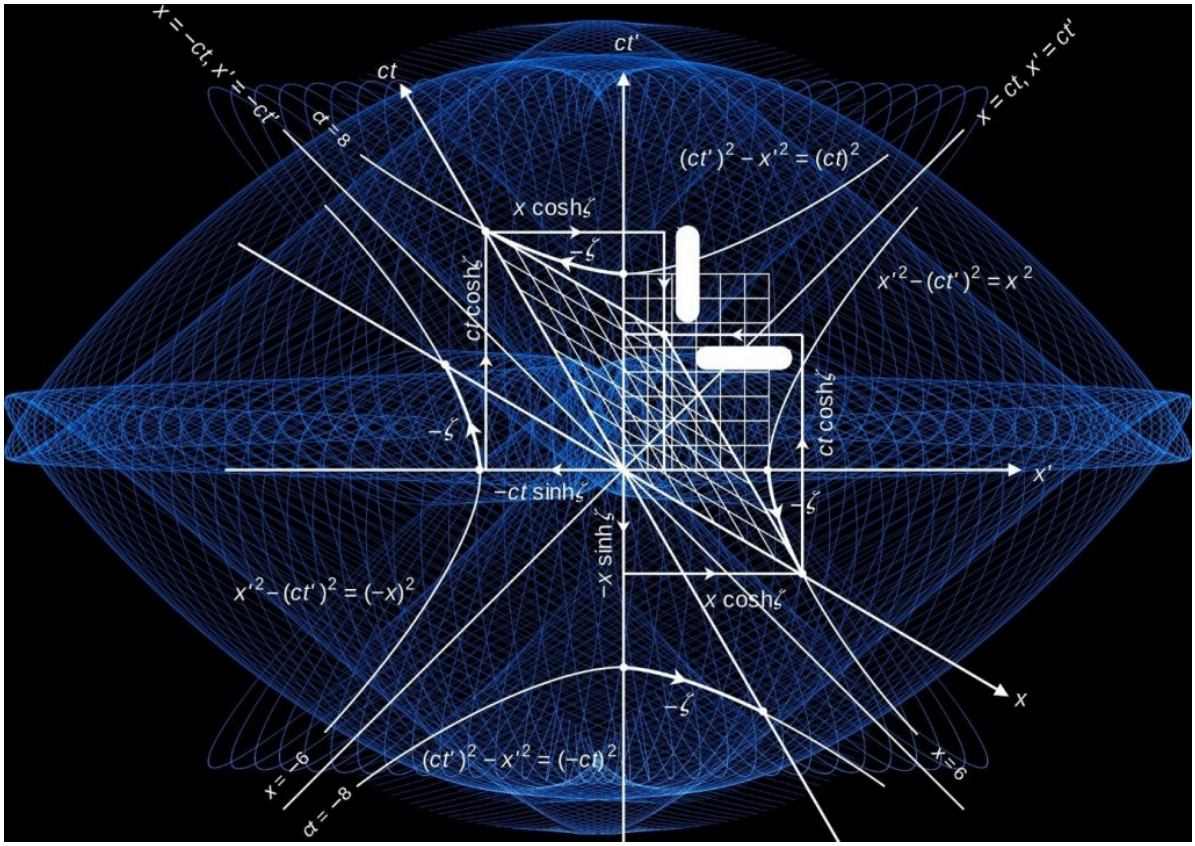
acp_analyse

- ######## analyse acp############
  ###### auteur:zakaria sarhan
  ###### data:05/01/2024




```
##### importation des packages necessaire########
if(!require(pacman)) install.packages("pacman")
```

```
Le chargement a nécessité le package : pacman

Warning: le package 'pacman' a été compilé avec la version R 4.3.2
```

```
library(pacman)
if(!require(reader)) install.packages("reader")
```

```
Le chargement a nécessité le package : reader

Warning: le package 'reader' a été compilé avec la version R 4.3.2

Le chargement a nécessité le package : NCmisc

Warning: le package 'NCmisc' a été compilé avec la version R 4.3.2


Attachement du package : 'reader'

Les objets suivants sont masqués depuis 'package:NCmisc':

    cat.path, get.ext, rmv.ext
```

```
library(reader)
if(! require(FactoMineR)) install.packages("FactoMineR")
```

```
Le chargement a nécessité le package : FactoMineR
```

```
library(FactoMineR)
if(!require(dplyr)) install.packages("VIM")
```

```
Le chargement a nécessité le package : dplyr

Warning: le package 'dplyr' a été compilé avec la version R 4.3.2


Attachement du package : 'dplyr'
```

```
Les objets suivants sont masqués depuis 'package:stats':

    filter, lag

Les objets suivants sont masqués depuis 'package:base':

    intersect, setdiff, setequal, union
```

```
library(VIM)
```

```
Warning: le package 'VIM' a été compilé avec la version R 4.3.2

Le chargement a nécessité le package : colorspace

Le chargement a nécessité le package : grid

VIM is ready to use.

Suggestions and bug-reports can be submitted at: https://github.com/statistikat/VIM/issues


Attachement du package : 'VIM'

L'objet suivant est masqué depuis 'package:datasets':

    sleep
```

```
if(!require(devtools)) install.packages("devtools")
```

```
Le chargement a nécessité le package : devtools

Warning: le package 'devtools' a été compilé avec la version R 4.3.2

Le chargement a nécessité le package : usethis

Warning: le package 'usethis' a été compilé avec la version R 4.3.2
```

```
library(devtools)
if(!require(ggplot2)) install.packages("ggplot2")
```

```
Le chargement a nécessité le package : ggplot2
```

```
Warning: le package 'ggplot2' a été compilé avec la version R 4.3.2
```

```
library(ggplot2)
if(!require(corrplot)) install.packages("corrplot")
```

```
Le chargement a nécessité le package : corrplot
```

```
Warning: le package 'corrplot' a été compilé avec la version R 4.3.2
```

```
corrplot 0.92 loaded
```

```
library(corrplot)
if(!require(factoextra)) install.packages("factoextra")
```

```
Le chargement a nécessité le package : factoextra
```

```
Warning: le package 'factoextra' a été compilé avec la version R 4.3.2
```

```
Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
library(factoextra)
if(!require(gtsummary)) install.packages("gtsummary")
```

```
Le chargement a nécessité le package : gtsummary
```

```
Warning: le package 'gtsummary' a été compilé avec la version R 4.3.2
```

```r
library(gtsummary)
if(!require(forcats)) install.packages("forcats")
```

```
Le chargement a nécessité le package : forcats
```

```
Warning: le package 'forcats' a été compilé avec la version R 4.3.2
```

```r
library(forcats)
```

```r
########## importation des donnes#########
data=read.table("decathlon.txt",sep="\t",header = T)
######### afficher les premiers lignes
head(data)
```

```
        X100m Long.jump Shot.put High.jump X400m X110m.hurdle Discus Pole.vault
SEBRLE  11.04      7.58    14.83      2.07 49.81        14.69  43.75       5.02
CLAY    10.76      7.40    14.26      1.86 49.37        14.05  50.72       4.92
KARPOV  11.02      7.30    14.77      2.04 48.37        14.09  48.95       4.92
BERNARD 11.02      7.23    14.25      1.92 48.93        14.99  40.87       5.32
YURKOV  11.34      7.09    15.19      2.10 50.42        15.31  46.26       4.72
WARNERS 11.11      7.60    14.31      1.98 48.68        14.23  41.10       4.92
        Javeline X1500m Rank Points Competition
SEBRLE     63.19  291.7    1   8217    Decastar
CLAY       60.15  301.5    2   8122    Decastar
KARPOV     50.31  300.2    3   8099    Decastar
BERNARD    62.77  280.1    4   8067    Decastar
YURKOV     63.44  276.4    5   8036    Decastar
WARNERS    51.77  278.1    6   8030    Decastar
```

```r
######### inspection des données########
theme_gtsummary_mean_sd()
data %>% tbl_summary()
```

```
Table printed with `knitr::kable()`, not {gt}. Learn why at
https://www.danieldsjoberg.com/gtsummary/articles/rmarkdown.html
To suppress this message, include `message = FALSE` in code chunk header.
```

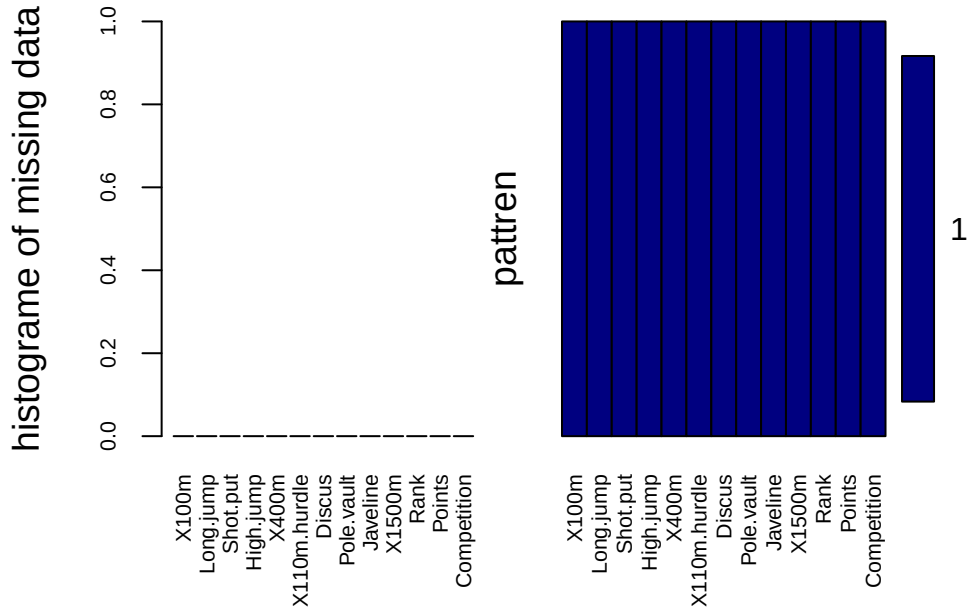
Characteristic	N = 41
X100m	11.00 (0.26)
Long.jump	7.26 (0.32)
Shot.put	14.48 (0.82)
High.jump	1.98 (0.09)
X400m	49.62 (1.15)
X110m.hurdle	14.61 (0.47)
Discus	44.3 (3.4)
Pole.vault	4.76 (0.28)
Javeline	58.3 (4.8)
X1500m	279 (12)
Rank	12 (8)
Points	8,005 (342)
Competition	
Decastar	13 (32%)
OlympicG	28 (68%)

```
## gestion des valeur manquantes
sum(is.na(data))
```

```
[1] 0
```

```
##### creer une fonction pour detecter les na pour chaque variable
def_manquante=function(data){
  valeur_manquante=sapply(data,function(x) sum(is.na(data)))
  proprtion_manquante=valeur_manquante/nrow(data)
  resultat=data.frame(nombre=valeur_manquante,proprtion=proprtion_manquante)
  return(resultat)

}
resulatat=def_manquante(data)
```

```
##### visualisation des valeurs manquantes
library(VIM)
aggr(data,col=c("navyblue","yellow"),bars=T,sortVars=TRUE,numbers=TRUE,     labels=names(d
```

