script para AMMI e GGE

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instalando e carregando pacotes requeridos.

Para instalar os pacotes retire o # abaixo. É necessário instalar uma única vez. Para carregar utilize os comandos `library()` como a seguir.

```
#install.packages("readr","agricolae","GGEBiplots","tidyverse","GGEBiplots")
library(readr)
library(agricolae)
library(GGEBiplots)
library(tidyverse)
```

```
## -- Attaching packages -----------------

## v ggplot2 3.3.2     v dplyr   1.0.2
## v tibble  3.0.3     v stringr 1.4.0
## v tidyr   1.1.1     v forcats 0.5.0
## v purrr   0.3.4

## -- Conflicts --------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
### Análise AMMI e GGE
#lendo os dados:
dados_sarti_aula <- read.csv("dados_sarti.csv")
glimpse(dados_sarti_aula)
```

```
## Rows: 200
## Columns: 5
## $ X      <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 1...
## $ blocks <int> 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, ...
## $ ef     <chr> "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", ...
## $ dataf  <dbl> 11153.414, 10697.478, 10440.566, 11458.662, 8816.668, 8360.7...
## $ genf   <chr> "g1", "g1", "g1", "g1", "g2", "g2", "g2", "g2", "g3", "g3", ...
```

```
head(dados_sarti_aula)# o data set contem genotipos, blocos, ambients e dados da producao de milho simu
```

```
##   X blocks ef     dataf genf
## 1 1      1 e1 11153.414   g1
```

```
## 2 2      2 e1 10697.478   g1
## 3 3      3 e1 10440.566   g1
## 4 4      4 e1 11458.662   g1
## 5 5      1 e1  8816.668   g2
## 6 6      2 e1  8360.731   g2
```

```
dados_sarti_aula=dados_sarti_aula[,-1] # retirando a primeira coluna que apenas diz o numero da observa

glimpse(dados_sarti_aula)
```

```
## Rows: 200
## Columns: 4
## $ blocks <int> 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, ...
## $ ef     <chr> "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", "e1", ...
## $ dataf  <dbl> 11153.414, 10697.478, 10440.566, 11458.662, 8816.668, 8360.7...
## $ genf   <chr> "g1", "g1", "g1", "g1", "g2", "g2", "g2", "g2", "g3", "g3", ...
```

```
head(dados_sarti_aula)
```

```
##   blocks ef     dataf genf
## 1      1 e1 11153.414   g1
## 2      2 e1 10697.478   g1
## 3      3 e1 10440.566   g1
## 4      4 e1 11458.662   g1
## 5      1 e1  8816.668   g2
## 6      2 e1  8360.731   g2
```

```
str(dados_sarti_aula)
```

```
## 'data.frame':    200 obs. of  4 variables:
##  $ blocks: int  1 2 3 4 1 2 3 4 1 2 ...
##  $ ef    : chr  "e1" "e1" "e1" "e1" ...
##  $ dataf : num  11153 10697 10441 11459 8817 ...
##  $ genf  : chr  "g1" "g1" "g1" "g1" ...
```

Análise AMMI com pacote agricolae

ajuste de parametros para rodar o modelo

```
Ambiente<- as.factor(dados_sarti_aula[,2])
Genotipo<-as.factor( dados_sarti_aula[, 4])
Bloco<-as.factor( dados_sarti_aula[, 1])
Prod<- dados_sarti_aula[, 3]
ENV=Ambiente
GEN=Genotipo
REP=Bloco
Y=Prod
model<-AMMI(Ambiente,Genotipo,Bloco, Prod,PC=T,console=T)
```

```
##
## ANALYSIS AMMI:  Prod
## Class level information
##
## ENV:  e1 e2 e3 e4 e5
## GEN:  g1 g2 g3 g4 g5 g6 g7 g8 g9 g10
## REP:  1 2 3 4
##
## Number of observations:  200
##
## model Y: Prod  ~ ENV + REP%in%ENV + GEN + ENV:GEN
## Random effect REP%in%ENV
##
## Analysis of Variance Table
##
## Response: Y
##            Df    Sum Sq   Mean Sq F value    Pr(>F)
## ENV         4 640136218 160034054  55.585 8.126e-09 ***
## REP(ENV)   15  43186196   2879080  34.515 < 2.2e-16 ***
## GEN         9 100918110  11213123 134.427 < 2.2e-16 ***
## ENV:GEN    36 260145965   7226277  86.631 < 2.2e-16 ***
## Residuals 135  11260950     83414
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Coeff var    Mean Prod
## 2.988485      9664.282
##
## Analysis
##     percent  acum Df    Sum.Sq  Mean.Sq F.value Pr.F
## PC1    66.3  66.3 12 172585034 14382086  172.42    0
## PC2    22.5  88.8 10  58450214  5845021   70.07    0
## PC3     6.9  95.7  8  17833738  2229217   26.72    0
## PC4     4.3 100.0  6  11276980  1879497   22.53    0
```

```
names(model) # verificar o que a funcao ammi torna disponivel
```

```
## [1] "ANOVA"    "genXenv"  "analysis" "means"    "biplot"   "PC"
```

