
Disvoice Documentation

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DisVoice

DisVoice is a python framework designed to compute features from speech files. Disvoice computes glottal, phonation, articulation, prosody, phonological, and features representation learning strategies using autoencoders. The features can be computed both from sustained vowels and continuous speech utterances with the aim to recognize praliguistic aspects from speech.

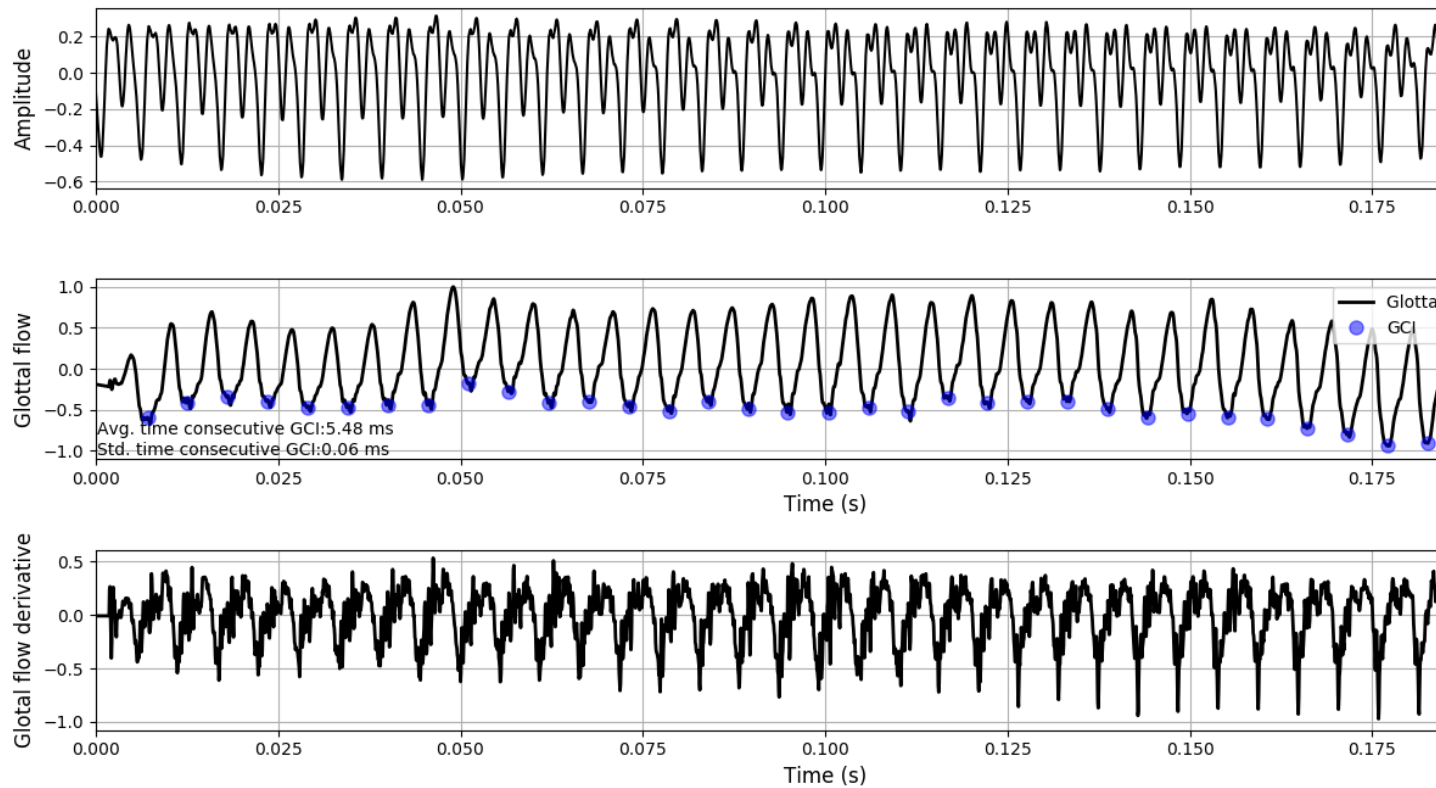
The features can be used in classifiers to recognize emotions, or communication capabilities of patients with different speech disorders including diseases with functional origin such as larynx cancer or nodules; cranio-facial based disorders such as hypernasality developed by cleft-lip and palate; or neurodegenerative disorders such as Parkinson's or Huntington's diseases.

The features are also suitable to evaluate mood problems like depression based on speech patterns.

For additional details about each feature type, and how to use DisVoice, please check

CHAPTER 1

Glottal features



class glottal.Glottal

Compute features based on the glottal source reconstruction from sustained vowels and continuous speech.

For continuous speech, the features are computed over voiced segments

Nine descriptors are computed:

1. Variability of time between consecutive glottal closure instants (GCI)
2. Average opening quotient (OQ) for consecutive glottal cycles-> rate of opening phase duration / duration of glottal cycle
3. Variability of opening quotient (OQ) for consecutive glottal cycles-> rate of opening phase duration /duration of glottal cycle
4. Average normalized amplitude quotient (NAQ) for consecutive glottal cycles-> ratio of the amplitude quotient and the duration of the glottal cycle
5. Variability of normalized amplitude quotient (NAQ) for consecutive glottal cycles-> ratio of the amplitude quotient and the duration of the glottal cycle
6. Average H1H2: Difference between the first two harmonics of the glottal flow signal
7. Variability H1H2: Difference between the first two harmonics of the glottal flow signal
8. Average of Harmonic richness factor (HRF): ratio of the sum of the harmonics amplitude and the amplitude of the fundamental frequency
9. Variability of HRF

Static or dynamic matrices can be computed:

Static matrix is formed with 36 features formed with (9 descriptors) x (4 functionals: mean, std, skewness, kurtosis)

Dynamic matrix is formed with the 9 descriptors computed for frames of 200 ms length with a time-shift of 50 ms.

Notes:

1. The fundamental frequency is computed using the RAPT algorithm.

```
>>> python glottal.py <file_or_folder_audio> <file_features> <dynamic_or_static>
↪<plots (true, false)> <format (csv, txt, npy, kald, torch)>
```

Examples command line:

```
>>> python glottal.py "../audios/001_a1_PCGITA.wav" "glottalfeaturesAst.txt"
↪"static" "true" "txt"
>>> python glottal.py "../audios/098_u1_PCGITA.wav" "glottalfeaturesUst.csv"
↪"static" "true" "csv"
>>> python glottal.py "../audios/098_u1_PCGITA.wav" "glottalfeaturesUst.ark"
↪"dynamic" "true" "kaldi"
>>> python glottal.py "../audios/098_u1_PCGITA.wav" "glottalfeaturesUst.pt"
↪"dynamic" "true" "torch"
```

