Exponential Smoothing

```
knitr::opts_chunk$set(echo = TRUE)
source("~/Downloads/model_2_ets.R")
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
load("~/Downloads/ts_train_data")
load("~/Downloads/ts_test_data")
```

Introduction

Apply an Exponential Smoothing model to forecast benzene concentration levels for the next 25 days.

Auto ETS

```
auto_ets(ts_train_data)
```

```
## ETS(A,N,A)
##
## Call:
##  ets(y = ts_data)
##
##   Smoothing parameters:
##     alpha = 0.7948
##     gamma = 1e-04
##
##   Initial states:
##     l = 12.2248
##     s = 1.4262 -0.256 -3.9253 -1.5542 1.4745 1.3404
##            1.4943
##
##   sigma:  3.1704
##
##       AIC     AICc      BIC
## 3015.882 3016.501 3054.908
##
## Training set error measures:
##                      ME     RMSE      MAE       MPE     MAPE      MASE
## Training set -0.01185409 3.131205 2.371584 -7.506504 28.85923 0.6295651
##                    ACF1
## Training set 0.02974435
```
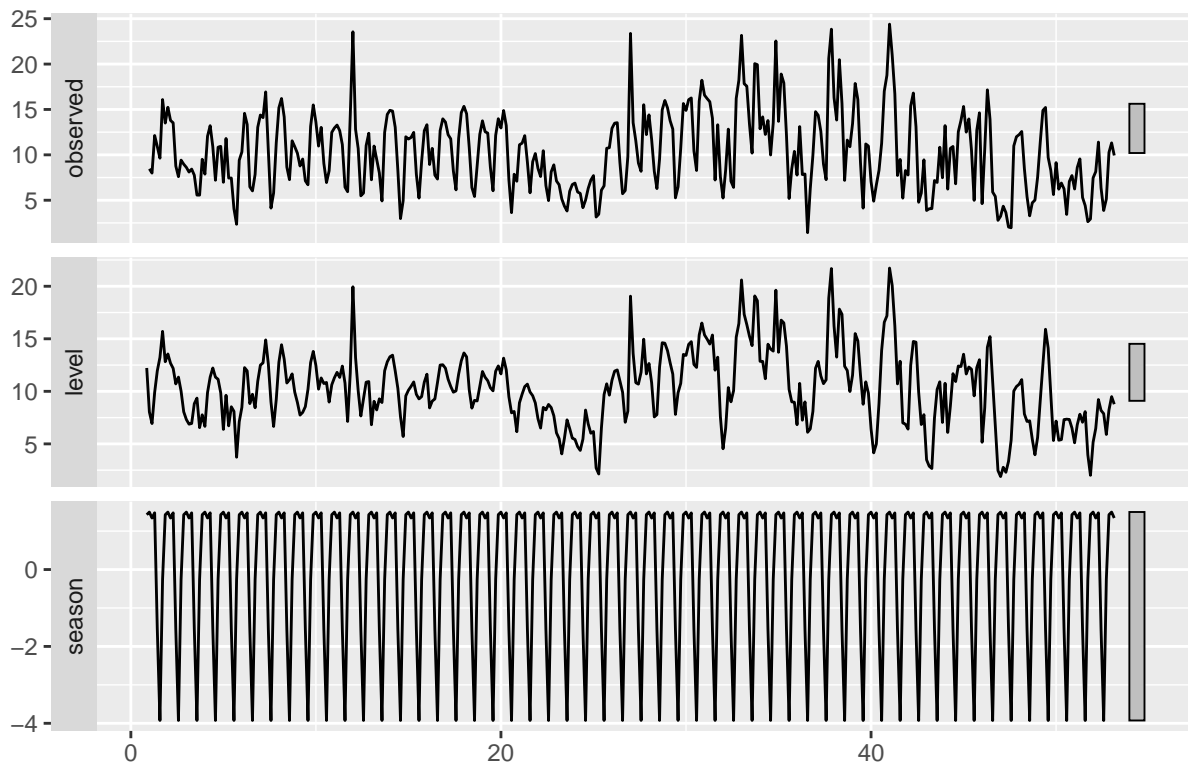
Custom Search

```
ets_model <- loop_ets(ts_train_data)
```

```
## ETS(A,N,A)
##
## Call:
##   ets(y = ts_data, model = model_config)
##
##   Smoothing parameters:
##     alpha = 0.7948
##     gamma = 1e-04
##
##   Initial states:
##     l = 12.2248
##     s = 1.4262 -0.256 -3.9253 -1.5542 1.4745 1.3404
##           1.4943
##
##   sigma:  3.1704
##
##       AIC      AICc      BIC
## 3015.882 3016.501 3054.908
```

