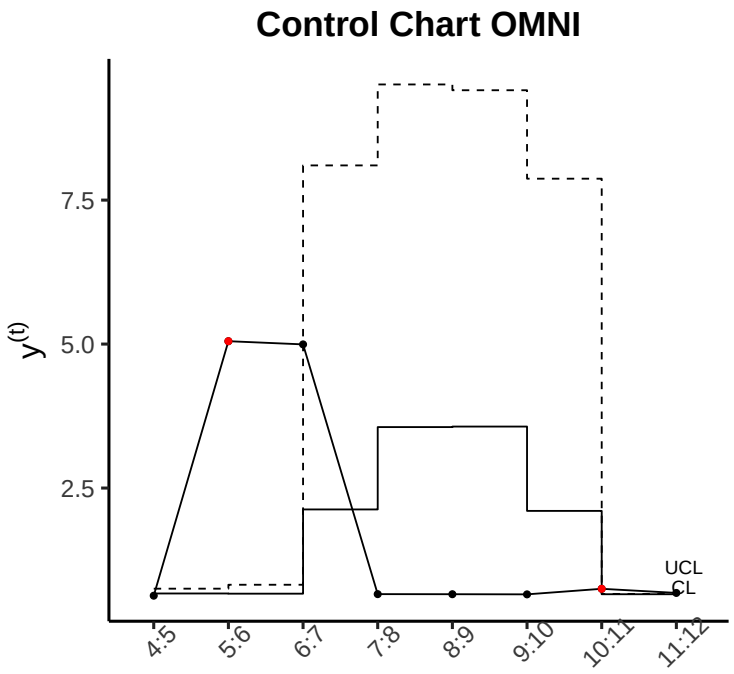
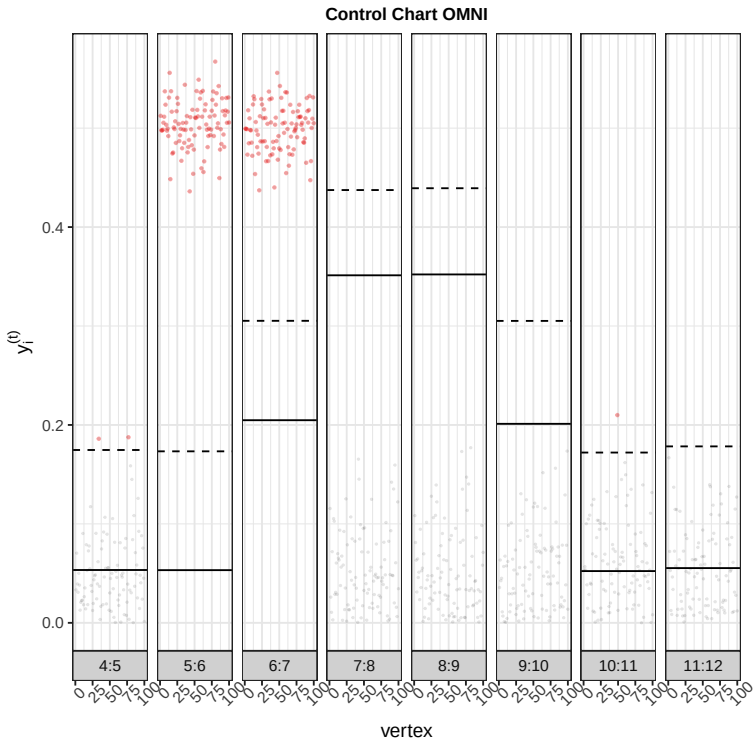
A Report Generated by knitr

August 14, 2020

The results below are generated from an R script.

