One of the most useful tools in both survey design as well as seismic interpretation is seismic modeling. There are several algorithmic approaches to modeling, everything from simple 1-D convolution to 2 ray tracing to full elastic 3D wave equation synthetics.

The following exercises are designed to introduce you to 1D and 2D modeling using the commercial software GXII.

1. 1-D: Compute synthetic seismic sections (zero offset, single fold) corresponding to the of the geologic model in Fig 3.8 on page 83 of Sheriff and Geldart using Ricker wavelets with dominant frequencies of:
   a) 15 hz
   b) 75 hz

Do not include multiples, but include spherical divergence and anelastic attenuation. Assume 10 single geophones spaced 10 m apart.

2. Repeat 1, but this time include the multiples mentioned in 3.8a.

3. A common tool for evaluating vertical resolution is the “Widess wedge”. Consider a geologic model (width = 500 m) consisting of two layers. Layer I is 5000 m thick and consists of material with a P velocity of 2500 m/s and density of 2.0 gr/cm$^3$. Layer II is underlain by a dipping interface that intersects Layer I at the right hand side of the model, and has a maximum thickness of 50 m at the left hand side of the model. The material within Layer II also has a velocity of 2500 m/s but a density of 2.5 gr/cm$^3$. The material beneath Layer II has a $V_p = 2000$m/sec and a density of 2.5 gr/cc. Compute and plot a raypath diagram and synthetic seismic sections (again, zero offset, one fold, no multiples) with a trace spacing of 200 m for this model using
a) a Ricker wavelet of dominant frequency = 25 hz

b) a Ricker wavelet of dominant frequency = 50 hz, and

c) a Klauder wavelet corresponding to a vibroseis sweep from 10 to 90 hz

In each case, plot the amplitude of the reflection from Layer I as a function of wedge thickness. For what thickness is the amplitude a maximum? How does this thickness compare with the wavelength of the seismic wave in the wedge?

4. (2D) Repeat 3b assuming that the velocity in layer I is

   a) 1000 m/sec
   b) 4000 m/sec

How do the raypaths compare for these models and that in problem 3? How much difference does this make to the resulting synthetic seismic section.
5. (2D) Compute a synthetic seismic section (zero offset, one fold) for the following geologic model using a 50 hz Ricker wavelet:

![Geologic Model Diagram]

- $v = 4$ km/s, $\rho = 2.0$ g/cc
- $v = 5$ km/s, $\rho = 2.5$ g/cc
- $v = 6$ km/s, $\rho = 2.5$ g/cc

6. (2D) Compute and plot raypaths and corresponding seismic traces for a shot gather for the model in problem 5 using a 50 hz Ricker wavelet. Assume the source is located at $x = 8$, and that single geophones record the shot every 200 m between $x = 0$ and $x = 7.8$ km. Do not include multiples or anelastic attenuation.