Pick_Sw: A Program for Interactive Picking of S-Wave Data, Version 2.00

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1. OVERVIEW

Program pick_sw is used to interactively pick travel times from S-wave data. It is assumed that the data are collected using 2 shots of opposite polarity at each shot location. The traces must be in either the SEG-2 format or the SU format. The program is written in the IDL and C programming languages, and the program is executed under the Windows operating system. (The program may also execute under other operating systems like UNIX if the C language functions are re-compiled).

This Open-File Report describes
- The contents and organization of the Zip file (section 2).
- Program pick_sw, including the program files, the installation of the program, the input files, and the execution of the program (section 3).
- Test data and some plots of the data (section 4).
- References having extensive information about the SEG-2 and the SU data formats (section 5).
- The address of the distributor of the IDL programming language (section 6).
- Addresses to which suggestions for improving the program may be sent (section 7).

The first release of pick_sw was version 1.00. The program was extensively revised and is now released as version 2.00. Compared to the previous version, this new version is easier to install, has GUIs that are easier to use, and has GUIs offering more capabilities. ("GUI" means graphical user interface.) In addition, the new version is object-oriented, making it easier to maintain.

2. CONTENTS AND ORGANIZATION OF THE ZIP FILE

The name of the Zip file is "pick_sw.zip." Within the Zip file are ofr_02-176.pdf, 18 files, and a directory labeled "test_data." File ofr_02-176.pdf is a copy of this file. The 18 files are needed to execute the program and are described in section 3.1. Directory test_data has 9 files that are either input to or output from program pick_sw. All 9 files are described in section 4.

The contents of pick_sw.zip may be extracted using program Winzip, which may be purchased at http://www.winzip.com.

3. PROGRAM Pick_Sw

3.1 Files

The computer code for program pick_sw is in 18 different files, which are briefly described in Table 1.

Table 1. Files with the code for program pick_sw.

File	Short Description
pick_sw.prj	Project file used by IDL.
pick_sw.pro	Creates the GUIs.
pick_sw__define.pro	Reads, processes, and plots the traces and the travel times.
error_message.pro	Prints an error message on the screen.
lib_name.pro	Determines the appropriate extension of a filename for a library.
handle_error.pro	Handles an error within an IDL procedure. (include file)
handle_error_gr.pro	Handles an error within an IDL procedure that creates graphics. (include file)
handle_error_rw.pro	Handles an error within an IDL procedure that reads and writes files. (include file)
About.txt	ASCII text file with general information about program pick_sw.
Help.txt	ASCII text file with information about the main GUI of program pick_sw.
Help_traces.txt	ASCII text file with information about the GUI used to view the traces, pick the travel times, and assign weights.
Help_spread.txt	ASCII text file with information about the GUI used to view the spread.
Help_times.txt	ASCII text file with information about the GUI used to view the travel times.
fnc_pick_sw.c	C-language functions used to read traces in the SEG-2 and the SU data formats.
fnc_pick_sw.def	ASCII file needed by the Visual C++ compiler.
su_head.h	C-language header used to define the trace header for the SU data format.
seg2.h	C-language header used to define the trace header for the SEG-2 data format.
fnc_pick_sw.dll	Function fnc_pick_sw.c compiled as a dynamic link library.

3.2 Installation

The installation requires three steps:

1. Copy the Zip file to a suitable directory on your computer.
2. Extract the contents of the Zip file using WinZip.
3. Load procedure pick_sw.pro into an editor and go to line 1587, which is
   ext_dir = 'd:\seismic\processing\pick_sw\fnc_pick_sw\debug\'
   Variable ext_dir is a string with the path to the library fnc_pick_sw.dll. Set this variable to the correct path. Be sure to include the quotes at the beginning and the end of the string.

3.3 Input Data

3.3.1 Information File

This file contains information about the receiver locations, the shot locations, the pairing of the shots with opposite polarities, and so on. The format of this file is described using "spr_info.txt," which is an example of an information file and is located in directory test_data:

```
Spread name: a1

Number of receivers = 24

Rec.        Location (m)
No.  x     y    z
101  2.    0.   0.
102  4.    0.   0.
103  6.    0.   0.
104  8.    0.   0.
105  10.   0.   0.
106  12.   0.   0.
107  14.   0.   0.
108  16.   0.   0.
109  18.   0.   0.
1010 20.   0.   0.
1011 22.   0.   0.
1012 24.   0.   0.
1013 26.   0.   0.
1014 28.   0.   0.
1015 30.   0.   0.
1016 32.   0.   0.
1017 34.   0.   0.
1018 36.   0.   0.
1019 38.   0.   0.
1020 40.   0.   0.
1021 42.   0.   0.
1022 44.   0.   0.
1023 46.   0.   0.
1024 48.   0.   0.

Number of shots = 4

Shot        Location (m)
No.  x     y    z    Seismogram File
101  0.    0.   0.   19707.dat
102  0.    0.   0.   20707.dat
103  50.   0.   0.   17707.dat
104  50.   0.   0.   18707.dat

File name for travel times: tt_picks.txt
```

