# Pstat175 Final Project

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# Contents

**Abstract** **3**

**Data Source and Backgriund information** **3**

**Research Question** **4**

**Data Exploration** **4**

**Up-sample & Down-sample and Kaplan-Meier estimation curves** **6**

**Model Building** **11**

KM Curves (TESTING?) . . . . . 11

Cox PH . . . . . 19

**Model Checking** **19**

Hypothesis Testing . . . . . 19

**Residual tests** **19**

**PH Assumpting** **19**

C-log-log plot . . . . . 19

**Interaction term ???** **19**

**Answer Question / Discussion** **19**

**Concluson** **19**

# Abstract

# Data Source and Backgriund information

```
# echo = FALSE
library(survival)
library(KMsurv)
# library(dplyr)
# library(ggplot2)
# library(GGally)
# library(rms)

data(pneumon)
head(pneumon,3)
```

```
##   chldage hospital mthage urban alcohol smoke region poverty bweight race
## 1      12        0     22     1       0     0      1       1       1    1
## 2      12        0     20     1       1     0      1       1       0    1
## 3       3        0     24     1       3     0      1       1       0    1
##   education nsibs wmonth sfmonth agepn
## 1        10     1      1       1     1
## 2        12     1      2       2    12
## 3        12     2      1       0     3
```

```
dim(pneumon)
```

```
## [1] 3470   15
```

This data frame contains the following columns:
chldage - Age child had pneumonia, months
hospital - Indicator for hospitalization for pneumonia (1=yes, 0=no)
mthage - Age of the mother, years
urban - Urban environment for mother (1=yes, 0=no)
alcohol - Alcohol use by mother during pregnancy (1=yes, 0=no)
smoke - Cigarette use by mother during pregnancy (1=yes, 0=no)
region - Region of the coutry (1=northeast, 2=north central, 3=south, 4=west)
poverty - Mother at poverty level (1=yes, 0=no)
bweight - Normal birthweight (>5.5 lbs.) (1=yes, 0=no)
race - Race of the mother (1=white, 2=black, 3=other)
education - Education of the mother, years of school
nsibs - Number of siblings of the child
wmonth - Month the child was weaned
sfmonth - Month the child on solid food
agepn - Age child in the hospital for pneumonia, months

# Research Question

# Data Exploration

```
summary(pneumon)
```

```
##     chldage          hospital           mthage          urban
##  Min.   : 0.500   Min.   :0.00000   Min.   :14.00   Min.   :0.0000
##  1st Qu.: 8.000   1st Qu.:0.00000   1st Qu.:20.00   1st Qu.:1.0000
##  Median :12.000   Median :0.00000   Median :22.00   Median :1.0000
##  Mean   : 9.845   Mean   :0.02104   Mean   :21.64   Mean   :0.7605
##  3rd Qu.:12.000   3rd Qu.:0.00000   3rd Qu.:23.00   3rd Qu.:1.0000
##  Max.   :12.000   Max.   :1.00000   Max.   :29.00   Max.   :1.0000
##     alcohol           smoke            region        poverty
##  Min.   :0.0000   Min.   :0.0000   Min.   :1.00   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:2.00   1st Qu.:1.0000
##  Median :0.0000   Median :0.0000   Median :3.00   Median :1.0000
##  Mean   :0.6646   Mean   :0.4415   Mean   :2.65   Mean   :0.9222
##  3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:3.00   3rd Qu.:1.0000
##  Max.   :4.0000   Max.   :2.0000   Max.   :4.00   Max.   :1.0000
##     bweight            race         education         nsibs
##  Min.   :0.0000   Min.   :1.00   Min.   : 0.00   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:1.00   1st Qu.:10.00   1st Qu.:0.0000
##  Median :0.0000   Median :1.00   Median :12.00   Median :0.0000
##  Mean   :0.3597   Mean   :1.61   Mean   :11.44   Mean   :0.6775
##  3rd Qu.:1.0000   3rd Qu.:2.00   3rd Qu.:12.00   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :3.00   Max.   :19.00   Max.   :6.0000
##      wmonth          sfmonth           agepn
##  Min.   : 0.000   Min.   : 0.000   Min.   : 0.000
##  1st Qu.: 0.000   1st Qu.: 0.000   1st Qu.: 3.000
##  Median : 0.000   Median : 0.000   Median :10.000
##  Mean   : 1.926   Mean   : 1.121   Mean   : 7.865
##  3rd Qu.: 2.000   3rd Qu.: 1.000   3rd Qu.:12.000
##  Max.   :28.000   Max.   :18.000   Max.   :12.000
```

```
mean(pneumon$chldage) #mean of Age child had pneumonia in
```

```
## [1] 9.844957
```

```
mean(pneumon$agepn)
```

```
## [1] 7.864553
```

