

# A classification framework for forecast-model selection

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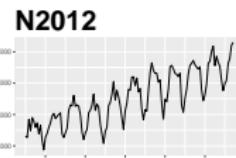
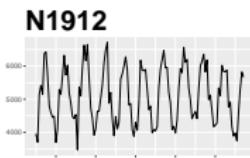
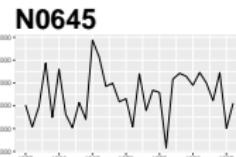
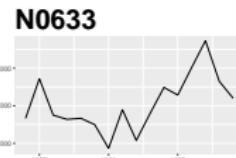
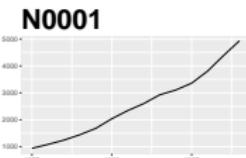
- strength of trend
- strength of seasonality
- lag-1 autocorrelation
- spectral entropy

# Feature-space of time series

## STL-decomposition

$$Y_t = T_t + S_t + R_t$$

- strength of trend:  $1 - \frac{\text{Var}(R_t)}{\text{Var}(Y_t - S_t)}$
- strength of seasonality:  $1 - \frac{\text{Var}(R_t)}{\text{Va}(Y_t - T_t)}$

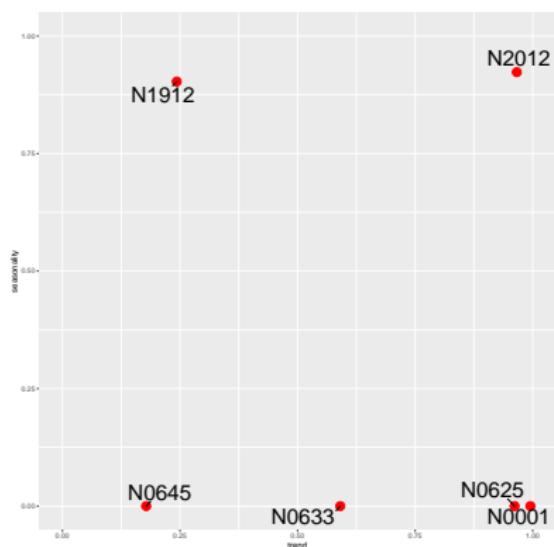
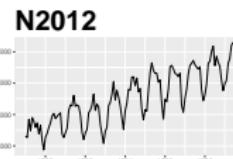
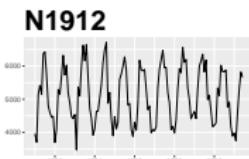
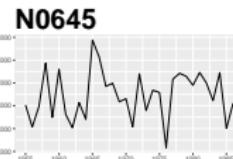
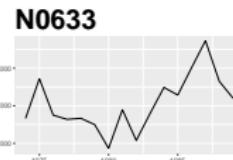
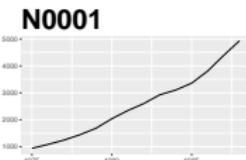


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# Time series features

- length
- strength of seasonality
- strength of trend
- linearity
- curvature
- spikiness
- stability
- lumpiness
- first ACF value of remainder series
- parameter estimates of Holt's linear trend method
- spectral entropy
- Hurst exponent
- nonlinearity
- parameter estimates of Holt-Winters' additive method
- unit root test statistics
- first ACF value of residual series of linear trend model
- ACF and PACF based features - calculated on both the raw and differenced series

## **FFORMS: Feature-based FORecast Model Selection**

### Offline

- A classification algorithm (the meta-learner) is trained.

### Online

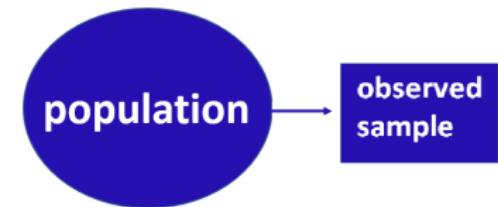
- Calculate the features of a time series and use the pre-trained classifier to identify the best forecasting method.