Examples directly in Python

```
>>> from disvoice.glottal import Glottal
>>> glottal=Glottal()
>>> file_audio="../audios/001_a1_PCGITA.wav"
>>> features=glottal.extract_features_file(file_audio, static, plots=True, fmt=
↪"numpy")
>>> features2=glottal.extract_features_file(file_audio, static, plots=True, fmt=
↪"dataframe")
>>> features3=glottal.extract_features_file(file_audio, dynamic, plots=True, fmt=
↪"torch")
```



```
>>> path_audios="../audios/"
>>> features1=glottal.extract_features_path(path_audios, static, plots=False, fmt=
↳ "numpy")
>>> features2=glottal.extract_features_path(path_audios, static, plots=False, fmt=
↳ "torch")
>>> features3=glottal.extract_features_path(path_audios, static, plots=False, fmt=
↳ "dataframe")
```

extract_features_file (*audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the glottal features from an audio file

Parameters

- **audio** – .wav audio file.
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> glottal=Glottal()
>>> file_audio="../audios/001_a1_PCGITA.wav"
>>> features1=glottal.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="numpy")
>>> features2=glottal.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="dataframe")
>>> features3=glottal.extract_features_file(file_audio, static=False,
↳ plots=True, fmt="torch")
>>> glottal.extract_features_file(file_audio, static=False, plots=False, fmt=
↳ "kaldi", kaldi_file="../test.ark")
```

extract_features_path (*path_audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the glottal features for audios inside a path

Parameters

- **path_audio** – directory with (.wav) audio files inside, sampled at 16 kHz
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> glottal=Glottal()
>>> path_audio="../audios/"
>>> features1=glottal.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="numpy")
>>> features2=glottal.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="csv")
```

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```
>>> features3=glottal.extract_features_path(path_audio, static=False,
↳plots=True, fmt="torch")
>>> glottal.extract_features_path(path_audio, static=False, plots=False, fmt=
↳"kaldi", kaldi_file="./test.ark")
```

extract_glottal_signal (*x*, *fs*)

Extract the glottal flow and the glottal flow derivative signals

Parameters

- **x** – data from the speech signal.
- **fs** – sampling frequency

Returns glottal signal**Returns** derivative of the glottal signal**Returns** glottal closure instants