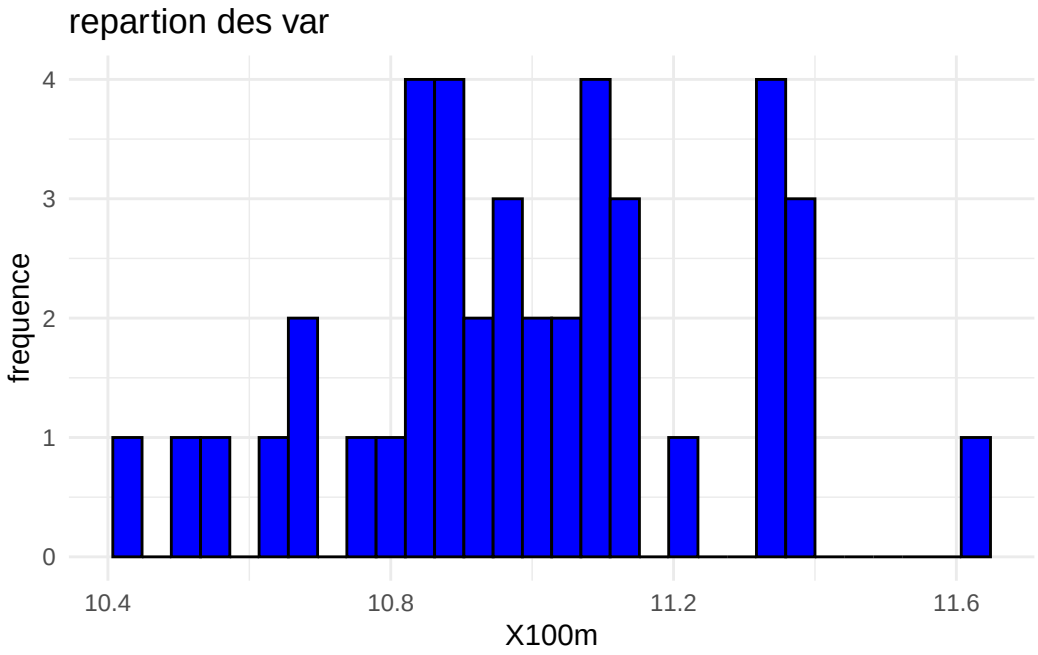


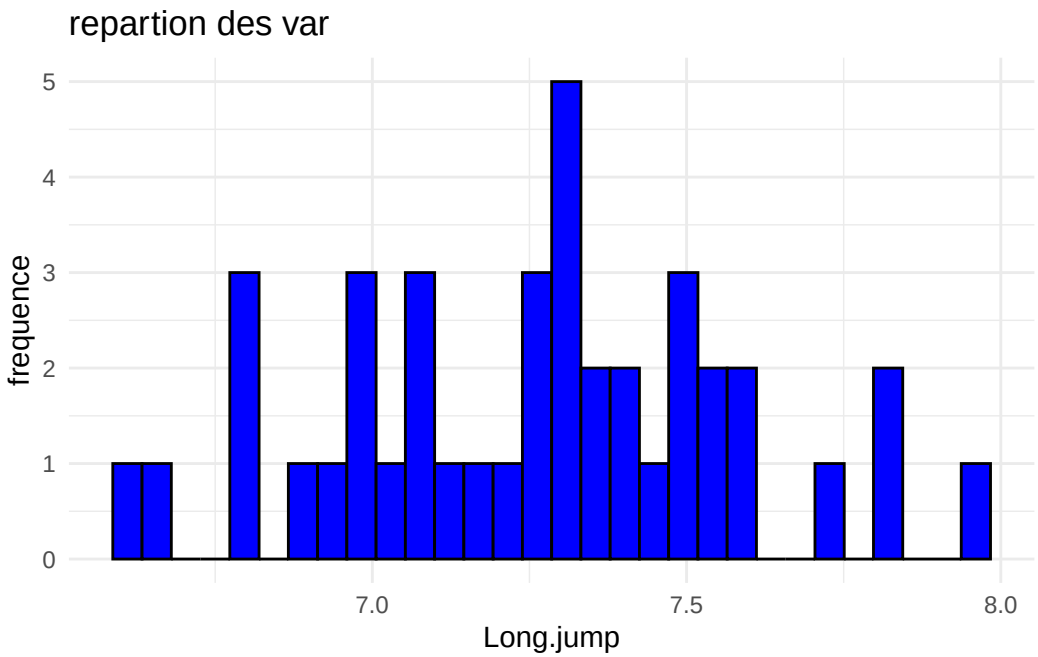

```
Variables sorted by number of missings:
    Variable Count
        X100m     0
   Long.jump      0
    Shot.put      0
   High.jump      0
        X400m     0
X110m.hurdle      0
      Discus      0
  Pole.vault      0
    Javeline      0
      X1500m      0
        Rank      0
      Points      0
 Competition      0
```

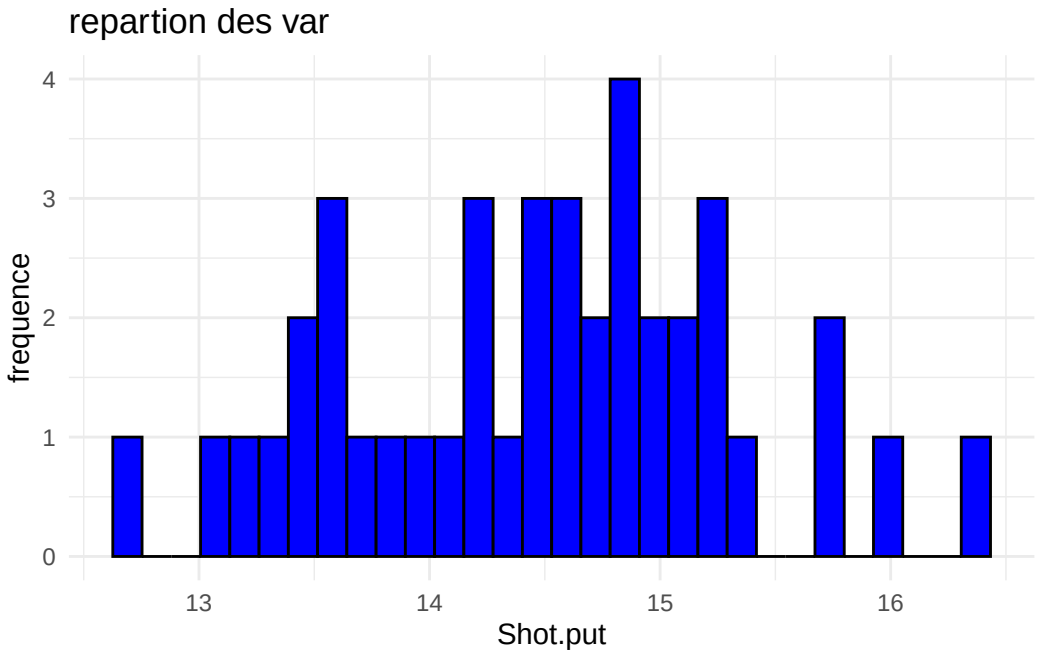
```
 ####### visualisation des variables quantitative (univarié)####
 var_quantitative=data %>% select_if("is.numeric")
 var_qun=sapply(data,is.numeric)
 for(var in names(data)[var_qun]) {
   print(ggplot(var_quantitative,aes_string(x=var))+
```

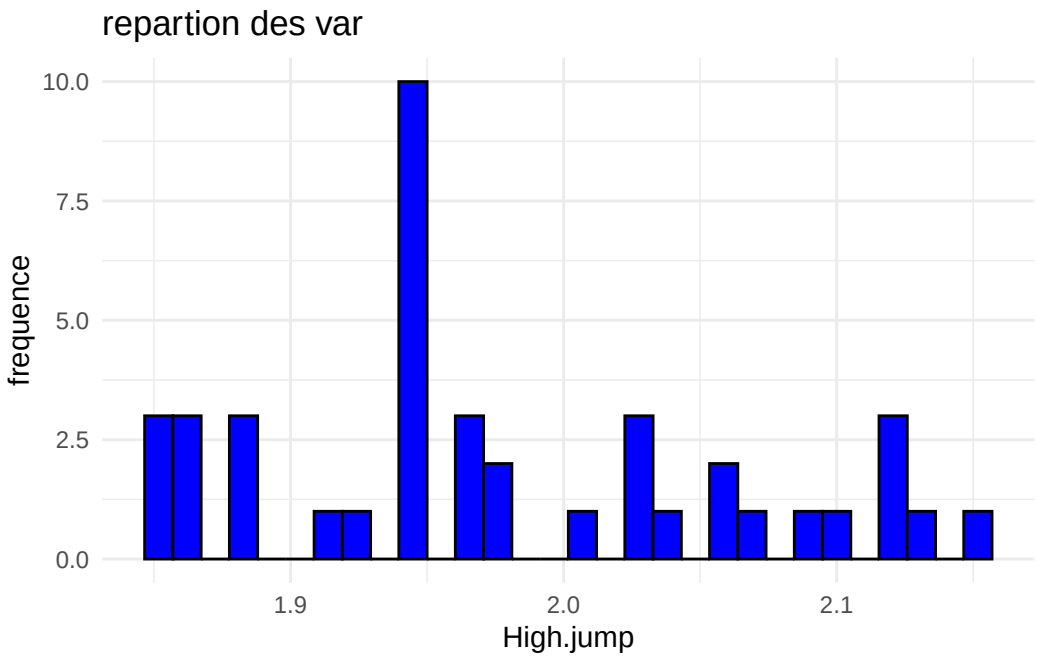
```
        geom_histogram(bins = 30,col="black",fill="blue")+theme_minimal()+labs(title="repa
        )
}
```

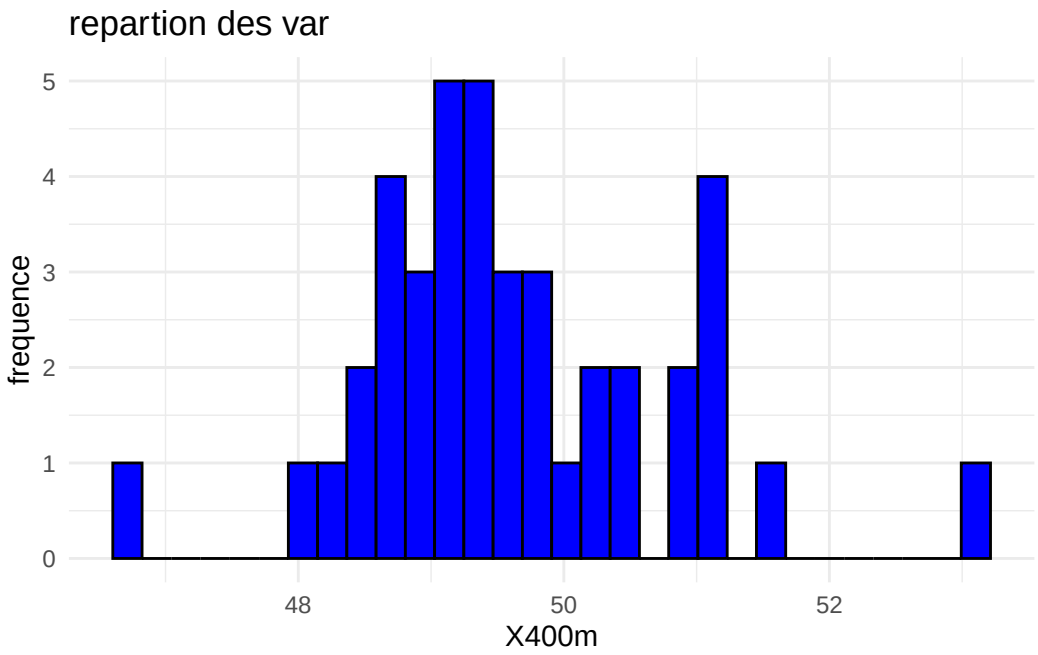
```
Warning: `aes_string()` was deprecated in ggplot2 3.0.0.
i Please use tidy evaluation idioms with `aes()`.
i See also `vignette("ggplot2-in-packages")` for more information.
```

