R-code for Chapter 2: Dependence measures

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01 March, 2019

Contents

Required R-packages

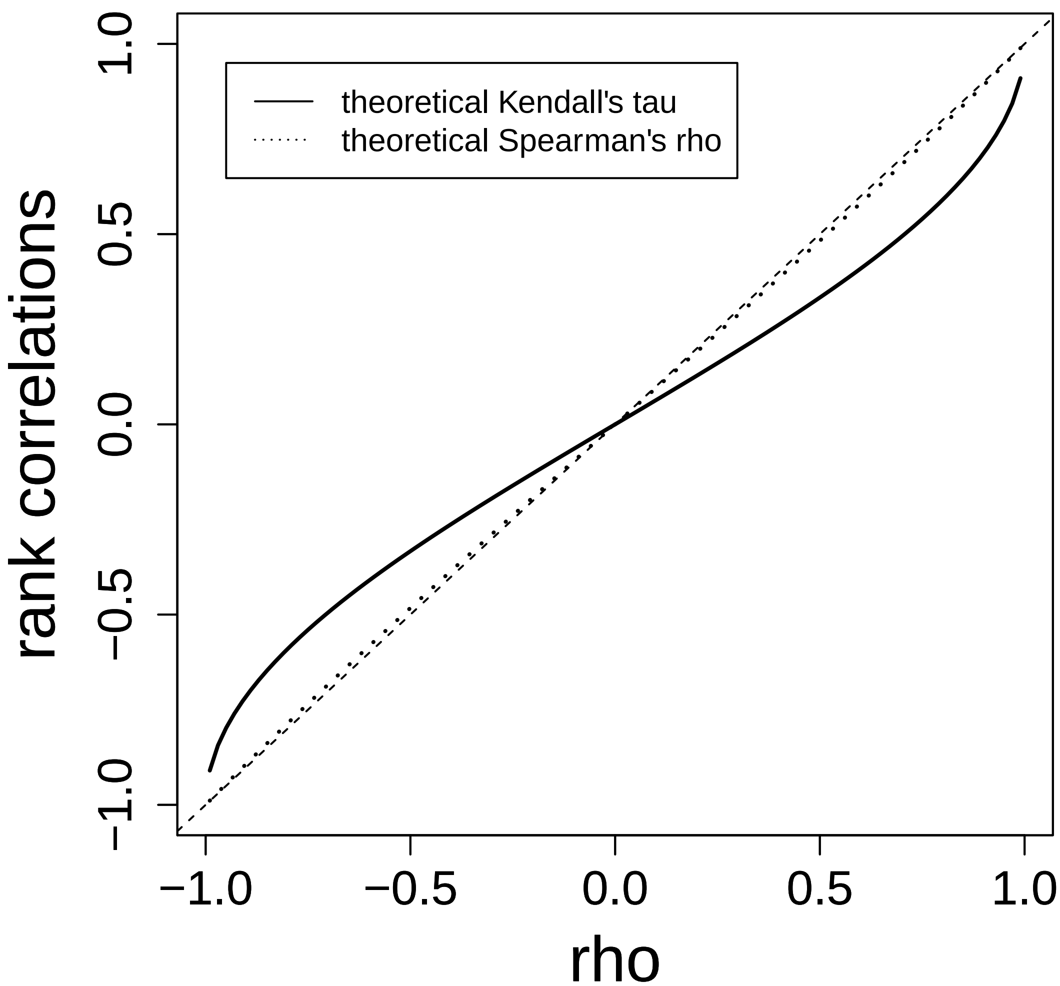
- VineCopula
- rafalib

Section 2.2: Kendall's τ and Spearman's ρ

Figure 2.1: Dependence measures: Kendall's τ (solid) and Spearman's ρ_s (dashed) for a bivariate normal distribution which changing Pearson correlation ρ (dotted line is the x = y axis).

```
cor.vec=seq(-.99,.99,length=100)
tau.vec=cor.vec
rho.vec=cor.vec
for(i in 1:100){
  tau.vec[i]=tau(normalCopula(cor.vec[i]))
  rho.vec[i]=rho(normalCopula(cor.vec[i]))
}
```

```
bigpar(1,1)
plot(cor.vec,tau.vec,type="l",lty=1,lwd=2,xlab="rho",ylab="rank correlations",
     ylim=c(-1,1))
par(new=T)
plot(cor.vec,rho.vec,type="l",lty=3,lwd=2,xlab="rho",ylab="rank correlations",
     ylim=c(-1,1))
legend(-.95,.95,legend=c("theoretical Kendall's tau",
                          "theoretical Spearman's rho"),lty=c(1,3))
abline(0,1,lty=2)
```



Ex 2.4: Estimated bivariate dependence measures for the wine data of Example 1.9.

