Time Series Analysis

Lecture 4

Mixed Autoregressive Moving Average (ARMA) Models

Autoregressive Integrated Moving Average (ARIMA) Models

Seasonal ARIMA (SARIMA) Models

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Random Walk Process

Random Walk Process: Introduction

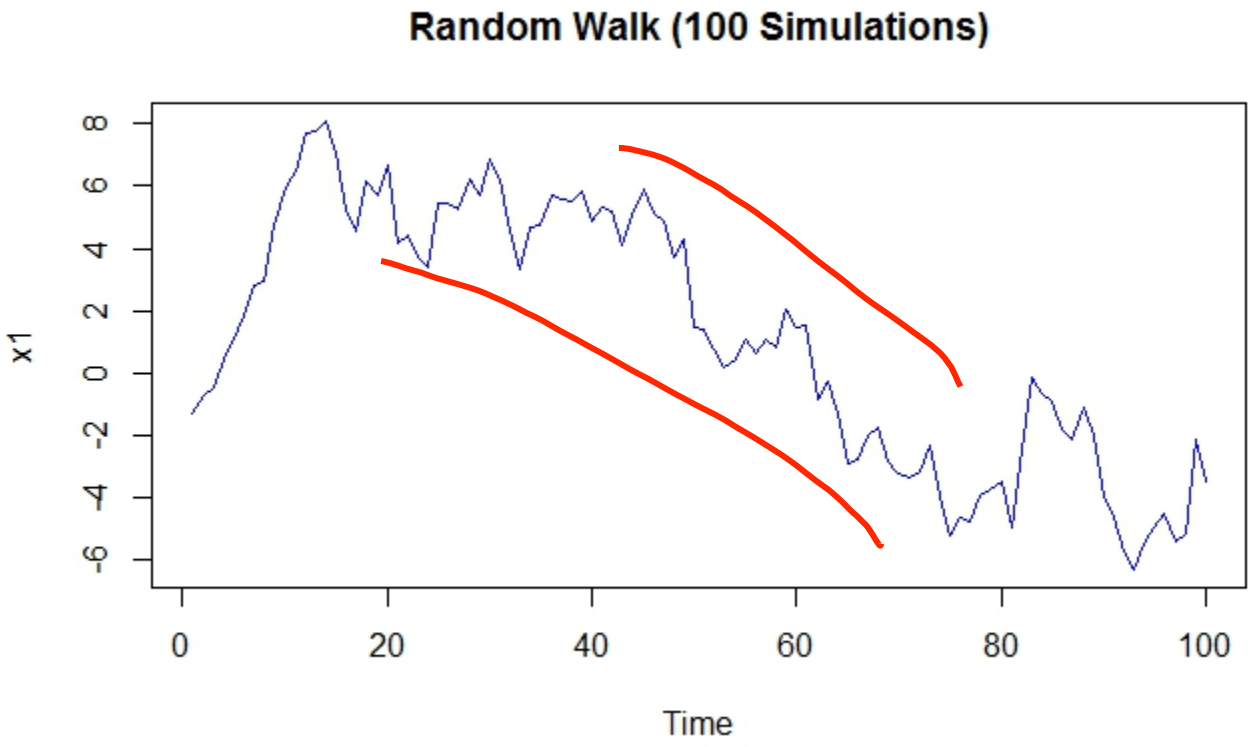
Random walk is nothing more than an AR(1) process with the AR parameter being 1:

$$y_t = \phi_1 y_{t-1} + \epsilon_t$$
$$\epsilon_t \sim WN(0, \sigma^2)$$

- As mentioned a few lectures ago, random walk is a very important process. It forms the foundation of many important processes in continuous-time finance.
- Note that a random walk does not revert back to any constant level. In particular, it is not a mean-reversion process.
- It wanders up and down with no tendency to settle at any particular level.
- Although random walk is ill-behaved (in that it is not covariance stationary), its first difference becomes a stationary white noise.

