coinfection

```r
library(cooccur)
library(asnipe)
library(gmp)
source("D:/Macquarie/PhD/Data/R/cooccur2.R")
bcfrt.c <- read.csv("D:/Macquarie/PhD/Data/bacteria.csv", header = T, s
tringsAsFactors = F)
bcfrt.c <- bcfrt.c[,-c(1:8,10, 167)]
```

Co-infection of bacterial strains

We used the package "cooccur" to test the association between each strain. The function "cooccur" calculated expected cooccurrence probablities and compared with observed cooccurrence probabilities. If no difference was detected, then the model concluded that the cooccurrence between this two strains was random. If expected > observed, two strains positively cooccurred. If expected < observed, two strains negatively cooccurred.

```r
#subset bcfrt by fortnight
sub.bcfrt <- by(bcfrt.c[,-1], list(bcfrt.c$Sampling.point), function(x)
{x})
#cooccurence was analyzed using "comb" model
cooc_mod<-lapply(
  list(t(sub.bcfrt[[1]]),t(sub.bcfrt[[2]]),t(sub.bcfrt[[3]]),t(sub.bcfr
t[[4]]),
      t(sub.bcfrt[[5]]),t(sub.bcfrt[[6]])),
  FUN=function(x) cooccur2(mat = x,thresh = F, spp_names = T,
                           prob = "comb"))

cooc_mod2<-lapply(
  list(t(sub.bcfrt[[1]]),t(sub.bcfrt[[2]]),t(sub.bcfrt[[3]]),t(sub.bcfr
t[[4]]),
      t(sub.bcfrt[[5]]),t(sub.bcfrt[[6]])),
  FUN=function(x) cooccur2(mat = x,thresh = F, spp_names = T,
                           prob = "comb", only_effects = T, eff_standar
d = T,
                           eff_matrix = T))
```

