

EXAMEN FINAL, ACT2040, AUTOMNE 2013

---- PARTIE 0 ----

```
> preamble=read.table(
+ "http://freakonometrics.free.fr/preamble.csv",header=TRUE,sep=";")
> table(preamble$Y)
```

```
 0  1  2  3  4  5  6
45 133 160 101 51  8  2
```

```
> reg0=glm(Y/N~1,family="binomial",weights=N,data=preamble)
> summary(reg0)
```

```
Call:
glm(formula = Y/N ~ 1, family = "binomial", data = preamble,
     weights = N)
```

```
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.12673  -0.87408  -0.01892   0.73065   2.74209
```

Coefficients:

```
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.3714      0.0352  -38.96  <2e-16 ***
```

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

(Dispersion parameter for binomial family taken to be 1)

```
Null deviance: 512.87  on 499  degrees of freedom
Residual deviance: 512.87  on 499  degrees of freedom
AIC: 1586.2
```

Number of Fisher Scoring iterations: 4

---- PARTIE 1 ----

```
> CORPOREL=read.table(
+ "http://freakonometrics.free.fr/corpo-rel-2040.csv",
+ header=TRUE,sep=";")
```

```
> tail(CORPOREL)
      degre age cat.age sexe vehicule anciennete alcool cat.alc
76336 indemne 45  40-49   M  voiture         6      0  0-20
76337 corporel 59  50-59   F  voiture         2      0  0-20
76338 indemne 34  30-39   F  voiture         2      0  0-20
76339 indemne 29  26-29   F  voiture         5      9  0-20
76340 indemne 64    60+   M  voiture         0      0  0-20
76341 indemne 57  50-59   F  voiture         1      0  0-20
```

```
> attach(CORPOREL)
> table(degre)
degre
corporel  deces  indemne
 31369     676  44296
```

```
> Y=degre=="deces"
```

```
> table(Y)
```

```
Y
FALSE TRUE
75665  676
```

```
> X1=vehicule; nom1=levels(X1)
```

```
> X2=cat.alc; nom2=levels(X2)
```

```
> comptage=table(X1,X2)
```

```
> deces=comptage
```

```
> for(k in 1:nrow(comptage)){
```

```
+ deces[k,]=tapply(Y[X1==nom1[k]],X2[X1==nom1[k]],sum)}
```

```
> deces[is.na(deces)]=0
```

```
> comptage
```

```
                X2
X1              0-20 150+ 20-50 50-80 80-150
bus-truck      3218   74    0    13    52
moto            2059   49    5    11    60
van             6237  120    8    32   113
voiture        62433  795   56   244   762
```

```
> deces
```

```
                X2
X1              0-20 150+ 20-50 50-80 80-150
bus-truck       93    6    0    1    2
moto            51    4    0    2    4
van             76    7    0    2    3
voiture        372   25    0   11   17
```

```

> taux=deces/comptage
> taux
      X2
X1      0-20      150+      20-50      50-80      80-150
bus-truck 0.028899938 0.081081081      0.076923077 0.038461538
moto      0.024769305 0.081632653 0.000000000 0.181818182 0.066666667
van       0.012185346 0.058333333 0.000000000 0.062500000 0.026548673
voiture   0.005958387 0.031446541 0.000000000 0.045081967 0.022309711

> comptage[is.na(comptage)]=0
> m=mean(Y)
>
> L<-matrix(NA,10,nrow(deces));C<-matrix(NA,10,ncol(deces))
> colnames(L)=nom1;colnames(C)=nom2
> C[1,]<-m
> for(j in 2:10){
+   for(k in 1:nrow(deces)){
+     L[j,k]<-sum(deces[k,])/sum(comptage[k,]*C[j-1,]) }
+   for(k in 1:ncol(deces)){
+     C[j,k]<-sum(deces[,k])/sum(comptage[,k]*L[j,]) }
+   }
> L[10,]
bus-truck      moto      van      voiture
3.3578117 3.0102805 1.4996518 0.7585497

> C[10,]
      0-20      150+      20-50      50-80      80-150
0.008030879 0.035623800 0.000000000 0.051639617 0.023578519

> pred1 = deces
> for(k in 1:nrow(deces)){pred1[k,]<-L[10,k]*C[10,]}

```

3

```

> pred1
      X2
X1      0-20      150+      20-50      50-80      80-150
bus-truck 0.026966178 0.119618012 0.000000000 0.173396109 0.079172227
moto      0.024175198 0.107237631 0.000000000 0.155449732 0.070977956
van       0.012043522 0.053423297 0.000000000 0.077441446 0.035359569
voiture   0.006091821 0.027022425 0.000000000 0.039171218 0.017885480

> reg1=glm(Y~vehicule+cat.alc,family=poisson(link="log"),data=CORPOREL)
> summary(reg1)

Call:
glm(formula = Y ~ vehicule + cat.alc, family = poisson(link = "log"),
    data = CORPOREL)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.5889 -0.1104 -0.1104 -0.1104  2.8660

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)   -3.6132     0.1006  -35.924 < 2e-16 ***
vehiculemoto  -0.1093     0.1620   -0.675  0.500
vehiculevan    -0.8061     0.1455   -5.539 3.04e-08 ***
vehiculevoiture -1.4876     0.1104  -13.472 < 2e-16 ***
cat.alc150+    1.4897     0.1600   9.308 < 2e-16 ***
cat.alc20-50  -10.4584    151.4947  -0.069  0.945
cat.alc50-80   1.8610     0.2534   7.344 2.07e-13 ***
cat.alc80-150  1.0770     0.2007   5.365 8.08e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 6390.6 on 76340 degrees of freedom
Residual deviance: 6064.0 on 76333 degrees of freedom
AIC: 7432

Number of Fisher Scoring iterations: 13

> newd=data.frame(vehicule=rep(nom1,length(nom2)),
+ cat.alc=rep(nom2,each=length(nom1)))