```
>>> from scipy.io.wavfile import read
>>> glottal=Glottal()
>>> file_audio="./audios/001_al_PCGITA.wav"
>>> fs, data_audio=read(audio)
>>> glottal, g_iaif, GCIs=glottal.extract_glottal_signal(data_audio, fs)
```

plot_glottal (*data_audio*, *fs*, *GCI*, *glottal_flow*, *glottal_sig*)

Plots of the glottal features

Parameters

- **data_audio** – speech signal.
- **fs** – sampling frequency
- **GCI** – glottal closure instants
- **glottal_flow** – glottal flow
- **glottal_sig** – reconstructed glottal signal

Returns plots of the glottal features.**glottal.SE_VQ_varF0** (*x*, *fs*, *f0=None*)

Function to extract GCIs using an adapted version of the SEDREAMS algorithm which is optimised for non-modal voice qualities (SE-VQ). Ncand maximum peaks are selected from the LP-residual signal in the interval defined by the mean-based signal.

A dynamic programming algorithm is then used to select the optimal path of GCI locations. Then a post-processing method, using the output of a resonator applied to the residual signal, is carried out to remove false positives occurring in creaky speech regions.

Note that this method is slightly different from the standard SE-VQ algorithm as the mean based signal is calculated using a variable window length.

This is set using an f0 contour interpolated over unvoiced regions and heavily smoothed. This is particularly useful for speech involving large f0 excursions (i.e. very expressive speech).

Parameters

- **x** – speech signal (in samples)
- **fs** – sampling frequency (Hz)

- **f0** – f0 contour (optional), otherwise its computed using the RAPT algorithm

Returns GCI Glottal closure instants (in samples)

References: Kane, J., Gobl, C., (2013) ‘Evaluation of glottal closure instant detection in a range of voice qualities’, Speech Communication 55(2), pp. 295-314.

ORIGINAL FUNCTION WAS CODED BY JOHN KANE AT THE PHONETICS AND SPEECH LAB IN TRINITY COLLEGE DUBLIN ON 2013.

THE SEDREAMS FUNCTION WAS CODED BY THOMAS DRUGMAN OF THE UNIVERSITY OF MONS THE CODE WAS TRANSLATED TO PYTHON AND ADAPTED BY J. C. Vasquez-Correa AT PATTERN RECOGNITION LAB UNIVERSITY OF ERLANGEN NUREMBER- GERMANY AND UNIVERSITY OF ANTIOQUIA, COLOMBIA JCAMILO.VASQUEZ@UDEA.EDU.CO <https://jcvasquezc.github.io>

`glottal.iaif(x, fs, GCI)`

Function to carry out iterative and adaptive inverse filtering (Alku et al 1992).

Parameters

- **x** – speech signal (in samples)
- **fs** – sampling frequency (in Hz)
- **GCI** – Glottal closure instants (in samples)

Returns glottal flow derivative estimate

Function Coded by John Kane @ The Phonetics and Speech Lab Trinity College Dublin, August 2012

THE CODE WAS TRANSLATED TO PYTHON AND ADAPTED BY J. C. Vasquez-Correa AT PATTERN RECOGNITION LAB UNIVERSITY OF ERLANGEN NUREMBER- GERMANY AND UNIVERSITY OF ANTIOQUIA, COLOMBIA JCAMILO.VASQUEZ@UDEA.EDU.CO <https://jcvasquezc.github.io>

`glottal.get_vq_params(gf, gfd, fs, GCI)`

Function to estimate the glottal parameters: NAQ, QOQ, H1-H2, and HRF

This function can be used to estimate a range of conventional glottal source parameters often used in the literature. This includes: the normalized amplitude quotient (NAQ), the quasi-open quotient (QOQ), the difference in amplitude of the first two harmonics of the differentiated glottal source spectrum (H1-H2), and the harmonic richness factor (HRF)

Parameters

- **gf** – [samples] [N] Glottal flow estimation
- **gfd** – [samples] [N] Glottal flow derivative estimation
- **fs** – [Hz] [1] sampling frequency
- **GCI** – [samples] [M] Glottal closure instants

Returns NAQ [s,samples] [Mx2] Normalised amplitude quotient

Returns QOQ[s,samples] [Mx2] Quasi-open quotient

Returns H1H2[s,dB] [Mx2] Difference in glottal harmonic amplitude

Returns HRF[s,samples] [Mx2] Harmonic richness factor

References: [1] Alku, P., Backstrom, T., and Vilkman, E. Normalized amplitude quotient for parameterization of the glottal flow. Journal of the Acoustical Society of America, 112(2):701-710, 2002.

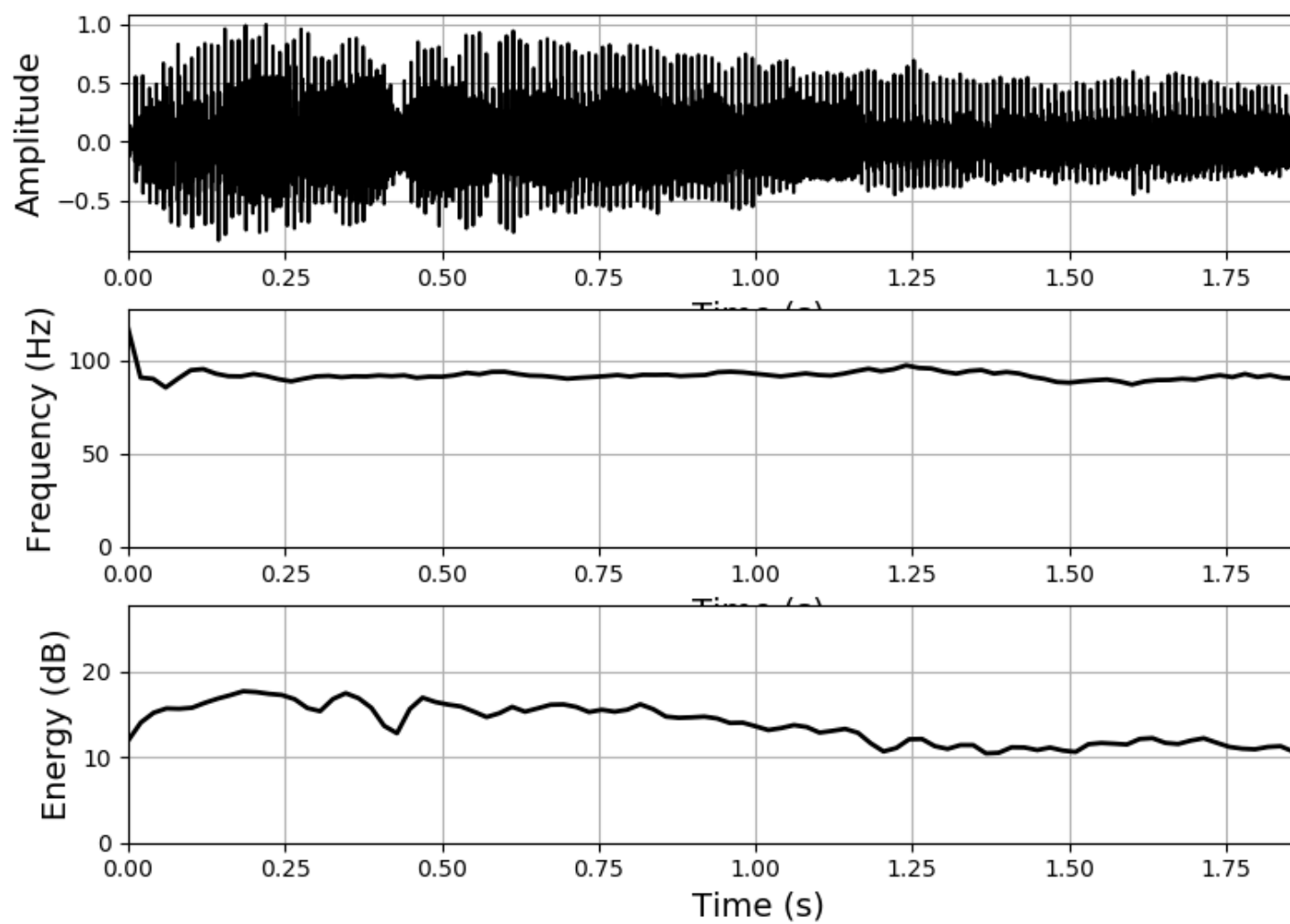
- [2] Hacki, T. Klassifizierung von glottisdysfunktionen mit hilfe der elektrolottographie. *Folia Phoniatica*, pages 43-48, 1989.
- [3] Alku, P., Strik, H., and Vilkman, E. Parabolic spectral parameter - A new method for quantification of the glottal flow. *Speech Communication*, 22(1):67-79, 1997.
- [4] Hanson, H. M. Glottal characteristics of female speakers: Acoustic correlates. *Journal of the Acoustical Society of America*, 10(1):466-481, 1997.
- [5] Childers, D. G. and Lee, C. K. Voice quality factors: Analysis, synthesis and perception. *Journal of the Acoustical Society of America*, 90(5):2394-2410, 1991.

Function Coded by John Kane @ The Phonetics and Speech Lab Trinity College Dublin, August 2012

THE CODE WAS TRANSLATED TO PYTHON AND ADAPTED BY J. C. Vasquez-Correa AT PATTERN RECOGNITION LAB UNIVERSITY OF ERLANGEN NUREMBERGER- GERMANY AND UNIVERSTY OF ANTIOQUIA, COLOMBIA JCAMILO.VASQUEZ@UDEA.EDU.CO <https://jcvasquezc.github.io>

CHAPTER 2

Phonation features



@author: J. C. Vasquez-Correa

class `phonation.Phonation`

Compute phonation features from sustained vowels and continuous speech.

For continuous speech, the features are computed over voiced segments

Seven descriptors are computed:

1. First derivative of the fundamental Frequency
2. Second derivative of the fundamental Frequency
3. Jitter
4. Shimmer
5. Amplitude perturbation quotient
6. Pitch perturbation quotient
7. Logarithmic Energy

Static or dynamic matrices can be computed:

Static matrix is formed with 29 features formed with (seven descriptors) x (4 functionals: mean, std, skewness, kurtosis) + degree of Unvoiced

Dynamic matrix is formed with the seven descriptors computed for frames of 40 ms.

Notes:

1. In dynamic features the first 11 frames of each recording are not considered to be able to stack the APQ and PPQ descriptors with the remaining ones.
2. The fundamental frequency is computed the RAPT algorithm. To use the PRAAT method, change the "self.pitch method" variable in the class constructor.

Script is called as follows

```
>>> python phonation.py <file_or_folder_audio> <file_features> <static (true or
↳false)> <plots (true or false)> <format (csv, txt, npy, kald, torch)>
```

Examples command line:

```
>>> python phonation.py "../audios/001_a1_PCGITA.wav" "phonationfeaturesAst.txt"
↳"true" "true" "txt"
>>> python phonation.py "../audios/098_u1_PCGITA.wav" "phonationfeaturesUst.csv"
↳"true" "true" "csv"
>>> python phonation.py "../audios/098_u1_PCGITA.wav" "phonationfeaturesUdyn.pt"
↳"false" "true" "torch"
```

```
>>> python phonation.py "../audios/" "phonationfeaturesst.txt" "true" "false" "txt"
↳"
>>> python phonation.py "../audios/" "phonationfeaturesst.csv" "true" "false" "csv"
↳"
>>> python phonation.py "../audios/" "phonationfeaturesdyn.pt" "false" "false"
↳"torch"
```

Examples directly in Python

```
>>> from disvoice.phonation import Phonation
>>> phonation=Phonation()
>>> file_audio="./audios/001_a1_PCGITA.wav"
>>> features=phonation.extract_features_file(file_audio, static, plots=True, fmt=
↳ "numpy")
>>> features2=phonation.extract_features_file(file_audio, static, plots=True, fmt=
↳ "dataframe")
>>> features3=phonation.extract_features_file(file_audio, dynamic, plots=True,
↳ fmt="torch")
```