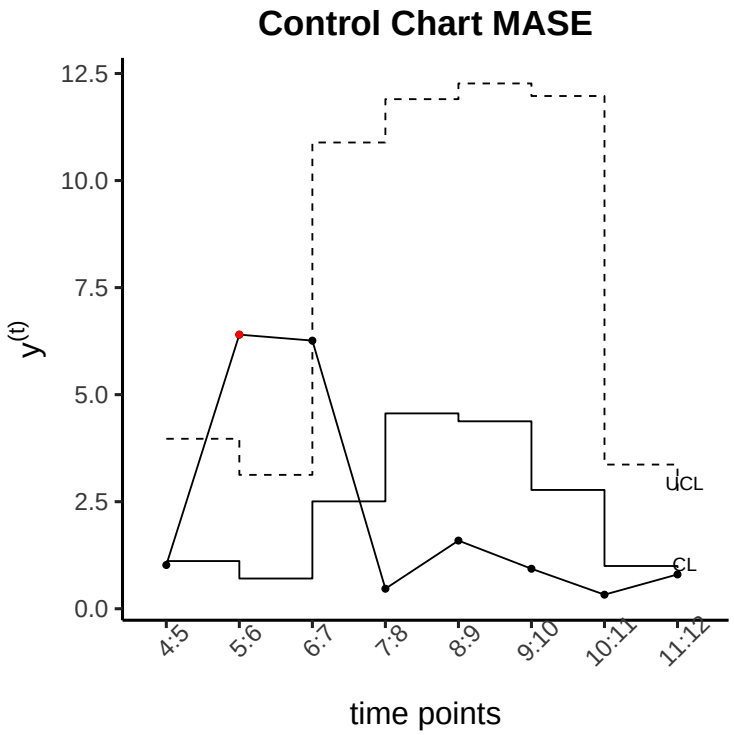
```
#source("utilAD.R")
#source("simulation.R")
#Example 1
#Generate a time series of ER graphs of length 12,
#create graph anomaly at time point 6
n <- 100
glist <- list()
for (i in 1:5) {
  glist[[i]] <- sample_gnp(n,.1)
  }
  glist[[6]] <- sample_gnp(n,.9)
  glist[[7]] <- sample_gnp(n,.1)
  for (i in 8:12) {
    glist[[i]] <- sample_gnp(n,.1)
  }
# Do anomaly detection with OMNI, provide the quantitative control chart for GraphAD and VertexAD
result.OMNI<- qccAD(glist, l=4,d=1,dsvd=NULL,method="OMNI",
 diag.augment = TRUE, approx=FALSE, par=FALSE, numpar=2)

## Warning:  'switch' is deprecated.
## Use 'strip.position' instead.
## See help("Deprecated")
```

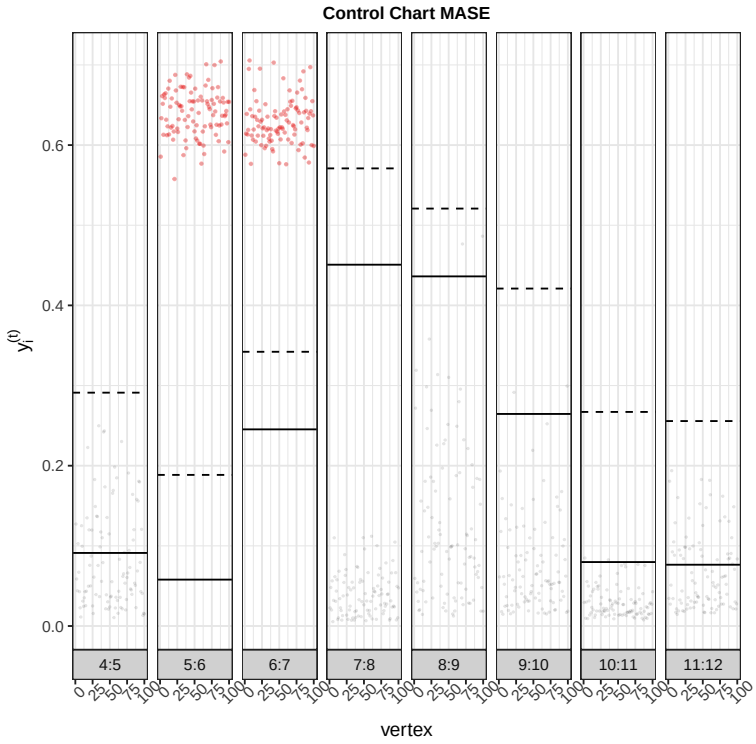





```
#print the number of deviation for GraphAD, only positive ones are meaningful
print(result.OMNI$GraphAD)

