excercise_1_code

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```
# remove all current objects
rm(list = ls())
```

```
# load R data and save
data()
library(ade4)
data(package = "ade4")
data("doubs")
str(doubs)
```

```
## List of 4
##  $ env    :'data.frame': 30 obs. of  11 variables:
##   ..$ dfs: num [1:30] 3 22 102 185 215 324 268 491 705 990 ...
##   ..$ alt: num [1:30] 934 932 914 854 849 846 841 792 752 617 ...
##   ..$ slo: num [1:30] 6.18 3.43 3.64 3.5 3.18 ...
##   ..$ flo: num [1:30] 84 100 180 253 264 286 400 130 480 1000 ...
##   ..$ pH : num [1:30] 79 80 83 80 81 79 81 81 80 77 ...
##   ..$ har: num [1:30] 45 40 52 72 84 60 88 94 90 82 ...
##   ..$ pho: num [1:30] 1 2 5 10 38 20 7 20 30 6 ...
##   ..$ nit: num [1:30] 20 20 22 21 52 15 15 41 82 75 ...
##   ..$ amm: num [1:30] 0 10 5 0 20 0 0 12 12 1 ...
##   ..$ oxy: num [1:30] 122 103 105 110 80 102 111 70 72 100 ...
##   ..$ bdo: num [1:30] 27 19 35 13 62 53 22 81 52 43 ...
##  $ fish   :'data.frame': 30 obs. of  27 variables:
##   ..$ Cogo: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Satr: num [1:30] 3 5 5 4 2 3 5 0 0 1 ...
##   ..$ Phph: num [1:30] 0 4 5 5 3 4 4 0 1 4 ...
##   ..$ Neba: num [1:30] 0 3 5 5 2 5 5 0 3 4 ...
##   ..$ Thth: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Teso: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Chna: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Chto: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Lele: num [1:30] 0 0 0 0 5 1 1 0 0 2 ...
##   ..$ Lece: num [1:30] 0 0 0 1 2 2 1 0 5 2 ...
##   ..$ Baba: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Spbi: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Gogo: num [1:30] 0 0 0 1 2 1 0 0 0 1 ...
##   ..$ Eslu: num [1:30] 0 0 1 2 4 1 0 0 0 0 ...
##   ..$ Pefl: num [1:30] 0 0 0 2 4 1 0 0 0 0 ...
##   ..$ Rham: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Legi: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Scer: num [1:30] 0 0 0 0 2 0 0 0 0 0 ...
##   ..$ Cyca: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
```

```
##   ..$ Titi: num [1:30] 0 0 0 1 3 2 0 0 1 0 ...
##   ..$ Abbr: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Icme: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Acce: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Ruru: num [1:30] 0 0 0 0 5 1 0 0 4 0 ...
##   ..$ Blbj: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Alal: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##   ..$ Anan: num [1:30] 0 0 0 0 0 0 0 0 0 0 ...
##  $ xy     :'data.frame': 30 obs. of  2 variables:
##   ..$ x: num [1:30] 88 94 102 100 106 112 114 110 136 168 ...
##   ..$ y: num [1:30] 7 14 18 28 39 51 61 76 100 112 ...
##  $ species:'data.frame': 27 obs. of  4 variables:
##   ..$ Scientific: chr [1:27] "Cottus gobio" "Salmo trutta fario" "Phoxinus phoxinus" "Nemacheilus ba
##   ..$ French    : chr [1:27] "chabot" "truite fario" "vairon" "loche franche" ...
##   ..$ English   : chr [1:27] "european bullhead" "brown trout" "minnow" "stone loach" ...
##   ..$ code      : Factor w/ 27 levels "Abbr","Acce",..: 9 22 19 17 26 25 7 8 16 14 ...
```

