Analysis of crop data

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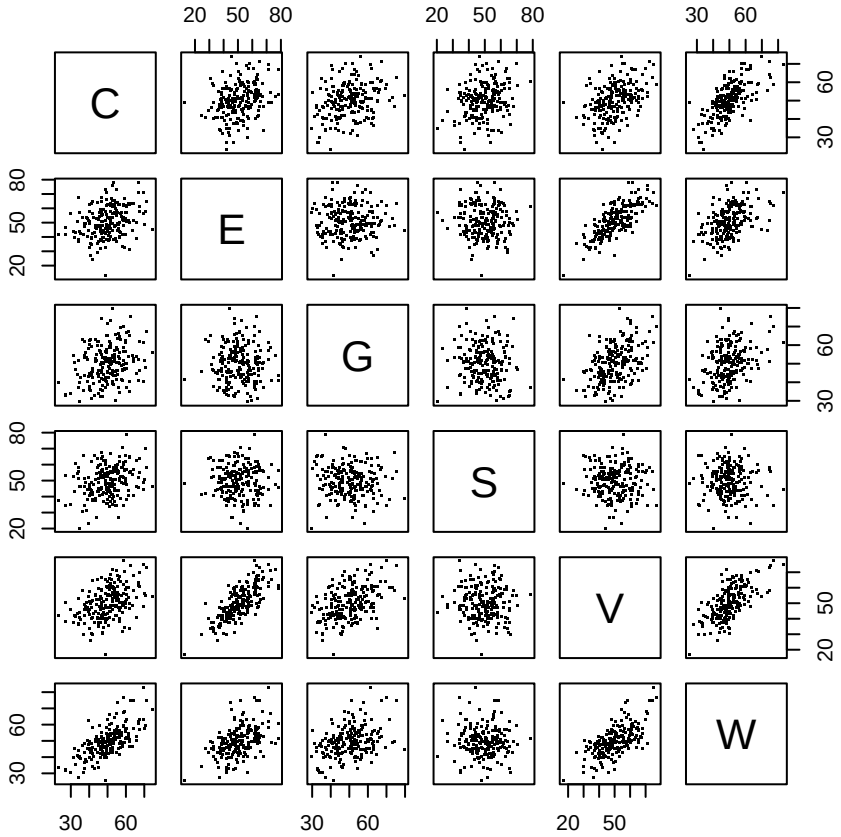
```
source("~/Documents/R_packages/cat_regression_chains/RCG/funs_RCG.R")
library("bnlearn")
library("ggm")
library(mnormt)
```

Read the data

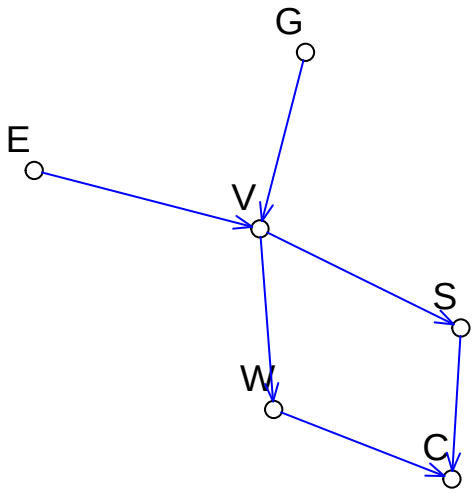
```
setwd("~/Documents/Talks/Firenze PhD 2024/")
crop <- read.table("cropdata.txt", header = TRUE)
crop <- data.frame(crop)
pairs(crop, pch = '.')
```




```
G <- DAG(C ~ S + W, S ~ V, W ~ V, V ~ G + E)
G
```

```
  C S W V G E
C 0 0 0 0 0 0
S 1 0 0 0 0 0
W 1 0 0 0 0 0
V 0 1 1 0 0 0
G 0 0 0 1 0 0
E 0 0 0 1 0 0
```

```
drawGraph(G)
```



Fit of the first equation

```
m_full1<- lm(C ~ S+W+V+G+E, data = crop)
round(summary(m_full1)$coef,3)
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.001      4.349   0.000    1.000
S              0.276      0.047   5.838    0.000
W              0.706      0.067  10.606    0.000
V             -0.098      0.098  -0.997    0.320
G              0.078      0.062   1.275    0.204
E              0.043      0.079   0.552    0.581
```

```
m_red1 <- lm(C ~ S + W, data = crop)
anova(m_red1, m_full1, test = "F")
```

```
Analysis of Variance Table

Model 1: C ~ S + W
Model 2: C ~ S + W + V + G + E
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1    197 7851.9
2    194 7770.3  3    81.565 0.6788  0.566
```