extraindo parametros da analise ammi

```
model$ANOVA # analise de variancia conjunta
```

```
## Analysis of Variance Table
##
## Response: Y
##            Df    Sum Sq   Mean Sq F value    Pr(>F)
## ENV         4 640136218 160034054  55.585 8.126e-09 ***
## REP(ENV)   15  43186196   2879080  34.515 < 2.2e-16 ***
## GEN         9 100918110  11213123 134.427 < 2.2e-16 ***
```

```
## ENV:GEN    36 260145965   7226277  86.631 < 2.2e-16 ***
## Residuals 135  11260950     83414
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
model$genXenv # tabela de residuos de genotipo dentro dos ambientes calculados a partir de regressao co
```

```
## GEN: g1
## ENV: e1
## [1] 197.7838
## ---------------------------------------------------------------
## GEN: g10
## ENV: e1
## [1] -782.9745
## ---------------------------------------------------------------
## GEN: g2
## ENV: e1
## [1] -1381.137
## ---------------------------------------------------------------
## GEN: g3
## ENV: e1
## [1] 929.8413
## ---------------------------------------------------------------
## GEN: g4
## ENV: e1
## [1] -1255.423
## ---------------------------------------------------------------
## GEN: g5
## ENV: e1
## [1] 995.8661
## ---------------------------------------------------------------
## GEN: g6
## ENV: e1
## [1] 1358.444
## ---------------------------------------------------------------
## GEN: g7
## ENV: e1
## [1] -689.295
## ---------------------------------------------------------------
## GEN: g8
## ENV: e1
## [1] 132.5584
## ---------------------------------------------------------------
## GEN: g9
## ENV: e1
## [1] 494.3363
## ---------------------------------------------------------------
## GEN: g1
## ENV: e2
## [1] 1423.61
## ---------------------------------------------------------------
## GEN: g10
## ENV: e2
## [1] -469.4436
```

```
## ----------------------------------------------------------------
## GEN: g2
## ENV: e2
## [1] 2181.435
## ----------------------------------------------------------------
## GEN: g3
## ENV: e2
## [1] -2461.497
## ----------------------------------------------------------------
## GEN: g4
## ENV: e2
## [1] 1790.727
## ----------------------------------------------------------------
## GEN: g5
## ENV: e2
## [1] -1111.238
## ----------------------------------------------------------------
## GEN: g6
## ENV: e2
## [1] 1658.733
## ----------------------------------------------------------------
## GEN: g7
## ENV: e2
## [1] 988.7608
## ----------------------------------------------------------------
## GEN: g8
## ENV: e2
## [1] -1899.932
## ----------------------------------------------------------------
## GEN: g9
## ENV: e2
## [1] -2101.154
## ----------------------------------------------------------------
## GEN: g1
## ENV: e3
## [1] -696.3915
## ----------------------------------------------------------------
## GEN: g10
## ENV: e3
## [1] 1297.969
## ----------------------------------------------------------------
## GEN: g2
## ENV: e3
## [1] 61.43404
## ----------------------------------------------------------------
## GEN: g3
## ENV: e3
## [1] 1488.047
## ----------------------------------------------------------------
## GEN: g4
## ENV: e3
## [1] -488.0003
## ----------------------------------------------------------------
## GEN: g5
```

```
## ENV: e3
## [1] -1153.758
## ----------------------------------------------------------------
## GEN: g6
## ENV: e3
## [1] -2071.734
## ----------------------------------------------------------------
## GEN: g7
## ENV: e3
## [1] -1062.421
## ----------------------------------------------------------------
## GEN: g8
## ENV: e3
## [1] 2464.901
## ----------------------------------------------------------------
## GEN: g9
## ENV: e3
## [1] 159.9536
## ----------------------------------------------------------------
## GEN: g1
## ENV: e4
## [1] -236.4588
## ----------------------------------------------------------------
## GEN: g10
## ENV: e4
## [1] 203.2668
## ----------------------------------------------------------------
## GEN: g2
## ENV: e4
## [1] 521.3668
## ----------------------------------------------------------------
## GEN: g3
## ENV: e4
## [1] -924.8852
## ----------------------------------------------------------------
## GEN: g4
## ENV: e4
## [1] -242.2998
## ----------------------------------------------------------------
## GEN: g5
## ENV: e4
## [1] -44.06599
## ----------------------------------------------------------------
## GEN: g6
## ENV: e4
## [1] 34.82079
## ----------------------------------------------------------------
## GEN: g7
## ENV: e4
## [1] 607.5197
## ----------------------------------------------------------------
## GEN: g8
## ENV: e4
## [1] -868.7389
```

```
## ---------------------------------------------------------------
## GEN: g9
## ENV: e4
## [1] 949.4745
## ---------------------------------------------------------------
## GEN: g1
## ENV: e5
## [1] -688.5434
## ---------------------------------------------------------------
## GEN: g10
## ENV: e5
## [1] -248.8178
## ---------------------------------------------------------------
## GEN: g2
## ENV: e5
## [1] -1383.099
## ---------------------------------------------------------------
## GEN: g3
## ENV: e5
## [1] 968.4946
## ---------------------------------------------------------------
## GEN: g4
## ENV: e5
## [1] 194.9964
## ---------------------------------------------------------------
## GEN: g5
## ENV: e5
## [1] 1313.196
## ---------------------------------------------------------------
## GEN: g6
## ENV: e5
## [1] -980.2638
## ---------------------------------------------------------------
## GEN: g7
## ENV: e5
## [1] 155.4351
## ---------------------------------------------------------------
## GEN: g8
## ENV: e5
## [1] 171.2116
## ---------------------------------------------------------------
## GEN: g9
## ENV: e5
## [1] 497.3899
```

