FDSN Web Services integrated with Automatic Moment Tensor calculation

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Introduction

Earthquake Moment Tensors (MTs), produced routinely by seismic observatories, are used in a wide range of operational fields, such as quick determination of the earthquake rupture plane, shakemap generation, tsunami warnings, etc. Thus, its automatic and quick determination constitutes an important task for seismic agencies. The Fortran software *calMwandFM* provides the ability for a near real-time automatic MT computation by applying the *FMNEAR* and the *MWNEAR* calculation approaches [1][2]. Meanwhile, the *FDSN* [3] has developed well-known utilities for homogeneous seismological waveform data, station metadata and seismic event information retrieval; the FDSN Web Services (*FDSNWS*). The Python library *ObsPy* [4] provides interconnection to the *FDSNWS* services. Here, we make use of these tools to check in real-time for new seismic events and trigger the automatic MT process, based on specified configurable thresholds.

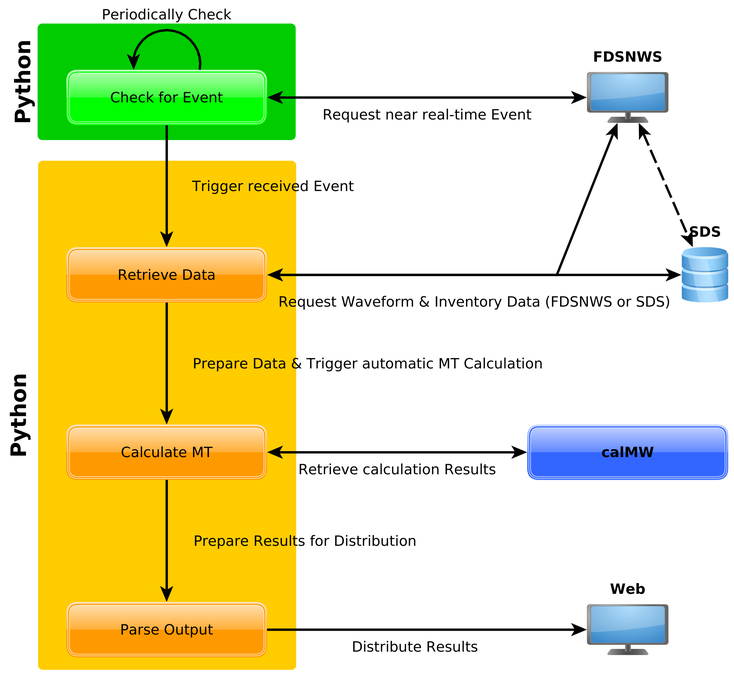
FDSNWS_2_FMNEAR

Our Python open-source software:

1. At first, *(green box)* periodically requests new near real-time seismic events based on specified configurable thresholds (e.g. time window, magnitude etc.) via the *FDSNWS-event* service. Subsequently, it feeds the second part of the program *(orange box)* with the information of the respective seismic events in a sequential order.

2. Consequently *(orange box)*, it triggers the automatic MT calculation for the specific seismic events. It successively *(a)* retrieves the respective seismic waveforms with their mutual stations' metadata, *(b)* prepares the waveform data for processing, *(c)* triggers the automatic MT calculation, and finally *(d)* prepares and distributes the results.

Process Flow Diagram



Real-time Operational Use at NOA

Automatic Moment Tensors

Automatic Estimation of Mw Magnitude and Moment Tensor

For methodology and further information on FMNEAR click [1] and [2]

2019 - 2018 - 2017 - 2016 - 2015 - 2014 - 2013

Event ID	Auto Origin Time	Latitude	Longitude	MwNear			FmNear								Images	
				Mw	NoStat	Error(+/-)	Mw	NoComp	Strike	Dip	Rake	RMS	Depth	Conf(%)	Focal Mechanism	Map	Complete Result
noa2019encqm	2019/03/06 01:54:45	38.3643	22.0166	4.5	20	0.25	3.9	26	315	45	-54	0.7	8	75	strike dip rake 315. 45. -54.		
noa2019eewgk	2019/03/01 13:37:14	38.7744	26.0303	4.4	14	0.25	3.8	19	70	60	-140	0.6	10	79	strike dip rake 70. 60. -141.		
noa2019ednrn	2019/02/28 20:09:27	37.6318	20.9326	4.8	24	0.09	4.6	53	140	65	82	0.6	6	79	strike dip rake 140. 65. 82.		
noa2019dzcso	2019/02/26 10:05:58	38.8623	20.6689	4.5	10	0.24	4.2	12	110	60	15	0.3	5	82	strike dip rake 110. 60. 15.		
noa2019doxyj	2019/02/20 20:20:36	37.5732	20.8154	4.0	14	0.11	3.7	37	50	60	-124	0.8	3	75	strike dip rake 50. 60. -124.		
															strike dip rake 85. 60. -134.		

The *FDSNWS_2_FMNEAR* software, operating at the National Observatory of Athens (NOA).

Future Research

- Select only good quality waveform data based on *EIDA WFCatalog* service, quality metrics or ambient noise analysis.
- Reprocess the MT calculations after updates on seismic event information.
- Integrate the *FDSNWS* to the *scisola* [5] open-source python based software for real-time automatic MT computation of events provided by *SeisComP3*.

References

[1] Bertrand Delouis, Jean Charlety, and Martin Vallée. A method for rapid determination of moment magnitude m w for moderate to large earthquakes from the near-field spectra of strong-motion records (mwsynth). *Bull. Seismol. Soc. Am.*, 99(3):1827–1840, 2009.

[2] Bertrand Delouis. Fmnear: Determination of focal mechanism and first estimate of rupture directivity using near-source records and a linear distribution of point sources. *Bull. Seismol. Soc. Am.*, 104(3):1479–1500, 2014.

[3] Timothy K Ahern. The fdsn and iris data management system: Providing easy access to terabytes of information. In *International Geophysics*, volume 81, pages 1645–1655. Elsevier, 2003.

[4] Moritz Beyreuther, Robert Barsch, Lion Krischer, Tobias Megies, Yannik Behr, and Joachim Wassermann. Obspy: A python toolbox for seismology. *Seismol. Res. Lett.*, 81(3):530–533, 2010.

[5] Nikolaos Triantafyllis, Efthimios Sokos, Aristidis Ilias, and Jiří Zahradník. Scisola: automatic moment tensor solution for seiscomp3. *Seismol. Res. Lett.*, 87(1):157–163, 2015.

More Information

- **GitHub:** github.com/nikosT/FDSNWS_2_FMNEAR
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