
pysptk Documentation

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A python wrapper for [Speech Signal Processing Toolkit \(SPTK\)](#).

<https://github.com/r9y9/pysptk>

The wrapper is based on a modified version of SPTK ([r9y9/SPTK](#))

CHAPTER 1

Full documentation

A full documentation of SPTK is available at <http://sp-tk.sourceforge.net>. If you are not familiar with SPTK, I recommend you to take a look at the doc first before using `pysptk`.

CHAPTER 2

Demonstration notebooks

- [Introduction notebook](#): a brief introduction to pysptk
- [Speech analysis and re-synthesis resynthesis notebook](#): a demonstration notebook for speech analysis and re-synthesis. Synthesized audio examples(English) are available on the notebook.

3.1 Installation guide

The latest release is available on pypi. Assuming you have already `numpy` installed, you can install `pysptk` by:

```
pip install pysptk
```

If you want the latest development version, run:

```
pip install git+https://github.com/r9y9/pysptk
```

or:

```
git clone https://github.com/r9y9/pysptk
cd pysptk
python setup.py develop # or install
```

This should resolve the package dependencies and install `pysptk` properly.

Note: If you use the development version, you need to have `cython` (and C compiler) installed to compile cython module(s).

3.1.1 For Windows users

There are some binary wheels available on pypi, so you can install `pysptk` via pip **without cython and C compiler** if there exists a binary wheel that matches your environment (depends on bits of system and python version). For now, wheels are available for:

- Python 2.7 on 32 bit system
- Python 2.7 on 64 bit system

- Python 3.4 on 32 bit system

If there is no binary wheel available for your environment, you can build `pysptk` from the source distribution, which is also available on pypi. Note that in order to compile `pysptk` from source in Windows, it is highly recommended to use [Anaconda](#) , since installation of numpy, cython and other scientific packages is really easy. In fact, continuous integration in Windows on AppVeyor uses Anaconda to build and test `pysptk`. See [pysptk/appveyor.yml](#) for the exact build steps.

4.1 API

4.1.1 Core SPTK API

All functionality in `pysptk.sptk` (the core API) is directly accessible from the top-level `pysptk.*` namespace.

For convenience, vector-to-vector functions (`pysptk.mcep`, `pysptk.mc2b`, etc) that takes an input vector as the first argument, can also accept matrix. As for matrix inputs, vector-to-vector functions are applied along with the last axis internally; e.g.

```
mc = pysptk.mcep(frames) # frames.shape == (num_frames, frame_len)
```

is equivalent to:

```
mc = np.apply_along_axis(pysptk.mcep, -1, frames)
```

Warning: The core APIs in `pysptk.sptk` package are based on the SPTK's internal APIs (e.g. code in `_mgc2sp.c`), so the functionalities are not exactly same as SPTK's CLI. If you find any inconsistency that should be addressed, please file an issue.

Note: Almost all of `pysptk` functions assume that the input array is **C-contiguous** and has `float64` element type. For vector-to-vector functions, the input array is automatically converted to `float64`-typed one, the function is executed on it, and then the output array is converted to have the same type with the input you provided.

Library routines

<code>agexp(r, x, y)</code>	Magnitude squared generalized exponential function
<code>gexp(r, x)</code>	Generalized exponential function
<code>glog(r, x)</code>	Generalized logarithmic function
<code>mseq()</code>	M-sequence
<code>acorr(x, order)</code>	Autocorrelation

pysptk.sptk.agexp

`pysptk.sptk.agexp(r, x, y)`
Magnitude squared generalized exponential function

Parameters

r [float] Gamma
x [float] Real part
y [float] Imaginary part

Returns

Value

pysptk.sptk.gexp

`pysptk.sptk.gexp(r, x)`
Generalized exponential function

Parameters

r [float] Gamma
x [float] Arg

Returns

Value

pysptk.sptk.glog

`pysptk.sptk.glog(r, x)`
Generalized logarithmic function

Parameters

r [float] Gamma
x [float] Arg

Returns

Value

pysptk.sptk.mseq

`pysptk.sptk.mseq()`
M-sequence

Returns

A sample of m-sequence

pysptk.sptk.acorr

`pysptk.sptk.acorr(x, order)`

Autocorrelation

Parameters

x [array] Input frame

order [int] Order of sequence

Returns

r [array] Autocorrelation

See also:

pysptk.sptk.levdur, pysptk.sptk.c2acr

Adaptive cepstrum analysis

<i>acep</i> (x, c[, lambda_coef, step, tau, pd, eps])	Adaptive cepstral analysis
<i>agcep</i> (x, c[, stage, lambda_coef, step, tau, eps])	Adaptive generalized cepstral analysis
<i>amcep</i> (x, b[, alpha, lambda_coef, step, tau, ...])	Adaptive mel-cepstral analysis

pysptk.sptk.acep

`pysptk.sptk.acep(x, c, lambda_coef=0.98, step=0.1, tau=0.9, pd=4, eps=1e-06)`

Adaptive cepstral analysis

Parameters

x [double] A input sample

c [array, shape(order + 1)] Cepstrum. The result is stored in place.

lambda_coef [float, optional] Leakage factor. Default is 0.98.

step [float, optional] Step size. Default is 0.1.

tau [float, optional] Momentum constant. Default is 0.9.

pd [int, optional] Order of pade approximation. Default is 4.

eps [float, optional] Minimum value for epsilon. Default is 1.0e-6.

Returns

prederr [float] Prediction error

Raises

ValueError if invalid order of pade approximation is specified

See also:

pysptk.sptk.uels, pysptk.sptk.gcep, pysptk.sptk.mcep, pysptk.sptk.mgcep, pysptk.sptk.amcep, pysptk.sptk.agcep, pysptk.sptk.lmadf

pysptk.sptk.agcep

`pysptk.sptk.agcep(x, c, stage=1, lambda_coef=0.98, step=0.1, tau=0.9, eps=1e-06)`

Adaptive generalized cepstral analysis

Parameters

- x** [float] A input sample
- c** [array, shape(`order + 1`), optional] Cepstrum. The result is stored in-place.
- stage** [int, optional] $-1 / \gamma$. Default is 1.
- lambda_coef** [float, optional] Leakage factor. Default is 0.98.
- step** [float, optional] Step size. Default is 0.1.
- tau** [float, optional] Momentum constant. Default is 0.9.
- eps** [float, optional] Minimum value for epsilon. Default is 1.0e-6.

Returns

prederr [float] Prediction error

Raises

ValueError if invalid number of stage is specified

See also:

`pysptk.sptk.acep`, `pysptk.sptk.amcep`, `pysptk.sptk.glsadf`

pysptk.sptk.amcep

`pysptk.sptk.amcep(x, b, alpha=0.35, lambda_coef=0.98, step=0.1, tau=0.9, pd=4, eps=1e-06)`

Adaptive mel-cepstral analysis

Parameters

- x** [float] A input sample
- b** [array, shape(`order + 1`), optional] MLSA filter coefficients. The result is stored in-place.
- alpha** [float, optional] All-pass constant. Default is 0.35.
- lambda_coef** [float, optional] Leakage factor. Default is 0.98.
- step** [float, optional] Step size. Default is 0.1.
- tau** [float, optional] Momentum constant. Default is 0.9.
- pd** [int, optional] Order of pade approximation. Default is 4.
- eps** [float, optional] Minimum value for epsilon. Default is 1.0e-6.