```
write.csv(doubs$env, "data/doubs_env.csv")
```

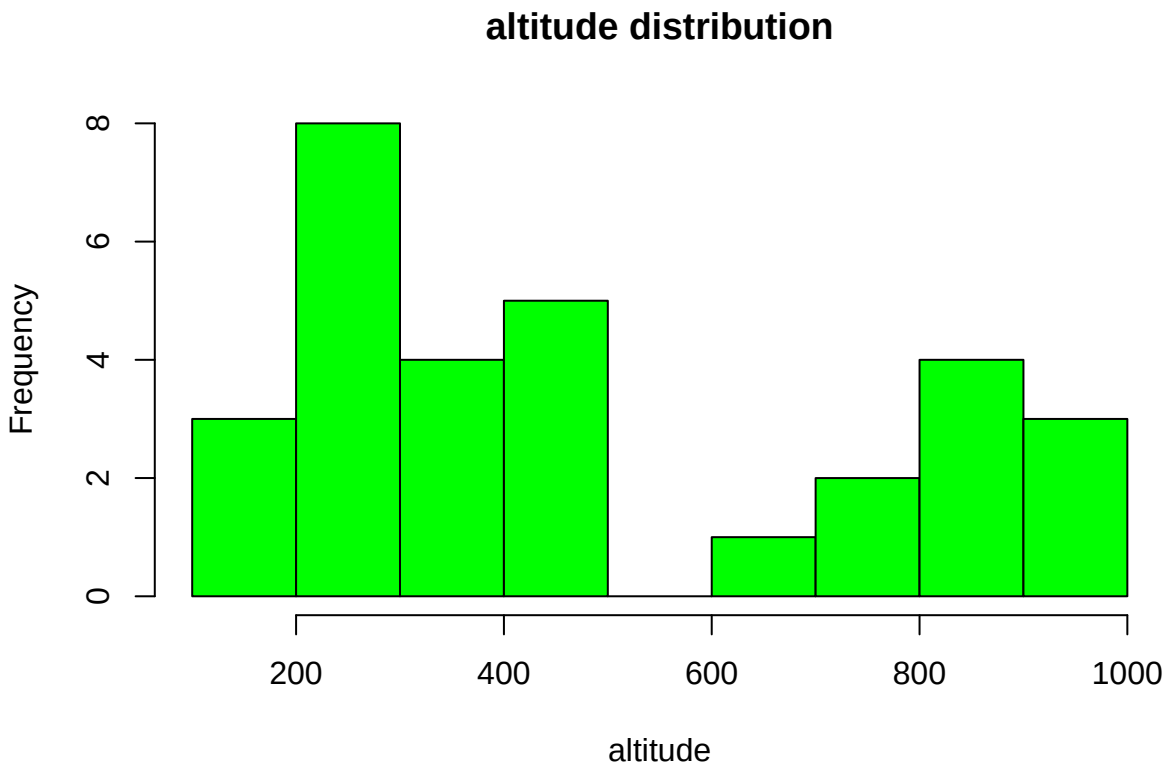
```
# load data and checking the data structure
mydata <- read.csv("data/doubs_env.csv")
head(mydata)
```

```
##   X dfs alt   slo flo pH har pho nit amm oxy bdo
## 1 1   3 934 6.176  84 79  45   1  20   0 122  27
## 2 2  22 932 3.434 100 80  40   2  20  10 103  19
## 3 3 102 914 3.638 180 83  52   5  22   5 105  35
## 4 4 185 854 3.497 253 80  72  10  21   0 110  13
## 5 5 215 849 3.178 264 81  84  38  52  20  80  62
## 6 6 324 846 3.497 286 79  60  20  15   0 102  53
```

```
mydata <- mydata[,-1]
head(mydata)
```

```
##   dfs alt   slo flo pH har pho nit amm oxy bdo
## 1   3 934 6.176  84 79  45   1  20   0 122  27
## 2  22 932 3.434 100 80  40   2  20  10 103  19
## 3 102 914 3.638 180 83  52   5  22   5 105  35
## 4 185 854 3.497 253 80  72  10  21   0 110  13
## 5 215 849 3.178 264 81  84  38  52  20  80  62
## 6 324 846 3.497 286 79  60  20  15   0 102  53
```

```
hist(mydata$alt,
     col = "green",
     main = "altitude distribution",
     xlab = "altitude")
```




```
# correlation analysis and visualization
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
res1 <- cor(mydata)
res1
```

