

NEW INTERACTIVE SOFTWARE FOR SEISMIC DATA PROCESSING

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Abstract

Seismon is an open source software package under GNU General Public License developed by Stefan Mertl (TU Wien). It is designed as a modular program with defined interface for specific types of modules. This gives programmer rules how to add new tools easily without disturbing the program integrity. Seismon is written in MATLAB and all input and output data are stored in MySQL database which can be accessed by more Seismon users simultaneously. Seismon is initially equipped with tools for communication with the database, various waveform file conversions, and basic tools for data analysis and visualization. To use this software for routine processing of data from local seismic network in West Bohemia (WEBNET), some adaptations had to be done, and the modified program was called Seismon_WB. There had to be put a great emphasis on user friendliness which required to define keyboard shortcuts, add status bars directly displaying current possibilities and properties, or extract the most important functions out of structured menus to main window as GUI components. Another method to facilitate the interpreter's work implemented in Seismon_WB is an automation of frequently used routines (i.e. automatic first motion detection or amplitude reading). In addition, specific tools for particular research purposes were added. Not negligible piece of work was also done during compilation of Seismon_WB. The compiled version intended for regular users does not require MATLAB installation anymore. On contrary, MATLAB is still essential for the developers. After all, Seismon_WB has replaced SeisBase completely at the beginning of 2013.

1 Introduction

Czech seismologists are monitoring a worldwide important seismic area in West Bohemia [6, 7]. This unique region is characterized by series of weak earthquakes called earthquake swarms. Once the ground motion is measured and stored in data file, it must be manually processed using some software tool. The seismologists must manually process all data files with measured ground motion. For this purpose a program called SeisBase has been used at our institute since 1980's, therefore there are some fundamental problems. First, it is difficult to run this DOS based program on regular PCs; second, it is almost impossible to upgrade it with new functions. Because of these limitations, we developed new interactive modular open source program named Seismon_WB. The new software must read various data formats, communicate with the database, provide tools for signal analysis and clear and user friendly environment to display the waveform data. Since the scientists must manually process all these records - seismic events - for precise studies, the software has to facilitate the users work as much as possible. Routinely, the scientist has to load the earthquake record from selected time period, mark time segments containing earthquake, find particular seismic waves and assign earthquake parameters (such as location, magnitude or source mechanism). The database then stores these values and keeps it accessible for anyone at any time.

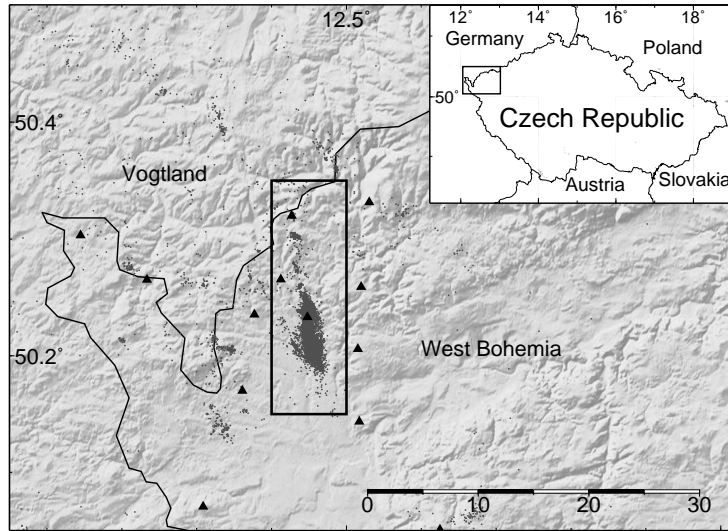


Figure 1: WEBNET - local seismic network in West Bohemia. Seismic stations are marked by black triangles, earthquake epicenters by gray dots.