##      Samples
## Group       [,1]
##     1 -1.3733018
```

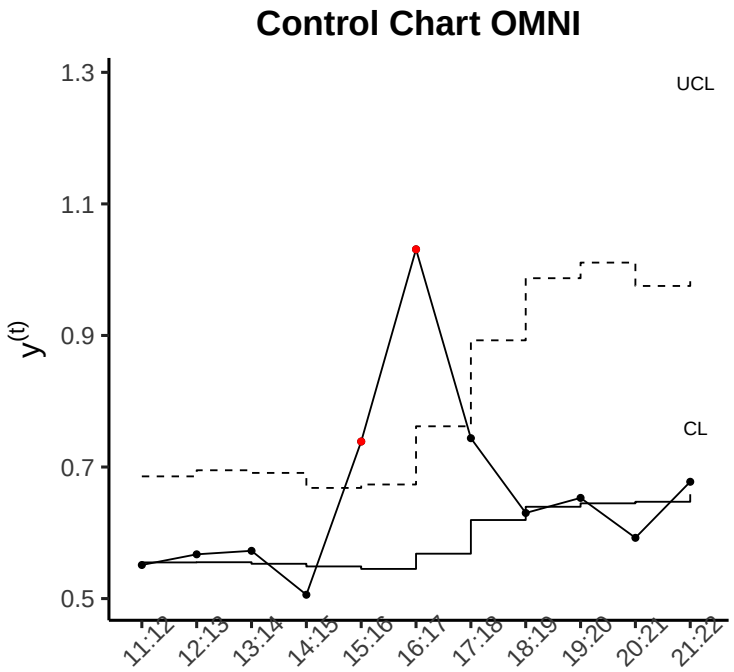
```
##      2 84.7970026
##      3  1.4393122
##      4 -1.4625044
##      5 -1.4953193
##      6 -0.7535285
##      7 53.6121408
##      8 -0.1885784

# Do anomaly detection with MASE
result.MASE<- qccAD(glist, l=4,d=2,dsvd=2,method="MASE",
               diag.augment = TRUE, approx=FALSE, par=FALSE, numpar=2)

## Warning:  'switch' is deprecated.
## Use 'strip.position' instead.
## See help("Deprecated")
```

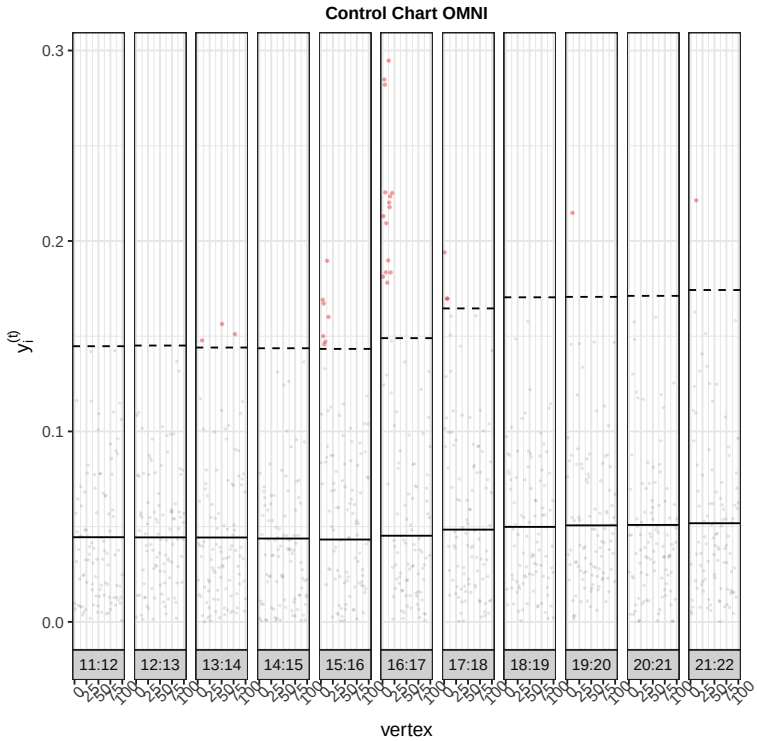





```
#print the number of deviation for GraphAD, only positive ones are meaningful
print(result.MASE$GraphAD)

##      Samples
## Group        [,1]
##     1 -0.09656679
##     2  7.05849907
##     3  1.34410088
##     4 -1.67362160
##     5 -1.05903744
##     6 -0.59989383
##     7 -0.84758103
##     8 -0.26854924