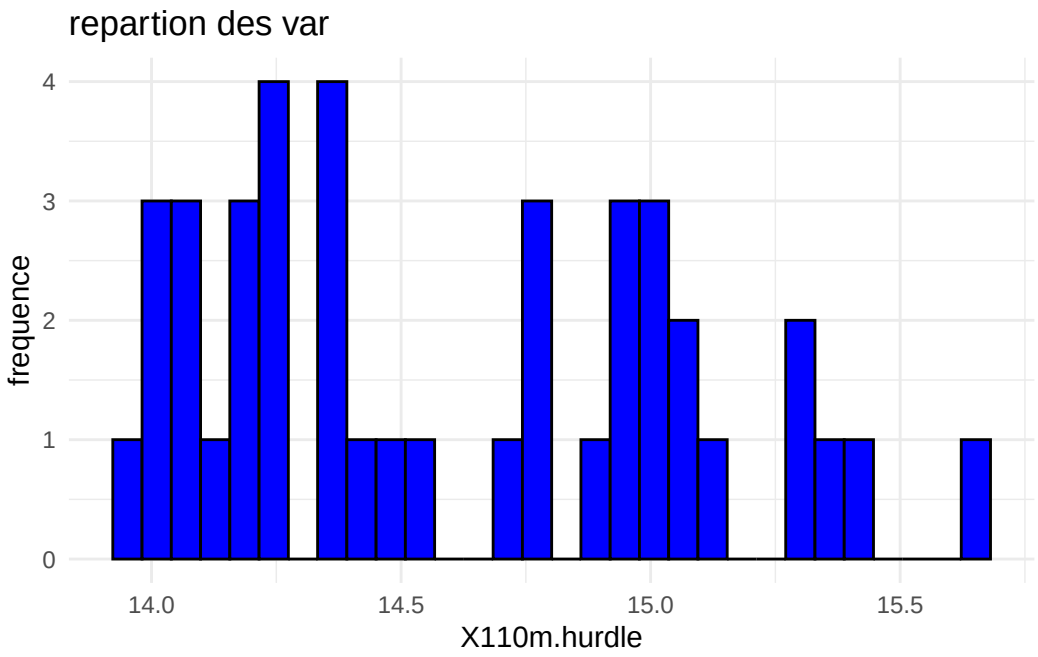


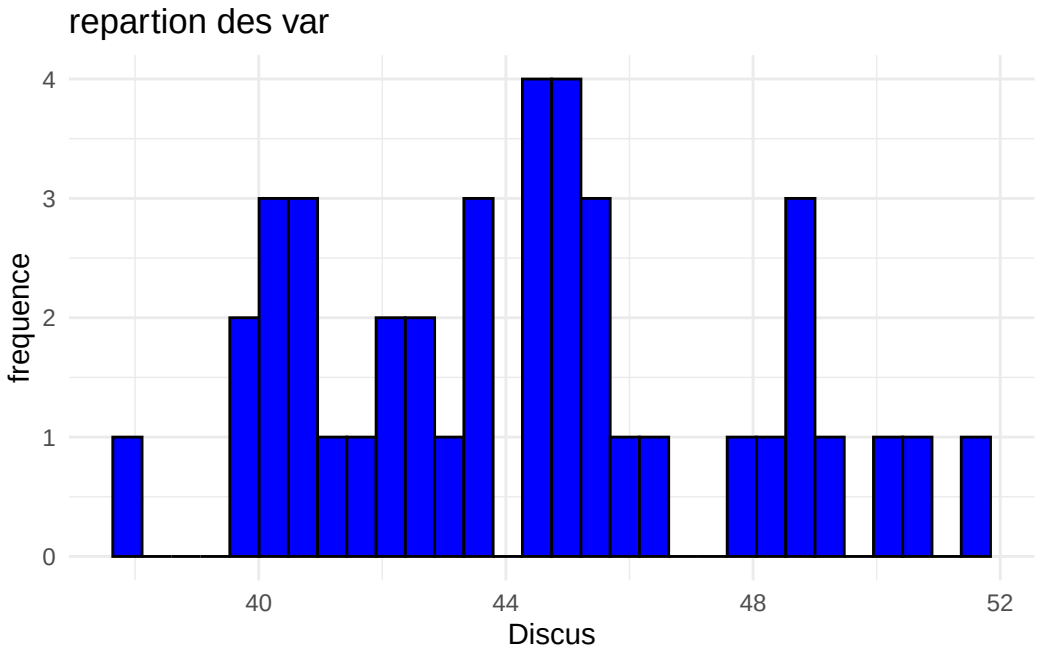

repartion des var
frequence
0
1
2
3
4
5
7.0
7.5
8.0
Long.jump

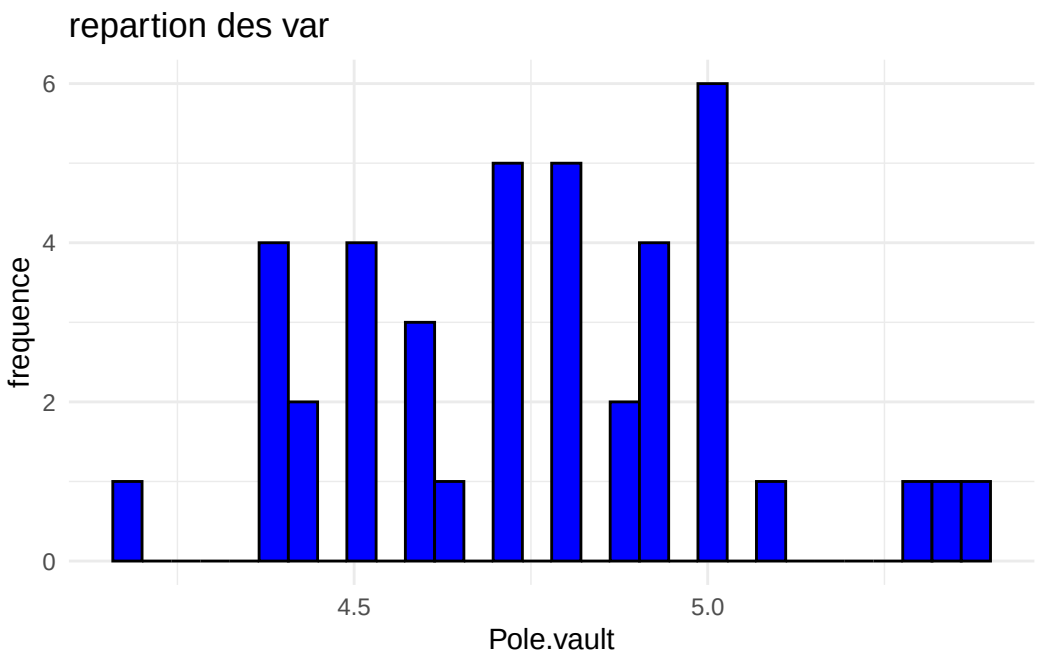

repartion des var
frequence
0
1
2
3
4
13
14
15
16
Shot.put

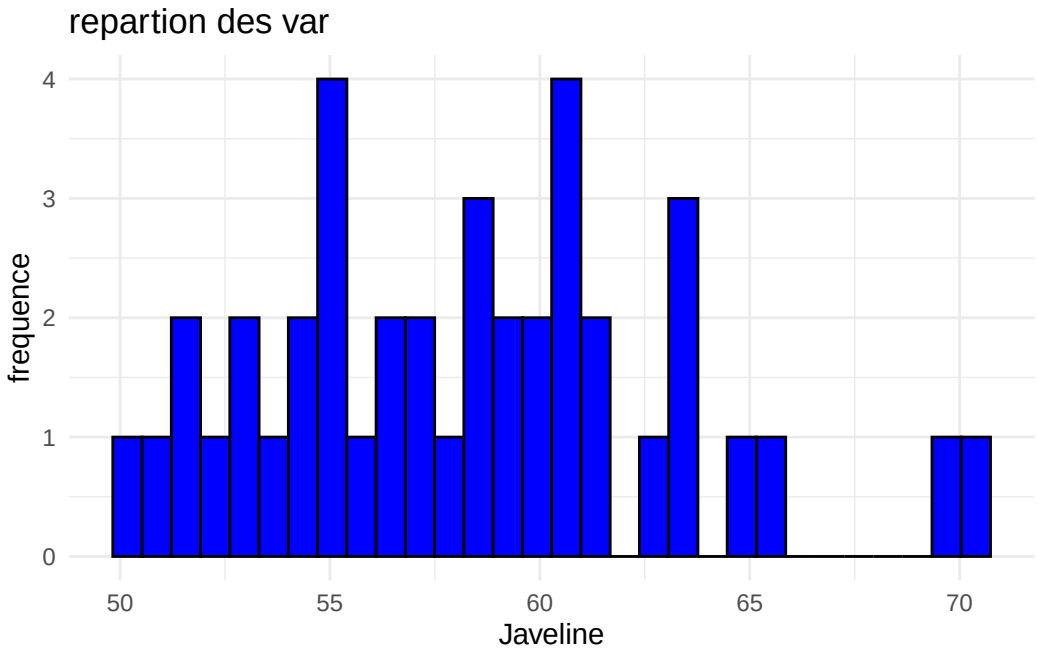

repartion des var
10.0
7.5
5.0
2.5
0.0
frequence
1.9
2.0
2.1
High.jump

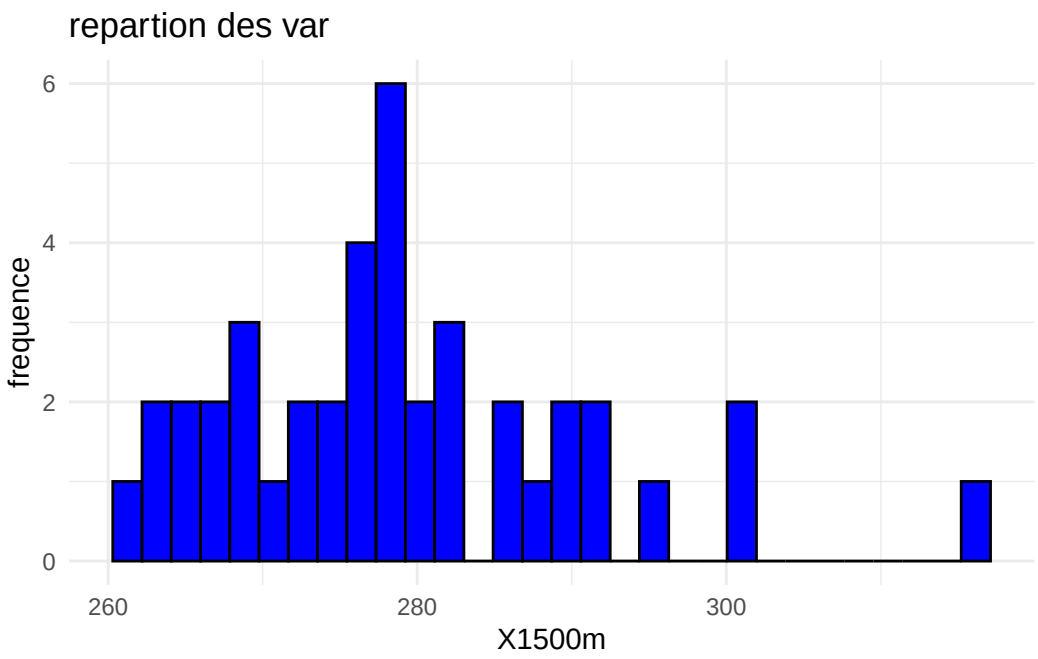

repartion des var
5
4
3
2
1
0
frequence
48
50
52
X400m

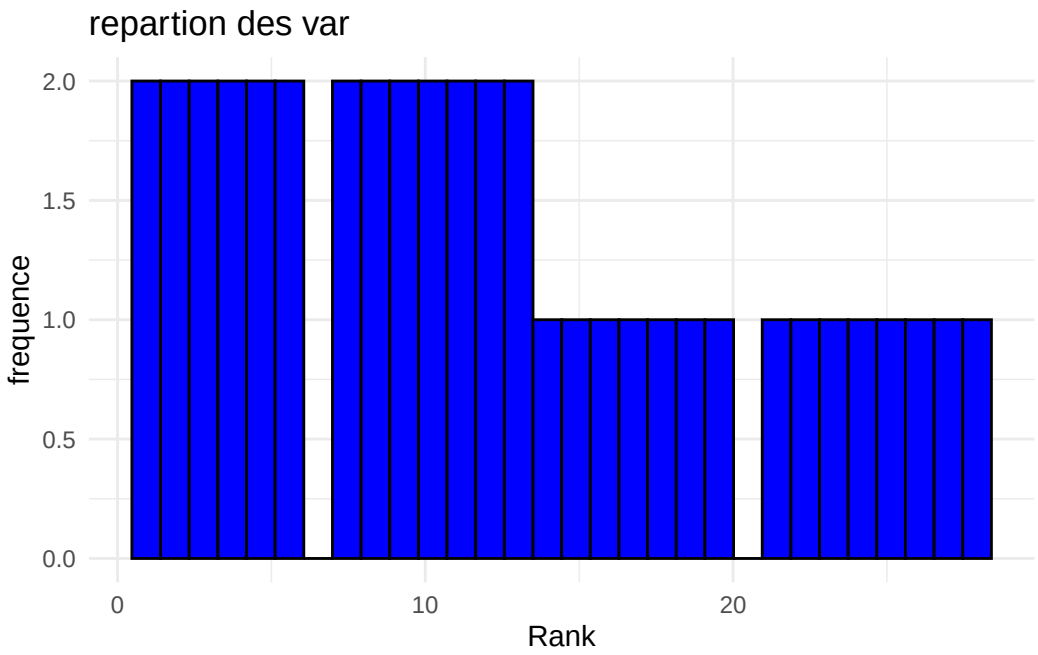

repartion des var
frequence
0
1
2
3
4
14.0
14.5
15.0
15.5
X110m.hurdle

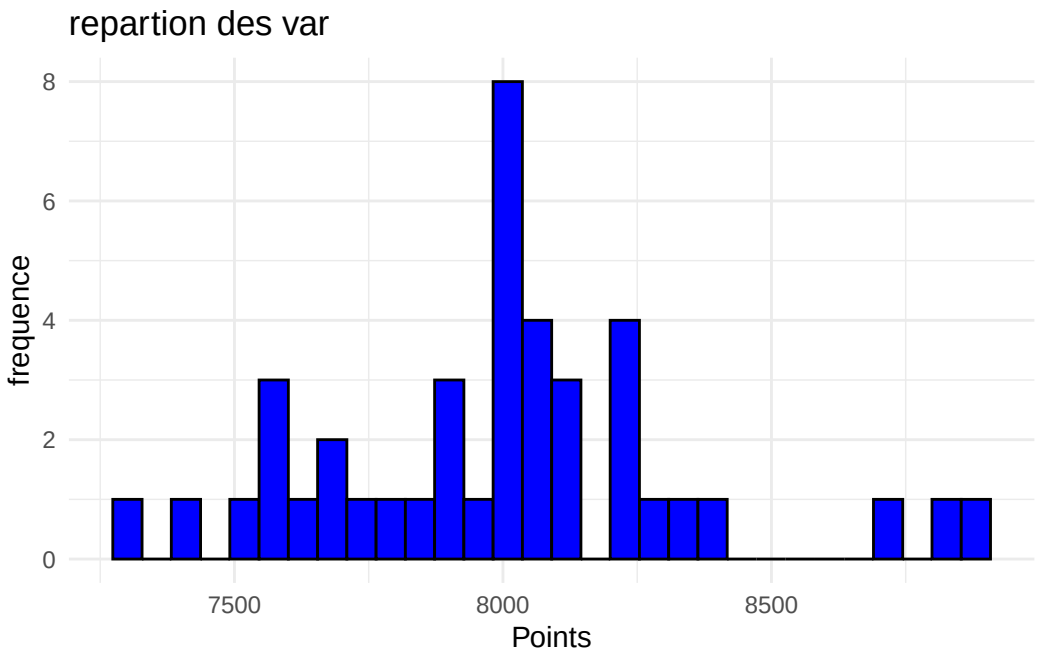

repartion des var
frequence
0
1
2
3
4
40
44
48
52
Discus


repartion des var
frequence
6
4
2
0
4.5
5.0
Pole.vault

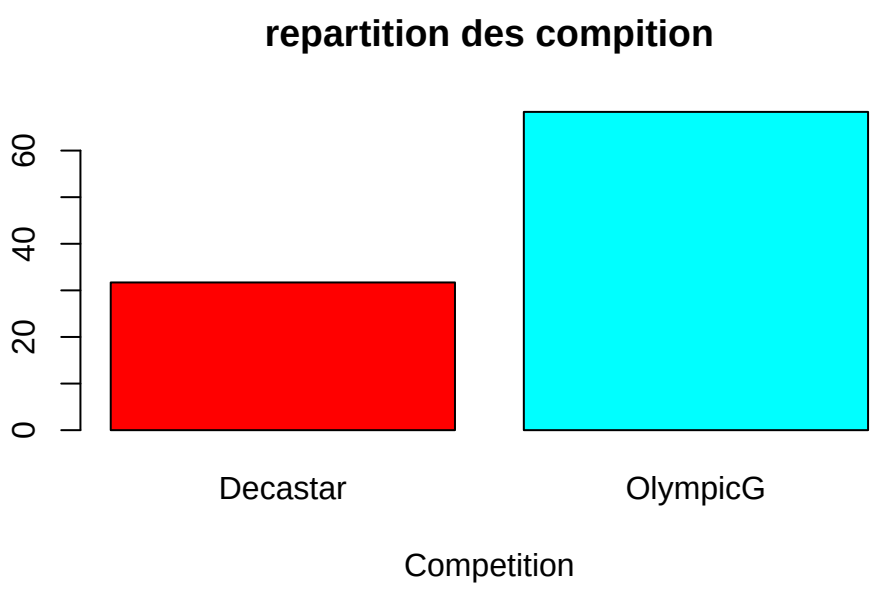

repartion des var
frequence
4
3
2
1
0
50
55
60
65
70
Javeline


repartion des var
6
4
