
An Introduction to Using WAVES+

Introduction

WAVES+ is a commercial interactive data visualization and manipulation tool from Entropic Research Laboratory that is tailored for analyzing speech signals.

WAVES+ is started by typing `xwaves` at the command line. With WAVES+ you generally have several windows; some are control windows and others are data display windows. The one named `xwaves Multidimensional Signal Display` is the main control panel. Another window named `Miscellaneous xwaves controls` provides access to various WAVES+ parameters. For the labs, you will not have to use either of these windows. We will have other programs/panels for controlling WAVES+.

To quit out of WAVES+ use the **QUIT** buttons on the control panels.

Data Windows

Time Markers

There are two different types of time markers in the data windows (waveform and spectrogram displays). One is a **cursor**, a solid vertical line, that indicates the current location of the pointer. The other is the **left** and **right** markers, which are dashed vertical lines indicating the start and end points, respectively, of a marked time region.

Status Information

The first line of the data window contains the following status information:

- Time: the time location of the cursor
- D: the duration of the marked region
- L: the time location of the left marker
- R: the time location of the right marker

- **F**: the reciprocal of the duration

In the lower left hand corner of the waveform display window, the value of the current data point (specified by the location of the pointer) is shown after the **ESPS sampled data** text.

In the spectrogram display, the first line also contains information on the frequency (**Freq**) and value (**Value**) of the current cursor location.

Scroll Bar

Below the status line is a scrollbar. It consists of a bridge-shaped marker that indicates what fraction of the total waveform (or spectrogram) is currently in view, where the entire width of the scrollbar represents the total length of the data. In the scrollbar:

- **left mouse click** advances forward through the data,
- **right mouse click** moves backward through the data, and
- **middle mouse click** moves directly to the specified position in the data.

You may not get any movement in the scrollbar if the window is currently displaying the entire waveform. These scrollbar manipulations are usually only useful if you have zoomed in on a piece of the waveform.

Data Display

Below the scrollbar is the data display. In this part of the display you can set the markers and execute a variety of commands from a menu. In the data display you can:

- **Set the time markers** using the left mouse button. You click the button at the beginning and drag and release at the end of the region you wish to mark. You can also mark a zero-length region by simply clicking (and not dragging).
- **Execute a command** using the right mouse button. Press and hold the right button to bring up the menu of command options. Move the pointer to highlight the command you desire and then release the button to execute the command.
- **Play the waveform between the time markers** by clicking the middle mouse button. This is most useful for playing (a portion of) an utterance again.

Most of the menu commands are self-explanatory except, perhaps, **[[bracket markers]]** which zooms in on the marked region such that the region fills the entire view. To zoom out to show the entire waveform, use **[[zoom full out]]**.

To print the current data window, choose the **[[print graphic]]** command. The window will be sent to the printer specified in the **PRINTER** environment variable.

If you move the different data display windows (e.g., the waveform and spectrogram), running the **[[align & rescale]]** command will get the windows back in sync.

Using the Spectrum Analyzer

The Spectrum Analyzer is a control panel for specifying parameters related to windowing waveforms, performing LPC and DFT analysis on the windowed waveforms, and controlling the spectral slice window.

Selecting an Analysis Region

The windowing mechanism, controlled by the `Window limits from:`, operates in two modes: `Cursor` and `Marker`.

In `Cursor` mode, you position the vertical cursor in a waveform window where you want the analysis window to be centered and then select the `[[xspectrum]]` command from the waveform command menu. The length of the waveform window is taken from the spectrum analyzer's control window in the `size (sec)` control. In the waveform window, the markers are repositioned to indicate the limits of the window.

Alternatively, in `Marker` mode, you set the limits of the window explicitly by marking a region in the waveform window and then executing the `[[xspectrum]]` command. In this case, the window size is set according to the marker positions and the `size (sec)` control is updated accordingly.

Modifying the Analysis Parameters

When you execute the `[[xspectrum]]` command, another window will appear (if it doesn't already exist) displaying a spectral slice of some type. Once the time slice is "captured" with the `[[xspectrum]]` command, you can then alter the spectrum analyzer settings such as window type, window size, and analysis type. Changing these settings immediately updates the current spectral slice.

The controls `Analysis type` and `Window type` are set by choosing a type from a menu. You bring up these menus by pressing the right mouse button in one of the buttons with the inverted triangle. You then choose the desired type and release the mouse button. The analysis type choices are:

- DFT: high-order radix-2 FFT with zero padding,
- DFTR: DFT with as many points as the window length (no padding), and
- AUTOC, COV, BURG, MBURG, FBURG, STRCOV, STRCOV1, VBURG: all LPC representations computed using the autocorrelation method, covariance method, Burg method, modified Burg method, fast modified Burg method, structured covariance methods (two of them), and vector Burg method.
- CEPST: cepstral liftering.

The LPC representations are controlled by the `order` control. This is the order of the LPC all-pole approximation.

The window types are self-explanatory. The `cos^4` window is half a cosine period raised to the fourth power.

The **Preemphasis coeff** control specifies the preemphasis coefficient to be applied prior to spectral analysis. The value 0.94 is reasonable.

The cepstral liftering is primarily controlled by the **Cep. cut (sec)** (cepstral que-frency cutoff) setting and the **Liftering** setting, which determines the type of liftering (none, lowpass, or highpass) to be done.

The Spectrum Display Window

In the spectral slice window, the vertical cursor indicates the current location of the pointer. In the first line of the display, the current frequency location and the associated spectrum value are shown.

You can save the current spectral slice (for comparison with future slices) by pressing the right mouse button and selecting the `[[save as ref spectrum]]` option. You can have up to four slices displayed simultaneously (three saved plus one current). If the saved slices are cluttering up your spectral slice window you can clear them with the menu command `[[clear ref spectra]]` or `[[clear all spectra]]`.

To print the current data window, choose the `[[print graphic]]` command. The win-dow will be sent to the printer specified in the `PRINTER` environment variable.