Components

```
autoplot(ets_model)
```

## Components of ETS(A,N,A) method

Forecast the Next 25 Days (Test Dataset Length)

```r
model_2_forecast_values <- forecast_ets(ets_model, forecast_horizon = nrow(ts_test_data))
save(model_2_forecast_values, file = "~/Downloads/model_2_forecast_values.RData")
```

Plot Forecast vs Historical Data

```r
plot_ets_forecast(model_2_forecast_values$mean, ts_train_data, ts_test_data)
```
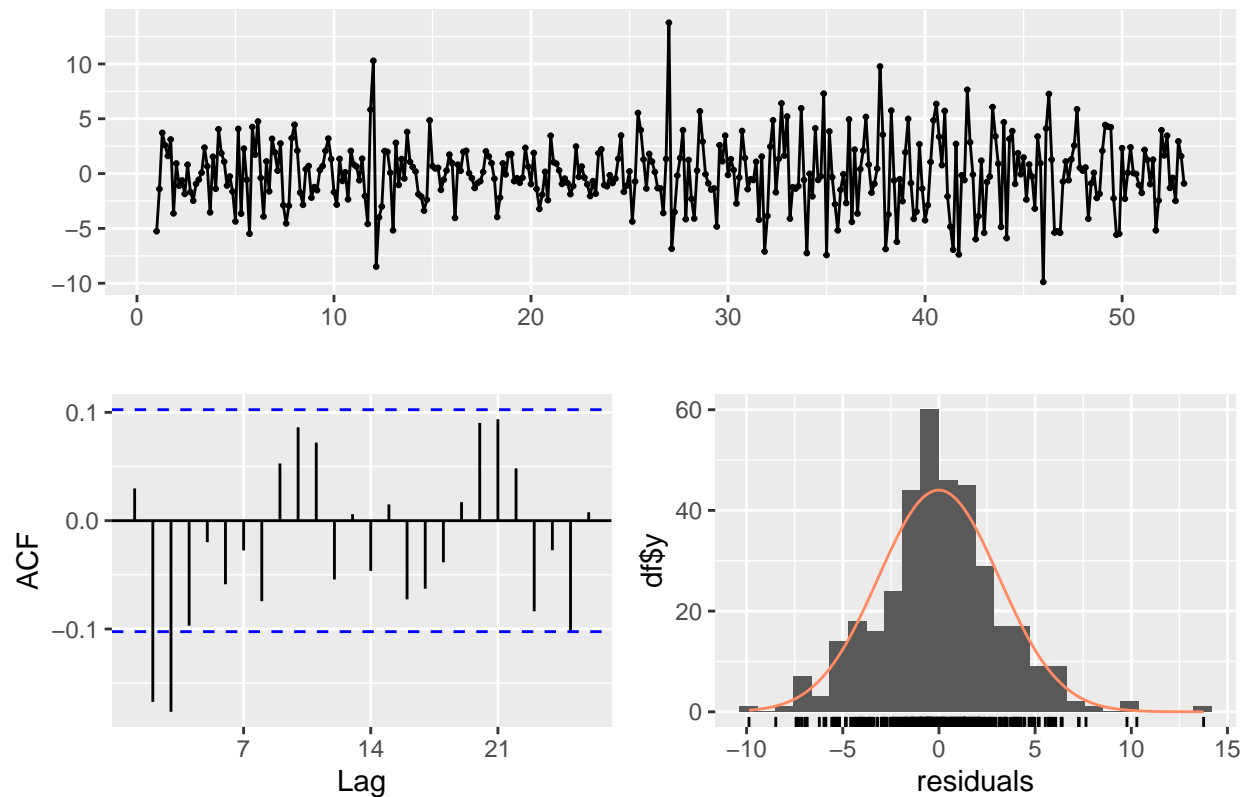