```

4

```

> pred2=predict(reg1,newdata=newd,type="response")
> P2=matrix(pred2,length(nom1),length(nom2))
> rownames(P2)=nom1;colnames(P2)=nom2
> table(CORPOREL$cat.alc)

 0-20  150+  20-50  50-80  80-150
73947 1038    69    300    987

> CORPOREL$cat.alc2=CORPOREL$cat.alc
> levels(CORPOREL$cat.alc2)=c("0-50","150+","0-50","50-150","50-150")
> table(CORPOREL$cat.alc2)

 0-50  150+  50-150
74016 1038  1287

> table(CORPOREL$vehicule)

bus-truck      moto      van  voiture
      3357      2184      6510      64290

> CORPOREL$veh2=CORPOREL$vehicule
> levels(CORPOREL$veh2)=c("bus-truck-moto",
+ "bus-truck-moto","van","voiture")
> table(CORPOREL$veh2)

bus-truck-moto      van      voiture
      5541      6510      64290

> reg2=glm(Y~veh2+cat.alc2,family=poisson(link="log"),data=CORPOREL)

```

```

> summary(reg2)

Call:
glm(formula = Y ~ veh2 + cat.alc2, family = poisson(link = "log"),
    data = CORPOREL)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.4783 -0.1104 -0.1104 -0.1104  2.8658

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -3.65936    0.08069  -45.351 < 2e-16 ***
veh2van      -0.76075    0.13230   -5.750 8.93e-09 ***
veh2voiture  -1.44099    0.09242  -15.592 < 2e-16 ***
cat.alc2150+  1.49099    0.16005   9.316 < 2e-16 ***
cat.alc250-150 1.30600    0.15991   8.167 3.15e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 6390.6 on 76340 degrees of freedom
Residual deviance: 6071.2 on 76336 degrees of freedom
AIC: 7433.2

Number of Fisher Scoring iterations: 7

> predict(reg2,newdata=data.frame(cat.alc2=c("0-50","50-150","150+"),
+ veh2=c("voiture","voiture","voiture")),
+ type="response")
           1           2           3
0.006094632 0.022497609 0.027069134

> reg3=glm(Y~veh2+cat.alc2,family=binomial(link="logit"),data=CORPOREL)

```

```

> summary(reg3)

Call:
glm(formula = Y ~ veh2 + cat.alc2, family = binomial(link = "logit"),
    data = CORPOREL)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.4832 -0.1104 -0.1104 -0.1104  3.1946

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -3.62662    0.08184 -44.311 < 2e-16 ***
veh2van      -0.78178    0.13395  -5.836 5.34e-09 ***
veh2voiture  -1.46987    0.09370 -15.688 < 2e-16 ***
cat.alc2150+  1.53780    0.16450  9.348 < 2e-16 ***
cat.alc250-150 1.34111    0.16351  8.202 2.36e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 7736.6  on 76340  degrees of freedom
Residual deviance: 7411.8  on 76336  degrees of freedom
AIC: 7421.8

Number of Fisher Scoring iterations: 7

> predict(reg3,newdata=data.frame(cat.alc2=c("0-50","50-150","150+"),
+ veh2=c("voiture","voiture","voiture")),
+ type="response")
      1      2      3
0.006080978 0.022856896 0.027687728

> table(CORPOREL$cat.alc2)/length((CORPOREL$cat.alc2))

    0-50    150+    50-150
0.96954454 0.01359689 0.01685857

> predict(reg3,newdata=data.frame(cat.alc2=c("0-50","50-150","150+"),
+ veh2=c("voiture","voiture","voiture")),
+ type="response)

```

```

> reg4=glm(Y~veh2+cat.alc2,family=quasipoisson(link="log"),data=CORPOREL)
> summary(reg4)

Call:
glm(formula = Y ~ veh2 + cat.alc2, family = quasipoisson(link = "log"),
    data = CORPOREL)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.4783 -0.1104 -0.1104 -0.1104  2.8658

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -3.65936    0.07991 -45.794 < 2e-16 ***
veh2van      -0.76075    0.13102  -5.806 6.42e-09 ***
veh2voiture  -1.44099    0.09152 -15.745 < 2e-16 ***
cat.alc2150+  1.49099    0.15850  9.407 < 2e-16 ***
cat.alc250-150 1.30600    0.15836  8.247 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for quasipoisson family taken to be 0.9807156)

    Null deviance: 6390.6  on 76340  degrees of freedom
Residual deviance: 6071.2  on 76336  degrees of freedom
AIC: NA

Number of Fisher Scoring iterations: 7

```

```

> library(nnet)
> CORPOREL$Y=degre
> reg5=multinom(Y~veh2+cat.alc2,data=CORPOREL)
# weights: 18 (10 variable)
initial value 83869.160729
iter 10 value 56945.564900
iter 20 value 54368.409072
iter 30 value 54349.196650
final value 54348.927382
converged

```

```

> summary(reg5)
Call:
multinom(formula = Y ~ veh2 + cat.alc2, data = CORPOREL)

