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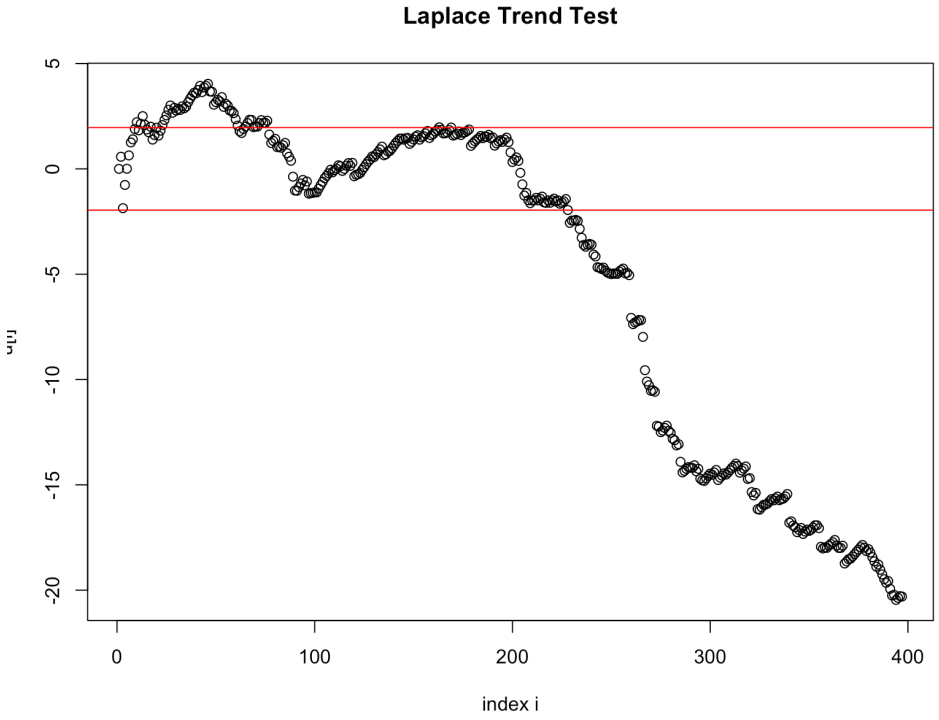
Homework 4, ECE 590 & CS320 Software Reliability.

1. The Laplace Trend Test code and results

Code for data1:

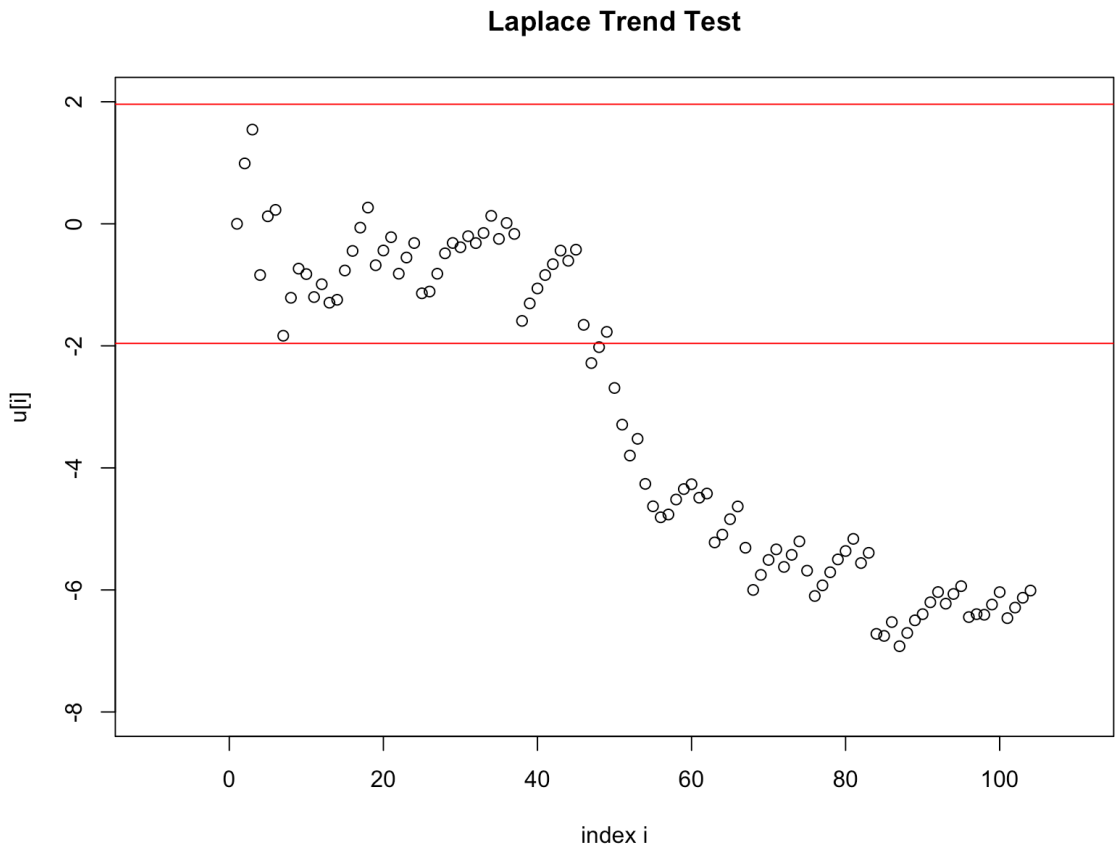
```
getS <- function(data, m){
  sum <- 0
  for(i in 1:m){
    sum <- (sum+data[i,2])
  }
  return(sum)
}

data1<-read.csv('../data1.csv',header = TRUE)
data2<-read.csv('../data2.csv',header = TRUE)

u <- rep(0,397)
for(i in 2:length(u)){
  tem = 0
  for(m in 1:(i-1)){
    sm <- getS(data1, m)
    tem <- (tem+sm)
  }
  u[i] <- (((1/(i-1))*tem) - (getS(data1, i)/2))/(getS(data1, i)*(sqrt(1/(12*(i-1)))))
}
x <- 1:397
plot(x, u, main = "Laplace Trend Test", xlab = "index i", ylab = "u[i]",)
abline(h = -1.96, col = "red")
abline(h = 1.96, col = "red")
```



Result for data1, the two red lines are upper and lower bound.

Code for data2:

```r
getS <- function(data, m){
  sum <- 0
  for(i in 1:m){
    sum <- (sum+data[i,2])
  }
  return(sum)
}

data1<-read.csv('../data1.csv',header = TRUE)
data2<-read.csv('../data2.csv',header = TRUE)

u <- rep(0,104)
for(i in 2:length(u)){
  tem = 0
  for(m in 1:(i-1)){
    sm <- getS(data2, m)
    tem <- (tem+sm)
  }
  u[i] <- (((1/(i-1))*tem) - (getS(data2, i)/2))/(getS(data2, i)*(sqrt(1/(12*(i-1)))))
}
x <- 1:104
plot(x, u, main = "Laplace Trend Test",  xlim = c(-10,110), ylim = c(-8,2), xlab = "index i", ylab = "u[i]")
abline(h = -1.96, col = "red")
abline(h = 1.96, col = "red")
```



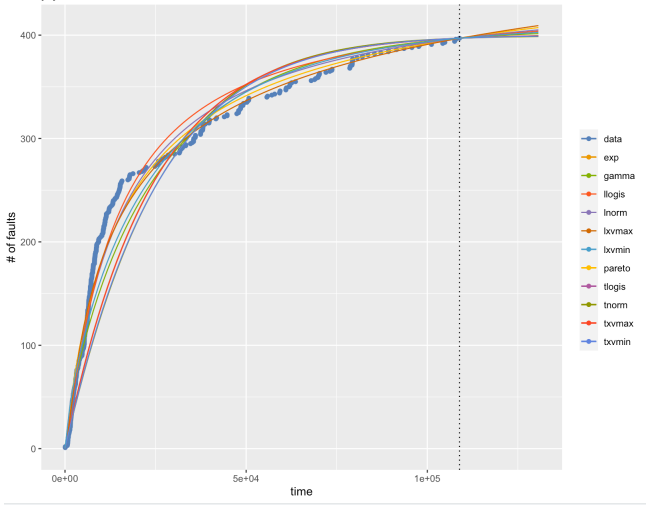
Result for data1, the two red lines are upper and lower bound.

