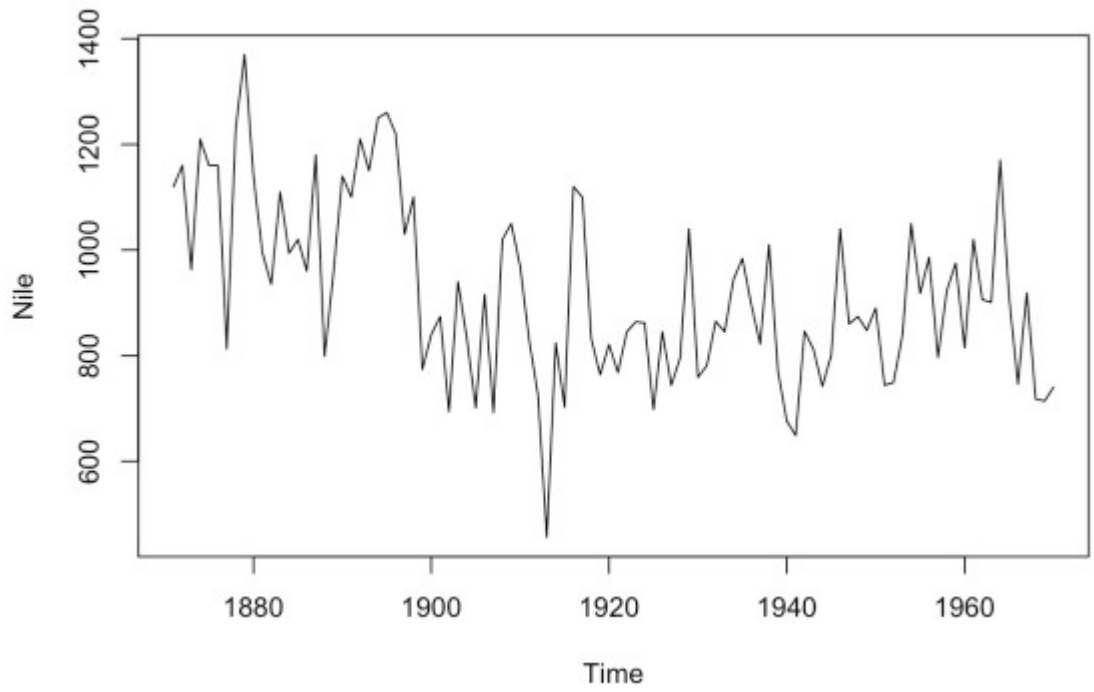
1 – univariate time series

The **Nile** dataset is used as univariate time series. It contains measurements of the annual flow of the river Nile at Aswan (formerly Assuan), 1871–1970, in 10^8 m^3, “with apparent changepoint near 1898” (Cobb(1978), Table 1, p.249).

```
library(datasets)
plot(Nile)
```



Split dataset into **training/testing** sets:

```
X <- matrix(Nile, ncol=1)
index_train <- 1:floor(nrow(X)*0.8)
X_train <- matrix(X[index_train, ], ncol=1)
X_test <- matrix(X[-index_train, ], ncol=1)
```

sklearn’s `BayesianRidge()` is the workhorse here, for nnetsauce’s `MTS`. It could actually be any Bayesian ML model possessing methods `fit` and `predict` (there’s literally an infinity of possibilities here for class `MTS`).

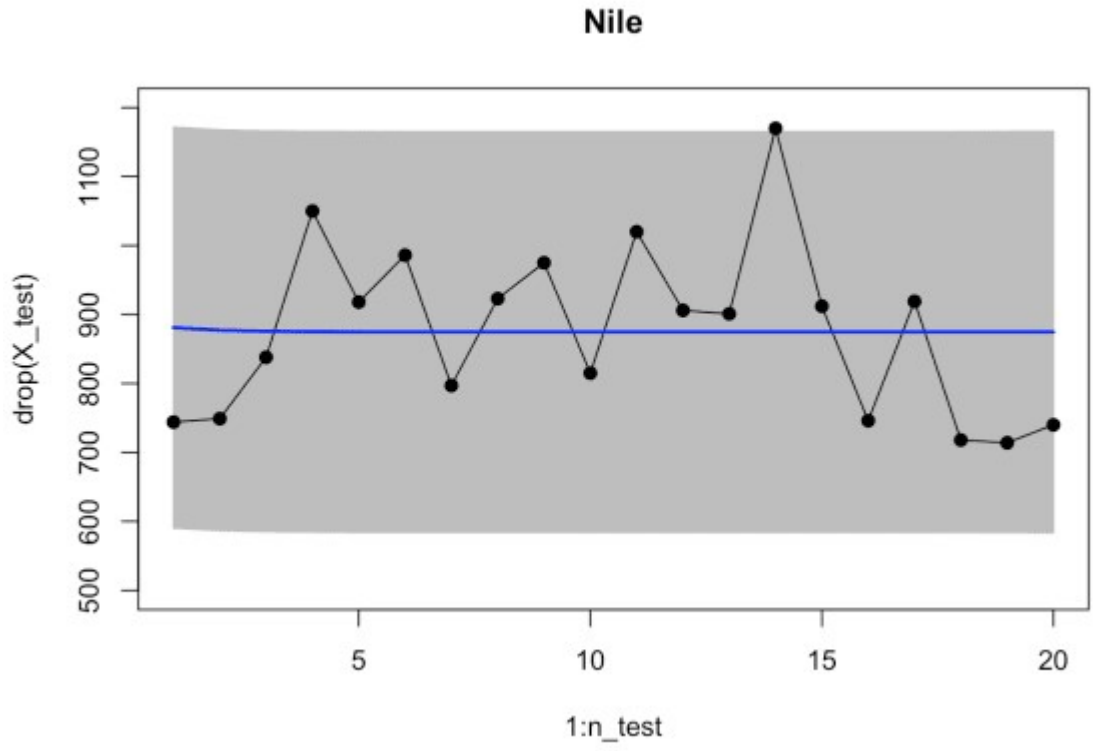
```
obj <- nnetsauce::sklearn$linear_model$BayesianRidge()
print(obj$get_params())
```

