CSSS/POLS 512 - Time Series and Panel Data Methods

Lab 3: Modeling Stationary Time Series

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Preview

- Estimating and interpreting ARMA models.
- Model selection
  - In-sample fit
  - Out-of-sample fit via CV
- Prediction and Visualization

Maximum Likelihood Estimaiton

1. Express the joint probability of the data using the chosen probability distribution (i.e. the likelihood of data given parameters)
2. Take a logarithm and transform the product of probabilities to the sum of log-probabilities (because $\sum$ is easier for optimization than $\prod$)
3. Substitute the linear predictor $\mu = X\beta$ (sometimes we call it "systematic component")

MLE-ARMA

$$\mathcal{L}(\beta, \phi_1 | \boldsymbol{y}, \boldsymbol{X}) = -\frac{1}{2}\log\left(\frac{\sigma^2}{1-\phi_1^2}\right) - \frac{\left(y_1 - \frac{\boldsymbol{x_1}\beta}{1-\phi_1}\right)^2}{\frac{2\sigma^2}{1-\phi_1^2}} - \frac{T-1}{2}\log\sigma^2 - \sum_{T=2}^{T}\frac{(y_t - \boldsymbol{x_t}\beta - \phi_1 y_{t-1})^2}{2\sigma^2}$$

Model selection

- In-sample fit: AIC, MSE, RMSE, and MAE.
- Cross-validation:
  - Expanding Window CV
  - Rolling Window CV.

