Introduction to Acoustic Phonetics

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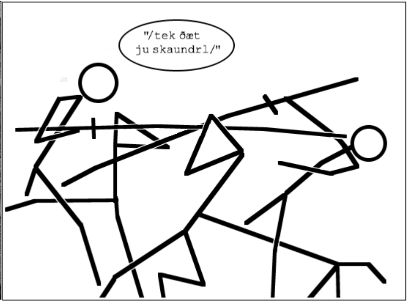
презентация доступна: **https://goo.gl/yve52K**

About course

- Here is a course website.
- Here is a course program.
- We expect some theoretical knowledge
  - read 2. chapter from [Gussenhoven, Jacobs 2011]
  - be able to use IPA symbols
- We expect some basic R skills:
  - import .csv files to R
  - dplyr, ggplot2

Phonetics?...

Phonetics



Phonology

from http://specgram.com/CLIII.1/09.parenchyma.cartoon.e.html

Phonetics is generally assumed to be a subfield that deals with **articulatory**, **acoustic** and **perceptional** aspects of phonological units. Phonology and phonetics together are supposed to describe organization of sounds in languages.

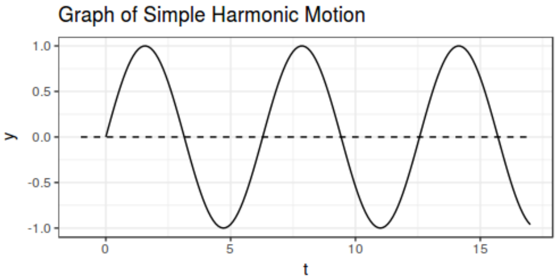
This course is about **acoustic phonetics**.

Simple Harmonic Motion

Periodic Motion is any type of motion that repeats itself after successuve equal time intervals.

Simple Harmonic Motion is specific type of periodic motion that arises from

- existence of some **equilibrium position** for a described object;
- **linear restoring force** that tending to pull the described object back to its equilibrium position.



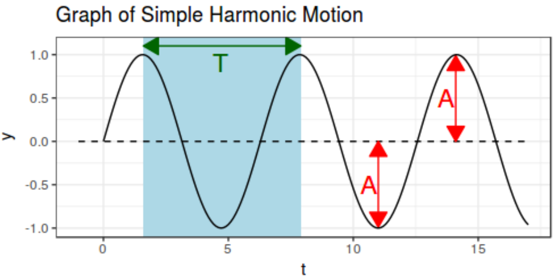
Simple Harmonic Motion

Amplitude is the maximum displacement of the equilibrium position.

Period (T) is the duration of time of one cycle in a repeating event. (s)

Frequency (f) is the number of period (cycles) per second. (Hz)

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$



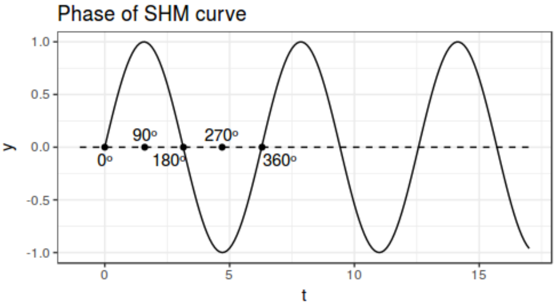
Sound as SHM

We can correlate the physical properties of sound waves with our perception:

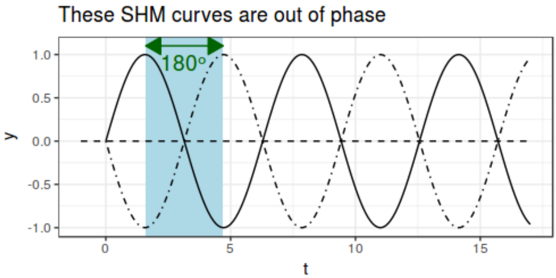
- We perceive changes in frequency as **pitch**
- We perceive changes in amplitude as **loudness**