Read in data and set column names

```
reddata<-read.csv(file="winequality-red.csv",sep=";")
n<-length(reddata[,1])
colnames(reddata)<-c("acf","acv","acc","sugar","clor","sf","st",
                     "den","ph","sp","alc","quality")
acf<-reddata[,1]
acv<-reddata[,2]
acc<-reddata[,3]
```

Table 2.1: WINE3: Estimated correlation ρ, Kendall's τ and Spearman's ρ_s for all pairs of variables of the red wine data of Example 1.9.

```
options(digits=2)
corvec<-c(cor(acf,acv),cor(acf,acc),
cor(acv,acc))
tauvec<-c(cor(acf,acv,method="kendall"),
cor(acf,acc,method="kendall"),
cor(acv,acc,method="kendall"))
spearvec<-c(cor(acf,acv,method="spearman"),
cor(acf,acc,method="spearman"),
cor(acv,acc,method="spearman"))
table<-rbind(corvec,tauvec,spearvec)
rownames(table)<-c("Pearson rho","Kendall's tau", "Spearman's rho")
colnames(table)<-c("(acf,acv)","(acf,acc)","(acv,acc)")
table
```

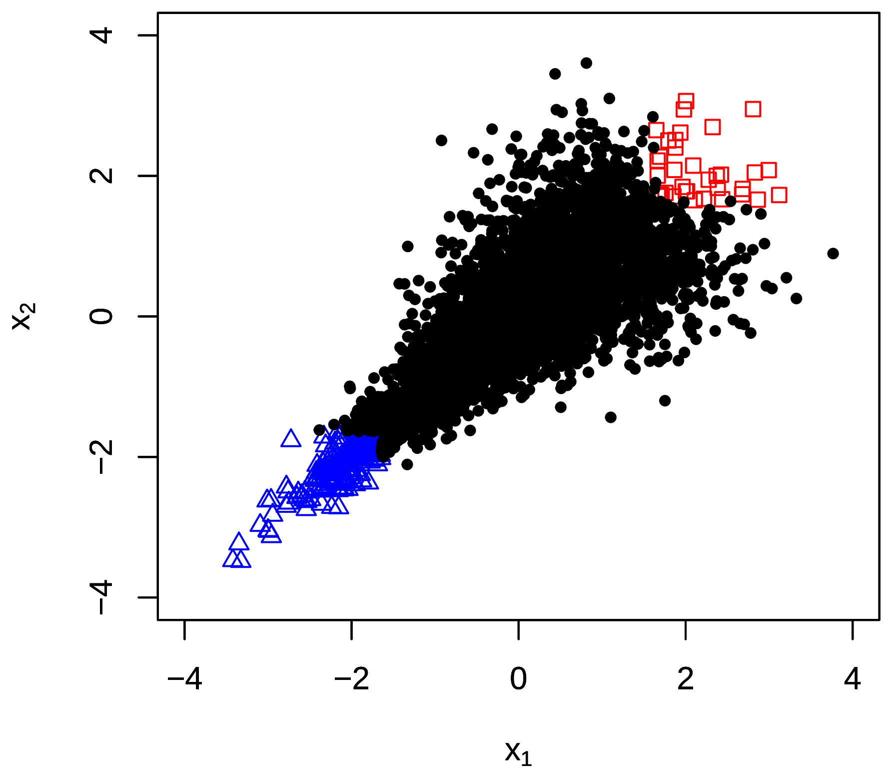
```
##                (acf,acv) (acf,acc) (acv,acc)
## Pearson rho        -0.26      0.67     -0.55
## Kendall's tau      -0.19      0.48     -0.43
## Spearman's rho     -0.28      0.66     -0.61
```

Section 2.3: Tail dependence

Figure 2.2: Tail dependence: Illustration of upper and lower tail dependence: upper tail dependence (squares), lower tail dependence (triangles).

```
theta<-BiCopTau2Par(3,.6)
N<-5000
u<-BiCopSim(N,3,theta)
i<-1:N
i.red<-i[u[,1]>.95 & u[,2]>.95]
i.blue<-i[u[,1]<.05 & u[,2]<.05]
i.mid<-i[-c(i.red,i.blue)]
plot(qnorm(u[i.red,1]),qnorm(u[i.red,2]),ylim=c(-4,4),xlim=c(-4,4),pch=0,
     col=2,ylab=expression('x'[2]),xlab=expression('x'[1]))
```

```
par(new=TRUE)
plot(qnorm(u[i.blue,1]),qnorm(u[i.blue,2]),ylim=c(-4,4),xlim=c(-4,4),pch=2,
     col=4,ylab=expression('x'[2]),xlab=expression('x'[1]))
par(new=TRUE)
plot(qnorm(u[i.mid,1]),qnorm(u[i.mid,2]),ylim=c(-4,4),xlim=c(-4,4),pch=20,
     col=1,ylab=expression('x'[2]),xlab=expression('x'[1]))
```



Partial and conditional correlations

Ex 2.8: Empirical partial and conditional correlation of the wine data of Example 1.9.

