LSTM autoencoder (encode-decode): An LSTM autoencoder learns temporal dependencies by encoding and decoding sequences; large reconstruction error flags anomalies. The model optimizes sequence reconstruction and thresholds errors via harutils().

Objectives: This Rmd demonstrates anomaly detection with an LSTM autoencoder (han\_autoencoder(..., autoenc\_lstm\_ed, ...)). The model encodes and decodes sequences; high reconstruction error flags anomalies. Steps: load packages/data, visualize, define the architecture/epochs, fit, detect, evaluate, and plot.

# Install Harbinger (only once, if needed)  
#install.packages("harbinger")

# Load required packages  
library(daltoolbox)  
library(daltoolboxdp)  
library(harbinger)

# Load example datasets bundled with harbinger  
data(examples\_anomalies)

# Select a simple synthetic time series with labeled anomalies  
dataset <- examples\_anomalies$simple  
head(dataset)

## serie event  
## 1 1.0000000 FALSE  
## 2 0.9689124 FALSE  
## 3 0.8775826 FALSE  
## 4 0.7316889 FALSE  
## 5 0.5403023 FALSE  
## 6 0.3153224 FALSE

# Plot the time series  
har\_plot(harbinger(), dataset$serie)



# Define LSTM autoencoder-based detector (autoenc\_lstm\_ed)  
 model <- han\_autoencoder(3, 2, autoenc\_lstm\_ed, num\_epochs = 1500)

# Fit the model  
 model <- fit(model, dataset$serie)

# Detect anomalies (reconstruction error -> events)  
 detection <- detect(model, dataset$serie)

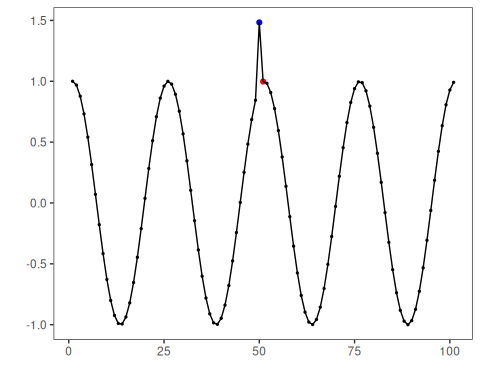
# Show only timestamps flagged as events  
 print(detection |> dplyr::filter(event==TRUE))

## idx event type  
## 1 51 TRUE anomaly

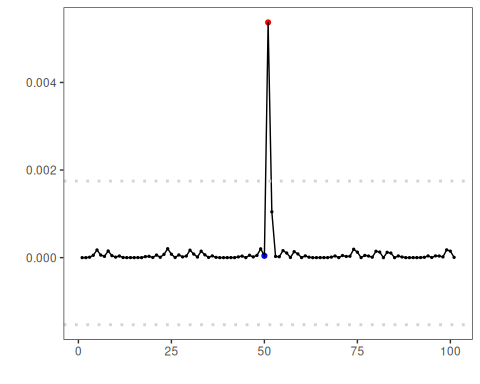
# Evaluate detections against ground-truth labels  
 evaluation <- evaluate(model, detection$event, dataset$event)  
 print(evaluation$confMatrix)

## event   
## detection TRUE FALSE  
## TRUE 0 1   
## FALSE 1 99

# Plot detections over the series  
 har\_plot(model, dataset$serie, detection, dataset$event)



# plotting the residuals  
 har\_plot(model, attr(detection, "res"), detection, dataset$event, yline = attr(detection, "threshold"))



References - Sakurada, M., Yairi, T. (2014). Anomaly Detection Using Autoencoders with Nonlinear Dimensionality Reduction. MLSDA 2014.