Returns

prederr [float] Prediction error

Raises

ValueError if invalid order of pade approximation is specified

See also:

`pysptk.sptk.acep`, `pysptk.sptk.agcep`, `pysptk.sptk.mc2b`, `pysptk.sptk.b2mc`,
`pysptk.sptk.mlsadf`

Mel-generalized cepstrum analysis

<code>mcep</code> (windowed[, order, alpha, miniter, ...])	Mel-cepstrum analysis
<code>gcep</code> (windowed[, order, gamma, miniter, ...])	Generalized-cepstrum analysis
<code>mgcep</code> (windowed[, order, alpha, gamma, ...])	Mel-generalized cepstrum analysis
<code>uels</code> (windowed[, order, miniter, maxiter, ...])	Unbiased estimation of log spectrum
<code>fftcep</code> (logsp[, order, num_iter, ...])	FFT-based cepstrum analysis
<code>lpc</code> (windowed[, order, min_det, use_scipy])	Linear prediction analysis

`pysptk.sptk.mcep`

`pysptk.sptk.mcep`(windowed, order=25, alpha=0.35, miniter=2, maxiter=30, threshold=0.001,
etype=0, eps=0.0, min_det=1e-06, itype=0)
Mel-cepstrum analysis

Parameters

windowed [array, shape (frame_len)] A windowed frame

order [int, optional] Order of mel-cepstrum. Default is 25.

alpha [float, optional] All pass constant. Default is 0.35.

miniter [int, optional] Minimum number of iteration. Default is 2.

maxiter [int, optional] Maximum number of iteration. Default is 30.

threshold [float, optional] Threshold in theq. Default is 0.001.

etype [int, optional]

Type of parameter **eps**

0. not used
1. initial value of log-periodogram
2. floor of periodogram in db

Default is 0.

eps [float, optional] Initial value for log-periodogram or floor of periodogram in db. Default is 0.0.

min_det [float, optional] Mimimum value of the determinant of normal matrix. Default is 1.0e-6

itype [float, optional]

Input data type

0. windowed signal
1. log amplitude in db
2. log amplitude
3. amplitude

4. periodogram

Default is 0.

Returns

mc [array, shape (order + 1)] Mel-cepstrum

Raises

ValueError

- if invalid `itype` is specified
- if invalid `etype` is specified
- if nonzero `eps` is specified when `etype = 0`
- if negative `eps` is specified
- if negative `min_det` is specified

RuntimeError

- if zero(s) are found in periodogram
- if error happened in theq

See also:

`pysptk.sptk.uels`, `pysptk.sptk.gcep`, `pysptk.sptk.mgcep`, `pysptk.sptk.mlsadf`

pysptk.sptk.gcep

`pysptk.sptk.gcep`(*windowed*, *order*=25, *gamma*=0.0, *miniter*=2, *maxiter*=30, *threshold*=0.001, *etype*=0, *eps*=0.0, *min_det*=1e-06, *itype*=0, *norm*=False)

Generalized-cepstrum analysis

Parameters

windowed [array, shape (frame_len)] A windowed frame

order [int, optional] Order of generalized-cepstrum. Default is 25.

gamma [float, optional] Parameter of generalized log function. Default is 0.0.

miniter [int, optional] Minimum number of iteration. Default is 2.

maxiter [int, optional] Maximum number of iteration. Default is 30.

threshold [float, optional] Threshold in theq. Default is 0.001

etype [int, optional]

Type of parameter **eps**

0. not used
1. initial value of log-periodogram
2. floor of periodogram in db

Default is 0.

eps [float, optional] Initial value for log-periodogram or floor of periodogram in db. Default is 0.0.

min_det [float, optional] Minimum value of the determinant of normal matrix. Default is 1.0e-6.

itype [float, optional]

Input data type

0. windowed signal
1. log amplitude in db
2. log amplitude
3. amplitude
4. periodogram

Default is 0.

Returns

gc [array, shape (order + 1)] Generalized cepstrum

Raises

ValueError

- if invalid `itype` is specified
- if invalid `etype` is specified
- if nonzero `eps` is specified when `etype = 0`
- if negative `eps` is specified
- if negative `min_det` is specified

RuntimeError

- if error happened in theq

See also:

[pysptk.sptk.uels](#), [pysptk.sptk.mcep](#), [pysptk.sptk.mgcep](#), [pysptk.sptk.glsadf](#)

pysptk.sptk.mgcep

`pysptk.sptk.mgcep` (*windowed*, *order*=25, *alpha*=0.35, *gamma*=0.0, *num recursions*=None, *miniter*=2, *maxiter*=30, *threshold*=0.001, *etype*=0, *eps*=0.0, *min_det*=1e-06, *itype*=0, *otype*=0)

Mel-generalized cepstrum analysis

Parameters

windowed [array, shape (*frame_len*)] A windowed frame

order [int, optional] Order of mel-generalized cepstrum. Default is 25.

alpha [float, optional] All pass constant. Default is 0.35.

gamma [float, optional] Parameter of generalized log function. Default is 0.0.

num recursions [int, optional] Number of recursions. Default is `len(windowed) - 1`.

miniter [int, optional] Minimum number of iteration. Default is 2.

maxiter [int, optional] Maximum number of iteration. Default is 30.

threshold [float, optional] Threshold. Default is 0.001.

etype [int, optional]

Type of paramter e

0. not used
1. initial value of log-periodogram
2. floor of periodogram in db

Default is 0.

eps [float, optional] Initial value for log-periodogram or floor of periodogram in db. Default is 0.0.

min_det [float, optional] Mimimum value of the determinant of normal matrix. Default is 1.0e-6.

itype [float, optional]

Input data type

0. windowed signal
1. log amplitude in db
2. log amplitude
3. amplitude
4. periodogram

Default is 0.

otype [int, optional]

Output data type

0. mel generalized cepstrum: (c~0...c~m)
1. MGLSA filter coefficients: b0...bm
2. $K_{\sim}, c_{\sim}^{'1...c_{\sim}^{'m}}$
3. $K, b^{'1...b^{'m}}$
4. $K_{\sim}, g_{\sim}^{'1...g_{\sim}^{'m}}$
5. $K, g^{'1...g^{'m}}$

Default is 0.

Returns

mgc [array, shape (order + 1)] mel-generalized cepstrum

Raises

ValueError

- if invalid `itype` is specified
- if invalid `etype` is specified
- if nonzero `eps` is specified when `etype = 0`
- if negative `eps` is specified
- if negative `min_det` is specified

- if invalid `otype` is specified

RuntimeError

- if error happened in theq

See also:

`pysptk.sptk.uels`, `pysptk.sptk.gcep`, `pysptk.sptk.mcep`, `pysptk.sptk.freqt`,
`pysptk.sptk.gc2gc`, `pysptk.sptk.mgc2mgc`, `pysptk.sptk.gnorm`, `pysptk.sptk.mglisadf`

pysptk.sptk.uels

`pysptk.sptk.uels` (*windowed*, *order*=25, *miniter*=2, *maxiter*=30, *threshold*=0.001, *etype*=0, *eps*=0.0, *itype*=0)

Unbiased estimation of log spectrum

Parameters

windowed [array, shape (*frame_len*)] A windowed frame

order [int, optional] Order of cepstrum. Default is 25.

miniter [int, optional] Minimum number of iteration. Default is 2.

maxiter [int, optional] Maximum number of iteration. Default is 30.

threshold [float, optional] Threshold in theq. Default is 0.001

etype [int, optional]

Type of parameter `eps`

0. not used
1. initial value of log-periodogram
2. floor of periodogram in db

Default is 0.

eps [float, optional] Initial value for log-periodogram or floor of periodogram in db. Default is 0.0.

itype [float, optional]

Input data type

0. windowed signal
1. log amplitude in db
2. log amplitude
3. amplitude
4. periodogram

Default is 0.

Returns

c [array, shape (*order* + 1)] cepstrum estimated by uels

Raises

ValueError

- if invalid `itype` is specified
- if invalid `etype` is specified
- if nonzero `eps` is specified when `etype = 0`
- if negative `eps` is specified

RuntimeError

- if zero(s) are found in periodogram

See also:

`pysptk.sptk.gcep`, `pysptk.sptk.mcep`, `pysptk.sptk.mgcep`, `pysptk.sptk.lmadf`

pysptk.sptk.fftcep

`pysptk.sptk.fftcep` (*logsp*, *order*=25, *num_iter*=0, *acceleration_factor*=0.0)
FFT-based cepstrum analysis

Parameters

- logsp** [array, shape (frame_len)] Log power spectrum
- order** [int, optional] Order of cepstrum. Default is 25.
- num_iter** [int, optional] Number of iteration. Default is 0.
- acceleration_factor** [float, optional] Acceleration factor. Default is 0.0.

Returns

- c** [array, shape (order + 1)] Cepstrum

See also:

`pysptk.sptk.uels`

pysptk.sptk.lpc

`pysptk.sptk.lpc` (*windowed*, *order*=25, *min_det*=1e-06, *use_scipy*=True)
Linear prediction analysis

Parameters

- windowed** [array, shape (frame_len)] A windowed frame
- order** [int, optional] Order of LPC. Default is 25.
- min_det** [float, optional] Mimimum value of the determinant of normal matrix. Default is 1.0e-6.
- use_scipy** [bool] Use scipy's solve_toeplitz implementation or not. Default is True. This would be more numerically stable than SPTK.

