ENVI Tutorial: Introduction to ENVI Plot Functions

Introduction to Plot Functions

This tutorial describes how to implement an ENVI plot function, which is a user-defined function that you can add to and call from the Plot_Function menu of any ENVI plot window. This tutorial assumes that you are familiar with the Interactive Data Language (IDL) and that you understand how to write functions and procedures in IDL. ENVI+IDL is required for this tutorial.

Files Used in this Tutorial

ENVI Resource DVD: `Data\programming`

File	Description
`pf_1st_derivative.pro`	Plot function to take the first derivative of a spectrum
`pf_2nd_derivative.pro`	Plot function to take the second derivative of a spectrum
`useradd.txt`	Modified (replacement) version of useradd.txt, which resides in the menu directory of your ENVI installation

ENVI Resource DVD: `Data\spec_lib`

File	Description
`usgs_min.sli (.hdr)`	USGS mineral spectral library

ENVI Plot Functions

Plot functions are a special class of ENVI user functions that modify data in an ENVI plot window, such as a Z Profile window. For example, ENVI's built-in plot functions (which are listed in the Plot_ Function menu in any plot window) include items such as Binary Encoding and Continuum Removal. Define user plot functions by adding a new line to the useradd.txt file that resides in your ENVI menu directory. However, while ordinary user functions are automatically called by XMANAGER and receive the event structure variable as a positional parameter, plot functions are automatically called by ENVI and receive several variables (as both parameters and keywords) that are related to the data in the plot window.

When you call a user plot function, normal plot data (all the spectra in the plot window) are passed to the user plot function. The plot function is applied to the data, and the resulting data are returned to the plot window where they are displayed. The user plot function is applied to every spectrum placed in that window until a different plot function is selected.

All user plot functions must have the following function definition statement:

```
function MY_PLOT_FUNCTION, x_data, y_data, bbl, bbl_array, $
    L_POS=l_pos, R_POS=r_pos, _EXTRA=_extra
```

Where:

`X_DATA`: Data values for the x-axis

`Y_DATA`: Data values for the y-axis

BBL: Vector whose values identify the band positions of the bad bands in the Z Profile data. For example, if the Z Profile contained 224 bands, but bands 3, 4, and 5 were in marked as bad bands in the ENVI header file, then BBL would be set to [2,3,4]. This applies only to Z Profile windows and will be undefined for all other plot windows.

BBL_ARRAY: Vector of ones and zeros with as many elements as x-axis data points. A value of 1 indicates that the corresponding y-axis value is good, and a value of 0 means it is bad (i.e., for Z Profiles, a value of 0 means the band is in the bad bands list).

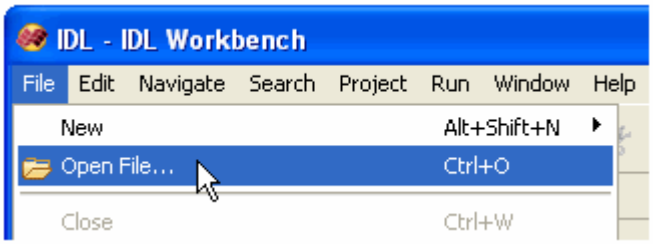
L_POS: Indicates the index into the X_DATA array where the x-axis plot begins. If the plot window is not zoomed-in, then L_POS is 0.

R_POS: Indicates the index into the X_DATA array where the x-axis plot ends. If the plot window is not zoomed-in, then the value of R_POS is n_elements(X_DATA)-1.

_EXTRA: Keyword variable that must be present to receive extra variables that ENVI may need to pass into the plot function. If the plot function is defined without this keyword, then you will likely receive errors when trying to use it in ENVI.

Create a Plot Function

1. Start ENVI+IDL.
2. From the IDL menu bar, select **File > Open File**. The Open File dialog appears.



3. Navigate to `Data\programming` and select `pf_1st_derivative.pro`. The following code appears in the IDL Editor:

```
function pf_1st_derivative, x, y, bbl, bbl_list, _extra=_extra

ptr= where (bbl_list eq 1, count)
result = fltarr(n_elements(y))
if (count ge 3) then $
   result(ptr) = deriv (x[ptr], y[ptr])
return, result
end
```

   This function accepts x and y data and a list of bad bands. Excluding the bad bands, the function takes the first derivative of the y value and returns it to the plot window.

4. Follow Steps 2-3 to open the file `pf_2nd_derivative.pro`. When you understand how these functions work, close the files.

Add the Plot Function to the Menu

To add a new button to a plot window's Plot_Function menu, add a new line to `useradd.txt` in the `menu` directory of your ENVI installation. For this tutorial, you will copy a previously edited version of `useradd.txt` to your menu directory. The following steps outline this process.