Read in data and set column names

```
reddata<-read.csv(file="winequality-red.csv",sep=";")
n<-length(reddata[,1])
colnames(reddata)<-c("acf","acv","acc","sugar","clor","sf","st",
                     "den","ph","sp","alc","quality")
acf<-reddata[,1]
```

```
acv<-reddata[,2]
acc<-reddata[,3]
```

Function to estimate partial correlations in 3 dimensions

```
par.cor<-function(x,y,z)
{
corxy<-cor(x,y)
corxz<-cor(x,z)
coryz<-cor(y,z)
temp1<-corxy-(corxz*coryz)
temp2<-(1-coryz^2)*(1-corxz^2)
temp1/sqrt(temp2)
}
```

Table 2.2: WINE3: Estimated partial correlations for the red wine data of Example 1.9.

```
round(par.cor(acf,acv,acc),digits=2)
```

```
## [1] 0.19
```

```
round(par.cor(acf,acc,acv),digits=2)
```

```
## [1] 0.66
```

```
round(par.cor(acv,acc,acf),digits=2)
```

```
## [1] -0.53
```

Section 2.5: Exercises

Exer 2.4: WINE7: Estimated bivariate dependencies

Read in data and set column names

```
reddata<-read.csv(file="winequality-red.csv",sep=";")
n<-length(reddata[,1])
colnames(reddata)<-c("acf","acv","acc","sugar","clor","sf","st",
                     "den","ph","sp","alc","quality")
reddata7<-reddata[,c(1,2,3,5,7,8,9)]
udata<-reddata
for(i in 1:12){
udata[,i]<-rank(reddata[,i])/(n+1)
}
udata7<-udata[,c(1,2,3,5,7,8,9)]
```

Table 2.3: WINE7: Estimated pairwise dependence measures (top: Kendall's τ , middle: Pearson correlations, bottom: Spearman's ρ_s .

```
red.kendall<-round(cor(reddata7,method="kendall"),digits=2)
red.pearson<-round(cor(reddata7,method="pearson"),digits=2)
red.spearman<-round(cor(udata7,method="spearman"),digits=2)
print(red.kendall,digits=2)
```

```
##        acf   acv   acc  clor    st   den    ph
## acf   1.00 -0.19  0.48  0.18 -0.06  0.46 -0.53
## acv  -0.19  1.00 -0.43  0.11  0.06  0.02  0.16
## acc   0.48 -0.43  1.00  0.08  0.01  0.25 -0.39
## clor  0.18  0.11  0.08  1.00  0.09  0.29 -0.16
## st   -0.06  0.06  0.01  0.09  1.00  0.09 -0.01
## den   0.46  0.02  0.25  0.29  0.09  1.00 -0.22
## ph   -0.53  0.16 -0.39 -0.16 -0.01 -0.22  1.00
```

```
print(red.pearson,digits=2)
```

```
##        acf   acv   acc  clor    st   den    ph
## acf   1.00 -0.26  0.67  0.09 -0.11  0.67 -0.68
## acv  -0.26  1.00 -0.55  0.06  0.08  0.02  0.23
## acc   0.67 -0.55  1.00  0.20  0.04  0.36 -0.54
## clor  0.09  0.06  0.20  1.00  0.05  0.20 -0.27
## st   -0.11  0.08  0.04  0.05  1.00  0.07 -0.07
## den   0.67  0.02  0.36  0.20  0.07  1.00 -0.34
## ph   -0.68  0.23 -0.54 -0.27 -0.07 -0.34  1.00
```

```
print(red.spearman,digits=2)
```

```
##        acf   acv   acc  clor    st   den    ph
## acf   1.00 -0.28  0.66  0.25 -0.09  0.62 -0.71
## acv  -0.28  1.00 -0.61  0.16  0.09  0.03  0.23
## acc   0.66 -0.61  1.00  0.11  0.01  0.35 -0.55
## clor  0.25  0.16  0.11  1.00  0.13  0.41 -0.23
## st   -0.09  0.09  0.01  0.13  1.00  0.13 -0.01
## den   0.62  0.03  0.35  0.41  0.13  1.00 -0.31
## ph   -0.71  0.23 -0.55 -0.23 -0.01 -0.31  1.00
```