#Example 2
# Sample a time series of RDPG graph (length tmax > 17) with same 1-1 matched vertices unweighted
# hollow symmetric undirected graphs, the latent positions i.i.d uniform.
# Some vertices in 16-th and 17-th graphs are given perturbations so there exists anomalies at 16:17.
n <- 100 #number of vertices
nperturb <- 20 #number of perturbed vertices
cperturb <- .12 #number of perturbation, larger cperturb means more obvious anomalies.
rmin <- .2 # parameter for uniform[rmin, rmax].
rmax <- .8 # parameter for uniform[rmin, rmax].
tmax <- 22 # number of graphs must be greater than 17.
#Generate data or load the data you want
glist <- generate.tsg(n, nperturb, cperturb=NULL, rmin, rmax, tmax)$glist

#Do anomaly detection with OMNI in parallel
result.OMNI <- qccAD(glist, l=11,d=1,dsvd=NULL,method="OMNI",
                     diag.augment = TRUE, approx=FALSE, par=TRUE, numpar=2)
```

```
## Warning:  'switch' is deprecated.
## Use 'strip.position' instead.
## See help("Deprecated")
```



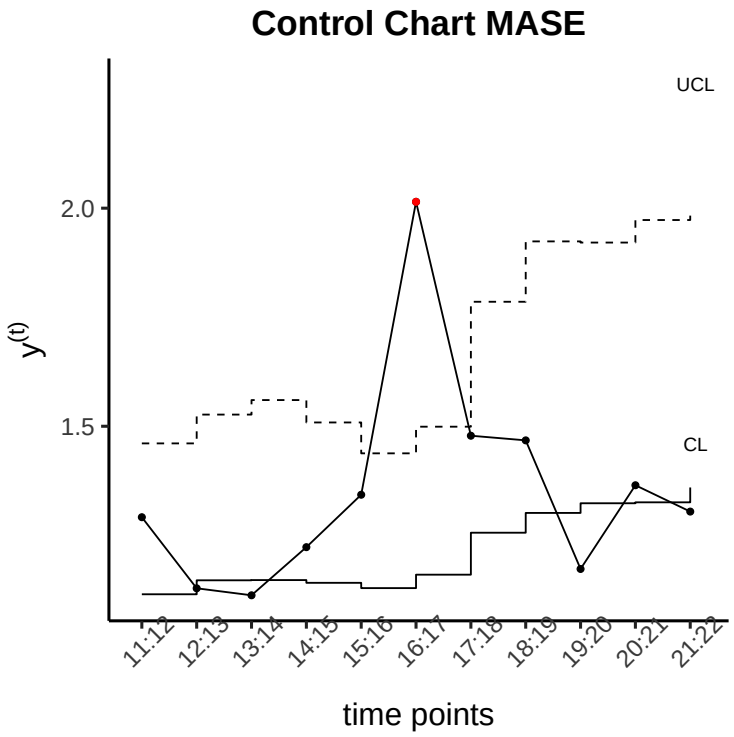


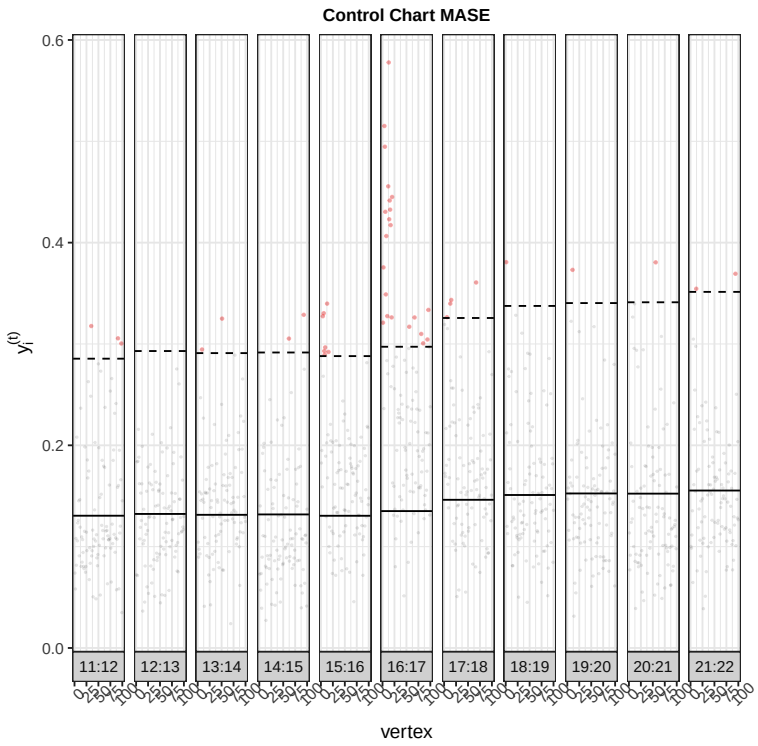
```r
#print the number of deviation for GraphAD, only positive ones are meaningful