```

Coefficients:

```

(Intercept) veh2van veh2voiture cat.alc2150+ cat.alc250-150
deces -3.128271 -0.3825518 -1.0360780 1.1238657 1.0381024
indemne -0.482676 0.8660091 0.9230502 -0.9679921 -0.6471955

```

Std. Errors:

```

(Intercept) veh2van veh2voiture cat.alc2150+ cat.alc250-150
deces 0.08209712 0.1350718 0.09420593 0.16545337 0.16485982
indemne 0.02827523 0.0379941 0.02937917 0.06732754 0.05821281

```

Residual Deviance: 108697.9

AIC: 108717.9

```

> reg6=multinom(Y~veh2+cat.alc2+sexe+anciennete,data=CORPOREL)
# weights: 24 (14 variable)
initial value 83869.160729
iter 10 value 60708.059345
iter 20 value 54354.056598
iter 30 value 54230.746815
iter 30 value 54230.746310
final value 54230.746310
converged

```

```

> summary(reg6)

```

Call:

```

multinom(formula = Y ~ veh2 + cat.alc2 + sexe + anciennete, data =
CORPOREL)

```

Coefficients:

```

(Intercept) veh2van veh2voiture cat.alc2150+ cat.alc250-150 sexeM anciennete
deces -3.4747251 -0.3657135 -0.9120289 1.082679 0.9816627 0.3509260 0.003250655
indemne -0.7231899 0.8768508 1.0129565 -1.002271 -0.6915642 0.2443382 0.002215666

```

Std. Errors:

```

(Intercept) veh2van veh2voiture cat.alc2150+ cat.alc250-150 sexeM anciennete
deces 0.12920722 0.13518641 0.09909299 0.16594222 0.16562513 0.09835261 0.009798542
indemne 0.03285738 0.03802368 0.03000948 0.06747606 0.05838016 0.01612267 0.001885893

```

Residual Deviance: 108461.5

AIC: 108489.5

---- PARTIE 2 ----

```

> source("http://freakonometrics.free.fr/triangle-intra2.R")

```

```

> intra

```

```

$triangle

```

	0	1	2	3	4	5	6	7	8	9
1988	5244	9228	10823	11352	11791	12082	12120	12199	12215	12215
1989	5984	9939	11725	12346	12746	12909	13034	13109	13113	NA
1990	7452	12421	14171	14752	15066	15354	15637	15720	NA	NA
1991	7115	11117	12488	13274	13662	13859	13872	NA	NA	NA
1992	5753	8969	9917	10697	11135	11282	NA	NA	NA	NA
1993	3937	6524	7989	8543	8757	NA	NA	NA	NA	NA
1994	5127	8212	8976	9325	NA	NA	NA	NA	NA	NA
1995	5046	8006	8984	NA	NA	NA	NA	NA	NA	NA
1996	5129	8202	NA	NA	NA	NA	NA	NA	NA	NA
1997	3689	NA	NA	NA	NA	NA	NA	NA	NA	NA

```

$prime

```

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	15883	16689	18029	17858	16709	14212	15083	15131	15465	11217

```

> mC=intra$triangle

```

```

> n=ncol(mC)

```

```
> MackChainLadder(mC)
MackChainLadder(Triangle = mC)
```

	Latest	Dev.To.Date	Ultimate	IBNR	Mack.S.E	CV(IBNR)
1988	12,215	1.000	12,215	0.0	0.0	NaN
1989	13,113	1.000	13,113	0.0	7.9	Inf
1990	15,720	0.999	15,732	12.4	15.7	1.262
1991	13,872	0.993	13,964	91.6	17.3	0.189
1992	11,282	0.985	11,453	170.7	111.9	0.656
1993	8,757	0.969	9,039	282.4	112.7	0.399
1994	9,325	0.940	9,923	598.2	148.2	0.248
1995	8,984	0.891	10,088	1,104.0	219.2	0.199
1996	8,202	0.779	10,529	2,326.9	473.3	0.203
1997	3,689	0.479	7,704	4,014.6	557.8	0.139

```
Totals
Latest: 105,159.00
Dev: 0.92
Ultimate: 113,759.72
IBNR: 8,600.72
Mack S.E.: 859.63
CV(IBNR): 0.10
```

```
> mY=mC
> n=ncol(mC)
> mY[,2:n]=mC[,2:n]-mC[,1:(n-1)]
> mY0=mY[, -n]
> Y=as.vector(mY0)
> futur=is.na(Y)
> A=rep(1988:1997,n-1)
> B=rep(0:(n-2),each=n)
> df=data.frame(Y,A,B,futur)
```

```
> reg1=lm(log(Y)~A+B,data=df)
> summary(reg1)
```

```
Call:
lm(formula = log(Y) ~ A + B, data = df)
```

```
Residuals:
    Min       1Q   Median       3Q      Max
-1.71387 -0.19797  0.06115  0.20978  1.29746
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 146.48471   61.81314   2.370   0.0216 *
A            -0.06916    0.03102  -2.229   0.0302 *
B            -0.74997    0.03244 -23.116 <2e-16 ***
```

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

```
Residual standard error: 0.4881 on 51 degrees of freedom
(36 observations deleted due to missingness)
Multiple R-squared:  0.9257, Adjusted R-squared:  0.9228
F-statistic: 317.6 on 2 and 51 DF,  p-value: < 2.2e-16
```

```
> reg2=lm(log(Y)~as.factor(A)+as.factor(B),data=df)
```

```
> summary(reg2)
```

```
Call:
lm(formula = log(Y) ~ as.factor(A) + as.factor(B), data = df)
```

```
Residuals:
```