Returns

- a** [array, shape (order + 1)] LPC

Raises**ValueError**

- if negative `min_det` is specified

RuntimeError

- if error happened in levdur

See also:

`pysptk.sptk.lpc2par`, `pysptk.sptk.par2lpc`, `pysptk.sptk.lpc2c`, `pysptk.sptk.lpc2lsp`, `pysptk.sptk.ltcdf`, `pysptk.sptk.lspdf`

MFCC

<code>mfcc(x[, order, fs, alpha, eps, window_len, ...])</code>	MFCC
--	------

pysptk.sptk.mfcc

`pysptk.sptk.mfcc(x, order=14, fs=16000, alpha=0.97, eps=1.0, window_len=None, frame_len=None, num_filterbanks=20, cepslift=22, use_dft=False, use_hamming=False, czero=False, power=False)`

MFCC

Parameters

- x** [array] A input signal
- order** [int, optional] Order of MFCC. Default is 14.
- fs** [int, optional] Sampling frequency. Default is 160000.
- alpha** [float, optional] Pre-emphasis coefficient. Default is 0.97.
- eps** [float, optional] Flooring value for calculating $\log(x)$ in filterbank analysis. Default is 1.0.
- window_len** [int, optional] Window lenght. Default is `len(x)`.
- frame_len** [int, optional] Frame length. Default is `len(x)`.
- num_filterbanks** [int, optional] Number of mel-filter banks. Default is 20.
- cepslift** [int, optional] Liftering coefficient. Default is 22.
- use_dft** [bool, optional] Use DFT (not FFT) or not. Default is False.
- use_hamming** [bool, optional] Use hamming window or not. Default is False.
- czero** [bool, optional] If True, `mfcc` returns 0-th coefficient as well. Default is False.
- power** [bool, optional] If True, `mfcc` returns power coefficient as well. Default is False.

Returns

- cc** [array] MFCC vector, which is ordered as:
`mfcc[0], mfcc[1], mfcc[2], ... mfcc[order-1], c0, Power`.

Note that `c0` and `Power` are optional.

Shape of `cc` is:

- `order` by default.
- `orde + 1` if `czero` or `power` is set to `True`.
- `order + 2` if both `czero` and `power` is set to `True`.

Raises

ValueError if `num_filterbanks` is less than or equal to `order`

See also:

`pysptk.sptk.gcep`, `pysptk.sptk.mcep`, `pysptk.sptk.mgcep`

LPC, LSP and PARCOR conversions

<code>lpc2c(lpc[, order])</code>	LPC to cepstrum
<code>lpc2lsp(lpc[, numsp, maxiter, eps, ...])</code>	LPC to LSP
<code>lpc2par(lpc)</code>	LPC to PARCOR
<code>par2lpc(par)</code>	PARCOR to LPC
<code>lsp2lpc(lsp[, has_gain, loggain, fs, itype])</code>	LSP to LPC
<code>lsp2sp(lsp[, fftlen, has_gain, loggain, fs, ...])</code>	LSP to spectrum

pysptk.sptk.lpc2c

`pysptk.sptk.lpc2c(lpc, order=None)`

LPC to cepstrum

Parameters

lpc [array] LPC

order [int, optional] Order of cepstrum. Default is `len(lpc) - 1`.

Returns

ceps [array, shape (order + 1)] cepstrum

See also:

`pysptk.sptk.lpc`, `pysptk.sptk.lspdf`

pysptk.sptk.lpc2lsp

`pysptk.sptk.lpc2lsp(lpc, numsp=128, maxiter=4, eps=1e-06, has_gain=True, loggain=False, otype=0, fs=None)`

LPC to LSP

Parameters

lpc [array] LPC

numsp [int, optional] Number of unit circle. Default is 128.

maxiter [int, optional] Maximum number of iteration. Default is 4.

eps [float, optional] End condition for iteration. Default is 1.0e-6.

has_gain [bool, optional] Whether input LPC has gain at the index 0 or not. Default is True.

loggain [bool, optional] whether the converted lsp should have loggain or not. Default is False.

fs [int, optional] Sampling frequency. Default is None and unused.

otype [int, optional]

Output format LSP

0. normalized frequency (0 ~ pi)
1. normalized frequency (0 ~ 0.5)
2. frequency (kHz)
3. frequency (Hz)

Default is 0.

Returns

lsp [array, shape (order + 1)] LSP

Raises

ValueError if `fs` is not specified when `otype = 2` or `3`.

See also:

pysptk.sptk.lpc, pysptk.sptk.lspdf

pysptk.sptk.lpc2par

`pysptk.sptk.lpc2par(lpc)`
LPC to PARCOR

Parameters

lpc [array] LPC

Returns

par [array, shape (same as lpc)] PARCOR

See also:

pysptk.sptk.lpc, pysptk.sptk.par2lpc, pysptk.sptk.ltcdf

pysptk.sptk.par2lpc

`pysptk.sptk.par2lpc(par)`
PARCOR to LPC

Parameters

par [array] PARCOR

Returns

lpc [array, shape (same as par)] LPC

See also:

pysptk.sptk.lpc, pysptk.sptk.lpc2par

pysptk.sptk.lsp2lpc

`pysptk.sptk.lsp2lpc(lsp, has_gain=True, loggain=False, fs=None, itype=0)`
LSP to LPC

Parameters

lpc [array] LPC

has_gain [bool, optional] Whether input LPC has gain at the index 0 or not. Default is True.

loggain [bool, optional] If True, it's assumed that input LPC has loggain and convert it to linear gain. Default is False.

fs [int, optional] Sampling frequency. Default is None and unused.

itype [int, optional]

Input LPC format

0. normalized frequency (0 ~ pi)
1. normalized frequency (0 ~ 0.5)
2. frequency (kHz)
3. frequency (Hz)

Default is 0.

Returns

lsp [array, shape (order + 1) if has_gain else (order)] LPC

Raises

ValueError if **fs** is not specified when **itype** = 2 or 3. if **loggain** and not **has_gain**.

See also:

[`pysptk.sptk.lpc2lsp`](#)

pysptk.sptk.lsp2sp

`pysptk.sptk.lsp2sp(lsp, fftlen=256, has_gain=True, loggain=False, fs=None, itype=0)`
LSP to spectrum

Parameters

lsp [array] LSP

fftlen [int, optional] FFT length

has_gain [bool, optional] Whether input LPC has gain at the index 0 or not. Default is True.

loggain [bool, optional] If True, it's assumed that input LPC has loggain and convert it to linear gain. Default is False.

fs [int, optional] Sampling frequency. Default is None and unused.

itype [int, optional]

Input LPC format

0. normalized frequency (0 ~ pi)
1. normalized frequency (0 ~ 0.5)
2. frequency (kHz)
3. frequency (Hz)

Default is 0.

Returns

sp [array, shape] Spectrum. $\ln|H(z)|$.

See also:

`pysptk.sptk.lpc2par`

Mel-generalized cepstrum conversions

<code>mc2b(mc[, alpha])</code>	Mel-cepstrum to MLSA filter coefficients
<code>b2mc(b[, alpha])</code>	MLSA filter coefficients to mel-cepstrum
<code>c2acr(c[, order, fftlen])</code>	Cepstrum to autocorrelation
<code>levdur(r[, eps, use_scipy])</code>	Solve an Autocorrelation Normal Equation Using Levinson-Durbin Method
<code>c2ir(c[, length])</code>	Cepstrum to impulse response
<code>ic2ir(h[, order])</code>	Impulse response to cepstrum
<code>c2ndps(c[, fftlen])</code>	Cepstrum to Negative Derivative of Phase Spectrum (NDPS)
<code>ndps2c(ndps[, order])</code>	Cepstrum to Negative Derivative of Phase Spectrum (NDPS)
<code>gc2gc(src_ceps[, src_gamma, dst_order, ...])</code>	Generalized cepstrum transform
<code>gnorm(ceps[, gamma])</code>	Gain normalization
<code>ignorm(ceps[, gamma])</code>	Inverse gain normalization
<code>freqt(ceps[, order, alpha])</code>	Frequency transform
<code>mgc2mgc(src_ceps[, src_alpha, src_gamma, ...])</code>	Mel-generalized cepstrum transform
<code>mgc2sp(ceps[, alpha, gamma, fftlen])</code>	Mel-generalized cepstrum transform
<code>mgc1sp2sp(lsp[, alpha, gamma, fftlen, gain])</code>	MGC-LSP to spectrum

pysptk.sptk.mc2b

`pysptk.sptk.mc2b(mc, alpha=0.35)`

Mel-cepstrum to MLSA filter coefficients

Parameters

mc [array, shape] Mel-cepstrum.

alpha [float, optional] All-pass constant. Default is 0.35.