print(result.OMNI$GraphAD)
```

```
##      Samples
## Group        [,1]
##     1  -0.08934863
##     2   0.25822764
##     3   0.42770895
##     4  -1.08170542
##     5   4.52750339
##     6   7.16829467
##     7   1.36646321
##     8  -0.08146716
##     9   0.06800435
##     10 -0.50088884
##     11  0.17556834
```

```r
# Do anomaly detection with MASE in parallel
result.MASE<- qccAD(glist, l=11,d=1,dsvd=2,method="MASE",
                    diag.augment = TRUE, approx=FALSE, par=TRUE, numpar=2)
```

```
## Warning:  'switch' is deprecated.
## Use 'strip.position' instead.
## See help("Deprecated")
```



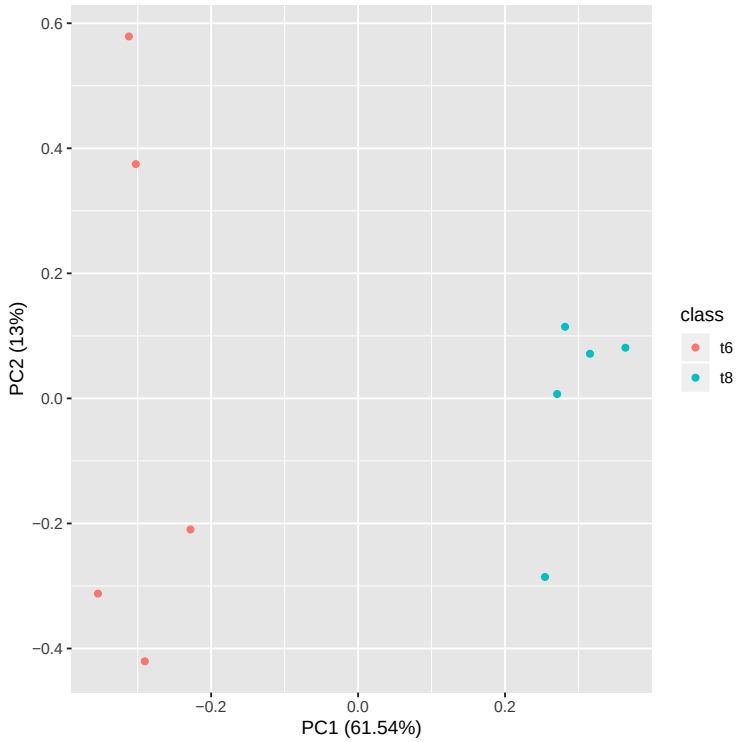



```
#print the number of deviation for GraphAD, only positive ones are meaningful
print(result.MASE$GraphAD)
```

```
##      Samples
## Group       [,1]
##     1   1.5323442
##     2  -0.1446884
##     3  -0.2533122
##     4   0.6673617
##     5   2.0787768
##     6   7.5591279
##     7   1.2601383
##     8   0.8019631
##     9  -0.7557727
##     10  0.1816826
##     11 -0.2652905
```

```
#Example 3
#five of ER tsg with change point at t=6 and five at t=8.