Min	1Q	Median	3Q	Max
-1.37436	-0.15434	0.00522	0.17412	1.22991

```
Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	8.8241	0.2118	41.667	< 2e-16 ***
as.factor(A)1989	-0.0580	0.2067	-0.281	0.7806
as.factor(A)1990	0.2258	0.2162	1.045	0.3032
as.factor(A)1991	-0.2504	0.2265	-1.105	0.2763
as.factor(A)1992	-0.1846	0.2388	-0.773	0.4446
as.factor(A)1993	-0.3847	0.2544	-1.512	0.1392
as.factor(A)1994	-0.4954	0.2756	-1.798	0.0806 .
as.factor(A)1995	-0.3722	0.3070	-1.212	0.2333
as.factor(A)1996	-0.3029	0.3610	-0.839	0.4069
as.factor(A)1997	-0.6110	0.4870	-1.255	0.2176
as.factor(B)1	-0.4694	0.2067	-2.271	0.0292 *
as.factor(B)2	-1.4816	0.2162	-6.853	5.12e-08 ***
as.factor(B)3	-2.2937	0.2265	-10.126	4.44e-12 ***
as.factor(B)4	-2.8431	0.2388	-11.905	4.84e-14 ***
as.factor(B)5	-3.4300	0.2544	-13.482	1.22e-15 ***
as.factor(B)6	-4.6344	0.2756	-16.817	< 2e-16 ***
as.factor(B)7	-4.5115	0.3070	-14.695	< 2e-16 ***
as.factor(B)8	-6.7157	0.3610	-18.604	< 2e-16 ***

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

```
Residual standard error: 0.4385 on 36 degrees of freedom
(36 observations deleted due to missingness)
Multiple R-squared: 0.9577, Adjusted R-squared: 0.9377
F-statistic: 47.89 on 17 and 36 DF, p-value: < 2.2e-16
```

```
> reg3=glm(Y~A+B,data=df,family=poisson(link="log"))
```

```
> summary(reg3)
```

```
Call:
glm(formula = Y ~ A + B, family = poisson(link = "log"), data = df)
```

```
Deviance Residuals:
```

Min	1Q	Median	3Q	Max
-23.9887	-6.8467	0.2444	4.5700	28.4783

```
Coefficients:
```

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	111.387202	2.323204	47.95	<2e-16 ***
A	-0.051564	0.001166	-44.21	<2e-16 ***
B	-0.697814	0.002702	-258.27	<2e-16 ***

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

```
(Dispersion parameter for poisson family taken to be 1)
```

```
Null deviance: 120911.7 on 53 degrees of freedom
Residual deviance: 5004.5 on 51 degrees of freedom
(36 observations deleted due to missingness)
AIC: 5466.6
```

```
Number of Fisher Scoring iterations: 4
```

```
> reg4=glm(Y~as.factor(A)+as.factor(B),
+ data=df,family=poisson(link="log"))
```

```
> summary(reg4)

Call:
glm(formula = Y ~ as.factor(A) + as.factor(B), family = poisson(link =
"log"),
     data = df)
```

```
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-12.2455  -3.5148  -0.4767   3.5907  13.4573
```

Coefficients:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	8.674092	0.009635	900.279	< 2e-16 ***
as.factor(A)1989	0.070939	0.012575	5.641	1.69e-08 ***
as.factor(A)1990	0.253059	0.012063	20.978	< 2e-16 ***
as.factor(A)1991	0.133791	0.012415	10.777	< 2e-16 ***
as.factor(A)1992	-0.064441	0.013070	-4.930	8.21e-07 ***
as.factor(A)1993	-0.301073	0.014023	-21.470	< 2e-16 ***
as.factor(A)1994	-0.207792	0.013788	-15.070	< 2e-16 ***
as.factor(A)1995	-0.191317	0.013960	-13.705	< 2e-16 ***
as.factor(A)1996	-0.148546	0.014393	-10.320	< 2e-16 ***
as.factor(A)1997	-0.460981	0.019076	-24.165	< 2e-16 ***
as.factor(B)1	-0.467200	0.007149	-65.353	< 2e-16 ***
as.factor(B)2	-1.456867	0.010717	-135.937	< 2e-16 ***
as.factor(B)3	-2.276393	0.016140	-141.038	< 2e-16 ***
as.factor(B)4	-2.802747	0.021910	-127.921	< 2e-16 ***
as.factor(B)5	-3.378022	0.030769	-109.787	< 2e-16 ***
as.factor(B)6	-4.050147	0.046987	-86.198	< 2e-16 ***
as.factor(B)7	-4.418412	0.065228	-67.738	< 2e-16 ***
as.factor(B)8	-6.407605	0.223720	-28.641	< 2e-16 ***

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

(Dispersion parameter for poisson family taken to be 1)

```
Null deviance: 120911.7 on 53 degrees of freedom
Residual deviance: 1558.2 on 36 degrees of freedom
(36 observations deleted due to missingness)
AIC: 2050.4
```

Number of Fisher Scoring iterations: 5

```
> sum(exp(predict(reg1,newdata=df)[futur]))
[1] 7643.561
> sum(exp(predict(reg2,newdata=df)[futur]))
[1] 8060.825
> sum(exp(predict(reg3,newdata=df)[futur]))
[1] 9177.528
> sum(exp(predict(reg4,newdata=df)[futur]))
[1] 8600.721
>
> mP=intra$prime
> df$P=rep(mP,n-1)
>
> reg5=glm(Y~as.factor(A)+as.factor(B)+offset(log(P)),
+ data=df,family=poisson(link="log"))
```



