Emergency Facilities Readiness Project

ALY6050: Introduction to Enterprise Analytics

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This report is regarding Emergency Facilities Readiness Project

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Introduction

A simulation is an inexact impersonation of an activity of a procedure or system; that speaks to its activity after some time. Simulation is utilized in numerous unique circumstances.
Simulation is a way of modelling where the developed model closely matches the real-world scenarios. By observing these scenarios, researches gain insights into the real world to generate probabilities and to use it in the real world for getting high success rates. Simulations can also be understood as a kind of imitation of the situation. For example, simulation technology is used in motor driving schools where the learners can drive the car in a simulator to learn the basics of car driving like operating the car, driving the car in busy streets, etc. which has been created using simulation. Developing the real world scenarios can be done using the data gathered during the contextual enquiry activities. Building scenarios is highly useful for the success of the simulated model.

Analysis

This report is regarding the handling of the emergency facilities such as handling the natural disasters. This project is focused on the transport of disaster victims from the campus to the five major hospitals. The project is done on R. Different types of simulation techniques are used in this project to get refined data. Since there is no past data that could be referred to for analysis, some data was assumed so as to create some number of samples so as to analyse them and come up with a way to tackle the situation. Considering the minimum number of patients to be 20 and maximum to be 300 with a peak of 80 patients at a time, we started analysing the data. This data was used to create 5000 random samples, but lying between the range of the maximum and minimum number of patients. These 5000 random samples depicted the number of patients at every event or calamity where the people at the campus had to be transferred to the hospitals mentioned. As we also have the probability of allocation of patients, we know in case of any event occurrence, how many patients would be allotted at each hospital. This is because of various reasons like availability of beds, availability of equipment, distance from the campus, etc. It is also assumed that there are two ambulances available at each hospital and one would leave from the hospital when the other reaches the campus.

1.

a) Here, we need to find the average number of victims at each hospital and the average total transport time needed to transport all the victims. For generating the random numbers, we need to use triangular distribution by importing the package called “EnvStats”. For generating the triangular distribution, function ‘rtri’ is used. This function provides information about the triangular distribution on the logarithmic interval from a to b with a maximum at c. This function is used to generate n random variables. For this project, the minimum number of victims was 20 and the maximum number was 300. We have taken 5000 different simulations/variations in order to perform the analysis. After generating the required simulations, we need to rearrange the simulations according to the victim distribution of the 5 hospitals. For example, in Beth Israel Hospital the allocation of disaster victims is 30% and Tufts Medical is 15%. So, after distribution the average number of victims expected at each hospital is calculated by using the mean () function. By using this function, the average number of victims for each of the hospital is calculated. The following are the average number of victims expected at each hospital:

Sr. No.	**Hospital name**	**Average No. of victims expected**
1	Beth Israel Hospital	40
2	Tufts Medical Hospital	20
3	Massachusetts General Hospital	26
4	Boston Medical Hospital	33
5	Brigham and Women’s Hospital	13

R-code:

```
x <- rtri(5000,20,300,80)
#Displaying the 5000 variables
x
#No. of victims expected at Beth Isarel hospital
bi <- x*0.3
bi
#No. of victims expected at Tufts Medical hospital
tm <- x*0.15
tm
#No. of victims expected at Massachussetts General hospital
mg <- x*0.20
mg
#No. of victims expected at Boston Medical hospital
bm <- x*0.25
bm
#No. of victims expected at Brigham and Women's hospital
bw <- x*0.10
bw
#Calculating the mean of patients at the Beth Isarel Hospital
```

```
mean_bi = mean(bi)
mean_bi
#Calculating the mean of patients at the Tufts Medical Hospital
mean_tm = mean(tm)
mean_tm
#Calculating the mean of patients at the Mass General Hospital
mean_mg = mean(mg)
mean_mg
#Calculating the mean of patients at the Boston Medical Hospital
mean_bm = mean(bm)
mean_bm #Calculating the mean of patients at the Brigham and Women's Hospital
mean_bw = mean(bw)
mean_bw
```

b) Here, we need to find the average total time (in Hours) needed to transport all victims to the hospital. For calculating the average total time needed to transport all the victims, we use the ‘rexp ()’ function. This function provides random generation for exponential distribution with rate. Rate in this case is the inverse of mean (1/mean). We have taken 5000 different simulations/variations in order to perform the analysis. After generating the required simulations, to calculate the time taken to transport victims, the average time given for transportation of one victim is considered as ‘rate’. Thus, the average time taken for one victim transportation to the Beth Israel Hospital is 7 minutes; the rate will be (1/7). And then we sum the outputs of the rexp () functions so as to find out the total average time. By using these two functions, the average time for transportation of the victims for each of the hospital is calculated. The following is the time for transportation of the victims for each of the hospital:

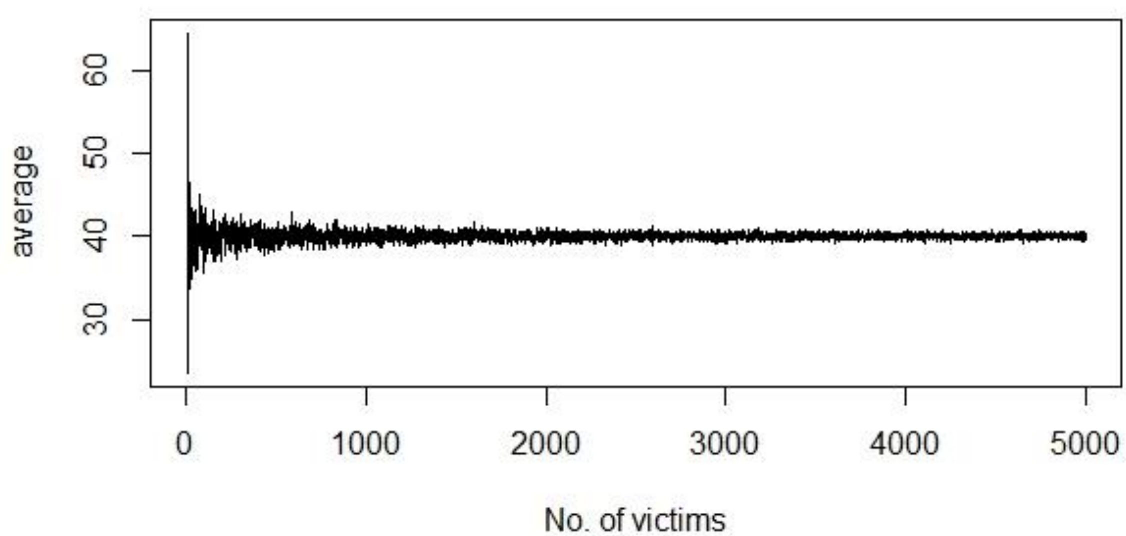
Sr. No.	**Hospital name**	**Total average time for victims transportation**
1	Beth Israel Hospital	4.49
2	Tufts Medical Hospital	1.95
3	Massachusetts General Hospital	3.18
4	Boston Medical Hospital	5.16
5	Brigham and Women’s Hospital	2.08

