BACHELOR DEGREE IN INFORMATICS (UPC). COURSE 18-19 Q2 – QUIZ1

Anàlisi de Dades i Explotació de la Informació (ADEI).

(Date: 30th/May/2019 14:00 Place: Room A5S108)

STUDENT NAME:	
DNI/PASSPORT:	

Lecturer:	Lídia Montero Mercadé
Office:	Edifici C5 D207
Norms:	Calculator, statistical tables and R Studio reference documents are allowed. Internet access, emailing and chatting is strictly forbidden. Mobile phones should be switched off.
Quiz duration:	1h 00 min
Date for posting marks:	Before June, 4th, 2019, to be posted at Subject's ATENEA WEB page.
Open-office:	June, 4th, 2019 at 11:00 (C5-207).

Problem 1: All qüestions account for 1 point

MASS package in R contains insurance dataframe. It consists on claims from a British car insurance company in 1973:

`District`	district of policyholder (1 to 4): 4 is major cities (London).
`Group`	group of car (1 to 4), <1 litre, 1–1.5 litre, 1.5–2 litre, >2 litre.
`Age`	of driver in 4 ordered groups, <25, 25–29, 30–35, >35.
`Holders`	numbers of policyholders (pòlisses)
`Claims`	numbers of claims (sinistres)

Source: L. A. Baxter, S. M. Coutts and G. A. F. Ross (1980) Applications of linear models in motor insurance. *Proceedings of the 21st International Congress of Actuaries*, *Zurich* pp. 11–29

Data refer to 23,359 holders accounting for 3,151 sinisters in 1973. Total number of claims (Claims) is the target variable. Data is grouped into 64 classes.

```
> summary(baxter)
 District    Group       Age        Holders           Claims          logHolders
 1:16     <1l   :16   <25  :16   Min.   :   3.00   Min.   :  0.00   Min.   :1.099
 2:16     1-1.5l:16   25-29:16   1st Qu.:  46.75   1st Qu.:  9.50   1st Qu.:3.844
 3:16     1.5-2l:16   30-35:16   Median : 136.00   Median : 22.00   Median :4.912
 4:16     >2l   :16   >35  :16   Mean   : 364.98   Mean   : 49.23   Mean   :4.904
                                 3rd Qu.: 327.50   3rd Qu.: 55.50   3rd Qu.:5.791
                                 Max.   :3582.00   Max.   :400.00   Max.   :8.184

> dim(df)
[1] 64  6
> sd(df$Claims)
[1] 71.1624
```

1. Determine the most promising variables for forecasting purposes of the selected target.

2. A model for Claims on Holders and Age is discussed. Fill the blank in the summary output from R.

```
> summary(m1)

Call: lm(formula = Claims ~ Holders + Age, data = df)
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 6.463138     ( 1 )    2.112    0.039
Holders     0.110360   0.003243  34.026    ( 2 )
Age25-29    2.674287     ( 3 )    0.619    0.539
Age30-35    1.108561   4.332954   0.256    0.799
Age>35      6.183251   5.367633   1.152    0.254
---

Residual standard error: ( 4 ) on ( 5 ) degrees of freedom
Multiple R-squared:  0.9724,
F-statistic: 520.4 on ( 6 ) and 59 DF,  p-value: < 2.2e-16
```

1	2	3
4	5	6

3. Write the prediction equation for model (m2) and predict the expected number of claims for a 50 years old person.

4. A new model containing all available factors and the total number of holder is calculated. Determine the significant net-effects of included variables.

5. Taking a look to residual diagnostics in model (m3), a new model (m4) is proposed. Discuss the meaning of the new modelling target and comments pros and cons of both modelling options.

6. A new model with interactions between factors and covariate is proposed (m4 and m5). Determine significant net-effect interactions that are worth to retain. Justify your answer.

7. Make a rough assessment of the quality of the model based on the first impression of the diagnosis of residuals for (m5).

8. A new binary factor consisting on grouping District levels into Others and London is defined and a new model m7 is obtained. Justify according to the provided output pros and cons of m5 and m7.