2
0
frequence
260
280
300
X1500m


repartion des var
2.0
1.5
1.0
0.5
0.0
frequence
0
10
20
Rank

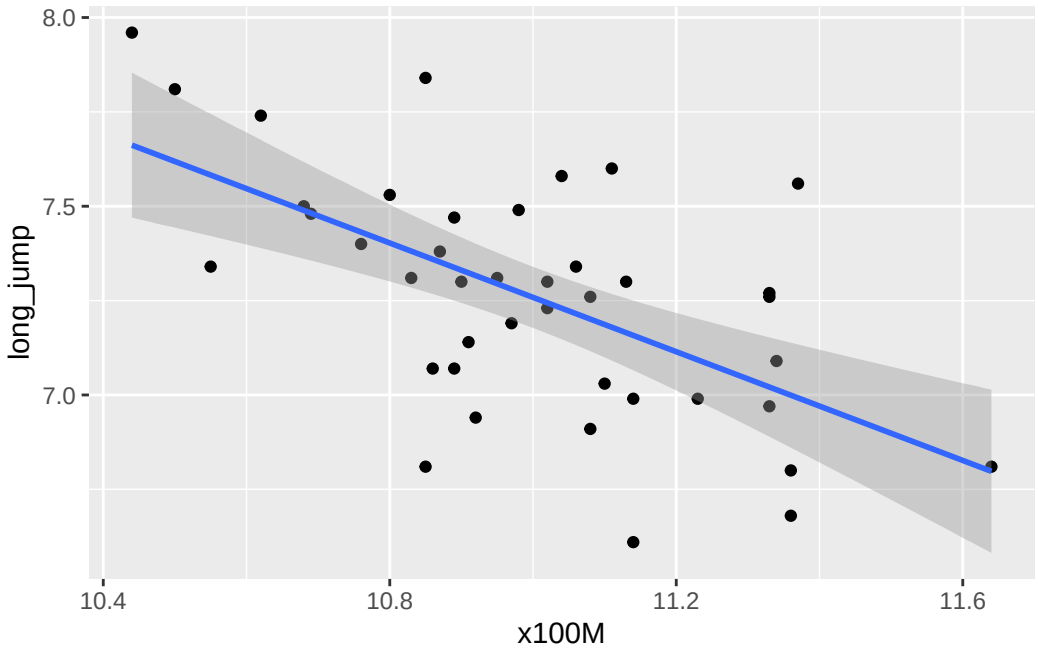



```
# visualiser variable qualitative#
attach(data)
tt=table(data$Competition)
pop=round(prop.table(tt)*100,1)
barplot(pop,col=rainbow(length(pop)),xlab="Competition",
        ylim=c(0,max(pop)+0.1),main="repartition des compition")
```



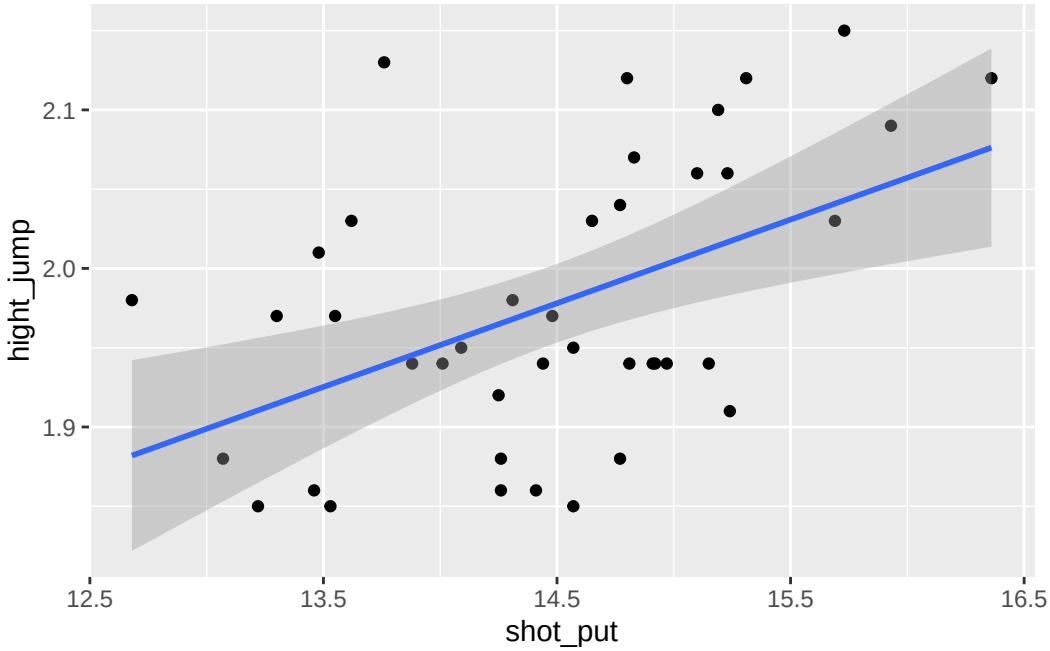

```
########## analyse bivarié quantitative#####
ggplot(data,aes(x=data$X100m,y=data$Long.jump))+geom_point()+
      geom_smooth(method = "lm",se = T)+xlab("x100M")+ylab("long_jump")
```

```
`geom_smooth()` using formula = 'y ~ x'
```




```
ggplot(data,aes(x=data$Shot.put,y=data$High.jump))+geom_point()+
      geom_smooth(method = "lm",se = T)+xlab("shot_put")+ylab("hight_jump")
```

```
`geom_smooth()` using formula = 'y ~ x'
```

