TU Informatics

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Visualization and sonification of earthquake events

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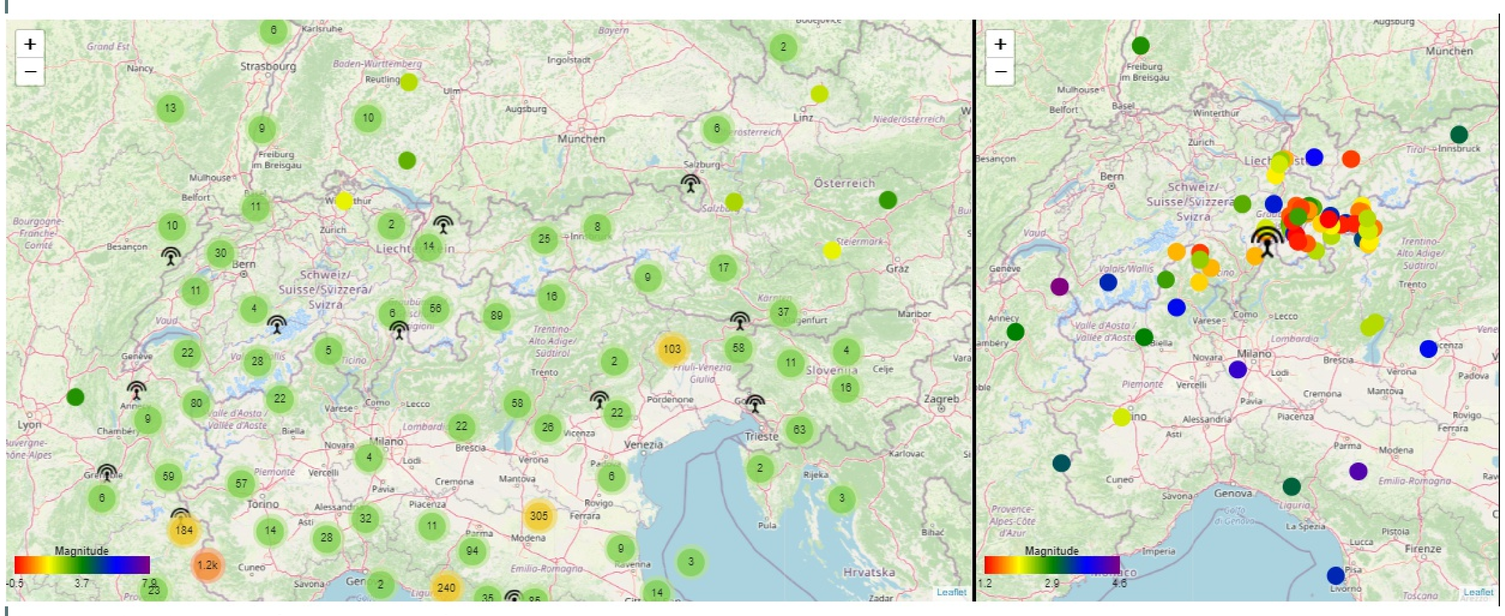
The goal of the project is the development of a dashboard, which supports the exploration of past earthquake events in details.
The earthquake events and the receiver stations are represented on maps, and the selected earthquake events are being queried on the backend in order to extract their details.
The processing will provide waveform and spectrogram representation of the event, as well its sonified form of the earthquake event: the waveform will be sonified on the way that the waveform will be audible by human ears, in order to make such event to be perceiveable not just by the eyes on the spectral form, but by the ears on the sonified

Visualization methodologies

Clustering

Clustering renders data clustered on an interactive map allowing to see a quick overview of similar items, where similarity means spatially close events are grouped to the same cluster in the current context. Additionally, clustering helps to render large amount of data efficiently on the map without exceeding the computational resources.



Quantiative color encoding

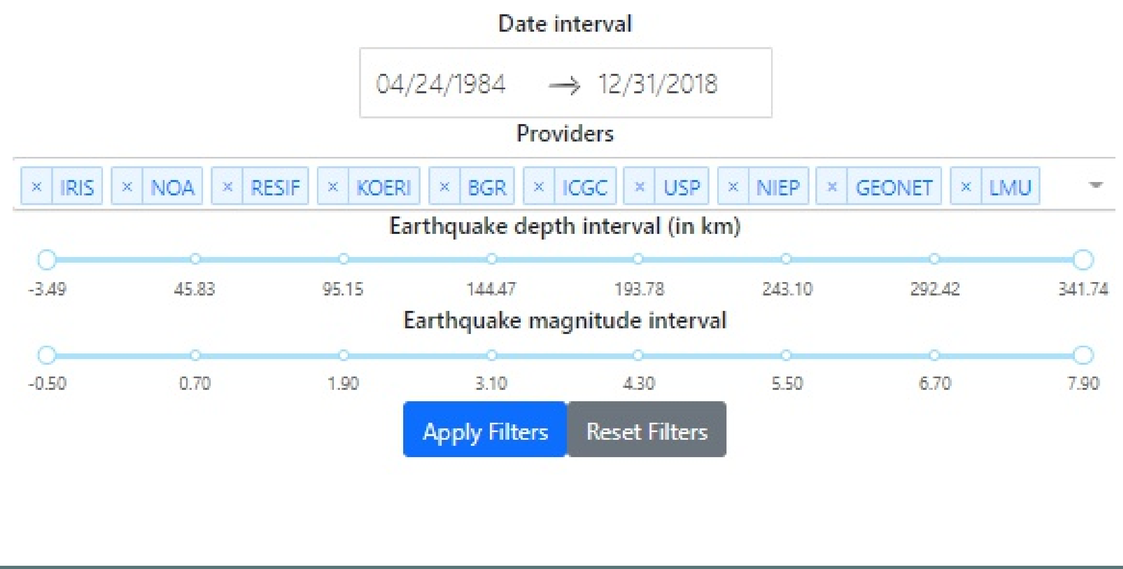
The mapped events are color encoded in two contexts: in clustered view, the color encodes number of events belonging to a specific cluster, while the individual events are color-coded, based on theirg magnitude, in which coloring, legend supports users to interpret such representation.