```
##             dfs         alt        slo         flo          pH         har
## dfs  1.00000000 -0.94102219 -0.7557286  0.94904174  0.00472656  0.69790332
## alt -0.94102219  1.00000000  0.7637673 -0.86926914 -0.03726938 -0.74481167
## slo -0.75572859  0.76376732  1.0000000 -0.71571143 -0.27091451 -0.65375106
## flo  0.94904174 -0.86926914 -0.7157114  1.00000000  0.02042538  0.69678410
## pH   0.00472656 -0.03726938 -0.2709145  0.02042538  1.00000000  0.08886897
## har  0.69790332 -0.74481167 -0.6537511  0.69678410  0.08886897  1.00000000
## pho  0.47789736 -0.44204914 -0.4037680  0.38528236 -0.08323950  0.36379811
## nit  0.74671936 -0.76054593 -0.6108798  0.60707232 -0.04887849  0.51073526
## amm  0.40866509 -0.38132330 -0.3514402  0.29490860 -0.12412055  0.29074449
## oxy -0.51035396  0.36190401  0.4637083 -0.35789468  0.17700293 -0.38239140
## bdo  0.39573704 -0.33784820 -0.3170900  0.25320534 -0.15181290  0.34496636
##             pho         nit        amm        oxy        bdo
## dfs  0.4778974  0.74671936  0.4086651 -0.5103540  0.3957370
## alt -0.4420491 -0.76054593 -0.3813233  0.3619040 -0.3378482
## slo -0.4037680 -0.61087984 -0.3514402  0.4637083 -0.3170900
## flo  0.3852824  0.60707232  0.2949086 -0.3578947  0.2532053
## pH  -0.0832395 -0.04887849 -0.1241205  0.1770029 -0.1518129
## har  0.3637981  0.51073526  0.2907445 -0.3823914  0.3449664
## pho  1.0000000  0.80025065  0.9695215 -0.7236924  0.8855369
## nit  0.8002507  1.00000000  0.7976855 -0.6290729  0.6422816
## amm  0.9695215  0.79768545  1.0000000 -0.7208146  0.8857985
## oxy -0.7236924 -0.62907291 -0.7208146  1.0000000 -0.8431211
```

