

# Knee Data - Sequential/Cumulative Random Effects Logit Models

February 8, 2012

For the sequential and cumulative random effects logit models we use the knee data from "catdata". We load the data "kneesequential" and "kneecumulative" which are already transformed and ready for use in the sequential or cumulative model.

```
> library(catdata)
> data(kneesequential)
> data(kneecumulative)
```

The covariate "Age" is centered around 30 years and a quadratic effect of "Age" is created for both data sets.

```
> kneesequential$Age <- kneesequential$Age - 30
> kneesequential$Age2 <- kneesequential$Age^2
> kneecumulative$Age <- kneecumulative$Age - 30
> kneecumulative$Age2 <- kneecumulative$Age^2
```

For the sequential random effects logit model with Gauss-Hermite-Quadrature the function "glmer" from "lme4" is used.

```
> library(lme4)
```

Now the sequential model with 25 quadrature points (option "nAGQ=25") and a random intercept is fitted.

```
> seqGH <- glmer(y ~ -1 + Icept1 + Icept2 + Icept3 + Icept4 + Th + Age + Age2 + (1 | Person),
+               family = binomial(link = logit), data = kneesequential, nAGQ = 25)
> summary(seqGH)
```

```
Generalized linear mixed model fit by the adaptive Gaussian Hermite approximation
Formula: y ~ -1 + Icept1 + Icept2 + Icept3 + Icept4 + Th + Age + Age2 + (1 | Person)
Data: kneesequential
AIC BIC logLik deviance
836 876 -410 820
Random effects:
Groups Name Variance Std.Dev.
Person (Intercept) 34.9 5.91
Number of obs: 1018, groups: Person, 127
```

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z )	
Icept1	-7.45916	1.11173	-6.71	2.0e-11	***
Icept2	-4.72017	1.07414	-4.39	1.1e-05	***
Icept3	-0.79305	1.05674	-0.75	0.4530	
Icept4	6.65642	1.32916	5.01	5.5e-07	***
Th	2.40205	1.11678	2.15	0.0315	*
Age	0.03688	0.06108	0.60	0.5459	
Age2	0.02286	0.00707	3.23	0.0012	**

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	Icept1	Icept2	Icept3	Icept4	Th	Age
Icept2	0.921					
Icept3	0.861	0.915				
Icept4	0.542	0.568	0.601			
Th	-0.524	-0.541	-0.520	-0.336		
Age	0.142	0.141	0.145	0.158	0.123	
Age2	-0.611	-0.611	-0.605	-0.429	-0.012	-0.287

The sequential model with Penalized Quasi-Likelihood is fitted with the function "glmmPQL" from the "MASS" library.

```
> library(MASS)
```

Here the sequential model with Penalized Quasi-Likelihood is fitted.

```
> seqPQL<-glmmPQL(y ~-1+Icept1+Icept2+Icept3+Icept4+Th+Age+Age2,
+ random=list(Person=~1), family=binomial(link=logit), data=kneesequential, niter=30)
> summary(seqPQL)
```

Linear mixed-effects model fit by maximum likelihood

Data: kneesequential

AIC BIC logLik

NA NA NA

Random effects:

Formula: ~1 | Person

(Intercept) Residual

StdDev: 5.43 0.631

Variance function:

Structure: fixed weights

Formula: ~invwt

Fixed effects: y ~ -1 + Icept1 + Icept2 + Icept3 + Icept4 + Th + Age + Age2

	Value	Std.Error	DF	t-value	p-value
Icept1	-7.10	0.964	888	-7.36	0.0000
Icept2	-4.03	0.937	888	-4.30	0.0000
Icept3	-0.18	0.928	888	-0.19	0.8485
Icept4	6.75	1.018	888	6.63	0.0000

```

Th      2.11      1.006 124      2.10  0.0377
Age     0.03      0.055 124      0.48  0.6346
Age2    0.02      0.006 124      2.77  0.0064
Correlation:
      Icept1 Icept2 Icept3 Icept4 Th      Age
Icept2 0.948
Icept3 0.913 0.954
Icept4 0.745 0.775 0.806
Th      -0.528 -0.540 -0.530 -0.437
Age     0.166 0.168 0.172 0.171 0.118
Age2    -0.613 -0.613 -0.609 -0.528 -0.020 -0.330

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-5.2851 -0.3074 -0.0354  0.2488 11.1251

```

```

Number of Observations: 1018
Number of Groups: 127

```

The cumulative models will be fitted with "clmm" from the package "ordinal".

```
> library(ordinal)
```

For the sequential random effects logit model with Gauss-Hermite Quadrature the number of quadrature points is defined by the option "nAGQ=25". Now the model is fitted again with a random intercept as the only random effect.

```

> cumGH<-clmm2(as.factor(y)~1+Th+Age+Age2, random = as.factor(Person), data =
+ kneecumulative, link = "logistic",nAGQ=25,start=c(-5,-3,3,5,rep(0.001,4)),Hess=TRUE)
> summary(cumGH)

```

Cumulative Link Mixed Model fitted with the adaptive Gauss-Hermite quadrature approximation with 25 quadrature points

```

Call:
clmm2(location = as.factor(y) ~ 1 + Th + Age + Age2, random = as.factor(Person),
      data = kneecumulative, start = c(-5, -3, 3, 5, rep(0.001,
      4)), Hess = TRUE, link = "logistic", nAGQ = 25)

```

```

Random effects:
      Var Std.Dev
as.factor(Person) 39.1  6.25

```

```

Location coefficients:
      Estimate Std. Error z value Pr(>|z|)
Th      -2.380    1.205    -1.975  0.048
Age     -0.034    0.066    -0.516  0.606
Age2    -0.021    0.008    -2.772  0.006

```

```
No scale coefficients
```

```

Threshold coefficients:
      Estimate Std. Error z value
1|2 -7.461     1.257    -5.937
2|3 -4.498     1.169    -3.846
3|4 -0.396     1.119    -0.354
4|5  7.363     1.391     5.294

```

```

log-likelihood: -380.42
AIC: 776.84
Condition number of Hessian: 227717.49

```

For Laplace–Approximation the option "nAGQ" can be dropped.

```

> cumLP<-clmm2(as.factor(y)~1+Th+Age+Age2, random = as.factor(Person), data =
+ kneecumulative, link = "logistic",start=c(-5,-3,3,5,rep(0.001,4)), Hess = TRUE)
> summary(cumLP)

```

Cumulative Link Mixed Model fitted with the Laplace approximation

```

Call:
clmm2(location = as.factor(y) ~ 1 + Th + Age + Age2, random = as.factor(Person),
      data = kneecumulative, start = c(-5, -3, 3, 5, rep(0.001,
      4)), Hess = TRUE, link = "logistic")

```

```

Random effects:
              Var Std.Dev
as.factor(Person) 40.6   6.37

```

```

Location coefficients:
      Estimate Std. Error z value Pr(>|z|)
Th    -2.667     1.263    -2.112  0.035
Age   -0.038     0.068    -0.561  0.575
Age2  -0.025     0.008    -3.289  0.001

```

No scale coefficients

```

Threshold coefficients:
      Estimate Std. Error z value
1|2 -8.024     1.338    -5.995
2|3 -5.073     1.239    -4.093
3|4 -0.949     1.170    -0.811
4|5  6.900     1.202     5.738

```

```

log-likelihood: -382.90
AIC: 781.80
Condition number of Hessian: 259398.88

```