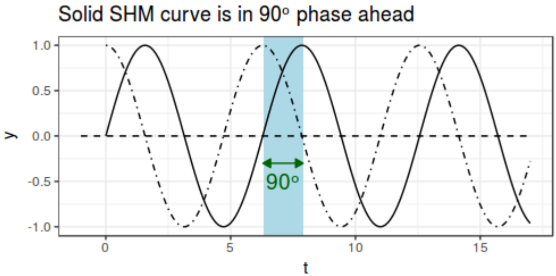
Phase of SHM

One period of SHM can be devided into 360^0 of **phase φ.**



SHMs comparison





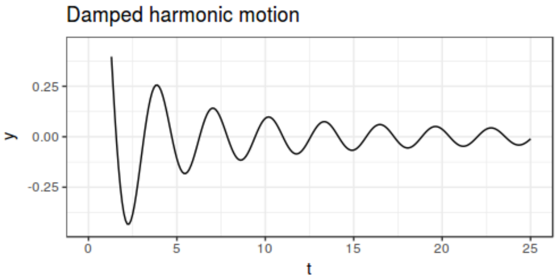
Wave representation

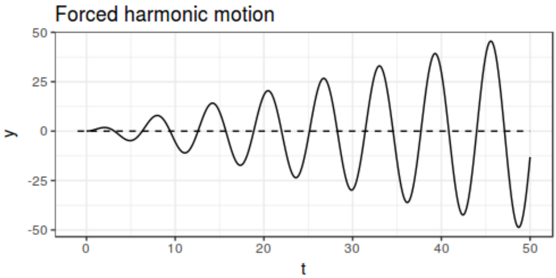
Waves can be represented by formula:

$$s(t) = A \times \cos(2\pi f t + \phi)$$

- A — amplitude
- f — is the fundamental frequency
- ϕ — phase
- t — time

Harmonic motion





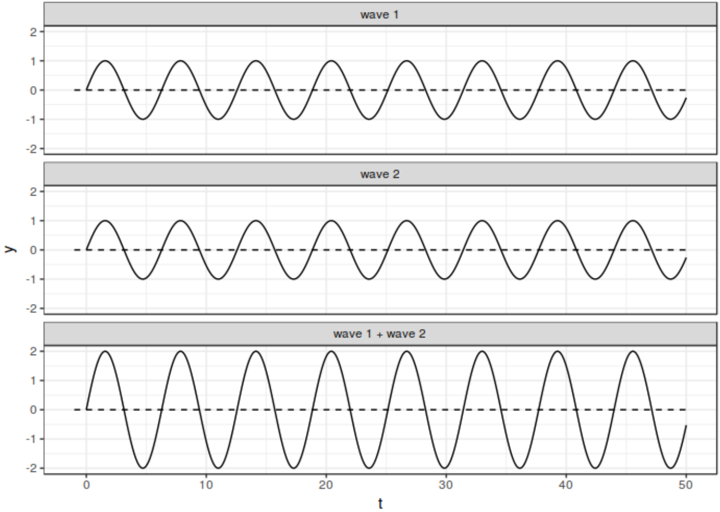
Harmonic motion

Harmonic motions are closely related with the phenomena of **resonance** and **antiresonance**.

Resonance is a phenomenon in which a vibrating system or external force drives another system to oscillate with greater amplitude at specific frequencies.

Antiresonance is a phenomenon in which a vibrating system or external force drives another system to oscillate with smaller amplitude at specific frequencies.

Addition of waves



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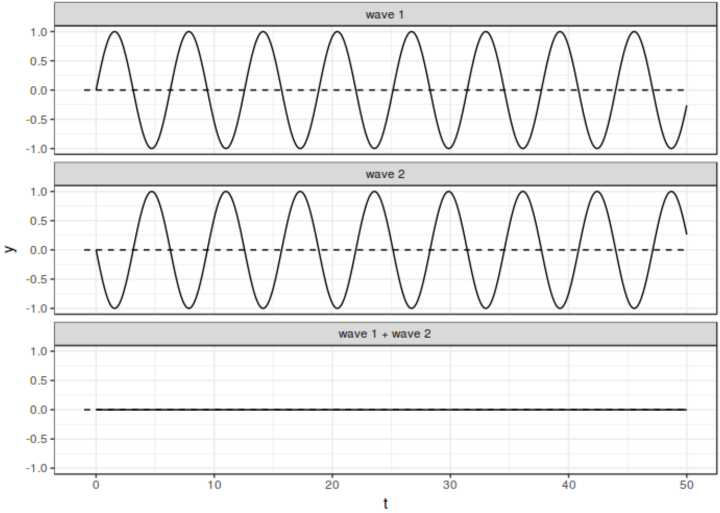
Addition of waves