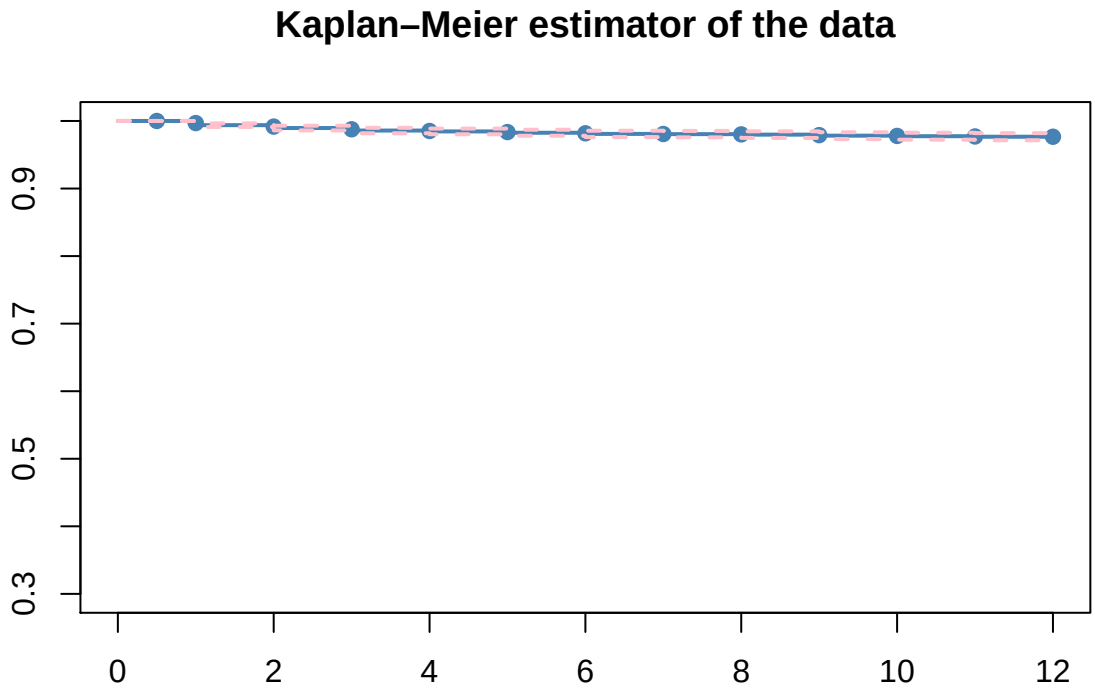
```
length(which(pneumon$hospital=="1"))
```

```
## [1] 73
```

```r
length(which(pneumon$hospital=="0"))
```

```
## [1] 3397
```

```r
#number of child Indicator for hospitalization for pneumonia

pneumon.fit <- survfit(Surv(pneumon$chldage,pneumon$hospital)~1)

plot(pneumon.fit,mark=19,lwd=2,ylim = c(0.3,1.0),
     col=c("steelblue","pink","pink"),
     main="Kaplan-Meier estimator of the data")
```




```r
summary(pneumon.fit)
```

```
## Call: survfit(formula = Surv(pneumon$chldage, pneumon$hospital) ~ 1)
##
##  time n.risk n.event survival std.err lower 95% CI upper 95% CI
##     1   3386      21    0.994 0.00135        0.991        0.996
##     2   3282      14    0.990 0.00176        0.986        0.993
##     3   3184      12    0.986 0.00205        0.982        0.990
##     4   3089       4    0.985 0.00215        0.980        0.989
##     5   2993       6    0.983 0.00229        0.978        0.987
##     6   2880       5    0.981 0.00241        0.976        0.986
##     7   2779       1    0.981 0.00243        0.976        0.985
```

```
##     8   2682       2    0.980 0.00249        0.975        0.985
##     9   2585       4    0.978 0.00260        0.973        0.983
##    10   2496       2    0.977 0.00265        0.972        0.983
##    11   2418       2    0.977 0.00271        0.971        0.982
```

```
print(pneumon.fit)
```

```
## Call: survfit(formula = Surv(pneumon$chldage, pneumon$hospital) ~ 1)
##
##       n  events  median 0.95LCL 0.95UCL
##    3470      73      NA      NA      NA
```

```
# why is it not working? All NA
quantile(pneumon.fit, probs=c(.75,.50,.25),
         conf.int=FALSE)
```

```
## 75 50 25
## NA NA NA
```

## Up-sample & Down-sample and Kaplan-Meier estimation curves

since we have 3397 censored and only 73 event in the original dataset, we are going to do up-sample and down-sample to get a better dataset.

```
table(pneumon$hospital)
```

```
##
##    0    1
## 3397   73
```

```
set.seed(99)
balance_data <- function(df, method, dsize){
  event <- df[df$hospital=="1",]
  censored <- df[df$hospital=="0",]
  nevent <- nrow(event)
  ncensored <- nrow(censored)

  if(method == "down"){
    if(nevent > ncensored)
    {
      dfe <- events[sample(1:nevent, dsize, replace=F),]
      new_dataset <- rbind(censored,dfe)
    }
    else{ #nevent <= ncensored
      dfc <- censored[sample(1:ncensored, dsize, replace = F),]
      new_dataset <- rbind(event,dfc)
    }
    new_dataset
  }
```