A Simulated Random Walk Series

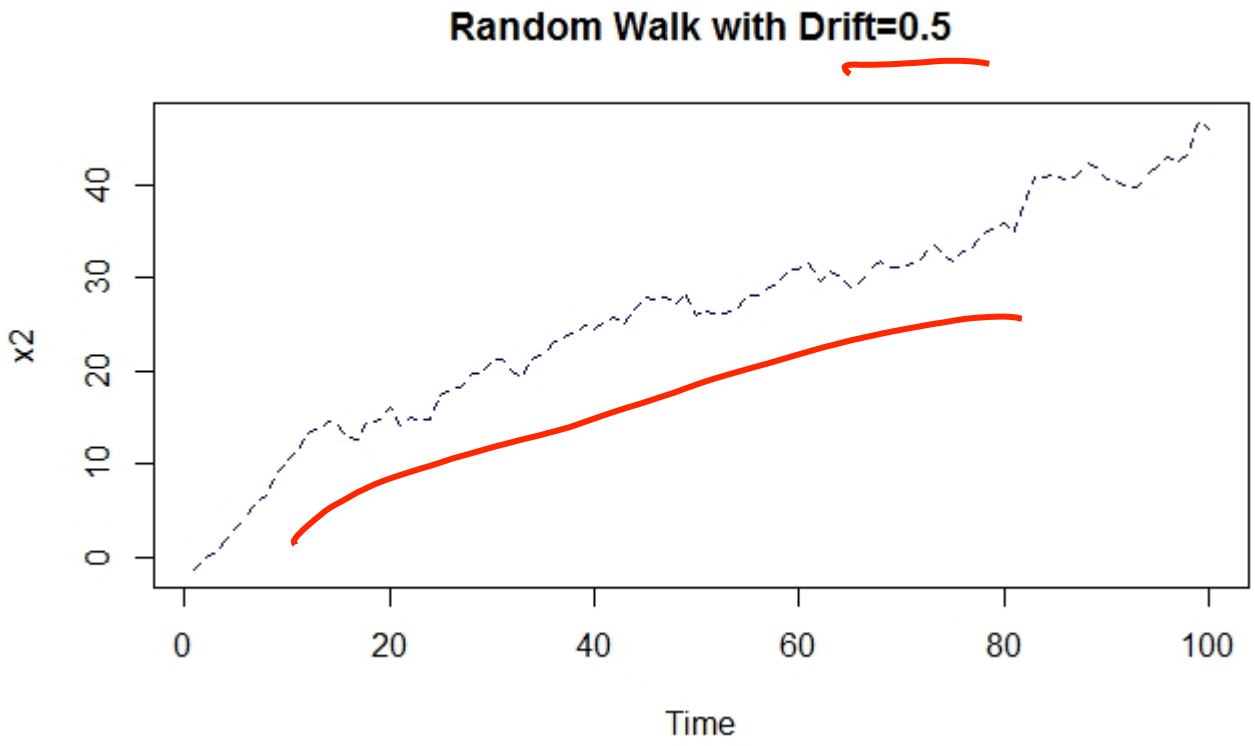
$$y_t = \phi_1 y_{t-1} + \epsilon_t$$
$$\epsilon_t \sim WN(0, \sigma^2)$$



