Ensemble Fuzzy anomaly detection: Ensemble voting with temporal fuzzification merges detections within a tolerance window into a single event before voting, reducing duplicate triggers and aligning with ground-truth granularity.

Objectives: This Rmd demonstrates anomaly detection using a fuzzy-tolerant ensemble (har\_ensemble(...) with time\_tolerance). Multiple detectors (FBIAD, ARIMA, EMD) vote and detections within a time tolerance are merged. Steps: load packages/data, visualize, define ensemble and tolerance, fit, detect, evaluate, and plot.

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

# Load required packages  
library(daltoolbox)  
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 the ensemble and set time tolerance for fuzzy matching  
 model <- har\_ensemble(hanr\_fbiad(), hanr\_arima(), hanr\_emd())  
 model$time\_tolerance <- 10

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

# Detect anomalies via ensemble voting with tolerance  
 detection <- detect(model, dataset$serie)

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

## idx event type  
## 1 50 TRUE anomaly

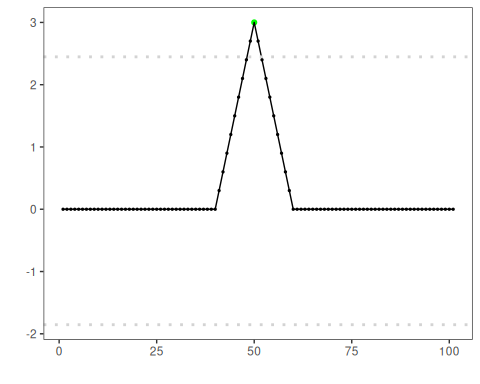
# Evaluate detections against ground-truth labels  
 evaluation <- evaluate(model, detection$event, dataset$event)  
 print(evaluation$confMatrix)

## event   
## detection TRUE FALSE  
## TRUE 1 0   
## FALSE 0 100

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



# Plot residual scores and threshold  
 har\_plot(model, attr(detection, "res"), detection, dataset$event, yline = attr(detection, "threshold"))



References - Ogasawara, E., Salles, R., Porto, F., Pacitti, E. Event Detection in Time Series. Springer, 2025. <doi:10.1007/978-3-031-75941-3>