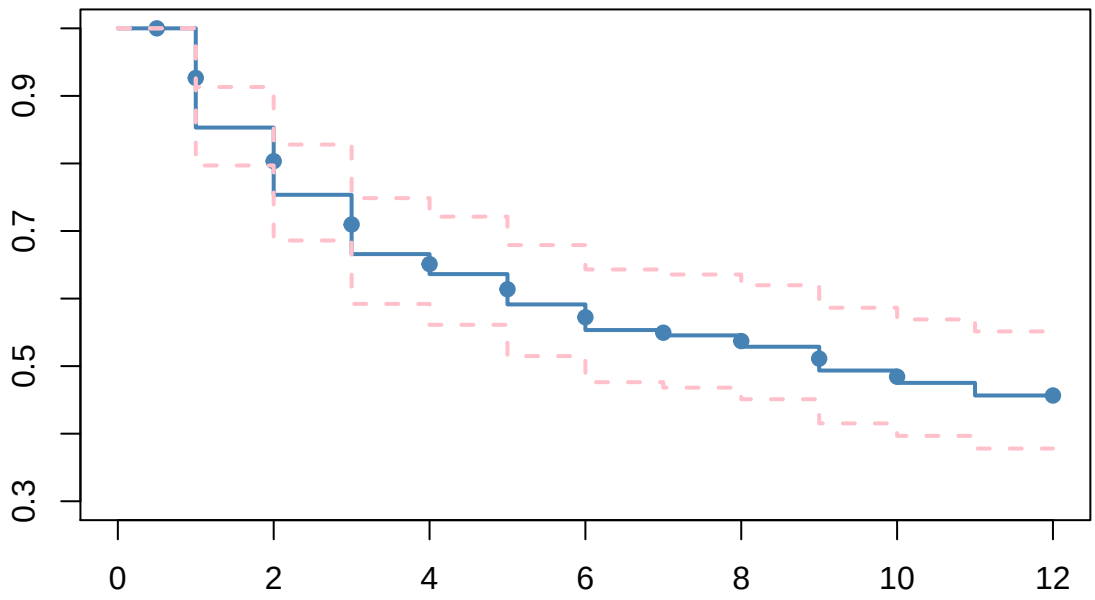
```
  else if(method =="up"){
    if(nevent < ncensored){
      dfe <- event[sample(1:nevent, dsize, replace = T),]
      new_dataset <- rbind(censored,dfe)
    }
    else{ #nevent <= ncensored
      dfc <- censored[sample(1:ncensored, dsize, replace = T),]
      new_dataset <- rbind(event,dfc)
    }
  }
  new_dataset
}

plotKM <- function(dataset){
  pneumon.fit <- survfit(Surv(dataset$chldage,dataset$hospital)~1)
  # print(summary(pneumon.fit))
  print(pneumon.fit)
  plot(pneumon.fit,mark=19,lwd=2,ylim = c(0.3,1.0),
       col=c("steelblue","pink","pink"))
  # pneumon.cox <- coxph((Surv(chldage,hospital)~.), data = dataset)
  # print(pneumon.cox)
}

#down sample to 73
new_dataset_down <- balance_data(pneumon,method="down",dsize = 73)
table(new_dataset_down$hospital)
```

```
##
##  0  1
## 73 73
```

```
plotKM(new_dataset_down)
```

```
## Call: survfit(formula = Surv(dataset$chldage, dataset$hospital) ~ 1)
##
##       n  events  median 0.95LCL 0.95UCL
##     146      73       9       6      NA
```

```
title("Kaplan-Meier estimator of the downsample 73 data")
```



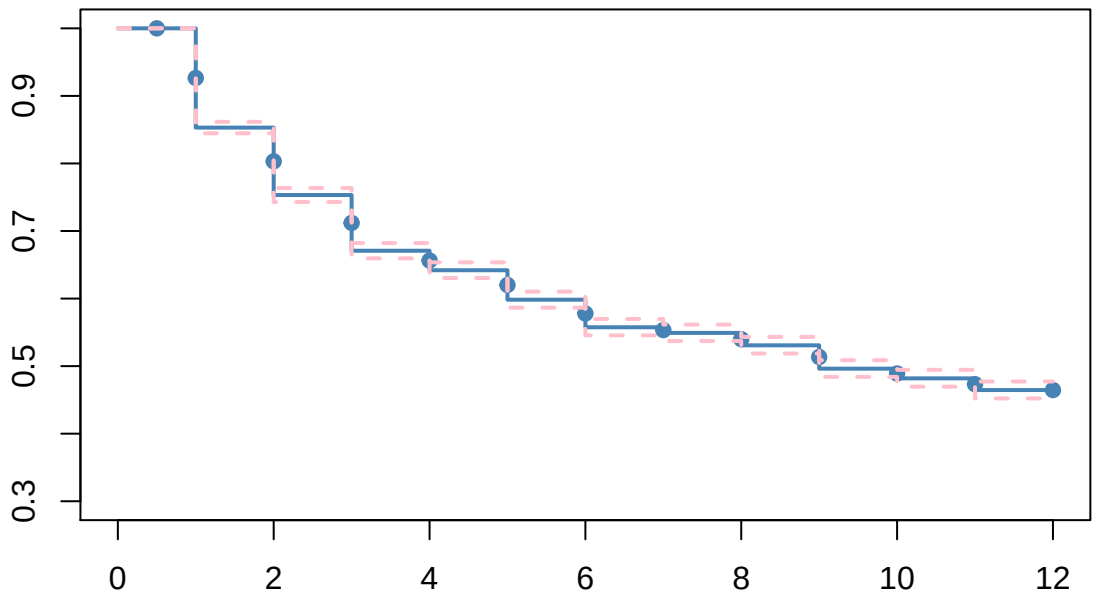

```
#up sample to 3397
new_dataset_up <- balance_data(pneumon,method="up", dsize = 3397)
table(new_dataset_up$hospital)
```

```
##
##    0    1
## 3397 3397
```

```
plotKM(new_dataset_up)
```

```
## Call: survfit(formula = Surv(dataset$chldage, dataset$hospital) ~ 1)
##
##       n  events  median 0.95LCL 0.95UCL
##    6794    3397       9       9      10
```

```
title("Kaplan-Meier estimator of the upsample to 3397 data")
```




```
#up sample for event and down sample for censored 300 each
new_dataset300 <- balance_data(pneumon,method="up", dsize = 300)
new_dataset300 <- balance_data(new_dataset300,method="down",dsize = 300)
table(new_dataset300$hospital)
```

```
##
##   0   1
## 300 300
```

```
summary(new_dataset300)
```

