```
library("svd")
library("forecast")
library("Rssa")
library("lattice")
library("parallel")
library("doParallel")
library("doRNG")
```

```
  trend_function1 <- function(n){
    # Input: аргумент - отметка на временной оси
    # Output: значение тренда как функции в точке
    return (-0.2 * exp(0.03 * n))
  }
```

```
harmonic_component1_function <- function(n){
  # Input: аргумент - отметка на временной оси
  # Output: значение гармонической компоненты как функции в точке
  return (2.65 * cos(2 * pi * n / 3))
}
```

```
set.seed(11-10-2021)
time_series_stamps = 0:100
actual_trend <- trend_function1(time_series_stamps)
refined_time_series <- actual_trend + harmonic_component1_function(time_series_stamps)
```

```
print(Sys.time())
```

```
cores <- detectCores()
cl <- makeCluster(cores[1] - 1)
registerDoParallel(cl)
M <- 100
signal_comp_num <- 3

st <- system.time(rejectEV <- foreach(
  i = 1:M,
  .export = c('ssa', 'rnorm', 'reconstruct', 'iossa', 'mean', 'sort', 'grouping.auto', 'eossa'),
  .combine = rbind
) %dorng% {
  time_series <- refined_time_series + rnorm(101, mean = 0, sd = 0.2)
  res <- refined_time_series - actual_trend

  s <- ssa(time_series, L = 48)

  #iossa with 5 separate groups
  ioss5 <- iossa(s, nested.groups = list(1, 2, 3), tol = 1e-3, maxiter = 500)
  g_iossa5 <- grouping.auto(ioss5, base = "series",
                freq.bins = list(Tendency = 1/240, Trend = 1/24),
                threshold = 0.7)

  rec5 <- reconstruct(ioss5, groups = g_iossa5)
  trend_time_series_iossa5 <- rec5$Trend

  residuals_time_series5 <- attr(rec5, "residuals") - attr(reconstruct(ioss5,
                                    groups = ioss5$iossa.groups), "residuals")
```

```
#iossa with 2 groups
ioss2 <- iossa(s, nested.groups = list(3, 1:2), tol = 1e-3, maxiter = 500)
g_iossa2 <- grouping.auto(ioss2, base = "series",
              freq.bins = list(Tendency = 1/240, Trend = 1/24),
              threshold = 0.8)

rec2 <- reconstruct(ioss2, groups = g_iossa2)
trend_time_series_iossa2 <- rec2$Trend
residuals_time_series2 <- attr(rec2, "residuals") - attr(reconstruct(ioss2, groups =
                                        ioss2$iossa.groups), "residuals")

#iossa with auto grouping

auto_grouping <- grouping.auto(s, base = "series",
              freq.bins = list(Tendency = 1/240, Trend = 1/24),
              threshold = 0.7)

trend_comp_all <- auto_grouping$Trend
trend_comp_signal <- trend_comp_all[trend_comp_all %in% 1:signal_comp_num]
signal_indices <- 1:signal_comp_num
res_comp <- signal_indices[!signal_indices %in% trend_comp_signal]

ioss2_auto <- iossa(s, nested.groups = list(trend_comp_signal, res_comp), tol = 1e-3, maxiter = 500)
rec2_auto <- reconstruct(ioss2_auto, groups = ioss2_auto$iossa.groups)

trend_time_series_iossa2_auto <- rec2_auto$F1
residuals_time_series2_auto <- rec2_auto$F2

#eossa with auto grouping

eoss <- eossa(s, nested.groups = list(1:3), k = 2)

rec_eossa <- reconstruct(eoss, groups = eoss$iossa.groups)
trend_time_series_eossa <- rec_eossa$F1
residuals_time_series_eossa <- rec_eossa$F2

#basic ssa with auto grouping

g_basic <- grouping.auto(s, base = "series",
              freq.bins = list(Tendency = 1/240, Trend = 1/24),
              threshold = 0.7)


trend_comp_all <- g_basic$Trend
trend_comp_signal <- trend_comp_all[trend_comp_all %in% 1:signal_comp_num]
signal_indices <- 1:signal_comp_num
res_comp <- signal_indices[!signal_indices %in% trend_comp_signal]

rec_basic <- reconstruct(s, groups = list(trend_comp_signal, res_comp))
trend_time_series_basic <- rec_basic$F1
residuals_time_series_basic <- rec_basic$F2
```

```
  data.frame(mse_no_grouping_trend = mean((trend_time_series_iossa5 - actual_trend) ^ 2),
             mse_no_grouping_residuals = mean((residuals_time_series5 - res) ^ 2),
             iter_no_grouping = ioss5$iossa.result$iter,
             mse_2_groups_manual_trend = mean((trend_time_series_iossa2 - actual_trend) ^ 2),
             mse_2_groups_manual_residuals = mean((residuals_time_series2 - res) ^ 2),
             iter_2_groups_manual = ioss2$iossa.result$iter,
             mse_auto_grouping_trend = mean((trend_time_series_iossa2_auto - actual_trend) ^ 2),
             mse_auto_grouping_residuals = mean((residuals_time_series2_auto - res) ^ 2),
