

# Survival fourth

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## Ex9.2

```
library(survival)
library(KMsurv)

data("bnct");attach(bnct)
Z1<-1*(trt==2);Z2<-1*(trt==3)
Z3<-log(time)*Z1;Z4<-log(time)*Z2
cox9.2full<-coxph(Surv(time,death)~Z1+Z2+Z3+Z4)
cox9.2re<-coxph(Surv(time,death)~Z1+Z2)
LR<-2*(cox9.2full$loglik[2]-cox9.2re$loglik[2])
p<-1-pchisq(LR,2)
detach(bnct)
```

## Solution

I constructed a coxph model with covariates: Z1-indicator for radiated (Z1 = 1 if radiated otherwise 0), Z2-indicator for radiate+BPA (Z2 = 1 if radiate+BPA otherwise 0), and corresponding artificial covariates  $Z3 = \ln(t)*Z1$ ,  $Z4 = \ln(t)*Z2$ . I Performed local likelihood ratio test on Z3 and Z4 equal zero simultaneously, the corresponding test statistic is 37.0532952, following  $\chi^2_2$  distribution. The p-values are  $8.9945444 \times 10^{-9}$ . It indicates there is not enough evidence to support proportional hazard assumption.

## Ex9.6

a)

```
data("rats");attach(rats)

Z1<-1*(trt==1)
cox9.6a<-coxph(Surv(time,tumor)~Z1,method = "breslow")
sum9.6a<-summary(cox9.6a)
sum9.6a$conf.int
```

```
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1   2.453399   0.4075979   1.317016   4.570306
```

b)

```
cox9.6b<-coxph(Surv(time,tumor)~Z1+strata(litter),method = "breslow")
sum9.6b<-summary(cox9.6b)
sum9.6b$conf.int

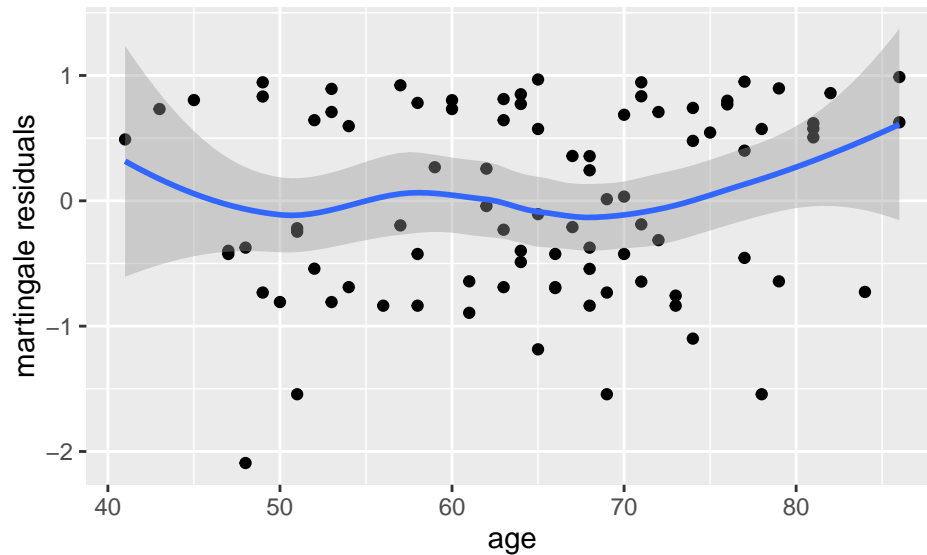
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1   2.410976   0.4147698   1.151142   5.049597

detach(rats)
```

## Ex11.1

a)

```
data("larynx");attach(larynx)
cox11.1a<-coxph(Surv(time,delta)~as.factor(stage),method = "breslow")
mres<-resid(cox11.1a)
data11.a<-data.frame(y=mres,x=age)
compare<-as.data.frame(lowess(y=mres,x=age))
library(ggplot2)
ggplot(data11.a,aes(x=x,y=y))+geom_point()+labs(x="age",y="martingale residuals")+stat_smooth(method = "lowess")
```