Cross-validation

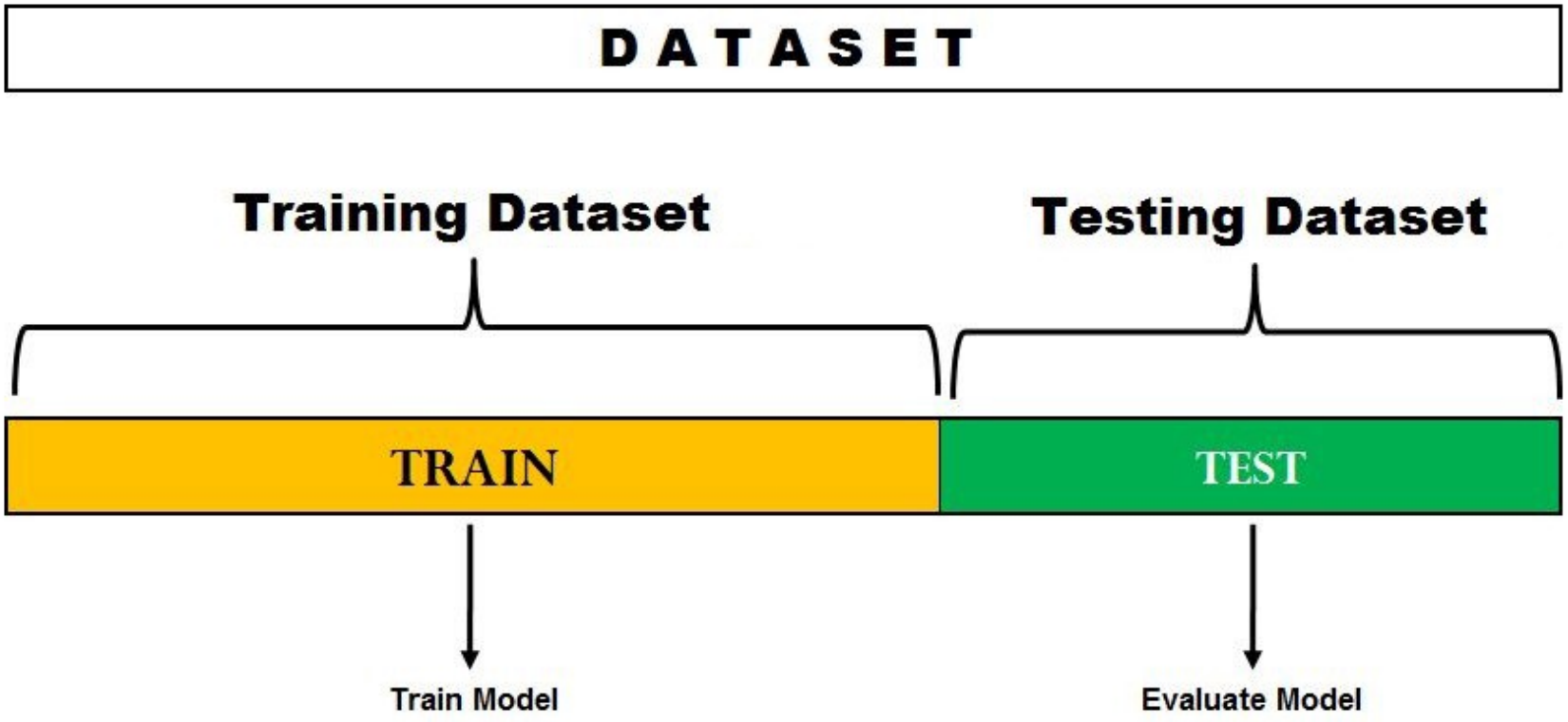


Figure 1: Hold Out