```
model$analysis# obtencao dos valores de pc para analise ammi
```

```
##     percent  acum Df     Sum.Sq  Mean.Sq F.value Pr.F
## PC1    66.3  66.3 12 172585034 14382086  172.42    0
## PC2    22.5  88.8 10  58450214  5845021   70.07    0
## PC3     6.9  95.7  8  17833738  2229217   26.72    0
## PC4     4.3 100.0  6  11276980  1879497   22.53    0
```

```r
model$means # medias de genotipos dentro de ambientes
```

```
##    ENV GEN      Prod    RESIDUAL
## 1   e1  g1 10937.530   197.78384
## 2   e1 g10  8064.665  -782.97449
## 3   e1  g2  8600.783 -1381.13750
## 4   e1  g3  9485.149   929.84134
## 5   e1  g4  8600.783 -1255.42318
## 6   e1  g5  9206.473   995.86614
## 7   e1  g6 10937.530  1358.44423
## 8   e1  g7  9206.473  -689.29502
## 9   e1  g8  9485.149   132.55835
## 10  e1  g9 10048.149   494.33627
## 11  e2  g1  9263.542  1423.60979
## 12  e2 g10  5478.383  -469.44356
## 13  e2  g2  9263.542  2181.43531
## 14  e2  g3  3193.997 -2461.49750
## 15  e2  g4  8747.120  1790.72683
## 16  e2  g5  4199.555 -1111.23771
## 17  e2  g6  8338.005  1658.73255
## 18  e2  g7  7984.715   988.76083
## 19  e2  g8  4552.845 -1899.93228
## 20  e2  g9  4552.845 -2101.15427
## 21  e3  g1 12657.665  -696.39148
## 22  e3 g10 12759.919  1297.96900
## 23  e3  g2 12657.665    61.43404
## 24  e3  g3 12657.665  1488.04677
## 25  e3  g4 11982.516  -488.00032
## 26  e3  g5  9671.158 -1153.75841
## 27  e3  g6 10121.662 -2071.73381
## 28  e3  g7 11447.657 -1062.42060
## 29  e3  g8 14431.802  2464.90121
## 30  e3  g9 12328.076   159.95360
## 31  e4  g1 10937.530  -236.45876
## 32  e4 g10  9485.149   203.26684
## 33  e4  g2 10937.530   521.36676
## 34  e4  g3  8064.665  -924.88520
## 35  e4  g4 10048.149  -242.29977
## 36  e4  g5  8600.783   -44.06599
## 37  e4  g6 10048.149    34.82079
## 38  e4  g7 10937.530   607.51971
## 39  e4  g8  8918.095  -868.73887
## 40  e4  g9 10937.530   949.47451
## 41  e5  g1 10937.530  -688.54339
## 42  e5 g10  9485.149  -248.81779
## 43  e5  g2  9485.149 -1383.09862
## 44  e5  g3 10410.130   968.49458
## 45  e5  g4 10937.530   194.99644
## 46  e5  g5 10410.130  1313.19597
## 47  e5  g6  9485.149  -980.26375
## 48  e5  g7 10937.530   155.43508
## 49  e5  g8 10410.130   171.21160
## 50  e5  g9 10937.530   497.38988
```

```r
model$biplot# coordenadas utilizadas na construcao de biplots
```

```
##     type      Prod        PC1        PC2         PC3        PC4
## g1   GEN 10946.759  19.832102  -2.233471  14.9420163   2.005777
## g10  GEN  9054.653  -9.423351  22.094489  -5.0505405  -8.388392
## g2   GEN 10188.934  29.879854  26.919443  -0.1715677 -11.450100
## g3   GEN  8762.321 -39.925876  -3.337252  10.5457131  10.440941
## g4   GEN 10063.220  22.527867  12.141486 -11.0251838  23.959793
## g5   GEN  8417.620 -11.029196 -32.343138 -11.2002077  11.485713
## g6   GEN  9786.099  29.020292 -27.927154  23.8162921  -9.131742
## g7   GEN 10102.781  17.965228  -3.386263 -19.5125904   2.038773
## g8   GEN  9559.604 -35.507597  21.009793  15.4681057   2.773656
## g9   GEN  9760.826 -23.339323 -12.937932 -17.8120370 -23.734420
## e1   ENV  9457.269 -14.548501 -37.850805  27.7945571  -6.747611
## e2   ENV  6557.455  65.632803  12.730605   8.6488695  10.557131
## e3   ENV 12071.578 -38.417963  44.337219  11.2202087  -1.550114
## e4   ENV  9891.511   9.368732  -3.385594 -24.9171874 -28.671690
## e5   ENV 10343.596 -22.035071 -15.831425 -22.7464479  26.412285
```

```r
model$PC # objeto com dados sobre a analise de componentes principais
```

```
## Call:
## princomp(x = OUTRES2, cor = FALSE)
##
## Standard deviations:
##       Comp.1       Comp.2       Comp.3       Comp.4       Comp.5
## 2.077168e+03 1.208824e+03 6.677151e+02 5.309656e+02 1.504844e-05
##
##  5  variables and  10 observations.
```

```r
model$PC$sdev # desvio padrao
```

```
##       Comp.1       Comp.2       Comp.3       Comp.4       Comp.5
## 2.077168e+03 1.208824e+03 6.677151e+02 5.309656e+02 1.504844e-05
```

```r
model$PC$loadings # pcs loadings
```

```
##
## Loadings:
##    Comp.1 Comp.2 Comp.3 Comp.4 Comp.5
## e1  0.180  0.612  0.605  0.165  0.447
## e2 -0.810 -0.206  0.188 -0.258  0.447
## e3  0.474 -0.717  0.244         0.447
## e4 -0.116        -0.542  0.700  0.447
## e5  0.272  0.256 -0.495 -0.645  0.447
##
##                Comp.1 Comp.2 Comp.3 Comp.4 Comp.5
## SS loadings       1.0    1.0    1.0    1.0    1.0
## Proportion Var    0.2    0.2    0.2    0.2    0.2
## Cumulative Var    0.2    0.4    0.6    0.8    1.0
```

```r
model$PC$center
```

```
##            e1            e2            e3            e4            e5
##  9.947598e-14  2.131628e-13 -1.572076e-13 -1.918465e-13  6.394885e-14
```

```r
model$PC$scale
```

```
## e1 e2 e3 e4 e5
##  1  1  1  1  1
```

```r
model$PC$n.obs
```

```
## [1] 10
```

```r
model$PC$scores # scores de genotipos
```

```
##
## GEN       Comp.1     Comp.2     Comp.3     Comp.4        Comp.5
##   g1  -1607.3281   138.0899  686.60159  -82.18941 -5.115908e-13
##   g10   763.7323 -1366.0465 -232.07772  343.72564  1.421085e-14
##   g2  -2421.6661 -1664.3613   -7.88372  469.18323  7.958079e-13
##   g3   3235.8638   206.3339  484.58677 -427.83160 -6.821210e-13
##   g4  -1825.8112  -750.6775 -506.61896 -981.78470  7.815970e-13
##   g5    893.8808  1999.6947 -514.66149 -470.64253  6.821210e-13
##   g6  -2352.0013  1726.6655 1094.38403  374.18538 -1.989520e-12
##   g7  -1456.0239   209.3641 -896.62435  -83.54148  7.247536e-13
##   g8   2877.7765 -1298.9825  710.77596 -113.65427 -1.278977e-13
##   g9   1891.5771   799.9197 -818.48210  972.54974  5.400125e-13
```