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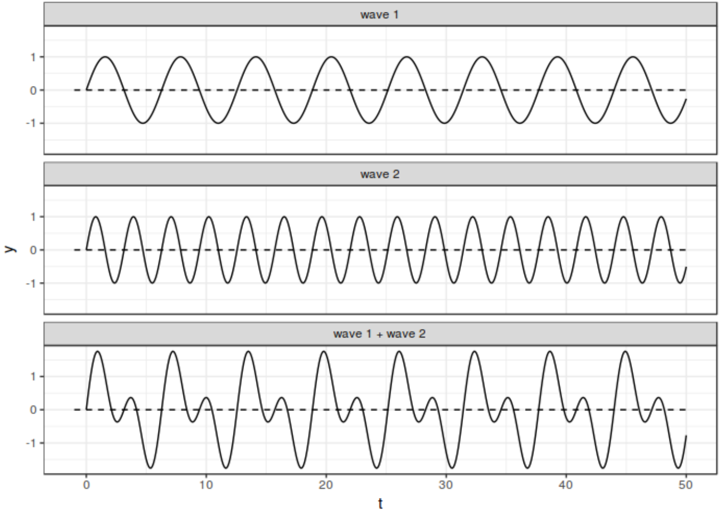
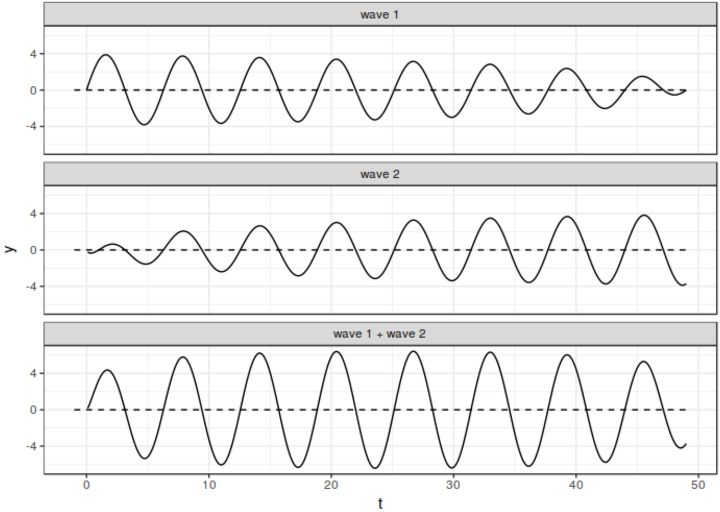
Addition of waves



Addition of waves



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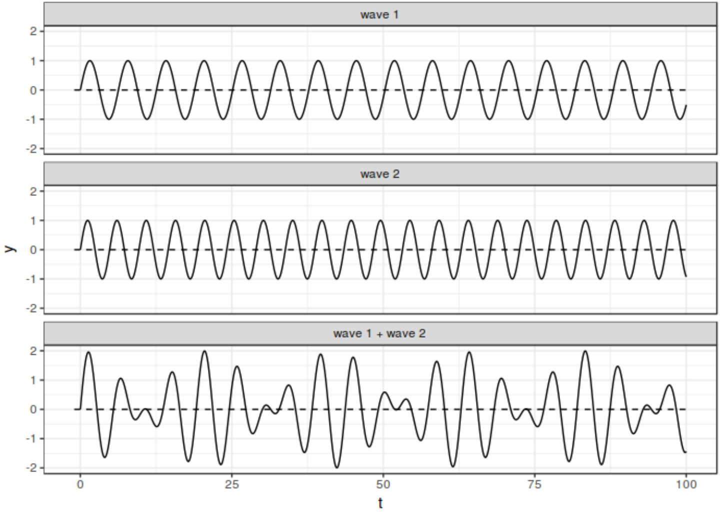
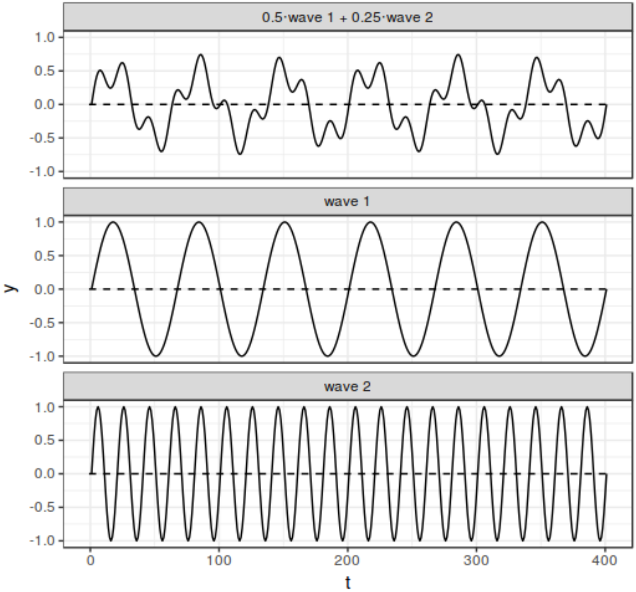
Beats

Beats is a phenomenon of the change in amplitude of the sum of two waves with slightly different frequencies.