Returns

b [array, shape(same as mc)] MLSA filter coefficients

See also:

`pysptk.sptk.mlsadf`, `pysptk.sptk.mgladf`, `pysptk.sptk.b2mc`, `pysptk.sptk.mcep`,
`pysptk.sptk.mgcep`, `pysptk.sptk.amcep`

pysptk.sptk.b2mc

`pysptk.sptk.b2mc(b, alpha=0.35)`

MLSA filter coefficients to mel-cepstrum

Parameters

b [array, shape] MLSA filter coefficients

alpha [float, optional] All-pass constant. Default is 0.35.

Returns

mc [array, shape (same as b)] Mel-cepstrum.

See also:

pysptk.sptk.mc2b, pysptk.sptk.mcep, pysptk.sptk.mlsadf

pysptk.sptk.c2acr

`pysptk.sptk.c2acr(c, order=None, fftlen=256)`

Cepstrum to autocorrelation

Parameters

c [array] Cepstrum

order [int, optional] Order of cepstrum. Default is `len(c) - 1`.

fftlen [int, optional] FFT length. Default is 256.

Returns

r [array, shape (order + 1)] Autocorrelation

Raises

ValueError if non power of 2 `fftlen` is specified

See also:

pysptk.sptk.uels, pysptk.sptk.c2ir, pysptk.sptk.lpc2c, pysptk.sptk.levdur

pysptk.sptk.levdur

`pysptk.sptk.levdur(r, eps=0.0, use_scipy=True)`

Solve an Autocorrelation Normal Equation Using Levinson-Durbin Method

Parameters

r [array] Autocorrelation sequence

eps [float] Singular check (eps(if -1., 0.0 is assumed))

use_scipy [bool] Use scipy's `solve_toeplitz` implementation or not. Default is True. This would be more numerically stable than SPTK.

Returns

a [array] LPC

Raises

RuntimeError

- if abnormally completed or unstable LPC

See also:

pysptk.sptk.c2acr

pysptk.sptk.c2ir

`pysptk.sptk.c2ir(c, length=256)`

Cepstrum to impulse response

Parameters

c [array] Cepstrum

length [int, optional] Length of impulse response. Default is 256.

Returns

h [array, shape (length)] impulse response

See also:

pysptk.sptk.c2acr

pysptk.sptk.ic2ir

`pysptk.sptk.ic2ir(h, order=25)`

Impulse response to cepstrum

Parameters

h [array] Impulse response

order [int, optional] Order of cepstrum. Default is 25.

Returns

c [array, shape (order + 1)] Cepstrum

See also:

pysptk.sptk.c2ir

pysptk.sptk.c2ndps

`pysptk.sptk.c2ndps(c, fftlen=256)`

Cepstrum to Negative Derivative of Phase Spectrum (NDPS)

Parameters

c [array] Cepstrum

fftlen [int, optional] FFT length. Default is 256.

Returns

ndps [array, shape (fftlen // 2 + 1)] NDPS

Raises

ValueError if non power of 2 `fftlen` is specified

See also:

pysptk.sptk.mgcep, *pysptk.sptk.ndps2c*

pysptk.sptk.ndps2c

`pysptk.sptk.ndps2c(ndps, order=25)`

Cepstrum to Negative Derivative of Phase Spectrum (NDPS)

Parameters

ndps [array, shape (fftlen // 2 + 1)] NDPS

order [int, optional] Order of cepstrum. Default is 25.

Returns

c [array, shape (order + 1)] Cepstrum

Raises

ValueError if non power of 2 `fftlen` is detected

See also:

`pysptk.sptk.mgc2sp`, `pysptk.sptk.c2ndps`

pysptk.sptk.gc2gc

`pysptk.sptk.gc2gc(src_ceps, src_gamma=0.0, dst_order=None, dst_gamma=0.0)`

Generalized cepstrum transform

Parameters

src_ceps [array] Generalized cepstrum.

src_gamma [float, optional] Gamma of source cepstrum. Default is 0.0.

dst_order [int, optional] Order of destination cepstrum. Default is `len(src_ceps) - 1`.

dst_gamma [float, optional] Gamma of destination cepstrum. Default is 0.0.

Returns

dst_ceps [array, shape (dst_order + 1)] Converted generalized cepstrum

Raises

ValueError

- if invalid `src_gamma` is specified
- if invalid `dst_gamma` is specified

See also:

`pysptk.sptk.gcep`, `pysptk.sptk.mgcep`, `pysptk.sptk.freqt`, `pysptk.sptk.mgc2mgc`,
`pysptk.sptk.lpc2c`

pysptk.sptk.gnorm

`pysptk.sptk.gnorm(ceps, gamma=0.0)`

Gain normalization

Parameters

ceps [array] Generalized cepstrum.

gamma [float, optional] Gamma. Default is 0.0.

Returns

dst_ceps [array, shape(same as `ceps`)] Normalized generalized cepstrum

Raises

ValueError if invalid `gamma` is specified

See also:

pysptk.sptk.ignorm, *pysptk.sptk.gcep*, *pysptk.sptk.mgcep*, *pysptk.sptk.gc2gc*,
pysptk.sptk.mgc2mgc, *pysptk.sptk.freqt*

pysptk.sptk.ignorm

`pysptk.sptk.ignorm(ceps, gamma=0.0)`

Inverse gain normalization

Parameters

c [array] Normalized generalized cepstrum

gamma [float, optional] Gamma. Default is 0.0.

Returns

dst_ceps [array, shape (same as `ceps`)] Generalized cepstrum

Raises

ValueError if invalid `gamma` is specified

See also:

pysptk.sptk.gnorm, *pysptk.sptk.gcep*, *pysptk.sptk.mgcep*, *pysptk.sptk.gc2gc*,
pysptk.sptk.mgc2mgc, *pysptk.sptk.freqt*

pysptk.sptk.freqt

`pysptk.sptk.freqt(ceps, order=25, alpha=0.0)`

Frequency transform

Parameters

ceps [array] Cepstrum.

order [int, optional] Desired order of transformed cepstrum. Default is 25.

alpha [float, optional] All-pass constant. Default is 0.0.

Returns

dst_ceps [array, shape(`order + 1`)] frequency transofmed cepsttrum (typically mel-cepstrum)

See also:

pysptk.sptk.mgc2mgc

pysptk.sptk.mgc2mgc

`pysptk.sptk.mgc2mgc` (*src_ceps*, *src_alpha*=0.0, *src_gamma*=0.0, *dst_order*=None, *dst_alpha*=0.0, *dst_gamma*=0.0)

Mel-generalized cepstrum transform

Parameters

- src_ceps** [array] Mel-generalized cepstrum.
- src_alpha** [float, optional] All-pass constant of source cepstrum. Default is 0.0.
- src_gamma** [float, optional] Gamma of source cepstrum. Default is 0.0.
- dst_order** [int, optional] Order of destination cepstrum. Default is `len(src_ceps) - 1`.
- dst_alpha** [float, optional] All-pass constant of destination cepstrum. Default is 0.0.
- dst_gamma** [float, optional] Gamma of destination cepstrum. Default is 0.0.