coeficiente de variacao

```r
#calculo de coeficiente de variacao ammi
model$ANOVA ###tabela 4 p?gina 67
```

```
## Analysis of Variance Table
##
## Response: Y
##            Df    Sum Sq   Mean Sq F value    Pr(>F)
## ENV         4 640136218 160034054  55.585 8.126e-09 ***
## REP(ENV)   15  43186196   2879080  34.515 < 2.2e-16 ***
## GEN         9 100918110  11213123 134.427 < 2.2e-16 ***
## ENV:GEN    36 260145965   7226277  86.631 < 2.2e-16 ***
## Residuals 135  11260950     83414
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
coefvar<-sqrt(222882)/mean(Prod)
coefvar
```

```
## [1] 0.04885038
```

```r
coefvar*100
```

```
## [1] 4.885038
```

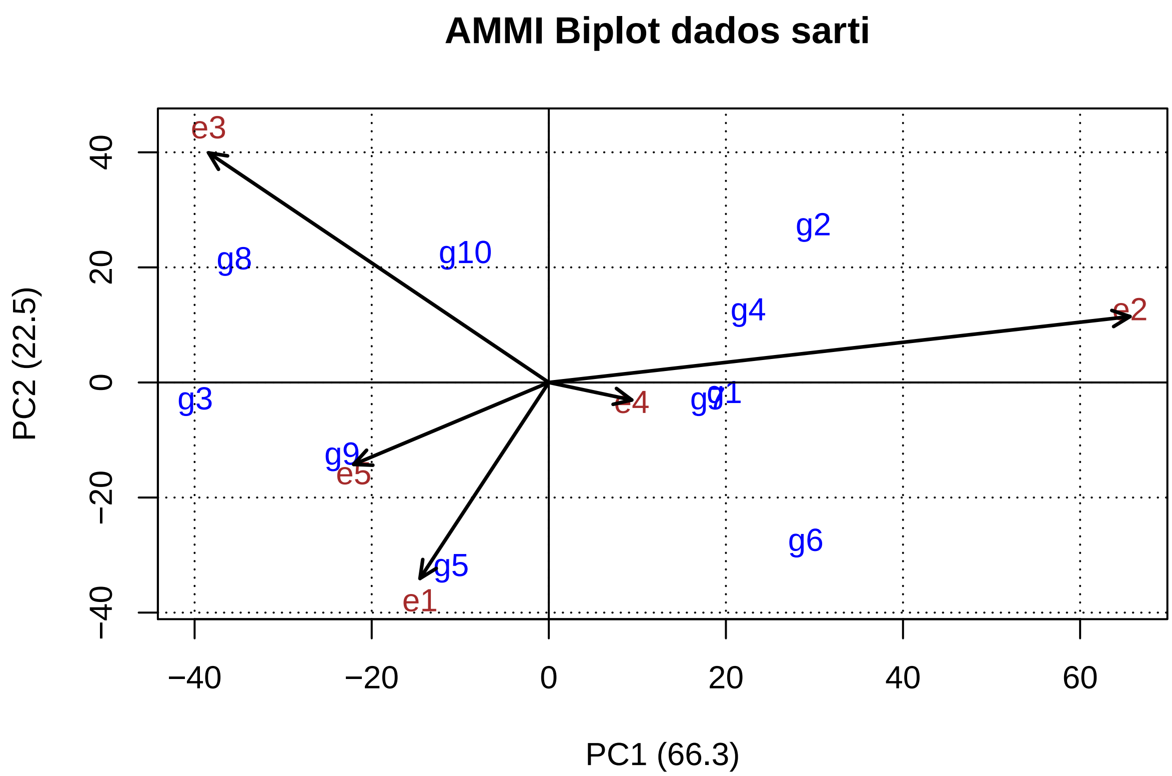
decomposicao de valores singulares na mao

```r
ngen=length(levels(GEN))
nenv=length(levels(ENV))
svd(model$genXenv, nu = min(ngen, nenv-1), nv = min(ngen, nenv-1))
```

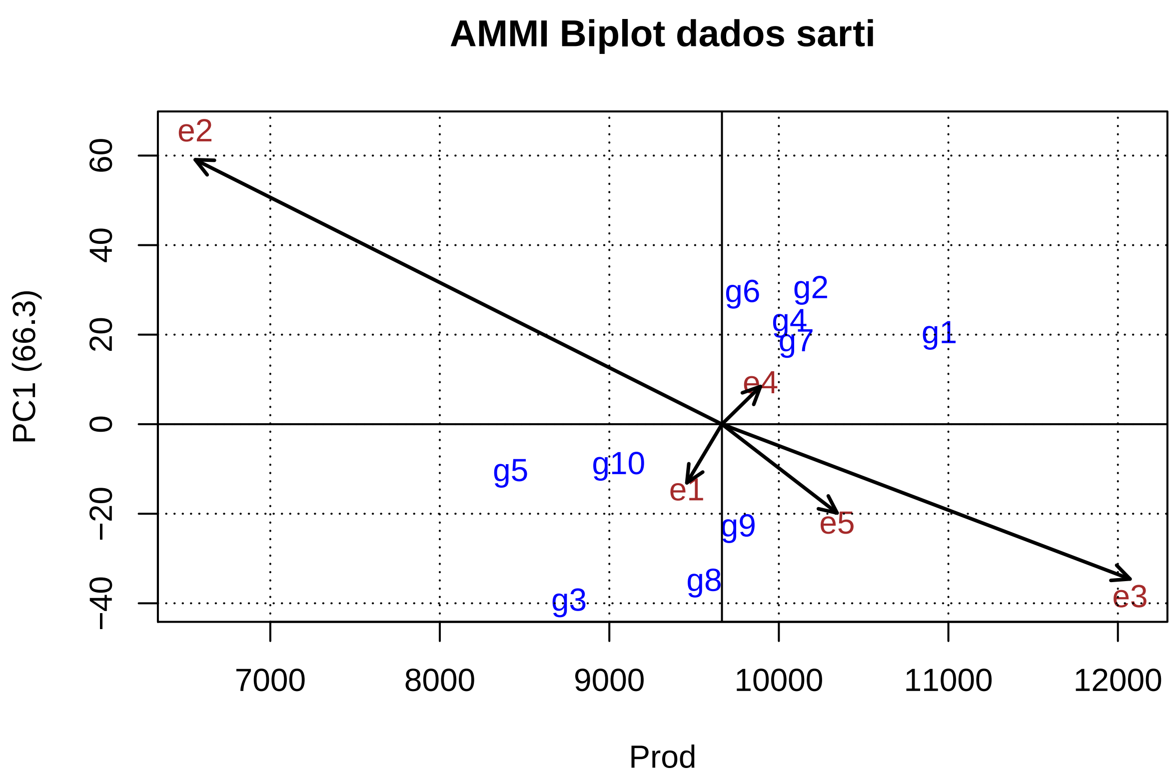
```
## $d
## [1] 6.568581e+03 3.822637e+03 2.111501e+03 1.679061e+03 1.319698e-12
##
## $u
##             [,1]        [,2]         [,3]        [,4]
##  [1,]  0.2446994 -0.03612424  0.325172348  0.04894963
##  [2,] -0.1162705  0.35735712 -0.109911278 -0.20471305
##  [3,]  0.3686742  0.43539611 -0.003733705 -0.27943196
##  [4,] -0.4926275 -0.05397685  0.229498764  0.25480413
##  [5,]  0.2779613  0.19637686 -0.239933142  0.58472256
##  [6,] -0.1360843 -0.52311917 -0.243742059  0.28030108
##  [7,]  0.3580684 -0.45169486  0.518296825 -0.22285399
##  [8,]  0.2216649 -0.05476955 -0.424638463  0.04975489
##  [9,] -0.4381124  0.33981319  0.336621252  0.06768920
## [10,] -0.2879735 -0.20925862 -0.387630542 -0.57922249
##
## $v
##            [,1]        [,2]       [,3]        [,4]
## [1,] -0.1795074 -0.61220037  0.6048729 -0.16467090
## [2,]  0.8098138  0.20590529  0.1882191  0.25763965
## [3,] -0.4740221  0.71711188  0.2441773 -0.03782949
## [4,]  0.1155966 -0.05475872 -0.5422548 -0.69971324
## [5,] -0.2718809 -0.25605808 -0.4950146  0.64457398
```