```
## bdo  0.8855369  0.64228156  0.8857985 -0.8431211  1.0000000
```

```
write.table(res1,"results/coeff.txt",sep="\t")
library(psych)
res2 <- corr.test(mydata)
res2$r
```

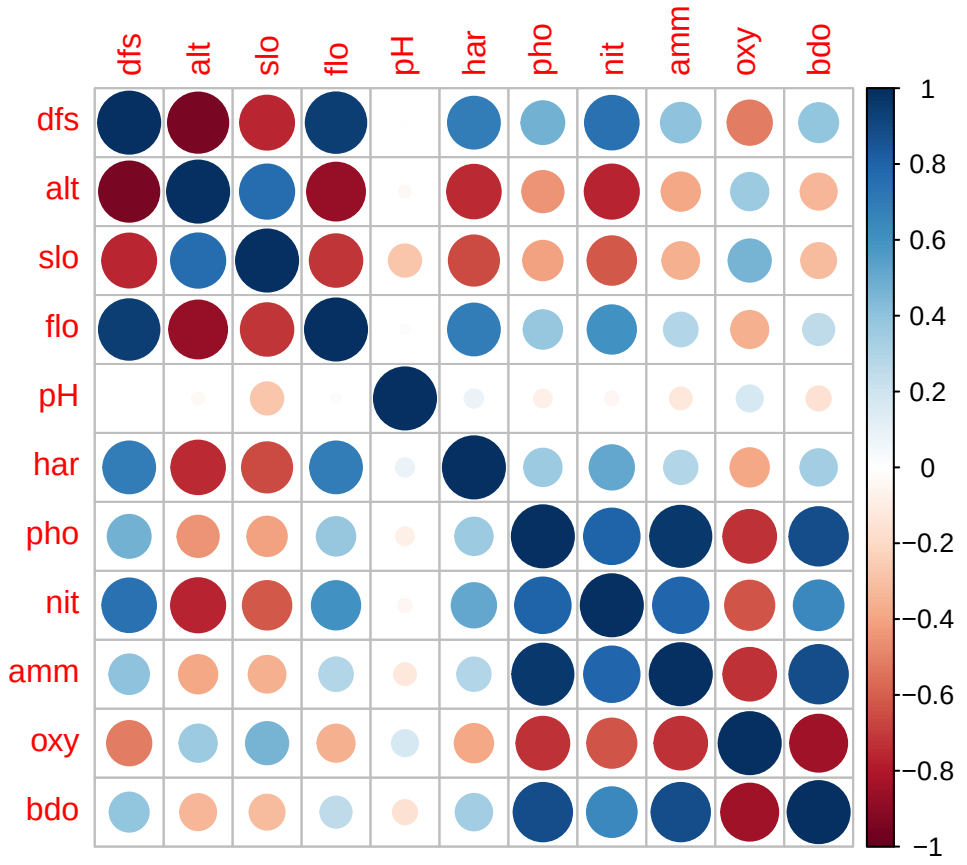
```
##             dfs         alt        slo         flo          pH         har
## dfs  1.00000000 -0.94102219 -0.7557286  0.94904174  0.00472656  0.69790332
## alt -0.94102219  1.00000000  0.7637673 -0.86926914 -0.03726938 -0.74481167
## slo -0.75572859  0.76376732  1.0000000 -0.71571143 -0.27091451 -0.65375106
## flo  0.94904174 -0.86926914 -0.7157114  1.00000000  0.02042538  0.69678410
## pH   0.00472656 -0.03726938 -0.2709145  0.02042538  1.00000000  0.08886897
## har  0.69790332 -0.74481167 -0.6537511  0.69678410  0.08886897  1.00000000
## pho  0.47789736 -0.44204914 -0.4037680  0.38528236 -0.08323950  0.36379811
## nit  0.74671936 -0.76054593 -0.6108798  0.60707232 -0.04887849  0.51073526
## amm  0.40866509 -0.38132330 -0.3514402  0.29490860 -0.12412055  0.29074449
## oxy -0.51035396  0.36190401  0.4637083 -0.35789468  0.17700293 -0.38239140
## bdo  0.39573704 -0.33784820 -0.3170900  0.25320534 -0.15181290  0.34496636
##            pho         nit        amm        oxy        bdo
## dfs  0.4778974  0.74671936  0.4086651 -0.5103540  0.3957370
## alt -0.4420491 -0.76054593 -0.3813233  0.3619040 -0.3378482
## slo -0.4037680 -0.61087984 -0.3514402  0.4637083 -0.3170900
## flo  0.3852824  0.60707232  0.2949086 -0.3578947  0.2532053
## pH  -0.0832395 -0.04887849 -0.1241205  0.1770029 -0.1518129
## har  0.3637981  0.51073526  0.2907445 -0.3823914  0.3449664
## pho  1.0000000  0.80025065  0.9695215 -0.7236924  0.8855369
## nit  0.8002507  1.00000000  0.7976855 -0.6290729  0.6422816
## amm  0.9695215  0.79768545  1.0000000 -0.7208146  0.8857985
## oxy -0.7236924 -0.62907291 -0.7208146  1.0000000 -0.8431211
## bdo  0.8855369  0.64228156  0.8857985 -0.8431211  1.0000000
```