Because all entries in this file are labeled, only a few remarks are necessary.

The number of shots must be even because the *S*-wave data are assumed to be collected with both polarities of the source. The polarities are indicated by the order of the shots in the information file: Shots 1 and 2 have the same location but different polarities;

likewise, shots 3 and 4 have the same location but different polarities; and so on. The program checks that shots 1 and 2 have the same location, that shots 3 and 4 have the same location, and so on.

The coordinate system used to specify the locations of the receivers and the shots does not affect the picking of the travel times. However, the coordinate system does affect the plots of the spread and the traveltimes (sections 4.4 and 4.5, respectively). The coordinate system should be oriented such that the x axis is parallel to the spread, the y axis is perpendicular to the spread, and the z axis is vertical. Thus, for a given receiver or shot, x refers to its distance along the spread, y to its offset from the spread, and z to its elevation. The coordinate system is right-handed, and its origin is arbitrary.

When editing the information file, be sure
1. To retain all labels such as "Spread name:," "Number of receivers =," etc.
2. To retain all blank lines.
3. That the number of receivers equals the number in the list of receivers.
4. That the number of shots equals the number in the list of shots.

3.3.2 Seismic Data

The seismic data must be in either the SEG-2 or the SU format (Section 5).

Program pick_sw executes properly only if two conditions on the data are met. First, two fields in the trace headers must be set: the number of samples per trace, and the sample interval. Second, traces must not have a time delay.

3.3.3 File with Travel Times and Weights

Frequently, re-examining the travel times and the weights is necessary. For this reason, program pick_sw always looks for the file with the travel times and the weights, whose name is specified in the information file (section 3.3.1). If the file exists, then it is read. Otherwise, the travel times are set to 0.0, and the weights are set to 1.0.

The format of this file is described using "tt_picks.txt," which is and is an example of a travel time file and is located in directory test_data:

```
Spread name: a1

                  Shots 101 & 102        Shots 103 & 104
       Rec          Time Weight            Time Weight
       101       1.52e-002   0.50       1.36e-001   1.00
       102       2.70e-002   0.50       1.35e-001   1.00
       103       3.60e-002   0.50       1.33e-001   1.00
       104       5.39e-002   1.00       1.31e-001   1.00
       105       6.55e-002   1.00       1.29e-001   1.00
       106       7.73e-002   1.00       1.27e-001   1.00
       107       8.99e-002   1.00       1.26e-001   1.00
       108       1.02e-001   1.00       1.24e-001   1.00
       109       1.09e-001   1.00       1.22e-001   1.00
      1010       1.11e-001   1.00       1.21e-001   1.00
      1011       1.12e-001   1.00       1.19e-001   1.00
      1012       1.14e-001   1.00       1.18e-001   1.00
      1013       1.15e-001   1.00       1.16e-001   1.00
      1014       1.17e-001   1.00       1.14e-001   1.00
      1015       1.19e-001   1.00       1.12e-001   1.00
      1016       1.22e-001   1.00       1.09e-001   1.00
      1017       1.24e-001   1.00       9.69e-002   1.00
      1018       1.26e-001   1.00       8.17e-002   1.00
      1019       1.27e-001   1.00       7.17e-002   1.00
      1020       1.29e-001   1.00       6.03e-002   1.00
      1021       1.31e-001   1.00       4.84e-002   0.50
      1022       1.32e-001   1.00       3.75e-002   0.25
      1023       1.34e-001   1.00       2.93e-002   0.25
      1024       1.36e-001   1.00       1.45e-002   0.25
```

Column 1 contains the receiver number. Columns 2 and 3 contain the travel times and the weights for shots 101 and 102. (The times are in seconds.) Likewise, columns 4 and 5 contain the travel times and the weights for shots 103 and 104.