Biplots PC1xPC2, PC1xmedia e triplot

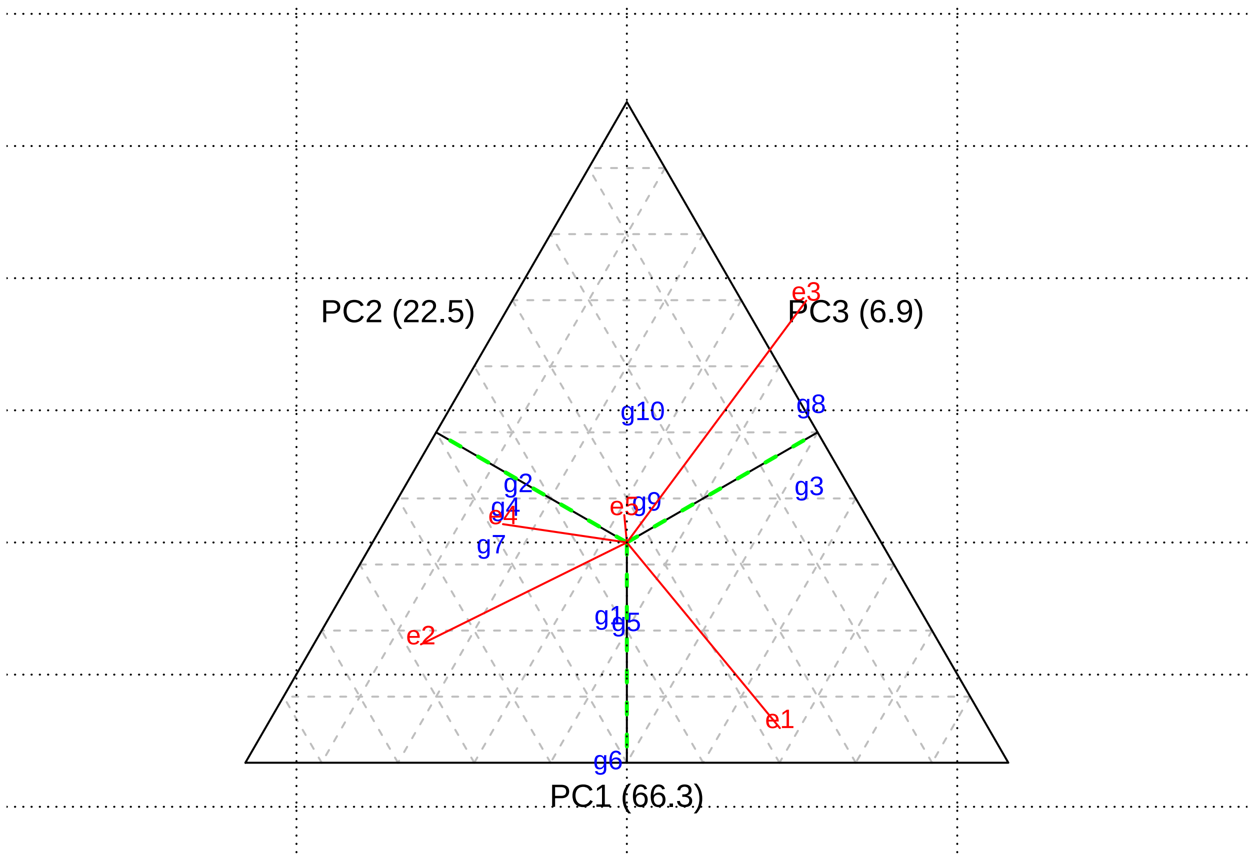
```r
plot(model,type = 1, main="AMMI Biplot dados sarti ")
grid(col="black")
```




```r
plot(model,first=0,second=1, main="AMMI Biplot dados sarti")
grid(col="black")
```



```r
plot(model,type = 2, main="AMMI Biplot dados sarti ")
grid(col="black")
```



GGE_analysis

preparando os dados para usar na funcao do pacote GGEBiplots

```r
sarti_medias=model$means #medias de genotipos dentro ambientes
sarti_medias=sarti_medias[,-4] # tira a coluna dos  e residuos
data_wide_sarti=spread(sarti_medias,ENV,Prod) # tabela no formato wide a ser usada pelo GGE
typeof(data_wide_sarti)
```

```
## [1] "list"
```

```r
#convertendo para data frame
data_wide_sarti=as.data.frame(data_wide_sarti)
glimpse(data_wide_sarti)
```

```
## Rows: 10
## Columns: 6
## $ GEN <chr> "g1", "g10", "g2", "g3", "g4", "g5", "g6", "g7", "g8", "g9"
```

```
## $ e1  <dbl> 10937.530, 8064.665, 8600.783, 9485.149, 8600.783, 9206.473, 10...
## $ e2  <dbl> 9263.542, 5478.383, 9263.542, 3193.997, 8747.120, 4199.555, 833...
## $ e3  <dbl> 12657.665, 12759.919, 12657.665, 12657.665, 11982.516, 9671.158...
## $ e4  <dbl> 10937.530, 9485.149, 10937.530, 8064.665, 10048.149, 8600.783, ...
## $ e5  <dbl> 10937.530, 9485.149, 9485.149, 10410.130, 10937.530, 10410.130,...
```

```
data_wide_sarti_gge=data_wide_sarti[,-1]
rownames(data_wide_sarti_gge)=data_wide_sarti[,1]
```