```
>>> path_audios="./audios/"
>>> features1=phonation.extract_features_path(path_audios, static, plots=False,
↳ fmt="numpy")
>>> features2=phonation.extract_features_path(path_audios, static, plots=False,
↳ fmt="torch")
>>> features3=phonation.extract_features_path(path_audios, static, plots=False,
↳ fmt="dataframe")
```

extract_features_file (*audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the phonation features from an audio file

Parameters

- **audio** – .wav audio file.
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> phonation=Phonation()
>>> file_audio="./audios/001_a1_PCGITA.wav"
>>> features1=phonation.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="numpy")
>>> features2=phonation.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="dataframe")
>>> features3=phonation.extract_features_file(file_audio, static=False,
↳ plots=True, fmt="torch")
>>> phonation.extract_features_file(file_audio, static=False, plots=False,
↳ fmt="kaldi", kaldi_file="./test")
```

extract_features_path (*path_audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the phonation features for audios inside a path

Parameters

- **path_audio** – directory with (.wav) audio files inside, sampled at 16 kHz
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> phonation=Phonation()
>>> path_audio="./audios/"
>>> features1=phonation.extract_features_path(path_audio, static=True,
↳plots=False, fmt="numpy")
>>> features2=phonation.extract_features_path(path_audio, static=True,
↳plots=False, fmt="csv")
>>> features3=phonation.extract_features_path(path_audio, static=False,
↳plots=True, fmt="torch")
>>> phonation.extract_features_path(path_audio, static=False, plots=False,
↳fmt="kaldi", kaldi_file="./test.ark")
```

plot_phon (*data_audio*, *fs*, *F0*, *logE*)

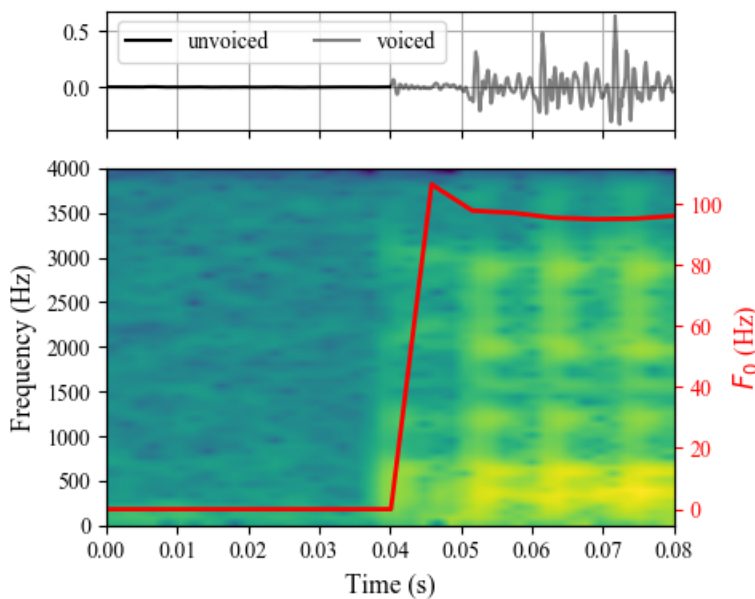
Plots of the phonation features

Parameters

- **data_audio** – speech signal.
- **fs** – sampling frequency
- **F0** – contour of the fundamental frequency
- **logE** – contour of the log-energy

Returns plots of the phonation features.

Articulation features



Created on Jul 21 2017

@author: J. C. Vasquez-Correa

class articulation.**Articulation**

Compute articulation features from continuous speech.

122 descriptors are computed:

1-22. Bark band energies in onset transitions (22 BBE).

23-34. Mel frequency cepstral coefficients in onset transitions (12 MFCC onset)

35-46. First derivative of the MFCCs in onset transitions (12 DMFCC onset)

47-58. Second derivative of the MFCCs in onset transitions (12 DDMFCC onset)

- 59-80. Bark band energies in offset transitions (22 BBE).
- 81-92. MFCCC in offset transitions (12 MFCC offset)
- 93-104. First derivative of the MFCCs in offset transitions (12 DMFCC offset)
- 105-116. Second derivative of the MFCCs in offset transitions (12 DMFCC offset)
- 117. First formant Frequency
- 118. First Derivative of the first formant frequency
- 119. Second Derivative of the first formant frequency
- 120. Second formant Frequency
- 121. First derivative of the Second formant Frequency
- 122. Second derivative of the Second formant Frequency

Static or dynamic matrices can be computed:

Static matrix is formed with 488 features formed with (122 descriptors) x (4 functionals: mean, std, skewness, kurtosis)

Dynamic matrix are formed with the 58 descriptors (22 BBEs, 12 MFCC, 12DMFCC, 12 DDMFCC) computed for frames of 40 ms with a time-shift of 20 ms in onset transitions.

The first two frames of each recording are not considered for dynamic analysis to be able to stack the derivatives of MFCCs

Notes: 1. The first two frames of each recording are not considered for dynamic analysis to be able to stack the derivatives of MFCCs 2. The fundamental frequency is computed the PRAAT algorithm. To use the RAPT method, change the “self.pitch method” variable in the class constructor.

Script is called as follows

```
>>> python articulation.py <file_or_folder_audio> <file_features> <static (true_
↳or false)> <plots (true or false)> <format (csv, txt, npy, kaldi, torch)>
```

Examples command line:

```
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKst.txt" "true" "true" txt
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKst.csv" "true" "true" csv
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKst.pt" "true" "true" torch
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKdyn.txt" "false" "true" txt
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKdyn.csv" "false" "true" csv
>>> python articulation.py "../audios/001_ddk1_PCGITA.wav" "articulation_
↳featuresDDKdyn.pt" "false" "true" torch
```

Examples directly in Python

```
>>> articulation=Articulation()
>>> file_audio="../audios/001_ddk1_PCGITA.wav"
>>> features1=articulation.extract_features_file(file_audio, static=True,
↳plots=True, fmt="npz")
>>> features2=articulation.extract_features_file(file_audio, static=True,
↳plots=True, fmt="dataframe")
```

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```
>>> features3=articulation.extract_features_file(file_audio, static=False,
↳plots=True, fmt="torch")
>>> articulation.extract_features_file(file_audio, static=False, plots=False, fmt=
↳"kaldi", kaldi_file="./test")
```

extract_features_file (*audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the articulation features from an audio file

Parameters

- **audio** – .wav audio file.
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when fmt=="kaldi"

Returns features computed from the audio file.

```
>>> articulation=Articulation()
>>> file_audio="./audios/001_ddk1_PCGITA.wav"
>>> features1=articulation.extract_features_file(file_audio, static=True,
↳plots=True, fmt="numpy")
>>> features2=articulation.extract_features_file(file_audio, static=True,
↳plots=True, fmt="dataframe")
>>> features3=articulation.extract_features_file(file_audio, static=False,
↳plots=True, fmt="torch")
>>> articulation.extract_features_file(file_audio, static=False, plots=False,
↳fmt="kaldi", kaldi_file="./test")
```

```
>>> path_audio="./audios/"
>>> features1=articulation.extract_features_path(path_audio, static=True,
↳plots=False, fmt="numpy")
>>> features2=articulation.extract_features_path(path_audio, static=True,
↳plots=False, fmt="csv")
>>> features3=articulation.extract_features_path(path_audio, static=False,
↳plots=True, fmt="torch")
>>> articulation.extract_features_path(path_audio, static=False, plots=False,
↳fmt="kaldi", kaldi_file="./test.ark")
```

extract_features_path (*path_audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the articulation features for audios inside a path

