Knee Data - Random Effects Logit Models

February 5, 2020

First the knee dataset is loaded:

```
> library(catdata)
> data(knee)
```

For the following models the data set is transformed into long format what can be done by the function "reshape".

In addition the dichotomized response variables "RD" is created. The groups are constructed by pain level up to level 2 und pain level higher than level 2.

```
> knee <- reshape(knee, direction="long", varying=list(5:8), v.names="R",timevar="Time")
> knee$RD <- rep(0, length(knee$R))
> knee$RD[knee$R>2] <- 1
```

For better interpretability the variable "Age" is centered around 30 , the variable "Age2" is created as quadratic effect of "Age".

```
> knee$Age <- knee$Age - 30
> knee$Age2 <- knee$Age^2
```

Since only the measurements 2, 3 and 4 are used for the models, measurement 1 can be eliminated.

```
> knee <- knee[knee$Time!=1,]
```

The first model will be fitted by Gauss–Hermite–Quadrature with 20 quadrature points by using function "glmmML" from library "glmmML".

```
> library(glmmML)
```

Now the random intercept model with Gauss–Hermite–Quadrature is fitted, the option "method" has to be set on "ghq", the number of quadrature points is set by "n.points".

```
> kneeGHQ <- glmmML(RD ~ as.factor(Th) + as.factor(Sex) + Age + Age2, data=knee,
+ family=binomial(), method="ghq", n.points=20, cluster=id)
> summary(kneeGHQ)

Call:  glmmML(formula = RD ~ as.factor(Th) + as.factor(Sex) + Age +        Age2, family = bi
```

```
                 coef se(coef)      z Pr(>|z|)
(Intercept)     3.0540  1.10110  2.774   0.0055
as.factor(Th)2 -1.8618  0.84628 -2.200   0.0280
as.factor(Sex)1 0.6071  0.88732  0.684   0.4900
Age             0.0324  0.04392  0.739   0.4600
Age2           -0.0155  0.00531 -2.922   0.0035


Scale parameter in mixing distribution:  3.62 gaussian
Std. Error:                              0.633

        LR p-value for H_0: sigma = 0:  1.51e-24

Residual deviance: 375 on 375 degrees of freedom        AIC: 387
```

The random intercept model with Penalized Quasi–Likelihood is fitted by use of "glmmPQL" from the library "MASS".

```
> kneePQL <- glmmPQL(RD ~ as.factor(Th) + as.factor(Sex) + Age + Age2, data=knee,
+ random = ~ 1|id, family=binomial())
> summary(kneePQL)

Linear mixed-effects model fit by maximum likelihood
 Data: knee
  AIC BIC logLik
   NA  NA     NA


Random effects:
 Formula: ~1 | id
        (Intercept) Residual
StdDev:        2.71    0.632


Variance function:
 Structure: fixed weights
 Formula: ~invwt
Fixed effects: RD ~ as.factor(Th) + as.factor(Sex) + Age + Age2
                Value Std.Error  DF t-value p-value
(Intercept)     2.143     0.715 254    3.00  0.0030
as.factor(Th)2 -1.295     0.564 122   -2.29  0.0235
as.factor(Sex)1 0.414     0.622 122    0.67  0.5062
Age             0.023     0.031 122    0.73  0.4639
Age2           -0.011     0.003 122   -3.17  0.0019
 Correlation:
                (Intr) a.(T)2 a.(S)1 Age
as.factor(Th)2  -0.451
as.factor(Sex)1 -0.673  0.046
Age              0.085  0.104  0.086
Age2            -0.526  0.006  0.091 -0.330


Standardized Within-Group Residuals:
   Min     Q1    Med     Q3    Max
-2.357 -0.395  0.266  0.353  2.240
```

```
Number of Observations: 381
Number of Groups: 127
```

The library "gee" is needed for fitting of the marginal model.

```
> library(gee)
```

For the marginal model the data set has to be arranged according to the variable "id" so that measurements from the same individual are arranged one after the other.

```
> knee <- knee[order(knee$id),]
> kneeGEE <- gee(RD ~ as.factor(Th) + as.factor(Sex) + Age + Age2, data=knee,
+ family=binomial(), id=id, corstr="exchangeable")

    (Intercept)  as.factor(Th)2 as.factor(Sex)1          Age          Age2
        1.17278        -0.67398         0.26569      0.01369      -0.00612

> summary(kneeGEE)

 GEE:  GENERALIZED LINEAR MODELS FOR DEPENDENT DATA
 gee S-function, version 4.13 modified 98/01/27 (1998)


Model:
 Link:                      Logit
 Variance to Mean Relation: Binomial
 Correlation Structure:     Exchangeable

Call:
gee(formula = RD ~ as.factor(Th) + as.factor(Sex) + Age + Age2,
    id = id, data = knee, family = binomial(), corstr = "exchangeable")

Summary of Residuals:
   Min     1Q Median     3Q    Max
-0.809 -0.477  0.239  0.388  0.766



Coefficients:
               Estimate Naive S.E. Naive z Robust S.E. Robust z
(Intercept)     1.17278    0.42386   2.767     0.44806    2.617
as.factor(Th)2 -0.67398    0.33316  -2.023     0.33421   -2.017
as.factor(Sex)1 0.26569    0.36012   0.738     0.36673    0.724
Age             0.01369    0.01792   0.764     0.01736    0.789
Age2           -0.00612    0.00206  -2.978     0.00198   -3.086

Estimated Scale Parameter:  1.02
Number of Iterations:  1

Working Correlation
      [,1]  [,2]  [,3]
```

```
[1,] 1.000 0.608 0.608
[2,] 0.608 1.000 0.608
[3,] 0.608 0.608 1.000
```