             iter_auto_grouping = ioss2_auto$iossa.result$iter,
             mse_eossa_trend = mean((trend_time_series_eossa - actual_trend) ^ 2),
             mse_eossa_residuals = mean((residuals_time_series_eossa - res) ^ 2),
             iter_eossa = 1,
             mse_basic_trend = mean((trend_time_series_basic - actual_trend) ^ 2),
             mse_basic_residuals = mean((residuals_time_series_basic - res) ^ 2),
             iter_basic = 1)
})

stopCluster(cl)

trend_mse <- c(paste0("mean: ", round(mean(rejectEV[[1]]), 4), ", med: "
                                , round(median(rejectEV[[1]]), 4)),
               paste0("mean: "                  , round(mean(rejectEV[[4]]), 4), ", med: "
                                , round(median(rejectEV[[4]]), 4)),
               paste0("mean: "                  , round(mean(rejectEV[[7]]), 4), ", med: "
                                , round(median(rejectEV[[7]]), 4)),
               paste0("mean: "                  , round(mean(rejectEV[[10]]), 4), ", med: "
                                , round(median(rejectEV[[10]]), 4)),
               paste0("mean: "                  , round(mean(rejectEV[[13]]), 4), ", med: "
                                , round(median(rejectEV[[13]]), 4)))

residuals_mse <- c(paste0("mean: ", round(mean(rejectEV[[2]]), 4), ", med: "
                                , round(median(rejectEV[[2]]), 4)),
                   paste0("mean: "                  , round(mean(rejectEV[[5]]), 4), ", med: "
                                , round(median(rejectEV[[5]]), 4)),
                   paste0("mean: "                  , round(mean(rejectEV[[8]]), 4), ", med: "
                                , round(median(rejectEV[[8]]), 4)),
                   paste0("mean: "                  , round(mean(rejectEV[[11]]), 4), ", med: "
                                , round(median(rejectEV[[11]]), 4)),
                   paste0("mean: "                  , round(mean(rejectEV[[14]]), 4), ", med: "
                                , round(median(rejectEV[[14]]), 4)))

iterations_num <- c(paste0("mean: ", round(mean(rejectEV[[3]])), ", med: "
                                , round(median(rejectEV[[3]]))),
                    paste0("mean: "                  , round(mean(rejectEV[[6]])), ", med: "
                                , round(median(rejectEV[[6]]))),
                    paste0("mean: "                  , round(mean(rejectEV[[9]])), ", med: "
                                , round(median(rejectEV[[9]]))),
                    paste0("mean: "                  , round(mean(rejectEV[[12]])), ", med: "
                                , round(median(rejectEV[[12]]))),
                    paste0("mean: "                  , round(mean(rejectEV[[15]])), ", med: "
                                , round(median(rejectEV[[15]]))))
result <- data.frame(trend_mse = trend_mse, residuals_mse = residuals_mse, iterations_num =
                                  iterations_num)
```

```
row.names(result) <- c("no grouping", "manual grouping", "auto grouping", "eossa", "basic_ssa")

library(knitr)
print(result)
```

```
##                                trend_mse              residuals_mse
## no grouping      mean: 0.0016, med: 0.0013 mean: 0.0029, med: 0.0026
## manual grouping mean: 0.0014, med: 0.0011 mean: 0.0027, med: 0.0024
## auto grouping      mean: 9e-04, med: 6e-04  mean: 0.0022, med: 0.002
## eossa              mean: 9e-04, med: 6e-04  mean: 0.0022, med: 0.002
## basic_ssa        mean: 0.1756, med: 0.0917 mean: 0.1822, med: 0.0852
##                  iterations_num
## no grouping      mean: 7, med: 3
## manual grouping mean: 3, med: 3
## auto grouping    mean: 3, med: 3
## eossa            mean: 1, med: 1
## basic_ssa        mean: 1, med: 1
```

```
kable(result)
```

	trend_mse	residuals_mse	iterations_num
no grouping	mean: 0.0016, med: 0.0013	mean: 0.0029, med: 0.0026	mean: 7, med: 3
manual grouping	mean: 0.0014, med: 0.0011	mean: 0.0027, med: 0.0024	mean: 3, med: 3
auto grouping	mean: 9e-04, med: 6e-04	mean: 0.0022, med: 0.002	mean: 3, med: 3
eossa	mean: 9e-04, med: 6e-04	mean: 0.0022, med: 0.002	mean: 1, med: 1
basic_ssa	mean: 0.1756, med: 0.0917	mean: 0.1822, med: 0.0852	mean: 1, med: 1