Parameters

- **path_audio** – directory with (.wav) audio files inside, sampled at 16 kHz
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when fmt=="kaldi"

Returns features computed from the audio file.

```
>>> articulation=Articulation()
>>> path_audio="./audios/"
>>> features1=articulation.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="numpy")
>>> features2=articulation.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="csv")
>>> features3=articulation.extract_features_path(path_audio, static=False,
↳ plots=True, fmt="torch")
>>> articulation.extract_features_path(path_audio, static=False, plots=False,
↳ fmt="kaldi", kaldi_file="./test.ark")
```

plot_art (*data_audio, fs, F0, F1, F2, segmentsOn, segmentsOff*)

Plots of the articulation features

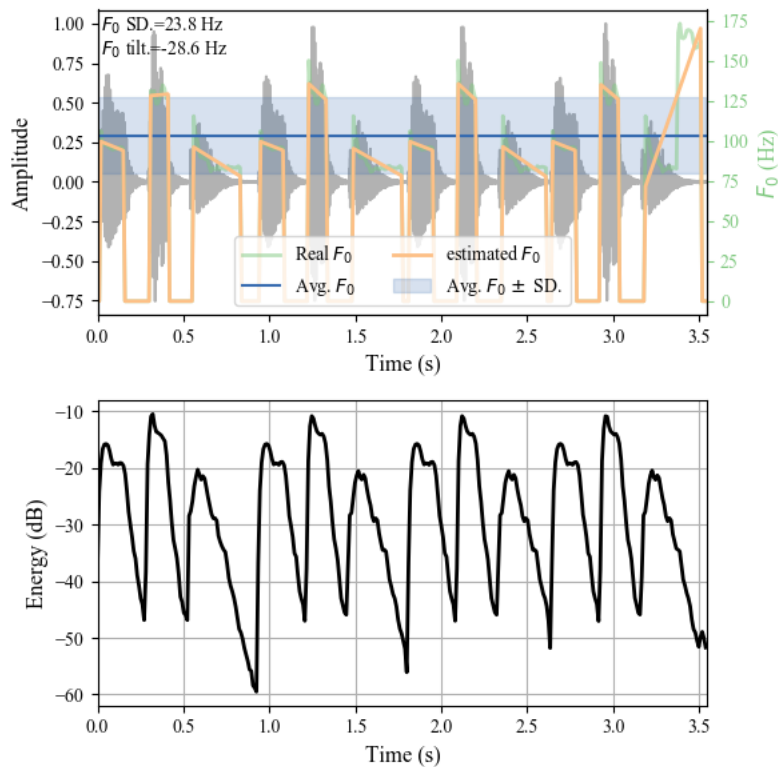
Parameters

- **data_audio** – speech signal.
- **fs** – sampling frequency
- **F0** – contour of the fundamental frequency
- **F1** – contour of the 1st formant
- **F2** – contour of the 2nd formant
- **segmentsOn** – list with the onset segments
- **segmentsOff** – list with the offset segments

Returns plots of the articulation features.

CHAPTER 4

Prosody features



Created on Jul 21 2017, Modified Apr 10

2018.

@author: J. C. Vasquez-Correa, T. Arias-Vergara, J. S. Guerrero

class prosody.Pro prosody

Compute prosody features from continuous speech based on duration, fundamental frequency and energy. Static or dynamic matrices can be computed: Static matrix is formed with 103 features and include

1-6 F0-contour: Avg., Std., Max., Min., Skewness, Kurtosis
7-12 Tilt of a linear estimation of F0 for each voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
13-18 MSE of a linear estimation of F0 for each voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
19-24 F0 on the first voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
25-30 F0 on the last voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
31-34 energy-contour for voiced segments: Avg., Std., Skewness, Kurtosis
35-38 Tilt of a linear estimation of energy contour for V segments: Avg., Std., Skewness, Kurtosis
39-42 MSE of a linear estimation of energy contour for V segment: Avg., Std., Skewness, Kurtosis
43-48 energy on the first voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
49-54 energy on the last voiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
55-58 energy-contour for unvoiced segments: Avg., Std., Skewness, Kurtosis
59-62 Tilt of a linear estimation of energy contour for U segments: Avg., Std., Skewness, Kurtosis
63-66 MSE of a linear estimation of energy contour for U segments: Avg., Std., Skewness, Kurtosis
67-72 energy on the first unvoiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
73-78 energy on the last unvoiced segment: Avg., Std., Max., Min., Skewness, Kurtosis
79 Voiced rate: Number of voiced segments per second
80-85 Duration of Voiced: Avg., Std., Max., Min., Skewness, Kurtosis
86-91 Duration of Unvoiced: Avg., Std., Max., Min., Skewness, Kurtosis
92-97 Duration of Pauses: Avg., Std., Max., Min., Skewness, Kurtosis
98-103 Duration ratios: Pause/(Voiced+Unvoiced), Pause/Unvoiced, Unvoiced/(Voiced+Unvoiced), Voiced/(Voiced+Unvoiced), Voiced/Puase, Unvoiced/Pause
Dynamic matrix is formed with 13 features computed for each voiced segment and contains
1-6. Coefficients of 5-degree Lagrange polynomial to model F0 contour
7-12. Coefficients of 5-degree Lagrange polynomial to model energy contour
13. Duration of the voiced segment

Dynamic prosody features are based on Najim Dehak, “Modeling Prosodic Features With Joint Factor Analysis for Speaker Verification”, 2007

Script is called as follows

```
>>> python prosody.py <file_or_folder_audio> <file_features> <static (true or false)> <plots (true or false)> <format (csv, txt, npy, kald, torch)>
```

Examples command line:

```
>>> python prosody.py "../audios/001_ddk1_PCGITA.wav" "prosodyfeaturesAst.txt"
↳ "true" "true" "txt"
>>> python prosody.py "../audios/001_ddk1_PCGITA.wav" "prosodyfeaturesUst.csv"
↳ "true" "true" "csv"
>>> python prosody.py "../audios/001_ddk1_PCGITA.wav" "prosodyfeaturesUdyn.pt"
↳ "false" "true" "torch"
```



```
>>> python prosody.py "../audios/" "prosodyfeaturesst.txt" "true" "false" "txt"
>>> python prosody.py "../audios/" "prosodyfeaturesst.csv" "true" "false" "csv"
>>> python prosody.py "../audios/" "prosodyfeaturesdyn.pt" "false" "false" "torch"
>>> python prosody.py "../audios/" "prosodyfeaturesdyn.csv" "false" "false" "csv"
```

