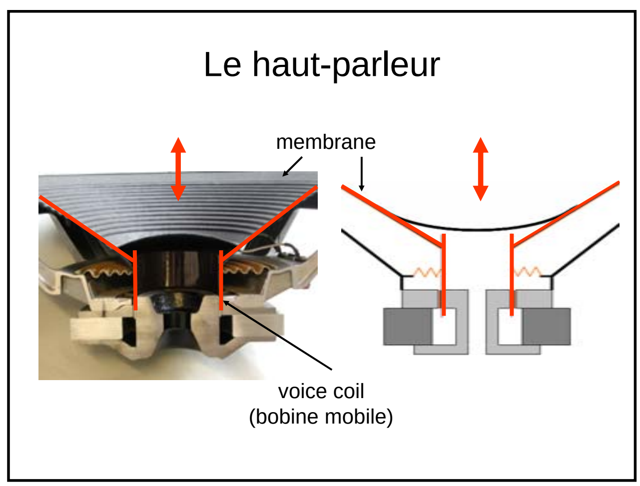
Sound consists of pressure waves carried by vibrating air molecules. It is usually produced by a vibrating surface.

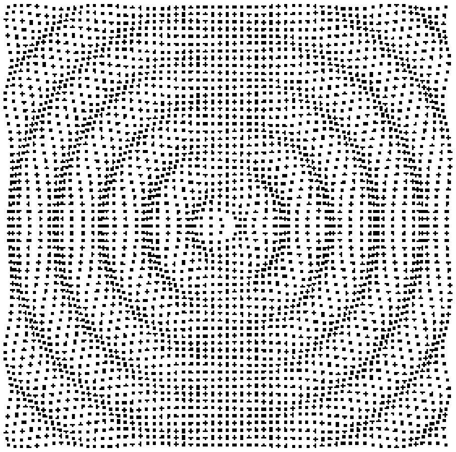



Sound Waves & Vibrating Bodies
Onde de pression

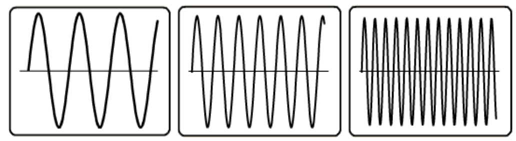

Sound Waves & Vibrating Bodies


Characteristics of a sine wave
Period (unit: seconds)
Amplitude
Amplitude
time (seconds)
Frequency (unit: cycles per second Hz)


Le haut-parleur
membrane
voice coil
(bobine mobile)



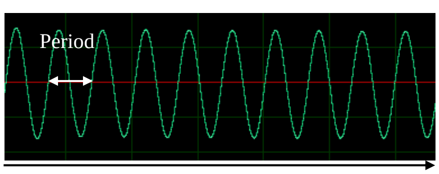
Pitch



Low pitch
Low frequency
Long wavelength

High pitch
High frequency
Short wavelength

Frequency and Period: *p=1/f*

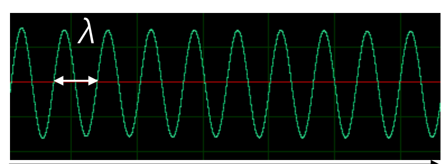


1 second

10 cycles in 1 second – the frequency is 10 Hz

The period (time between peaks) is 1/10 s or 100 ms

Frequency and Period: *p=1/f*



340 m

Sound travels 340m in 1s
10 cycles in 340m – wavelength of 10 Hz = 34m!

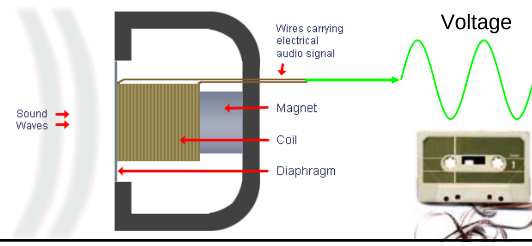
$$v_s = f \times \lambda = 340 m/s$$

Harmonics

A real object will swing at more than one frequency:

1f	2f	3f	4f
100Hz	100Hz +200Hz	100Hz +200Hz +300Hz	100Hz +200Hz +300Hz +400Hz

How are analog sounds recorded by a computer?



