conrec

Phonetice

SHM

Soun

Phase

motion

Addition

Spectrogran

Model

Summary

Introduction to Acoustic Phonetics

G. Moroz

20 May, 2017

About course

course

Phonetics

SHM

Soun

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motion

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Source-Filter

Model

· Here is a course website.

· Here is a course program.

· We expect some theoretical knowledge

· read 2. chapter from [Gussenhoven, Jacobs 2011]

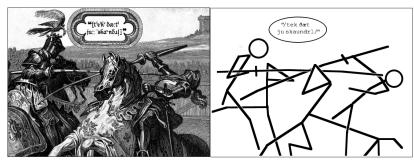
· be able to use IPA symbols

· We expect some basic R skills:

· import .csv files to R

· dplyr, ggplot2

Phonetics?...



Phonetics

Phonetics

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

Phonology

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.

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

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.

Graph of Simple Harmonic Motion

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Phonetics

SHM

DI.

Harmon

Addition o

Spectrogram

Source-Filter Model

Simple Harmonic Motion

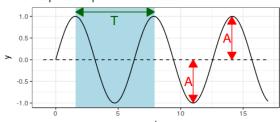
Amplitude is the maximum displacement of the equilibrium position.

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)

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

Graph of Simple Harmonic Motion



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Phonetics

SHM

Phas

Harmon motion

Addition of waves

Spectrogran

Source-Filte Model

Sound as SHM

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Phonetics

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Sound

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motion

Addition waves

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Source-Filte Model

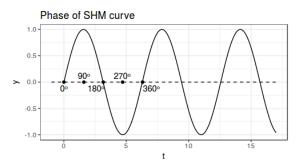
Summary

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 .



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Sound

Phase

motion

waves

Spectrogran

Source-Filte Model

SHMs comparison

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Phonetics

SHM

Soun

Phase

Harmo

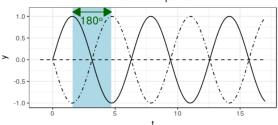
Addition of waves

Spectrogran

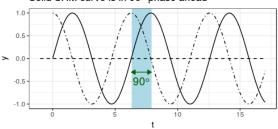
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Summary

These SHM curves are out of phase



Solid SHM curve is in 90° phase ahead



Wave representation

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motion

waves

Spectrogran

Model Model

Summar

Waves can be represented by formula:

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

- · *A* amplitude
- $\cdot f$ is the fundamental frequency
- $\cdot \phi$ phase
- · *t* time

Harmonic motion

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Sound

Phase

Harmonic motion

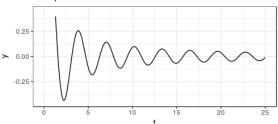
Addition of waves

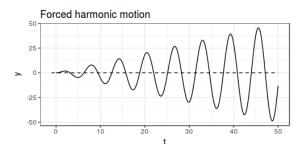
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Summary

Damped harmonic motion





Harmonic motion

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Model

Summar

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.



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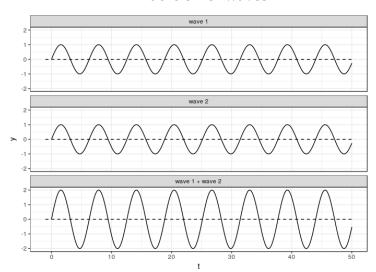
Phase

Harmon motion

Addition of waves

Spectrogran

Source-Filte Model





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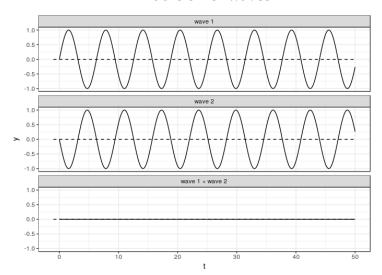
Phas

Harmor

Addition of waves

Spectrogran

Source-Filte Model





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SHM

Soun

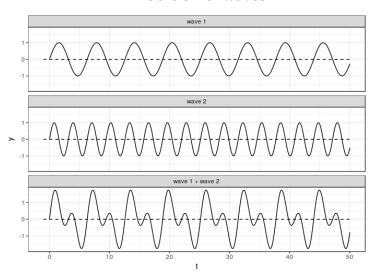
Phase

Harmoni motion

Addition of waves

Spectrogram

Source-Filte Model





Phonetics

SHM

Soun

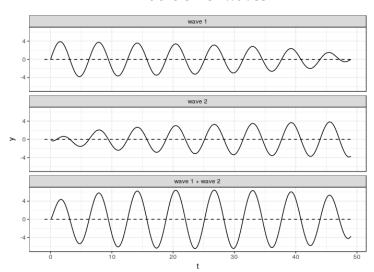
Phase

Harmon motion

Addition of waves

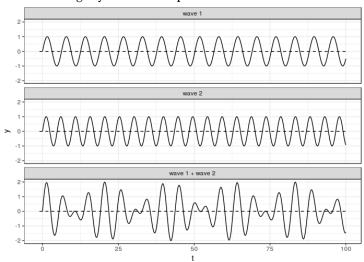
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Beats