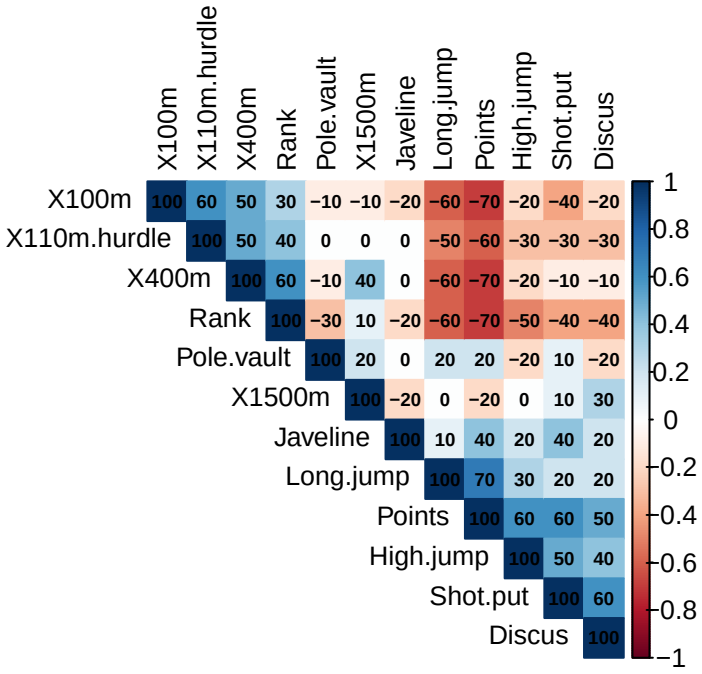



```
######## corrélation variable quantitative###########
df_cor=round(cor(var_quantitative,use = "complete.obs"),1)
df_cor
```

```
             X100m Long.jump Shot.put High.jump X400m X110m.hurdle Discus
X100m          1.0      -0.6     -0.4      -0.2   0.5          0.6   -0.2
Long.jump     -0.6       1.0      0.2       0.3  -0.6         -0.5    0.2
Shot.put      -0.4       0.2      1.0       0.5  -0.1         -0.3    0.6
High.jump     -0.2       0.3      0.5       1.0  -0.2         -0.3    0.4
X400m          0.5      -0.6     -0.1      -0.2   1.0          0.5   -0.1
X110m.hurdle   0.6      -0.5     -0.3      -0.3   0.5          1.0   -0.3
Discus        -0.2       0.2      0.6       0.4  -0.1         -0.3    1.0
Pole.vault    -0.1       0.2      0.1      -0.2  -0.1          0.0   -0.2
Javeline      -0.2       0.1      0.4       0.2   0.0          0.0    0.2
X1500m        -0.1       0.0      0.1       0.0   0.4          0.0    0.3
Rank           0.3      -0.6     -0.4      -0.5   0.6          0.4   -0.4
Points        -0.7       0.7      0.6       0.6  -0.7         -0.6    0.5
             Pole.vault Javeline X1500m Rank Points
X100m              -0.1     -0.2   -0.1  0.3   -0.7
Long.jump           0.2      0.1    0.0 -0.6    0.7
Shot.put            0.1      0.4    0.1 -0.4    0.6
High.jump          -0.2      0.2    0.0 -0.5    0.6
```

```
X400m           -0.1      0.0    0.4  0.6   -0.7
X110m.hurdle     0.0      0.0    0.0  0.4   -0.6
Discus          -0.2      0.2    0.3 -0.4    0.5
Pole.vault       1.0      0.0    0.2 -0.3    0.2
Javeline         0.0      1.0   -0.2 -0.2    0.4
X1500m           0.2     -0.2    1.0  0.1   -0.2
Rank            -0.3     -0.2    0.1  1.0   -0.7
Points           0.2      0.4   -0.2 -0.7    1.0
```

```
###### heatmap de correlation######
corrplot(df_cor,method="color",type = "upper",order = "hclust",
         tl.col = "black",addCoef.col = "black",tl.cex = 0.8,
         addCoefasPercent = TRUE,number.cex = 0.6,number.digits = 3)
```




```
########## analyse_ACP##########
######### 1 etape  (centrer et reduire les donnes)
scal_data=scale(var_quantitative,center = T,scale = T)
print(scal_data)
```

```
                X100m  Long.jump      Shot.put   High.jump       X400m
SEBRLE     0.15949639  1.0113727  0.428087000  1.04744448  0.16789492
```

```
CLAY         -0.90504930  0.4424756 -0.263301610 -1.31341860 -0.21356911
KARPOV        0.08345742  0.1264216  0.355309251  0.71017832 -1.08053282
BERNARD       0.08345742 -0.0948162 -0.275431235 -0.63888629 -0.59503314
YURKOV        1.30008106 -0.5372918  0.864753490  1.38471063  0.69674279
WARNERS       0.42563282  1.0745835 -0.202653486  0.03564602 -0.81177407
ZSIVOCZKY     0.50167179  0.1264216 -1.209412340  0.37291217 -0.86379189
McMULLEN     -0.63891288  0.1580270 -0.869782847  1.72197679  0.25459130
MARTINEAU     2.44066574 -1.4222429  0.112716757 -0.30162014  0.45399295
HERNU         1.41413953  0.9481620 -0.081357239 -1.31341860  1.28627811
BARRAS        1.26206158 -0.9165566 -0.469505231 -0.30162014 -0.11820310
NOOL          1.26206158  0.0316054 -2.179782319  0.03564602 -0.36095294
BOURGUIGNON   1.37612004 -1.4538483 -1.233671589 -1.31341860  1.33829594
Sebrle       -0.56287390  1.8331131  2.283919585  1.60955474 -1.08920246
Clay         -2.12167295  2.2123779  0.913271989  0.93502243 -0.36962258
Karpov       -1.89355602  1.7382969  1.762345721  1.27228858 -2.43299621
Macey        -0.41079594  0.6637134  1.519753226  1.94682089 -0.56035459
Warners      -1.43732215  1.5170591  0.003550134 -0.07677604 -1.42731831
Zsivoczky    -0.33475696 -0.3792648  1.010308987  1.60955474 -0.18756020
Hernu        -0.10664003 -0.2212378  0.209753755  0.59775627 -0.76842589
Nool         -0.75297134  0.8533458 -0.263301610 -1.08857450 -0.69906879
Bernard      -1.17118572  0.6953188  0.391698126  1.60955474 -0.42164040
Schwarzl     -0.06862054  0.7269242 -0.566542229 -0.41404219  0.12454674
Pogorelov    -0.18267901  0.1580270  0.755586868  0.93502243  1.01751936
Schoenbeck   -0.37277645  0.1264216  0.355309251 -1.08857450  0.59270714
Barras        0.53969128 -0.8533458  0.525123998 -0.41404219 -0.17889056
Smith        -0.56287390 -1.4222429  0.925401614 -0.75130834 -0.30026548
Averyanov    -1.70345857  0.2528432 -0.044968365 -0.41404219  0.08986819
Ojaniemi     -1.20920521  0.7585296  0.597901746 -0.41404219 -0.43031004
Smirnov      -0.41079594 -0.6005026 -0.724227350 -0.41404219 -0.43897967
Qi            0.23553537  0.2528432 -1.124504967 -0.07677604  0.02918073
Drews        -0.48683492  0.3792648 -1.706726954 -1.08857450 -0.95915790
Parkhomenko   0.53969128 -2.0543509  1.471234727  0.59775627  1.23426029
Terek        -0.29673748 -1.0113727  0.816234992 -0.41404219 -0.04884600
Gomez         0.31157435  0.0000000  0.112716757 -1.42584065 -0.87246153
Turi          0.31157435 -1.1061889 -1.039597593  0.59775627  1.78044743
Lorenzo       0.38761333 -0.7269242 -1.524782583 -1.42584065 -0.23957802
Karlivans     1.26206158  0.0000000 -1.427745585 -0.07677604  0.80077843
Korkizoglou  -0.52485441 -0.6005026  0.403827750 -0.41404219  1.33829594
Uldal         0.88186669 -0.8533458 -1.148764216 -1.42584065  1.15623356
Casarsa       1.37612004 -1.8331131  0.537253623 -0.41404219  3.10690191
             X110m.hurdle      Discus Pole.vault     Javeline      X1500m
SEBRLE        0.17835587 -0.17040740  0.9264789  1.009653240  1.08582657
CLAY         -1.17818270  1.89303852  0.5667665  0.379839017  1.92535303
```

```
KARPOV       -1.09339904  1.36903575  0.5667665 -1.658770177  1.81398728
BERNARD       0.81423333 -1.02302207  2.0056163  0.922639433  0.09210136
YURKOV        1.49250261  0.57266997 -0.1526585  1.061447173 -0.22486271
WARNERS      -0.79665623 -0.95493132  0.5667665 -1.356293610 -0.07923057
ZSIVOCZKY    -0.92383172  0.39800238 -1.2317958 -0.610460978 -0.94445683
McMULLEN     -0.47871750  0.02498346 -1.2317958 -0.403285246  0.52043119
MARTINEAU     0.68705783  0.96937262  0.5667665 -1.240275200 -1.44988603
HERNU         0.96260473  0.19669058  0.2070540 -0.233401147  0.52043119
BARRAS       -0.26675835 -0.65888456 -0.1526585 -0.604245706  0.25486670
NOOL          1.45011078 -1.89636002 -0.5123709 -0.181607214 -1.06438918
BOURGUIGNON   2.25555555 -1.13551984  0.9264789 -0.753412232  1.08582657
Sebrle       -1.17818270  1.30094500  0.8545364  2.528251350  0.08439142
Clay         -1.00861538  1.71244999  0.4948240  2.360439007  0.25486670
Karpov       -1.34775002  2.16836201 -0.5843134 -0.575241103 -0.07837391
Macey        -0.09719103  1.18844723 -1.3037383  0.029712032 -1.16547502
Warners      -1.26296636 -0.17632834  0.4948240 -0.606317463 -0.08351387
Zsivoczky     0.72944966  0.38320004 -0.2246009  1.063518930 -0.81253124
Hernu        -0.75426439  0.11675795  0.1351115 -0.115310980 -1.25713760
Nool          0.41151094 -0.67368690  2.2933863  0.624306380 -0.23085933
Bernard      -0.92383172  0.12563936 -1.3037383 -0.631178551 -0.23257265
Schwarzl     -0.75426439 -0.56118913  1.2142489 -0.413644033 -0.46815406
Pogorelov    -0.83904806  0.08123234  0.8545364 -1.008238381  0.73716609
Schoenbeck   -0.56350116  0.02498346  0.8545364  0.533149058 -0.01755108
Barras       -0.49991341  0.14932310 -0.5843134  1.291412235 -1.02241286
Smith        -1.26296636  1.38975902 -2.0231632  0.663669769 -0.53840015
Averyanov    -0.45752158 -1.31610837  0.1351115 -0.788632106 -0.68574561
Ojaniemi      0.85662516 -1.17696639 -0.5843134  0.195452617 -0.28397223
Smirnov       0.34792319 -0.54934726 -0.2246009  0.531077301 -1.34623021
Qi            0.36911911  0.23813713 -0.9440259  0.512431485 -0.54782341
Drews        -1.26296636 -1.24801761  0.8545364 -1.406015785 -0.41247118
Parkhomenko   0.58107826 -0.71809391  0.1351115  1.554525413 -0.09293713
Terek         1.08978022  0.38320004  1.9336738 -1.594545701  0.97103417
Gomez        -0.41512975 -0.99933833 -1.3037383  0.495857427 -0.79882469
Turi         -0.73306848 -1.33091071  0.1351115  0.212026675  0.94105108
Lorenzo       1.64087402 -1.21545247 -0.9440259  0.008994459 -1.36593338
Karlivans     0.79303741 -0.29178658 -0.9440259 -1.118041519 -0.03040097
Korkizoglou   0.75064558  0.51642108 -0.2246009 -1.091108674  3.25317551
Uldal         1.02619248 -0.38948201 -0.9440259  0.348762658  0.22916691
Casarsa       1.66206993  1.28318219 -1.3037383  0.062860149  1.46447014
                    Rank      Points
SEBRLE       -1.40447311  0.618117197
CLAY         -1.27819373  0.340651888
KARPOV       -1.15191435  0.273476077
```