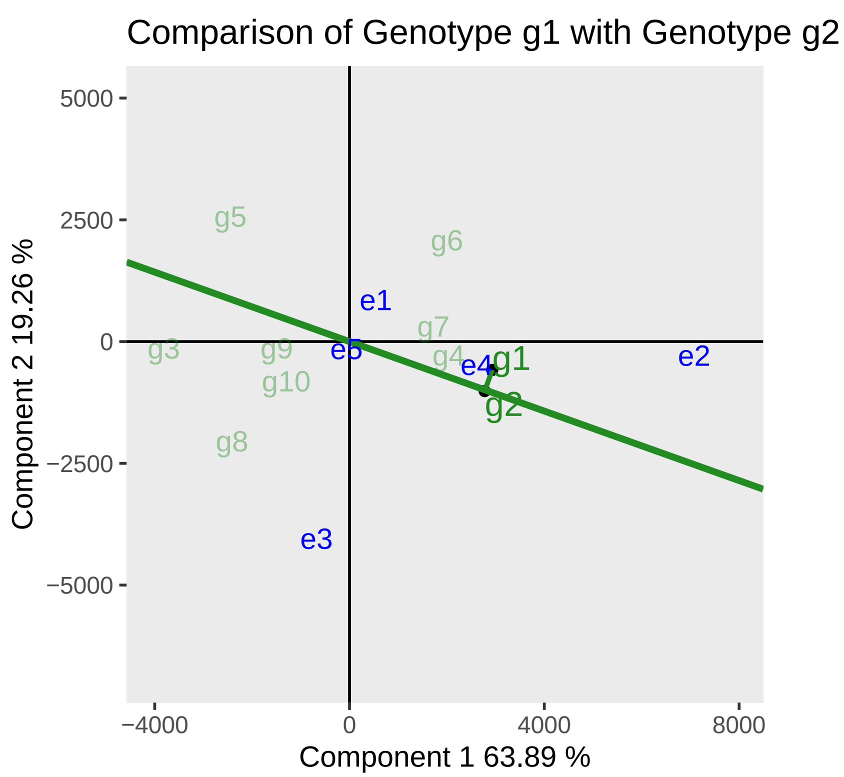
```
sarti_GGE1<-GGEModel(data_wide_sarti_gge,scaling = "none", centering = "tester",SVP="dual")

#str(sarti_GGE1) Verificar tudo que é retornado pela funcao,. basta descomentar tirando o #. se quise a


sarti_GGE1$eigenvalues
```

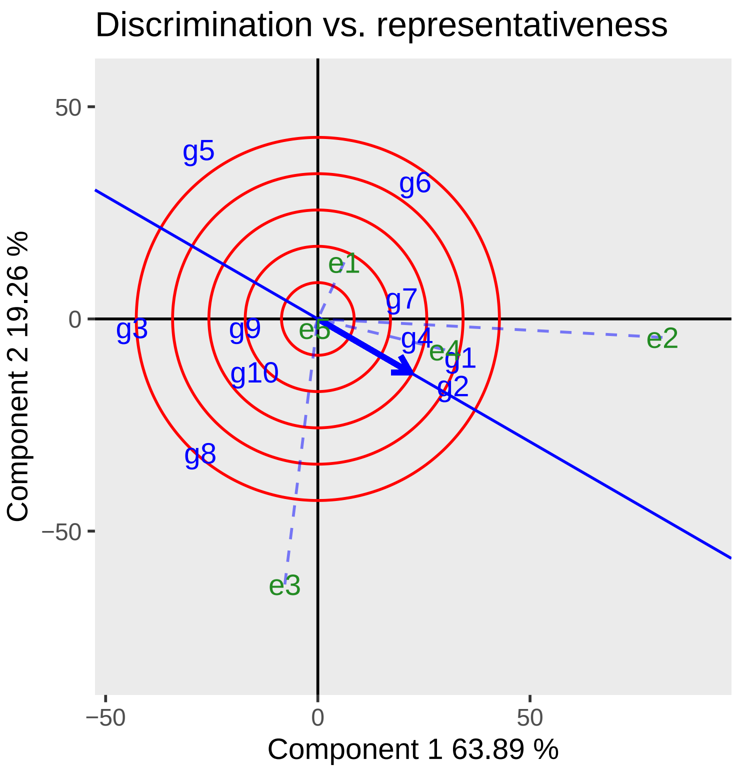
```
## [1] 7594.120 4169.234 2900.118 2055.870 1604.852
```

```
CompareGens(sarti_GGE1,"g1","g2")
```



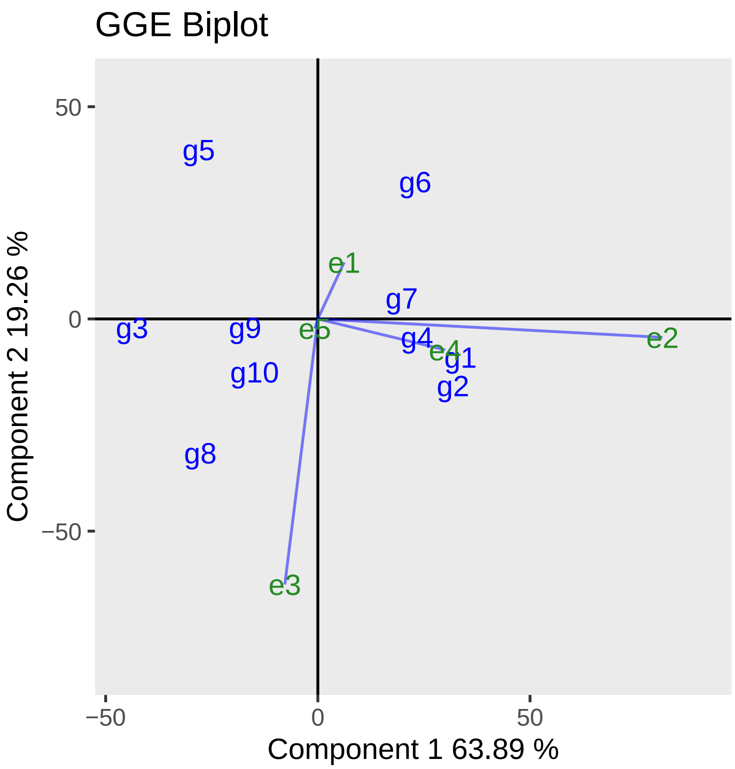
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Dual Metric Preserving SVP and Tester−Centered G+GE with no scaling

```
sarti_GGE1<-GGEModel(data_wide_sarti_gge,SVP="symmetrical")
DiscRep(sarti_GGE1)
```