Focus + Context, Overview and Detail

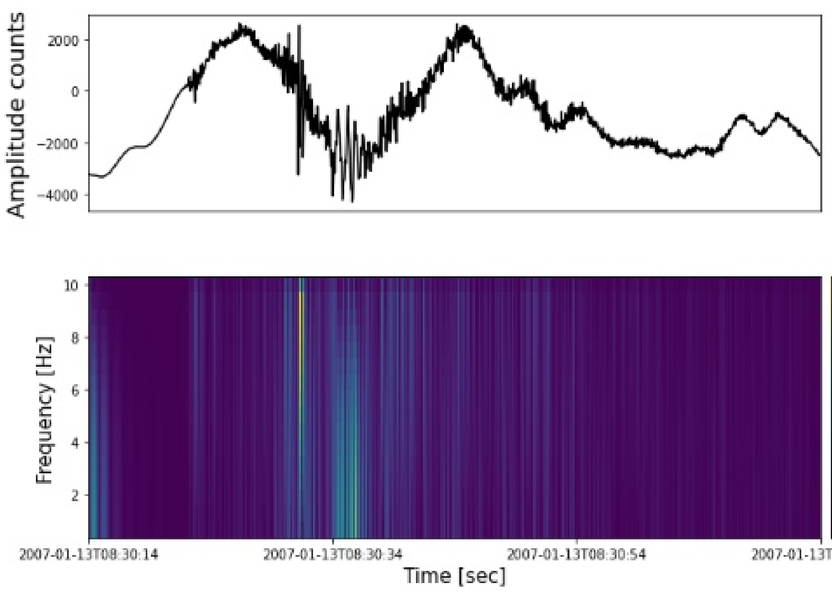
In order to gain insights of the events recorded by the very same receiver station, detailed view would be beneficial to place them in context: By selecting a specific receiver station on the general Overview map, the corresponding events will be highlighted on the Detail-map. The color encoding of such events are re-scaled in order to distinguish their magnitude characteristics better even in visual form.

Dynamic Query

In dynamic queries the query is represented by a number of widgets such as sliders and dropdown boxes.
Sliders are useful tools for query numeric attribute ranges, while dropdowns could be essential for categorical filtering. Complex attributes, such as dates can be filtered with special components, such as calendar style date range selector tools. The Dashboard provides filtering abilities regarding the date of recording, the depth and the magnitude of earthquake events, as well as the ability to filter for records based on the recording sensor's provider.



Seismic data extraction



Seismic Waveform

A seismic wave is an elastic wave generated by an impulse such as an earthquake or an explosion.

Spectrogram

Spectrograms are basically two-dimensional graphs, with a third dimension represented by colors. The horizontal axis represents the time dimension, the vertical represents the frequencies occur in each time frame, which can also be thought of as pitch or tone, with the lowest frequencies at the bottom and the highest frequencies at the top. The amplitude (or energy or “loudness”) of a particular frequency at a particular time is represented by the colormap.

Sonification

In order to sonify the earthquake events, loudness normalization methodology which adjusts the recording based its perceived loudness will be applied, without changing the waveform's dynamics.

Event-specific details

Event-specific informations, such as the time, the extracted location based on longitude and latitude, magnitude, and depth of specific earthquakes are represented in tabular form.

trace_name	TNS.GR_20020922045909_EV
location	Blumenstraße, Landkreis Reutlingen, Baden-Württemberg, Germany
latitude	48.522
longitude	9.466
event_recorded_at	2002-09-22 04:59:10
earthquake_depth	5.7 km
earthquake_magnitude	2.2

Implementation

The dashboard was developed with educational purposes to gain insght to the characterization of earthquake events. The implementation was done in Python with Dash framework. The extraction of waveform of earthquake events were supported by the ObsPy framework, which provide methods to request data from specific earthquake sensory stations.