Examples directly in Python

```
>>> prosody=Prosody()
>>> file_audio="../audios/001_ddk1_PCGITA.wav"
>>> features1=prosody.extract_features_file(file_audio, static=True, plots=True,
↳fmt="numpy")
>>> features2=prosody.extract_features_file(file_audio, static=True, plots=True,
↳fmt="dataframe")
>>> features3=prosody.extract_features_file(file_audio, static=False, plots=True,
↳fmt="torch")
>>> prosody.extract_features_file(file_audio, static=False, plots=False, fmt=
↳"kaldi", kaldi_file="./test")
```

```
>>> path_audio="../audios/"
>>> features1=prosody.extract_features_path(path_audio, static=True, plots=False,
↳fmt="numpy")
>>> features2=prosody.extract_features_path(path_audio, static=True, plots=False,
↳fmt="csv")
>>> features3=prosody.extract_features_path(path_audio, static=False, plots=True,
↳fmt="torch")
>>> prosody.extract_features_path(path_audio, static=False, plots=False, fmt=
↳"kaldi", kaldi_file="./test.ark")
```

extract_features_file (*audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the prosody features from an audio file

Parameters

- **audio** – .wav audio file.
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> prosody=Prosody()
>>> file_audio="../audios/001_ddk1_PCGITA.wav"
>>> features1=prosody.extract_features_file(file_audio, static=True,
↳plots=True, fmt="numpy")
>>> features2=prosody.extract_features_file(file_audio, static=True,
↳plots=True, fmt="dataframe")
>>> features3=prosody.extract_features_file(file_audio, static=False,
↳plots=True, fmt="torch")
>>> prosody.extract_features_file(file_audio, static=False, plots=False, fmt=
↳"kaldi", kaldi_file="./test")
```

extract_features_path (*path_audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the prosody features for audios inside a path

Parameters

- **path_audio** – directory with (.wav) audio files inside, sampled at 16 kHz
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldil)
- **kaldi_file** – file to store kaldifeatures, only valid when `fmt=="kaldi"`

Returns features computed from the audio file.

```
>>> prosody=Prosody()
>>> path_audio="./audios/"
>>> features1=prosody.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="numpy")
>>> features2=prosody.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="csv")
>>> features3=prosody.extract_features_path(path_audio, static=False,
↳ plots=True, fmt="torch")
>>> prosody.extract_features_path(path_audio, static=False, plots=False, fmt=
↳ "kaldi", kaldi_file="./test.ark")
```

plot_pros (*data_audio, fs, F0, segmentsV, segmentsU, F0_features*)

Plots of the prosody features

Parameters

- **data_audio** – speech signal.
- **fs** – sampling frequency
- **F0** – contour of the fundamental frequency
- **segmentsV** – list with the voiced segments
- **segmentsU** – list with the unvoiced segments
- **F0_features** – vector with f0-based features

Returns plots of the prosody features.

prosody_dynamic (*audio*)

Extract the dynamic prosody features from an audio file

Parameters **audio** – .wav audio file.

Returns array (N,13) with the prosody features extracted from an audio file. N= number of voiced segments

```
>>> prosody=Prosody()
>>> file_audio="./audios/001_ddk1_PCGITA.wav"
>>> features=prosody.prosody_dynamic(file_audio)
```

prosody_static (*audio, plots*)

Extract the static prosody features from an audio file

Parameters

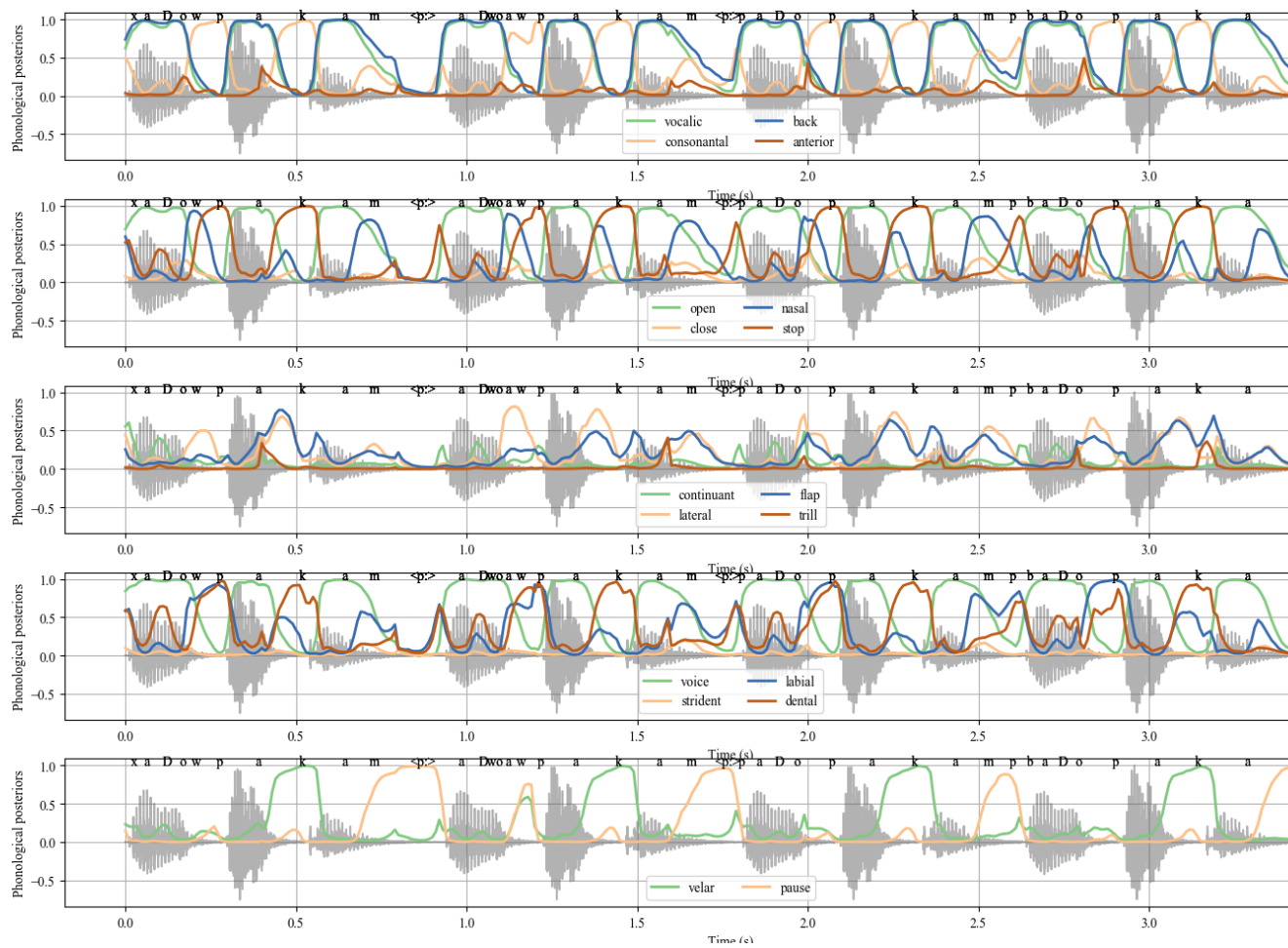
- **audio** – .wav audio file.
- **plots** – timeshift to extract the features

Returns array with the 103 prosody features