3.4 Execution

To execute the program, there are four steps:

1. Start IDL.
2. From the menu, chose "File," and "Open Project." Open file "pick_sw.prj."
3. From the menu, chose "Project," "Compile," and "All Files."
4. From the menu, chose "Project," "Run."

The look and feel of the program is similar to that of most Windows programs, and so most users will readily figure-out how the progam works. If a question arises, users can get an answer in the "Help" documentation, which is loaded when the Help button is pressed.

To exit from program pick_sw, select, on the main menu, "File" and then "Exit."

4. Test Data

In directory test_data are 9 files, which may be used to test whether program pick_sw is properly installed. The 9 files are described in sections 4.1 through 4.6.

4.1 File "spr_info.txt": Information File

This information file is setup for some *S*-wave refraction data, which were collected in an alluvial valley. The sediments consist mostly of sands and gravels and are about 4 meters thick. The bedrock is shale. The seismic spread consisted of 24 geophones and 4 shots. The 4 shots were at 2 different locations at which both polarities of the source were used. Details about the format of this file are in section 3.3.1.

4.2 Files "17707.dat", "18707.dat", "19707.dat", "20707.dat": *S*-Wave Refraction Data

These four files contain the seismic data stored in the SEG-2 format. For files "19707.dat" and "20707.dat", the shots were in the same location, but the polarities differed. Files "17707.dat" and "18707.dat" are similarly related.

Each file contains 24 traces, each of which consists of 2048 samples. The sample interval is 0.1 milli-seconds.

4.3 File "tt_picks.txt": Travel Times

Using program pick_sw, travel times were picked and weights were assigned to the picks. Both the times and the picks were written in file tt_picks.txt. Details about the format of this file are in section 3.3.3.

4.4 File "spread.ps": Plot of the Spread

In the plot of the spread, each "X" represents two shots, which have the same location but opposite polarity. The labels adjacent to a cross are the shot numbers and the names of the files with the traces. Each dot represents a receiver (geophone). Approximately every 12th receiver is labeled. The file is in postscript format.

This postscript file, as well as the postscript files described in sections 4.5 and 4.6, is easily converted to PDF files using Adobe Acrobat Distiller, and these files can be view with Adobe Acrobat Reader. In addition, these postscript files may be sent directly to a postscript-compatible printer.

4.5 File "tt.ps": Plot of the Travel Times

In the plot of the traveltimes, the vertical axis is the travel time, and the horizontal axis is the distance in the x direction. The filled circles represent travel times, the colors of the circles denote their weights, and the rectangles along the horizontal axis represent shot locations. The file is in postscript format.

4.6 File "traces.ps": Plot of the Traces for Shots 101 and 102

In the plot of the traces, the vertical axis represents time, and the horizontal axis represents distance in the x direction. For each receiver, there are two traces because there are two shots having the same location, but opposite polarity. The paired traces are plotted at the distance (in the x direction) of the associated receiver. The file is in postscript format.

5. Further Information about the SEG-2 and SU Data Formats

In 1990, members of the Society of Exploration Geophysicsts (SEG) established a standard format for storing seismic data that was collected for engineering-scale or small-scale investigations. This standard format is called "SEG-2" and is now widely used. Detailed information about this format is in an SEG report (Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, 1990).

"SU" means Seismic Unix --- it is a software package for processing and displaying seismic data, and it runs on computers with the Unix operating system and X-windows (Cohen and Stockwell, 1999). The package is free and can be obtained from the anonymous ftp site at the Colorado School of Mines: ftp.cwp.mines.edu (138.67.12.4).

6. Distributor of the IDL Programming Language

IDL (Interactive Data Language) is designed especially for interactive visualization of scientific and technical data. To execute program pick_sw, version 5.5 or higher of IDL must be installed. IDL is not supplied in this Zip file; it may be obtained from

> Research Systems, Inc.
> 4990 East Pearl Circle
> Boulder, Colorado   80301
>
> Telephone: 303.786.9900
> Email: info@rsinc.com
> Internet: http://www.rsinc.com

7. Suggestions for Improving the Program

If you have any suggestions for improving the program, please contact:

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8. Disclaimers

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9. Acknowledgements

10. References

Cohen, J. K., and Stockwell, Jr., J. W., 1999, CWP/SU: Seismic Unix release 33: A free package for seismic reseach and processing, Center for Wave Phenomenon, Colorado School of Mines.

Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, Pullan, S. E., Chairman, 1990, Recommended standard for seismic (/radar) files in the personal computer environment: Geophysics, vol. 55, no. 9, p. 1260-1271.