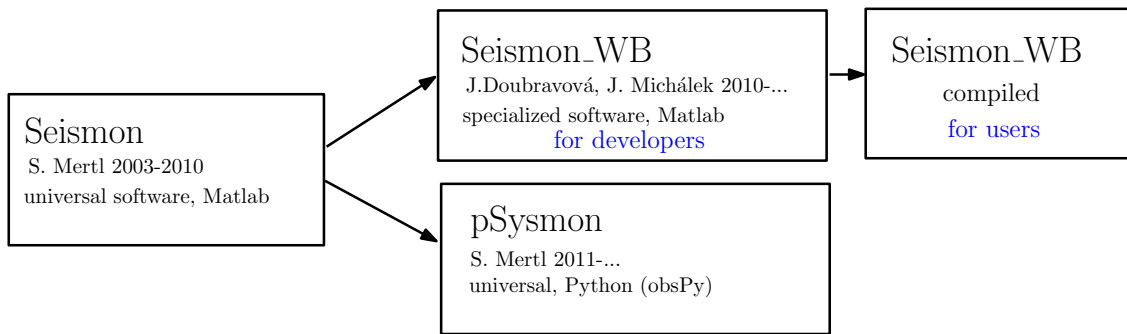


Figure 2: Seismon evolution

2 Program structure

There are more versions based on the same architecture proposed by Stefan Mertl [5]. The original version of Seismon is a very flexible and universal software package. It gives the user all autonomy in selecting all parameters manually. Therefore this version is suitable for special experimental studies. On contrary, we need to fix the settings for routine processing to get consistent results. This will accelerate the manual processing, as well as prevent the user's mistakes. We called this customized version Seismon_WB. Fig. 2 shows that there is also being developed new version of Seismon based on Python called pSysmon [2].

Seismon is written in MATLAB and all input and output data are stored in MySQL database which can be accessed by more Seismon users simultaneously. The database server provides Seismon with information about waveform files, users and projects. As an output of Seismon there are stored seismic events, their locations, magnitudes, or source parameters. The raw seismic waveforms are archived on waveform server. It can be in all standard seismic formats (such as mSEED, GSE, SEG-Y, SAC), .mat, or ASCII.

The program architecture consists of several modules. The user can concatenate modules to create more complex function targeted to specific purpose. For example, we take two modules to analyze the signals - first module loads the waveform data from the database and next module displays the results and enables the user to operate them. Because the interface is fixed, any programmer can define his own modules with this specified interface according to his specific

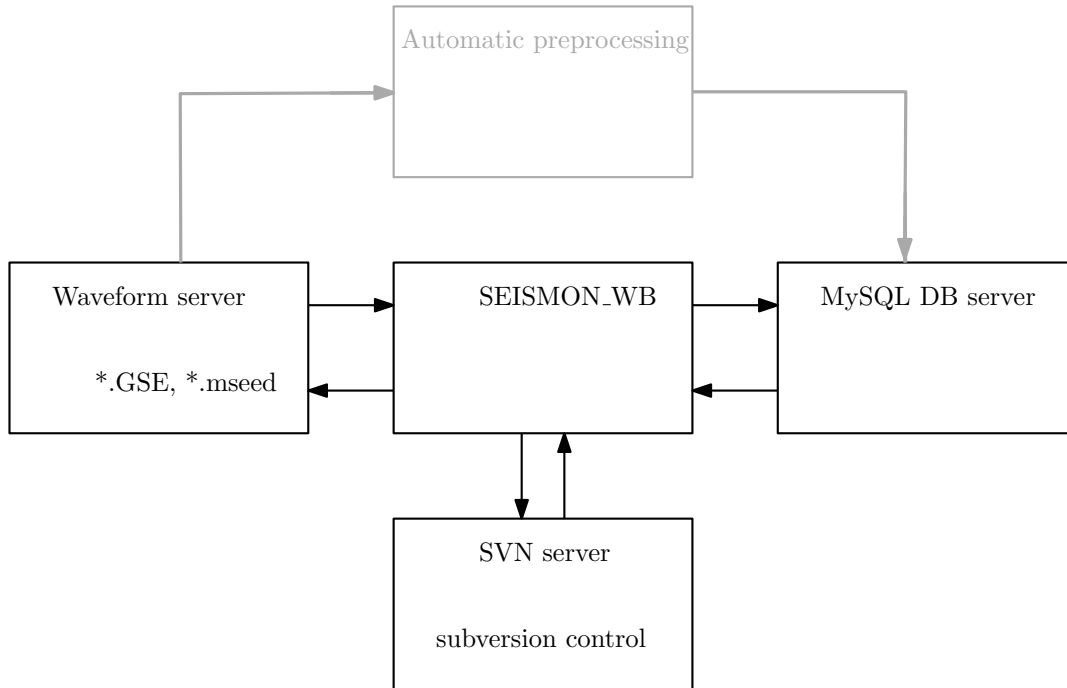


Figure 3: Data flow

needs. This makes the program flexible, i.e. it is easy to change it and develop it.