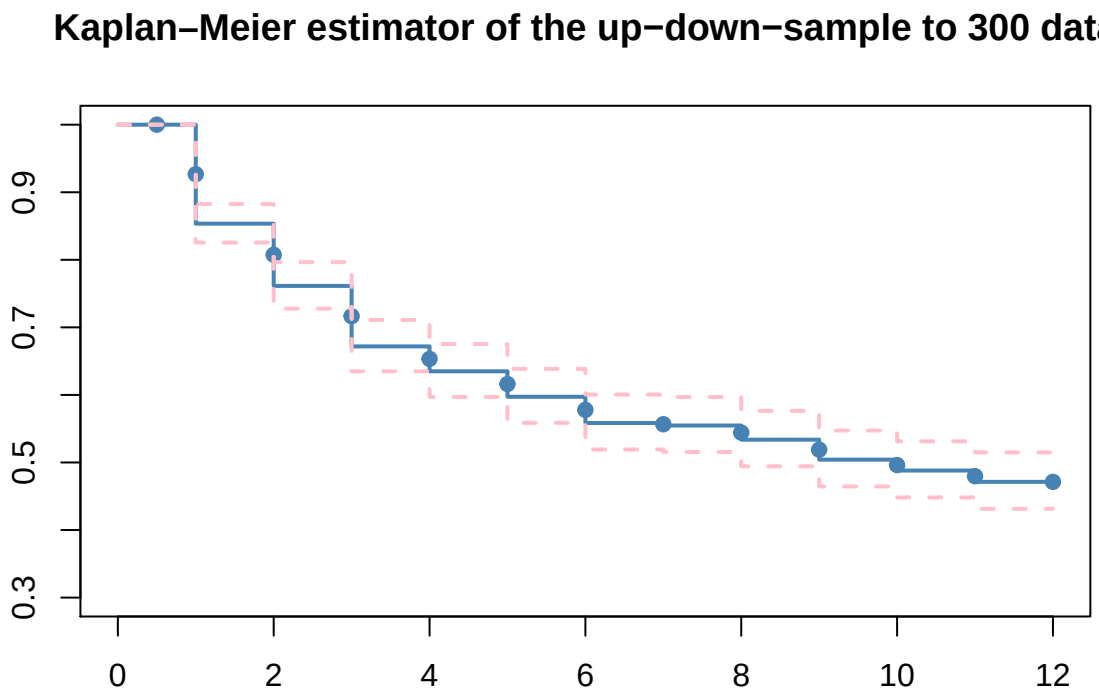
```
##     chldage          hospital       mthage          urban
##  Min.   : 0.500   Min.   :0.0   Min.   :16.00   Min.   :0.0000
##  1st Qu.: 2.000   1st Qu.:0.0   1st Qu.:19.00   1st Qu.:0.0000
##  Median : 6.000   Median :0.5   Median :21.00   Median :1.0000
##  Mean   : 6.938   Mean   :0.5   Mean   :21.19   Mean   :0.7167
##  3rd Qu.:12.000   3rd Qu.:1.0   3rd Qu.:23.00   3rd Qu.:1.0000
##  Max.   :12.000   Max.   :1.0   Max.   :28.00   Max.   :1.0000
##     alcohol          smoke           region        poverty
##  Min.   :0.00   Min.   :0.0000   Min.   :1.00   Min.   :0.0000
##  1st Qu.:0.00   1st Qu.:0.0000   1st Qu.:2.00   1st Qu.:1.0000
##  Median :0.00   Median :0.0000   Median :3.00   Median :1.0000
##  Mean   :0.67   Mean   :0.5867   Mean   :2.52   Mean   :0.9217
##  3rd Qu.:1.00   3rd Qu.:1.0000   3rd Qu.:3.00   3rd Qu.:1.0000
##  Max.   :4.00   Max.   :2.0000   Max.   :4.00   Max.   :1.0000
```

```
##     bweight            race        education      nsibs
##  Min.   :0.0000   Min.   :1.00   Min.   : 2   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:1.00   1st Qu.:10   1st Qu.:0.0000
##  Median :0.0000   Median :1.00   Median :11   Median :1.0000
##  Mean   :0.4117   Mean   :1.62   Mean   :11   Mean   :0.8583
##  3rd Qu.:1.0000   3rd Qu.:2.00   3rd Qu.:12   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :3.00   Max.   :17   Max.   :6.0000
##      wmonth          sfmonth           agepn
##  Min.   : 0.000   Min.   :0.0000   Min.   : 0.000
##  1st Qu.: 0.000   1st Qu.:0.0000   1st Qu.: 4.000
##  Median : 0.000   Median :0.0000   Median :12.000
##  Mean   : 1.165   Mean   :0.7083   Mean   : 8.457
##  3rd Qu.: 1.000   3rd Qu.:1.0000   3rd Qu.:12.000
##  Max.   :22.000   Max.   :9.0000   Max.   :12.000
```

```
plotKM(new_dataset300)
```

```
## Call: survfit(formula = Surv(dataset$chldage, dataset$hospital) ~ 1)
##
##       n  events  median 0.95LCL 0.95UCL
##     600     300      10       8      NA
```

```
title("Kaplan-Meier estimator of the up-down-sample to 300 data")
```




We are going to use new_dataset300, which will have 300 data for both censored and event.