n <- 100
dat <- matrix(0, 10, 8)
for (j in 1:5) {
  glist <- list()
  for (i in 1:5) {
    glist[[i]] <- sample_gnp(n,.1)
  }
  glist[[6]] <- sample_gnp(n,.9)
  for (i in 7:12) {
    glist[[i]] <- sample_gnp(n,.1)
  }
```

```
  # Do anomaly detection with OMNI, provide the quantitative control chart for GraphAD and VertexAD
  result.OMNI<- qccAD(glist, l=4,d=1,dsvd=NULL,method="OMNI",
                      diag.augment = TRUE, approx=FALSE, par=FALSE, numpar=2, plot.figure = FALSE)
  dat[j,] <- result.OMNI$GraphAD
}
for (j in 6:10) {
  glist <- list()
  for (i in 1:7) {
    glist[[i]] <- sample_gnp(n,.1)
  }
  glist[[8]] <- sample_gnp(n,.9)
  for (i in 9:12) {
    glist[[i]] <- sample_gnp(n,.1)
  }
  # Do anomaly detection with OMNI, provide the quantitative control chart for GraphAD and VertexAD
  result.OMNI<- qccAD(glist, l=4,d=1,dsvd=NULL,method="OMNI",
                      diag.augment = TRUE, approx=FALSE, par=FALSE, numpar=2, plot.figure = FALSE)
  dat[j,] <- result.OMNI$GraphAD
}
df <- data.frame(dat,class=factor(c(rep("t6",5),rep("t8",5))))
pca_res <- prcomp(dat, scale. = TRUE)
library(ggfortify)
autoplot(pca_res, data = df,colour="class")
```



The R session information (including the OS info, R version and all packages used):

```
sessionInfo()

## R version 3.6.1 (2019-07-05)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
```

```
## Running under: macOS Sierra 10.12.3
##
## Matrix products: default
## BLAS:   /System/Library/Frameworks/Accelerate.framework/Versions/A/Frameworks/vecLib.framework/Versio
## LAPACK: /Library/Frameworks/R.framework/Versions/3.6/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] parallel  stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] AnomalyDetection_0.1.0 rARPACK_0.11-0         igraph_1.2.4.1
##  [4] dplyr_0.8.3            latex2exp_0.4.0        gtools_3.8.1
##  [7] irlba_2.3.3            Matrix_1.2-17          doParallel_1.0.15
## [10] iterators_1.0.12       qcc_2.7                foreach_1.4.7
## [13] ggfortify_0.4.10       ggplot2_3.2.1          knitr_1.24
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.2        lattice_0.20-38   tidyr_1.0.0       prettyunits_1.0.2
##  [5] ps_1.3.0          assertthat_0.2.1  rprojroot_1.3-2   digest_0.6.20
##  [9] RSpectra_0.16-0   R6_2.4.0          backports_1.1.4   evaluate_0.14
## [13] highr_0.8         pillar_1.4.2      rlang_0.4.5       lazyeval_0.2.2
## [17] curl_4.0          rstudioapi_0.10   callr_3.3.1       DT_0.8
## [21] labeling_0.3      desc_1.2.0        devtools_2.2.0    stringr_1.4.0
## [25] htmlwidgets_1.3   munsell_0.5.0     compiler_3.6.1    xfun_0.9
## [29] pkgconfig_2.0.2   pkgbuild_1.0.5    htmltools_0.3.6   tidyselect_0.2.5
## [33] tibble_2.1.3      gridExtra_2.3     codetools_0.2-16  crayon_1.3.4
## [37] withr_2.1.2       MASS_7.3-51.4     grid_3.6.1        gtable_0.3.0
## [41] lifecycle_0.1.0   magrittr_1.5      scales_1.0.0      cli_1.1.0
## [45] stringi_1.4.3     fs_1.3.1          remotes_2.1.0     testthat_2.2.1
## [49] ellipsis_0.2.0.1  vctrs_0.2.4       tools_3.6.1       glue_1.3.1
## [53] purrr_0.3.3       processx_3.4.1    pkgload_1.0.2     colorspace_1.4-1
## [57] sessioninfo_1.1.1 memoise_1.1.0     usethis_1.5.1

Sys.time()

## [1] "2020-08-14 10:45:41 EDT"
```