R-code:

```
#The average total time needed to transport all victims
total_time_bi =sum(rexp(mean_bi[1], 1/7))
total_time_bi <- total_time_bi/60
total_time_bi
#The average total time needed to transport all victims
total_time_tm =sum(rexp( tm[1], 1/10))
total_time_tm <- total_time_tm/60
total_time_tm
#The average total time needed to transport all victims
total_time_mg =sum(rexp( mg[1], 1/15))
total_time_mg <- total_time_mg/60
```

```
total_time_mg
#The average total time needed to transport all victims
total_time_bm =sum(rexp( bm[1], 1/15))
total_time_bm <- total_time_bm/60
total_time_bm
#The average total time needed to transport all victims
total_time_bw =sum(rexp( bw[1], 1/20))
total_time_bw <- total_time_bw/60
total_time_bw
```

c) The law of large numbers, in probability and statistics, states that as a sample size grows, its mean gets closer to the average of the whole population. Thus, in our analysis, we used the law of large numbers to show that the average number of victims at the Beth Israel Hospital will come closer to the mean value as the number of victims increase. As we can see in the graph below, the starting average number of victims is very high. But, as the number increases, the graph gets closer to the mean value of the whole population. Here, we have first sampled the dataset using 'function ()' for 5000 variables and calculated the collective mean. After finding the mean, we have plotted that on a graph. The graph for law of large numbers is as follows:



R-code:

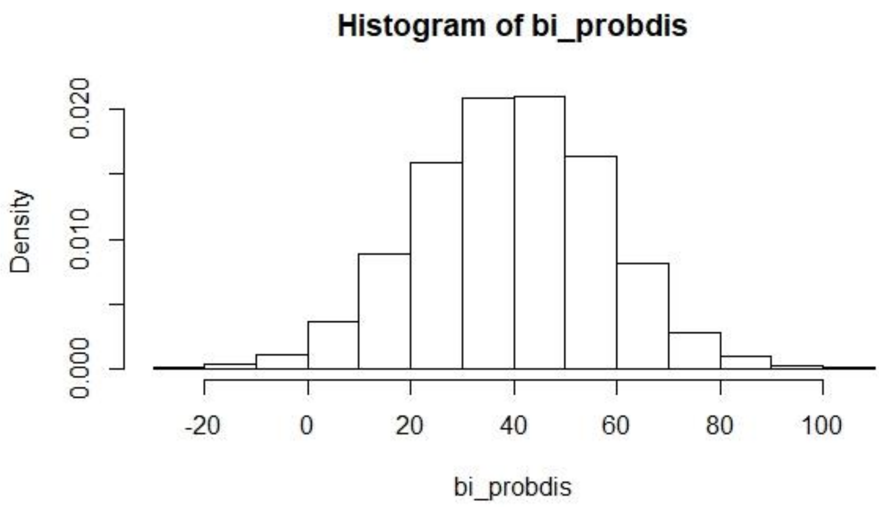
```
#Displaying the law of large nos. chart for Beth Isarel Hospital
bi_ln <- bi
b_avg <- function(n) {
  mean(sample(bi_ln, size = n, replace = TRUE))
}
b_avg
#Plotting for displaying the law of large nos. chart for Beth Isarel Hospital
plot(sapply(1:5000, b_avg), type = "l", xlab = "No. of victims", ylab = "average")
abline(h = 0.2)
```

d) i) A 95% confidence interval is a range of values that you can be 95% certain contains the true mean of the population. The 95% confidence interval defines a range of values that you can be 95% certain contains the population mean. Here, we have calculated the 95% confidence interval using the mean and the standard deviation. That actually gives the 'Expected Value' which is basically the range in which the 95% mean values should fall in. The 95% confidence interval with these values is: 0.07312266 to 1.059088.

R-code:

```
#Calculating the +/- 95% confidence interval  for time taken by a patient for reaching the Beth Isarel Hospital
EV1 = (mean(bi)+1.96*sd(bi))/sqrt(5000)
EV1
EV2 = (mean(bi)-1.96*sd(bi))/sqrt(5000)
EV2
```

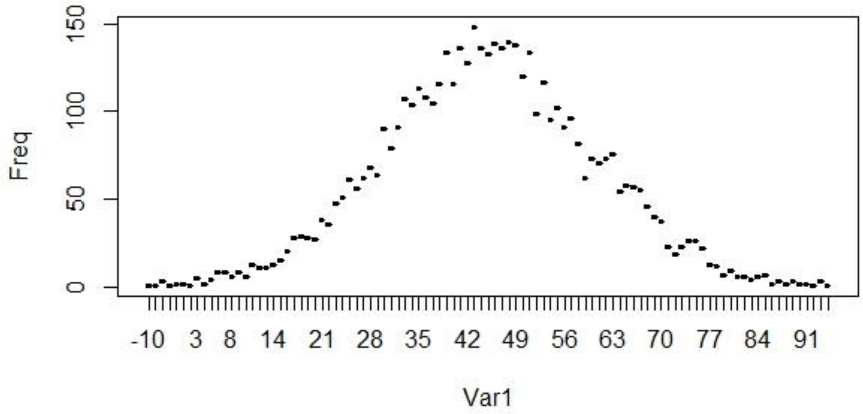
ii) A probability distribution is a statistical function that describes all the possible values and likelihoods that a random variable can take within a given range. Here, the values that fall under the given probability values can be shown in the range of the Beth Israel Hospital time taken for victim transportation.



R-code:

```
#Probability distribution that best fits the total transport time
bi_probdis <- rnorm(5000, mean = mean(bi), sd = sd(bi))
round(bi_probdis)
hist(bi_probdis, prob = TRUE)
```

iii) The frequency distribution of a data variable is a summary of the data occurrence in a collection of non-overlapping categories. Here, the frequency values are the number of occurrences of the events in this simulation. It is a normal distribution plot.



R-Code:

```
#Frequency distribution of the total travel time to and from Beth Isarel Hospital
bi_freqdist <- as.data.frame(table(round(bi_probdis)))
bi_freqdist
plot(bi_freqdist)
```

Chi-Square test in R is a statistical method which used to determine if two categorical variables have a significant correlation between them. The two variables are selected from the same population. Here, the test was conducted between observed and expected values. If the null hypothesis is rejected, it means that the observed value is not equal to the expected value and if the null hypothesis is not rejected, then it means that the observed value is equal to the expected value. Here, the chi-square goodness of fit test is not rejected as all the values are greater than 0.05% significance level.