# Model Building

## KM Curves (TESTING?)

```
pneumon300 <- new_dataset300

library(My.stepwise)
# Stepwise Variable Selection Procedure for
# Cox's Proportional Hazards Model and Cox's Model

pneumon.variable.list <- c("mthage","urban", "alcohol","smoke", "region","poverty", "bweight","race", "
My.stepwise.coxph(Time = "chldage", Status = "hospital", variable.list = pneumon.variable.list , data =
```

```
## # ------------------------------------------------------------------------------------------------
## # Initial Model:
## Call:
## coxph(formula = formula, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##            coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.4746    0.6221   0.0758 -6.261 3.84e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## sfmonth    0.6222      1.607    0.5363    0.7218
##
## Concordance= 0.62  (se = 0.012 )
## Likelihood ratio test= 67.77  on 1 df,   p=<2e-16
## Wald test            = 39.19  on 1 df,   p=4e-10
## Score (logrank) test = 44.92  on 1 df,   p=2e-11
##
## # ------------------------------------------------------------------------------------------------
## ### iter num = 1, Forward Selection by LR Test: + nsibs
## Call:
## coxph(formula = Surv(chldage, hospital) ~ sfmonth + nsibs, data = data,
##     method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.45130   0.63680  0.07482 -6.032 1.62e-09 ***
## nsibs    0.24229   1.27416  0.05297  4.574 4.78e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## sfmonth    0.6368     1.5704    0.5499    0.7374
## nsibs      1.2742     0.7848    1.1485    1.4136
##
## Concordance= 0.657  (se = 0.016 )
```

```
## Likelihood ratio test= 86.44  on 2 df,   p=<2e-16
## Wald test            = 62.33  on 2 df,   p=3e-14
## Score (logrank) test = 69.09  on 2 df,   p=1e-15
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
## sfmonth   nsibs
##  1.0004  1.0004
## # ------------------------------------------------------------------------------------------------
## ### iter num = 2, Forward Selection by LR Test: + urban
## Call:
## coxph(formula = Surv(chldage, hospital) ~ sfmonth + nsibs + urban,
##     data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.44222   0.64261  0.07521 -5.880 4.10e-09 ***
## nsibs    0.22855   1.25678  0.05306  4.307 1.65e-05 ***
## urban   -0.49928   0.60697  0.12053 -4.142 3.44e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## sfmonth    0.6426     1.5562    0.5545    0.7447
## nsibs      1.2568     0.7957    1.1326    1.3945
## urban      0.6070     1.6475    0.4793    0.7687
##
## Concordance= 0.674  (se = 0.016 )
## Likelihood ratio test= 102.8  on 3 df,   p=<2e-16
## Wald test            = 79.39  on 3 df,   p=<2e-16
## Score (logrank) test = 86.6  on 3 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##  sfmonth    nsibs    urban
## 1.000650 1.001546 1.001003
## # ------------------------------------------------------------------------------------------------
## ### iter num = 3, Forward Selection by LR Test: + region
## Call:
## coxph(formula = Surv(chldage, hospital) ~ sfmonth + nsibs + urban +
##     region, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.44692   0.63960  0.07618 -5.867 4.45e-09 ***
## nsibs    0.23809   1.26883  0.05299  4.493 7.03e-06 ***
## urban   -0.54966   0.57715  0.12193 -4.508 6.54e-06 ***
## region  -0.26516   0.76709  0.06884 -3.852 0.000117 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
```

```
## sfmonth    0.6396     1.5635    0.5509    0.7426
## nsibs      1.2688     0.7881    1.1437    1.4077
## urban      0.5771     1.7327    0.4545    0.7329
## region     0.7671     1.3036    0.6703    0.8779
##
## Concordance= 0.69  (se = 0.016 )
## Likelihood ratio test= 117.6  on 4 df,   p=<2e-16
## Wald test            = 90.15  on 4 df,   p=<2e-16
## Score (logrank) test = 97.27  on 4 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##  sfmonth    nsibs    urban   region
## 1.000944 1.005174 1.010440 1.014071
## # ------------------------------------------------------------------------------------------------
## ### iter num = 4, Forward Selection by LR Test: + mthage
## Call:
## coxph(formula = Surv(chldage, hospital) ~ sfmonth + nsibs + urban +
##     region + mthage, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.40668   0.66586  0.07697 -5.284 1.27e-07 ***
## nsibs    0.32054   1.37786  0.05712  5.612 2.01e-08 ***
## urban   -0.54733   0.57849  0.12175 -4.496 6.94e-06 ***
## region  -0.28681   0.75065  0.06950 -4.127 3.68e-05 ***
## mthage  -0.09056   0.91342  0.02412 -3.755 0.000174 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## sfmonth    0.6659     1.5018    0.5726    0.7743
## nsibs      1.3779     0.7258    1.2319    1.5411
## urban      0.5785     1.7286    0.4557    0.7344
## region     0.7507     1.3322    0.6551    0.8602
## mthage     0.9134     1.0948    0.8712    0.9576
##
## Concordance= 0.697  (se = 0.016 )
## Likelihood ratio test= 132  on 5 df,   p=<2e-16
## Wald test            = 102.4  on 5 df,   p=<2e-16
## Score (logrank) test = 112.6  on 5 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##  sfmonth    nsibs    urban   region   mthage
## 1.014450 1.166133 1.018286 1.037648 1.187362
## # ------------------------------------------------------------------------------------------------
## ### iter num = 5, Forward Selection by LR Test: + wmonth
## Call:
## coxph(formula = Surv(chldage, hospital) ~ sfmonth + nsibs + urban +
##     region + mthage + wmonth, data = data, method = "efron")
##
##   n= 600, number of events= 300
```

```
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## sfmonth -0.16493   0.84795  0.13671 -1.206 0.227646
## nsibs    0.32956   1.39036  0.05697  5.785 7.27e-09 ***
## urban   -0.54427   0.58026  0.12174 -4.471 7.79e-06 ***
## region  -0.29254   0.74637  0.07003 -4.178 2.95e-05 ***
## mthage  -0.08658   0.91706  0.02409 -3.594 0.000325 ***
## wmonth  -0.17046   0.84328  0.08651 -1.970 0.048803 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## sfmonth    0.8480     1.1793    0.6486    1.1085
## nsibs      1.3904     0.7192    1.2435    1.5546
## urban      0.5803     1.7234    0.4571    0.7366
## region     0.7464     1.3398    0.6506    0.8562
## mthage     0.9171     1.0904    0.8748    0.9614
## wmonth     0.8433     1.1858    0.7118    0.9991
##
## Concordance= 0.699  (se = 0.016 )
## Likelihood ratio test= 137.1  on 6 df,   p=<2e-16
## Wald test            = 103.9  on 6 df,   p=<2e-16
## Score (logrank) test = 114.8  on 6 df,   p=<2e-16
##
## ---------------- Variance Inflating Factor (VIF) ----------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##  sfmonth    nsibs    urban   region   mthage   wmonth
## 3.768362 1.196618 1.020828 1.036422 1.188194 3.772316
## # ------------------------------------------------------------------------------------------------
## ### iter num = 5, Backward Selection by LR Test: - sfmonth
## Call:
## coxph(formula = Surv(chldage, hospital) ~ nsibs + urban + region +
##     mthage + wmonth, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## nsibs   0.33908   1.40365  0.05631  6.021 1.73e-09 ***
## urban  -0.54442   0.58018  0.12167 -4.475 7.65e-06 ***
## region -0.29646   0.74345  0.06997 -4.237 2.27e-05 ***
## mthage -0.08681   0.91685  0.02405 -3.609 0.000307 ***
## wmonth -0.26382   0.76811  0.05056 -5.218 1.81e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##        exp(coef) exp(-coef) lower .95 upper .95
## nsibs     1.4037     0.7124    1.2570    1.5674
## urban     0.5802     1.7236    0.4571    0.7364
## region    0.7434     1.3451    0.6482    0.8527
## mthage    0.9169     1.0907    0.8746    0.9611
## wmonth    0.7681     1.3019    0.6957    0.8481
##
## Concordance= 0.698  (se = 0.016 )
## Likelihood ratio test= 135.6  on 5 df,   p=<2e-16
```

```
