NNS Multivariate Dependence vs. multivariance package

Intro

There's a new companion package `multivariance` in R to research demonstrateing multivariate dependence,[1] stating:

Distance multivariance is a measure of dependence which can be used to detect and quantify dependence.

`NNS` has had this capability for years![2]

We will show some known cases in 3 dimensions to illustrate the difference in capabilities between the two methods.

Load Packages `NNS (>= 4.5)`

```
require(devtools); install_github('OVVO-Financial/NNS', ref = "NNS-Beta-Version")
library(NNS)
library(data.table)
library(rgl)
library(multivariance)
```

Case 1: Total Dependence and Total Correlation

The easiest way to demonstrate this is to show a straight line in 3 dimensions, where the variables would axiomatically be dependent upon one another. All observations would occupy the Co-Upper Partial Moment quadrant (green) or Co-Lower Partial Moment quadrant (red).

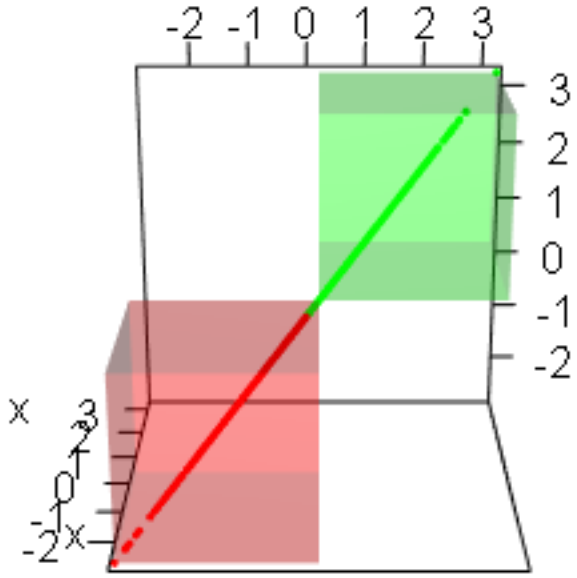
```
set.seed(123)

x <- rnorm(1000)

x3 <- cbind(x,x,x)

NNS.dep.hd(x3, plot = TRUE, independence.overlay = TRUE)
```

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

```
multicorrelation(x3)
```

```
## multicorrelation.2
##                  1
```

[1] Dependence and Dependence Structures: Estimation and Visualization Using Distance Multivariance. <arXiv:1712.06532>.
[2] Deriving Nonlinear Correlation Coefficients from Partial Moments https://ssrn.com/abstract=2148522



X

Case 2: Total Dependence and Negative Correlation

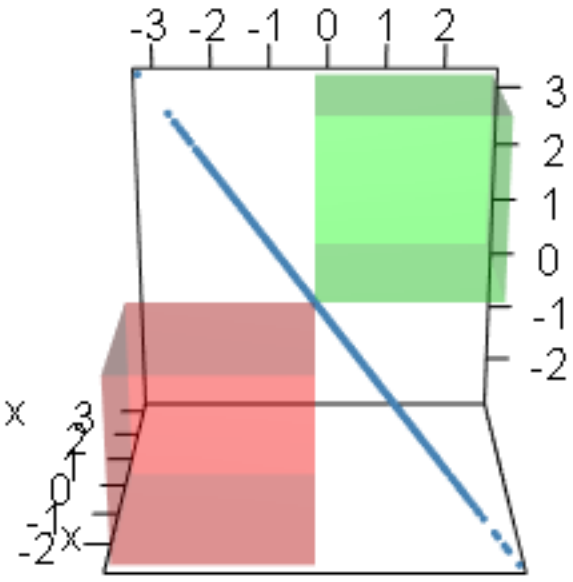
This case too would be a straight line in 3 dimensions, however, it would span the divergent partial moment quadrants (non-highlted ones).

```
set.seed(123)

x <- rnorm(1000)

x3 <- cbind(-x,x,x)

NNS.dep.hd(x3, plot = TRUE, independence.overlay = TRUE)
```

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

```
multicorrelation(x3)
```

```
## multicorrelation.2
##                  1
```