```

> summary(reg5)

Call:
glm(formula = Y ~ as.factor(A) + as.factor(B) + offset(log(P)),
     family = poisson(link = "log"), data = df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-12.2455  -3.5148  -0.4767   3.5907  13.4573

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -0.998913   0.009635 -103.677 < 2e-16 ***
as.factor(A)1989  0.021439   0.012575   1.705  0.0882 .
as.factor(A)1990  0.126327   0.012063  10.472 < 2e-16 ***
as.factor(A)1991  0.016589   0.012415   1.336  0.1815
as.factor(A)1992 -0.115139   0.013070  -8.809 < 2e-16 ***
as.factor(A)1993 -0.189910   0.014023 -13.543 < 2e-16 ***
as.factor(A)1994 -0.156111   0.013788 -11.322 < 2e-16 ***
as.factor(A)1995 -0.142813   0.013960 -10.230 < 2e-16 ***
as.factor(A)1996 -0.121876   0.014393  -8.468 < 2e-16 ***
as.factor(A)1997 -0.113162   0.019076  -5.932 2.99e-09 ***
as.factor(B)1    -0.467200   0.007149 -65.353 < 2e-16 ***
as.factor(B)2    -1.456867   0.010717 -135.937 < 2e-16 ***
as.factor(B)3    -2.276393   0.016140 -141.038 < 2e-16 ***
as.factor(B)4    -2.802747   0.021910 -127.921 < 2e-16 ***
as.factor(B)5    -3.378022   0.030769 -109.787 < 2e-16 ***
as.factor(B)6    -4.050147   0.046987  -86.198 < 2e-16 ***
as.factor(B)7    -4.418412   0.065228  -67.738 < 2e-16 ***
as.factor(B)8    -6.407605   0.223720  -28.641 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 123797.6 on 53 degrees of freedom
Residual deviance: 1558.2 on 36 degrees of freedom
(36 observations deleted due to missingness)
AIC: 2050.4

Number of Fisher Scoring iterations: 5

```

```

> reg6=glm(Y~as.factor(B)+offset(log(P)),data=df,
+ family=poisson(link="log"))
> summary(reg6)

Call:
glm(formula = Y ~ as.factor(B) + offset(log(P)), family = poisson(link =
"log"),
     data = df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-14.9933  -4.2664  -0.6501   4.3320  15.4796

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.053863   0.004284 -245.97 <2e-16 ***
as.factor(B)1 -0.462836   0.007055  -65.60 <2e-16 ***
as.factor(B)2 -1.444326   0.010592 -136.36 <2e-16 ***
as.factor(B)3 -2.251304   0.016014 -140.58 <2e-16 ***
as.factor(B)4 -2.759817   0.021780 -126.72 <2e-16 ***
as.factor(B)5 -3.308261   0.030646 -107.95 <2e-16 ***
as.factor(B)6 -3.951077   0.046872  -84.30 <2e-16 ***
as.factor(B)7 -4.309803   0.065098  -66.20 <2e-16 ***
as.factor(B)8 -6.341613   0.223648  -28.36 <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 123798 on 53 degrees of freedom
Residual deviance: 2633 on 45 degrees of freedom
(36 observations deleted due to missingness)
AIC: 3107.2

Number of Fisher Scoring iterations: 5

> sum(exp(predict(reg6,newdata=df)[futur]))
[1] 9511.738
>
> reg7=glm(Y/P~as.factor(B),weights=P,data=df,family=binomial)

```

```
> summary(reg7)
```

```
Call:
glm(formula = Y/P ~ as.factor(B), family = binomial, data = df,
     weights = P)
```

```
Deviance Residuals:
```

Min	1Q	Median	3Q	Max
-18.2392	-4.7326	-0.7622	4.3798	18.0161

```
Coefficients:
```

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-0.625250	0.005308	-117.78	<2e-16 ***
as.factor(B)1	-0.643713	0.008272	-77.82	<2e-16 ***
as.factor(B)2	-1.787127	0.011420	-156.49	<2e-16 ***
as.factor(B)3	-2.642534	0.016594	-159.25	<2e-16 ***
as.factor(B)4	-3.166117	0.022237	-142.38	<2e-16 ***
as.factor(B)5	-3.724041	0.030998	-120.14	<2e-16 ***
as.factor(B)6	-4.372963	0.047133	-92.78	<2e-16 ***
as.factor(B)7	-4.733722	0.065326	-72.46	<2e-16 ***
as.factor(B)8	-6.769612	0.223738	-30.26	<2e-16 ***

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

```
(Dispersion parameter for binomial family taken to be 1)
```

```
Null deviance: 141663.0 on 53 degrees of freedom
Residual deviance: 3202.2 on 45 degrees of freedom
(36 observations deleted due to missingness)
AIC: 3668.7
```

```
Number of Fisher Scoring iterations: 5
```

```
> df1=df
> df1$P=1
> sum(predict(reg7,newdata=df1,type="response")[futur] * df$P[futur])
[1] 9511.738
```

---- PARTIE 3 ----

```
> DECES=read.table(
+ "http://freakonometrics.free.fr/DECES-CAN.csv",header=TRUE,sep=";")
> tail(DECES)
```

	D	E	A	Y
772	84	147	105	2010
773	39	76	106	2010
774	23	40	107	2010
775	15	20	108	2010
776	7	8	109	2010
777	5	5	110	2010