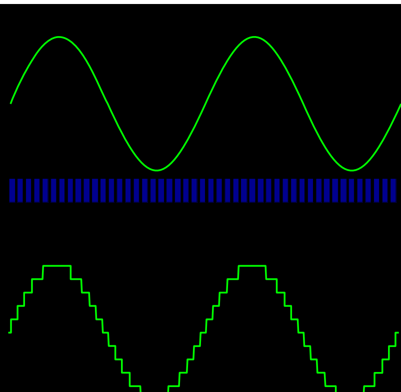
Analog Signal

analog waveform

Clock

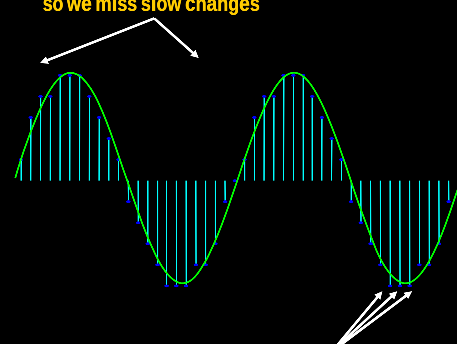
Digital Signal

digized waveform

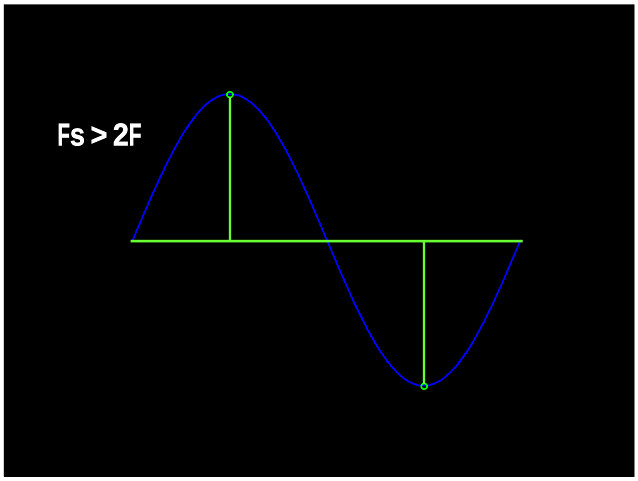


sample values 0 0.2 0.6 0.8 0.8 1 1 1 0.8 0.6 0.4 0.2 -0.2 -0.4

We only measure a limited time
so we miss slow changes

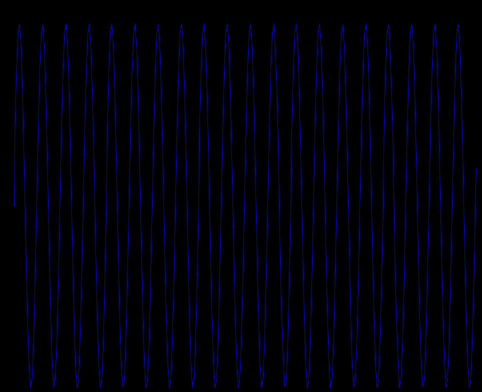


We only measure at certain intervals
so we miss fast changes

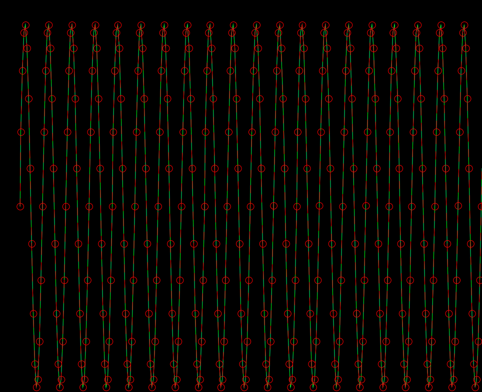


Sampling with lower & lower Frequencies...