Returns

dst_ceps [array, shape (`dst_order + 1`)] Converted mel-generalized cepstrum

Raises

ValueError

- if invalid `src_gamma` is specified
- if invalid `dst_gamma` is specified

See also:

`pysptk.sptk.uels`, `pysptk.sptk.gcep`, `pysptk.sptk.mcep`, `pysptk.sptk.mgcep`,
`pysptk.sptk.gc2gc`, `pysptk.sptk.freqt`, `pysptk.sptk.lpc2c`

pysptk.sptk.mgc2sp

`pysptk.sptk.mgc2sp` (*ceps*, *alpha*=0.0, *gamma*=0.0, *fftl*=256)

Mel-generalized cepstrum transform

Parameters

- ceps** [array] Mel-generalized cepstrum.
- alpha** [float, optional] All-pass constant. Default is 0.0.
- gamma** [float, optional] Gamma. Default is 0.0.
- fftl** [int, optional] FFT length. Default is 256.

Returns

sp [array, shape (`fftl // 2 + 1`)] Complex spectrum $\log_e(H(\omega))$

.. warning:: There's no equivalent option “o” in SPTK's `mgc2sp`. You have to normalize spectrum manually if needed.

Raises

ValueError

- if invalid `gamma` is specified
- if non power of 2 `fftl` is specified

See also:

`pysptk.sptk.mgc2mgc`, `pysptk.sptk.gc2gc`, `pysptk.sptk.freqt`, `pysptk.sptk.gnorm`,
`pysptk.sptk.lpc2c`

pysptk.sptk.mgclsp2sp

`pysptk.sptk.mgclsp2sp` (*lsp*, *alpha*=0.0, *gamma*=0.0, *fftl*len=256, *gain*=True)
 MGC-LSP to spectrum

Parameters

- lsp** [array] MGC-LSP
- alpha** [float, optional] All-pass constant. Default is 0.0.
- gamma** [float, optional] Gamma. Default is 0.0.
- fftl**len [int, optional] FFT length. Default is 256.
- gain** [bool, optional] Whether the input MGC-LSP should have loggain or not. Default is True.

Returns

sp [array, shape (fftl

len // 2 + 1)] Complex spectrum

Raises

ValueError

- if invalid *gamma* is specified
- if non power of 2 *fftl*len is specified

See also:

`pysptk.sptk.mgc2mgc`

F0 analysis

<code>swipe</code> (<i>x</i> , <i>fs</i> , <i>hops</i> size[, <i>min</i> , <i>max</i> , <i>threshold</i> , ...])	SWIPE' - A Saw-tooth Waveform Inspired Pitch Estimation
<code>rapt</code> (<i>x</i> , <i>fs</i> , <i>hops</i> size[, <i>min</i> , <i>max</i> , <i>voice</i> _bias, ...])	RAPT - a robust algorithm for pitch tracking

pysptk.sptk.swipe

`pysptk.sptk.swipe` (*x*, *fs*, *hops*size, *min*=60.0, *max*=240.0, *threshold*=0.3, *otype*='f0')
 SWIPE' - A Saw-tooth Waveform Inspired Pitch Estimation

Parameters

- x** [array] A whole audio signal
- fs** [int] Sampling frequency.
- hops**size [int] Hop size.
- min** [float, optional] Minimum fundamental frequency. Default is 60.0
- max** [float, optional] Maximum fundamental frequency. Default is 240.0
- threshold** [float, optional] Voice/unvoiced threshold. Default is 0.3.

otype [str or int, optional]

Output format

0. pitch
1. f0
2. log(f0)

Default is f0.

Returns

f0 [array, shape(np.ceil(float(len(x))/hopsize))] Estimated f0 trajectory

Raises

ValueError if invalid otype is specified

See also:

`pysptk.sptk.rapt`

Examples

pysptk.sptk.rapt

`pysptk.sptk.rapt(x, fs, hopsize, min=60, max=240, voice_bias=0.0, otype='f0')`

RAPT - a robust algorithm for pitch tracking

Parameters

x [array, dtype=np.float32] A whole audio signal

fs [int] Sampling frequency.

hopsize [int] Hop size.

min [float, optional] Minimum fundamental frequency. Default is 60.0

max [float, optional] Maximum fundamental frequency. Default is 240.0

voice_bias [float, optional] Voice/unvoiced threshold. Default is 0.0.

otype [str or int, optional]

Output format

0. pitch
1. f0
2. log(f0)

Default is f0.

Returns

f0 [array, shape(np.ceil(float(len(x))/hopsize))] Estimated f0 trajectory

Raises

ValueError

- if invalid min/max frequency specified
- if invalid frame period specified (not in [1/fs, 0.1])

- if input range too small for analysis by `get_f0`

RuntimeError

- problem in `init_dp_f0()`

Please see also the **RAPT** code in **SPTK** for more detailed exception conditions.

See also:

`pysptk.sptk.swipe`

Notes

It is assumed that input array `x` has `np.float32` dtype, while `swipe` assumes `np.float64` dtype.

Examples**Excitation generation**

<code>excite(pitch[, hopsize, interp_period, ...])</code>	Excitation generation
---	-----------------------

pysptk.sptk.excite

`pysptk.sptk.excite (pitch, hopsize=100, interp_period=1, gaussian=False, seed=1)`

Excitation generation

Parameters

pitch [array] Pitch sequence.

Note: `excite` assumes that input is a **pitch** sequence, not **f0** sequence. Pitch sequence can be obtained by specifying `otype="pitch"` to F0 estimation methods.

hopsize [int] Hop size (frame period in sample). Default is 100.

interp_period [int] Interpolation period. Default is 1.

gaussian [bool] If True, generate gaussian noise for unvoiced frames, otherwise generate M-sequence. Default is False.

seed [int] Seed for `nrand` for Gaussian noise. Default is 1.

Returns

excitation [array] Excitation signal

See also:

`pysptk.sptk.poledf`, `pysptk.sptk.swipe`, `pysptk.sptk.rapt`

Window functions

<code>blackman(n[, normalize])</code>	Blackman window
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Continued on next page

Table 9 – continued from previous page

<i>hamming</i> (n[, normalize])	Hamming window
<i>hanning</i> (n[, normalize])	Hanning window
<i>bartlett</i> (n[, normalize])	Bartlett window
<i>trapezoid</i> (n[, normalize])	Trapezoid window
<i>rectangular</i> (n[, normalize])	Rectangular window

pysptk.sptk.blackman

pysptk.sptk.**blackman** (*n*, *normalize=1*)

Blackman window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] blackman window

pysptk.sptk.hamming

pysptk.sptk.**hamming** (*n*, *normalize=1*)

Hamming window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] hamming window

pysptk.sptk.hanning

pysptk.sptk.**hanning** (*n*, *normalize=1*)

Hanning window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] hanning window

pysptk.sptk.bartlett

`pysptk.sptk.bartlett(n, normalize=1)`

Bartlett window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] bartlett window

pysptk.sptk.trapezoid

`pysptk.sptk.trapezoid(n, normalize=1)`

Trapezoid window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] trapezoid window

pysptk.sptk.rectangular

`pysptk.sptk.rectangular` (*n*, *normalize=1*)

Rectangular window

Parameters

n [int] Window length

normalize [int, optional]

Normalization flag

- 0. don't normalize
- 1. normalize by power
- 2. normalize by magnitude

Default is 1.

Returns

w [array, shape (n,)] rectangular window

Waveform generation filters

<code>zerodf</code> (<i>x</i> , <i>b</i> , <i>delay</i>)	All zero digital filter
<code>zerodft</code> (<i>x</i> , <i>b</i> , <i>delay</i>)	Transpose All zero digital filter
<code>poledf</code> (<i>x</i> , <i>a</i> , <i>delay</i>)	All-pole digital filter
<code>poledft</code> (<i>x</i> , <i>a</i> , <i>delay</i>)	Transpose All-pole digital filter
<code>lmadf</code> (<i>x</i> , <i>b</i> , <i>pd</i> , <i>delay</i>)	LMA digital filter
<code>lspdf</code> (<i>x</i> , <i>f</i> , <i>delay</i>)	LSP synthesis digital filter
<code>ltcdf</code> (<i>x</i> , <i>k</i> , <i>delay</i>)	All-pole lattice digital filter
<code>glسادf</code> (<i>x</i> , <i>c</i> , <i>stage</i> , <i>delay</i>)	GLSA digital filter
<code>glسادft</code> (<i>x</i> , <i>c</i> , <i>stage</i> , <i>delay</i>)	Transpose GLSA digital filter
<code>mlسادf</code> (<i>x</i> , <i>b</i> , <i>alpha</i> , <i>pd</i> , <i>delay</i>)	MLSA digital filter
<code>mlسادft</code> (<i>x</i> , <i>b</i> , <i>alpha</i> , <i>pd</i> , <i>delay</i>)	Transpose MLSA digital filter
<code>mglسادf</code> (<i>x</i> , <i>b</i> , <i>alpha</i> , <i>stage</i> , <i>delay</i>)	MGLSA digital filter
<code>mglسادft</code> (<i>x</i> , <i>b</i> , <i>alpha</i> , <i>stage</i> , <i>delay</i>)	Transpose MGLSA digital filter

pysptk.sptk.zerodf

`pysptk.sptk.zerodf` (*x*, *b*, *delay*)

