GEOP 415
Spring 2010
Programming Project A
Wavelet Estimation by Wavelet Matching

(Due date: 7/6/2010)

Introduction

- The objective of this project is to write a program that estimates the source wavelet from the data by searching for the Ricker wavelet that produces the best fit between synthetic and actual traces.
- The grade of this project will be equivalent to 10% of the total course grade. The project grade will be extra credit used to offset the course grade. The 10% will be distributed as follows:
  - 5% on the program.
  - 5% on the presentation.

Background

The wavelet will be estimated using the wavelet matching method. The idea can be summarized in the following steps:

1. Generate Ricker wavelets R(t) using all possible f_D values.
2. Convolve each wavelet with the given earth reflectivity e(t) from the well to generate synthetic traces s(t).
3. Compare synthetic traces with the given actual trace sa(t) by calculating the sum of squared error (SSE) between the two.
4. The synthetic trace that gives the lowest SSE corresponds to the best estimated Ricker wavelet.

Input

- Actual seismic trace sa(t) in text column format (plotted in Figure 1). The time sampling interval is Δt = 4 ms and there are M = 1,001 samples in the trace. The filename is Trace.txt.
- Earth reflectivity e(t) in text column format (plotted in Figure 2). The time sampling interval is Δt = 4 ms and there are M = 1,001 samples in the trace. The filename is e.txt.
- The Ricker wavelet is given by:

$$R(t) = (1 - 2\pi^2 f_D^2 t^2) e^{-\pi^2 f_D^2 t^2}$$

where f_D is the wavelet dominant frequency.

Exercises

You are charged of the following tasks.

(a) Writing a program that:
   (1) Reads and plots the input files above.
   (2) Performs the steps mentioned in the Background above.
   (3) Outputs the following plots:
      a. The best estimated Ricker wavelet indicating its f_D value.
      b. Best synthetic trace indicating its corresponding SSE value.
      c. SSE versus f_D of all attempted Ricker wavelets.

(b) Give a presentation in which you will present:
   (1) Summary of the project's objectives, background, and software description.
   (2) Results.
   (3) Comments on the limitations of the program.
   (4) Answers to the questions below.
   (5) Plots of all inputs, intermediates, and outputs.

Questions

1. What is your approach for selecting the length of the wavelet? Why?
2. What is your minimum, maximum, and increment f_D values? Why?
3. Did you have to worry about the amplitudes of the attempted R(t)? Why?
4. What are the possible sources of errors?
5. Suggest ways to reduce this error.

Figure 1: Trace s(t) with additive random noise

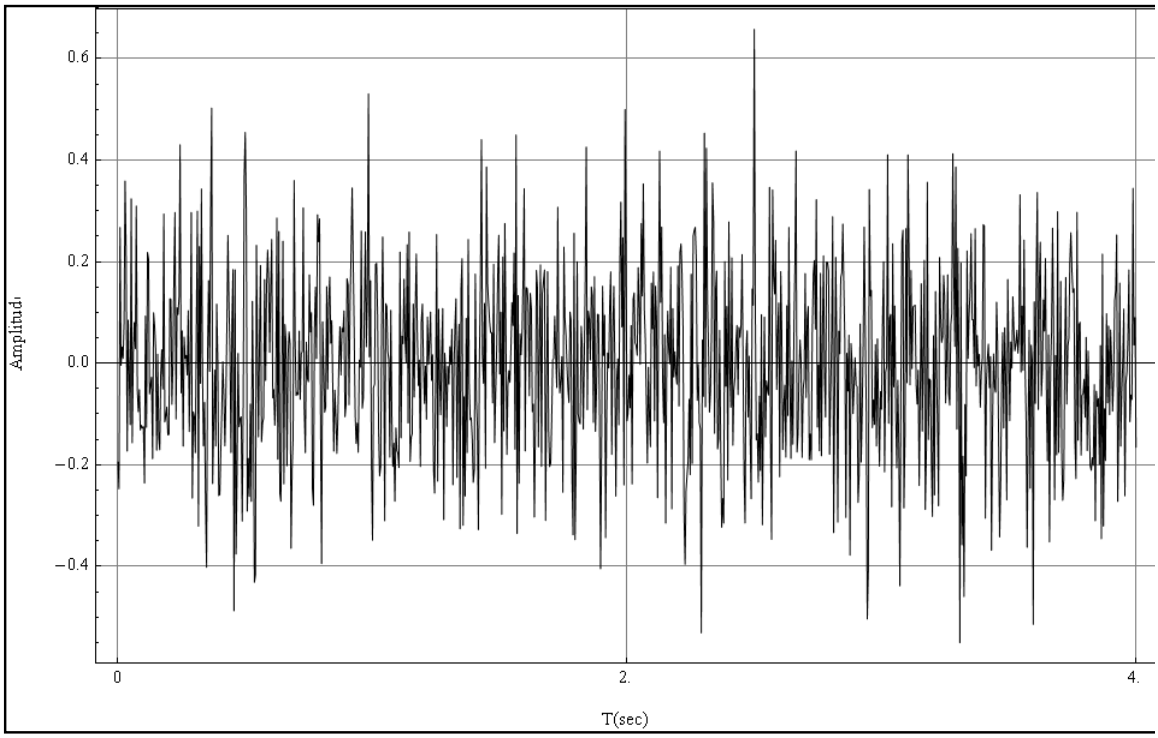

Figure 2: Reflectivity e(t) with no additive random noise