Using the BPNN as a general feature detector

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Introduction
In earthquake seismology and exploration seismology, a major step is often the detection of characteristic features from the seismic traces as a basis for further interpretation and analysis. These features may be the first break, wavelet shape, polarization direction, attenuation, and other attributes. Detecting these involves intensive pattern recognition. The back-propagation neural network (BPNN) (Rumelhart, Hinton and Williams, 1986) has been shown to provide an improved performance over conventional techniques for such tasks and widespread general applications. Here, the BPNN is used as a general feature detector to detect residual moveout.

The approach
In our previous work (Dai and MacBeth, 1995, 1997), a three-layered BPNN was used to pick arrival time from seismic traces. In this approach, the trained BPNN was applied as a filter by sliding a window along the entire seismic trace. The outputs yield a time series which is then interrogated, and a decision made regarding the attribute sorts. The value of this output time series is the similarity between the test and training segments. In the approach, a high threshold applied to the output time series was used to detect the P- and S-arrivals from the seismic trace. However, some small peaks in the time series hinted at smaller scale, but significant changes in charters along seismic trace. In Figure 1, for example, two high peaks correspond to the P- and S-arrivals, but these low magnitude peaks are obviously corresponded to some weak arrivals. The local maximum of the peaks of the BPNN output made it easy to locate the arrival onset times. Note that this BPNN only trained with P-arrival samples, this is an encouraging result. This show a potential application using the BPNN as a general feature detector.

Application
We can apply this approach to detect the residual moveout and corresponding amplitude from CDP gathers for AVO analysis (Li, 1997, MacBeth et al, 1997). Figure 2 shows an example. Here, it is difficult to automatically pick the moveout and amplitude (shaded curves) due to variations in waveforms. However, applying the above approach, we use the samples with large amplitudes in the near-offset traces to train the BPNN. The trained BPNN is applied to all traces in the section, and it can then pick those weaker waves in the far offset traces. The peaks of the BPNN output locate the residual moveout and the corresponding amplitudes.

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References


**Figure 1:** An example of using BPNN to detect arrival times. M(t) is the vector modulus of 3-C recording of a local earthquake, N(t) the trained BPNN output. The horizontal dashed line is the threshold for detecting the P- and S-waves. Two solid lines exactly indicate the P- and S-arrivals on set times. Other dashed lines indicate the onset times of other weak arrivals.

**Figure 2:** An example showing the method to pick the residual moveout and amplitude. Shaded curves on the Bottom chalk are picked interactively. Training samples are selected from the near offset traces in the CDP gather 420. The trained BPNN locates the weak arrival for both CDP gather.