```
>>> prosody=Prosody()  
>>> file_audio="../audios/001_ddk1_PCGITA.wav"  
>>> features=prosody.prosody_static(file_audio, plots=True)
```


CHAPTER 5

Phonological features



Created on Jun 24 2020

@author: J. C. Vasquez-Correa

class phonological.Phonological

Compute phonological features from continuous speech files.

18 descriptors are computed, bases on 18 different phonological classes from the phonet toolkit <https://phonet.readthedocs.io/en/latest/?badge=latest>

It computes the phonological log-likelihood ratio features from phonet

Static or dynamic matrices can be computed:

Static matrix is formed with 108 features formed with (18 descriptors) x (6 functionals: mean, std, skewness, kurtosis, max, min)

Dynamic matrix is formed with the 18 descriptors computed for frames of 25 ms with a time-shift of 10 ms.

Script is called as follows

```
>>> python phonological.py <file_or_folder_audio> <file_features> <static (true,
↳ or false)> <plots (true or false)> <format (csv, txt, npy, kaldi, torch)>
```

Examples command line:

```
>>> python phonological.py "../audios/001_ddk1_PCGITA.wav"
↳ "phonologicalfeaturesAst.txt" "true" "true" "txt"
>>> python phonological.py "../audios/001_ddk1_PCGITA.wav"
↳ "phonologicalfeaturesUst.csv" "true" "true" "csv"
>>> python phonological.py "../audios/001_ddk1_PCGITA.wav"
↳ "phonologicalfeaturesUdyn.pt" "false" "true" "torch"
```

```
>>> python phonological.py "../audios/" "phonologicalfeaturesst.txt" "true" "false"
↳ "txt"
>>> python phonological.py "../audios/" "phonologicalfeaturesst.csv" "true" "false"
↳ "csv"
>>> python phonological.py "../audios/" "phonologicalfeaturesdyn.pt" "false"
↳ "false" "torch"
>>> python phonological.py "../audios/" "phonologicalfeaturesdyn.csv" "false"
↳ "false" "csv"
```

Examples directly in Python

```
>>> phonological=Phonological()
>>> file_audio="../audios/001_ddk1_PCGITA.wav"
>>> features1=phonological.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="npy")
>>> features2=phonological.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="dataframe")
>>> features3=phonological.extract_features_file(file_audio, static=False,
↳ plots=True, fmt="torch")
>>> phonological.extract_features_file(file_audio, static=False, plots=False, fmt=
↳ "kaldi", kaldi_file="./test")
```

extract_features_file (*audio*, *static=True*, *plots=False*, *fmt='npy'*, *kaldi_file=""*)

Extract the phonological features from an audio file

Parameters

- **audio** – .wav audio file.
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames

- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldi features, only valid when fmt=="kaldi"

Returns features computed from the audio file.

```
>>> phonological=Phonological()
>>> file_audio="./audios/001_ddk1_PCGITA.wav"
>>> features1=phonological.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="numpy")
>>> features2=phonological.extract_features_file(file_audio, static=True,
↳ plots=True, fmt="dataframe")
>>> features3=phonological.extract_features_file(file_audio, static=False,
↳ plots=True, fmt="torch")
>>> phonological.extract_features_file(file_audio, static=False, plots=False,
↳ fmt="kaldi", kaldi_file="./test")
```

```
>>> phonological=Phonological()
>>> path_audio="./audios/"
>>> features1=phonological.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="numpy")
>>> features2=phonological.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="csv")
>>> features3=phonological.extract_features_path(path_audio, static=False,
↳ plots=True, fmt="torch")
>>> phonological.extract_features_path(path_audio, static=False, plots=False,
↳ fmt="kaldi", kaldi_file="./test.ark")
```

extract_features_path (*path_audio*, *static=True*, *plots=False*, *fmt='numpy'*, *kaldi_file=""*)

Extract the phonological features for audios inside a path

Parameters

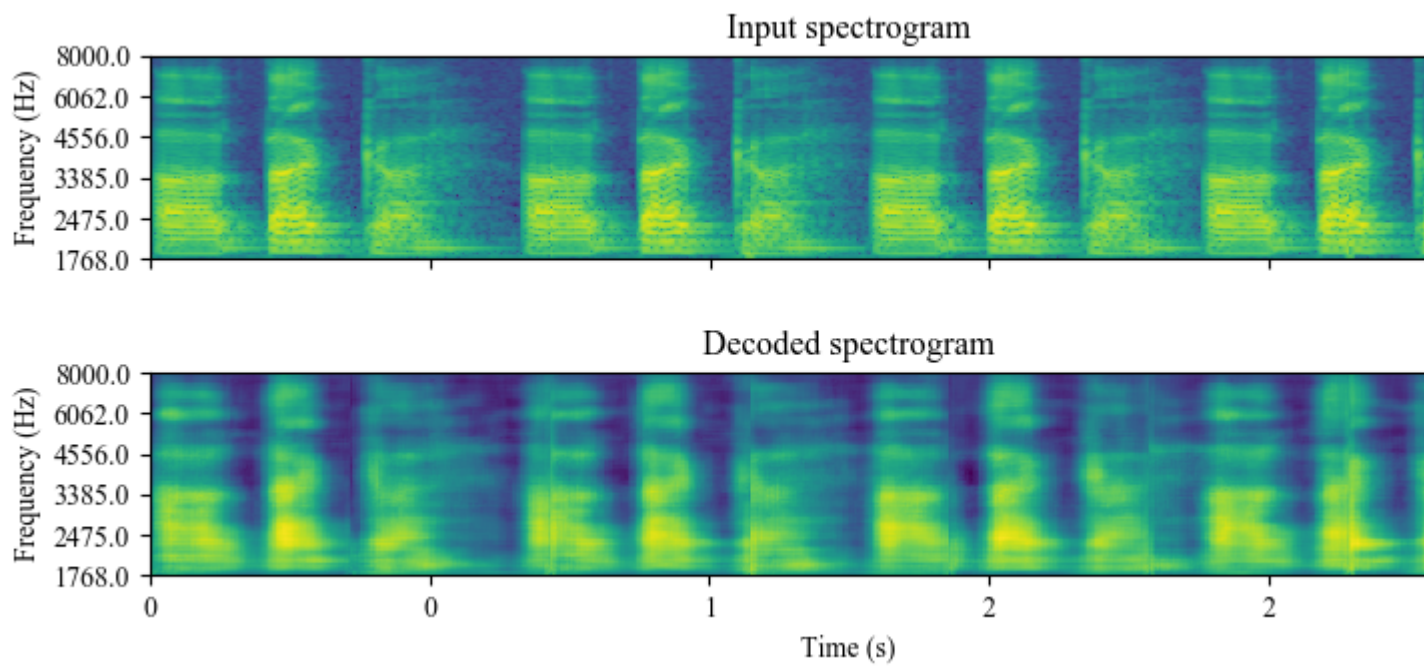
- **path_audio** – directory with (.wav) audio files inside, sampled at 16 kHz
- **static** – whether to compute and return statistic functionals over the feature matrix, or return the feature matrix computed over frames
- **plots** – timeshift to extract the features
- **fmt** – format to return the features (numpy, dataframe, torch, kaldi)
- **kaldi_file** – file to store kaldifeatures, only valid when fmt=="kaldi"

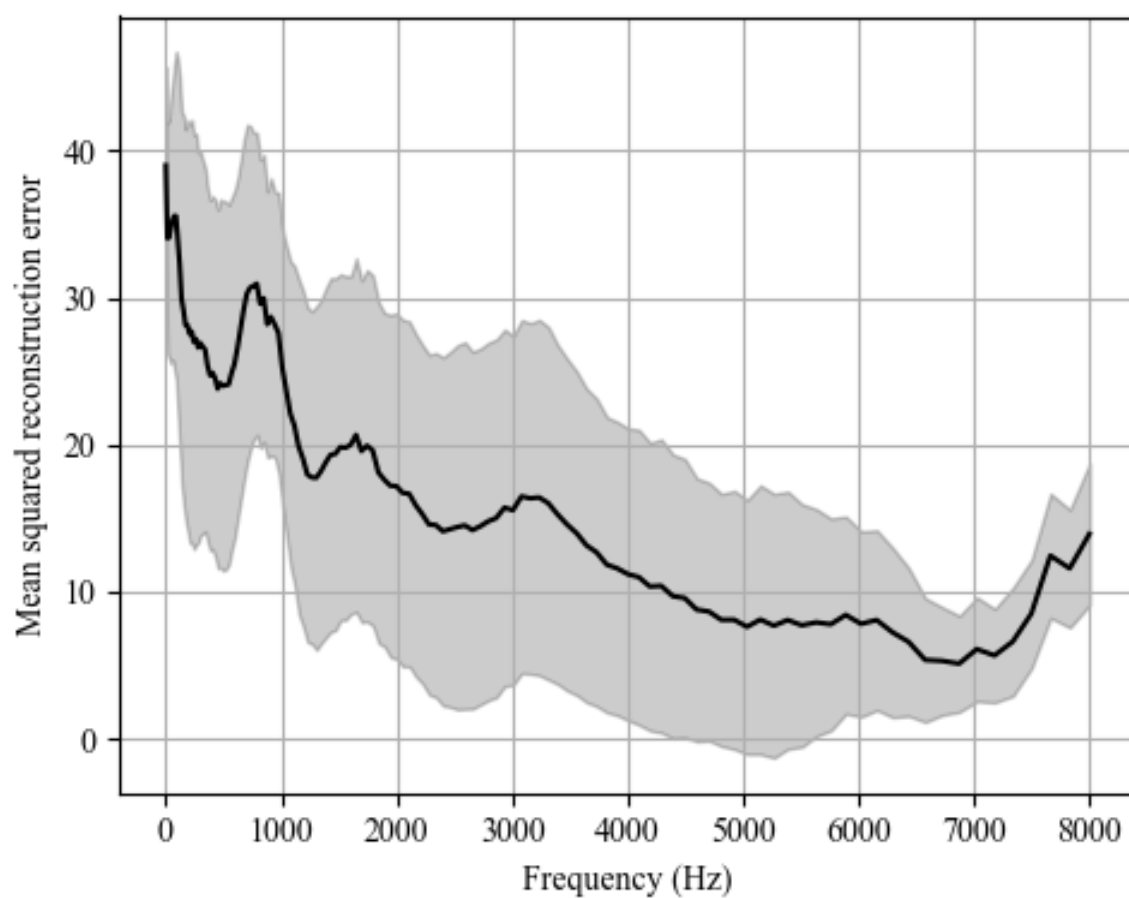
Returns features computed from the audio file.