R-Code:

```
#Performing a Chi-squared Goodness of fit test for the total travel time to and from Beth Isarel Hospital
summary(bi_freqdist)
breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115)
tags <- c("[-25--15)","[-15--5)", "[-5-5)", "[5-15)", "[15-25)", "[25-35)","[35-45)", "[45-55)","[55-65)", "[65-75)", "[75-85)", "[85-95)", "[95-105)", "[105-115)")
group_tags <- cut(bi_freqdist$Freq, breaks=breaks,
                  include.lowest=TRUE,
                  right=FALSE,
                  labels=tags )
summary(group_tags)
chisq.test(table(group_tags), p = c(0,24,19,11,8,7,5,6,4,6,3,11,4)/108)
```

e) In statistics, exploratory data analysis is an approach to analysing data sets to summarize their main characteristics, often with visual methods. A statistical model can be used or not, but primarily EDA is for seeing what the data can tell us beyond the formal modelling or hypothesis testing task.

R-Code:

```
#Assigning the avg total travel time of victims to 't'
t <- total_time_bi
t
#Performing the exploratory data analysis of 't'
#Installing the following Packages
install.packages("tidyverse")
install.packages("funModeling")
install.packages("Hmisc")
#Loading the needed libraries
library(funModeling)
library(tidyverse)
library(Hmisc)
#Printing the status of 't'
print(status(t))
#Calculating the frequency of 't'
freq(t)
#Printing the profiling number of 't'
print(profiling_num(t))
#Describing the variable 't'
describe(t)
```

2.

a) Here, we need to find the average number of victims at each hospital and the average total transport time needed to transport all the victims. For generating the random numbers, we use the 'rnorm' distribution. For generating the random distribution, function 'rnorm' is used. This function provides information about the random distribution on the basis of the mean and the standard deviation that is given. This function is used to generate n random variables. We have taken 5000 different simulations/variations in order to perform the analysis. After generating the required simulations, we need to rearrange the simulations according to the victim distribution of the 5 hospitals. For example, in Beth Israel Hospital the allocation of disaster victims is 30% and Tufts Medical is 15%. So, after distribution the average number of victims expected at each hospital is calculated by using the mean () function. By using this function, the average number of victims for each of the hospital is calculated. The following are the average number of victims expected at each hospital:

Sr. No.	**Hospital name**	**Average No. of victims expected**
1	Beth Israel Hospital	45
2	Tufts Medical Hospital	22
3	Massachusetts General Hospital	30
4	Boston Medical Hospital	37
5	Brigham and Women's Hospital	15

R-Code:

```
#Generating 5000 variables for analysis with mean = 150 and SD=50
m <- rnorm(5000, mean=150, sd=50)
#Displaying the 5000 variables
m
#No. of victims expected at Beth Isarel hospital
bi_m <- m*0.3
bi
#No. of victims expected at Tufts Medical hospital
tm_m <- m*0.15
tm
#No. of victims expected at Massachussetts General hospital
mg_m <- m*0.20
mg
#No. of victims expected at Boston Medical hospital
bm_m <- m*0.25
bm
#No. of victims expected at Brigham and Women's hospital
bw_m <- m*0.10
bw
#Calculating the mean of patients at the Beth Isarel Hospital
mean_bi_m = mean(bi_m)
mean_bi_m
#Calculating the mean of patients at the Tufts Medical Hospital
```

```
mean_tm_m = mean(tm_m)
mean_tm_m
#Calculating the mean of patients at the Mass General Hospital
mean_mg_m = mean(mg_m)
mean_mg_m
#Calculating the mean of patients at the Boston Medical Hospital
mean_bm_m = mean(bm_m)
mean_bm_m
#Calculating the mean of patients at the Brigham and Women's Hospital
mean_bw_m = mean(bw_m)
mean_bw_m
```

b) Here, we need to find the average total time (in Hours) needed to transport all victims to the hospital. For calculating the average total time needed to transport all the victims, we use the 'rexp ()' function. This function provides random generation for exponential distribution with rate. Rate in this case is the inverse of mean (1/mean). We have taken 5000 different simulations/variations in order to perform the analysis. After generating the required simulations, to calculate the time taken to transport victims, the average time given for transportation of one victim is considered as 'rate'. Thus, the average time taken for one victim transportation to the Beth Israel Hospital is 7 minutes; the rate will be (1/7). And then we sum the outputs of the rexp () functions so as to find out the total average time. By using these two functions, the average time for transportation of the victims for each of the hospital is calculated. The following is the time for transportation of the victims for each of the hospital:

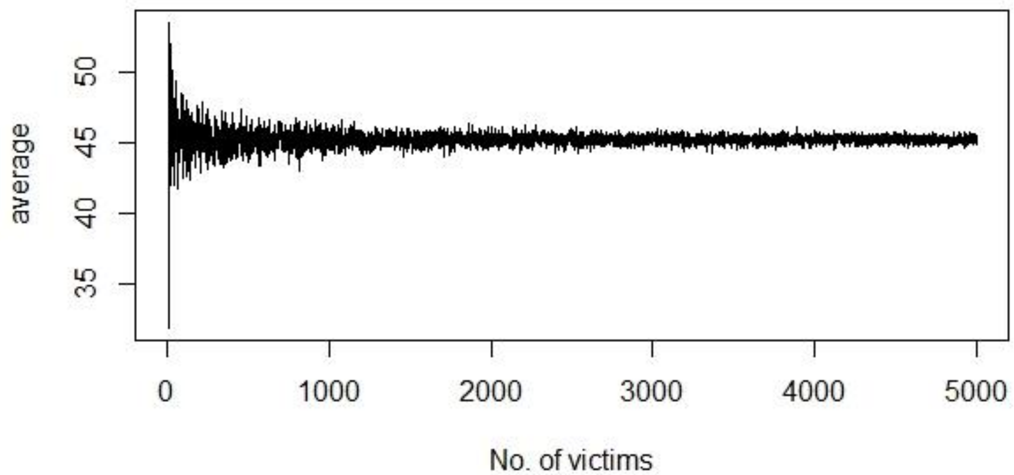
Sr. No.	**Hospital name**	**Total average time for victims transportation**
1	Beth Israel Hospital	6.34
2	Tufts Medical Hospital	4.31
3	Massachusetts General Hospital	9.64
4	Boston Medical Hospital	14.61
5	Brigham and Women's Hospital	4.85

