



# Adventures in Bayesian Structural Time Series

## *Part 1: Introduction*

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## ⊠ Structural time series



- ⊠ Structural time series
- ⊠ Bayesian approach to structural time series



- ⊠ Structural time series
- ⊠ Bayesian approach to structural time series
- ⊠ Implementation via `bsts` in R





## ⊠ Predicting the Present with Bayesian Structural Time Series



- ❖ Predicting the Present with Bayesian Structural Time Series
- ❖ An Introduction to State Space Time Series Analysis



- ⊠ Predicting the Present with Bayesian Structural Time Series
- ⊠ An Introduction to State Space Time Series Analysis
- ⊠ Time Series Analysis By State Space Methods





- ⊠ Predicting the Present with Bayesian Structural Time Series
- ⊠ An Introduction to State Space Time Series Analysis
- ⊠ Time Series Analysis By State Space Methods
- ⊠ **bsts** documentation



## Useful Resources

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- ⊠ Predicting the Present with Bayesian Structural Time Series
- ⊠ An Introduction to State Space Time Series Analysis
- ⊠ Time Series Analysis By State Space Methods
- ⊠ **bsts** documentation
- ⊠ Adventures in BSTS GitHub



⊗ Stochastic process indexed by time



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$$\otimes \{X_t, t \in \mathbb{T}\}$$



# Time Series Review

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$$\otimes E[X_t] = \mu$$

$$\otimes \text{Cov}(X_t, X_{t+k}) = \gamma(k)$$

⊠ Not i.i.d.



## AR(1)




$$X_t = \phi X_{t-1} + e_t$$



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  $|\phi| < 1$



Simulated AR(1)





## MA(1)




$$X_t = \theta e_{t-1} + e_t$$



## MA(1)



$$X_t = \theta e_{t-1} + e_t$$

  $e_t$  i.i.d.  $(0, \sigma^2)$



Simulated MA(1)







## ARMA(p,q)



$$\phi(B)X_t = \theta(B)e_t$$



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$$\phi(B)X_t = \theta(B)e_t$$

$$\otimes \phi(B)X_t = X_t - \phi_1 X_{t-1} - \cdots - \phi_p X_{t-p}$$



## ARMA(p,q)



$$\phi(B)X_t = \theta(B)e_t$$

$$\phi(B)X_t = X_t - \phi_1X_{t-1} - \cdots - \phi_pX_{t-p}$$

$$\theta(B)e_t = e_t + \theta_1e_{t-1} + \cdots + \theta_qe_{t-q}$$



Your quest...