All zero digital filter

Parameters

x [float] A input sample

b [array] FIR parameters

delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.lpc, pysptk.sptk.ltcdf, pysptk.sptk.lmadf

pysptk.sptk.zerodft

`pysptk.sptk.zerodft(x, b, delay)`

Transpose All zero digital filter

Parameters

x [float] A input sample

b [array] FIR parameters

delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.zerodf

pysptk.sptk.poledf

`pysptk.sptk.poledf(x, a, delay)`

All-pole digital filter

Parameters

x [float] A input sample

a [array] AR coefficients

delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.lpc, pysptk.sptk.ltcdf, pysptk.sptk.lmadf

pysptk.sptk.poledft

`pysptk.sptk.poledft` (*x*, *a*, *delay*)
Transpose All-pole digital filter

Parameters

x [float] A input sample
a [array] AR coefficients
delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.poledf

pysptk.sptk.lmadf

`pysptk.sptk.lmadf` (*x*, *b*, *pd*, *delay*)
LMA digital filter

Parameters

x [float] A input sample
c [array] Cepstrum
pd [int] Order of pade approximation
delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError

- if invalid order of pade approximation is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.uels, *pysptk.sptk.acep*, *pysptk.sptk.poledf*, *pysptk.sptk.ltcdf*,
pysptk.sptk.glsadf, *pysptk.sptk.mlsadf*, *pysptk.sptk.mgladf*

pysptk.sptk.lspdf

`pysptk.sptk.lspdf` (*x*, *f*, *delay*)
LSP synthesis digital filter

Parameters

x [float] A input sample
f [array] LSP coefficients
delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.lpc2lsp

pysptk.sptk.ltcdf

`pysptk.sptk.ltcdf(x, k, delay)`
All-pole lattice digital filter

Parameters

x [float] A input sample
k [array] PARCOR coefficients.
delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError if invalid delay length is supplied

See also:

pysptk.sptk.lpc, *pysptk.sptk.lpc2par*, *pysptk.sptk.lpc2lsp*, *pysptk.sptk.poledf*,
pysptk.sptk.lspdf

pysptk.sptk.glsadf

`pysptk.sptk.glsadf(x, c, stage, delay)`
GLSA digital filter

Parameters

x [float] A input sample
c [array] Geneeraized cepstrum
stage [int] -1 / gamma
delay [array] Delay

Returns

y [float] A filtered sample

Raises

ValueError

- if invalid number of stage is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.ltcdf, *pysptk.sptk.lmadf*, *pysptk.sptk.lspdf*, *pysptk.sptk.mlsadf*,
pysptk.sptk.mglsadf

pysptk.sptk.glsadf

`pysptk.sptk.glsadf` (*x*, *c*, *stage*, *delay*)

Transpose GLSA digital filter

Parameters

- x** [float] A input sample
- c** [array] Geneeraized cepstrum
- stage** [int] -1 / gamma
- delay** [array] Delay

Returns

- y** [float] A filtered sample

Raises

ValueError

- if invalid number of stage is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.glsadf

pysptk.sptk.mlsadf

`pysptk.sptk.mlsadf` (*x*, *b*, *alpha*, *pd*, *delay*)

MLSA digital filter

Parameters

- x** [float] A input sample
- b** [array] MLSA filter coefficients
- alpha** [float] All-pass constant
- pd** [int] Order of pade approximation
- delay** [array] Delay

Returns

- y** [float] A filtered sample

Raises

ValueError

- if invalid order of pade approximation is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.mcep, *pysptk.sptk.amcep*, *pysptk.sptk.poledf*, *pysptk.sptk.ltcdf*,
pysptk.sptk.lmadf, *pysptk.sptk.lspdf*, *pysptk.sptk.glsadf*, *pysptk.sptk.mgladf*

pysptk.sptk.mlsadft

`pysptk.sptk.mlsadft(x, b, alpha, pd, delay)`

Transpose MLSA digital filter

Parameters

- x** [float] A input sample
- b** [array] MLSA filter coefficients
- alpha** [float] All-pass constant
- pd** [int] Order of pade approximation
- delay** [array] Delay

Returns

- y** [float] A filtered sample

Raises**ValueError**

- if invalid order of pade approximation is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.mlsadf

pysptk.sptk.mgladf

`pysptk.sptk.mgladf(x, b, alpha, stage, delay)`

MGLSA digital filter

Parameters

- x** [float] A input sample
- b** [array] MGLSA filter coefficients
- alpha** [float] All-pass constant
- stage** [int] -1 / gamma
- delay** [array] Delay

Returns

- y** [float] A filtered sample

Raises**ValueError**

- if invalid number of stage is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.mgcep, pysptk.sptk.poledf, pysptk.sptk.ltcdf, pysptk.sptk.lmadf, pysptk.sptk.lspdf, pysptk.sptk.mlsadf, pysptk.sptk.glsadf

pysptk.sptk.mglsadft

`pysptk.sptk.mglsadft(x, b, alpha, stage, delay)`

Transpose MGLSA digital filter

Parameters

- x** [float] A input sample
- b** [array] MGLSA filter coefficients
- alpha** [float] All-pass constant
- stage** [int] -1 / gamma
- delay** [array] Delay

Returns

- y** [float] A filtered sample

Raises**ValueError**

- if invalid number of stage is specified
- if invalid delay length is supplied

See also:

pysptk.sptk.mglsadf

Utilities for waveform generation filters

<i>zerodf_delay</i> (order)	Delay for zerodf
<i>poledf_delay</i> (order)	Delay for poledf
<i>lmadf_delay</i> (order, pd)	Delay for lmadf
<i>lspdf_delay</i> (order)	Delay for lspdf
<i>ltcdf_delay</i> (order)	Delay for ltcdff
<i>glsadf_delay</i> (order, stage)	Delay for glsadf
<i>mlsadf_delay</i> (order, pd)	Delay for mlsadf
<i>mglsadf_delay</i> (order, stage)	Delay for mglsadf

pysptk.sptk.zerodf_delay

`pysptk.sptk.zerodf_delay(order)`

Delay for zerodf

Parameters

order [int] Order of zerodf filter coefficients

Returns

delay [array] Delay

pysptk.sptk.poledf_delay

`pysptk.sptk.poledf_delay(order)`

Delay for poledf

Parameters

order [int] Order of poledf filter coefficients

Returns

delay [array] Delay

pysptk.sptk.lmadf_delay

`pysptk.sptk.lmadf_delay(order, pd)`

Delay for lmadf

Parameters

order [int] Order of lmadf filter coefficients

pd [int] Order of pade approximation.

Returns

delay [array] Delay

pysptk.sptk.lspdf_delay

`pysptk.sptk.lspdf_delay(order)`

Delay for lspdf

Parameters

order [int] Order of lspdf filter coefficients

Returns

delay [array] Delay

pysptk.sptk.ltcdf_delay

`pysptk.sptk.ltcdf_delay` (*order*)

Delay for ltcdf

Parameters

order [int] Order of ltcdf filter coefficients

Returns

delay [array] Delay

pysptk.sptk.glsadf_delay

`pysptk.sptk.glsadf_delay` (*order, stage*)

Delay for glsadf

Parameters

order [int] Order of glsadf filter coefficients

stage [int] -1 / gamma

Returns

delay [array] Delay

pysptk.sptk.mlsadf_delay

`pysptk.sptk.mlsadf_delay` (*order, pd*)

Delay for mlsadf

Parameters

order [int] Order of mlsadf filter coefficients

pd [int] Order of pade approximation.