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



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Addition of

waves

Fourier Transform allows to extract components of the complex wave.



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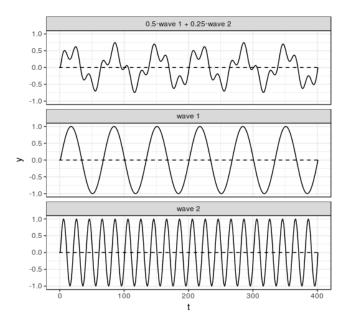
Phas

Harmo

Addition

Spectrogram

Source-Filte Model



Fourier Transform allows to extract components of the complex wave.

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Soun

Phase

Harmo

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waves

Spectrogram

Source-Filte Model

Summai

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smoothie complex wave

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1 banana, cut in chunks
1 cup grapes
1000 Hz

vanilla yogurt
1/2 apple, cored and chopped
1.5 cup fresh spinach leaves
```

Spectrogram



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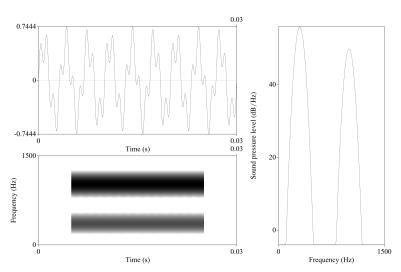
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Addition of waves

Spectrogram

Source-Filte Model



Spectral slices

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Phas

Harmon

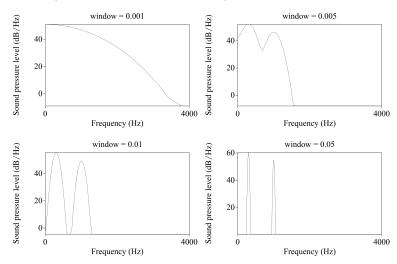
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Spectrograms are differ in window length



Spectrograms

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Sound

Phase

Harmon

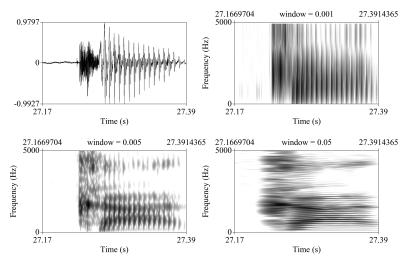
Addition waves

Spectrogram

Source-Filte Model

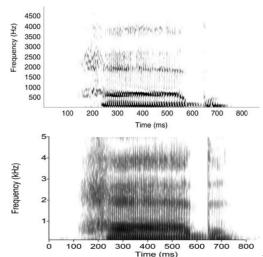
Summar

Syllable [ka]



Not by Fourier alone

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

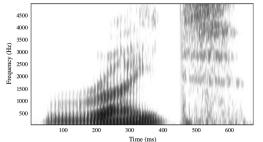


Spectrogram

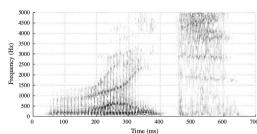
from [Fulop 2011: 119]

Not by Fourier alone

Conventional and reassigned spectrograms of the English word *right*



Spectrogram

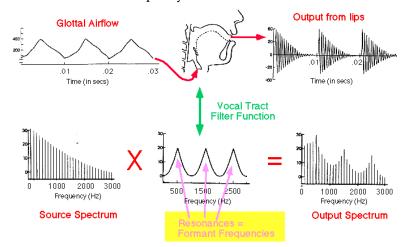


from [Fulop 2011: 142]

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

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.



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

Source-Filter

Model

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.

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Addition of waves

Spectrogran

Model Model

Summary

Thank you!

Please, don't hesitate to write me agricolamz@gmail.com

Reference

course

Phonetics

SHM

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DI.

Harmo

Addition

Spectrogran

Source-Filte Model

Summar

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). <u>Understanding Phonology Hodder Education.</u> USA.