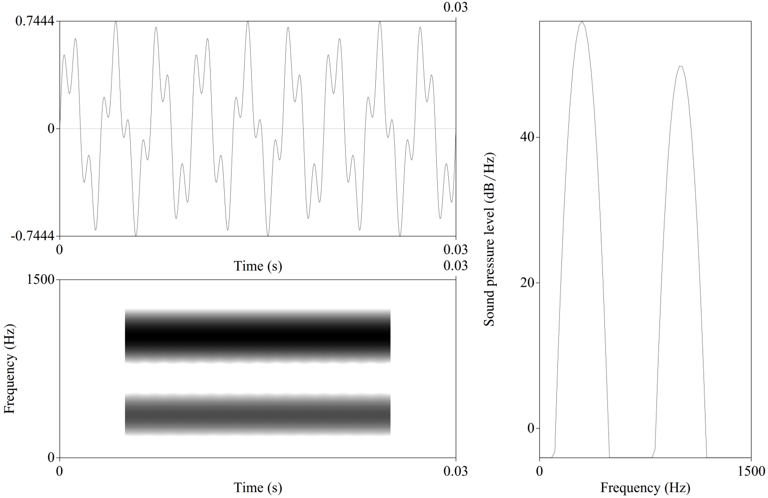
Fourier Transform allows to extract components of the complex wave.



Fourier Transform allows to extract components of the complex wave.

smoothie	complex wave
↓	↓
1 banana, cut in chunks	300 Hz
1 cup grapes	1000 Hz
vanilla yogurt	
1/2 apple, cored and chopped	
1.5 cup fresh spinach leaves	

Spectrogram



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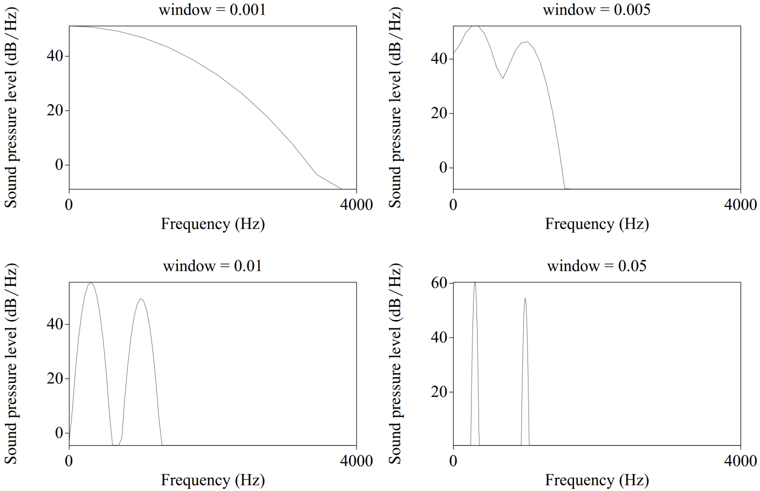
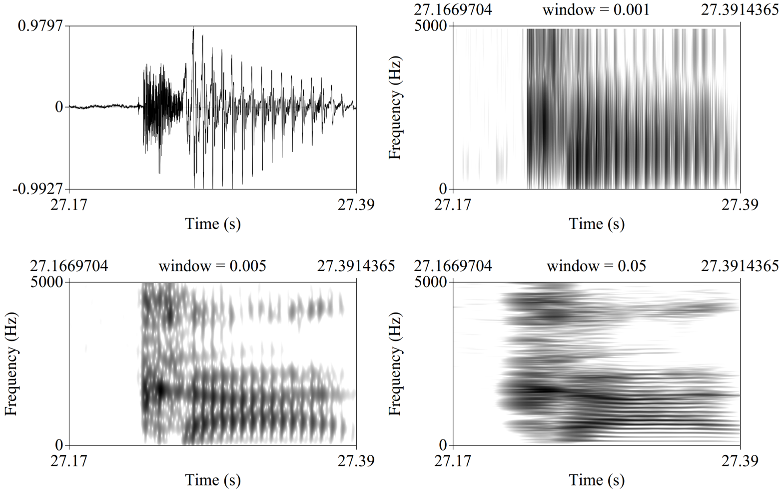
Spectral slices

