**Pyrocko**

*Pyrocko*: A Versatile Software Framework for Seismology

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### Introduction

**Pyrocko** is an open-source seismology toolbox and library, written in the Python programming language. It can be utilized flexibly for a variety of geophysical tasks, like seismological data processing and analysis, modelling of waveforms, InSAR or GPS displacement data, or for seismic source characterization.

At its core, Pyrocko is a library and framework providing building blocks for researchers and students wishing to develop their own applications.

This poster gives a glimpse of Pyrocko’s features, for more examples and tutorials visit [http://pyrocko.org](http://pyrocko.org).

### Waveform Processing

With Pyrocko you can read, handle and write many different file formats such as MiniSEED, SAC, SEISAN, GSE1/2, SEG-Y and many more. Your local waveform archives can be organized, accessed and batch-processed through `pyrocko.pile` in a memory-efficient way.

```python
from pyrocko import pile
p = pile.pile(['project_folder/']) # or thousands of filenames here
for traces in p.chopper(tmin=tmin, tinc=tinc, tpad=tpad):
    for tr in traces:
        tr.downsample_to(target_deltat, snap=True, demean=False)
```

Listing 1: Example how a pile of waveform data is build, and chops of traces are downsampled efficiently.

With **Sniffer** you interactively browse through your seismograms, maybe be your big archives or small datasets. Sniffer features plug-ins (snuffling) that provide you with a broad variety of seismological applications. A selection of features include:

- Event and phase picking and management
- Earthquake cluster analysis
- Beamforming
- Cross-correlation of traces
- Station network mapping
- Synthetic travel-time markers
- Interactive synthetic waveform modeling

### Datasets

The `pyrocko.dataset` submodule gives convenient access to useful online and offline geo datasets:

- **Seismic velocity models** through CRUST2.0 and the Global Crustal Database (USGS).
- **DEM data** from ETOPO1 and SRTM3.
- **Tectonic datasets** include a plate boundary model *PeterBird2003* and global strain rate model *GSRM1*.
- **Geographical data** from the GSHHG coast-line database and Geonames.org, (city names and population)

### Clients and Data Access

**Online waveform data** archives from different institutions can be accessed through the FDSN protocol - popular providers are pre-configured in Pyrocko (e.g. IRIS, Geofon).

**Earthquake catalog data** from Geofon, GlobalCMT, USGS and more.

**GPS position data** served by the National Geodetic Lab of the University of Nevada, Reno can be accessed.

### Travel-Time Calculations

**Cake** is a very tasty tool for 1D travel-time and ray-path computations. You can use it to solve classical seismic ray theory problems for layered-earth models (layer cake models) on a spherical Earth.

E.g. for various seismic phases Cake calculates:

- Phase arrival times
- Ray paths
- Reflection and transmission coefficients
- Take-off and incidence angles

This is an example of how a pile of waveform data is built, and chops of traces are downsampled efficiently.

### Forward Modelling

Use **Fomosto** and **pyrocko.gf** to calculate Green’s functions (GF) tailored to your earth model and problem. The GFs are stored and managed in ready-to-use databases. In this way you can separate the computationally expensive operation from any source modelling. Pyrocko wraps different numerical forward-modelling codes, such as QSEIS, QSSP and PSSRN/PSCMP to calculate Green’s function databases.

**Pyrocko** provides a broad variety of seismological features (plug-ins) that can be big archives or small datasets. **Snuffer** interactively browses through your seismograms, may be your big archives or small datasets. Sniffer features plug-ins that provide you with a broad variety of seismological applications.

**Pyrocko** is an open-source seismology toolbox and library, written in the Python programming language. It can be utilized flexibly for a variety of geophysical tasks, like seismological data processing and analysis, modelling of waveforms, InSAR or GPS displacement data, or for seismic source characterization.

At its core, **Pyrocko** is a library and framework providing building blocks for researchers and students wishing to develop their own applications.

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### Ecosystem

In Pyrocko’s wake the development of seismological software thrives:

- **Grond** – The Earthquake Buster. Probabilistic source optimisation from waveform and geodetic data.
- **Lassie** – A friendly Earthquake Detector. Even shifts the fastest tremor.
- **BEAT** – Bayesian Earthquake Analysis Tool. Source optimisation from geodetic and seismic data.
- **Talpa** – Interactive Static Source Modelling. Analytical and numerical displacement source modelling.
- **Automap** – Beautiful Maps from GMT. Swiftly create informational maps through Pyrocko.
- **Jackseis** – Waveform archive data manipulation.

**The Seismologist’s Swiss Army Knife**

### Selected References


