1. Format description of the Input files

Inversion of an n-layer model (the n-layer is infinite half space) using the GMFinv requires three input files. In order to run the inversion program, you must configure these files in the following format, unless the program has been modified by the user.

1) input-data.txt

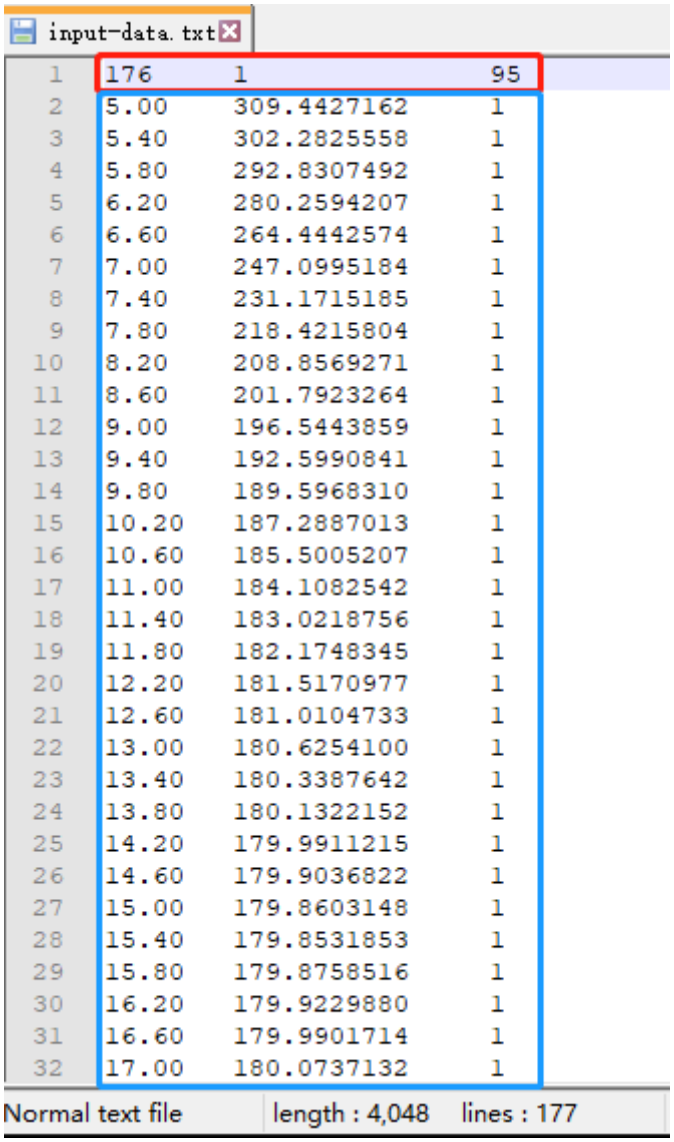

Figure 1

This file is a dispersion point data file. As shown in Figure 1, the file consists of two parts, the red box of file retrieval information and the blue box of dispersion information.

In the red box, the first value is N_L, which means that the file contains N_L dispersion points in the blue box. In Figure 1, N_L=176, and it shows that the file contains 177 lines. The second and third values are the starting and ending position indexes of the fundamental point in the N_L points respectively. In Figure 1, the second and third values are 1 and 95. It means that in the blue box, from top to

bottom, lines 1 to 95 are the fundamental points. At the same time, we require that the fundamental points should be sorted by frequency from low to high. If the second value is set to 0, the program will consider that there are no fundamental points in the file, that is, all the points in the file are nondiscriminable mode points. During the inversion, the program will call the GMF degenerated to DMF for inversion.

In the blue box, each row represents the data of a dispersion point, so in figure 1, there are 176 points in blue box. The first to third values from left to right in each row are the frequency (Hz), phase velocity (m/s), and weight (Dimensionless) of the point.

2) input-mods.txt

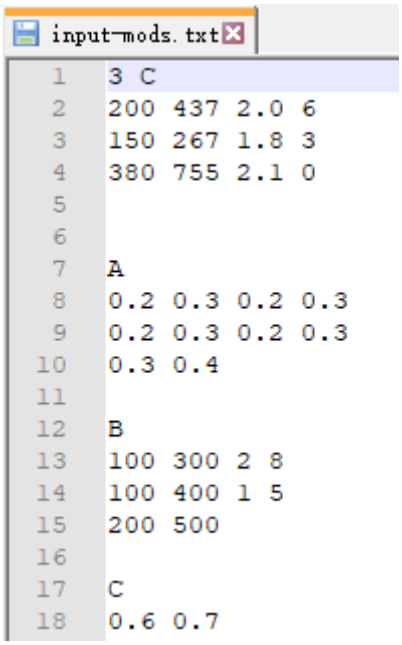

Figure 2

The first value in the first row is the number of layers of the initial model. In GMFinv, it must be greater than 1. The second value in the first row indicates the type of search range set according to the initial model. It must be A or B or C.

In figure 2, the number of layers of the initial model is 3. Therefore, the 3 lines immediately after the first line are the parameters of the initial model. The first to fourth columns from left to right are the S-wave velocity, P-wave velocity, density and layer thickness of each layer of the initial model. The last layer is an infinite half space, and its layer thickness is infinite. The inversion program does not invert the layer thickness, so it is set to 0. The international system of units is used as the parameters.

