# seer: R package for featue-based forecast model selection

Thiyanga S Talagala
Rob J Hyndman
George Athanasopoulos

Monash University, Australia

UseR, 2018

# Large collections of time series

- Forecasting demand for thousands of products across multiple warehouses.

# Time series features

## Objective

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

# Time series features

**Objective**

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.

# Time series features

## Objective

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.
- Examples for time series features

# Time series features

## Objective

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.
- Examples for time series features
  - strength of trend

# Time series features

## Objective

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.
- Examples for time series features
  - strength of trend
  - strength of seasonality

# Time series features

**Objective**

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.
- Examples for time series features
  - strength of trend
  - strength of seasonality
  - lag-1 autocorrelation

# Time series features

## Objective

Develop a framework that automates the selection of the most appropriate forecasting method for a given time series by using an array of features computed from the time series.

- **Basic idea:**
  Transform a given time series $y = \{y_1, y_2, \cdots, y_n\}$ to a feature vector $F = (f_1(y), f_2(y), \cdots, f_p(y))'$.
- Examples for time series features
  - strength of trend
  - strength of seasonality
  - lag-1 autocorrelation
  - spectral entropy

# 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

# Methodology: FFORMS

**FFORMS: F**eature-based **FOR**ecast **M**odel **S**election

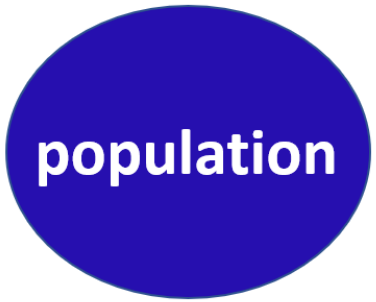
Offline

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

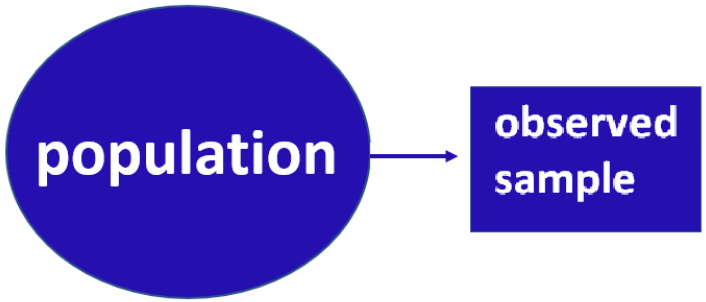
Online

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

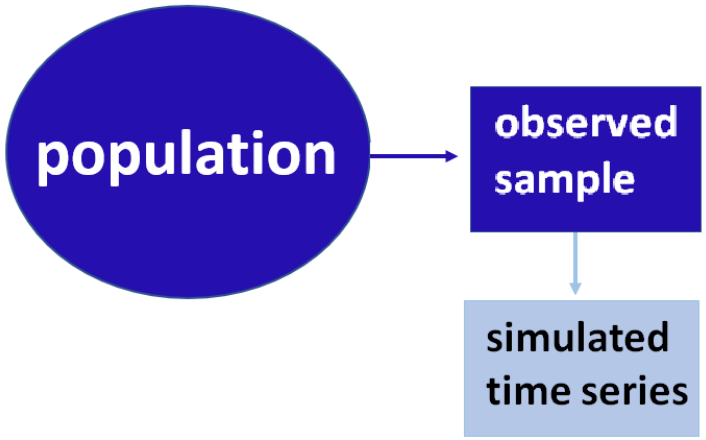
# FFORMS: population



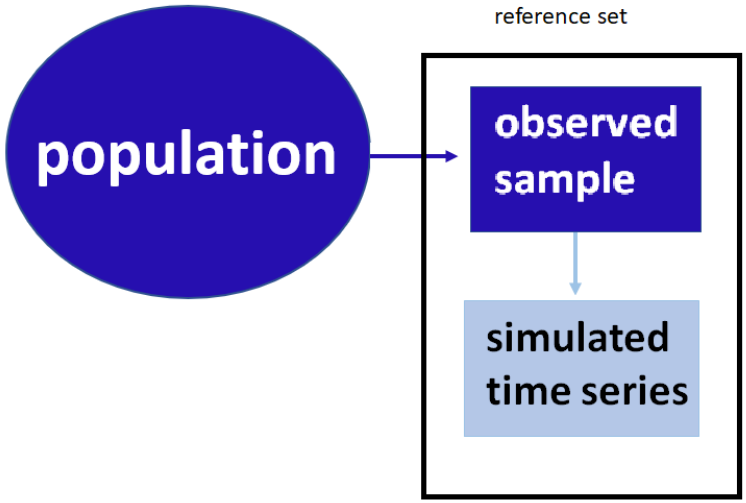
# FFORMS: observed sample



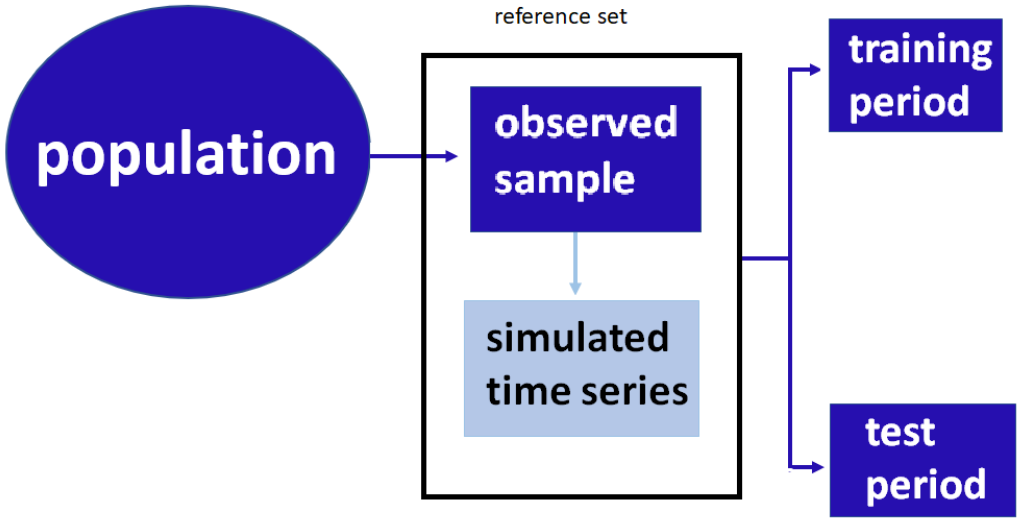
# FFORMS: simulated time series



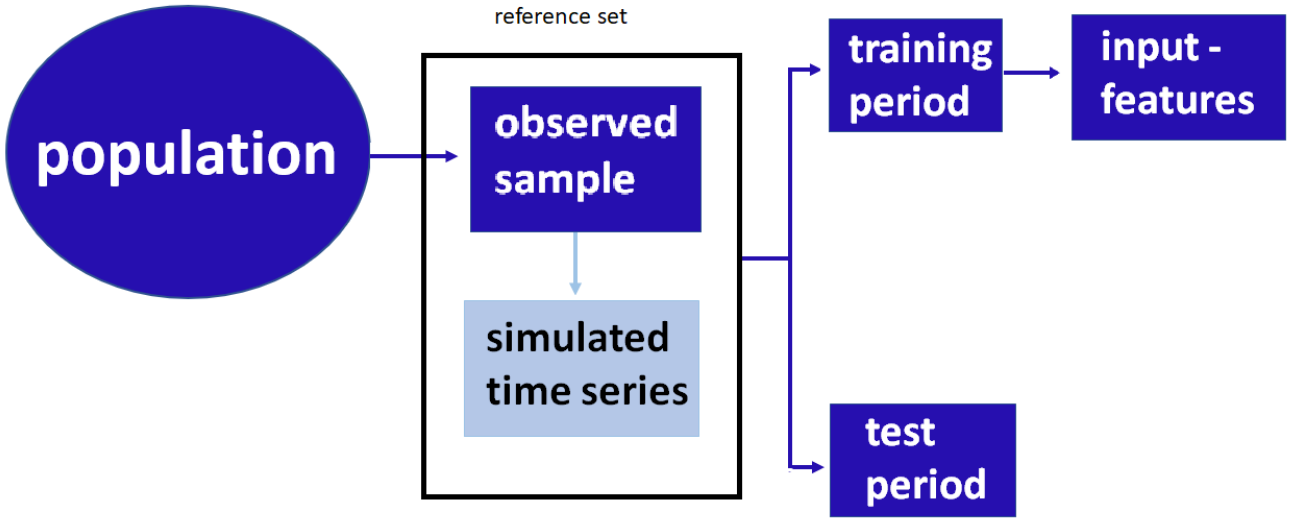