Cross-Validation

Cross-validation

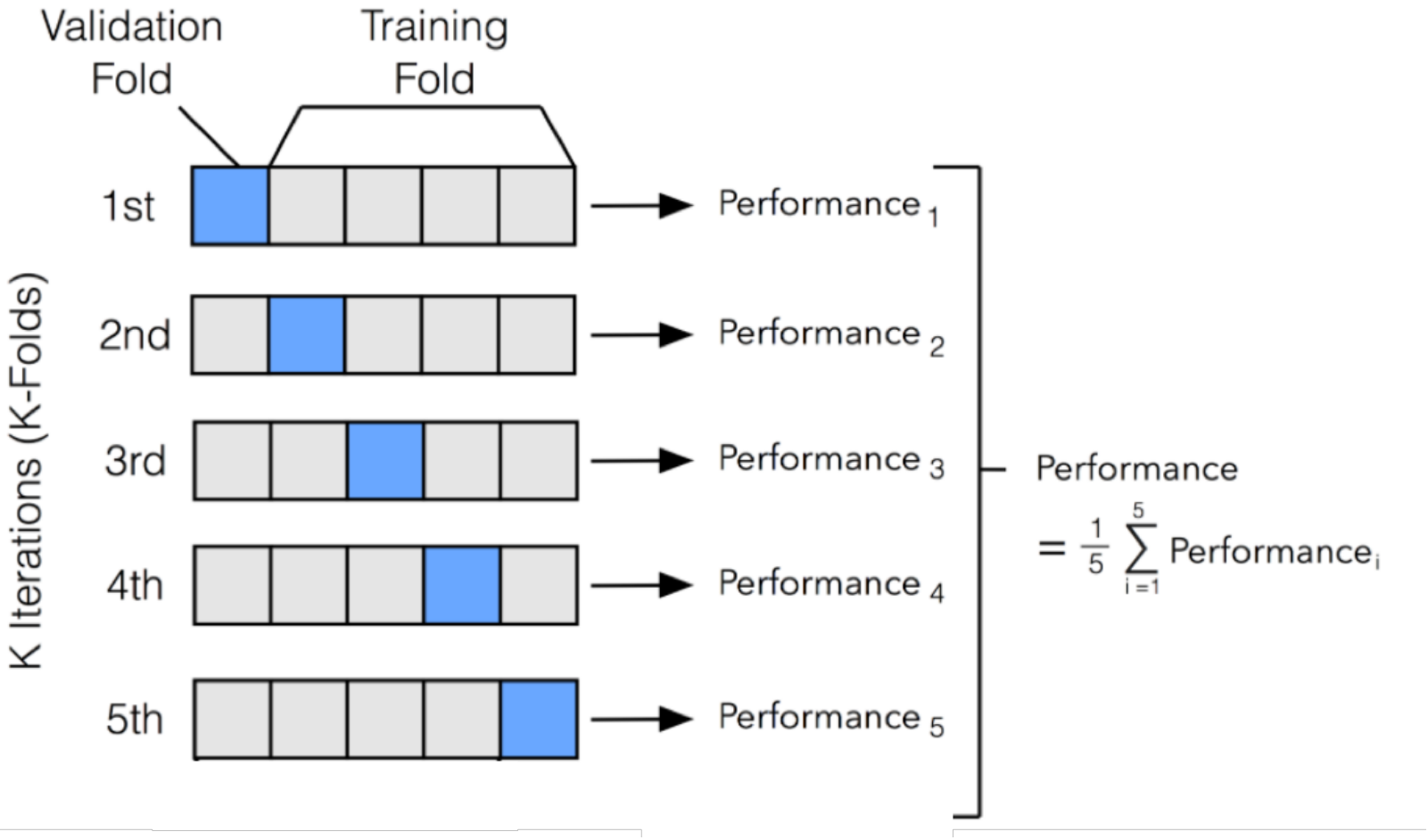