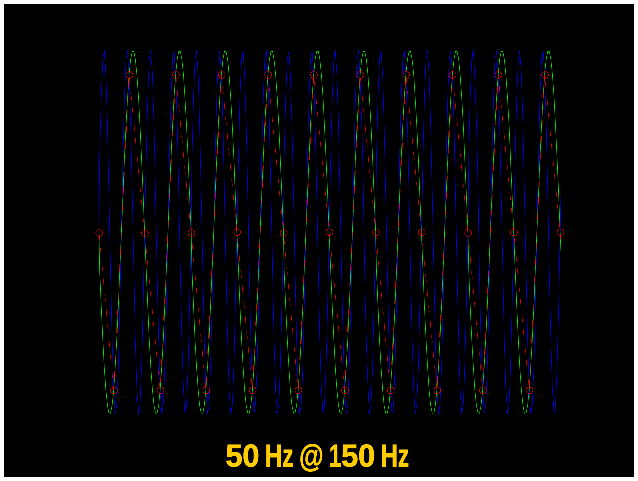
100 Hz Sine Tone, first 200 ms

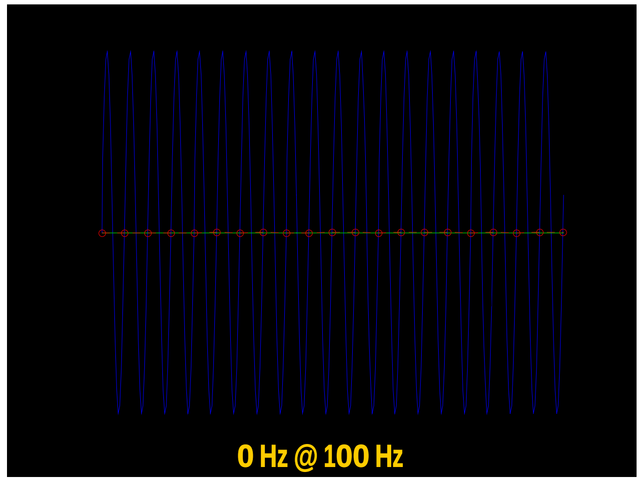


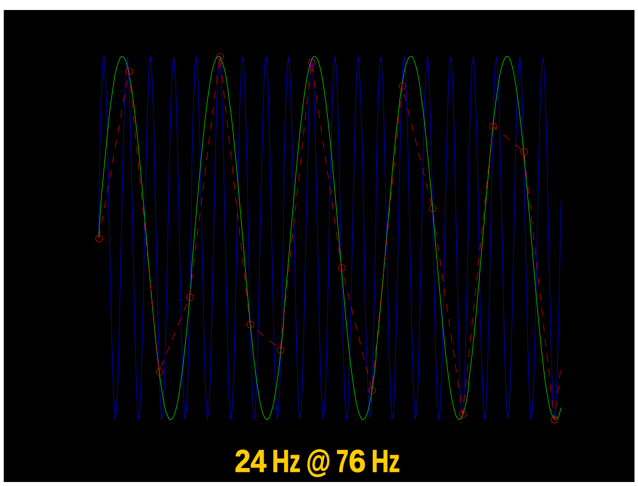
Original Signal 100 Hz



100 Hz @ 1500 Hz







Nyquest theorem

Fs > 2F

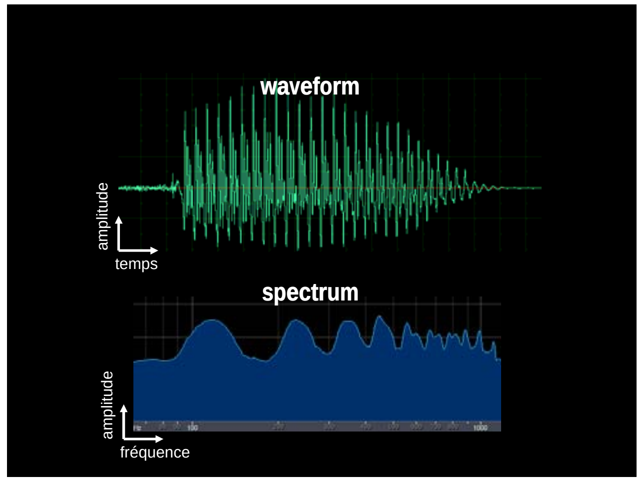
Sample at least twice as fast
as the highest frequency in your signal

Looking at sound signals

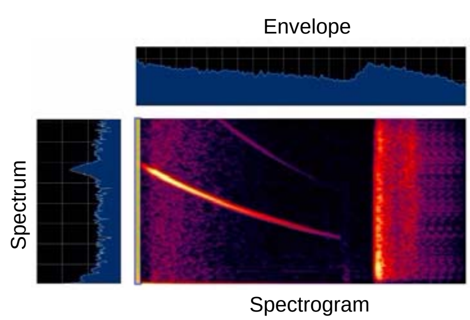
We can look at a sound as pressure variations over time: **waveform**

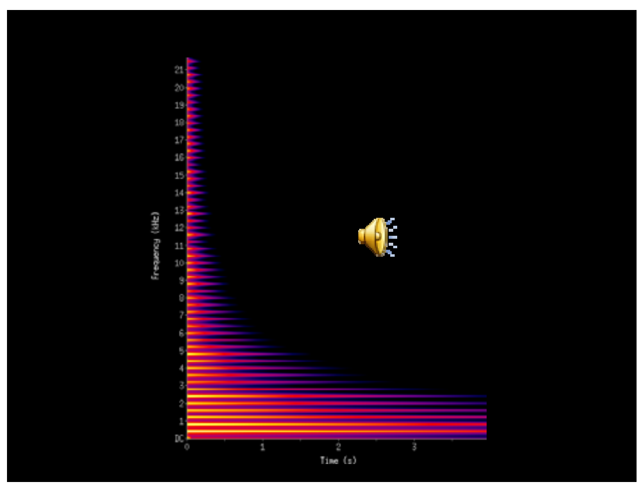
We can look which frequencies are present in a sound: frequency **spectrum**
This works because any sound can be described as a sum of sine waves of different frequencies (Fourier transform).