# FFORMS: reference set



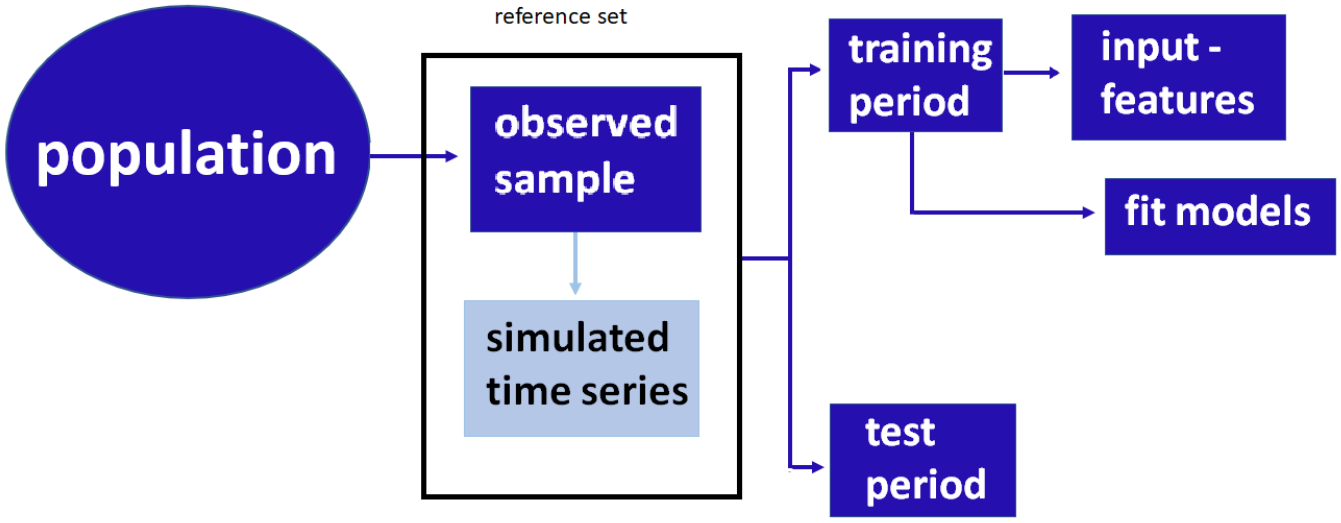
# FFORMS: Meta-data



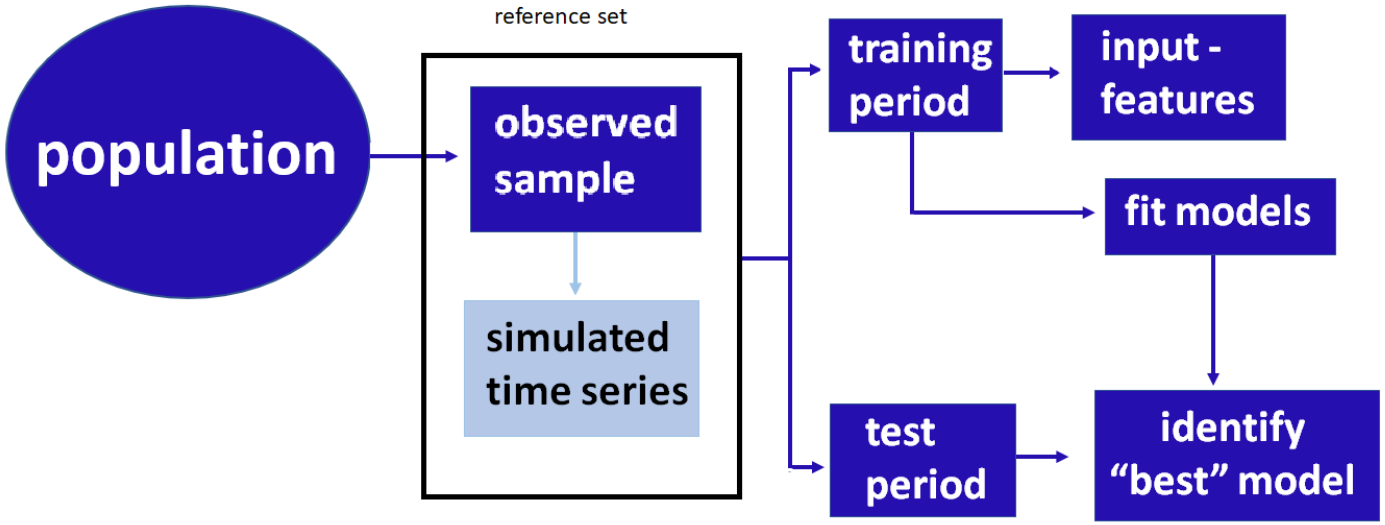
# FFORMS: Meta-data



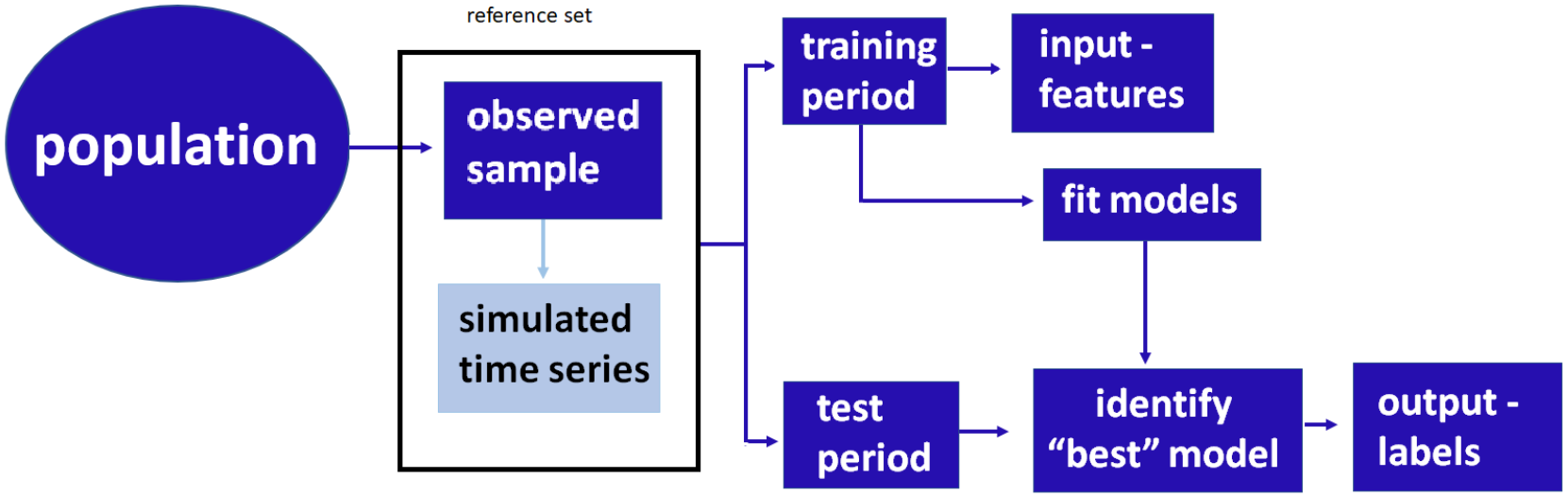
# FFORMS: Meta-data



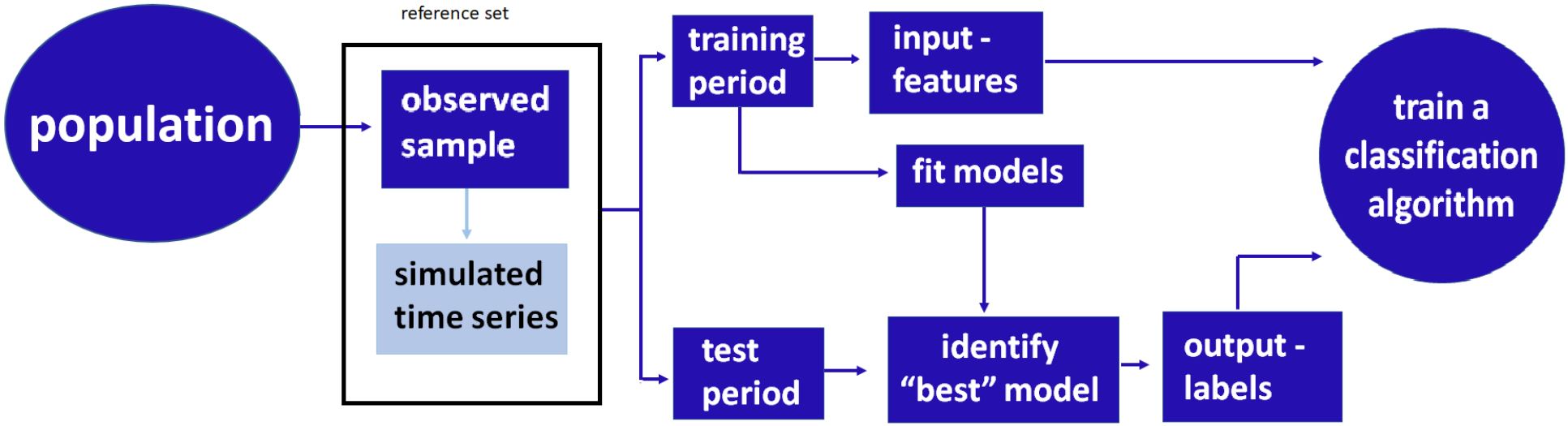
# FFORMS: Meta-data



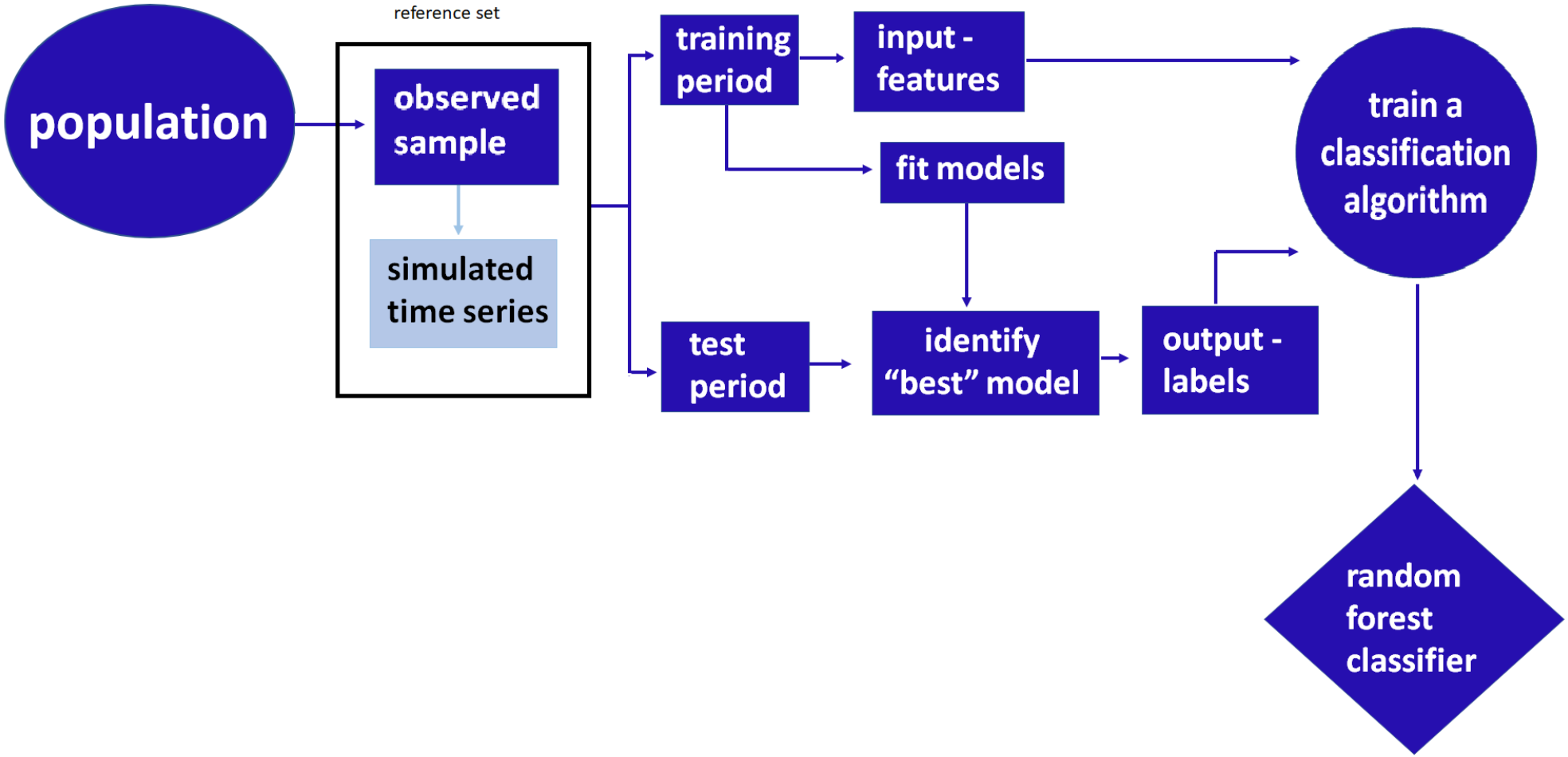
# FFORMS: Meta-data



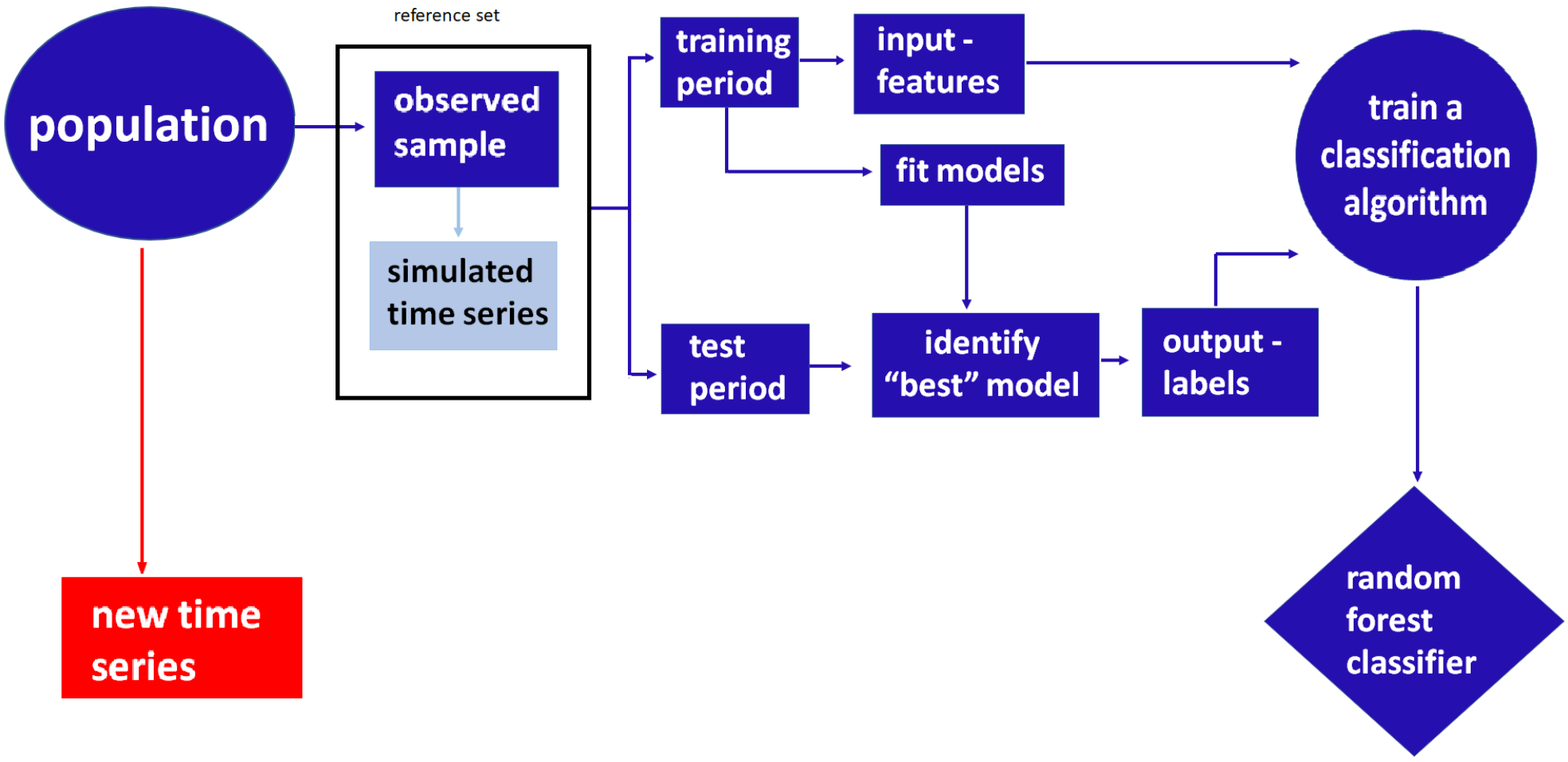
# FFORMS: Meta-data



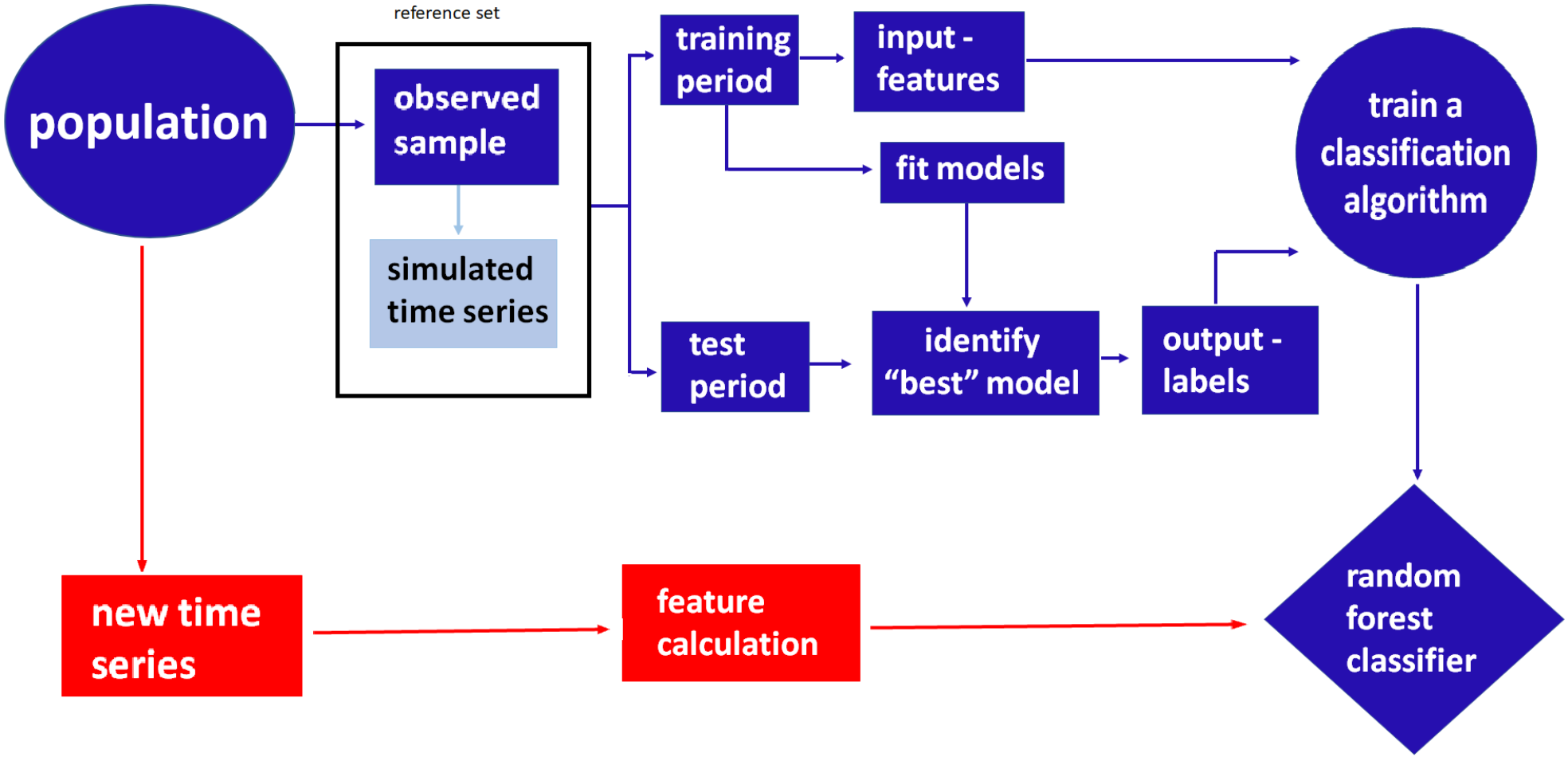
# FFORMS: Random-forest classifier



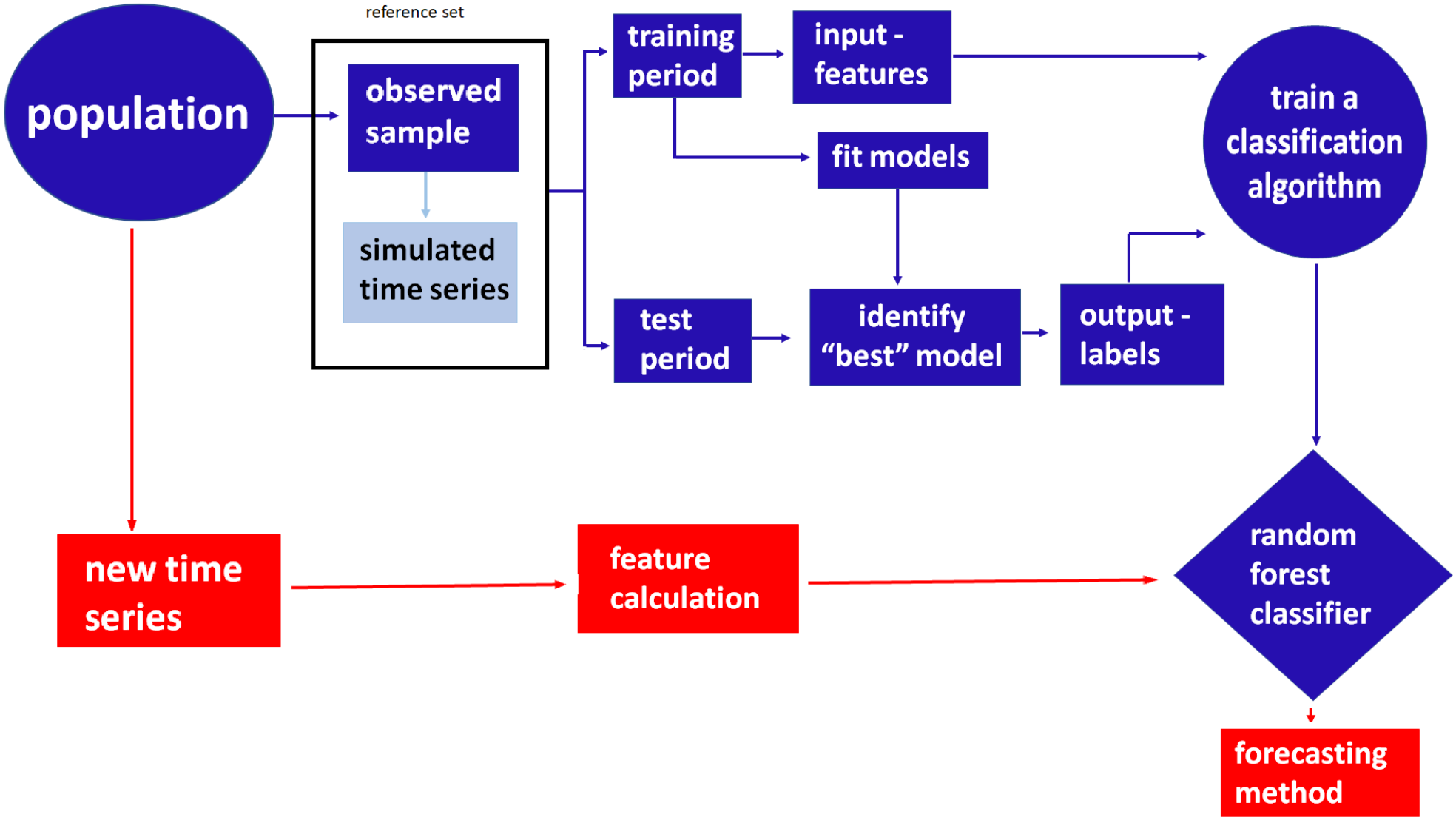
# FFORMS: "online" part of the algorithm



# FFORMS: "online" part of the algorithm



# FFORMS: "online" part of the algorithm



# Discussion and Conclusions

- FFORMS: framework for forecast model selection using meta-learning based on time series features.

# Discussion and Conclusions

- FFORMS: framework for forecast model selection using meta-learning based on time series features.
- FFORMS algorithm uses the knowledge of the past performance of candidate forecast models on a collection of time series in order to identify the best forecasting method for a new series.

# Discussion and Conclusions

- FFORMS: framework for forecast model selection using meta-learning based on time series features.
- FFORMS algorithm uses the knowledge of the past performance of candidate forecast models on a collection of time series in order to identify the best forecasting method for a new series.
- 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.

# Discussion and Conclusions

- FFORMS: framework for forecast model selection using meta-learning based on time series features.
- FFORMS algorithm uses the knowledge of the past performance of candidate forecast models on a collection of time series in order to identify the best forecasting method for a new series.
- 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

## Installation

```
devtools::install_github("thiyangt/seer")
library(seer)
```

# R package: seer


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

## Installation

```
devtools::install_github("thiyangt/seer")
library(seer)
```

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

Email: thiyanga.talagala@monash.edu