Analysis of crop data

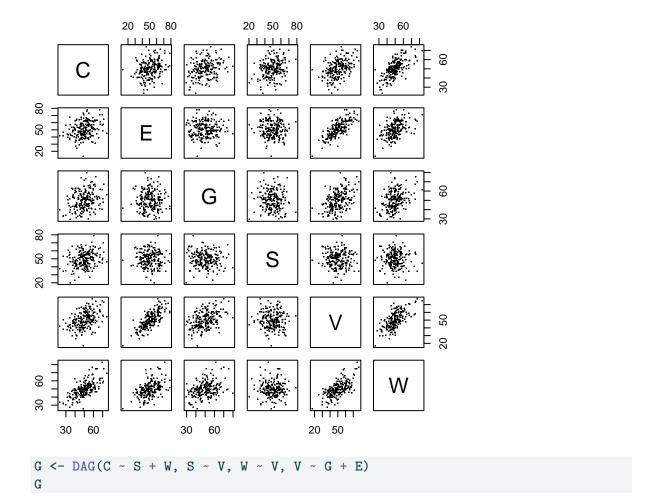
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```
source("~/Documents/R_packages/cat_regression_chains/RCG/funs_RCG.R")
library("bnlearn")
library("ggm")
library(mnormt)
```

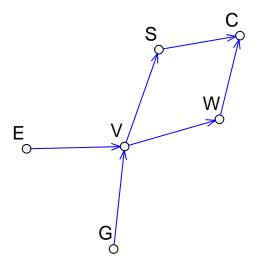
Read the data

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



C S W V G E
C O O O O O O
S 1 O O O O O
W 1 O O O O O
V O 1 1 O O
G O O O 1 O O
E O O O 1 O O

drawGraph(G)



Fit of the first equation

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

```
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
                                         0.320
                        0.098 -0.997
G
              0.078
                         0.062
                                         0.204
                               1.275
                                0.552
Ε
              0.043
                         0.079
                                         0.581
```

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

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) {

10 <- logLik(m_red)[1]

lsat <- logLik(m_full)[1]

w <- 2 * (lsat - 10)

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)</pre>
```

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

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

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)</pre>
```

```
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
            -0.035
Ε
                      0.084 -0.420
                                    0.675
```

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

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)</pre>
```

```
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</pre>
```

Last equation

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

```
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")</pre>
```

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)
                  df
0.01905948 1.00000000 0.89019611
Fit DAG
ord <- colnames(G)</pre>
S <- cov(crop[,ord])
lapply(fitDag(G, S, n=200), function(x) round(x,3))
$Shat
      С
                                          Ε
             S
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
 С
        S
               W
                      V
                             G
                                    Ε
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
     С
             S
                             V
 39.457 90.388 45.902 25.090 96.019 115.416
$dev
[1] 5.159
$df
[1] 9
```