

FakeQuakes Installation Instructions

*Note: FakeQuakes can only be run on a Mac or Linux machine

Setup Python Environment

The following dependencies are required to run FakeQuakes:

Obspy `$ conda install -c conda-forge obspy`

Pyproj `$ conda install -c conda-forge pyproj`

UTM `$ conda install -c conda-forge utm`

mpi4py `$ conda install -c anaconda mpi4py`

GCC and **GFortran**

- If you are using a Mac, you can just install **Xcode Developer Tools** (Apple app store)
- If you are on a Linux machine: `$ sudo apt install build-essential` `$ sudo apt-get install gfortran`

Download Tutorial

The Jupyter notebook and data for this tutorial are stored in a git repository. Clone this repository somewhere on your machine:

```
$ git clone https://github.com/taranye96/FakeQuakes_tutorial.git
```

Install MudPy

1. Clone MudPy repository

```
$ git clone https://github.com/dmelgarm/MudPy.git
```

2. Build the fk Green's function code

- Inside MudPy/src/fk/ run:

```
$ make clean
```

```
$ make all
```

3. Set paths (.bash_profile or .bashrc script)

- Add the Mudpy src/fk folder to your PATH variable

i.e. in my .bash_profile script I have

```
export PATH=/path/to/MudPy/src/fk:$PATH
```

- Add the Mudpy src/python folder to your PYTHONPATH

i.e. in my .bash_profile script I have

```
export PYTHONPATH=/path/to/MudPy/src/python:$PYTHONPATH
```

- Define the MUD environment variable

i.e. in my .bash_profile script I have

```
export MUD=/path/to/MudPy
```

4. Verify everything worked

Type the following into the terminal and a help screen should appear:

```
$ fk.pl
```

```
$ syn
```

```
Usage: fk.pl -Mmodel/depth[/f_or_k] [-D] [-Hf1/f2] [-Nnt/dt/smith/dk/taper] [-Ppmin/pmax[/kmax]] [-Rrdep] [-SsrcType] [-Uupdn]
[-Xcmd] distances ...
-M: model name and source depth in km. f triggers earth flattening (off), k indicates that the 3rd column is vp/vs ratio (vp).
model has the following format (in units of km, km/s, g/cm3):
  thickness vs vp_or_vp/vs [rho Qs Qp]
  rho=0.77 + 0.32*vp if not provided or the 4th column is larger than 20 (treated as Qs).
  Qs=500, Qp=2*Qs, if they are not specified.
  If the first layer thickness is zero, it represents the top elastic half-space.
  Otherwise, the top half-space is assumed to be vacuum and does not need to be specified.
  The last layer (i.e. the bottom half space) thickness should be always be zero.
-D: use degrees instead of km (off).
-H: apply a high-pass filter with a cosine transition zone between freq. f1 and f2 in Hz (0/0).
-N: nt is the number of points, must be 2^n (256).
  Note that nt=1 will compute static displacements (require st_fk compiled).
  nt=2 will compute static displacements using the dynamic solution.
  dt is the sampling interval (1 sec).
  smith makes the final sampling interval to be dt/smith, must be 2^n (1).
  dk is the non-dimensional sampling interval of wavenumber (0.2).
  taper applies a low-pass cosine filter at fc=(1-taper)*f_Niquest (0.3).
-P: specify the min. and max. slownesses in term of 1/vs_at_the_source (0/1)
  and optionally kmax at zero frequency in term of 1/hs (10).
-R: receiver depth (0).
-S: 0=explosion; 1=single force; 2=double couple (2).
-U: 1=down-going wave only; -1=up-going wave only (0).
-X: dump the input to cmd for debug (fk).
Examples
* To compute Green's functions up to 5 Hz with a duration of 51.2 s and at a dt of 0.1 s every 5 kms for a 15 km deep source i
n the HK model, use
fk.pl -Mhk/15/k -N512/0.1 05 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
* To compute static Green's functions for the same source, use
fk.pl -Mhk/15/k -N2 05 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 > st.out
or use
fk.pl -Mhk/15/k -N1 05 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 > st.out
* To compute Green's functions every 10 degrees for a 10 km deep source in the PREM model.
fk.pl -Mprem/10/f -D 10 20 30 40 50 60
Author: Lupei Zhu, 02/15/2005, SLU
```

Figure 1: fk.pl help screen

```

Usage: syn -Mmag([[Strike/Dip]/Rake])/Mxx/Mxy/Mxz/Myx/Myz/Mzz) -Aazimuth ([-SsrcFunctionName | -Ddura[/rise]] [-Ff1/f2[/n]] [-I | -J] -OoutName.z -GfirstCompOfGreen | -P)
Compute displacements in cm in the up, radial, and transverse (clockwise) directions produced by difference seismic sources
-M Specify source magnitude and orientation or moment-tensor
  For double-couple, mag is Mw, strike/dip/rake are in A&R convention
  For explosion; mag in in dyne-cm, no strike, dip, and rake needed
  For single-force source; mag is in dyne, only strike and dip are needed
  For moment-tensor; mag in dyne-cm, x=N,y=E,z=Down
-A Set station azimuth in degree measured from the North
-D Specify the source time function as a trapezoid,
  give the total duration and rise-time (0-0.5, default 0.5=triangle)
-F apply n-th order Butterworth band-pass filter, SAC lib required (off, n=4, must be < 10)
-G Give the name of the first component of the FK Green function
-I Integration once
-J Differentiate the synthetics
-O Output SAC file name
-P Compute static displacement, input Green functions from stdin in the form
  distance Z45 R45 T45 ZDD RDD TDD ZSS RSS TSS [distance ZEX REX TEX]
  The displacements will be output to stdout in the form of
  distance azimuth z r t
-Q Convolve a Futterman Q operator of tstar (no)
-S Specify the SAC file name of the source time function (its sum. must be 1)
Examples:
* To compute three-component velocity at N33.5E azimuth from a Mw 4.5
  earthquake (strike 355, dip 80, rake -70), use:
  syn -M4.5/355/80/-70 -D1 -A33.5 -OPAS.z -Ghk_15/50.grn.0
* To compute the static displacements from the same earthquake, use:
  nawk '$1==50' st.out | syn -M4.5/355/80/-70 -A33.5 -P
* To compute displacement from an explosion, use:
  syn -M3.3e20 -D1 -A33.5 -OPAS.z -Ghk_15/50.grn.a
  or
  syn -M3.3e20/1/0/0/1/0/1 -D1 -A33.5 -OPAS.z -Ghk_15/50.grn.0

```

Figure 2: syn help screen