Time Series Analysis Basics

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Abstract: Abstract...

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1 Introduction to Time Series

A time series is simply a collection of data where each element in the dataset has a corresponding time associated with it.

A *statistically stationary* time series is a

1.1 Random Walks

A *random walk* is a state process $\{x_k\}$ satisfying

$$x_k = x_{k-1} + \omega_k, \tag{1.1}$$

where $\{\omega_k\}$ are iid Gaussian $\mathcal{N}(0, 1)$ and constitute a discrete white noise time series.

1.1.1 Autoregressive Models

An *autoregressive model* is a model consisting of a dependent variable that is dependent on one or more of previous values of itself. In particular, an autoregressive model of order p, denoted $AR(p)$, is defined by the equation

$$X_t = c + \sum_{i=1}^{p} \phi_i X_{t-i} + \omega_t, \tag{1.2}$$

where $\phi_1, \dots, \phi_p$ are the parameters of the model, c is a constant, and ω_t is white noise.

2 Moving Average Models

A *moving-average model* is very similar to an autoregressive model, but, instead of the process being dependent on only previous values of itself, it is also dependent on a linear combination of past values of the white noise. In particular, we have

$$x_t = \omega_t + \beta_1 \omega_{t-1} + \dots \beta_p \omega_{t-p}. \tag{2.1}$$

3 Autoregressive Moving Average Models

$$
\begin{aligned}
x_t &= \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \cdots + \omega_t + \beta_1 \omega_{t-1} + \beta_2 \omega_{t-2} \ldots \beta_q \omega_{t-q} \\
&= \sum_{i=1}^{p} \alpha_i x_{t-i} + \omega_t + \sum_{i=1}^{q} \beta_i \omega_{t-i} \qquad (3.1)
\end{aligned}
$$