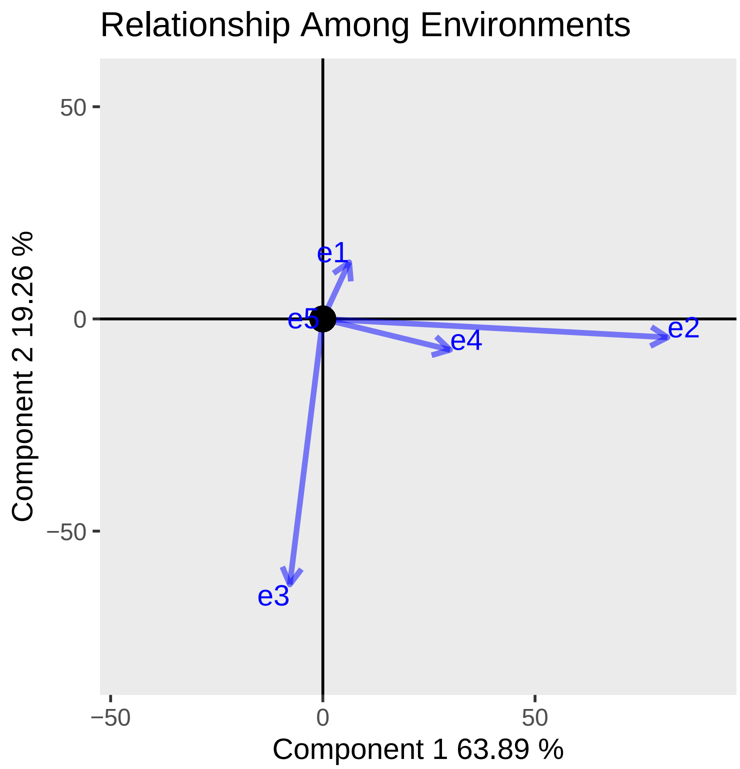
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1)
```



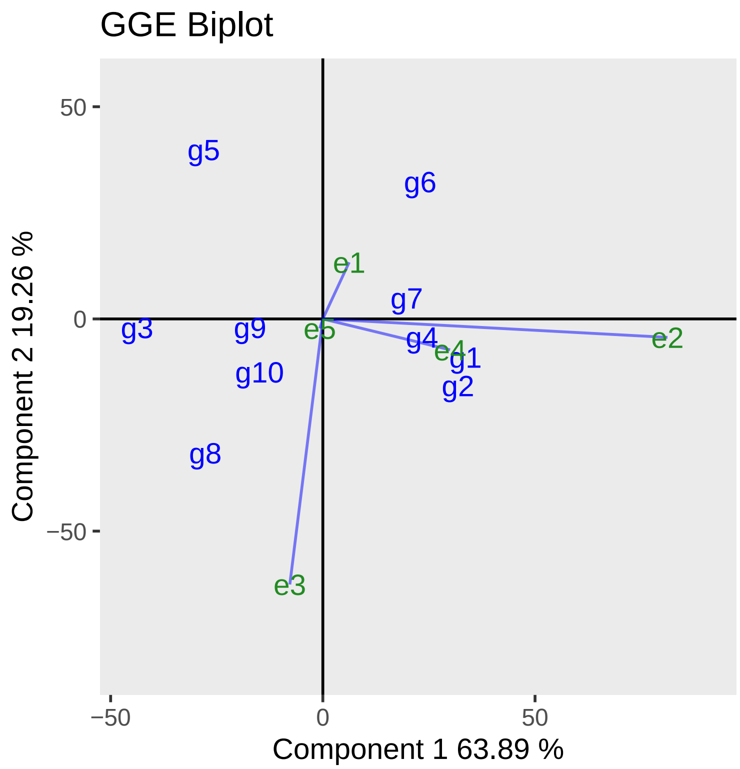
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
EnvRelationship(sarti_GGE1)
```



