# Linear Time Series Analysis and Its Applications - Part 2

## Contents



## 1 Introduction: Different Types of Non-Stationary Models

### 1.1 Random walk

$$Y_t = Y_{t-1} + \epsilon_t$$

#### 1.1.1 Random walk process: Mean

$$E(Y_t) = E(Y_{t-1} + \epsilon_t)$$

- non-mean-reverting process: move away from the mean either in a positive or negative direction.

#### 1.1.2 Random walk process: Variance

- the variance evolves over time and goes to infinity as time goes to infinity;

#### 1.1.3 Simulation

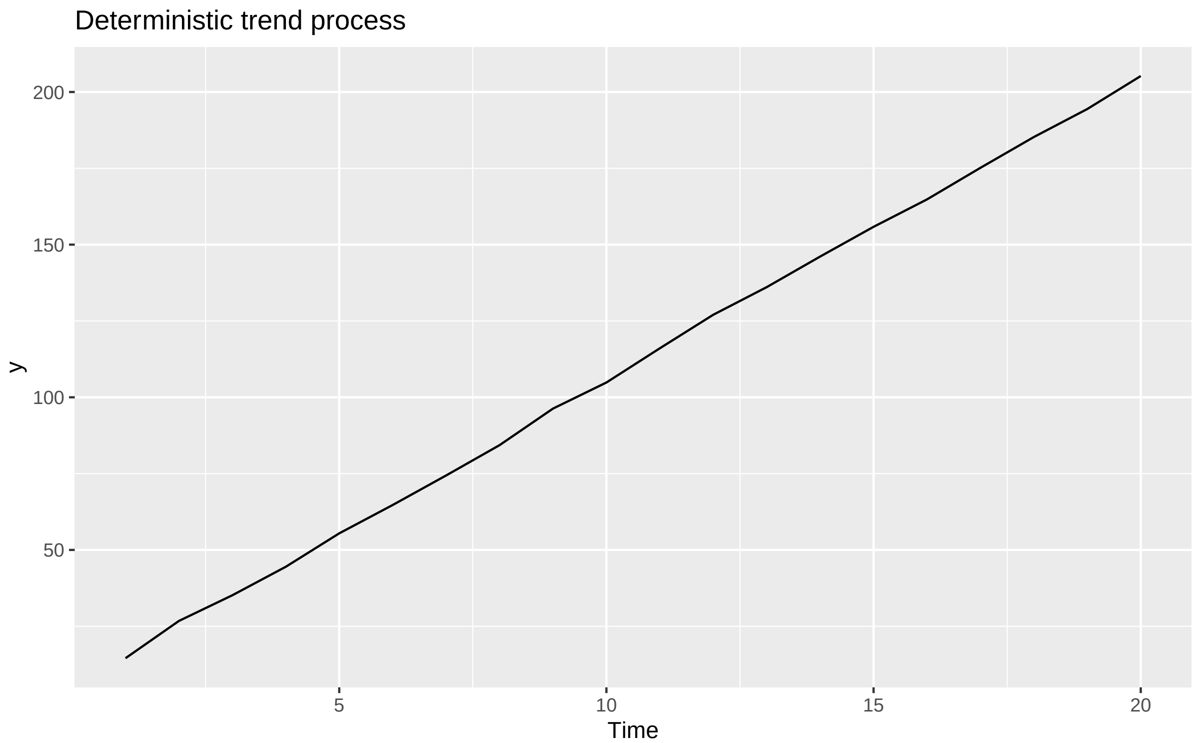
### 1.2 Random walk with drift

#### 1.2.1 Simulation

### 1.3 Deterministic trend

#### 1.3.1 Simulation

```
library(forecast)
t <- 1:20
y <- 5 + 10*t + rnorm(20)
y <- as.ts(y)
autoplot(y)+ggtitle("Deterministic trend process")
```




### 1.4 Random walk with drift and deterministic trend

## 2 How to convert a nonstationary series to a stationary time series?

### 2.1 Difference stationary

A random walk with or without a drift can be transformed to a stationary process by differencing (subtracting $Y_{t-1}$ from $Y_t$, taking the difference $Y_t - Y_{t-1}$).

Let, $X_t$ be the difference series of a random walk process. Then,

$$X_t = Y_t - Y_{t-1} = \epsilon_t.$$

We can see $X_t$ is equal to a white noise process.

Similarly, the difference series of a random walk with drift process is

$$X_t = Y_t - Y_{t-1} = \alpha + \epsilon_t,$$

where $\alpha$ is a constant. Further for

## 2.2 Trend stationary process

## 2.3 Unit root tests