R-Code:

```
#The average total time needed to transport all victims
total_time_bi_m =sum(rexp( bi_m[1], 1/7))
total_time_bi_m <- total_time_bi_m/60
total_time_bi_m
#The average total time needed to transport all victims
total_time_tm_m =sum(rexp( tm_m[1], 1/10))
total_time_tm_m <- total_time_tm_m/60
total_time_tm_m
#The average total time needed to transport all victims
total_time_mg_m =sum(rexp( mg_m[1], 1/15))
total_time_mg_m <- total_time_mg_m/60
total_time_mg_m
#The average total time needed to transport all victims
total_time_bm_m =sum(rexp( bm_m[1], 1/15))
```

```
total_time_bm_m <- total_time_bm_m/60
total_time_bm_m
#The average total time needed to transport all victims
total_time_bw_m =sum(rexp( bw_m[1], 1/20))
total_time_bw_m <- total_time_bw_m/60
total_time_bw_m
```

c) The law of large numbers, in probability and statistics, states that as a sample size grows, its mean gets closer to the average of the whole population. Thus, in our analysis, we used the law of large numbers to show that the average number of victims at the Beth Israel Hospital will come closer to the mean value as the number of victims increase. As we can see in the graph below, the starting average number of victims is very high. But, as the number increases, the graph gets closer to the mean value of the whole population. Here, we have first sampled the dataset using 'function ()' for 5000 variables and calculated the collective mean. After finding the mean, we have plotted that on a graph. The graph for law of large numbers is as follows:



R-Code:

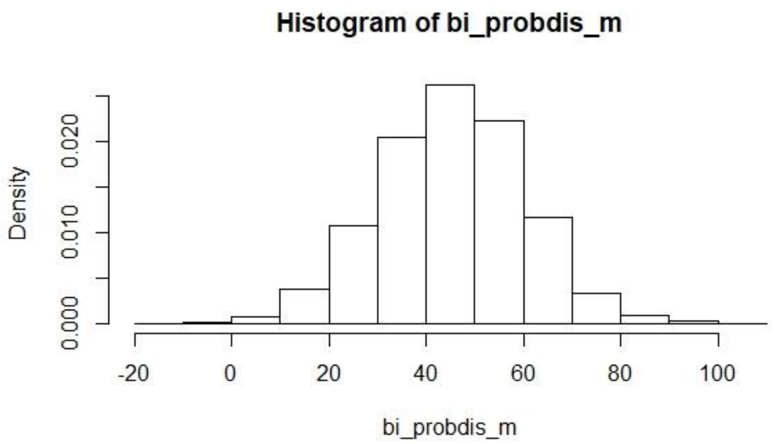
```
#Displaying the law of large nos. chart for Beth Isarel Hospital
bi_ln_m <- bi_m
bi_avg_m <- function(n) {
  mean(sample(bi_ln_m, size = n, replace = TRUE))
}
#Plotting for displaying the law of large nos. chart for Beth Isarel Hospital
plot(sapply(1:5000, bi_avg_m), type = "l", xlab = "No. of victims", ylab = "average")
abline(h = 0.5, col = "red")
```

d) i) A 95% confidence interval is a range of values that you can be 95% certain contains the true mean of the population. The 95% confidence interval defines a range of values that you can be 95% certain contains the population mean. Here, we have calculated the 95% confidence interval using the mean and the standard deviation. That actually gives the ‘Expected Value’ which is basically the range in which the 95% mean values should fall in. The 95% confidence interval with these values is: 0.1459208 to 1.131886.

R-Code:

```
#Calculating the +/- 95% confidence interval  for time taken by a patient for reaching the Beth Isarel Hospital
EV1 = (mean(bi_m)+1.96*sd(bi))/sqrt(5000)
EV1
EV2 = (mean(bi_m)-1.96*sd(bi))/sqrt(5000)
EV2
```

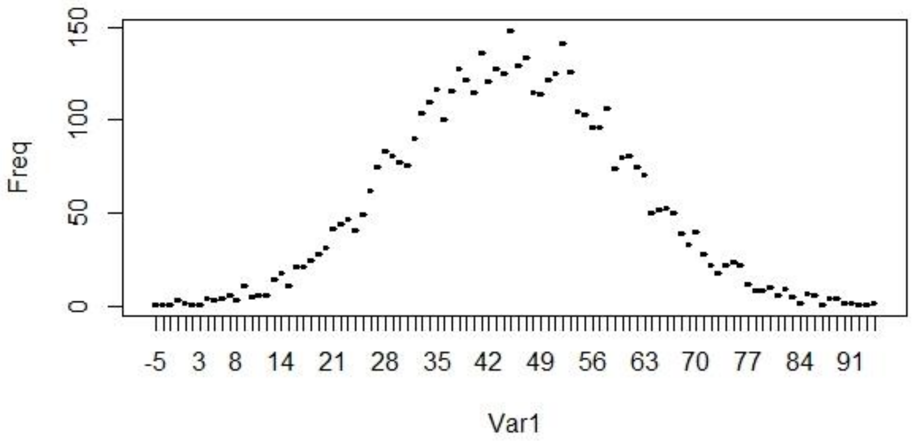
ii) A probability distribution is a statistical function that describes all the possible values and likelihoods that a random variable can take within a given range. Here, the values that fall under the given probability values can be shown in the range of the Beth Israel Hospital time taken for victim transportation.



R-Code:

```
#Probability distribution that best fits the total transport time
bi_probdis_m <- rnorm(5000, mean = mean(bi_m), sd = sd(bi_m))
round(bi_probdis_m)
hist(bi_probdis_m, prob = TRUE)
```

iii) The frequency distribution of a data variable is a summary of the data occurrence in a collection of non-overlapping categories. Here, the frequency values are the number of occurrences of the events in this simulation. It is a normal distribution plot.



R-Code:

```
#Frequency distribution of the total travel time to and from Beth Isarel Hospital
bi_freqdist_m <- as.data.frame(table(round(bi_probdis_m)))
bi_freqdist_m
plot(bi_freqdist_m)
```

Chi-Square test in R is a statistical method which used to determine if two categorical variables have a significant correlation between them. The two variables are selected from the same population. Here, the test was conducted between observed and expected values. If the null hypothesis is rejected, it means that the observed value is not equal to the expected value and if the null hypothesis is not rejected, then it means that the observed value is equal to the expected value. Here, the chi-square goodness of fit test is not rejected as all the values are greater than 0.05% significance level.

R-Code:

```
#Performing a Chi-squared Goodness of fit test for the total travel time to and from Beth Isarel Hospital
summary(bi_freqdist_m)
breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115)
tags <- c("[-25--15)","[-15--5)", "[-5-5)", "[5-15)", "[15-25)", "[25-35)","[35-45)", "[45-55)","[55-65)", "[65-75)", "[75-85)", "[85-95)", "[95-105)", "[105-115)")
group_tags_m <- cut(bi_freqdist_m$Freq, breaks=breaks,
        include.lowest=TRUE,
        right=FALSE,
        labels=tags )
summary(group_tags_m)
chisq.test(table(group_tags_m), p = c(19,18,6,6,15,4,4,8,4,3,3,5,4)/99)
```

e) In statistics, exploratory data analysis is an approach to analysing data sets to summarize their main characteristics, often with visual methods. A statistical model can be used or not, but primarily EDA is for seeing what the data can tell us beyond the formal modelling or hypothesis testing task.