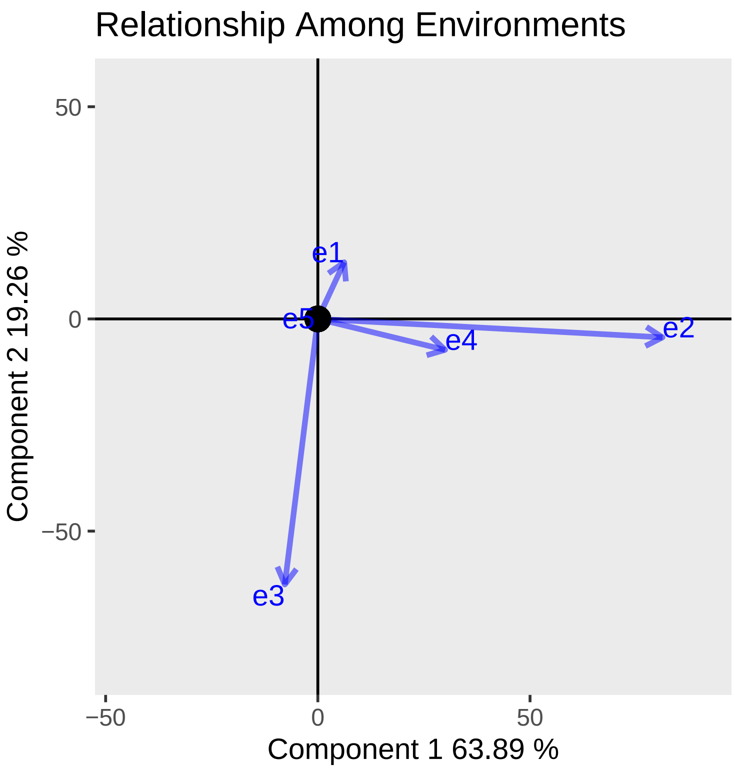
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1, type=1)
```



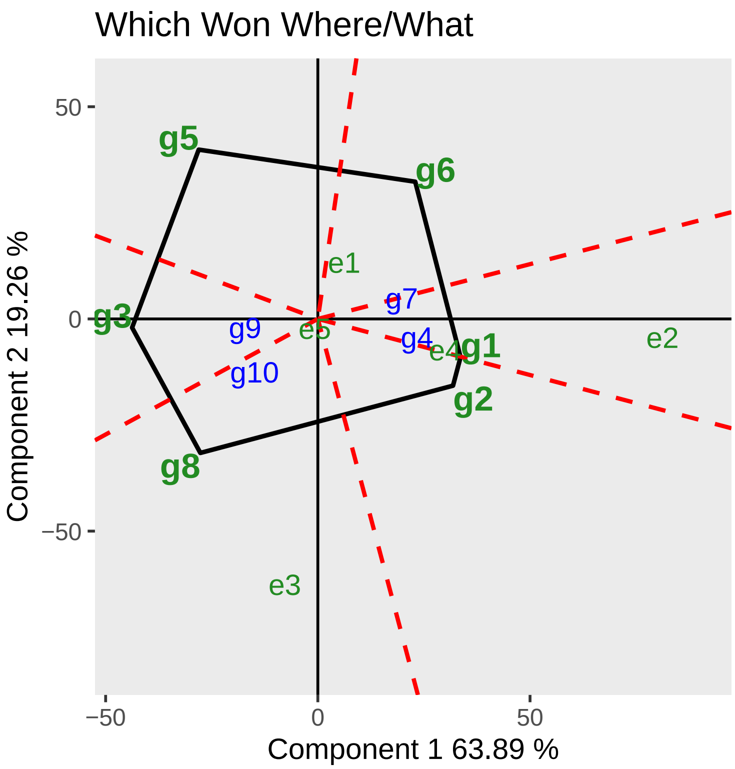
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1, type=4)
```



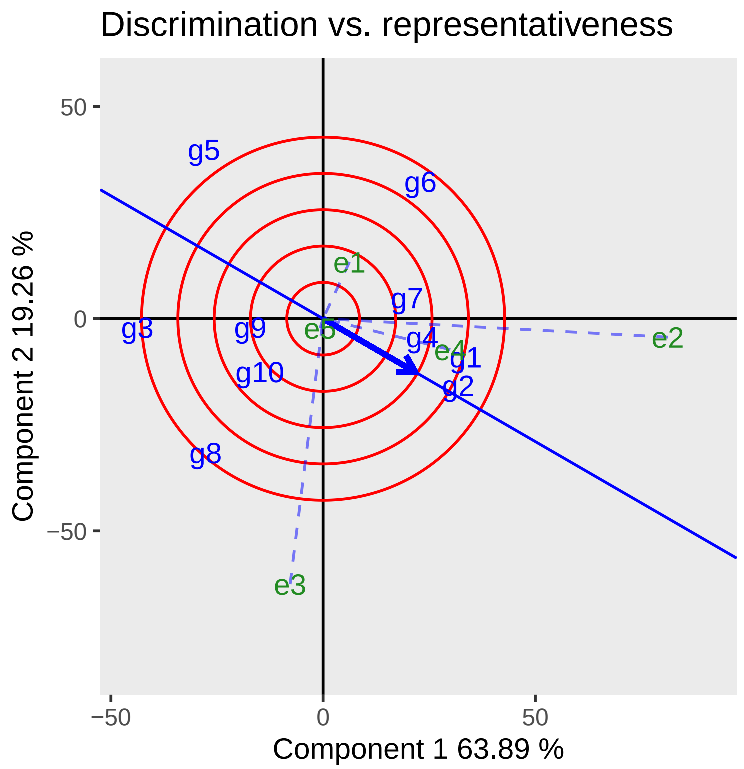
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1, type=6)
```



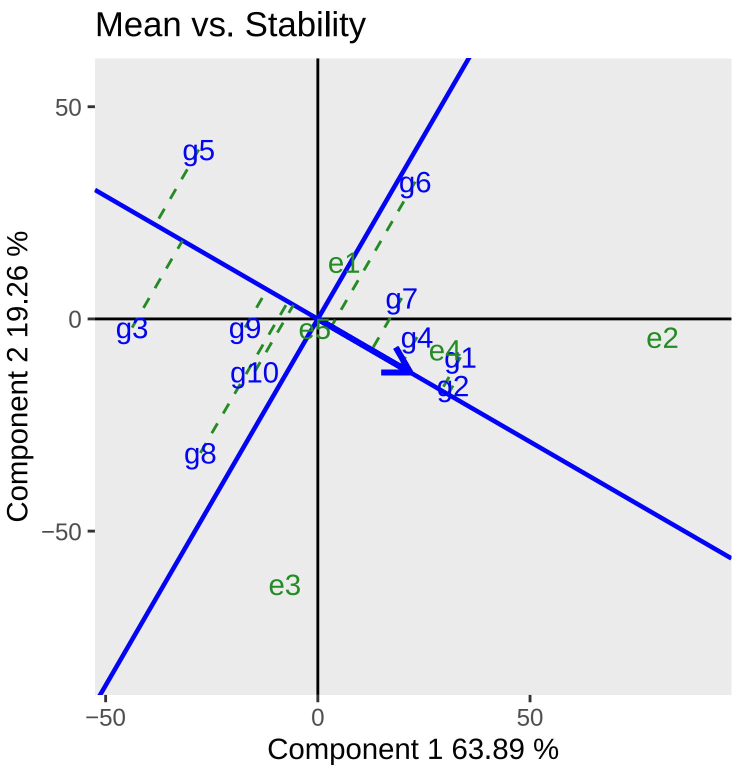
GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1, type=7)
```



GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling

```
GGEPlot(sarti_GGE1, type=9)
```



GGE Biplot showing components 1 and 2 explaining 83.15% of the total variation using Symmetrical SVP and Tester−Centered G+GE with no scaling