## Wald test            = 103  on 5 df,   p=<2e-16
## Score (logrank) test = 113.2  on 5 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##    nsibs    urban   region   mthage   wmonth
## 1.170646 1.021174 1.035316 1.187670 1.013440
## # ------------------------------------------------------------------------------------------------
## ### iter num = 6, Forward Selection by LR Test: + alcohol
## Call:
## coxph(formula = Surv(chldage, hospital) ~ nsibs + urban + region +
##     mthage + wmonth + alcohol, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## nsibs    0.34658   1.41423  0.05681  6.100 1.06e-09 ***
## urban   -0.53768   0.58410  0.12208 -4.404 1.06e-05 ***
## region  -0.30983   0.73357  0.07015 -4.416 1.00e-05 ***
## mthage  -0.09106   0.91296  0.02411 -3.776 0.000159 ***
## wmonth  -0.26790   0.76498  0.05064 -5.291 1.22e-07 ***
## alcohol -0.08967   0.91423  0.04931 -1.819 0.068973 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## nsibs      1.4142     0.7071    1.2652    1.5808
## urban      0.5841     1.7120    0.4598    0.7420
## region     0.7336     1.3632    0.6393    0.8417
## mthage     0.9130     1.0953    0.8708    0.9571
## wmonth     0.7650     1.3072    0.6927    0.8448
## alcohol    0.9142     1.0938    0.8300    1.0070
##
## Concordance= 0.698  (se = 0.016 )
## Likelihood ratio test= 139.1  on 6 df,   p=<2e-16
## Wald test            = 105.7  on 6 df,   p=<2e-16
## Score (logrank) test = 115.6  on 6 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##    nsibs    urban   region   mthage   wmonth  alcohol
## 1.170522 1.020981 1.043606 1.187563 1.014188 1.009239
## # ------------------------------------------------------------------------------------------------
## ### iter num = 7, Forward Selection by LR Test: + smoke
## Call:
## coxph(formula = Surv(chldage, hospital) ~ nsibs + urban + region +
##     mthage + wmonth + alcohol + smoke, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## nsibs    0.33957   1.40434  0.05749  5.907 3.48e-09 ***
## urban   -0.51207   0.59925  0.12273 -4.172 3.01e-05 ***
## region  -0.29538   0.74425  0.07062 -4.183 2.88e-05 ***
```

```
## mthage  -0.08881   0.91502  0.02424 -3.664 0.000248 ***
## wmonth  -0.26297   0.76877  0.05043 -5.215 1.84e-07 ***
## alcohol -0.11681   0.88976  0.05127 -2.278 0.022704 *
## smoke    0.16604   1.18062  0.08107  2.048 0.040535 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## nsibs      1.4043     0.7121    1.2547    1.5718
## urban      0.5993     1.6687    0.4711    0.7622
## region     0.7442     1.3436    0.6480    0.8547
## mthage     0.9150     1.0929    0.8726    0.9595
## wmonth     0.7688     1.3008    0.6964    0.8486
## alcohol    0.8898     1.1239    0.8047    0.9838
## smoke      1.1806     0.8470    1.0072    1.3839
##
## Concordance= 0.697  (se = 0.016 )
## Likelihood ratio test= 143.2  on 7 df,   p=<2e-16
## Wald test            = 111  on 7 df,   p=<2e-16
## Score (logrank) test = 120.3  on 7 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##    nsibs    urban   region   mthage   wmonth  alcohol    smoke
## 1.175731 1.027389 1.047481 1.193130 1.017993 1.069334 1.075324
## # ------------------------------------------------------------------------------------------------
## ### iter num = 8, Forward Selection by LR Test: + agepn
## Call:
## coxph(formula = Surv(chldage, hospital) ~ nsibs + urban + region +
##     mthage + wmonth + alcohol + smoke + agepn, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## nsibs    0.33882   1.40329  0.05773  5.869 4.39e-09 ***
## urban   -0.49633   0.60876  0.12347 -4.020 5.82e-05 ***
## region  -0.29539   0.74424  0.07064 -4.181 2.90e-05 ***
## mthage  -0.09979   0.90502  0.02504 -3.985 6.74e-05 ***
## wmonth  -0.25748   0.77300  0.05021 -5.128 2.93e-07 ***
## alcohol -0.11740   0.88923  0.05127 -2.290   0.0220 *
## smoke    0.16881   1.18389  0.08104  2.083   0.0372 *
## agepn   -0.02461   0.97569  0.01443 -1.705   0.0882 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## nsibs      1.4033     0.7126    1.2532    1.5714
## urban      0.6088     1.6427    0.4779    0.7754
## region     0.7442     1.3437    0.6480    0.8548
## mthage     0.9050     1.1049    0.8617    0.9506
## wmonth     0.7730     1.2937    0.7005    0.8529
## alcohol    0.8892     1.1246    0.8042    0.9832
## smoke      1.1839     0.8447    1.0100    1.3877
## agepn      0.9757     1.0249    0.9485    1.0037
```