1. From the IDL menu bar, select **File > Open**. A file selection dialog appears.
2. Navigate to `Data\programming` and select `useradd.txt`. Click **Open**. This file contains the following code. Note the fourth and fifth lines:

```
{plot} {Normal} {sp_normal} {type=0}
{plot} {Continuum Removed} {sp_continuum_removed} {type=1}
{plot} {Binary Encoding} {sp_binary_encoding} {type=0}
{plot} {1st Derivative} {pf_1st_derivative} {type=0}
{plot} {2nd Derivative} {pf_2nd_derivative} {type=0}

{identify} {Spectral Angle Mapper} {SAM} {envi_identify_sam} {0,.78539816}
{identify} {Spectral Feature Fitting} {SFF} {envi_identify_sff} {0,.1}
{identify} {Binary Encoding} {BE} {envi_identify_be} {0,1.}
```

   Using the fourth field above as an example, the format is as follows:

   `{plot}`: Tag that indicates the following definition is a plot function (since `useradd.txt` can contain several different types of routines)

   `{1st Derivative}`: Menu button name for the Plot_Function menu. Note that 1st Derivative will be placed immediately after the Binary Encoding menu option.

   `{pf_1st_derivative}`: Name of the user plot function

   `{type=0}`: Type of plot function updates. Set `{type=0}` to call the plot function only when new data are available. Set `{type=1}` to call the plot function when new data are available or the plot is zoomed.
   you are satisfied that you understand the user function format, exit ENVI+IDL.

3. Copy and paste `Data\programming\useradd.txt` to the menu directory of your ENVI installation, overwriting the existing file. On a Windows platform, this directory is in the following location (where *xx* indicates the software version):

   `C:\Program Files\ITT\IDLxx\products\envixx\menu`

Set up ENVI to Run the Plot Function

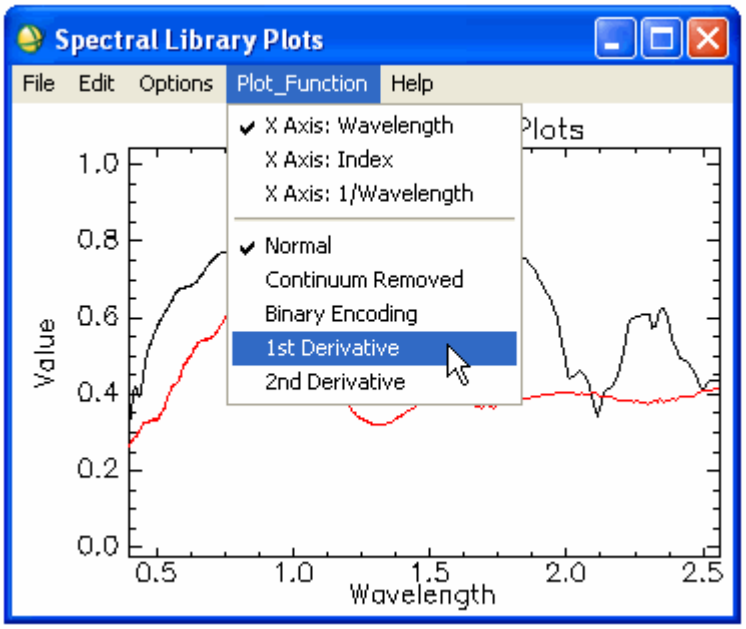
1. ENVI requires that IDL functions reside in the `save_add` directory of your ENVI installation. Copy `Data\programming\pf*.pro` to the following directory (assuming a Windows platform):

   `C:\Program Files\ITT\IDL`*xx*`\products\envi`*xx*`\save_add`

2. Restart ENVI+IDL. ENVI looks in the `save_add` directory for new functions and automatically loads them when it starts.

Open a Spectral Library and Plot Spectra

1. From the ENVI main menu bar, select **Spectral > Spectral Libraries > Spectral Library Viewer**. A Spectral Library Input File dialog appears.
2. Click **Open** and select **Spectral Library**. A file selection dialog appears.
3. Navigate to `Data\spec_lib\usgs_min` and select `usgs_min.sli`. Click **Open**.
4. Click **OK** in the Spectral Library Input File dialog. The Spectral Library Viewer dialog appears.
5. Select one or more spectra; the corresponding spectral profiles appear in a Spectral Library Plots window.
6. From the Spectral Library Plots window menu bar, select **Plot_Function > 1st Derivative**. ENVI calculates the first derivative spectra of all plots and displays the results in the Spectral Library Plots window.



7. From the Spectral Library Plots window menu bar, select **Plot_Function > 2nd Derivative**. ENVI calculates the second derivative spectra of all plots and displays the results in the Spectral Library Plots window.
8. From the Spectral Library Plots window menu bar, select **Plot_Function > Normal** to return to the standard reflectance spectrum.
9. When you are finished, select **File > Exit** from the ENVI main menu bar.