R-Code:

```
#Assigning the avg total travel time of victims to 't_m'
t_m <- total_time_bi_m
t_m
#Printing the status of 't_m'
print(status(t_m))
#Calculating the frequency of 't_m'
freq(t_m)
#Printing the profiling number of 't_m'
print(profiling_num(t_m))
#Describing the variable 't_m'
describe(t_m)
```

3. In the above simulations, we have taken the liberty to generate random variables based on the data characteristics like probability, mean, standard deviation, etc. provided. This was done because we did not have any past data to consider. We started by using the triangular distribution to generate 5000 random variables as we had the maximum, minimum and peak values of the victims that need to be handled. Then, we generated 5000 random variables for each individual hospital based on the probabilities given. Using this data, we found the average number of victims expected at each hospital. This was done using the empirical mean method. Then, to determine the average total time required to transport the victims to the hospitals was calculated by summing exponential values of those 5000 random variables. This was done using the rexp () function. The average time given for each hospital was taken as mean which is equal to lambda. The inverse of lambda is taken as rate which is used to calculate the exponential values. And to convert the output in hours, it was divided by 60. The law of large numbers was checked by plotting a scattered plot to check the difference between the observed values and the expected values. Basically, this was done to check that the values we are considering; is their average coinciding with the theoretical values. After this, we conducted an exploratory data analysis of the total transport time. For this, we calculated a 95% confidence interval to check the range of values. It was found that maximum values fall in the confidence interval calculated. The, we determined the probability distribution using the ‘rnorm’ function and the mean and the standard deviation, which was normal (normal distribution). To support this, we created a frequency distribution which was normally distributed

and then the chi squared Goodness of fit test. The chi squared Goodness of fit test was performed to check the correlation between the frequency and variables.

4. Major qualitative and quantitative differences in simulations (1) and (2) include
    - Using triangular distribution method to generate random variables in (1) and using ‘rnorm’ function to generate random variables in (2).
    - Maximum, minimum and peak values are given in (1) whereas the mean and the standard deviation are given in (2).
    - Using these two major differences in the inputs given, the output did not vary much. But, since it is a simulation and even a single number deviation can make a lot of difference, we can say that simulation (1) gives us values which are less as compared to simulation (2).
    - The law of large numbers for both the simulations are similar; they only vary on the average (y-axis). This means that simulation (1) has a lower average as compared to simulation (2).
    - The average total transport time in simulation (1) is lower as compared to the average total transport time in simulation (2) and that is because simulation (1) depends on the triangular distribution whereas simulation (2) depends on normal distribution.

5. All the outputs/outcomes from the above simulations can be used to design a system that can be used at a time of natural calamity, human errors leading to accidents and much more that can go wrong at the campus. According to the simulation above, it will take around 7 minutes for one victim to reach the nearest hospital, i.e. - Beth Israel Hospital and another 10 minutes to reach the second nearest hospital. Now, all of this depends on a lot of external factors like weather, type of calamity or accident, etc. We also know that the university campus is huge in terms if area and we need to also look at where exactly in the campus the accident or calamity has taken place. If the calamity has taken place at the south end, then we can find a nearer hospital in case the nearest hospital mentioned in the list is near from an another part of the university.
   After analysis, the average total time taken for all the victims to reach the nearest hospital is significantly high and during a calamity, this can lead to a lot of issues where the victim number is very high. After the analysis is done, there are few places where there is still a place for

improvement. The places where we can improve in case of a calamity are number of ambulances used; adding of more beds/increasing the capacity of the number of victims that can be accommodated; type of calamity – fire, accident, pandemic, storm, excess rainfall, etc. The campus has to be ready to counter any and every problem that may arise due to any of the above listed reasons.

After the simulation, we know that average number of victims that can be allotted to each hospital. We can speak to them in advance and try and block some extra number of beds exclusively for our campus whenever needed. This also gives us the foresight to work on our health insurance policies. If it is third-party insurance, then we know how fast we need to act so as to give the victims the right type of coverage and treatment without worrying about the expenses and other external factors.

6. We have done simulations to predict how many average victims are expected at each hospital in the list and the average total time required for the victims to reach the hospitals. These simulations were conducted on the basis of mean values and not real – world values. Even if we consider 5000 simulations or variations, the deviation by a small factor also might make a lot of difference during a calamity. If we change the simulation to find the exact number of victims expected at each hospital, we can determine the exact amount of preparation to be done by each hospital in order to accommodate those numbers of victims. This simulation can further be changed and used to determine which victim has to be sent to which hospital based on the best service and treatment that they offer or specialize in. Say for example, a fire burnt victim can be sent to Boston Medical as they are experts in handling cases like these whereas a victim who has suffered a physical accident on campus will have to be sent to a different hospital in which they particularly specialize in.

   We have also undertaken a simulation to find the average total time to transport the victims from the campus to the hospital in case of a calamity using two ambulances. With this simulation, we are able to determine the need or necessity of transport vehicles for the victims to considerably reduce the transfer time of a victim from the campus to the hospital. Here, we have only considered that the hospital has 2 ambulances, but by knowing the number of victims to be transported or transferred to the particular hospital in advance, we can arrange for some extra that can considerably reduce the transport time of the victims.

   Since we have the expertise of each hospital and also the average total time needed to transport the victims, we can coordinate with the hospital for a particular injury that they specialize in and inform them to be ready for some extra patients and need for some extra transport vehicles like ambulances. This will considerably reduce the transport time and increase the chances of the victim receiving the best treatment possible for a particular injury.

References:

1. https://thesystemsthinker.com/why-simulate-using-models-for-strategic-planning/
2. https://www.probabilitycourse.com/chapter4/4_2_2_exponential.php
3.