```
res2$ci
```

```
##                lower           r        upper            p
## dfs-alt -0.971822764 -0.94102219 -0.878625885 1.049782e-14
## dfs-slo -0.877173509 -0.75572859 -0.543411787 1.375428e-06
## dfs-flo  0.894669401  0.94904174  0.975706600 1.425990e-15
## dfs-pH  -0.356149126  0.00472656  0.364375312 9.802237e-01
## dfs-har  0.451040639  0.69790332  0.845568616 1.808633e-05
## dfs-pho  0.142092432  0.47789736  0.715054436 7.563926e-03
## dfs-nit  0.528674031  0.74671936  0.872317680 2.147957e-06
## dfs-amm  0.056751340  0.40866509  0.670253289 2.495075e-02
## dfs-oxy -0.735407594 -0.51035396 -0.183896909 3.958641e-03
## dfs-bdo  0.041365355  0.39573704  0.661670639 3.041168e-02
## alt-slo  0.556673379  0.76376732  0.881485386 9.091572e-07
## alt-flo -0.936312515 -0.86926914 -0.741086732 4.607434e-10
## alt-pH  -0.392271570 -0.03726938  0.327395787 8.449807e-01
## alt-har -0.871286277 -0.74481167 -0.525570107 2.355032e-06
## alt-pho -0.692097238 -0.44204914 -0.097270968 1.445273e-02
## alt-nit -0.879759826 -0.76054593 -0.551346310 1.075278e-06
## alt-amm -0.652018803 -0.38132330 -0.024407107 3.760434e-02
## alt-oxy  0.001879889  0.36190401  0.638874885 4.939185e-02
## alt-bdo -0.622365401 -0.33784820  0.025528228 6.785730e-02
## slo-flo -0.855413346 -0.71571143 -0.478935027 8.743953e-06
## slo-pH  -0.575056935 -0.27091451  0.099019199 1.476033e-01
```

```
## slo-har -0.820719247 -0.65375106 -0.383900552 8.941138e-05
## slo-pho -0.667010425 -0.40376800 -0.050903453 2.691626e-02
## slo-nit -0.795970841 -0.61087984 -0.321329117 3.363877e-04
## slo-amm -0.631724824 -0.35144024  0.010108900 5.686101e-02
## slo-oxy  0.124185542  0.46370835  0.706028549 9.852365e-03
## slo-bdo -0.607912673 -0.31709005  0.048748044 8.775646e-02
## flo-pH  -0.342363171  0.02042538  0.377913671 9.146845e-01
## flo-har  0.449303460  0.69678410  0.844946510 1.889905e-05
## flo-pho  0.029044695  0.38528236  0.654678663 3.550482e-02
## flo-nit  0.315891572  0.60707232  0.793742529 3.749547e-04
## flo-amm -0.073130481  0.29490860  0.592253016 1.136354e-01
## flo-oxy -0.636140890 -0.35789468  0.002726033 5.215593e-02
## flo-bdo -0.117810833  0.25320534  0.562190381 1.769985e-01
## pH-har  -0.280377010  0.08886897  0.435204365 6.405011e-01
## pH-pho  -0.430595749 -0.08323950  0.285594301 6.618872e-01
## pH-nit  -0.402067536 -0.04887849  0.316972434 7.975680e-01
## pH-amm  -0.463656529 -0.12412055  0.247202795 5.134447e-01
## pH-oxy  -0.195748948  0.17700293  0.505064824 3.494239e-01
## pH-bdo  -0.485526947 -0.15181290  0.220517183 4.232248e-01
## har-pho  0.004061161  0.36379811  0.640164059 4.812707e-02
## har-nit  0.184395148  0.51073526  0.735644313 3.927170e-03
## har-amm -0.077659252  0.29074449  0.589287982 1.190684e-01
## har-oxy -0.652737053 -0.38239140 -0.025656752 3.702833e-02
## har-bdo -0.017474617  0.34496636  0.627277108 6.190921e-02
## pho-nit  0.618216861  0.80025065  0.900810958 1.108952e-07
## pho-amm  0.936286648  0.96952148  0.985549388 1.213309e-18
## pho-oxy -0.859792901 -0.72369241 -0.491593448 6.201863e-06
## pho-bdo  0.771354121  0.88553693  0.944485375 7.957577e-11
## nit-amm  0.613815442  0.79768545  0.899465045 1.303429e-07
## nit-oxy -0.806549334 -0.62907291 -0.347577015 1.963562e-04
## nit-bdo  0.366914177  0.64228156  0.814159039 1.299832e-04
## amm-oxy -0.858216007 -0.72081459 -0.487017685 7.029051e-06
## amm-bdo  0.771845048  0.88579850  0.944616193 7.719627e-11
## oxy-bdo -0.923021883 -0.84312109 -0.693504165 4.995033e-09
```

```
corr_fig <- corrplot(res1)
```




```
pairs.panels(mydata[,2:6])
```