Fit and predict using `obj`:

```
fit_obj <- nnetsauce::MTS(obj = obj)
fit_obj$fit(X_train)
preds <- fit_obj$predict(h = nrow(X_test), level=95L,
                         return_std=TRUE)
```

95% **credible intervals**:

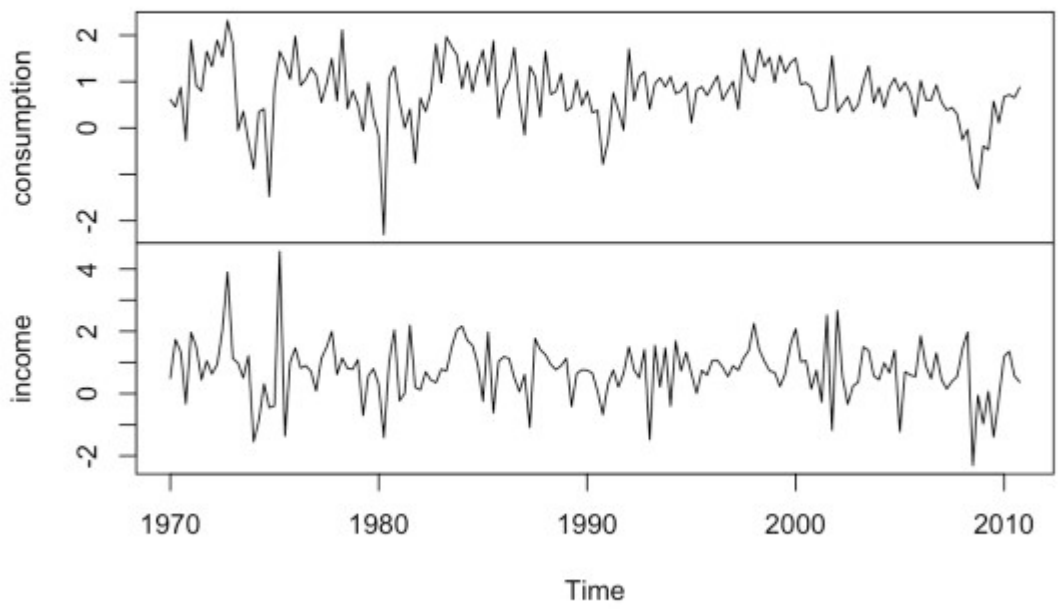
```
n_test <- nrow(X_test)
xx <- c(1:n_test, n_test:1)
yy <- c(preds$lower, rev(preds$upper))
plot(1:n_test, drop(X_test), type='l', main="Nile",
     ylim = c(500, 1200))
polygon(xx, yy, col = "gray", border = "gray")
points(1:n_test, drop(X_test), pch=19)
lines(1:n_test, drop(X_test))
lines(1:n_test, drop(preds$mean), col="blue", lwd=2)
```



2 - multivariate time series

The **usconsumption** dataset is used as an example of multivariate time series. It contains percentage changes in quarterly personal consumption expenditure and personal disposable income for the US, 1970 to 2010. (Federal Reserve Bank of St Louis. http://data.is/AnVtzB. http://data.is/wQPcjU.)

```
library(fpp)
plot(fpp::usconsumption)
```



Split dataset into **training/testing** sets:

```
X <- as.matrix(fpp::usconsumption)
index_train <- 1:floor(nrow(X)*0.8)
X_train <- X[index_train, ]
X_test <- X[-index_train, ]
```

Fit and predict:

```
obj <- nnetsauce::sklearn$linear_model$BayesianRidge()
fit_obj2 <- nnetsauce::MTS(obj = obj)

fit_obj2$fit(X_train)
preds <- fit_obj2$predict(h = nrow(X_test), level=95L,
                          return_std=TRUE) # standardize output+#plot
against X_test
```

95% **credible intervals**:

```
n_test <- nrow(X_test)

xx <- c(1:n_test, n_test:1)
yy <- c(preds$lower[,1], rev(preds$upper[,1]))
yy2 <- c(preds$lower[,2], rev(preds$upper[,2]))

par(mfrow=c(1, 2))
# 95% credible intervals
plot(1:n_test, X_test[,1], type='l', ylim=c(-2.5, 3),
     main="consumption")
polygon(xx, yy, col = "gray", border = "gray")
```

```
points(1:n_test, X_test[,1], pch=19)
lines(1:n_test, X_test[,1])
lines(1:n_test, preds$mean[,1], col="blue", lwd=2)

plot(1:n_test, X_test[,2], type='l', ylim=c(-2.5, 3),
     main="income")
polygon(xx, yy2, col = "gray", border = "gray")
points(1:n_test, X_test[,2], pch=19)
lines(1:n_test, X_test[,2])
lines(1:n_test, preds$mean[,2], col="blue", lwd=2)
```