# FFORMS: population

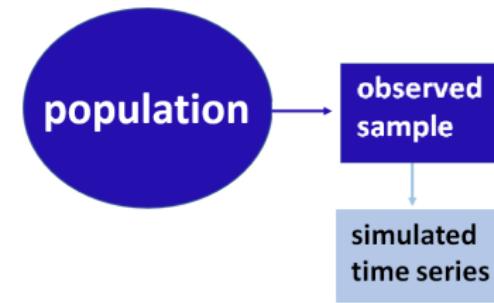


population

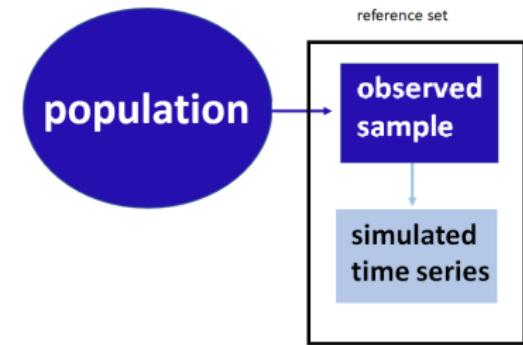
# FFORMS: observed sample



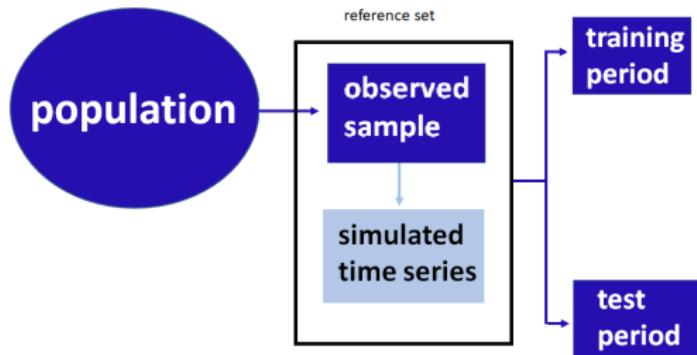
# FFORMS: simulated time series



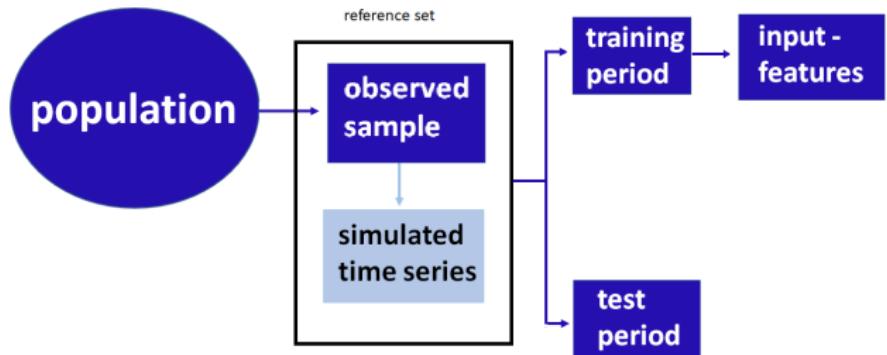
# FFORMS: reference set



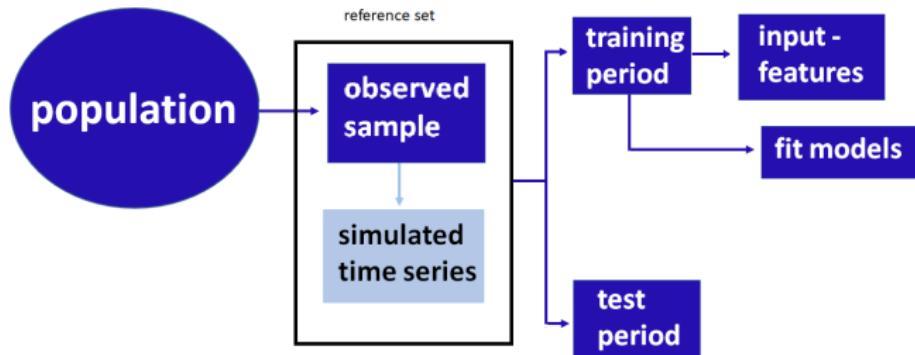