- R Code:

```
#ALY6050 Week 2 Project_DHRUV VIJAY GUJRATHI
#Part 1
#Installing EnvStats Package
install.packages("EnvStats")
#Loading library EnvStats
library(EnvStats)
#Generating 5000 variables for analysis lying between the triangulation variables
x <- rtri(5000,20,300,80)
#Displaying the 5000 variables
x
#No. of victims expected at Beth Isarel hospital
bi <- x*0.3
bi
#No. of victims expected at Tufts Medical hospital
tm <- x*0.15
tm
#No. of victims expected at Massachussetts General hospital
mg <- x*0.20
mg
#No. of victims expected at Boston Medical hospital
bm <- x*0.25
bm
#No. of victims expected at Brigham and Women's hospital
bw <- x*0.10
bw
#Calculating the mean of patients at the Beth Isarel Hospital
mean_bi = mean(bi)
mean_bi
#Calculating the mean of patients at the Tufts Medical Hospital
mean_tm = mean(tm)
mean_tm
#Calculating the mean of patients at the Mass General Hospital
mean_mg = mean(mg)
mean_mg
#Calculating the mean of patients at the Boston Medical Hospital
mean_bm = mean(bm)
mean_bm
#Calculating the mean of patients at the Brigham and Women's Hospital
mean_bw = mean(bw)
```

```
mean_bw
rexp#The average total time needed to transport all victims
total_time_bi =sum(rexp(mean_bi[1], 1/7))
total_time_bi <- total_time_bi/60
total_time_bi
#The average total time needed to transport all victims
total_time_tm =sum(rexp( tm[1], 1/10))
total_time_tm <- total_time_tm/60
total_time_tm
#The average total time needed to transport all victims
total_time_mg =sum(rexp( mg[1], 1/15))
total_time_mg <- total_time_mg/60
total_time_mg
#The average total time needed to transport all victims
total_time_bm =sum(rexp( bm[1], 1/15))
total_time_bm <- total_time_bm/60
total_time_bm
#The average total time needed to transport all victims
total_time_bw =sum(rexp( bw[1], 1/20))
total_time_bw <- total_time_bw/60
total_time_bw
#Displaying the law of large nos. chart for Beth Isarel Hospital
bi_ln <- bi
b_avg <- function(n) {
  mean(sample(bi_ln, size = n, replace = TRUE))
}
b_avg
#Plotting for displaying the law of large nos. chart for Beth Isarel Hospital
plot(sapply(1:5000, b_avg), type = "l", xlab = "No. of victims", ylab =
     "average")
abline(h = 0.2)
#Calculating the +/- 95% confidence interval  for time taken by a patient
     for reaching the Beth Isarel Hospital
EV1 = (mean(bi)+1.96*sd(bi))/sqrt(5000)
EV1
EV2 = (mean(bi)-1.96*sd(bi))/sqrt(5000)
EV2
#Probability distribution that best fits the total transport time
bi_probdis <- rnorm(5000, mean = mean(bi), sd = sd(bi))
round(bi_probdis)
hist(bi_probdis, prob = TRUE)
#Frequency distribution of the total travel time to and from Beth Isarel
     Hospital
```

```
bi_freqdist <- as.data.frame(table(round(bi_probdis)))
bi_freqdist
plot(bi_freqdist)
#Performing a Chi-squared Goodness of fit test for the total travel time to
    and from Beth Isarel Hospital
summary(bi_freqdist)
breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115)
tags  <-  c("[-25--15)","[-15--5)",  "[-5-5)",  "[5-15)",  "[15-25)",  "[25-
    35)","[35-45)",  "[45-55)","[55-65)",  "[65-75)",  "[75-85)",  "[85-95)",
    "[95-105)", "[105-115)")
group_tags <- cut(bi_freqdist$Freq, breaks=breaks,
                  include.lowest=TRUE,
                  right=FALSE,
                  labels=tags )
summary(group_tags)
chisq.test(table(group_tags), p = c(0,24,19,11,8,7,5,6,4,6,3,11,4)/108)
#Assigning the avg total travel time of victims to 't'
t <- total_time_bi
t
#Performing the exploratory data analysis of 't'
#Installing the following Packages
install.packages("tidyverse")
install.packages("funModeling")
install.packages("Hmisc")
#Loading the needed libraries
library(funModeling)
library(tidyverse)
library(Hmisc)
#Printing the status of 't'
print(status(t))
#Calculating the frequency of 't'
freq(t)
#Printing the profiling number of 't'
print(profiling_num(t))
#Describing the variable 't'
describe(t)

#Part 2
#Generating 5000 variables for analysis with mean = 150 and SD=50
m <- rnorm(5000, mean=150, sd=50)
#Displaying the 5000 variables
m
#No. of victims expected at Beth Isarel hospital
```

```
bi_m <- m*0.3
bi
#No. of victims expected at Tufts Medical hospital
tm_m <- m*0.15
tm
#No. of victims expected at Massachussetts General hospital
mg_m <- m*0.20
mg
#No. of victims expected at Boston Medical hospital
bm_m <- m*0.25
bm
#No. of victims expected at Brigham and Women's hospital
bw_m <- m*0.10
bw
#Calculating the mean of patients at the Beth Isarel Hospital
mean_bi_m = mean(bi_m)
mean_bi_m
#Calculating the mean of patients at the Tufts Medical Hospital
mean_tm_m = mean(tm_m)
mean_tm_m
#Calculating the mean of patients at the Mass General Hospital
mean_mg_m = mean(mg_m)
mean_mg_m
#Calculating the mean of patients at the Boston Medical Hospital
mean_bm_m = mean(bm_m)
mean_bm_m
#Calculating the mean of patients at the Brigham and Women's Hospital
mean_bw_m = mean(bw_m)
mean_bw_m
#The average total time needed to transport all victims
total_time_bi_m =sum(rexp( bi_m[1], 1/7))
total_time_bi_m <- total_time_bi_m/60
total_time_bi_m
#The average total time needed to transport all victims
total_time_tm_m =sum(rexp( tm_m[1], 1/10))
total_time_tm_m <- total_time_tm_m/60
total_time_tm_m
#The average total time needed to transport all victims
total_time_mg_m =sum(rexp( mg_m[1], 1/15))
total_time_mg_m <- total_time_mg_m/60
total_time_mg_m
#The average total time needed to transport all victims
total_time_bm_m =sum(rexp( bm_m[1], 1/15))
```

```
total_time_bm_m <- total_time_bm_m/60
total_time_bm_m
#The average total time needed to transport all victims
total_time_bw_m =sum(rexp( bw_m[1], 1/20))
total_time_bw_m <- total_time_bw_m/60
total_time_bw_m
#Displaying the law of large nos. chart for Beth Isarel Hospital
bi_ln_m <- bi_m
bi_avg_m <- function(n) {
  mean(sample(bi_ln_m, size = n, replace = TRUE))
}
#Plotting for displaying the law of large nos. chart for Beth Isarel Hospital
plot(sapply(1:5000, bi_avg_m), type = "l", xlab = "No. of victims", ylab =
    "average")
abline(h = 0.5, col = "red")

#Calculating the +/- 95% confidence interval  for time taken by a patient
    for reaching the Beth Isarel Hospital
EV1 = (mean(bi_m)+1.96*sd(bi))/sqrt(5000)
EV1
EV2 = (mean(bi_m)-1.96*sd(bi))/sqrt(5000)
EV2
#Probability distribution that best fits the total transport time
bi_probdis_m <- rnorm(5000, mean = mean(bi_m), sd = sd(bi_m))
round(bi_probdis_m)
hist(bi_probdis_m, prob = TRUE)
#Frequency distribution of the total travel time to and from Beth Isarel
    Hospital
bi_freqdist_m <- as.data.frame(table(round(bi_probdis_m)))
bi_freqdist_m
plot(bi_freqdist_m)
#Performing a Chi-squared Goodness of fit test for the total travel time to
    and from Beth Isarel Hospital
summary(bi_freqdist_m)
breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115)
tags <- c("[-25--15)","[-15--5)", "[-5-5)", "[5-15)", "[15-25)", "[25-
    35)","[35-45)", "[45-55)","[55-65)", "[65-75)", "[75-85)", "[85-95)",
    "[95-105)", "[105-115)")
group_tags_m <- cut(bi_freqdist_m$Freq, breaks=breaks,
                include.lowest=TRUE,
                right=FALSE,
                labels=tags )
summary(group_tags_m)
```

chisq.test(table(group_tags_m), p = c(19,18,6,6,15,4,4,8,4,3,3,5,4)/99)