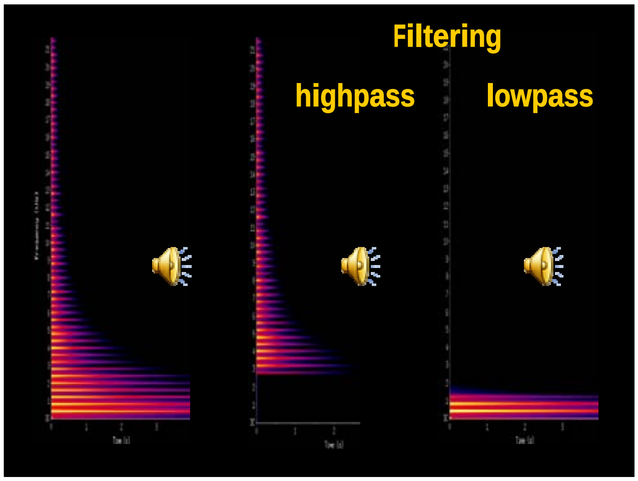
We can look at how the frequency content changes over time: **spectrogram**.

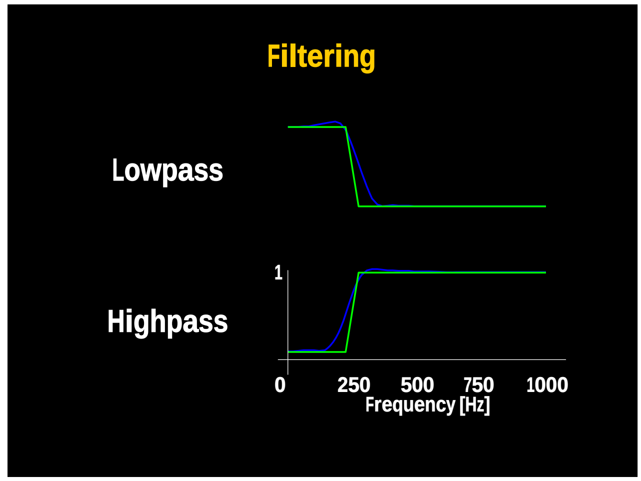


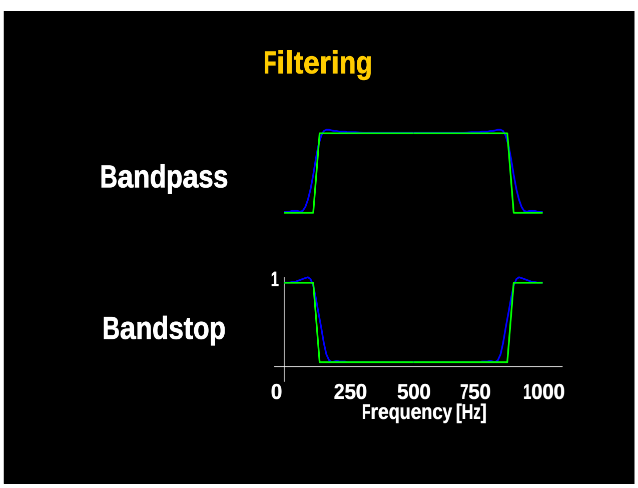
The spectrogram

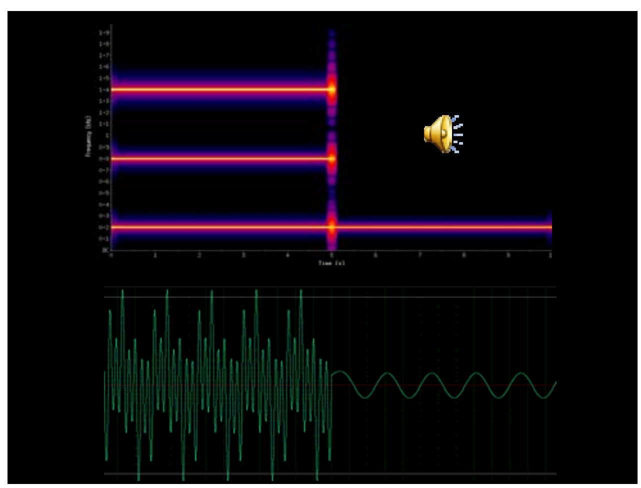





Filtering
highpass
lowpass


Filtering
Lowpass
Highpass
1
0
250
500
750
1000
Frequency [Hz]


Filtering
Bandpass
Bandstop
1
0
250
500
750
1000
Frequency [Hz]



Vocabulary

sine tones
amplitude
frequency
harmonics
loudspeaker
microphone
digitizing a sound
Nyquest theorem
wavelength
waveform
spectrum
spectrogram
envelop
filtering (high-,low,-bandpass, band reject)

Suggestions for your lab reports

Hand in one report per group.

Work together in your group and help each other! Do not let one person do all the work – take turns with the different exercises.

You can ask me if you are stuck with something, but I expect that you at least try to figure things out!

Don’t print your reports on paper – you can email a Word document of a PDF to me (marc.schoenwiesner @umontreal.ca)