# FFORMS: Meta-data



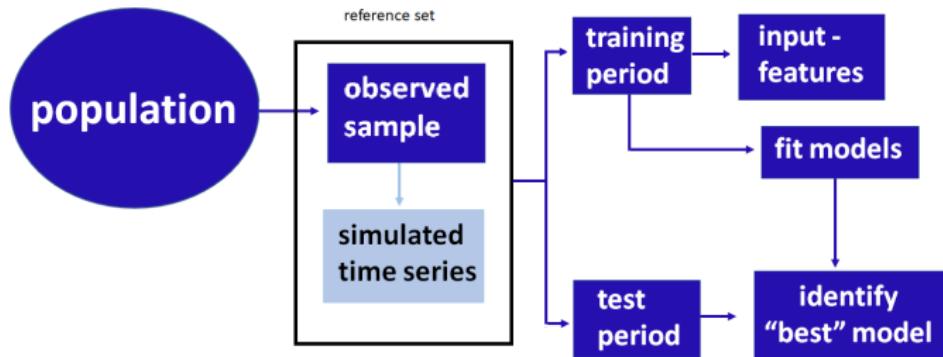
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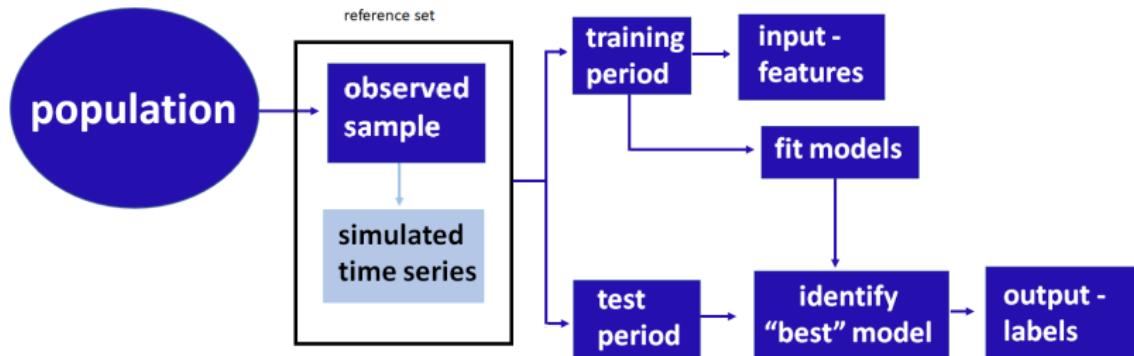
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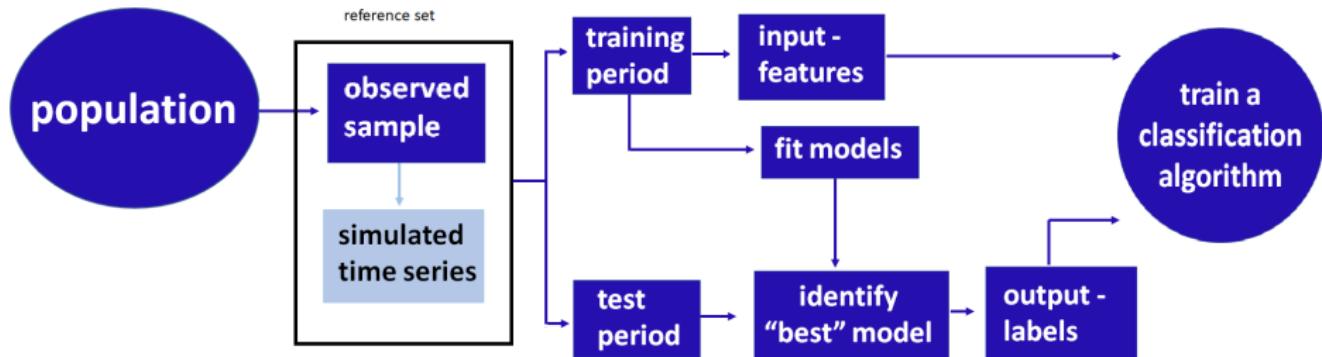