ETS Model Forecast vs Historical Data
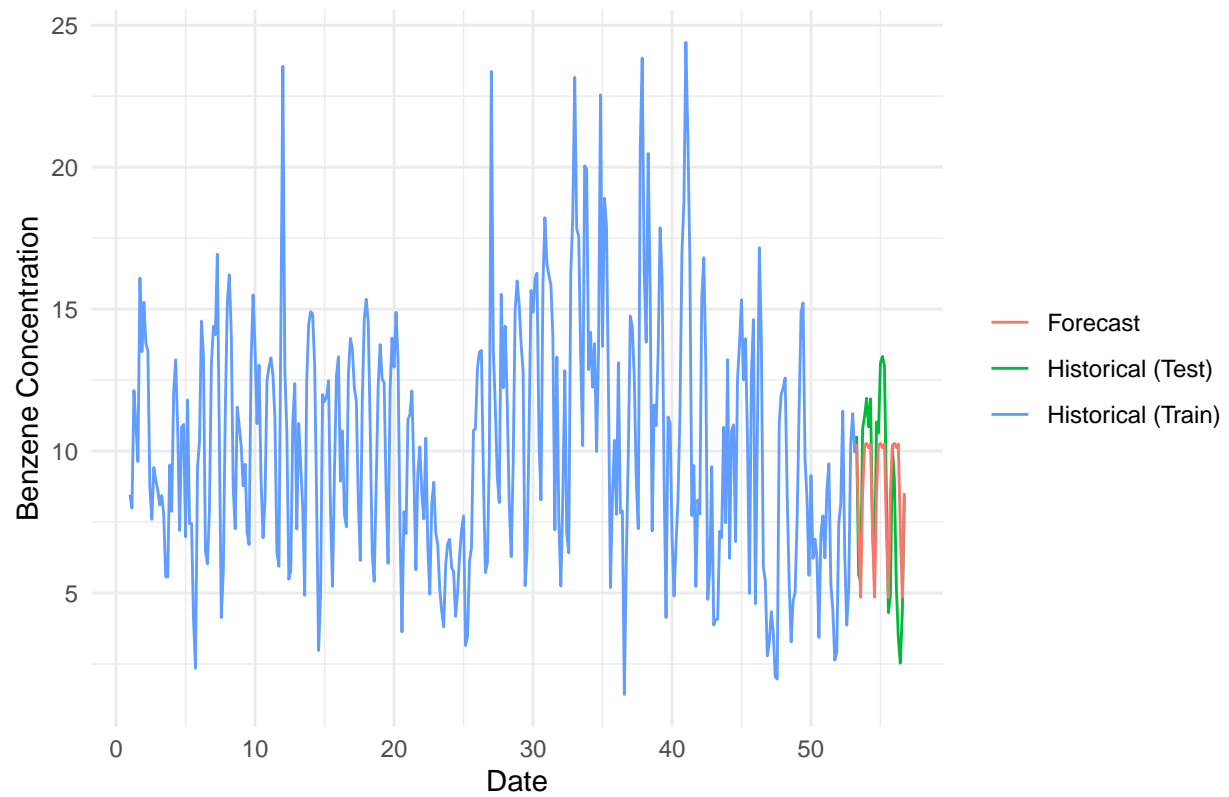
Model Residuals

```r
checkresiduals(ets_model)
```
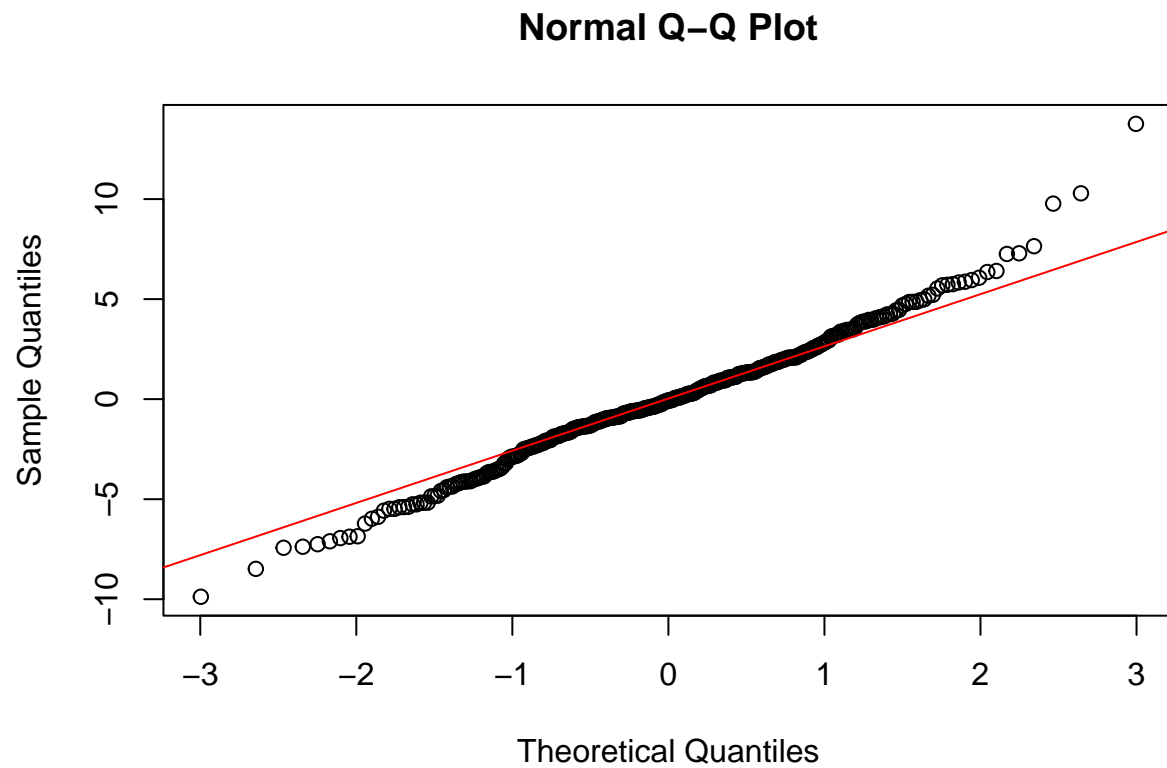
Residuals from ETS(A,N,A)


```
## 
##  Ljung-Box test
## 
## data:  Residuals from ETS(A,N,A)
## Q* = 37.334, df = 14, p-value = 0.0006566
## 
## Model df: 0.   Total lags used: 14
```

Model Residual Test

```
ets_residuals <- residuals(ets_model)
residuals_test(ets_residuals)
```

```
## 
##  Box-Ljung test
## 
## data:  residuals
## X-squared = 27.463, df = 7, p-value = 0.000275
## 
## 
##  Shapiro-Wilk normality test
## 
```

```
## data:  residuals
## W = 0.98781, p-value = 0.00367
```

Normal Q–Q Plot

Evaluation Metrics

```
evaluation_metrics(as.numeric(ts_test_data), model_2_forecast_values$mean)
```

```
## [1] "MRE: 0.327805675070746"
## [1] "MAE: 1.8323839203764"
## [1] "MSE: 6.27511051175738"
## [1] "RMSE: 2.5050170681569"
```