Returns

delay [array] Delay

pysptk.sptk.mglsadf_delay

`pysptk.sptk.mglsadf_delay` (*order, stage*)

Delay for mglsadf

Parameters

order [int] Order of mglsadf filter coefficients

stage [int] -1 / gamma

Returns

delay [array] Delay

Metrics

<code>cdist(c1, c2[, otype, frame])</code>	Calculation of cepstral distance
--	----------------------------------

pysptk.sptk.cdist

`pysptk.sptk.cdist(c1, c2, otype=0, frame=False)`
Calculation of cepstral distance

Parameters

c1 [array] Minimum-phase cepstrum

c2 [array] Minimum-phase cepstrum

otype [int]

Output data type

0. [db]

1. squared error

2. root squared error

Default is 0.

frame [bool] If True, returns frame-wise distance, otherwise returns mean distance. Default is False.

Returns

distance

4.1.2 Other conversions

Not exist in SPTK itself, but can be used with the core API. Functions in the `pysptk.conversion` module can also be directly accesible by `pysptk.*`.

<code>mgc2b(mgc[, alpha, gamma])</code>	Mel-generalized cepstrum to MGLSA filter coefficients
<code>sp2mc(powerspec, order, alpha)</code>	Convert spectrum envelope to mel-cepstrum
<code>mc2sp(mc, alpha, fftlen)</code>	Convert mel-cepstrum back to power spectrum
<code>mc2e(mc[, alpha, irlen])</code>	Compute energy from mel-cepstrum

pysptk.conversion.mgc2b

`pysptk.conversion.mgc2b(mgc, alpha=0.35, gamma=0.0)`
Mel-generalized cepstrum to MGLSA filter coefficients

Parameters

mgc [array, shape] Mel-generalized cepstrum

alpha [float] All-pass constant. Default is 0.35.

gamma [float] Parameter of generalized log function. Default is 0.0.

Returns

b [array, shape(same as `mgc`)] MGLSA filter coefficients

See also:

`pysptk.sptk.mlsadf`, `pysptk.sptk.mglسادf`, `pysptk.sptk.mc2b`, `pysptk.sptk.b2mc`,
`pysptk.sptk.mcep`, `pysptk.sptk.mgcep`

pysptk.conversion.sp2mc

`pysptk.conversion.sp2mc` (*powerspec*, *order*, *alpha*)

Convert spectrum envelope to mel-cepstrum

This is a simplified implementation of `mcep` for input type is 4.

Parameters

powerspec [array] Power spectrum

order [int] Order of mel-cepstrum

alpha [float] All-pass constant.

Returns

mc [array, shape(`order+1`)] mel-cepstrum

See also:

`pysptk.sptk.mcep`, `pysptk.conversion.mc2sp`

pysptk.conversion.mc2sp

`pysptk.conversion.mc2sp` (*mc*, *alpha*, *fftl*)

Convert mel-cepstrum back to power spectrum

Parameters

mc [array] Mel-spectrum

alpha [float] All-pass constant.

fftl [int] FFT length

Returns

powerspec [array, shape(`fftl//2 +1`)] Power spectrum

See also:

`pysptk.sptk.mcep`, `pysptk.conversion.sp2mc`

pysptk.conversion.mc2e

`pysptk.conversion.mc2e` (*mc*, *alpha*=0.35, *irlen*=256)

Compute energy from mel-cepstrum

Inspired from `hts_engine`

Parameters

mc [array] Mel-spectrum

alpha [float] All-pass constant.

irlen [int] IIR filter length

Returns

energy [floating point, scalar] frame energy

4.1.3 High-level interface for waveform synthesis

Module `pysptk.synthesis` provides high-level interface that wraps low-level SPTK waveform synthesis functions (e.g. `mlsadf`),

Synthesis filter interface

class `pysptk.synthesis.SynthesisFilter`

Synthesis filter interface

All synthesis filters must implement this interface.

filt (*x*, *coef*)

Filter one sample

Parameters

x [float] A input sample

coef [array] Filter coefficients

Returns

y [float] A filtered sample

filtt (*x*, *coef*)

Transpose filter

Can be optional.

Parameters

x [float] A input sample

coef [array] Filter coefficients

Returns

y [float] A filtered sample

Synthesizer

class `pysptk.synthesis.Synthesizer` (*filt*, *hopsize*, *transpose=False*)

Speech waveform synthesizer

Attributes

filt [SynthesisFilter] A speech synthesis filter

hopsize [int] Hop size

transpose [bool] Transpose filter or not. Default is False.

synthesis (*source*, *b*)

Synthesize a waveform given a source excitation and sequence of filter coefficients (e.g. cepstrum).

Parameters

source [array] Source excitation

b [array] Filter coefficients

Returns

y [array, shape (same as `source`)] Synthesized waveform

synthesis_one_frame (*source, prev_b, curr_b*)
Synthesize one frame waveform

Parameters

source [array] Source excitation

prev_b [array] Filter coefficients of previous frame

curr_b [array] Filter coefficients of current frame

Returns

y [array] Synthesized waveform

SynthesisFilters

LMADF

class pysptk.synthesis.**LMADF** (*order=25, pd=4*)
LMA digital filter that wraps `lmadf`

Attributes

pd [int] Order of pade approximation. Default is 4.

delay [array] Delay

filt (*x, coef*)
Filter one sample using `lmadf`

Parameters

x [float] A input sample

coef: array LMA filter coefficients (i.e. Cepstrum)

Returns

y [float] A filtered sample

See also:

[*pysptk.sptk.lmadf*](#)

MLSADF

class pysptk.synthesis.**MLSADF** (*order=25, alpha=0.35, pd=4*)
MLSA digital filter that wraps `mlsadf`

Attributes

alpha [float] All-pass constant

pd [int] Order of pade approximation. Default is 4.

delay [array] Delay

filt (*x*, *coef*)

Filter one sample using `mlsadf`

Parameters

x [float] A input sample

coef: array MLSA filter coefficients

Returns

y [float] A filtered sample

See also:

`pysptk.sptk.mlsadf`, *`pysptk.sptk.mc2b`*

filtt (*x*, *coef*)

Transpose filter using `mlsadft`

Parameters

x [float] A input sample

coef: array MLSA filter coefficients

Returns

y [float] A filtered sample

See also:

`pysptk.sptk.mlsadft`

GLSADF

class `pysptk.synthesis.GLSADF` (*order=25*, *stage=1*)

GLSA digital filter that wraps `glsadf`

Attributes

stage [int] -1/gamma

delay [array] Delay

filt (*x*, *coef*)

Filter one sample using `glsadf`

Parameters

x [float] A input sample

coef: array GLSA filter coefficients

Returns

y [float] A filtered sample

See also:

`pysptk.sptk.glsadf`

filtt (*x*, *coef*)

Filter one sample using `glsadft`

Parameters

x [float] A input sample
coef: array GLSA filter coefficients

Returns

y [float] A filtered sample

See also:

pysptk.sptk.glsadft

MGLSADF

class `pysptk.synthesis.MGLSADF` (*order=25, alpha=0.35, stage=1*)
MGLSA digital filter that wraps `mglsadf`

Attributes

alpha [float] All-pass constant
stage [int] -1/gamma
delay [array] Delay

filt (*x, coef*)

Filter one sample using `mglsadf`

Parameters

x [float] A input sample
coef: array MGLSA filter coefficients

Returns

y [float] A filtered sample

See also:

pysptk.sptk.mglsadf

filtt (*x, coef*)

Filter one sample using `mglsadft`

Parameters

x [float] A input sample
coef: array MGLSA filter coefficients

Returns

y [float] A filtered sample

See also:

pysptk.sptk.mglsadft

AllZeroDF

class pysptk.synthesis.**AllZeroDF**(*order=25*)

All-zero digital filter that wraps `zerodf`

Attributes

delay [array] Delay

filt (*x, coef*)

Filter one sample using using `zerodf`

Parameters

x [float]

A input sample

coef: array FIR parameters

—

y [float] A filtered sample

filtt (*x, coef*)

Filter one sample using using `zerodft`

Parameters

x [float] A input sample

coef: array FIR parameters

Returns

y [float] A filtered sample

See also:

[*pysptk.sptk.zerodft*](#)

AllPoleDF

class pysptk.synthesis.**AllPoleDF**(*order=25*)

All-pole digital filter that wraps `poledf`

Attributes

delay [array] Delay

filt (*x, coef*)

Filter one sample using using `poledf`

Parameters

x [float] A input sample

coef: array LPC (with loggain)

Returns

y [float] A filtered sample

See also:

pysptk.sptk.poledf

filtt (*x*, *coef*)

Filter one sample using using poledft

Parameters

x [float] A input sample

coef: array LPC (with loggain)

Returns

y [float] A filtered sample

See also:

pysptk.sptk.poledft

AllPoleLatticeDF

class pysptk.synthesis.**AllPoleLatticeDF** (*order=25*)

All-pole lattice digital filter that wraps ltcdf

Attributes

delay [array] Delay

filt (*x*, *coef*)

Filter one sample using using ltcdf

Parameters

x [float] A input sample

coef: array PARCOR coefficients (with loggain)

Returns

y [float] A filtered sample

See also:

pysptk.sptk.ltcdf

4.1.4 Utilities

Audio files

example_audio_file()

Get the path to an included audio example file.

pysptk.util.example_audio_file

pysptk.util.**example_audio_file**()

Get the path to an included audio example file.