#Assigning the avg total travel time of victims to 't_m'
t_m <- total_time_bi_m
t_m
#Printing the status of 't_m'
print(status(t_m))
#Calculating the frequency of 't_m'
freq(t_m)
#Printing the profiling number of 't_m'
print(profiling_num(t_m))
#Describing the variable 't_m'
describe(t_m)

OUTPUT:

```
> #ALY6050 Week 2 Project_DHRUV VIJAY GUJRATHI
> #Part 1
> #Installing EnvStats Package
> install.packages("EnvStats")
> #Loading library EnvStats
> library(EnvStats)
> #Generating 5000 variables for analysis lying between the triangulation
variables
> x <- rtri(5000,20,300,80)
> #Displaying the 5000 variables
> x
   [1]  99.70750  88.42988  96.11481 148.23712 134.63520 190.73466  30.456
90
   [8] 157.46504  87.32802 183.57760 175.98834 120.23458 146.05138 247.032
01
  [15] 191.86559  66.32022  85.44739 105.27765  79.07189 192.31716 179.621
66
  [22]  63.82891  74.83886 164.63228 163.18588 247.40667 214.14944 138.093
26
  [29] 151.61166  66.33828 125.51001  31.70998  73.95298 139.90062 127.367
45
  [36] 135.96754  74.74595  89.26897 112.07082 102.29234  73.42593  74.400
10
  [43] 240.04955  81.35130  84.28730 141.45866 143.85401 189.74385 109.105
31
  [50]  91.59041 193.65764  58.69096  65.31536  92.31345 113.28049  53.897
83
  [57] 103.90160 217.14439  69.67854 241.50803 214.82628 160.17751 286.177
36
  [64]  49.38371  35.08130  99.62652 120.58216 216.18724  68.38628 198.626
20
  [71] 106.70073 194.33425 158.67985 224.43288 172.30636 168.10896  87.284
34
  [78] 119.29620 171.24344 109.47375 223.55509 197.12659 156.93178 150.640
34
  [85] 213.87323  59.11424 205.02889 108.33107 139.49484 101.51871  90.773
16
  [92] 153.68373 201.64125 156.37325 100.14204  72.34953 126.18139 106.047
07
  [99] 173.91532 107.44742  46.33958  92.44859 110.36423 116.34821 223.453
92
 [106] 144.42385 201.64614 157.86986 118.44732 181.05825 130.52251  62.042
74
```

```
 [113]  41.00899  81.07844 129.40487  67.28423 136.71954  51.70654  45.044
36
 [120] 134.83279  67.42354 263.62861 258.57960 148.61843 187.95644  96.921
35
 [127] 137.79963  62.37437 152.31413 122.08794 105.56145 116.82097 278.052
38
 [134] 140.59324  97.56292 203.04683 157.69542 146.42953 177.07605 131.185
73
 [141] 155.93773 100.20776 132.64957 151.71906 235.87790 148.24116 209.853
43
 [148] 104.09128 244.34160 216.59417  97.89117 170.27726 170.36540 146.974
66
 [155] 216.50240 112.57086 136.84696  80.85538 132.89818 245.58319  85.925
54
 [162]  85.69678 107.88999  53.31477 168.71438  92.55851 114.98316 180.133
50
 [169] 105.00515  80.59216 184.43953 138.21428 167.48606 169.59937  96.576
13
 [176]  81.62915 128.83223  61.77388  21.37014 145.08101 197.49371 132.423
10
 [183] 120.86966 162.26456 164.44902 170.58594  98.79757 177.16243 237.399
95
 [190] 127.76959 168.91486 183.29997 166.27287  90.28181  78.55818 239.211
82
 [197]  68.77758 192.04021  77.56862 124.35930 162.48757 111.32187  94.374
17
 [204] 225.87394 178.83236 105.75829  56.99944  62.02832 132.36907  62.851
11
 [211]  73.25799 189.12519 240.05986  43.95967 234.51685  72.66443 101.154
08
 [218] 185.62563  51.42236  63.33109 151.24923 184.39141 103.72221 252.288
33
 [225] 158.80238 194.30571 100.91039  60.07189 261.92106  91.60661 239.119
15
 [232]  43.57597 113.05965 124.73053  85.49909  52.16569 106.43894  60.963
60
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00
 [246] 191.33762 112.92775 108.79922 256.30471 251.43855  82.74698 170.950
52
 [253] 229.23376 111.93025 189.82437 136.29579 115.67552 113.80878 198.306
83
 [260] 212.18642 112.27621 223.67159  74.03158 169.38807  91.45864  67.957
87
 [267] 123.45573 285.96768  70.68520  62.64415  77.68288  73.44143 168.576
42
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34
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70
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72
 [295] 119.19862 210.21514 152.89433 236.75419  79.08438 136.08244 122.522
00
 [302] 233.10816  93.57856  26.32600 127.40227 197.33678  95.77801 117.176
81
 [309]  61.91102 135.49588 234.64607 241.72765  87.26716 141.33404  67.224
70
 [316] 121.54850 161.39969 219.36827  89.07528 257.88324 121.07143 182.382
93
 [323] 142.46929 125.46406 121.14174  95.93617  31.97768 166.10940 251.134
22
 [330] 128.10401 133.92878  67.35457  35.21982 235.44879  61.83672 137.319
07
 [337] 111.32808  91.03692 154.10762  56.45424 252.57352 162.05891  67.969
59
 [344] 244.67351 255.11845  78.30591 162.83098 205.11560 208.26954  34.111
38
```

```
 [351] 114.25910 121.18449 175.57141  40.62864  71.69715 140.97210 130.257
35
 [358] 132.59924  71.11066 102.22231 166.58771  60.82979 159.03505 104.686
18
 [365]  89.43305 107.68311 159.22052 158.85210 117.70997  81.86752 198.269
17
 [372]  81.92624 184.60607  61.67573 108.69752 205.98481 125.61853 245.530
08
 [379] 109.21545 172.98110 114.46607 237.02046 109.37387 221.31813 149.407
49
 [386] 125.88308 124.42185 256.28130  99.35642  85.04917  84.77904  28.829
20
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83
 [400] 126.39841  78.83953  81.34826 192.88977  54.44983 153.85947  81.434
97
 [407]  64.47480 259.58820 149.96059 108.43967  72.27091 190.13220  93.445
26
 [414] 134.59778 149.22390 181.33231  44.23680 213.48458 252.96662 151.433
13
 [421] 149.02399 187.75558 151.77344 116.57902  69.35484 182.48290 132.550
20
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92
 [435]  57.43336 173.21025  78.32497  81.04053 172.74590 150.37346 110.916
94
 [442] 111.19467  80.32038 131.07595 123.67082  97.94130 100.45868  66.293
53
 [449] 219.69539 128.20635  41.83613 154.79153 209.65233  90.38151 143.504
15
 [456] 192.95797 169.76059  72.62584 126.06493  92.55808 142.51472  98.284
24
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47
 [470] 130.82884 146.76506 187.46486 189.39978  89.28799 108.56904 100.366
87
