Homework 4 (EAS 8803: OBS SEISMOLOGY - SPRING 2019)

Undergraduate Only Total points: 100. Due 04/09/2019

1. (Computer. Question 4.8 in Peter Shearer's book: Introduction to Seismology, second edition) Consider MARMOD, a velocity versus depth model, which is typical of much of the oceanic crust (Table 1.1 below). Linear velocity gradients are assumed to exist at intermediate depths in the model; for example, the *P* velocity at 3.75 km is 6.9 km/s. Write a computer program to trace rays through this model and produce a *P*-wave $T(X)$ curve, using 100 value so the ray parameter $p$ equally spaced between 0.1236 and 0.2217 s/km. You will find it help to use subroutine LAYERXT (provided in the following link), which gives $dx$ and $dt$ as a function of $p$ for layers with linear velocity gradients. Your program will involve an outer loop over ray parameter and an inner loop over depth in the model. For each ray, set $x$ and $t$ to zero and then, starting with the surface layer and to the turning point. Multiply by two to obtain the total surface-to-surface values of $X(p)$ and $T(p)$. Now produce plots of:
    a. $T(X)$ plotted with a reduction velocity of 8 km/s;
    b. $X(p)$, and
    c. $\tau(p)$.

    (50 points)

Table 1.1 MARMOD, a Generic Marine Seismic Model

| Depth (km) | $\alpha$ (km/s) | $\beta$ (km/s) | $\rho$ (g/cc) |
|---|---|---|---|
| 0.0 | 4.50 | 2.40 | 2.0 |
| 1.5 | 6.8 | 3.75 | 2.8 |
| 6.0 | 7.00 | 3.85 | 2.9 |
| 6.5 | 8.00 | 4.60 | 3.1 |
| 10.0 | 8.10 | 4.70 | 3.1 |

Electronic version of this table:
**http://geophysics.eas.gatech.edu/classes/ObsSeis/misc/hw4_table_11.txt**

Link:
Fortran version of LAYERXT:
**http://geophysics.eas.gatech.edu/classes/ObsSeis/misc/layerxt.f**
Matlab version of LAYERXT:
**http://geophysics.eas.gatech.edu/classes/ObsSeis/misc/layerxt.m**

2. (Computer. Modified from page 420 in the Stein and Wysession book) Given the set of equations in pages 418-419, please compute model evolutions, residuals and errors for iteration number with the following starting models (and velocity of 5 km/s). Please comment on the choices of starting numbers on the iterations (50 points).
    a. (x,y,z,t): (5 km, 5 km, 5 km, -5 s)
    b. (x,y,z,t): (20 km, 20 km, 20 km, -10 s)

**Invert for location and origin time**

model evolution

| parameter | actual value | model for iteration number |
|---|---|---|
| *x* | 0.0 | |
| *y* | 0.0 | |
| *z* | 10.0 | |
| origin time | 0.0 | |

| station location | | residual for iteration number |
|---|---|---|
| 35.0 | 9.0 | |
| −44.0 | 10.0 | |
| −11.0 | −25.0 | |
| 23.0 | −39.0 | |
| 42.0 | −27.0 | |
| −12.0 | 50.0 | |
| −45.0 | 16.0 | |
| 5.0 | −19.0 | |
| −1.0 | −11.0 | |
| 20.0 | 11.0 | |
| error | | |

Note:

1. Your code can be written in any scientific languages (e.g., Fortran, C, Matlab). Please make sure that the code can be compiled under standard Linux machine. Please submit your code electronically to zpeng@gatech.edu, and submit a write-up that includes all the figures and answers to all questions.

2. The MatSAC package can be downloaded from the following link:
   http://geophysics.eas.gatech.edu/people/zpeng/Teaching/SAC_Tutorial/MatSAC.tar.gz
   Use fget_sac to read the SAC binary format data into Matlab.
   Alternatively, you can use sacdump program to extract data from SAC into two column ASCII output.