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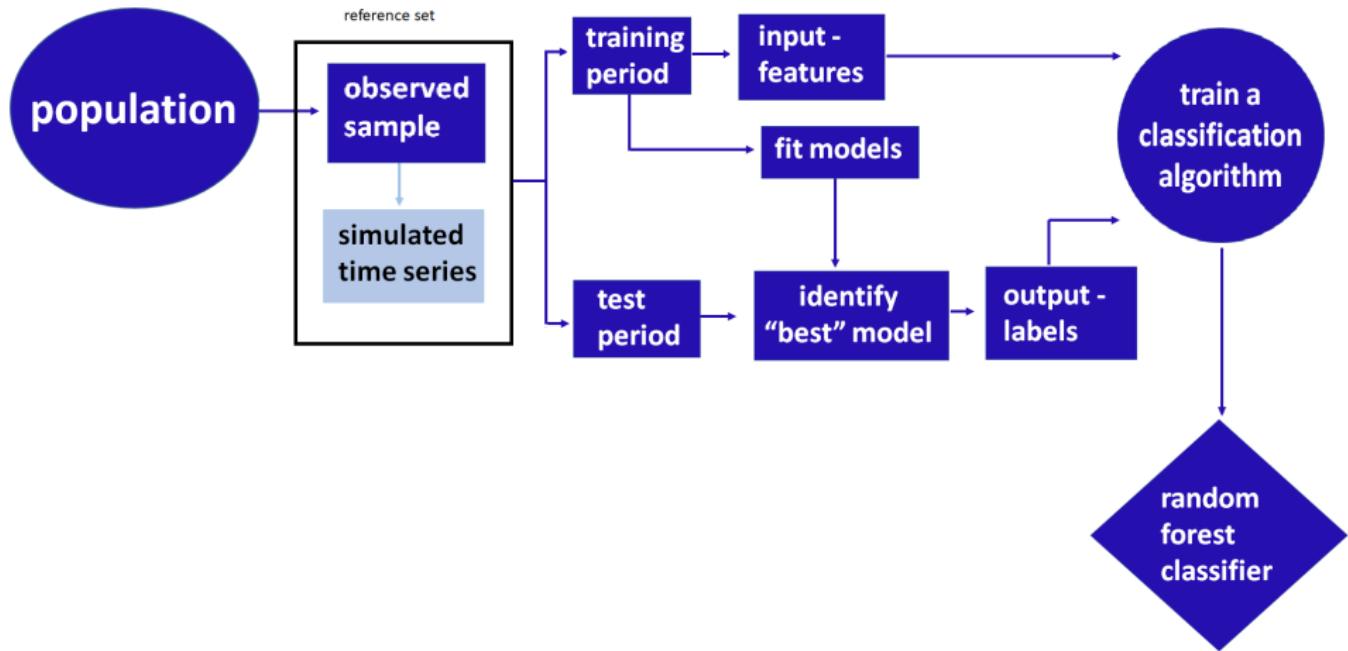
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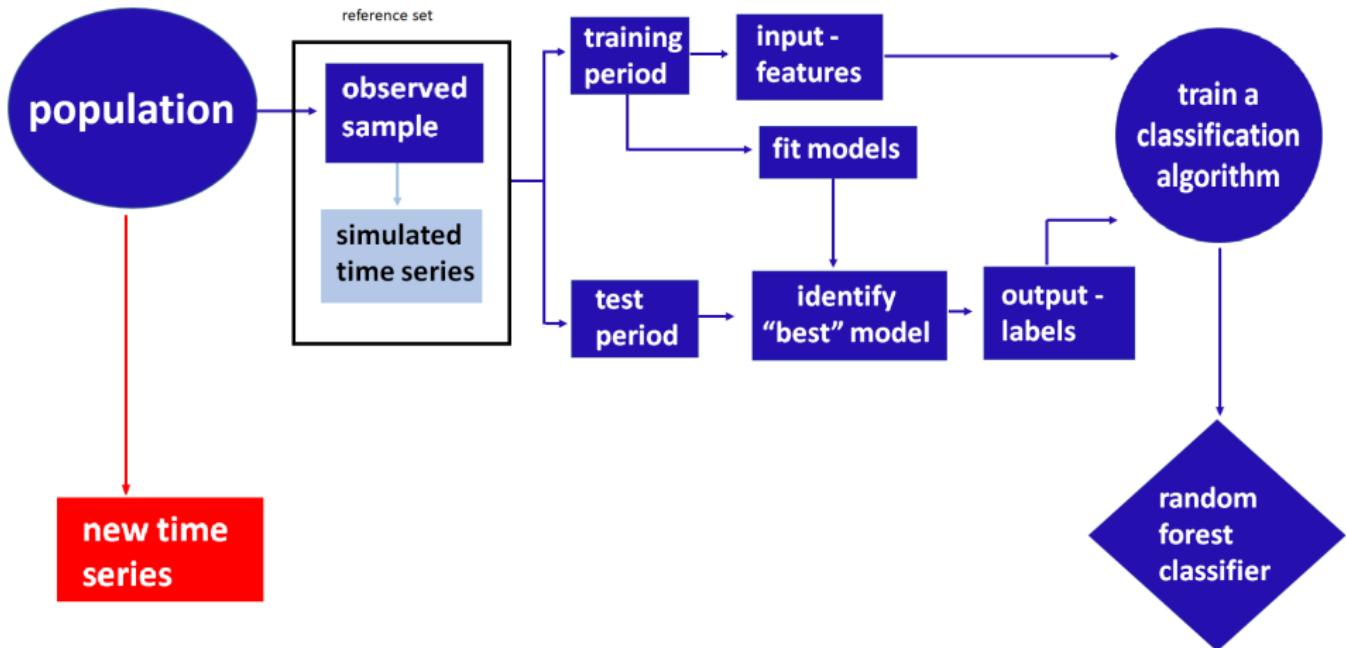
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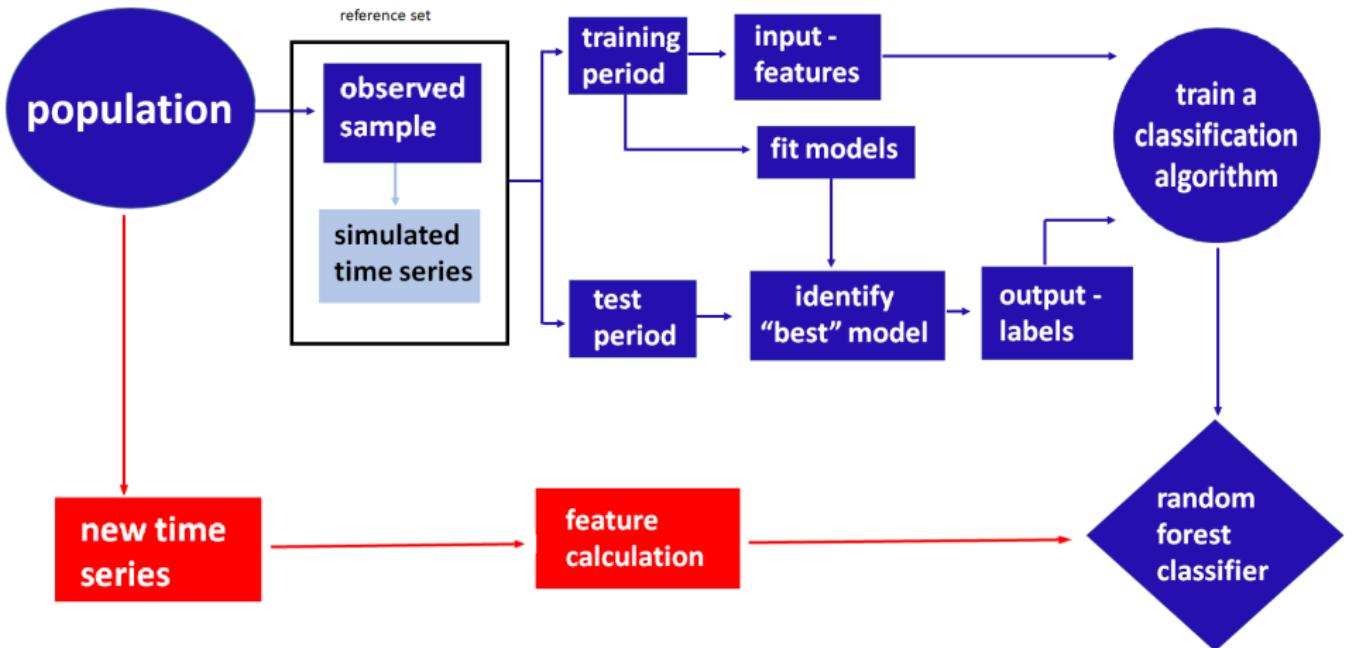
# FFORMS: Random-forest classifier