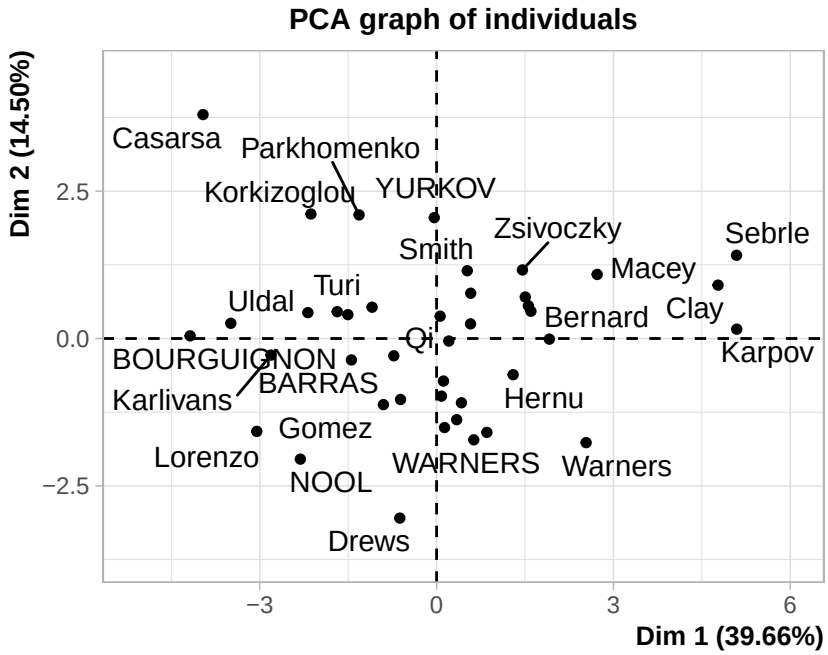
```
BERNARD     -1.02563497  0.180014078
YURKOV      -0.89935559  0.089472767
WARNERS     -0.77307621  0.071948642
ZSIVOCZKY   -0.64679683 -0.003989232
McMULLEN    -0.52051745 -0.030275419
MARTINEAU   -0.39423807 -0.593968098
HERNU       -0.26795869 -0.795495533
BARRAS      -0.14167931 -0.868512719
NOOL        -0.01539992 -1.034991904
BOURGUIGNON  0.11087946 -2.022184265
Sebrle      -1.40447311  2.592501918
Clay        -1.27819373  2.379291734
Karpov      -1.15191435  2.101826425
Macey       -1.02563497  1.193492626
Warners     -0.89935559  0.986123817
Zsivoczky   -0.77307621  0.822565319
Hernu       -0.64679683  0.676530946
Nool        -0.52051745  0.670689571
Bernard     -0.39423807  0.641482697
Schwarzl    -0.26795869  0.282238139
Pogorelov   -0.14167931  0.229665765
Schoenbeck  -0.01539992  0.209220953
Barras       0.11087946  0.180014078
Smith        0.23715884  0.051503830
Averyanov    0.36343822  0.045662455
Ojaniemi     0.48971760  0.001852143
Smirnov      0.61599698 -0.036116794
Qi           0.74227636 -0.208437354
Drews        0.86855574 -0.231802853
Parkhomenko  0.99483512 -0.255168353
Terek        1.12111450 -0.328185539
Gomez        1.24739388 -0.409964788
Turi         1.37367327 -0.868512719
Lorenzo      1.49995265 -1.207312464
Karlivans    1.62623203 -1.233598651
Korkizoglou  1.75251141 -1.262805526
Uldal        1.87879079 -1.490619148
Casarsa      2.00507017 -1.756401706
attr(,"scaled:center")
       X100m    Long.jump     Shot.put    High.jump        X400m X110m.hurdle
   10.998049     7.260000    14.477073     1.976829    49.616341    14.605854
      Discus   Pole.vault     Javeline       X1500m         Rank       Points
   44.325610     4.762439    58.316585   279.024878    12.121951  8005.365854
```

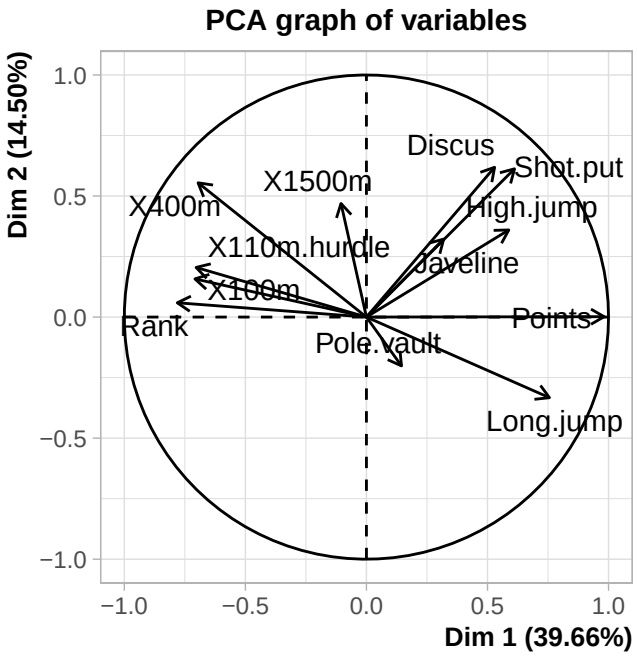
```
attr(,"scaled:scale")
       X100m    Long.jump     Shot.put    High.jump        X400m X110m.hurdle
 0.26302300   0.31640164   0.82442781   0.08895052   1.15345081   0.47178902
      Discus   Pole.vault     Javeline       X1500m         Rank       Points
 3.37784476   0.27799982   4.82682018  11.67324722   7.91894918 342.38514542
```

```
##### autre fonction pour standardisation
stanrdise=function(x){
  return((x-mean(x))/sd(x))
}
donner_std=as.data.frame(lapply(var_quantitative,stanrdise))
```

```
######## etape2 realiser une ACP avec factorminer#######
acp_resultat=PCA(scal_data,graph = T)
```

```
Warning: ggrepel: 17 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```





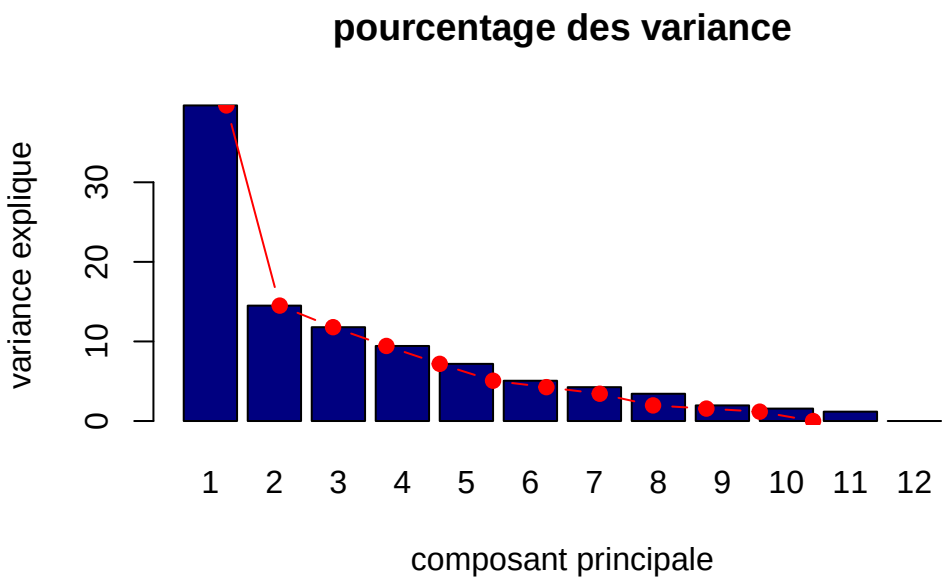

```
print(acp_resultat)
```

```
**Results for the Principal Component Analysis (PCA)**
The analysis was performed on 41 individuals, described by 12 variables
*The results are available in the following objects:

   name               description
1  "$eig"             "eigenvalues"
2  "$var"             "results for the variables"
3  "$var$coord"       "coord. for the variables"
4  "$var$cor"         "correlations variables - dimensions"
5  "$var$cos2"        "cos2 for the variables"
6  "$var$contrib"     "contributions of the variables"
7  "$ind"             "results for the individuals"
8  "$ind$coord"       "coord. for the individuals"
9  "$ind$cos2"        "cos2 for the individuals"
10 "$ind$contrib"     "contributions of the individuals"
11 "$call"            "summary statistics"
12 "$call$centre"     "mean of the variables"
13 "$call$ecart.type" "standard error of the variables"
14 "$call$row.w"      "weights for the individuals"
15 "$call$col.w"      "weights for the variables"
```

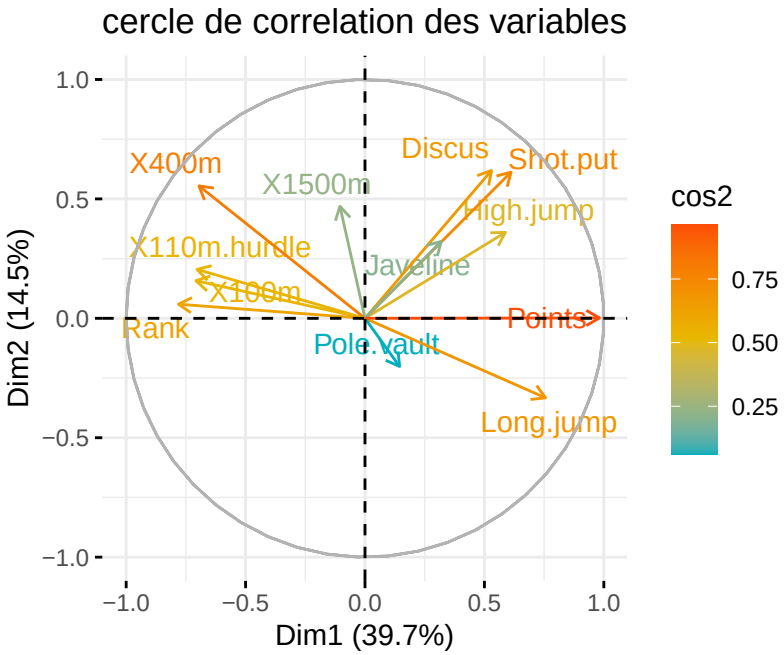
```r
#### etape3 chois nombre d'axe factoriel######
valeur_propre=acp_resultat$eig
print(valeur_propre)
```

```
         eigenvalue percentage of variance cumulative percentage of variance
comp 1  4.758790e+00          3.965659e+01                          39.65659
comp 2  1.740146e+00          1.450122e+01                          54.15780
comp 3  1.414902e+00          1.179085e+01                          65.94866
comp 4  1.131778e+00          9.431483e+00                          75.38014
comp 5  8.619423e-01          7.182852e+00                          82.56299
comp 6  6.073189e-01          5.060991e+00                          87.62398
comp 7  5.104506e-01          4.253755e+00                          91.87774
comp 8  4.110845e-01          3.425704e+00                          95.30344
comp 9  2.352087e-01          1.960072e+00                          97.26351
comp 10 1.873636e-01          1.561364e+00                          98.82488
comp 11 1.409606e-01          1.174671e+00                          99.99955
comp 12 5.402403e-05          4.502002e-04                         100.00000
```

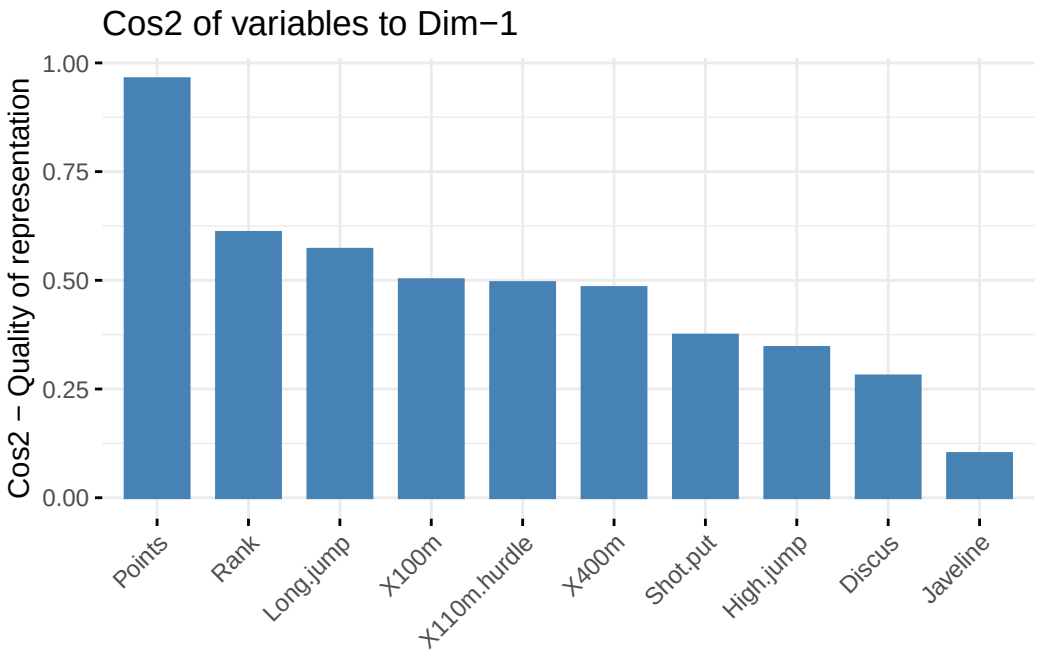
```r
####### affichage sur un graphic les valeurs propres