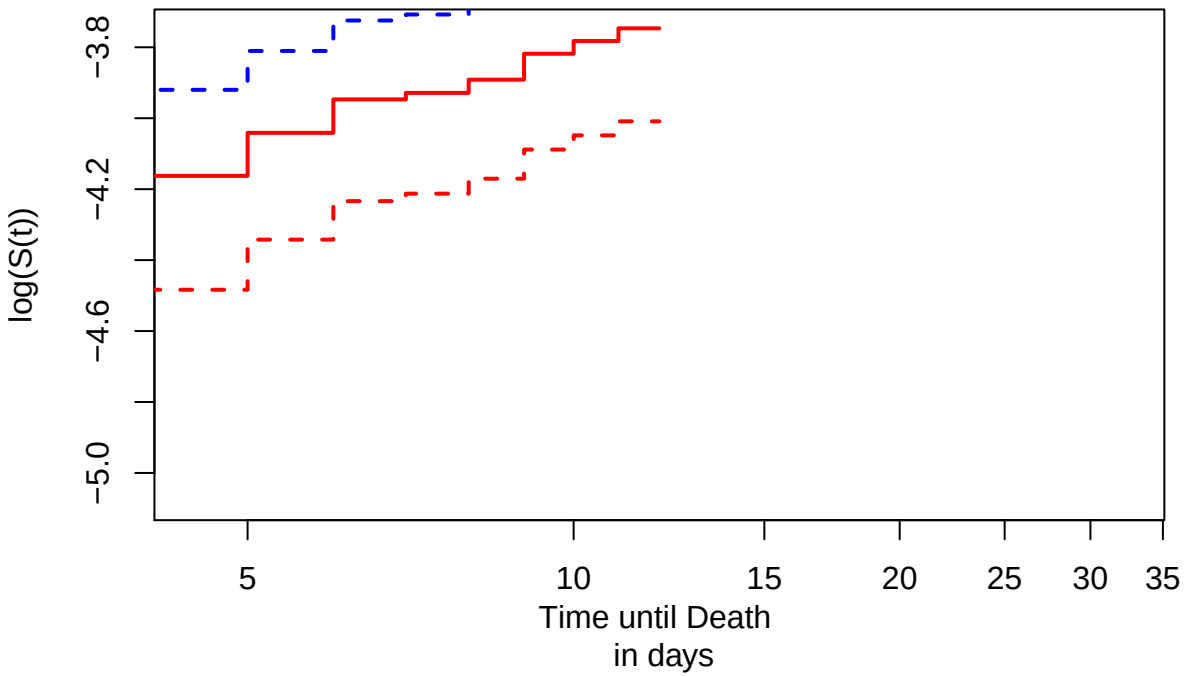
```
##
## Concordance= 0.7  (se = 0.016 )
## Likelihood ratio test= 146.1  on 8 df,   p=<2e-16
## Wald test            = 114.4  on 8 df,   p=<2e-16
## Score (logrank) test = 123.5  on 8 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##    nsibs    urban   region   mthage   wmonth  alcohol    smoke    agepn
## 1.183997 1.029633 1.047906 1.252776 1.020316 1.071038 1.075519 1.086457
## # ================================================================================================
## *** Stepwise Final Model (in.lr.test: sle = 0.15; out.lr.test: sls = 0.15; variable selection restri
## Call:
## coxph(formula = Surv(chldage, hospital) ~ nsibs + urban + region +
##     mthage + wmonth + alcohol + smoke + agepn, data = data, method = "efron")
##
##   n= 600, number of events= 300
##
##             coef exp(coef) se(coef)      z Pr(>|z|)
## nsibs    0.33882   1.40329  0.05773  5.869 4.39e-09 ***
## urban   -0.49633   0.60876  0.12347 -4.020 5.82e-05 ***
## region  -0.29539   0.74424  0.07064 -4.181 2.90e-05 ***
## mthage  -0.09979   0.90502  0.02504 -3.985 6.74e-05 ***
## wmonth  -0.25748   0.77300  0.05021 -5.128 2.93e-07 ***
## alcohol -0.11740   0.88923  0.05127 -2.290   0.0220 *
## smoke    0.16881   1.18389  0.08104  2.083   0.0372 *
## agepn   -0.02461   0.97569  0.01443 -1.705   0.0882 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##         exp(coef) exp(-coef) lower .95 upper .95
## nsibs      1.4033     0.7126    1.2532    1.5714
## urban      0.6088     1.6427    0.4779    0.7754
## region     0.7442     1.3437    0.6480    0.8548
## mthage     0.9050     1.1049    0.8617    0.9506
## wmonth     0.7730     1.2937    0.7005    0.8529
## alcohol    0.8892     1.1246    0.8042    0.9832
## smoke      1.1839     0.8447    1.0100    1.3877
## agepn      0.9757     1.0249    0.9485    1.0037
##
## Concordance= 0.7  (se = 0.016 )
## Likelihood ratio test= 146.1  on 8 df,   p=<2e-16
## Wald test            = 114.4  on 8 df,   p=<2e-16
## Score (logrank) test = 123.5  on 8 df,   p=<2e-16
##
## --------------- Variance Inflating Factor (VIF) ---------------
## Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous Variable) o
##    nsibs    urban   region   mthage   wmonth  alcohol    smoke    agepn
## 1.183997 1.029633 1.047906 1.252776 1.020316 1.071038 1.075519 1.086457
```

```
pneumon300.fit <- coxph(Surv(chldage,hospital)~nsibs + urban + region +
                          mthage + wmonth + alcohol + smoke + agepn, data = pneumon300)
anova(pneumon300.fit)
```

```
## Analysis of Deviance Table
##  Cox model: response is Surv(chldage, hospital)
## Terms added sequentially (first to last)
##
##          loglik   Chisq Df Pr(>|Chi|)
## NULL    -1807.7
## nsibs   -1795.6 24.3488  1  8.038e-07 ***
## urban   -1784.9 21.2938  1  3.940e-06 ***
## region  -1777.0 15.9016  1  6.672e-05 ***
## mthage  -1763.0 27.8230  1  1.329e-07 ***
## wmonth  -1739.9 46.2562  1  1.038e-11 ***
## alcohol -1738.2  3.4947  1    0.06157 .
## smoke   -1736.1  4.0967  1    0.04297 *
## agepn   -1734.7  2.8435  1    0.09175 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#   Confidence Intervals for the Coefficients

plot(pneumon.fit,lwd=2,col=c(2,4),
fun="cloglog",xlab="Time until Death \n in days",ylab="log(S(t))")
```

```
## Warning in xy.coords(x, y, xlabel, ylabel, log): 1 x value <= 0 omitted
## from logarithmic plot
```



```
## Cox Proportional Hazards Model
# pneumon300.cox <- coxph((Surv(chldage,hospital)~.),data = pneumon300)
# summary(pneumon300.cox)
# pneumon300.cox_fit <- survfit(pneumon300.cox)
```

### Cox PH

## Model Checking

### Hypothesis Testing

## Residual tests

## PH Assumpting

### C-log-log plot

## Interaction term ???

## Answer Question / Discussion

## Concluson