Since the inversion program only inverts layer thickness and S-wave velocity, the search range will consist of layer thickness and S-wave velocity. There are three types of search range, which are introduced below.

A. Given the deviation ratio. As shown in Figure 2, the three lines immediately after the letter "A" are the deviation ratios of the search range

of the S-wave velocity and the layer thickness of each layer of the three-layer model. Take the eighth line as an example, the first two values are the deviation ratios of the S-wave velocity of the first layer, which are 0.2 and 0.3 respectively, which means that the PSO algorithm will search for the S-wave velocity of the first layer in interval [200*(1-0.2), 200*(1+0.3)] m/s. Among them, 200 is the S-wave velocity of the first layer of the given initial model. The last two values are the deviation ratios of the first layer thickness, which are 0.2 and 0.3 respectively, which means that the PSO algorithm will search for the first layer thickness in interval [6*(1-0.2), 6*(1+0.3)] m. Among them, 6 is the first layer thickness of the given initial model.

The other layers can be deduced by analogy. For the last layer, since the layer thickness is not searched, its deviation ratio is not set

B. Given the value of the lower and upper bounds of the search range. Type B is similar to type A, but type B is more direct. It directly gives the boundary value of the search range. Taking the 13th line as an example, the first two values are the lower and upper bounds of the search range of the first layer S-wave velocity, which are 100 and 300 respectively, which means that the PSO algorithm will search for the S-wave velocity of the first layer in interval [100, 300] m/s. The last two values are the lower and upper bounds of the search range of the first layer thickness, which are 2 and 8 respectively, which means that the PSO algorithm will search for the first layer thickness in interval [2, 8] m.

C. A simple setting of search range deviation ratio. In type A and B, we need to set the S-wave velocity and layer thickness of each layer, which is very troublesome sometimes, so we designed type C. The meaning of the value in type C is similar to that in type A, but it only contains two values, as shown in the figure, which are 0.6 and 0.7, respectively. This means that for the S-wave velocity and thickness of all layers, the PSO will search for the S-wave velocity and layer thickness in interval [x*(1-0.6), x*(1+0.7)] m. Among them, x is the S-wave velocity or layer thickness of the given initial model.

In practice, we don't need to give all three types A, B and C in the “input-mods.txt” file. We just need to give one of them as needed, as shown in the figure 3 below.

input-mods.txt

```
1  3 C
2  200 437 2.0 6
3  150 267 1.8 3
4  380 755 2.1 0
5
6  C
7  0.6 0.7
8
9
```

Figure 3

3) input-pars.txt

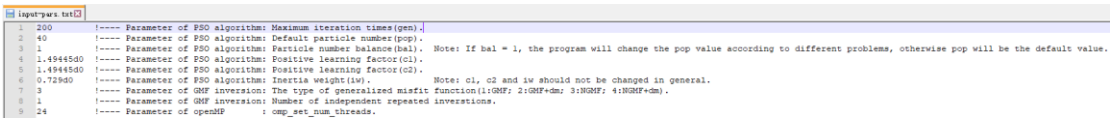

Figure 4

The meaning of each parameter is shown in figure 4. The picture may not be clear, so I set the text in the table 1 below.

Table 1

200	!---- Parameter of PSO algorithm: Maximum iteration times(gen).
40	!---- Parameter of PSO algorithm: Default particle number(pop).
1	!---- Parameter of PSO algorithm: Particle number balance(bal). Note: If bal = 1, the program will change the pop value according to different problems, otherwise pop will be the default value.
1.49445d0	!---- Parameter of PSO algorithm: Positive learning factor(c1).
1.49445d0	!---- Parameter of PSO algorithm: Positive learning factor(c2).
0.729d0	!---- Parameter of PSO algorithm: Inertia weight(iw). Note: c1, c2 and iw should not be changed in general.
3	!---- Parameter of GMF inversion: The type of generalized misfit function(1:GMF; 2:GMF+dm; 3:NGMF; 4:NGMF+dm).
1	!---- Parameter of GMF inversion: Number of independent repeated inverstions.
24	!---- Parameter of openMP : omp_set_num_threads.

2. Format description of the Output files

Inversion of an n-layer model using the GMFinv will output three files (the n-layer is infinite half space):

1) out_profile.inv

This is the S-wave velocity profile file of the inversion result. The file contains one row of data. The first value is the sequence number of the inversion result, and the second value is the misfit value of the inversion result. The values from the 3rd to n+1 are the layer thicknesses of each layer, and the n+2 to the last are the S-wave velocities of each layer.

2) out_finalmodel.inv

This file is the final model file of inversion results (when cyc > 1, the file is empty). This file contains four columns of data, from left to right: S-wave velocity, P-wave velocity, density and layer thickness. The number of rows is the number of model layers n.

3) out_iteration.inv

This file contains inversion iteration process and other information (when cyc > 1, the file is empty). The first column of this file is the iteration number, the second column is the sequence number of the optimal individual in the PSO, the third column is the misfit value of the optimal individual corresponding to the the iteration number, and the fourth column to the last column is the S-wave velocity profile of the optimal individual (the meaning of the S-wave velocity profile is consistent with the "out_profile.inv" file).