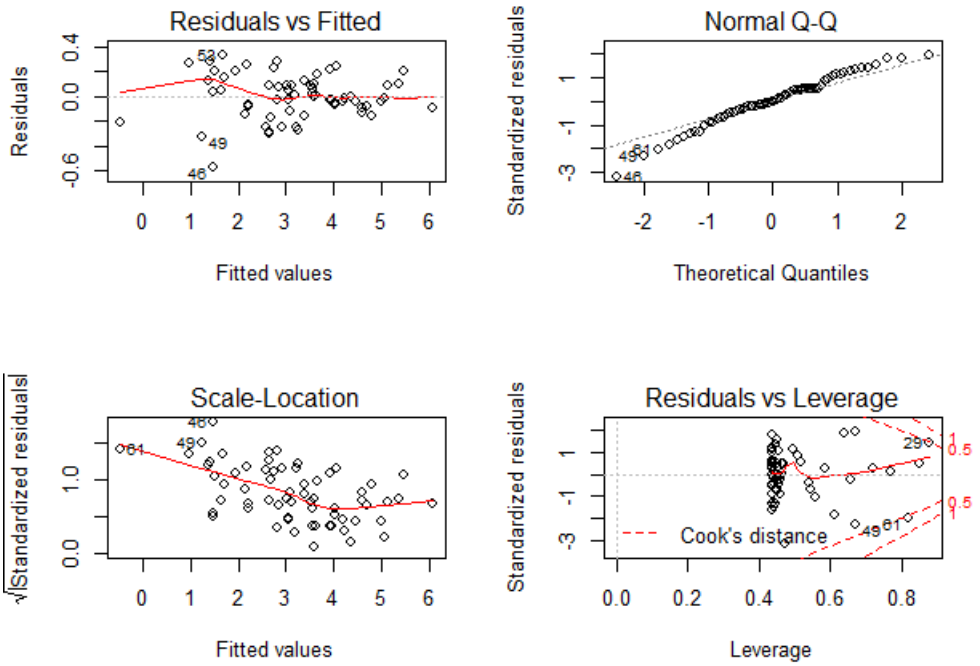
9. Influent and atypical data analysis has to be discussed using influencePlot() output. Are there any atypical and/or influent data classes according to the output?

10. Indicate a 95% confidence interval for the expected number of claims according to (m7) for a person in the [30-35] age segment living in London and holding an insurance for a car in the most powerful group.