LR test (asymptotic)

```
`LRtest` <- function(m_red, m_full) {
l0 <- logLik(m_red)[1]
lsat <- logLik(m_full)[1]
w = 2 * (lsat - l0)
df = m_red$df.residual - m_full$df.residual
p = 1 - pchisq(w, df)
c(w = w, df = df, p = p)
}
```

```
LRtest(m_red1, m_full1)
```

```
        w        df         p
2.0884556 3.0000000 0.5542518
```

Second equation

```
m_full2 <- lm(S ~ W + V + G + E, data = crop)
round(summary(m_full2)$coef,3)
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   54.374      5.313  10.235    0.000
W              0.020      0.101   0.199    0.842
V              0.014      0.148   0.097    0.923
G             -0.081      0.093  -0.874    0.383
E             -0.048      0.119  -0.402    0.688
```

```
m_red2 <- lm(S ~ 1, data = crop)
anova(m_red2, m_full2, test = "F")
```

```
Analysis of Variance Table

Model 1: S ~ 1
Model 2: S ~ W + V + G + E
  Res.Df   RSS Df Sum of Sq      F Pr(>F)
1    199 18031
2    195 17915  4       116 0.3157 0.8673
```

LR test

```
LRtest(m_red2, m_full2)
```

```
        w        df         p
1.2909126 4.0000000 0.8629154
```

Third equation

```
m_full3 <- lm(W ~ V + G + E, data = crop)
round(summary(m_full3)$coef,3)
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   18.702      3.518   5.317    0.000
V              0.593      0.096   6.168    0.000
G              0.062      0.066   0.947    0.345
E             -0.035      0.084  -0.420    0.675
```

```
m_red3 <- lm(W ~ V, data = crop)
anova(m_red3, m_full3, test = "F")
```

```
Analysis of Variance Table

Model 1: W ~ V
Model 2: W ~ V + G + E
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1    198 9134.5
2    196 9032.6  2     101.8 1.1045 0.3334
```

LR test

```
LRtest(m_red3, m_full3)
```

```
        w        df         p
2.2415432 2.0000000 0.3260281
```

Fourth equation

```
m_full4 <- lm(V ~ G + E, data = crop)
round(summary(m_full4)$coef,3)
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -10.455      2.500  -4.182        0
G              0.455      0.036  12.501        0
E              0.743      0.033  22.357        0
```

```
m_red4 <- m_full4
```

Last equation

```
m_full5 <- lm(G ~ E, data = crop)
round(summary(m_full5)$coef,3)
```

```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   49.692      3.365  14.766    0.000
E              0.009      0.065   0.137    0.891
```

```
m_red5 <- lm(G ~ 1, data = crop)
anova(m_red5, m_full5, test = "F")
```

```
Analysis of Variance Table

Model 1: G ~ 1
Model 2: G ~ E
  Res.Df   RSS Df Sum of Sq      F Pr(>F)
1    199 19108
2    198 19106  1    1.8208 0.0189 0.8909
```

LR test

```
LRtest(m_red5, m_full5)
```

```
         w         df          p
0.01905948 1.00000000 0.89019611
```

Fit DAG

```
ord <- colnames(G)
S <- cov(crop[,ord])
lapply(fitDag(G, S, n= 200), function(x) round(x,3))
```

```
$Shat
       C      S      W       V      G       E
C 84.539 22.814 56.638  42.640 17.156  33.639
S 22.814 90.605 -2.860  -4.848 -1.950  -3.824
W 56.638 -2.860 83.725  64.107 25.792  50.574
V 42.640 -4.848 64.107 108.656 43.716  85.719
G 17.156 -1.950 25.792  43.716 96.019   0.000
E 33.639 -3.824 50.574  85.719  0.000 115.416

$Ahat
  C      S      W      V      G      E
C 1 -0.273 -0.686  0.000  0.000  0.000
S 0  1.000  0.000  0.045  0.000  0.000
W 0  0.000  1.000 -0.590  0.000  0.000
V 0  0.000  0.000  1.000 -0.455 -0.743
G 0  0.000  0.000  0.000  1.000  0.000
E 0  0.000  0.000  0.000  0.000  1.000

$Dhat
      C       S       W       V       G       E
 39.457  90.388  45.902  25.090  96.019 115.416

$dev
[1] 5.159

$df
[1] 9
```

```
knitr::knit_exit()
```