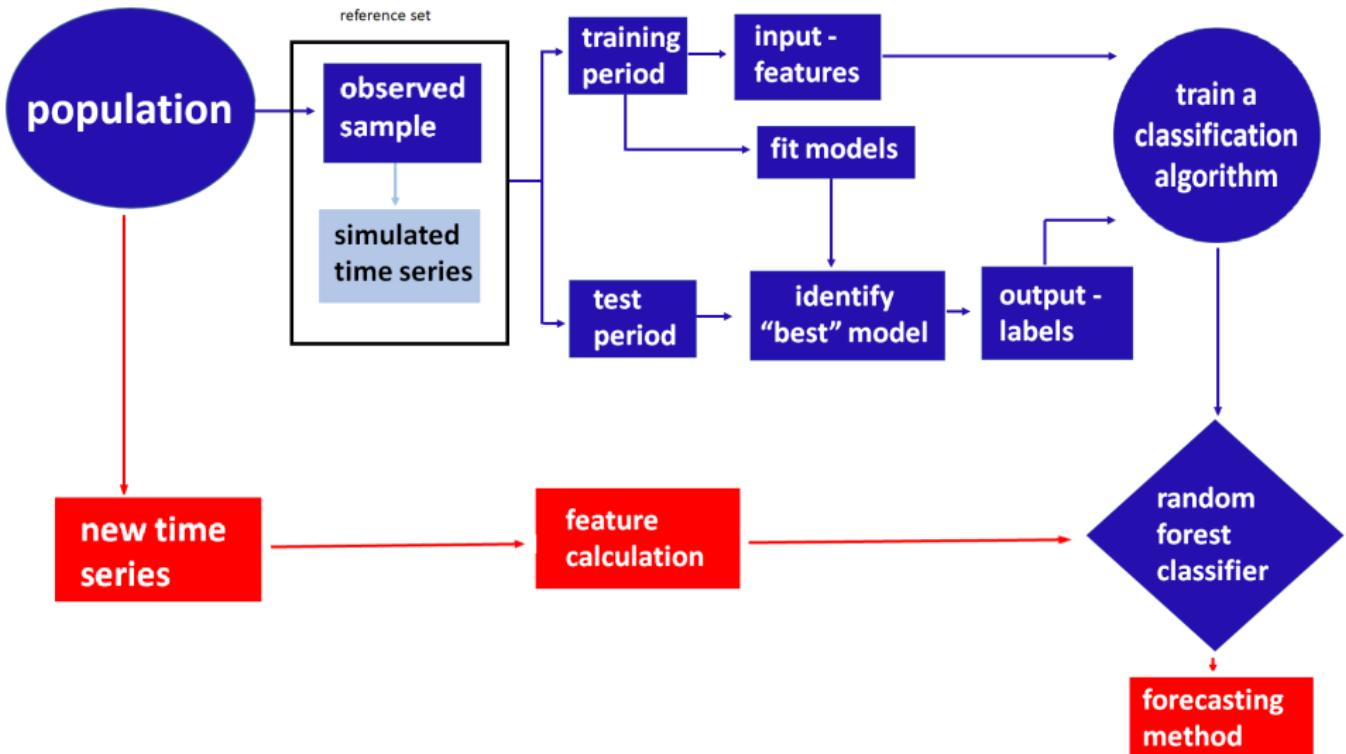
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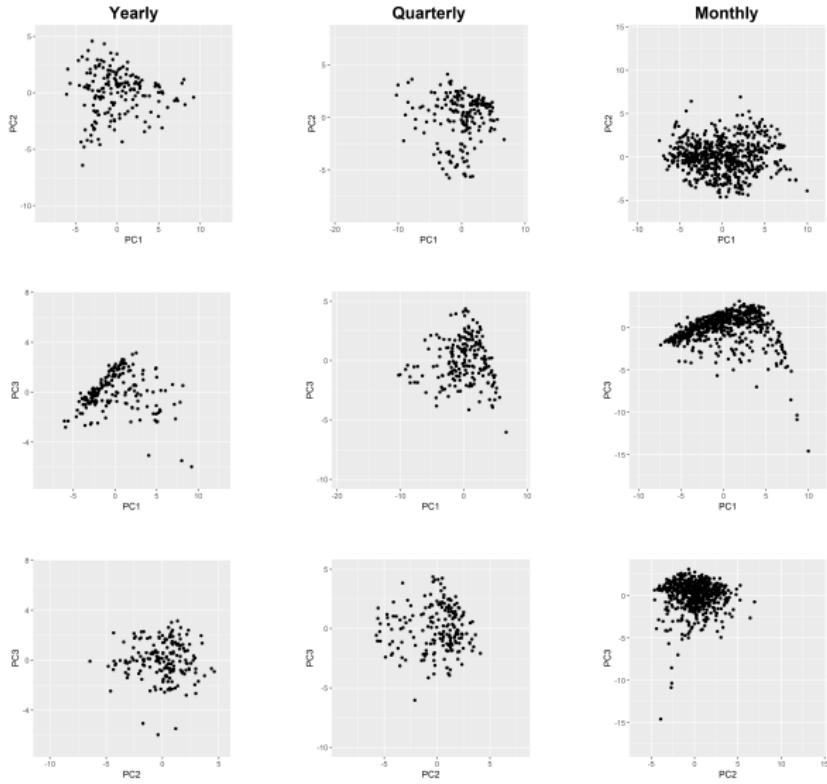
# Application to M competition data