RESULTS

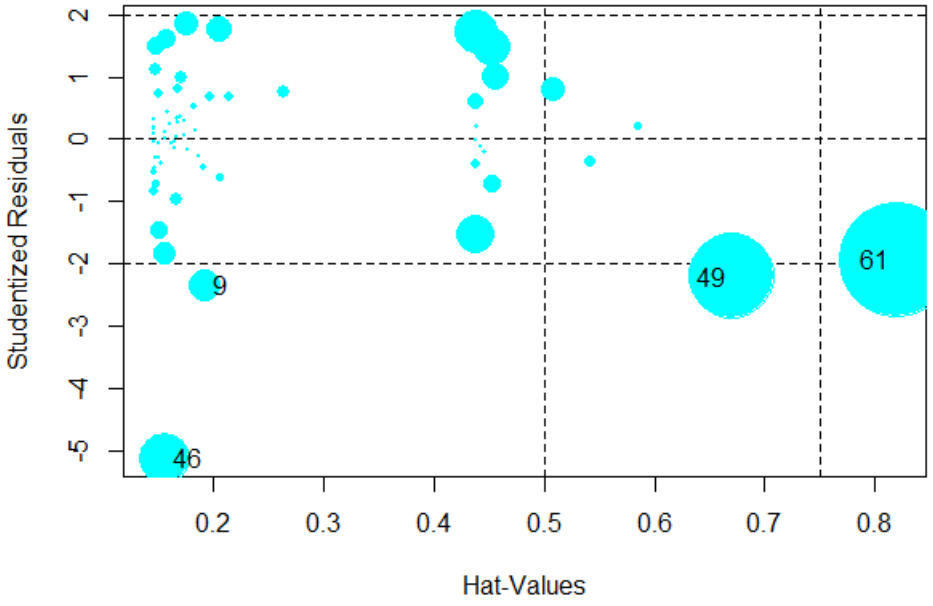
```
> condes(baxter,5)
$quanti
            correlation      p.value
Holders       0.9857701 9.887964e-50
logHolders    0.7741853 6.251833e-14

$quali
                 R2      p.value
Age      0.4315501 1.834931e-07
Group    0.1459450 2.287953e-02
District 0.1235997 4.641178e-02

$category
        Estimate      p.value
>35     79.82812 5.058682e-09
1-1.5l  41.39062 6.227092e-03
1       37.07812 1.487515e-02
>2l    -30.54687 4.652338e-02
<25    -34.92187 2.217507e-02

> m2<-lm(log(Claims+0.5)~log(Holders)+Age,data=df)
> summary(m2)

Call: lm(formula = log(Claims + 0.5) ~ log(Holders) + Age, data = df)

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.95149    0.17008  -5.594 6.03e-07 ***
log(Holders)  0.85354    0.04111  20.763  < 2e-16 ***
Age25-29     -0.07094    0.12277  -0.578    0.566
Age30-35     -0.13827    0.12720  -1.087    0.281
Age>35       -0.07535    0.16874  -0.447    0.657
---
Residual standard error: 0.3297 on 59 degrees of freedom
Multiple R-squared:  0.9386,   Adjusted R-squared:  0.9345
F-statistic: 225.6 on 4 and 59 DF,  p-value: < 2.2e-16

> m3<-lm(log(Claims+0.5)~log(Holders)+District+Group+Age,data=df)
> summary(m3)

Call:lm(formula = log(Claims + 0.5) ~ log(Holders) + District + Group +
    Age, data = df)

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   -2.1369     0.7522  -2.841 0.006369 **
log(Holders)   1.0575     0.1627   6.502 2.86e-08 ***
District2      0.1715     0.1341   1.279 0.206609
District3      0.1564     0.2113   0.740 0.462606
District4      0.3136     0.3099   1.012 0.316208
Group1-1.5l    0.1020     0.1629   0.626 0.534054
Group1.5-2l    0.4176     0.1015   4.112 0.000137 ***
Group>2l       0.6284     0.2187   2.874 0.005827 **
Age25-29      -0.2619     0.1825  -1.435 0.157288
Age30-35      -0.3907     0.2251  -1.736 0.088419 .
Age>35        -0.6806     0.4931  -1.380 0.173290
---

Residual standard error: 0.2848 on 53 degrees of freedom
Multiple R-squared:  0.9589,   Adjusted R-squared:  0.9511
F-statistic: 123.6 on 10 and 53 DF,  p-value: < 2.2e-16

> Anova(m3)
Anova Table (Type II tests)
Response: log(Claims + 0.5)
             Sum Sq Df F value    Pr(>F)
log(Holders) 3.4279  1 42.2703 2.856e-08 ***
District     0.1718  3  0.7064 0.5524821
Group        1.8784  3  7.7210 0.0002269 ***
Age          0.2703  3  1.1110 0.3529063
Residuals    4.2980 53
---
```

```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> m4<-
lm(log(Claims+0.5)~log(Holders)*(District+Group+Age)+(District+Group+Age)^2,data=df)
> summary(m4)

Call: lm(formula = log(Claims + 0.5) ~ log(Holders) * (District + Group +
    Age) + (District + Group + Age)^2, data = df)

…

Residual standard error: 0.3016 on 17 degrees of freedom
Multiple R-squared:  0.9852,   Adjusted R-squared:  0.9452
F-statistic: 24.61 on 46 and 17 DF,  p-value: 2.288e-09

> m5<-step(m4)
…

Step:  AIC=-159.59
log(Claims + 0.5) ~ log(Holders) + District + Group + Age + log(Holders):District +
    District:Group + District:Age

                         Df Sum of Sq    RSS     AIC
<none>                                 1.9451 -159.59
- District:Age            9   1.11592 3.0610 -148.57
- District:Group          9   1.18381 3.1289 -147.17
- log(Holders):District   3   0.86227 2.8073 -142.10

> par(mfrow=c(2,2))
> plot(m5)
> par(mfrow=c(1,1))
>
```




```
> Anova(m5)
Anova Table (Type II tests)

Response: log(Claims + 0.5)
                      Sum Sq Df F value    Pr(>F)
log(Holders)          2.73039  1 44.9201 1.445e-07 ***
District              0.17184  3  0.9424  0.431684
Group                 1.98156  3 10.8668 4.433e-05 ***
Age                   0.35523  3  1.9481  0.141696
log(Holders):District 0.86227  3  4.7287  0.007671 **
District:Group        1.18381  9  2.1640  0.052491 .
District:Age          1.11592  9  2.0399  0.066960 .
Residuals             1.94506 32
```

```
> df$London <- factor(ifelse(df$District!=4,0,1),labels=c("Other","London"))
> m6<-lm(log(Claims+0.5)~log(Holders)*(London+Group+Age)+(London+Group+Age)^2,data=df)
> summary(m6)

Call:
lm(formula = log(Claims + 0.5) ~ log(Holders) * (London + Group +
    Age) + (London + Group + Age)^2, data = df)

…

Residual standard error: 0.2932 on 33 degrees of freedom
Multiple R-squared:  0.9729,   Adjusted R-squared:  0.9482
F-statistic: 39.43 on 30 and 33 DF,  p-value: < 2.2e-16

> m7<-step(m6)
> anova(m7,m5)
Analysis of Variance Table

Model 1: log(Claims + 0.5) ~ log(Holders) + London + Group + Age + log(Holders):London
+ London:Group + London:Age
Model 2: log(Claims + 0.5) ~ log(Holders) + District + Group + Age +
log(Holders):District + District:Group + District:Age

  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1     48 3.3743
2     32 1.9451 16    1.4292 1.4696 0.1725

> BIC(m7,m5)
   df      BIC
m7 17 63.99292
m5 33 95.27760
>
> influencePlot(m7,col="cyan",pch=19)
     StudRes       Hat      CookD
9  -2.348364 0.1932308 0.07545664
46 -5.120061 0.1565165 0.19932177
49 -2.207329 0.6708584 0.57433866
61 -1.945311 0.8193086 1.01363233
```




```
> predict(m7, newdata=data.frame(Holders=1,London="London",Group=">2l",Age="30-
35"),interval ="prediction",se.fit=T)
$fit
        fit       lwr       upr
  -3.337568 -5.438462 -1.236674
```