The flunctuation of co-infection through time

MRQAP with Double-Semi-Partialing was adopted to evaluate the relationship of cooccurrence between fortnights. In the model of MRQAP (e.g. y ~ x1 + x2), where y and xi are N×N matrices, the relationship between y and x1 was tested while controlling for x2. Each fortnight was explained by all of its previous fortnights in our models.

```r
#transform dataset
coc_matrix <- lapply(list(cooc_mod2[[1]],cooc_mod2[[2]],cooc_mod2[[3]],
cooc_mod2[[4]],cooc_mod2[[5]],cooc_mod2[[6]]), FUN=function(x) as.matri
x(x))

#different models of MRQAP
reg6 <- mrqap.dsp(coc_matrix[[6]]~coc_matrix[[1]]+coc_matrix[[2]]+coc_m
atrix[[3]]+coc_matrix[[4]]+coc_matrix[[5]], randomisations = 1000)

reg5 <- mrqap.dsp(coc_matrix[[5]]~coc_matrix[[1]]+coc_matrix[[2]]+coc_m
atrix[[3]]+coc_matrix[[4]], randomisations = 1000)

reg4 <- mrqap.dsp(coc_matrix[[4]]~coc_matrix[[1]]+coc_matrix[[2]]+coc_m
atrix[[3]], randomisations = 1000)

reg3 <- mrqap.dsp(coc_matrix[[3]]~coc_matrix[[1]]+coc_matrix[[2]], rand
omisations = 1000)

reg2 <- mrqap.dsp(coc_matrix[[2]]~coc_matrix[[1]], randomisations = 100
0)

reg6

## MRQAP with Double-Semi-Partialing (DSP)
##
## Formula:  coc_matrix[[6]] ~ coc_matrix[[1]] + coc_matrix[[2]] + coc_
matrix[[3]] +     coc_matrix[[4]] + coc_matrix[[5]]
##
## Coefficients:
##                 Estimate      P(β>=r) P(β<=r) P(|β|<=|r|)
## intercept        0.0003162996 0.754   0.246   0.246
## coc_matrix[[1]] -0.0157211507 0.040   0.960   0.093
## coc_matrix[[2]]  0.0488379018 1.000   0.000   0.000
## coc_matrix[[3]]  0.0139460209 0.898   0.102   0.202
## coc_matrix[[4]]  0.0520937688 1.000   0.000   0.000
## coc_matrix[[5]]  0.5611031762 1.000   0.000   0.000
##
## Residual standard error: 0.009912 on 12084 degrees of freedom
## F-statistic: 790.8 on 5 and 12084 degrees of freedom, p-value:     0

## Multiple R-squared: 0.2465   Adjusted R-squared: 0.2462
## AIC: -676.3196

reg5

## MRQAP with Double-Semi-Partialing (DSP)
##
## Formula:  coc_matrix[[5]] ~ coc_matrix[[1]] + coc_matrix[[2]] + coc_
matrix[[3]] +     coc_matrix[[4]]
##
```

```
## Coefficients:
##                   Estimate      P(β>=r) P(β<=r) P(|β|<=|r|)
## intercept        0.0009822194 0.987    0.013   0.013
## coc_matrix[[1]]  0.0647910605 1.000    0.000   0.000
## coc_matrix[[2]]  0.0353566098 1.000    0.000   0.000
## coc_matrix[[3]]  0.0858478365 1.000    0.000   0.000
## coc_matrix[[4]]  0.3328565843 1.000    0.000   0.000
##
## Residual standard error: 0.009402 on 12085 degrees of freedom
## F-statistic: 275.6 on 4 and 12085 degrees of freedom, p-value:     0

## Multiple R-squared: 0.0836   Adjusted R-squared: 0.08329
## AIC: -672.1627

reg4

## MRQAP with Double-Semi-Partialing (DSP)
##
## Formula:  coc_matrix[[4]] ~ coc_matrix[[1]] + coc_matrix[[2]] + coc_
matrix[[3]]
##
## Coefficients:
##                   Estimate      P(β>=r) P(β<=r) P(|β|<=|r|)
## intercept        0.0004929296 0.957    0.043   0.043
## coc_matrix[[1]]  0.0595369980 1.000    0.000   0.000
## coc_matrix[[2]]  0.0255768232 0.998    0.002   0.003
## coc_matrix[[3]]  0.1173125463 1.000    0.000   0.000
##
## Residual standard error: 0.007138 on 12086 degrees of freedom
## F-statistic: 133.7 on 3 and 12086 degrees of freedom, p-value:     0

## Multiple R-squared: 0.03212  Adjusted R-squared: 0.03188
## AIC: -710.9744

reg3

## MRQAP with Double-Semi-Partialing (DSP)
##
## Formula:  coc_matrix[[3]] ~ coc_matrix[[1]] + coc_matrix[[2]]
##
## Coefficients:
##                   Estimate     P(β>=r) P(β<=r) P(|β|<=|r|)
## intercept        0.000559544 0.948    0.052   0.052
## coc_matrix[[1]]  0.079678097 1.000    0.000   0.000
## coc_matrix[[2]]  0.190238913 1.000    0.000   0.000
##
## Residual standard error: 0.008734 on 12087 degrees of freedom
## F-statistic: 255.9 on 2 and 12087 degrees of freedom, p-value:     0
```

```
## Multiple R-squared: 0.04062  Adjusted R-squared: 0.04046
## AIC: -718.3056

reg2

## MRQAP with Double-Semi-Partialing (DSP)
##
## Formula:  coc_matrix[[2]] ~ coc_matrix[[1]]
##
## Coefficients:
##                   Estimate      P(β>=r) P(β<=r) P(|β|<=|r|)
## intercept        0.0003271879 0.869    0.131   0.131
## coc_matrix[[1]] 0.1065911858 1.000    0.000   0.000
##
## Residual standard error: 0.008022 on 12088 degrees of freedom
## F-statistic: 192.4 on 1 and 12088 degrees of freedom, p-value:     0

## Multiple R-squared: 0.01566  Adjusted R-squared: 0.01558
## AIC: -738.8985
```