Case 3: Independence

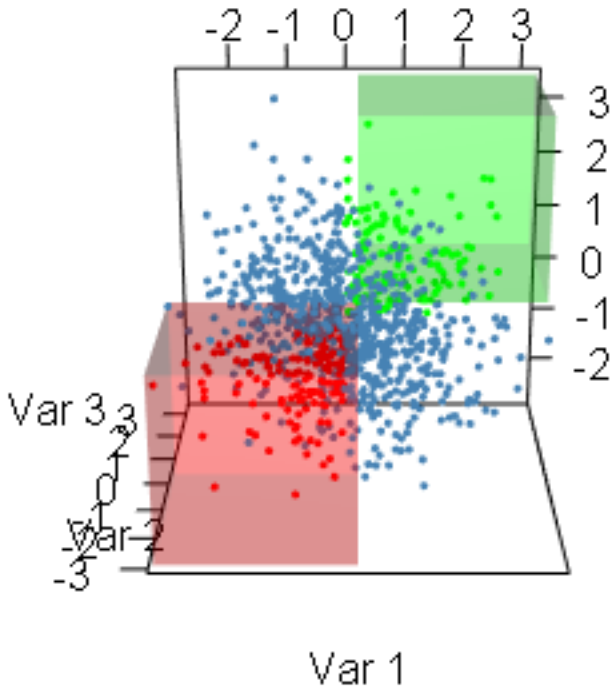
3 Normal random variables...

```
set.seed(123)

x3 <- cbind(rnorm(1000),rnorm(1000),rnorm(1000))

NNS.dep.hd(x3, plot = TRUE, independence.overlay = TRUE)
```

```
## [1] 0.02266667
```

```
multicorrelation(x3)
```

```
## multicorrelation.2
##         0.00407423
```



So far so good!

Case 4: Their Example

```
y = rnorm(100)
x = cbind(y,y*2,(y-2)/3,y+1,y*5)

NNS.dep.hd(x, plot = TRUE, independence.overlay = TRUE)
```

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

```
multicorrelation(x)
```

```
## multicorrelation.2
##                  1
```

Still good!

Case 5: Their Example Expanded

Let's add some more terms to the matrix, and add more observations to eliminate any small sample concerns.

```
y = rnorm(1000)
x = cbind(y,y*2,(y-2)/3,y+1,y*5,y^2,-y^3,-3*y^4,(y^5-4)/3)

NNS.dep.hd(x, plot = TRUE, independence.overlay = TRUE)
```

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

```
multicorrelation(x)
```

```
## multicorrelation.2
##          0.6288725
```

Wait... what happened? All the variables are still very much related according to the pairwise `NNS.dep` measures.[3]

```
round(NNS.dep(x)$Dependence, 3)
```

```
##       y
## y 1.000 1.000 1.000 1.000 1.000 0.971 0.917 0.920 0.885
##   1.000 1.000 1.000 1.000 1.000 0.971 0.917 0.920 0.885
##   1.000 1.000 1.000 1.000 1.000 0.971 0.917 0.920 0.885
##   1.000 1.000 1.000 1.000 1.000 0.971 0.917 0.920 0.885
##   1.000 1.000 1.000 1.000 1.000 0.971 0.917 0.920 0.885
##   0.971 0.971 0.971 0.971 0.971 1.000 0.987 0.977 0.830
##   0.917 0.917 0.917 0.917 0.917 0.987 1.000 0.988 0.974
##   0.920 0.920 0.920 0.920 0.920 0.977 0.988 1.000 0.988
##   0.885 0.885 0.885 0.885 0.885 0.830 0.974 0.988 1.000
```

[3] Nonlinear Correlation and Dependence Using NNS https://ssrn.com/abstract=3010414

Timing

Using the prior case settings, let's compare the timing of the results for each.

```
library(microbenchmark)

microbenchmark(NNS=NNS.dep.hd(x),multivariance=multicorrelation(x),times = 100)
```

```
## Unit: milliseconds
##           expr      min       lq     mean   median        uq      max
##            NNS   2.3336   2.5423   3.6197   2.6941   2.88995  58.3502
##  multivariance 250.7399 265.9429 274.3464 270.3265 275.12455 319.1066
##  neval
##    100
##    100
```

Comments

I look forward to further discussions and collaboration with those equally as passionate about these issues, and open to embracing alternative solutions. If you found this presentation interesting or useful, please feel free to reach out via e-mail: ovvo.financial.systems@gmail.com

Thanks for your interest!