- Proposed algorithm is applied to yearly, quarterly and monthly series separately.
- We run two experiments for each case.

	Source	Experiment 1			Source	Experiment 2		
		Y	Q	M		Y	Q	M
Observed series	M1	181	203	617	M3	645	756	1428
Simulated series		362000	406000	123400		1290000	1512000	285600
New series	M3	645	756	1428	M1	181	203	617

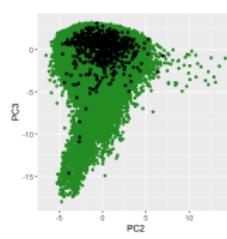
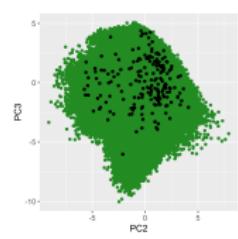
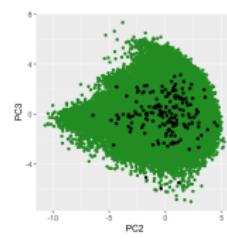
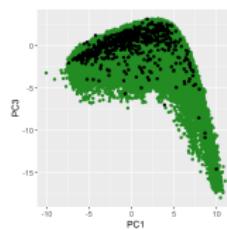
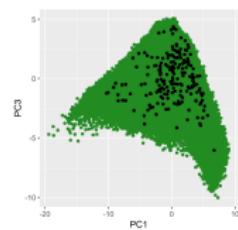
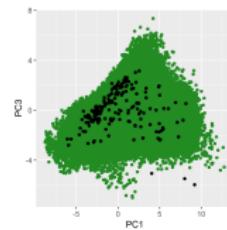
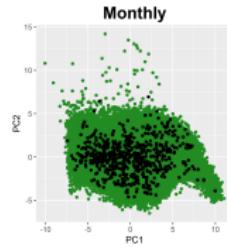
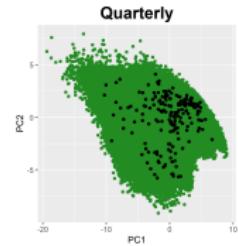
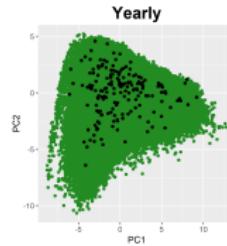
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observed - M1



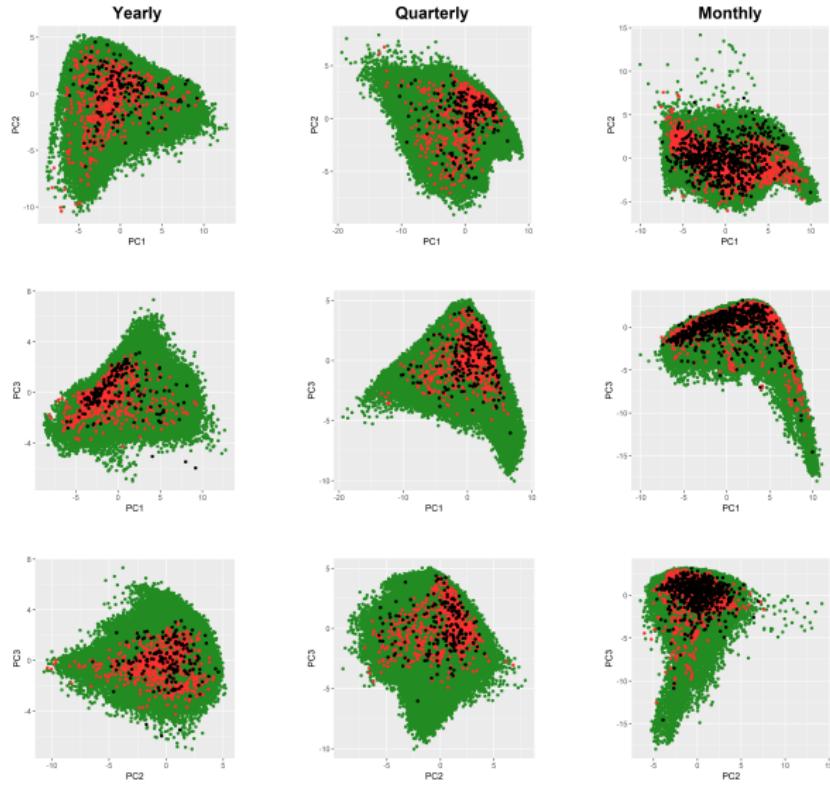
# Experiment 1: Distribution of time series in the PCA space

observed - M1 simulated



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observed - M1 simulated new - M3



