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

```r
  trend_function1 <- function(n){
    # Input:      -
    # Output:
    return (2 * exp(0.03 * n) - 0.1 * n - 20)
  }
```

```r
  harmonic_component1_function <- function(n){
    # Input:      -
    # Output:
    return (5.2 * cos(2 * pi * n / 6 + pi / 4))
  }
```

```r
  harmonic_component2_function <- function(n){
    # Input:      -
    # Output:
    return (5.2 * cos(2 * pi * n / 3))
  }
```

```r
  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) +
    harmonic_component2_function(time_series_stamps)
  harmonics <- refined_time_series - actual_trend
```

```r
#tol = 1e-3, maxiter = 1000, 1000 launches

print(Sys.time())
```

```
## [1] "2022-06-06 16:52:27 MSK"
```

```r
cores <- detectCores()
cl <- makeCluster(cores[1] - 1)
registerDoParallel(cl)
M <- 100
signal_comp_num <- 6

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)
```

```r
res <- refined_time_series - actual_trend

s <- ssa(time_series, L = 48)

#iossa with 6 separate groups
ioss5 <- iossa(s, nested.groups = list(1, 2, 3, 4, 5, 6), tol = 1e-3, maxiter = 1000)
g_iossa5 <- grouping.auto(ioss5, base = "series",
               freq.bins = list(Tendency = 1/240, Trend = 1/24),
               threshold = 0.8)

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

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

#iossa with 2 groups
ioss2 <- iossa(s, nested.groups = list(1:2, 3:6), tol = 1e-3, maxiter = 1000)
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.gr

#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 = 100
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(1:6), 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 = 0.8)


  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]])
               paste0("mean: ", round(mean(rejectEV[[4]]), 4), ", med: ", round(median(rejectEV[[4]])
               paste0("mean: ", round(mean(rejectEV[[7]]), 4), ", med: ", round(median(rejectEV[[7]])
               paste0("mean: ", round(mean(rejectEV[[10]]), 4), ", med: ", round(median(rejectEV[[10]]
               paste0("mean: ", round(mean(rejectEV[[13]]), 4), ", med: ", round(median(rejectEV[[13]]

residuals_mse <- c(paste0("mean: ", round(mean(rejectEV[[2]]), 4), ", med: ", round(median(rejectEV[[1
                   paste0("mean: ", round(mean(rejectEV[[5]]), 4), ", med: ", round(median(rejectEV[[5
                   paste0("mean: ", round(mean(rejectEV[[8]]), 4), ", med: ", round(median(rejectEV[[8
                   paste0("mean: ", round(mean(rejectEV[[11]]), 4), ", med: ", round(median(rejectEV[
                   paste0("mean: ", round(mean(rejectEV[[14]]), 4), ", med: ", round(median(rejectEV[

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

```
  library(knitr)
  print(result)
```

```
##                                  trend_mse             residuals_mse
## no grouping     mean: 0.0031, med: 0.0029 mean: 0.0054, med: 0.0049
## manual grouping mean: 0.0022, med: 0.0019 mean: 0.0046, med: 0.0044
## auto grouping   mean: 0.3337, med: 0.0017 mean: 0.3268, med: 0.0044
## eossa           mean: 0.0019, med: 0.0016 mean: 0.0044, med: 0.0041
## basic_ssa       mean: 5.9826, med: 2.9367 mean: 5.9596, med: 2.9348
##                       iterations_num
## no grouping     mean: 477, med: 372
## manual grouping     mean: 4, med: 4
## auto grouping       mean: 5, med: 4
## eossa               mean: 1, med: 1
## basic_ssa           mean: 1, med: 1
```

```
  kable(result)
```

	trend_mse	residuals_mse	iterations_num
no grouping	mean: 0.0031, med: 0.0029	mean: 0.0054, med: 0.0049	mean: 477, med: 372
manual grouping	mean: 0.0022, med: 0.0019	mean: 0.0046, med: 0.0044	mean: 4, med: 4
auto grouping	mean: 0.3337, med: 0.0017	mean: 0.3268, med: 0.0044	mean: 5, med: 4
eossa	mean: 0.0019, med: 0.0016	mean: 0.0044, med: 0.0041	mean: 1, med: 1
basic_ssa	mean: 5.9826, med: 2.9367	mean: 5.9596, med: 2.9348	mean: 1, med: 1