FakeQuakes Installation Instructions

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

Setup Python Environment

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 following lines of code to the bottom of your .bash_profile or .bashrc script. They should be placed after *# <<< conda init <<<*.

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

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

   - Add the Mudpy src/python folder to your PYTHONPATH

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

   - 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/smth/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).
    smth makes the final sampling interval to be dt/smth, 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/Myy/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