```
> DECES[DECES$A==20,]
> DECES[DECES$A==40,]
> DECES[DECES$A==60,]
> DECES[DECES$A==80,]
> reg1=glm(D~as.factor(A)+Y+offset(log(E)),data=DECES,
+ family=poisson(link="log"))
> summary(reg1)
```

```
Call:
glm(formula = D ~ as.factor(A) + Y + offset(log(E)), family =
poisson(link = "log"),
     data = DECES)
```

```
Deviance Residuals:
```

Min	1Q	Median	3Q	Max
-42.979	-2.853	-0.608	1.939	60.519

```
Coefficients:
```

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	2.649e+01	9.186e-02	288.393	<2e-16 ***
as.factor(A)1	-2.623e+00	1.787e-02	-146.811	<2e-16 ***
as.factor(A)2	-3.135e+00	2.280e-02	-137.495	<2e-16 ***
as.factor(A)3	-3.372e+00	2.548e-02	-132.312	<2e-16 ***
as.factor(A)4	-3.566e+00	2.796e-02	-127.526	<2e-16 ***
as.factor(A)5	-3.588e+00	2.836e-02	-126.514	<2e-16 ***
as.factor(A)6	-3.718e+00	3.029e-02	-122.770	<2e-16 ***
as.factor(A)7	-3.869e+00	3.264e-02	-118.563	<2e-16 ***
as.factor(A)8	-3.973e+00	3.435e-02	-115.663	<2e-16 ***
as.factor(A)9	-4.035e+00	3.555e-02	-113.528	<2e-16 ***

```

as.factor(A)10 -4.058e+00 3.622e-02 -112.050 <2e-16 ***
as.factor(A)11 -4.127e+00 3.766e-02 -109.592 <2e-16 ***
as.factor(A)12 -3.992e+00 3.527e-02 -113.181 <2e-16 ***
as.factor(A)13 -3.976e+00 3.495e-02 -113.741 <2e-16 ***
as.factor(A)14 -3.706e+00 3.062e-02 -121.003 <2e-16 ***
as.factor(A)15 -3.541e+00 2.833e-02 -124.982 <2e-16 ***
as.factor(A)16 -3.227e+00 2.441e-02 -132.164 <2e-16 ***
as.factor(A)17 -3.060e+00 2.255e-02 -135.661 <2e-16 ***
as.factor(A)18 -2.926e+00 2.113e-02 -138.484 <2e-16 ***
as.factor(A)19 -2.830e+00 2.021e-02 -140.058 <2e-16 ***
as.factor(A)20 -2.795e+00 1.999e-02 -139.849 <2e-16 ***
as.factor(A)21 -2.823e+00 2.036e-02 -138.685 <2e-16 ***
as.factor(A)22 -2.888e+00 2.102e-02 -137.360 <2e-16 ***
as.factor(A)23 -2.872e+00 2.083e-02 -137.838 <2e-16 ***
as.factor(A)24 -2.923e+00 2.132e-02 -137.143 <2e-16 ***
as.factor(A)25 -2.911e+00 2.122e-02 -137.181 <2e-16 ***
as.factor(A)26 -2.907e+00 2.126e-02 -136.779 <2e-16 ***
as.factor(A)27 -2.874e+00 2.097e-02 -137.034 <2e-16 ***
as.factor(A)28 -2.916e+00 2.144e-02 -136.019 <2e-16 ***
as.factor(A)29 -2.886e+00 2.122e-02 -135.988 <2e-16 ***
as.factor(A)30 -2.854e+00 2.100e-02 -135.863 <2e-16 ***
as.factor(A)31 -2.818e+00 2.070e-02 -136.177 <2e-16 ***
as.factor(A)32 -2.788e+00 2.045e-02 -136.351 <2e-16 ***
as.factor(A)33 -2.742e+00 2.011e-02 -136.353 <2e-16 ***
as.factor(A)34 -2.648e+00 1.930e-02 -137.218 <2e-16 ***
as.factor(A)35 -2.612e+00 1.902e-02 -137.339 <2e-16 ***
as.factor(A)36 -2.546e+00 1.853e-02 -137.379 <2e-16 ***
as.factor(A)37 -2.469e+00 1.799e-02 -137.210 <2e-16 ***
as.factor(A)38 -2.382e+00 1.738e-02 -137.061 <2e-16 ***
as.factor(A)39 -2.321e+00 1.701e-02 -136.458 <2e-16 ***
as.factor(A)40 -2.237e+00 1.649e-02 -135.686 <2e-16 ***
as.factor(A)41 -2.152e+00 1.595e-02 -134.895 <2e-16 ***
as.factor(A)42 -2.039e+00 1.525e-02 -133.694 <2e-16 ***
as.factor(A)43 -1.979e+00 1.496e-02 -132.317 <2e-16 ***
as.factor(A)44 -1.891e+00 1.446e-02 -130.814 <2e-16 ***
as.factor(A)45 -1.795e+00 1.392e-02 -128.981 <2e-16 ***
as.factor(A)46 -1.681e+00 1.334e-02 -125.979 <2e-16 ***
as.factor(A)47 -1.602e+00 1.303e-02 -122.918 <2e-16 ***
as.factor(A)48 -1.492e+00 1.256e-02 -118.802 <2e-16 ***
as.factor(A)49 -1.371e+00 1.206e-02 -113.757 <2e-16 ***
as.factor(A)50 -1.301e+00 1.182e-02 -109.982 <2e-16 ***
as.factor(A)51 -1.238e+00 1.161e-02 -106.611 <2e-16 ***

```

