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Automated system for seismological monitoring

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Conducting continuous seismological monitoring is accompanied by technical difficulties resulting in several significant problems: 1) the presence of vast amounts of continuous, high-discretized data in various formats; 2) heterogeneity of seismological catalogs and metadata of seismological stations; 3) labor-intensive routine processing of seismological data requiring a large amount of time.

The SeisComP software package helps address issues related to data systematization and storage [1]. This software uses commonly accepted formats for storing continuous seismic records "MSEED," information about seismological stations "StationXML," and seismological catalogs "QuakeML." These formats have a flexible set of fillable fields that can be customized for specific types of research. Access to data is provided through an interface implemented via the FDSNWS server.

SeisComP also has functionality for real-time automatic data processing. However, for detecting earthquake signals in continuous records, SeisComP uses STA/LTA algorithms, which produce many false triggers and are not suitable for detecting signals with a low signal-to-noise ratio. In addition, SeisComP allows get continuous seismic data by SeedLink protocol, but this way works when the equipment is installed in place with good internet connection. Therefore, there is a demand for creating a more reliable system that allows for getting seismic data from remote territories, automatic detection of local earthquake signals, distinguishing P- and S-wave arrivals, and visualizing processing results for analysis.

Currently, a prototype system for automatic data processing is being developed to fill the gaps in SeisComP. The system consists of a set of web applications, including data processing and visualization modules. Neural network algorithms are being developed [2] for detecting and determining wave arrival times, which will be integrated into the server application. A web service has been developed to evaluate the performance of the algorithms and adjust P- and S-wave times. After evaluating and correcting the arrival times, earthquake parameters are determined: hypocenter coordinates, origin time, and magnitude. Processing results are displayed in the data analysis web application. This application implements a set of basic tools for data analysis: 1) construction of a recurrence plot to assess a- and b-values; 2) construction of depth distribution profiles of earthquake hypocenters.

Besides, device for remote data transfer is under development. The operating logic is to isolate earthquake signals and transmit short data intervals through module «LoRaWAN».

At present, the developing service allows for manual data processing and result analysis. Additionally, ongoing improvements and testing of developed neural network algorithms are being conducted, with plans to add automatic detection and picking of P- and S-waves. In the future, this system will complement the SeisComP software package, enabling real-time seismological monitoring of local events.

References:

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