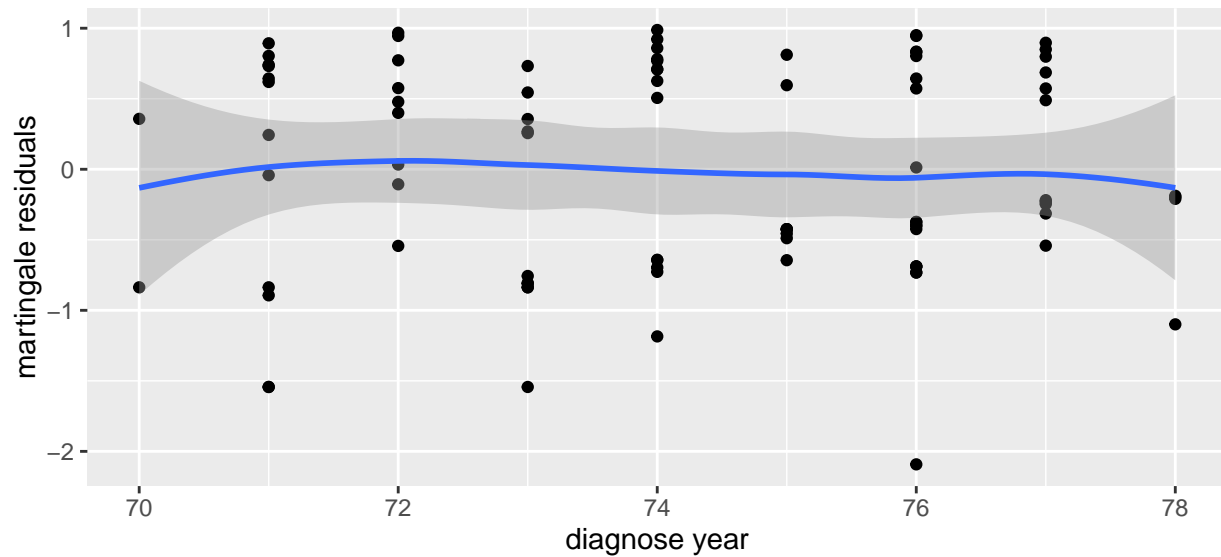


## Solution

First I fit a coxph model using stage as covariates. Here I plot the LOWESS smoothed martingale residuals against age plot. It suggests age should enter the model as a indicator covariate.

b)

```
data11.b<-data.frame(y=mres,x=diagyr)
ggplot(data11.b,aes(x=x,y=y))+geom_point()+labs(x="diagnose year",y="martingale residuals")+stat_smooth(method = "lowess")
```



### Solution

Here is the LOWESS smoothed martingale residuals against year plot. It suggests year should enter the model in a step function form.

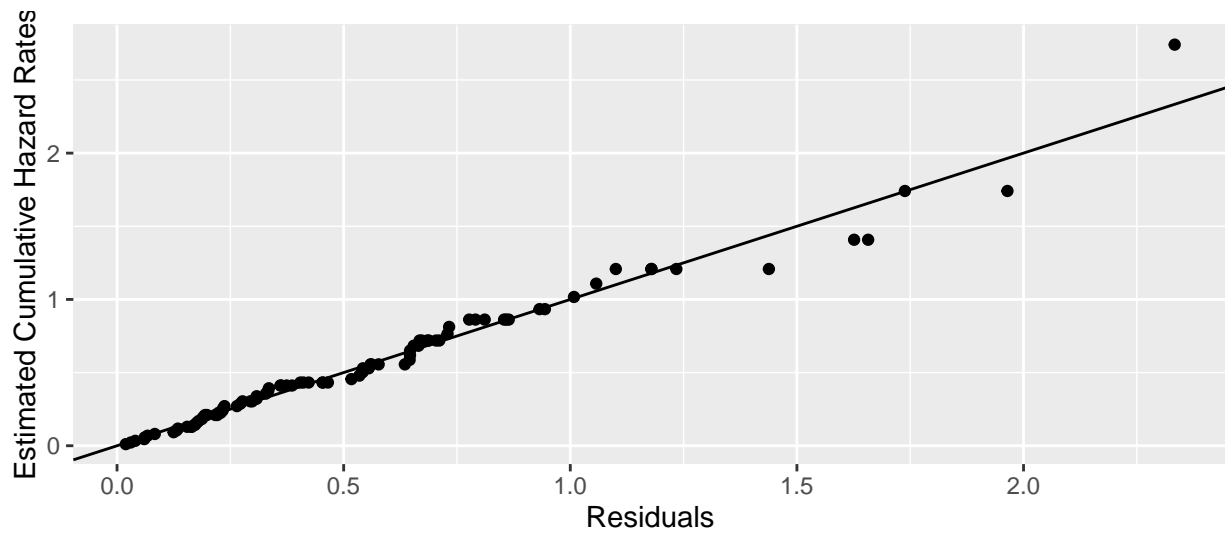
c)

```
cox11.1c<-coxph(Surv(time,delta)~as.factor(stage)+age,method = "breslow")
coxsnell<-delta-resid(cox11.1c)
cumhaz<-survfit(Surv(coxsnell,larynx$delta)~1,type="fl")
data11.c<-data.frame(residual=cumhaz$time,estimate=-log(cumhaz$surv))
detach(larynx)
```

### Solution

I fit a coxph model using stage and age in linear form as covariates. Plot a diagnostic plot, y-axis is the estimated cumulative hazard rates while x-axis is cox-snell residuals. The plot is approximately in a straight line, indicating our assumption of proportional hazard model is acceptable.

```
ggplot(data11.c,aes(x=residual,y=estimate))+geom_point()+geom_abline(intercept=0,slope=1)+labs(y="Estimate")
```



## Ex11.2

```
data("bfeed");attach(bfeed)
library(gridExtra)
cox11.2<-coxph(Surv(duration,delta)~as.factor(race)+smoke+poverty,method = "breslow")
mres<-resid(cox11.2)
motherage<-data.frame(y=mres,x=agemth)
m1<-ggplot(motherage,aes(x=x,y=y))+geom_point()+labs(x="mother's age",y="matingale residual")+stat_smooth()
motheredu<-data.frame(y=mres,x=yschool)
m2<-ggplot(motheredu,aes(x=x,y=y))+geom_point()+labs(x="mother's year of education",y="matingale residual")+stat_smooth()
yrbirth<-data.frame(y=mres,x=ybirth)
m3<-ggplot(yrbirth,aes(x=x,y=y))+geom_point()+labs(x="year of birth",y="matingale residual")+stat_smooth()
grid.arrange(m1,m2,m3,ncol=3)
```