Spectrograms are differ in window length



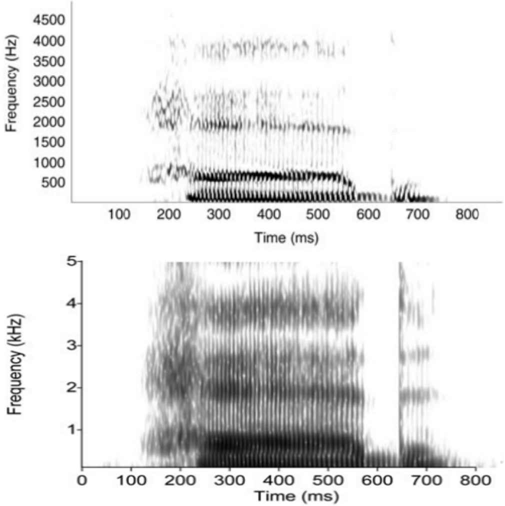
Spectrograms

Syllable [ka]



Not by Fourier alone

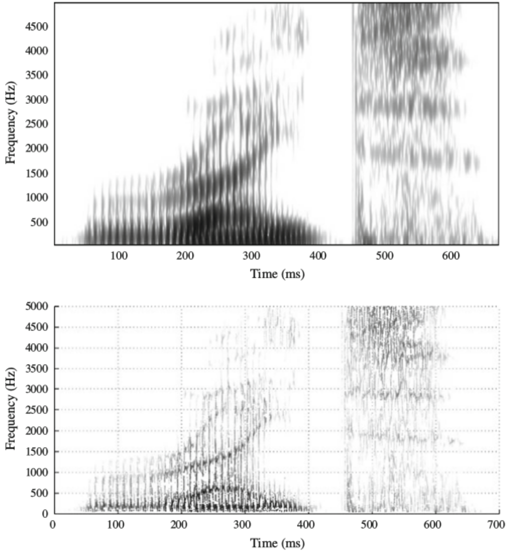
Conventional spectrogram and Zhao-Atlas-Marks distribution of the English word *had*, computed using a Kaiser tapering function.



from [Fulop 2011: 119]

Not by Fourier alone

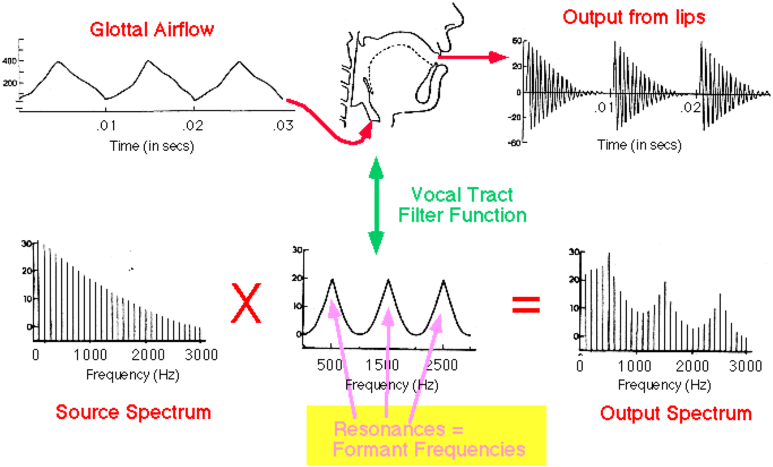
Conventional and reassigned spectrograms of the English word *right*



from [Fulop 2011: 142]

Source-Filter Model of Speech Production

The output energy (at the mouth) for a given frequency is equal to the amplitude the source harmonic, multiplied by the magnitude of the filter function for that the frequency.



Summary

- sounds are waves (with amplitude, frequency and phase)
- simple waves can be combined to the complex one
- Fourier transform allows to extract components of the complex wave
- It is not only Fourier transform that allows to extract components of the complex wave
- Source-Filter Model: vocal tract is a resonator that filters some frequencies of the wave produced by vocal folds vibration.

Thank you!

Please, don't hesitate to write me

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Reference

Berg, R. E., Stork D. G. (2005). The physics of sound. Pearson Education.

Fulop, S. (2011). Speech spectrum analysis. Springer Science & Business Media.

Gussenhoven, Carlos, Haike Jacobs (2011). Understanding Phonology Hodder Education. USA.

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