barplot(valeur_propre[,2],names.arg = 1:nrow(valeur_propre),
        main="pourcentage des variance",
        xlab="composant principale",
        ylab="variance explique",
        col="navyblue"
        )
lines(1:nrow(valeur_propre),valeur_propre[,2],type="b",pch=19,col="red")
```



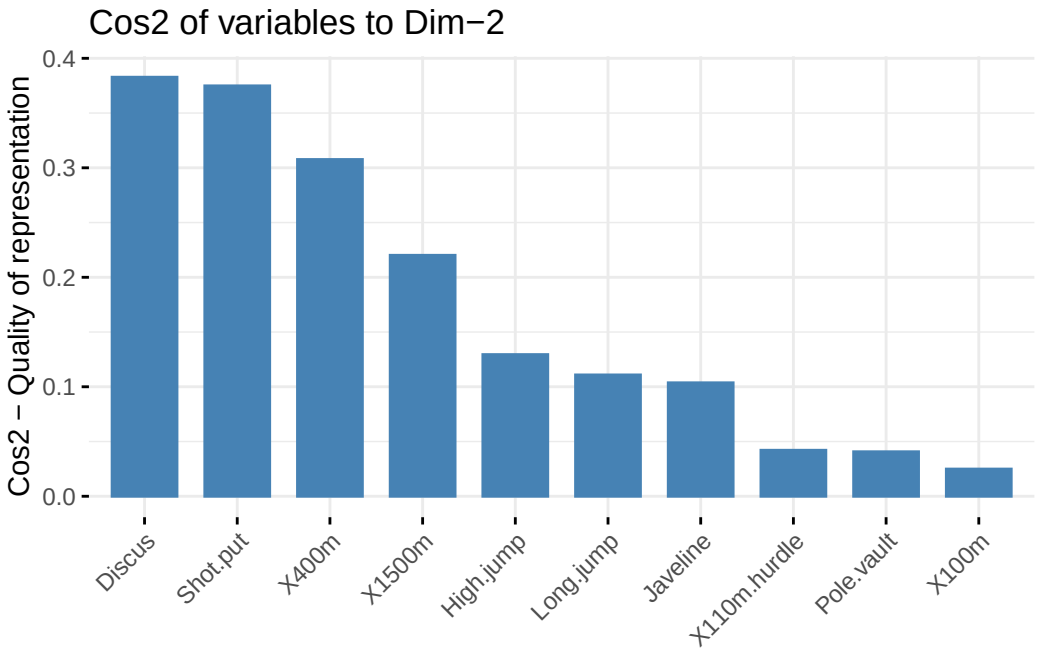

```
######### creation graphic de cercle pour etudier la correlation des variables
fviz_pca_var(acp_resultat,
             col.var = "cos2",
             gradient.col=c("#00AFBB","#E7B800","#FC4E07"),
              repel = TRUE,
             title='cercle de correlation des variables')
```



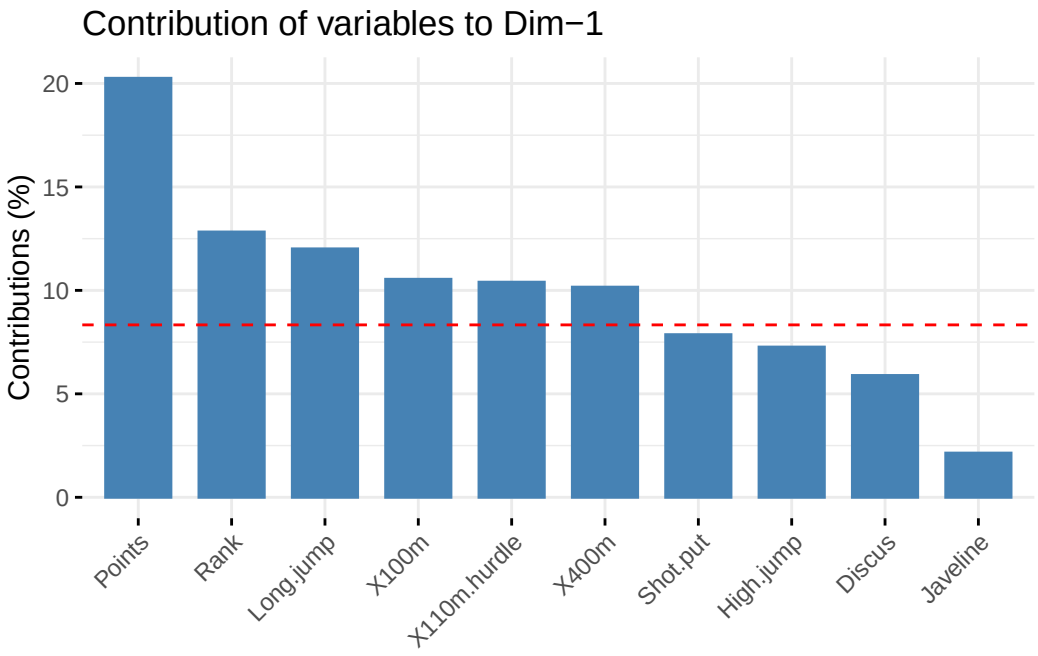

```
# COSINUS des variation des variables sur pca1

fviz_cos2(acp_resultat,choice = "var",axes = 1,top = 10)
```



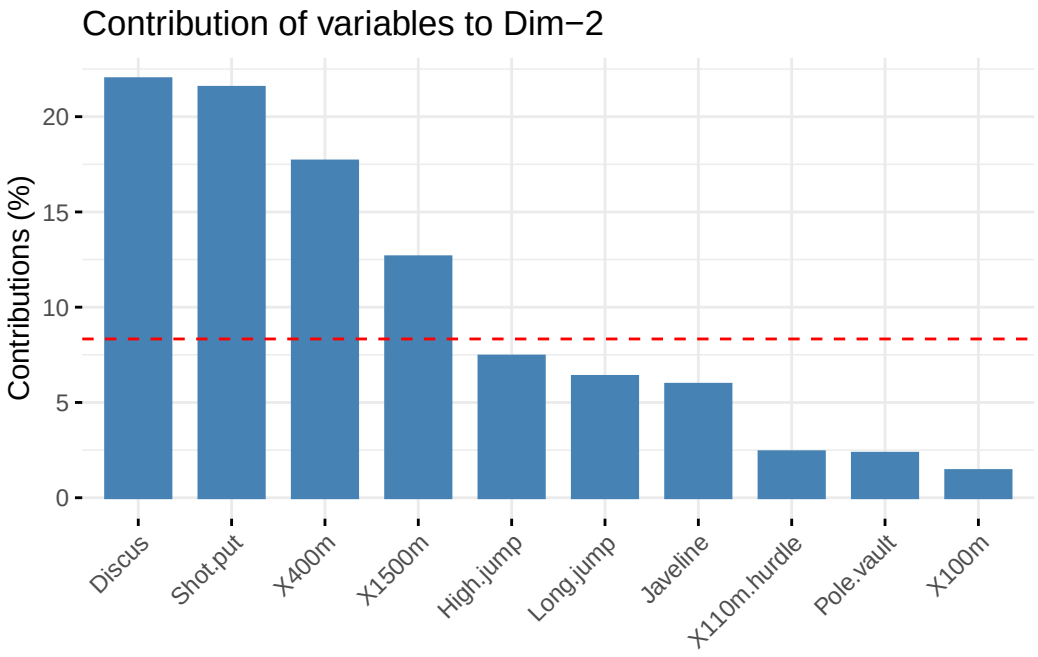

```r
# COSINUS des variation des variables sur pca2
fviz_cos2(acp_resultat,choice = "var",axes = 2,top = 10)
```



```r
# contribution  des variables sur pca1
fviz_contrib(acp_resultat,choice="var",axes = 1,top=10)
```




```r
# contribution  des variables sur pca2
fviz_contrib(acp_resultat,choice="var",axes = 2,top=10)
```




```r
# afficher les indivudis
head(acp_resultat$ind$coord)
```

```
             Dim.1      Dim.2      Dim.3      Dim.4       Dim.5
SEBRLE   1.50509908  0.7038928  0.9418516  1.4300073  0.57877082
CLAY     1.55741711  0.5554568  2.1891163 -0.5335835 -0.78038352
KARPOV   1.59996822  0.4625653  2.0569580 -1.5276391  1.57216651
BERNARD  0.08242073 -0.9779441  0.9724700  2.4695691  0.08487193
YURKOV  -0.03923536  2.0507210 -1.0717485  1.5007847  1.41509091
WARNERS  0.63094174 -1.7190474  0.8258308 -0.3128895  1.15564917
```