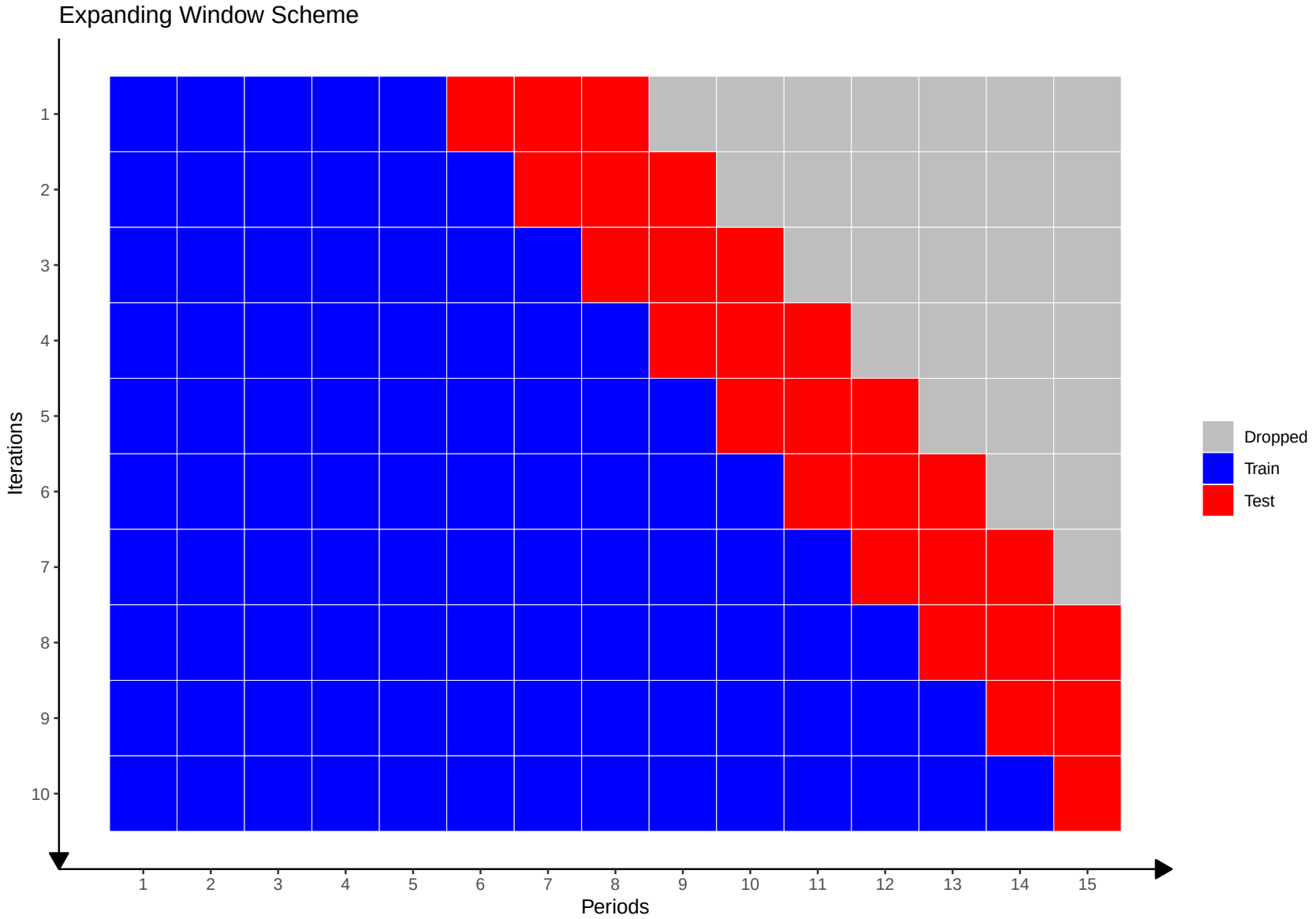
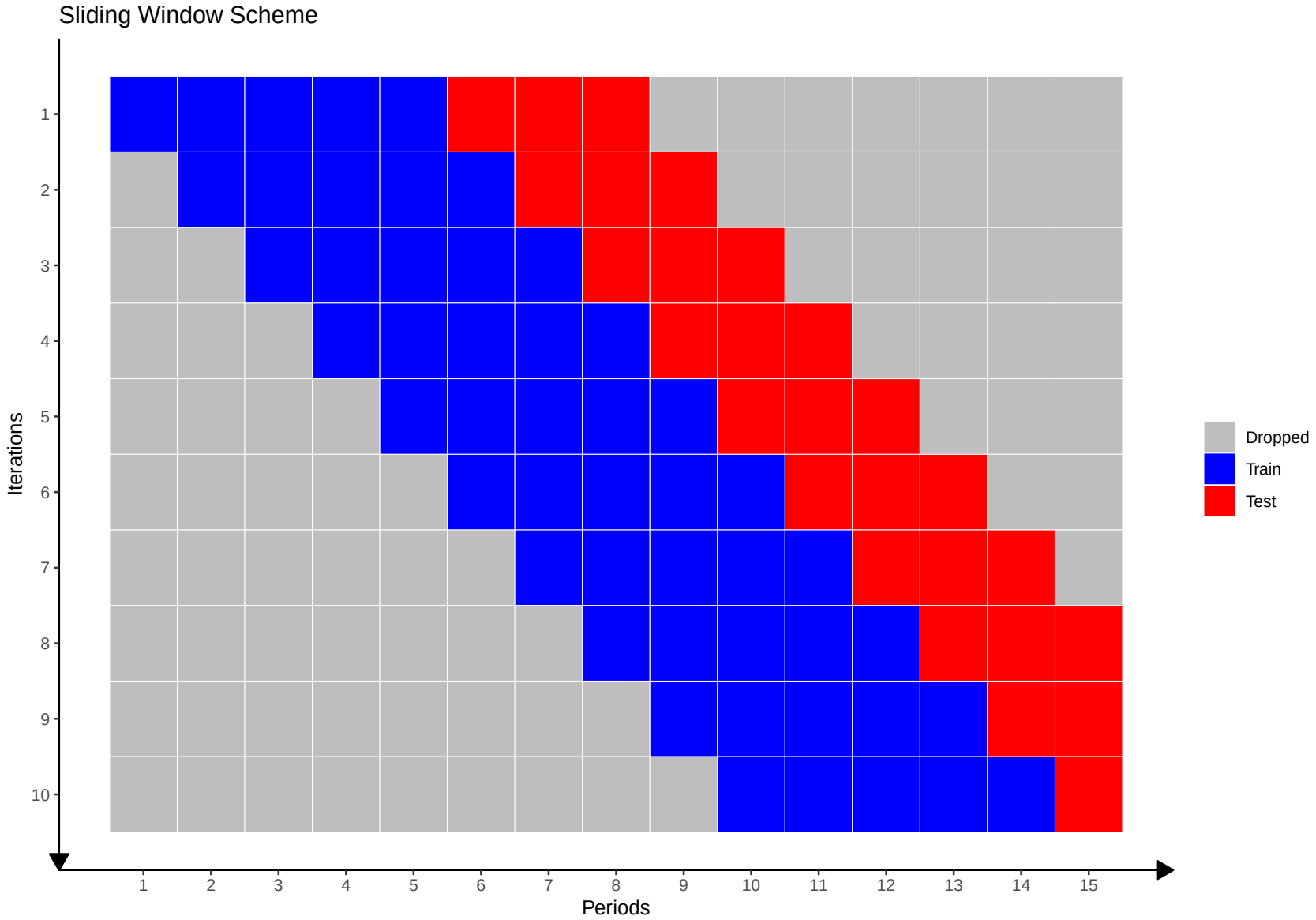