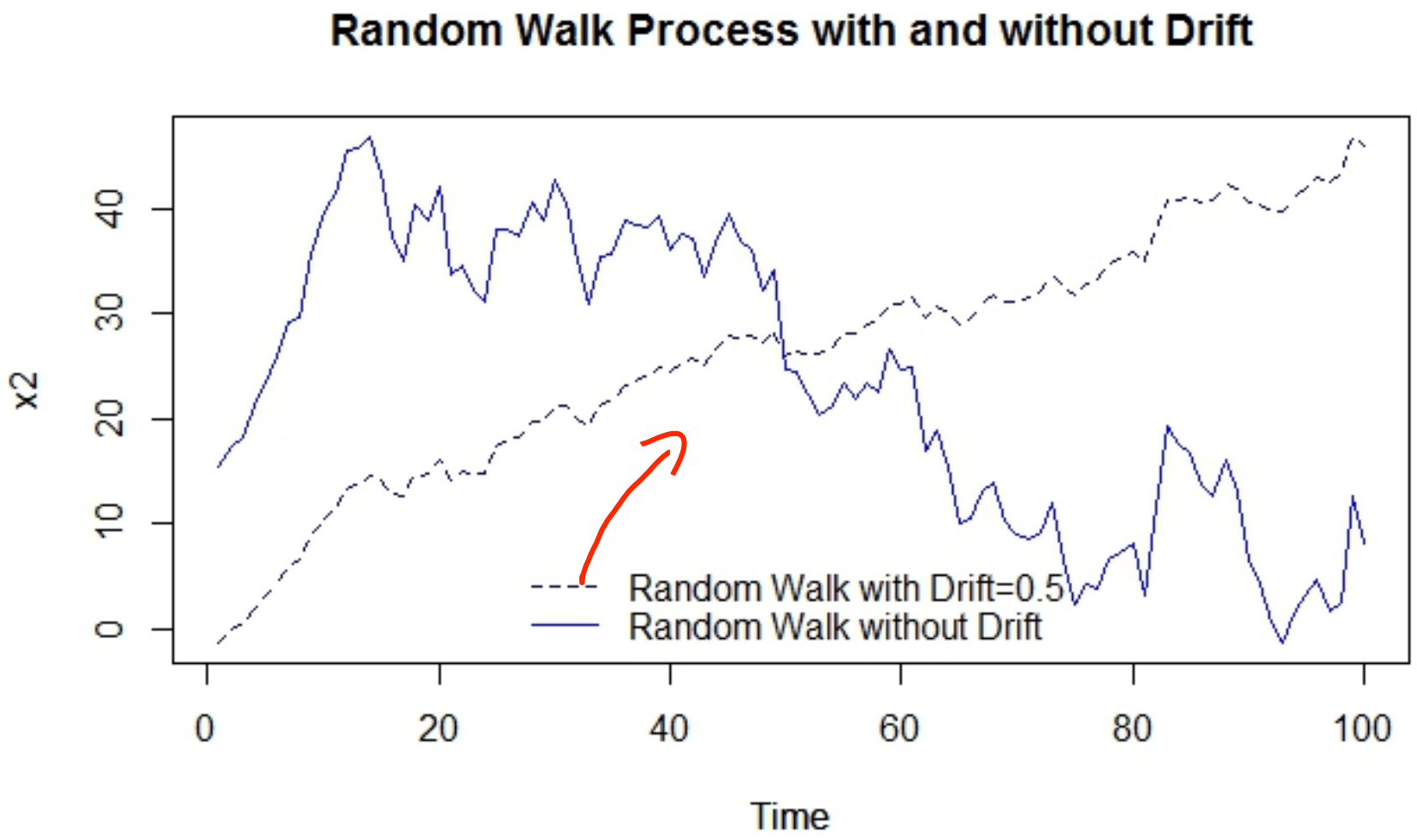
Random Walk With Drift Process

- Random walk with drift is essentially a model of trend.
- On average, the process "grows" by the drift in each period.

$$y_t = \delta + y_{t-1} + \epsilon_t$$
$$\epsilon_t \sim WN(0, \sigma^2)$$



Random Walk With Drift Process



Random Walk Process

- In fact, the drift parameter plays the same role as the slope parameter in deterministic linear trend models.
- On average, the process "grows" by the drift in each period.
- The random walk with drift is also called a model of **stochastic trend**, as its trend is driven by stochastic shocks.
- The most distinctive feature of random walk is that shocks affect the series permanently: If a shock lowers the value of the series, the random walk has no tendency to rise again, and it would stay lower permanently (until a new shock comes).
- That is, a unit shock moves the expected future path of the series by one unit!

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