```

as.factor(A)52 -1.114e+00 1.113e-02 -100.128 <2e-16 ***
as.factor(A)53 -1.029e+00 1.088e-02 -94.560 <2e-16 ***
as.factor(A)54 -9.142e-01 1.051e-02 -86.986 <2e-16 ***
as.factor(A)55 -8.511e-01 1.035e-02 -82.240 <2e-16 ***
as.factor(A)56 -7.691e-01 1.012e-02 -76.001 <2e-16 ***
as.factor(A)57 -6.683e-01 9.840e-03 -67.914 <2e-16 ***
as.factor(A)58 -5.587e-01 9.548e-03 -58.516 <2e-16 ***
as.factor(A)59 -4.648e-01 9.342e-03 -49.758 <2e-16 ***
as.factor(A)60 -3.869e-01 9.207e-03 -42.022 <2e-16 ***
as.factor(A)61 -3.073e-01 9.042e-03 -33.980 <2e-16 ***
as.factor(A)62 -1.980e-01 8.780e-03 -22.547 <2e-16 ***
as.factor(A)63 -1.323e-01 8.681e-03 -15.240 <2e-16 ***
as.factor(A)64 -1.563e-02 8.431e-03 -1.854 0.0637 .
as.factor(A)65 7.591e-02 8.262e-03 9.188 <2e-16 ***
as.factor(A)66 1.467e-01 8.161e-03 17.973 <2e-16 ***
as.factor(A)67 2.320e-01 8.031e-03 28.891 <2e-16 ***
as.factor(A)68 3.279e-01 7.895e-03 41.528 <2e-16 ***
as.factor(A)69 4.324e-01 7.768e-03 55.659 <2e-16 ***
as.factor(A)70 5.107e-01 7.725e-03 66.109 <2e-16 ***
as.factor(A)71 5.712e-01 7.706e-03 74.118 <2e-16 ***
as.factor(A)72 6.990e-01 7.516e-03 93.000 <2e-16 ***
as.factor(A)73 7.894e-01 7.419e-03 106.396 <2e-16 ***
as.factor(A)74 8.836e-01 7.327e-03 120.588 <2e-16 ***
as.factor(A)75 9.676e-01 7.282e-03 132.867 <2e-16 ***
as.factor(A)76 1.059e+00 7.238e-03 146.259 <2e-16 ***
as.factor(A)77 1.146e+00 7.211e-03 158.902 <2e-16 ***
as.factor(A)78 1.271e+00 7.119e-03 178.563 <2e-16 ***
as.factor(A)79 1.378e+00 7.099e-03 194.088 <2e-16 ***
as.factor(A)80 1.453e+00 7.169e-03 202.679 <2e-16 ***
as.factor(A)81 1.543e+00 7.187e-03 214.687 <2e-16 ***
as.factor(A)82 1.646e+00 7.196e-03 228.677 <2e-16 ***
as.factor(A)83 1.749e+00 7.198e-03 242.927 <2e-16 ***
as.factor(A)84 1.874e+00 7.179e-03 261.090 <2e-16 ***
as.factor(A)85 1.959e+00 7.299e-03 268.420 <2e-16 ***
as.factor(A)86 2.070e+00 7.392e-03 280.018 <2e-16 ***
as.factor(A)87 2.159e+00 7.578e-03 284.909 <2e-16 ***
as.factor(A)88 2.267e+00 7.739e-03 292.986 <2e-16 ***
as.factor(A)89 2.374e+00 7.980e-03 297.484 <2e-16 ***
as.factor(A)90 2.455e+00 8.399e-03 292.272 <2e-16 ***
as.factor(A)91 2.556e+00 8.754e-03 291.982 <2e-16 ***
as.factor(A)92 2.662e+00 9.207e-03 289.081 <2e-16 ***
as.factor(A)93 2.764e+00 9.772e-03 282.813 <2e-16 ***

```

```

as.factor(A)94 2.839e+00 1.057e-02 268.734 <2e-16 ***
as.factor(A)95 2.947e+00 1.144e-02 257.572 <2e-16 ***
as.factor(A)96 3.026e+00 1.273e-02 237.685 <2e-16 ***
as.factor(A)97 3.125e+00 1.432e-02 218.195 <2e-16 ***
as.factor(A)98 3.254e+00 1.617e-02 201.188 <2e-16 ***
as.factor(A)99 3.212e+00 1.992e-02 161.250 <2e-16 ***
as.factor(A)100 3.377e+00 2.273e-02 148.581 <2e-16 ***
as.factor(A)101 3.466e+00 2.721e-02 127.372 <2e-16 ***
as.factor(A)102 3.438e+00 3.528e-02 97.440 <2e-16 ***
as.factor(A)103 3.586e+00 4.256e-02 84.254 <2e-16 ***
as.factor(A)104 3.600e+00 5.593e-02 64.369 <2e-16 ***
as.factor(A)105 3.800e+00 6.836e-02 55.589 <2e-16 ***
as.factor(A)106 3.686e+00 9.503e-02 38.789 <2e-16 ***
as.factor(A)107 3.739e+00 1.241e-01 30.125 <2e-16 ***
as.factor(A)108 3.738e+00 1.667e-01 22.419 <2e-16 ***
as.factor(A)109 3.735e+00 2.236e-01 16.703 <2e-16 ***
as.factor(A)110 3.505e+00 2.423e-01 14.464 <2e-16 ***
Y -1.544e-02 4.648e-05 -332.097 <2e-16 ***

```

```

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

```

(Dispersion parameter for poisson family taken to be 1)