Figure 2: *K*-fold Cross-Validation

Expanding Window



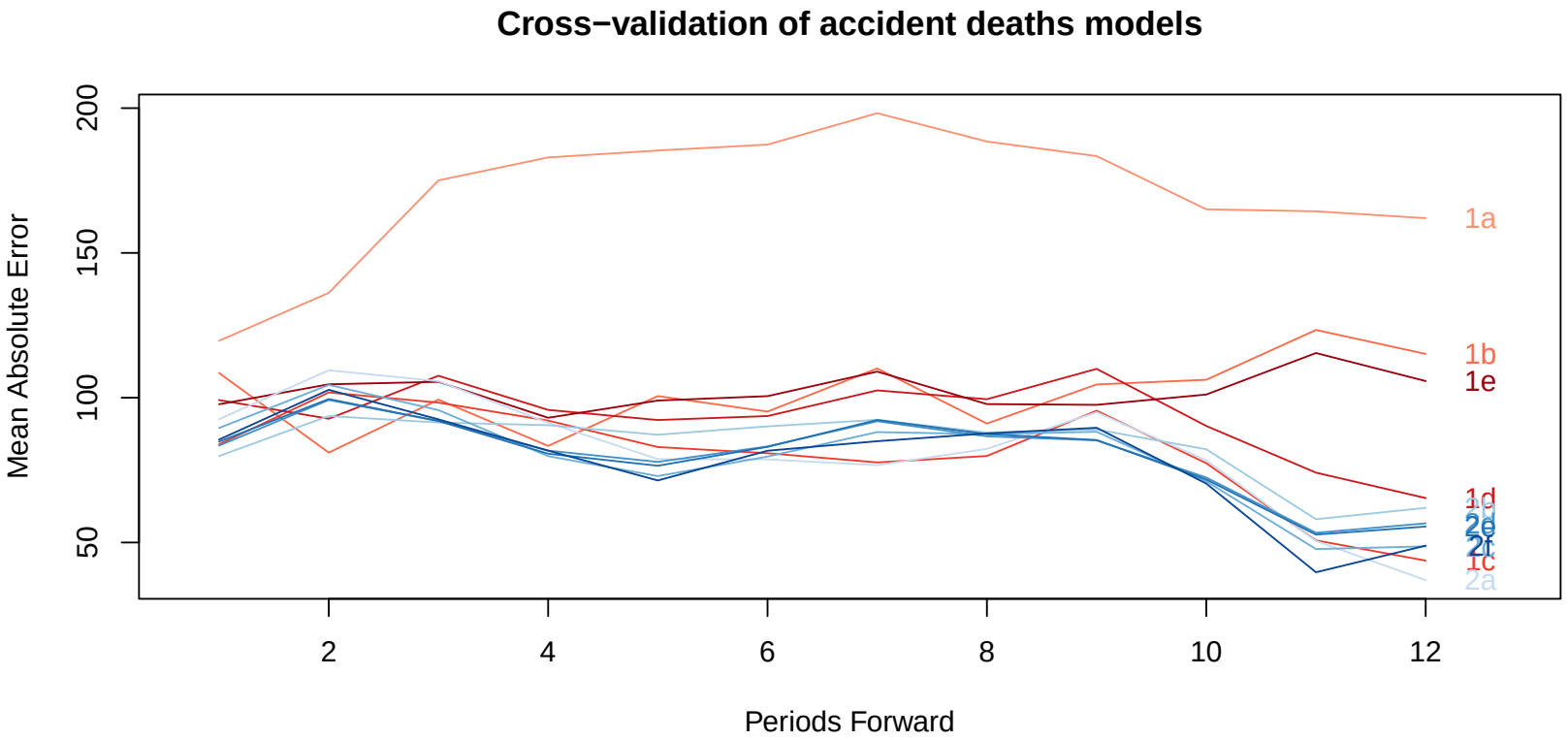
Rolling/sliding Window Scheme



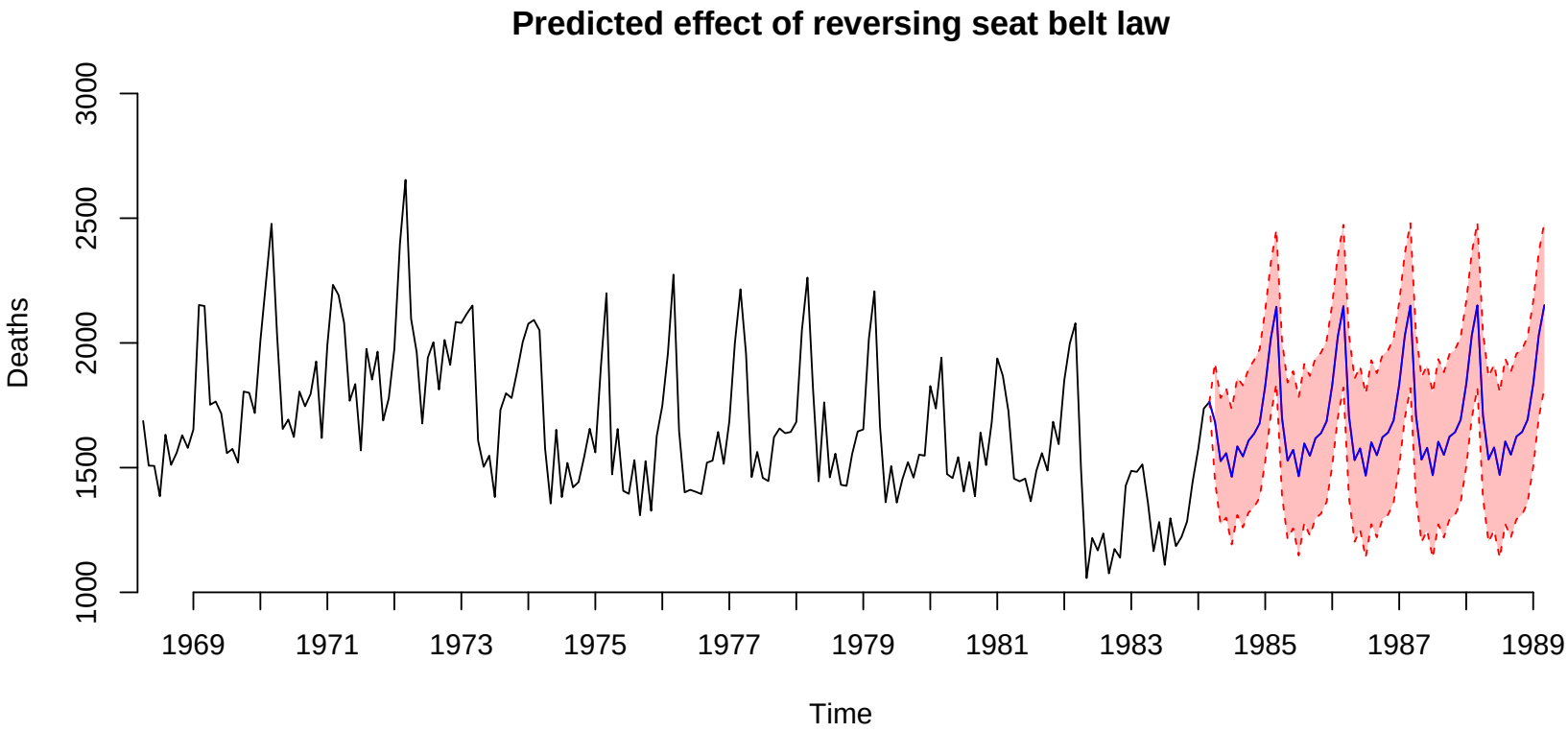
Model selection

- We will look on how to program a function for time-series CV.
  - We will use `arimaCV()` from Chris's code.
- We will estimate several models and choose the best fitted.
  - We will compare least squares with MLE-arima.
- Finally, we will do prediction and visualizaiton.

Model selection: time-series CV



Model selection: time-series CV



Let's get started!

Please, open the file Lab3.Rmd.