```r
# cosinus des individus#
acp_resultat$ind$cos2
```

```
                Dim.1        Dim.2        Dim.3        Dim.4        Dim.5
SEBRLE     0.2822876661 6.174116e-02 1.105418e-01 0.2548227573 0.0417421654
CLAY       0.1721144249 2.189313e-02 3.400518e-01 0.0202028307 0.0432139102
KARPOV     0.1973363095 1.649417e-02 3.261633e-01 0.1798977856 0.1905378987
BERNARD    0.0007769458 1.093820e-01 1.081609e-01 0.6975256188 0.0008238458
YURKOV     0.0001547923 4.228704e-01 1.154994e-01 0.2264805202 0.2013551540
```

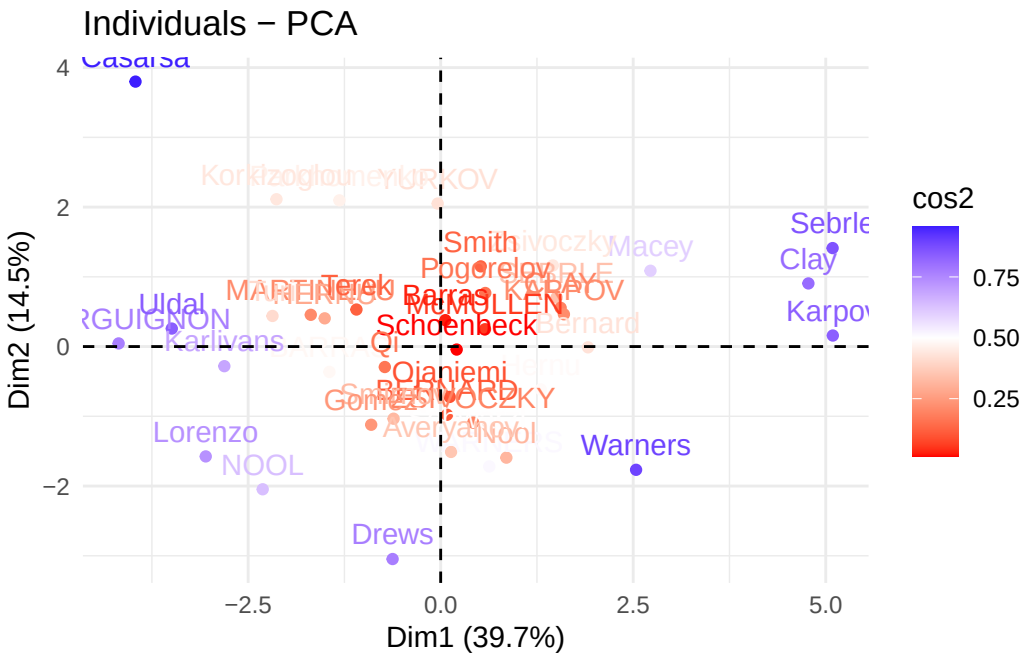
```
WARNERS     0.0611270308 4.537645e-01 1.047218e-01 0.0150326881 0.2050722061
ZSIVOCZKY   0.0253869608 1.699576e-01 2.144882e-01 0.2445555214 0.1759989229
McMULLEN    0.0484608249 9.039191e-03 2.077886e-02 0.2963544283 0.0560564725
MARTINEAU   0.1958438318 1.426592e-02 2.324720e-02 0.0140601424 0.4283356421
HERNU       0.2657943204 1.921523e-02 1.013546e-01 0.0523315913 0.0228060995
BARRAS      0.4535724435 2.870520e-02 1.166529e-03 0.0165805567 0.1812211791
NOOL        0.3550592509 2.784146e-01 1.052258e-01 0.0346102758 0.0834722727
BOURGUIGNON 0.7709406316 8.948418e-05 9.275709e-02 0.0573234815 0.0270869558
Sebrle      0.8002983693 6.160608e-02 2.427776e-03 0.0869129261 0.0042964821
Clay        0.7840960513 2.820796e-02 1.192646e-03 0.0292507263 0.0752627211
Karpov      0.8378235563 8.108608e-04 1.835618e-04 0.0913888038 0.0011199852
Macey       0.5178494796 8.248261e-02 2.286175e-01 0.0238254601 0.0758086835
Warners     0.6016902813 2.918661e-01 6.355797e-02 0.0281460830 0.0057583712
Zsivoczky   0.2688350727 1.715151e-01 2.557791e-01 0.1229113955 0.0322359250
Hernu       0.3992577433 8.911269e-02 1.803088e-01 0.0003120170 0.1091708620
Nool        0.0703745524 2.453829e-01 1.739493e-01 0.4210299826 0.0455718505
Bernard     0.4268677588 1.447221e-05 7.051764e-02 0.3059815878 0.0075518238
Schwarzl    0.0287651623 4.694950e-01 1.651585e-01 0.0519036347 0.0039279644
Pogorelov   0.0582587315 1.026094e-01 3.207656e-01 0.0370853343 0.0618608059
Schoenbeck  0.0131742902 5.586059e-04 1.513295e-01 0.1472757853 0.3013798522
Barras      0.0007322831 2.869714e-02 5.034501e-01 0.0563338404 0.0528353597
Smith       0.0215467964 1.052600e-01 2.314929e-01 0.1906352193 0.1168205539
Averyanov   0.0027914099 3.516403e-01 5.110334e-03 0.0326315572 0.1703717778
Ojaniemi    0.0024011089 9.128948e-02 3.656377e-02 0.0061592586 0.2894414608
Smirnov     0.0836383197 2.391967e-01 3.766341e-01 0.0333544485 0.1095066970
Qi          0.1413039553 2.310471e-02 3.371796e-01 0.0270631710 0.0379165047
Drews       0.0310793606 7.401450e-01 7.031516e-02 0.0659453837 0.0150793875
Parkhomenko 0.1306847208 3.323232e-01 8.165108e-02 0.1533714667 0.0385319675
Terek       0.0982834285 2.319053e-02 3.789741e-01 0.0003846975 0.0017437753
Gomez       0.0947452375 1.463622e-01 2.377703e-01 0.0218745103 0.2262675811
Turi        0.3933541503 1.589687e-02 1.586789e-02 0.0073761542 0.0303595188
Lorenzo     0.5773099608 1.539344e-01 1.556210e-01 0.0020919699 0.0346597127
Karlivans   0.6812391748 6.823144e-03 1.315915e-02 0.1122935988 0.0220522177
Korkizoglou 0.2208767390 2.168643e-01 3.006338e-01 0.1351944085 0.0613665776
Uldal       0.8364842047 4.572875e-03 1.758090e-02 0.0038729818 0.0858727230
Casarsa     0.4984941473 4.583527e-01 4.848416e-09 0.0168983651 0.0076251572
```

```r
# contribution des indivIdUs
acp_resultat$ind$contrib
```

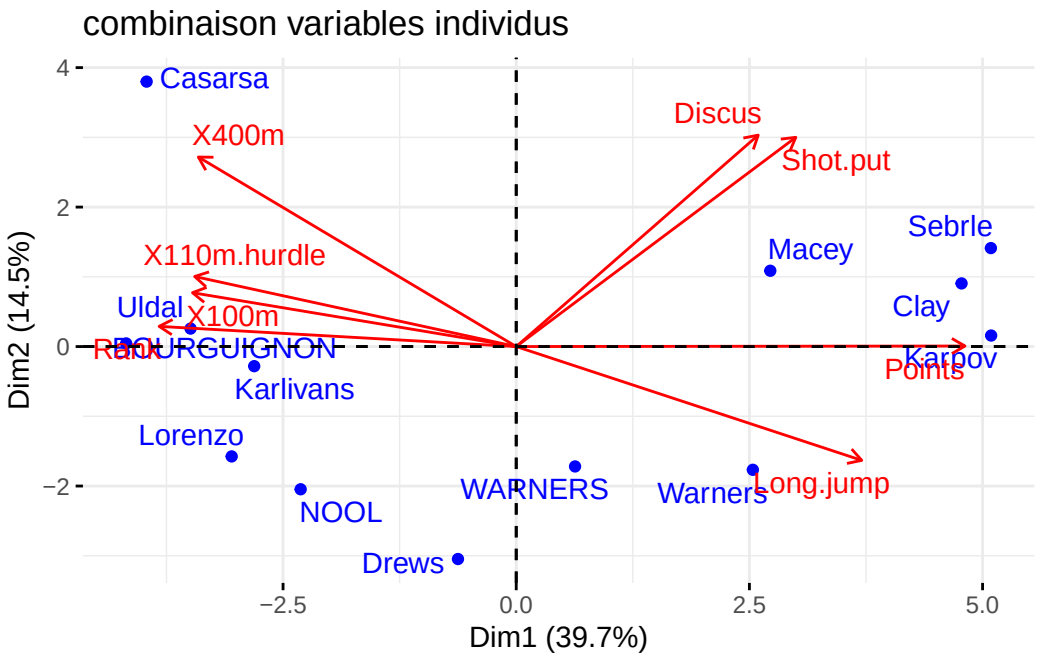
```
                Dim.1        Dim.2        Dim.3       Dim.4       Dim.5
SEBRLE      1.161047e+00 6.944540e-01 1.529166e+00  4.40688164  0.94787531
```

```
CLAY        1.243167e+00 4.324451e-01 8.260899e+00  0.61356381  1.72327322
KARPOV      1.312026e+00 2.999001e-01 7.293576e+00  5.02917132  6.99415163
BERNARD     3.481709e-03 1.340474e+00 1.630204e+00 13.14308356  0.02038291
YURKOV      7.889962e-04 5.894454e+00 1.980047e+00  4.85390962  5.66639235
WARNERS     2.040319e-01 4.141962e+00 1.175633e+00  0.21097780  3.77911393
ZSIVOCZKY   9.106087e-02 1.667141e+00 2.587585e+00  3.68836484  3.48537467
McMULLEN    1.698643e-01 8.664665e-02 2.449645e-01  4.36775390  1.08481471
MARTINEAU   1.457992e+00 2.904397e-01 5.820845e-01  0.44011920 17.60547978
HERNU       1.162183e+00 2.297658e-01 1.490536e+00  0.96211761  0.55055194
BARRAS      1.070195e+00 1.852199e-01 9.257250e-03  0.16449424  2.36071527
NOOL        2.737428e+00 5.870088e+00 2.728564e+00  1.12197244  3.55305906
BOURGUIGNON 8.962399e+00 2.844857e-03 3.626775e+00  2.80201992  1.73852892
Sebrle      1.327472e+01 2.794525e+00 1.354417e-01  6.06168406  0.39346399
Clay        1.168499e+01 1.149586e+00 5.977791e-02  1.83286734  6.19237650
Karpov      1.328911e+01 3.517227e-02 9.792550e-03  6.09497045  0.09807853
Macey       3.803293e+00 1.656645e+00 5.647233e+00  0.73575435  3.07392707
Warners     3.299204e+00 4.376538e+00 1.172132e+00  0.64891752  0.17432282
Zsivoczky   1.087110e+00 1.896709e+00 3.478744e+00  2.08984882  0.71969075
Hernu       8.647134e-01 5.277998e-01 1.313427e+00  0.00284140  1.30540109
Nool        3.728440e-01 3.555221e+00 3.099590e+00  9.37907106  1.33298888
Bernard     1.875960e+00 1.739305e-04 1.042313e+00  5.65406647  0.18323166
Schwarzl    5.955507e-02 2.658237e+00 1.150067e+00  0.45184036  0.04489912
Pogorelov   1.717747e-01 8.273635e-01 3.180944e+00  0.45976477  1.00700615
Schoenbeck  2.210883e-02 2.563627e-03 8.541462e-01  1.03921441  2.79235795
Barras      1.873513e-03 2.007831e-01 4.332158e+00  0.60601363  0.74631258
Smith       1.387714e-01 1.853922e+00 5.014469e+00  5.16244696  4.15388803
Averyanov   9.287482e-03 3.199513e+00 5.718653e-02  0.45650705  3.12961130
Ojaniemi    7.027017e-03 7.306185e-01 3.598986e-01  0.07579192  4.67668646
Smirnov     1.918551e-01 1.500493e+00 2.905747e+00  0.32170444  1.38684214
Qi          2.696091e-01 1.205567e-01 2.163772e+00  0.21711718  0.39941730
Drews       1.997935e-01 1.301179e+01 1.520297e+00  1.78249798  0.53519421
Parkhomenko 8.862201e-01 6.162945e+00 1.862296e+00  4.37317309  1.44263459
Terek       6.131176e-01 3.956262e-01 7.951390e+00  0.01009063  0.06005821
Gomez       4.172436e-01 1.762674e+00 3.521763e+00  0.40504753  5.50139779
Turi        2.444126e+00 2.701235e-01 3.316111e-01  0.19271041  1.04148525
Lorenzo     4.770186e+00 3.478347e+00 4.324785e+00  0.07268035  1.58113734
Karlivans   4.044443e+00 1.107782e-01 2.627587e-01  2.80316968  0.72281926
Korkizoglou 2.330223e+00 6.256717e+00 1.066732e+01  5.99710415  3.57435615
Uldal       6.247695e+00 9.340331e-02 4.416449e-01  0.12163061  3.54107976
Casarsa     8.047480e+00 2.023534e+01 2.632509e-07  1.14704348  0.67962141
```

```
fviz_pca_ind(acp_resultat,col.ind = "cos2")+scale_color_gradient2(low="red",mid = "white",
```




```
#### filter les indivIdUS qu'ont cos2> 50
ind_cos2=apply(acp_resultat$ind$cos2,1,max)>0.5
###### creation un graphic qui combine entre les variables et individus
fviz_pca_biplot(acp_resultat,select.ind=list(cos2=0.5),
                select.var=list(cos2=0.5),
                repel = T,
                title="combinaison variables individus",
                col.ind = "blue",
                col.var = "red")
```




```
#### les variables les plus correlé  pour chaque dimession
var_acp=dimdesc(acp_resultat,axes = c(1,2),proba = 0.05)
print(var_acp)
```

```
$Dim.1

Link between the variable and the continuous variables (R-square)
================================================================================
             correlation      p.value
Points         0.9816991 1.051268e-29
Long.jump      0.7559094 1.102973e-08
Shot.put       0.6116490 2.150346e-05
High.jump      0.5878896 5.307214e-05
Discus         0.5293816 3.723514e-04
Javeline       0.3189638 4.208894e-02
X400m         -0.6952784 4.540305e-07
X110m.hurdle  -0.7034326 2.906722e-07
X100m         -0.7081629 2.228788e-07
Rank          -0.7811767 1.678628e-09

$Dim.2
```

```
Link between the variable and the continuous variables (R-square)
================================================================================
           correlation      p.value
Discus       0.6186595 1.623995e-05
Shot.put     0.6122609 2.098858e-05
X400m        0.5545972 1.680931e-04
X1500m       0.4691259 1.974548e-03
High.jump    0.3597240 2.088507e-02
Javeline     0.3219153 4.011990e-02
Long.jump   -0.3329181 3.343001e-02
```

```
###### les varibales plus contributives#####
fviz_pca_var(acp_resultat,choice = "var",col.var="contrib",
             gradient.cols=c("#00AFBB","#E7B800","#FC4E07"),
            repel=TRUE,title="contribution des varibales")
```