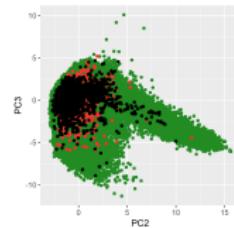
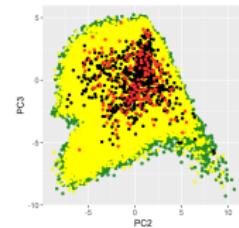
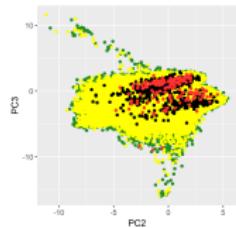
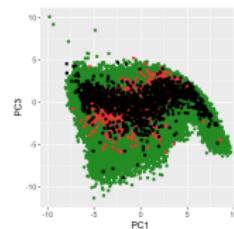
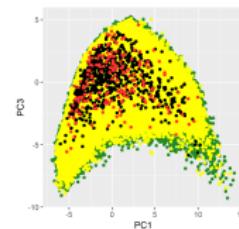
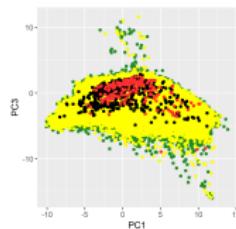
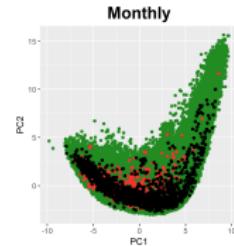
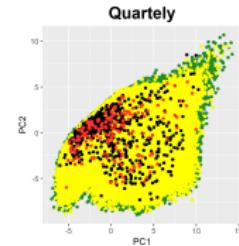
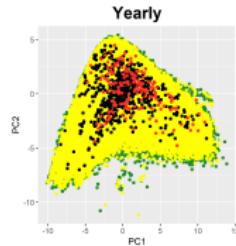
# Experiment 2: Distribution of time series in the PCA space