2. The SRGMs fitting results collected from Rsrat

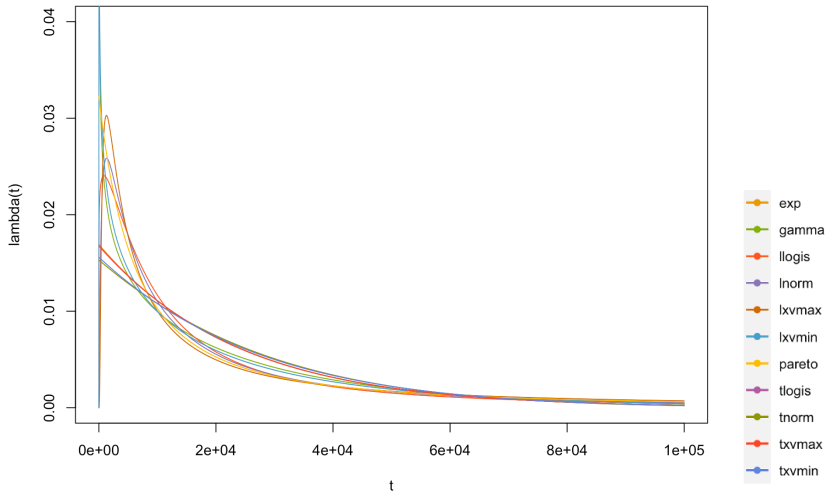
Code for data1:

```
library(Rsrat)
data1<-read.csv('../data1.csv',header = TRUE)
data2<-read.csv('../data2.csv',header = TRUE)

sys1 <- data1$Time.to.Failure
(result <- fit.srm.nhpp(time=sys1[sys1>=0], te=-8,selection = NULL))
#mvfplot(time=sys1[sys1>=0], te=-8, srms=result)

plot(0:100000, result$exp$srm$intensity(0:100000), type = "l", col="#E19C24",  ylim = c(0,0.04),xlab = "t", ylab = "lambda(t)")
par(new = TRUE)
plot(0:100000, result$gamma$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8FB032")
par(new = TRUE)
plot(0:100000, result$llogis$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#EB6235")
par(new = TRUE)
plot(0:100000, result$lnorm$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8778B3")
par(new = TRUE)
plot(0:100000, result$lxvmax$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#C56E1A")
par(new = TRUE)
plot(0:100000, result$lxvmin$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#5D9EC7")
par(new = TRUE)
plot(0:100000, result$pareto$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#FFBF00")
par(new = TRUE)
plot(0:100000, result$tlogis$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#A5609D")
par(new = TRUE)
plot(0:100000, result$tnorm$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#929600")
par(new = TRUE)
plot(0:100000, result$txvmax$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#E95536")
par(new = TRUE)
plot(0:100000, result$txvmin$srm$intensity(0:100000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#6685D9")
```

Original m(t) and fitted m(t) curves:



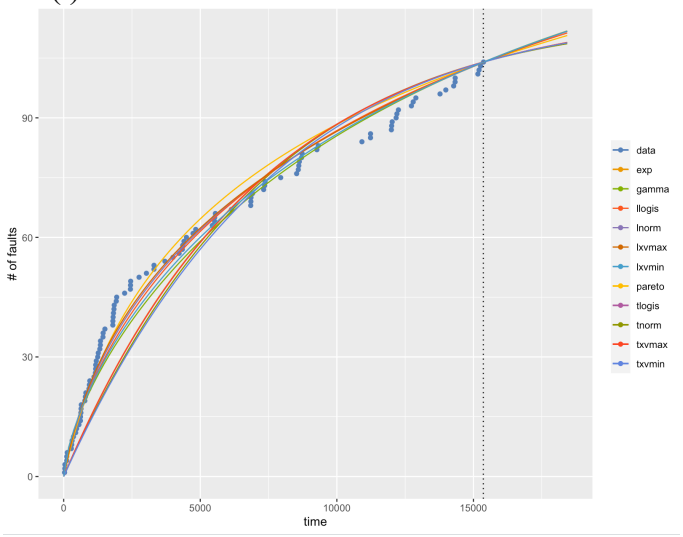
λ(t) curves:



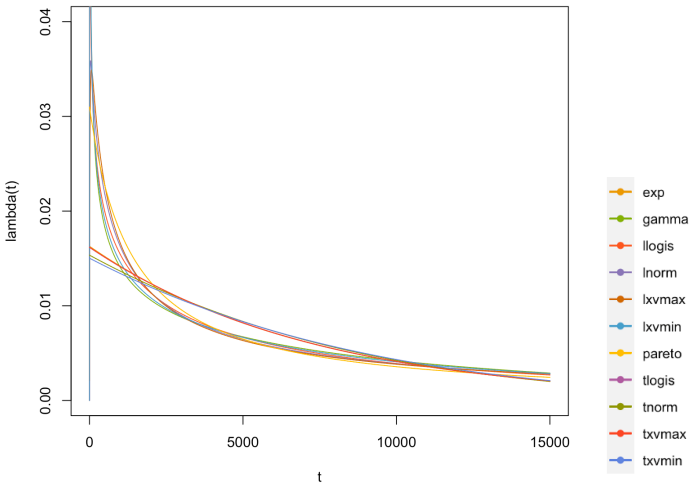
Code for data2:

```
library(Rsrat)
data1<-read.csv('../data1.csv',header = TRUE)
data2<-read.csv('../data2.csv',header = TRUE)

sys1 <- data2$Time.to.Failure
(result <- fit.srm.nhpp(time=sys1[sys1>=0], te=-8,selection = NULL))
#mvfplot(time=sys1[sys1>=0], te=-8, srms=result)

plot(0:15000, result$exp$srm$intensity(0:15000), type = "l", col="#E19C24",  ylim = c(0,0.04),xlab = "t", ylab = "lambda(t)")
par(new = TRUE)
plot(0:15000, result$gamma$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8FB032")
par(new = TRUE)
plot(0:15000, result$llogis$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#EB6235")
par(new = TRUE)
plot(0:15000, result$lnorm$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8778B3")
par(new = TRUE)
plot(0:15000, result$lxvmax$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#C56E1A")
par(new = TRUE)
plot(0:15000, result$lxvmin$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#5D9EC7")
par(new = TRUE)
plot(0:15000, result$pareto$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#FFBF00")
par(new = TRUE)
plot(0:15000, result$tlogis$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#A5609D")
par(new = TRUE)
plot(0:15000, result$tnorm$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#929600")
par(new = TRUE)
plot(0:15000, result$txvmax$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#E95536")
par(new = TRUE)
plot(0:15000, result$txvmin$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#6685D9")
```

Original m(t) and fitted m(t) curves:



λ(t) curves:



From the above result, I find that for *lnorm, llogis, lxvmax* and *lxvmin,* there are some strange points in the beginning of the curve, some sharp increase. However, I cannot find the corresponding data points in the original m(t) and fitted m(t) curves. Therefore, I think these points are outliers, and I changes some codes to make sense of the results

```
library(Rsrat)
data1<-read.csv('../data1.csv',header = TRUE)
data2<-read.csv('../data2.csv',header = TRUE)

sys1 <- data2$Time.to.Failure
(result <- fit.srm.nhpp(time=sys1[sys1>=0], te=-8,selection = NULL))
#mvfplot(time=sys1[sys1>=0], te=-8, srms=result)

plot(0:15000, result$exp$srm$intensity(0:15000), type = "l", col="#E19C24",  ylim = c(0,0.04),xlab = "t", ylab = "lambda(t)")
par(new = TRUE)
plot(0:15000, result$gamma$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8FB032")
par(new = TRUE)
plot(20:15000, result$llogis$srm$intensity(20:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#EB6235")
par(new = TRUE)
plot(20:15000, result$lnorm$srm$intensity(20:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#8778B3")
par(new = TRUE)
plot(30:15000, result$lxvmax$srm$intensity(30:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#C56E1A")
par(new = TRUE)
plot(20:15000, result$lxvmin$srm$intensity(20:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#5D9EC7")
par(new = TRUE)
plot(0:15000, result$pareto$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#FFBF00")
par(new = TRUE)
plot(0:15000, result$tlogis$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#A5609D")
par(new = TRUE)
plot(0:15000, result$tnorm$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#929600")
par(new = TRUE)
plot(0:15000, result$txvmax$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#E95536")
par(new = TRUE)
plot(0:15000, result$txvmin$srm$intensity(0:15000), type = "l",xlab = "",ylim = c(0,0.04),axes = FALSE, ylab = "", col="#6685D9")
```