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The analysis of transient signals and stationary noise

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It is often the case that statistical techniques designed for stationary processes are applied to non-stationary data for want of a better alternative. In this thesis the situation is considered where the data are of the form of a transient signal observed with additive stationary noise. This covers many types of data but the main problem considered here is that where a signal is received at an array of sensors.

A brief coverage of some relevant theory for stationary processes is given in Chapter 1, together with a description of some earlier work on the statistical treatment of transients. Chapter 2 contains a discussion of frequency domain models which are used for estimating the velocity and direction of a signal received at an array. Some methods of estimation in common use are considered.

In Chapter 3 the methods to be used for transient signals are explained. Estimators of the signal velocity and similar parameters are found both when the estimation is performed using a single narrow band of frequencies and when a broad band is used. In the former case, approximate confidence intervals are derived in Chapter 3, whilst in the latter case strong consistency and asymptotic normality of the parameter estimates are proved in Chapter 4. The methods are illustrated on some earthquake data in Chapter 5, which also contains simulations to test the adequacy of the asymptotic theory.

In Chapter 6 a strong law of large numbers and a central limit theorem are proved for a class of statistics obtained from stationary processes.

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This class includes an estimate of the prediction variance and several statistics which are used in tests of fit and which are derived from this estimate. As a consequence it is shown that these tests may be applied to stationary noise when a transient is superimposed, without first estimating the transient.

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