Seismon is initially equipped with tools for communication with the database, various waveform file conversions, and basic tools for data analysis and visualization. It can be also extended with some external programs. The database interface consists of user friendly dialogs to update the database tables. This means, a scientist without knowledge of MySQL can easily add new record (or update existing one) to the database, for example when new station is deployed or a seismometer is replaced. Reading and writing all standard seismic formats is fundamental for such a software, because there are more formats used for seismic data and they may differ according to source used. To maintain user's comfort it is necessary to make the file conversions an elementary part of the program. Additionally there are interface modules to communicate with external programs needed, such as NonLinLoc [3] for location, AMT [4] for moment tensor solution or Google Earth [5] for fine map view. The signal processing tools provide all functions usually required, such as filtering, integration, differentiation, frequency spectrum, rotation, particle motion or magnitude determination. Other tools for special research purposes were also added, namely a tool for fitting source parameters from the FFT spectra developed by J. Michálek [8] or magnitude determination related to West Bohemia region according to formula in [6].

There had to be put a great emphasis on user friendliness which required to define keyboard shortcuts, add status bars directly displaying current possibilities and properties, or extract the most important functions out of structured menus to main window as GUI components. Another method to facilitate the interpreter's work implemented in Seismon_WB is an automation of frequently used routines (i.e. automatic first motion detection or amplitude reading).

3 Conclusions

So far we made a program which is an adequate substitution for our scientists to continue with routine processing consistently. In addition, Seismon_WB can be widely used and developed by

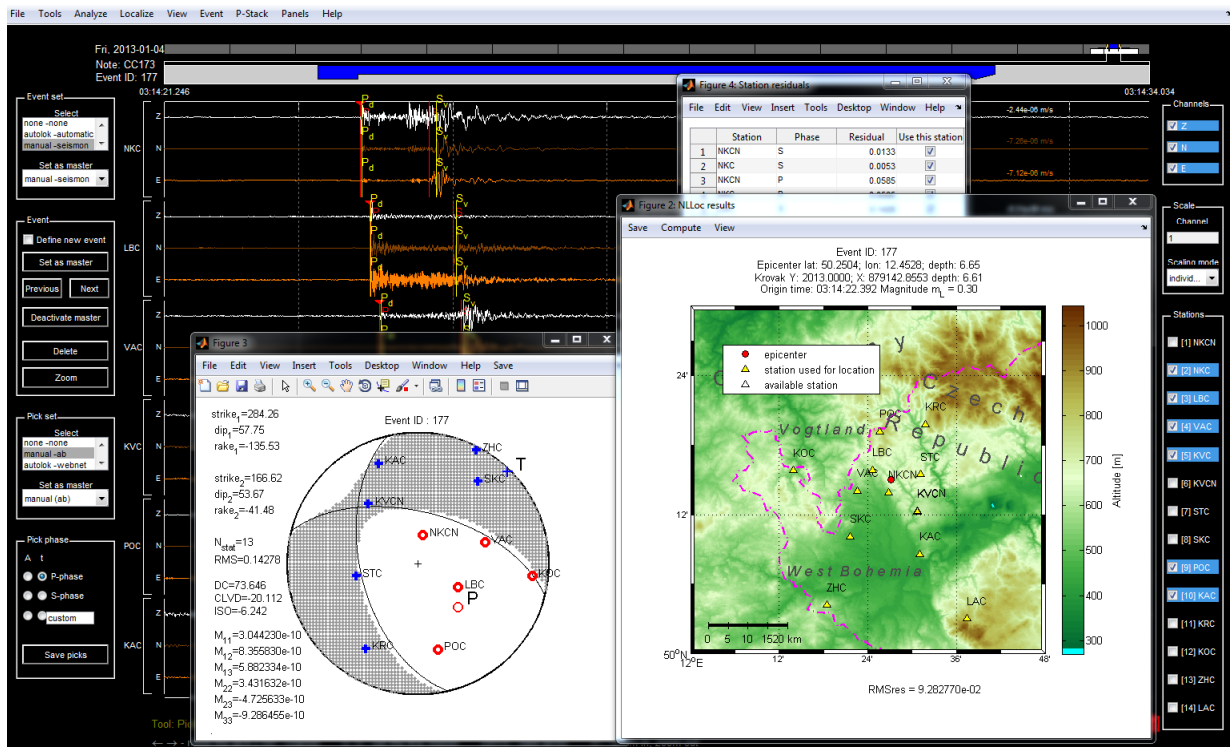


Figure 4: Screenshot - Record from seismic stations with P and S picks (background) and earthquake location using NLLoc tool (map) with displayed residual for each pick (table) and moment tensor solution from AMT (focal sphere).

various modules. It is an open source project, therefore anyone with Matlab license can contribute to its development. In the future we want to include modules for automatic pre-processing (i.e. event detection, classification, picking, location...). This means that the program would produce output similar to the human operator without additional manpower interaction and the results would be available immediately.

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