```
>>> phonological=Phonological()
>>> path_audio="./audios/"
>>> features1=phonological.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="numpy")
>>> features2=phonological.extract_features_path(path_audio, static=True,
↳ plots=False, fmt="csv")
>>> features3=phonological.extract_features_path(path_audio, static=False,
↳ plots=True, fmt="torch")
>>> phonological.extract_features_path(path_audio, static=False, plots=False,
↳ fmt="kaldi", kaldi_file="./test.ark")
```


CHAPTER 6

Representation learning features





CHAPTER 7

Need Help?

If you have trouble with Disvoice, please write to Camilo Vasquez at: juan.vasquez@fau.de

If you use Disvoice for research purposes, please cite the following papers, depending on the features you use:

8.1 glottal features

[1] Belalcázar-Bolaños, E. A., Orozco-Arroyave, J. R., Vargas-Bonilla, J. F., Haderlein, T., & Nöth, E. (2016, September). Glottal Flow Patterns Analyses for Parkinson’s Disease Detection: Acoustic and Nonlinear Approaches. In International Conference on Text, Speech, and Dialogue (pp. 400-407). Springer.

8.2 phonation features

[1] T. Arias-Vergara, J. C. Vásquez-Correa, J. R. Orozco-Arroyave, Parkinson’s Disease and Aging: Analysis of Their Effect in Phonation and Articulation of Speech, Cognitive computation, (2017).

[2] Vásquez-Correa, J. C., et al. “Towards an automatic evaluation of the dysarthria level of patients with Parkinson’s disease.” Journal of communication disorders 76 (2018): 21-36.

8.3 articulation features

[1] Vásquez-Correa, J. C., et al. “Towards an automatic evaluation of the dysarthria level of patients with Parkinson’s disease.” Journal of communication disorders 76 (2018): 21-36.

[2]. J. R. Orozco-Arroyave, J. C. Vásquez-Correa et al. “NeuroSpeech: An open-source software for Parkinson’s speech analysis.” Digital Signal Processing (2017).

8.4 prosody features

[1]. N., Dehak, P. Dumouchel, and P. Kenny. “Modeling prosodic features with joint factor analysis for speaker verification.” *IEEE Transactions on Audio, Speech, and Language Processing* 15.7 (2007): 2095-2103.

[2] Vásquez-Correa, J. C., et al. “Towards an automatic evaluation of the dysarthria level of patients with Parkinson’s disease.” *Journal of communication disorders* 76 (2018): 21-36.

8.5 phonological features

[1] Vásquez-Correa, J. C., Klumpp, P., Orozco-Arroyave, J. R., & Nöth, E. (2019). Phonet: a Tool Based on Gated Recurrent Neural Networks to Extract Phonological Posteriors from Speech. *Proc. Interspeech 2019*, 549-553.

8.6 Representation learning features

[1] Vasquez-Correa, J. C., et al. (2020). Parallel Representation Learning for the Classification of Pathological Speech: Studies on Parkinson’s Disease and Cleft Lip and Palate. *Speech Communication*, 122, 56-67.

CHAPTER 9

Installation

From the source file:

```
git clone https://github.com/jcvasquezc/disvoice
cd disvoice
bash install.sh
```


CHAPTER 10

Indices and tables

- `genindex`
- `modindex`
- `search`

CHAPTER 11

Help

If you have trouble with Disvoice, please write to Camilo Vasquez at: juan.vasquez@fau.de

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