Outliers in Time Series

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Outlier Models

- ARIMA(p, d, q) process

$$X_t = \frac{\theta(B)}{\alpha(B)\phi(B)} Z_t$$

- Roots of $\theta(B), \phi(B)$ outside unit circle
- $\alpha(B) = (1 - B)^d$
- $Z_t \sim_{iid}$ Normal$(0, \sigma^2)$

Outlier Models

- Observed series

$$X_t^* = X_t + \text{ outlier effect}$$

- Four models for outlier effect:
  - Additive outlier (AO)
  - Level shift (LS)
  - Temporary change (TC)
  - Innovational outlier (IO)