Examples

Mel-cepstrum analysis

<code>mcepalpha(fs[, start, stop, step, num_points])</code>	Compute appropriate frequency warping parameter given a sampling frequency
---	--

pysptk.util.mcepalpha

`pysptk.util.mcepalpha` (*fs*, *start*=0.0, *stop*=1.0, *step*=0.001, *num_points*=1000)

Compute appropriate frequency warping parameter given a sampling frequency

It would be useful to determine alpha parameter in mel-cepstrum analysis.

The code is traslated from https://bitbucket.org/happyalu/mcep_alpha_calc.

Parameters

fs [int] Sampling frequency

start [float] start value that will be passed to `numpy.arange`. Default is 0.0.

stop [float] stop value that will be passed to `numpy.arange`. Default is 1.0.

step [float] step value that will be passed to `numpy.arange`. Default is 0.001.

num_points [int] Number of points used in approximating mel-scale vectors in fixed- length.

Returns

alpha [float] frequency warping paramter (offen denoted by alpha)

See also:

`pysptk.sptk.mcep`, `pysptk.sptk.mgcep`

5.1 Developer Documentation

5.1.1 Design principle

pysptk is a thin python wrapper of SPTK. It is designed to be API consistent with the original SPTK as possible, but give better interface. There are a few design principles to wrap C interface:

1. Avoid really short names for variables (e.g. a, b, c, aa, bb, dd)

Variable names should be informative. If the C functions have such short names, use self-descriptive names instead for python interfaces, unless they have clear meanings in their context.

2. Avoid too many function arguments

Less is better. If the C functions have too many function arguments, use keyword arguments with proper default values for optional ones in python.

3. Handle errors in python

Since C functions might *exit* (unfortunately) inside their functions for unexpected inputs, it should be check if the inputs are supported or not in python.

To wrap C interface, Cython is totally used.

5.1.2 How to build pysptk

You have to install `numpy` and `cython` first, and then:

```
git clone https://github.com/r9y9/pysptk
cd pysptk
git submodule update --init
python setup.py develop
```

should work.

Note: Dependency to the SPTK is added as a submodule. You have to checkout the supported SPTK as `git submodule update --init` before running `setup.py`.

5.1.3 How to build docs

pysptk docs are managed by the python sphinx. Docs-related dependencies can be resolved by:

```
pip install .[docs]
```

at the top of pysptk directory.

To build docs, go to the *docs* directory and then:

```
make html
```

You will see the generated docs in *_build* directory as follows (might different depends on sphinx version):

```
% tree _build/ -d
_build/
├── doctrees
│   └── generated
├── html
│   ├── _images
│   ├── _modules
│   │   └── pysptk
│   ├── _sources
│   │   └── generated
│   ├── _static
│   │   ├── css
│   │   ├── fonts
│   │   └── js
│   └── generated
├── plot_directive
│   └── generated
```

See *_build/html/index.html* for the top page of the generated docs.

5.1.4 How to add a new function

There are a lot of functions unexposed from SPTK. To add a new function to pysptk, there are a few typical steps:

1. Add function signature to `_sptk.pxd`
2. Add cython implementation to `_sptk.pyx`
3. Add python interface (with docstrings) to `sptk.py` (or some proper module)

As you can see in `setup.py`, `_sptk.pyx` and SPTK sources are compiled into a single extension module.

Note: You might wonder why cython implementation and python interface should be separated because cython module can be directly accessed by python. The reasons are 1) to avoid rebuilding cython module when docs strings

are changed in the source 2) to make doc looks great, since sphinx seems unable to collect function arguments correctly from cython module for now. Relevant issue: [pysptk/#33](#)

An example

In _sptk.pyd:

```
cdef extern from "SPTK.h":
    double _agexp "agexp"(double r, double x, double y)
```

In _sptk.pyx:

```
def agexp(r, x, y):
    return _agexp(r, x, y)
```

In sptk.pyx:

```
def agexp(r, x, y):
    """Magnitude squared generalized exponential function

    Parameters
    -----
    r : float
        Gamma
    x : float
        Real part
    y : float
        Imaginary part

    Returns
    -----
    Value

    """
    return _sptk.agexp(r, x, y)
```

5.2 Change log

5.2.1 v0.1.14 <2018-11-25>

- #62, #64: **IMPORTANT:** Add `use_scipy` option to `levdur` and `lpc`, and set it to `True` by default to improve numerical stability. The results should be same regardless to the option, but this would be technically a breaking change.
- #64: Add `acorr`.

5.2.2 v0.1.13 <2018-11-19>

- Add All zero synthesis filter.
- Add `levdur`.
- Add tranposed synthesis filters (`mlsadft`, `poledft`, `mglsadft`, `glsadft`)

- Add missing high level synthesis filter class GLSADE.

5.2.3 v0.1.12 <2018-10-27>

- #63: Fix lpc2lsp bug, add lsp2lpc function. Add regression tests for those.

5.2.4 v0.1.11 <2018-02-05>

- #55: Add numpy implementation of cdist

5.2.5 v0.1.10 <2018-01-02>

- #54: Changes from SPTK v3.11 release. 6 and 7 pade approximatio in lmadf and mlsadf is now supported,

5.2.6 v0.1.9 <2018-01-01>

- BUG fix: example_audio_data is now included in the release tar.gz

5.2.7 v0.1.8 <2017-12-25>

- c2acr: Fix segfaults for small fftsize

5.2.8 v0.1.7 <2017-06-28>

- Extend vec2vec functions to mat2mat #49
- Support automatic type conversions #48

5.2.9 v0.1.6 <2017-05-18>

- Add mcepalpha. #43
- Add mc2e. #42
- Add sp2mc and mc2sp. #41

5.2.10 v0.1.5 <2017-04-22>

- Fix mcep eps check and input length #39

5.2.11 v0.1.4 <2015-11-23>

- Add developer documentation (#34)
- Separate cython implementation and interface (#35)
- Add RAPT (#32)
- Add excite function (#31) @jfsantos

- Fix inconsistent docs about normalization flag for window functions
- Fix test failure in c2dps / ndps2c (#29)

5.2.12 v0.1.3 <2015-10-02>

- Building binary wheels for Windows using Appveyor (#28)
- Add Installation guide on windows (#25)
- Start Windows continuous integration on AppVeyor (#24). As part of the issue, binary dependency was updated so that SPTK library can be compiled on linux, osx and Windows as well.
- Remove unnecessary array initialization (#23)

5.2.13 v0.1.2 <2015-09-12>

- Add `pysptk.synthesis` package that provides high level interfaces for speech waveform synthesis (#14)
- Add cross-link to the docs
- Add `pysptk.conversion.mgc2b`
- Add speech analysis and re-synthesis demonstration notebook (#13)
- Add `pysptk.util.example_audio_file`
- Add `fftcep` (#18)
- Add `mfcc` (#21)
- Cython is now only required to build development versioni of pysptk. (#8)

5.2.14 v0.1.1 <2015-09-05>

- Include *.c to pypi distribution

5.2.15 v0.1.0 <2015-09-05>

- Initial release

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