observed - M3

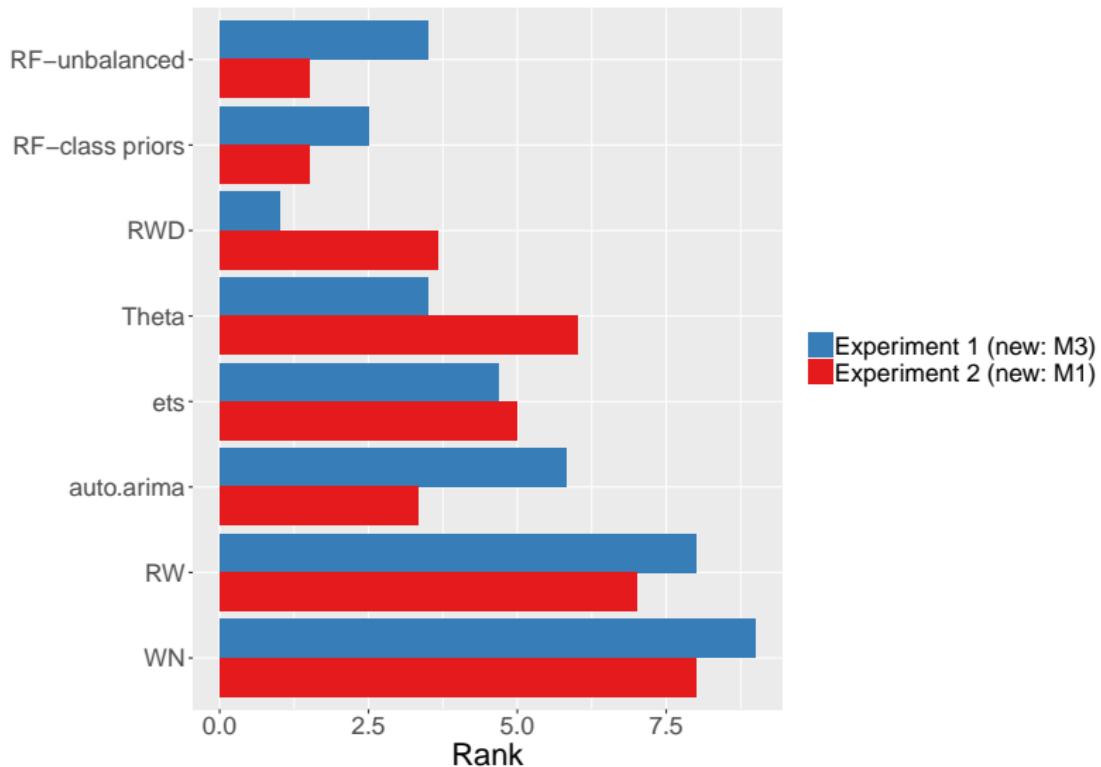
simulated

subset

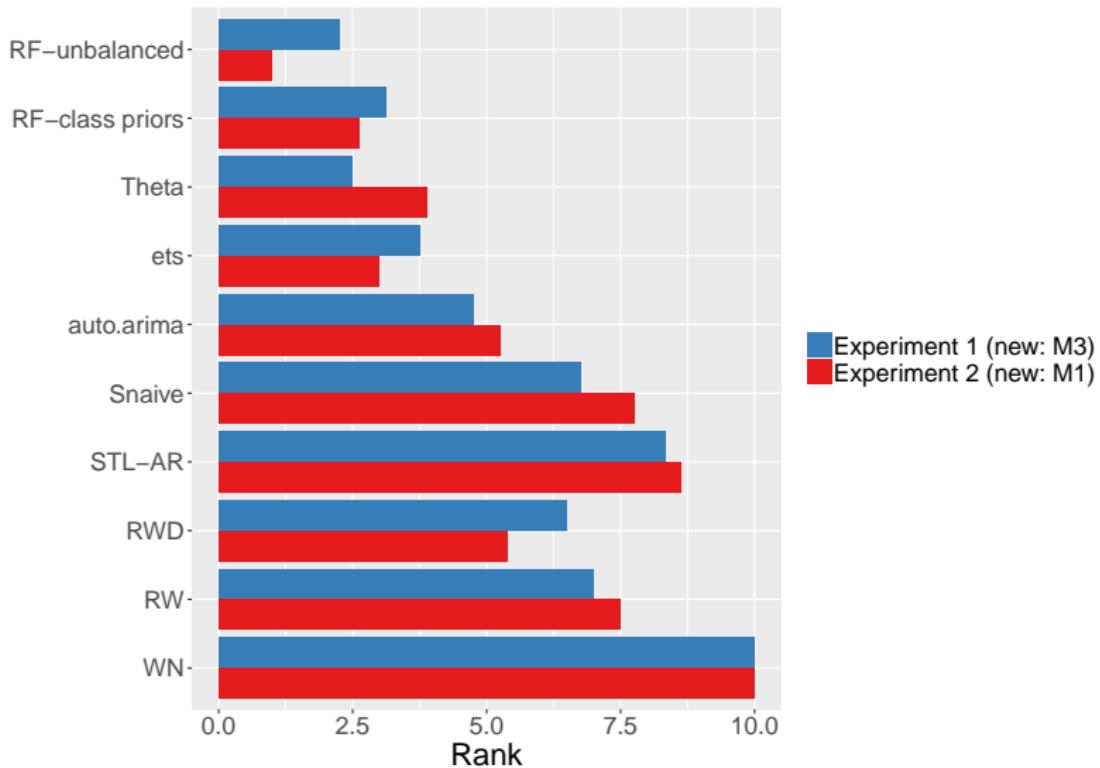
new - M1



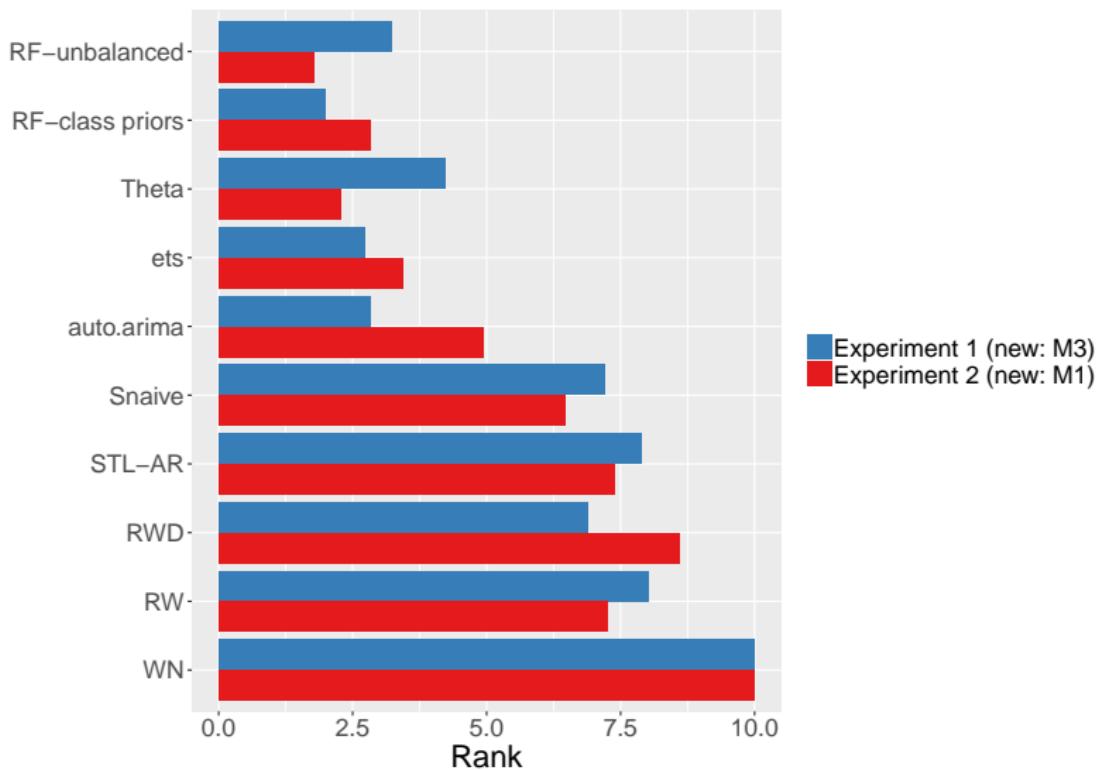
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# Results: Quarterly



## Results: Monthly



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- For real-time forecasting, our framework involves only the calculation of features, the selection of a forecast method based on the FFORMS random forest classifier, and the calculation of the forecasts from the chosen model.
- We have also introduced a simple set of time series features that are useful in identifying the "best" forecast method for a given time series.

## R package: seer



available at: <https://github.com/thiyangt/seer>

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paper: <https://robjhyndman.com/publications/fforms/>

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