

Audio Content Analysis
Assignment # 4
Instructor: Juan Pablo Bello

A Implementation [7 pts]

*In this section you will be implementing a series of functions, and finally a script tying them all together. Each function should be saved as a separate .m file, where the filename is identical to the function name. The functions definitions should **exactly** follow the given code. You may use any previously submitted functions. Submit all code to NYU classes as a single zip file named “YourLastName4.zip”.*

Details for each function can be found at the end of the assignment.

1. For each of the following, write a Matlab function that estimates the pitch of a given mono audio signal $x(n)$ using the stated method.

- (a) Short-term unbiased auto-correlation function [2.5 pts]

```
[pitch, t_pitch] = ...  
    detect_pitch_acf(x_t, t, fs, win_size, hop_size, min_lag, max_lag)
```

- (b) YIN [2.5 pts]

```
[pitch, t_pitch] = ...  
    detect_pitch_yin(x_t, t, fs, win_size, hop_size, min_lag, max_lag)
```

The estimated pitch should be the one that maximizes/minimizes the detection function within the specified range of lags.

2. Write a function that computes and plots the estimated pitch values over time (as black dots) for each of the above methods as subplots in a single figure [1 pt].

```
[] = plot_pitch(filepath, win_size, hop_size, min_lag, max_lag)
```

3. Write a Matlab script called `assignment4.m` which runs the code used to write your report (see the Analysis section below) [1 pt].

B Analysis [3 pts]

Write a report addressing each of the questions below. Please submit your report as a pdf file to NYU Classes.

For each of the provided audio files (available on NYUClasses):

1. Using the default parameters `win_size=2048`, `hop_size=256`, `min_lag=15`, and `max_lag=800`, plot the detected pitches using the `plot_pitch` function [1 pts].
2. Comment on the difference in the methods with respect to the characteristics of the sound [1 pts].
3. Play with the parameters and find a setting that gives better results. Plot these results and comment on why your choices improved the output [1 pts].

4. Explore alternative methods for selecting the pitch based on the computed function. Can you improve results further? [Extra point]

Function Details

The functions you write for section A should begin with the headers below, and the inputs/outputs should follow the specifications in the function's doc-strings.

```
function [pitch, t_pitch] = ...
    detect_pitch_lacf(x_t, t, fs, win_size, hop_size, min_lag, max_lag)
%   Detect pitch using the unbiased autocorrelation function.
%
%   Parameters
%   -----
%   x_t : 1 x T array
%         time domain signal
%   t : 1 x T array
%        time points in seconds
%   fs : int
%        sample rate (samples per second)
%   win_size : int
%        window size (in samples)
%   hop_size : int
%        hop size (in samples)
%   min_lag : int
%        minimum possible lag value (in samples)
%   max_lag : int
%        maximum possible lag value (in samples)
%
%   Returns
%   -----
%   pitch : 1 x P array
%           detected pitch values (Hz)
%   t_pitch : 1 x P array
%            time points in seconds

function [pitch, t_pitch] = ...
    detect_pitch_yin(x_t, t, fs, win_size, hop_size, min_lag, max_lag)
%   Detect pitch using yin.
%
%   Parameters
%   -----
%   x_t : 1 x T array
%         time domain signal
%   t : 1 x T array
%        time points in seconds
%   fs : int
%        sample rate (samples per second)
%   win_size : int
%        window size (in samples)
%   hop_size : int
%        hop size (in samples)
%   min_lag : int
%        minimum possible lag value (in samples)
%   max_lag : int
%        maximum possible lag value (in samples)
%
%   Returns
%   -----
%   pitch : 1 x P array
%           detected pitch values (Hz)
```

```

%     t_pitch : 1 x P array
%           time points in seconds

function [] = plot_pitch(filepath, win_size, hop_size, min_lag, max_lag)
%     Compute and plot pitch estimates for unbiased autocorrelation function and for yin.
%
%     Parameters
%     -----
%     filepath : string
%           path to .wav file
%     win_size : int
%           window size (in samples)
%     hop_size : int
%           hop size (in samples)
%     min_lag : int
%           minimum possible lag value (in samples)
%     max_lag : int
%           maximum possible lag value (in samples)
%
%     Returns
%     -----
%     None

```