```

Null deviance: 3445251 on 776 degrees of freedom
Residual deviance: 21594 on 665 degrees of freedom
AIC: 28187

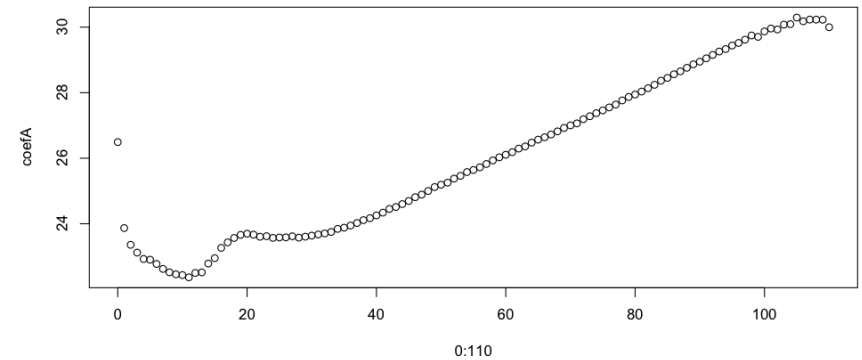
```

Number of Fisher Scoring iterations: 4

```

> coefA=c(0,coefficients(reg1)[2:111])+coefficients(reg1)[1]
> plot(0:110,coefA)

```



```

> brk=c(12,20,30)
> positive1=function(x) ifelse(x<brk[1],brk[1]-x,0)
> positive2=function(x) ifelse(x<brk[2],brk[2]-x,0)
> positive3=function(x) ifelse(x<brk[3],brk[3]-x,0)
>
> reg2=glm(D~A+positive1(A)+positive2(A)+positive3(A)+Y+
+ offset(log(E)),data=DECES,family=poisson(link="log"))

```

```
> summary(reg2)
```

```
Call:
glm(formula = D ~ A + positive1(A) + positive2(A) + positive3(A) +
     Y + offset(log(E)), family = poisson(link = "log"), data = DECES)
```

```
Deviance Residuals:
```

Min	1Q	Median	3Q	Max
-51.631	-3.229	-0.473	3.120	125.758

```
Coefficients:
```

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	2.025e+01	9.144e-02	221.5	<2e-16	***
A	9.320e-02	6.599e-05	1412.3	<2e-16	***
positive1(A)	8.934e-01	4.069e-03	219.6	<2e-16	***
positive2(A)	-5.152e-01	3.083e-03	-167.1	<2e-16	***
positive3(A)	1.631e-01	9.309e-04	175.2	<2e-16	***
Y	-1.531e-02	4.632e-05	-330.4	<2e-16	***

```
---
```

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

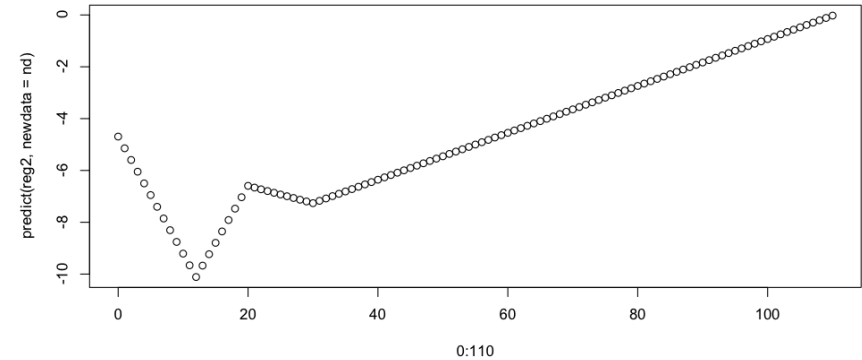
```
(Dispersion parameter for poisson family taken to be 1)
```

```
Null deviance: 3445251 on 776 degrees of freedom
Residual deviance: 83077 on 771 degrees of freedom
AIC: 89458
```

```
Number of Fisher Scoring iterations: 5
```

```
> nd=data.frame(A=0:110,Y=0,E=1)
```

```
> plot(0:110,predict(reg2,newdata=nd))
```



```
> reg3=glm(D/E~A+positive1(A)+positive2(A)+positive3(A)+Y,
+ data=DECES,weights=E,family=binomial(link="logit"))
```

```
> summary(reg3)
```

```
Call:
glm(formula = D/E ~ A + positive1(A) + positive2(A) + positive3(A) +
     Y, family = binomial(link = "logit"), data = DECES, weights = E)
```

```
Deviance Residuals:
```

Min	1Q	Median	3Q	Max
-52.293	-2.748	0.550	4.211	125.924

```
Coefficients:
```

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	2.159e+01	9.457e-02	228.3	<2e-16	***
A	9.741e-02	7.023e-05	1387.1	<2e-16	***
positive1(A)	9.015e-01	4.079e-03	221.0	<2e-16	***
positive2(A)	-5.350e-01	3.088e-03	-173.3	<2e-16	***
positive3(A)	1.810e-01	9.366e-04	193.2	<2e-16	***
Y	-1.610e-02	4.795e-05	-335.8	<2e-16	***

```
---
```

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

```
(Dispersion parameter for binomial family taken to be 1)
```

```
Null deviance: 3519013 on 776 degrees of freedom
Residual deviance: 87176 on 771 degrees of freedom
AIC: 93459
```

```
Number of Fisher Scoring iterations: 5
```

```
> nd=data.frame(A=0:110,Y=0,E=1)
> plot(0:110,predict(reg4,newdata=nd))
```