 [477] 203.85603 111.66582 192.87192 147.00176  39.76962  50.25665  35.067
50
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12
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27
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75
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03
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91
 [533] 183.81662 199.09932 282.62398 119.87171 121.76730 162.72498 247.957
02
 [540]  51.25693  94.75019 180.31320 285.11624  41.34520 103.16197 245.846
94
 [547]  72.43852 118.62136  82.33777  68.56874  61.39662 137.33090 193.307
37
 [554] 247.28520 274.13138 162.16286 109.31879 130.48754 178.16139  92.939
17
 [561] 135.36906 113.01908 110.31876 186.06995 215.89739 158.52564 212.336
67
 [568] 284.96733  76.97504 132.61684 102.87307 132.99499 182.61325 245.968
86
 [575] 143.16347  79.39253 219.59174 162.99612 122.36185  74.72427  87.738
66
 [582]  98.27053  72.24227 103.08044 241.22306 227.06602 234.74979 279.300
65
```

```
 [589]  97.03601 280.67521  87.53838 110.89342 155.64073 118.23064  72.716
42
 [596] 138.25138 129.16399 128.49080  85.68924 125.42011 174.81296  66.384
79
 [603]  26.62506 136.40829 159.41897  29.47058  51.85154 129.91103  86.936
56
 [610] 169.47652 127.32621 108.48278 122.52789  76.57018 124.61176 262.111
22
 [617]  44.92165 117.25365  69.92851 135.92117 190.36053 122.59204 192.407
02
 [624] 256.28805 178.13065  54.15827 160.80931 149.29978  98.43619  56.650
59
 [631] 154.55973 103.31249  85.82280 248.20683 106.89350  78.05972 205.169
03
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26
 [645] 151.00354 294.28435  75.27996 175.04690 147.27720  57.45971 214.623
76
 [652] 114.96162 251.04839 163.80185  91.56655 160.58017 136.37688 121.260
10
 [659]  72.96996  62.68616  84.71084 204.77649  61.46186  44.26835 103.007
76
 [666] 141.15351 174.86716 258.62097 268.47457 139.35128 107.79613 161.670
61
 [673] 174.27976 193.19386  86.14367 138.68781  80.68291 183.85892  65.040
93
 [680]  92.53670 161.20575  81.29486  57.48090 174.79041 151.60436 122.930
34
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88
 [694] 231.46974  68.86171 279.81483  90.54360  97.44878 128.34064  95.289
09
 [701] 139.82407 185.05898  92.69319  98.34786  80.62331 178.79832 123.833
00
 [708] 167.31586  50.17364  61.33410  41.80812  62.41113 199.55202  79.074
67
 [715] 122.74636 121.77922 233.35841 117.86976 102.99889  74.56144  80.292
65
 [722] 183.45584 194.81173 175.90026  71.28519 274.45520  97.53978 234.730
67
 [729] 190.46155 217.26348 148.20804 150.71044  79.69069 140.28457 115.124
09
 [736] 127.36210 118.69086 195.67592 143.00897 222.78353 150.79232 236.186
89
 [743] 101.45358 228.63031  83.01296  77.14073 135.94928 204.63950  53.884
86
 [750] 142.62827  90.28767 224.55486 109.07386  94.38254  50.24267 193.165
72
 [757] 227.07687  61.60498  99.90346 139.93306 166.18644 203.31055  62.366
96
 [764] 120.70746 103.65415  72.87211  77.75052  97.21245 182.64796  96.522
58
 [771] 114.42230 231.68373 219.59301 143.70958 189.09945  70.64185  94.589
27
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64
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25
 [792]  90.01856 159.81370 126.74035  64.73628  87.44457  36.56338 130.262
09
 [799] 139.26129 176.10296  42.43508  65.24342  55.11180  83.21430 222.444
39
 [806] 238.24812 164.61440 120.06690 266.93696 162.16330  94.89828 289.951
28
 [813] 214.23643 105.73941 134.36465  99.43049 189.65133  96.03178 145.662
56
 [820]  96.35671 123.59911 237.35859  48.46824 163.25739  85.23101 219.382
27
```

```
 [827] 106.10119 117.17990 107.20216 248.92765  52.55600  55.65209 130.043
41
 [834] 143.21213 106.67823 150.27724  79.63954  60.42073 188.04402  61.907
20
 [841] 135.90720  85.82836 104.80219  81.07434 209.08459 158.66109  91.044
42
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36
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91
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44
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99
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12
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28
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99
 [939] 200.53224 119.66033 101.43246 243.83454  76.35140  32.84702 146.836
93
 [946]  62.79507 151.24976 129.05792 111.61651 134.10037 206.63347 216.792
97
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 [ reached getOption("max.print") -- omitted 4000 entries ]
> #Calculating the mean of patients at the Beth Isarel Hospital
> mean_bi = mean(bi)
> mean_bi
[1] 39.98613
> #Calculating the mean of patients at the Tufts Medical Hospital
> mean_tm = mean(tm)
> mean_tm
```

```
[1] 19.99306
> #Calculating the mean of patients at the Mass General Hospital
> mean_mg = mean(mg)
> mean_mg
[1] 26.65742
> #Calculating the mean of patients at the Boston Medical Hospital
> mean_bm = mean(bm)
> mean_bm
[1] 33.32177
> #Calculating the mean of patients at the Brigham and Women's Hospital
> mean_bw = mean(bw)
> mean_bw
[1] 13.32871
> #The average total time needed to transport all victims
> total_time_bi =sum(rexp(mean_bi[1], 1/7))
> total_time_bi <- total_time_bi/60
> total_time_bi
[1] 4.384823
> #The average total time needed to transport all victims
> total_time_tm =sum(rexp( tm[1], 1/10))
> total_time_tm <- total_time_tm/60
> total_time_tm
[1] 1.497335
> #The average total time needed to transport all victims
> total_time_mg =sum(rexp( mg[1], 1/15))
> total_time_mg <- total_time_mg/60
> total_time_mg
[1] 3.828335
> #The average total time needed to transport all victims
> total_time_bm =sum(rexp( bm[1], 1/15))
> total_time_bm <- total_time_bm/60
> total_time_bm
[1] 4.487945
> #The average total time needed to transport all victims
> total_time_bw =sum(rexp( bw[1], 1/20))
> total_time_bw <- total_time_bw/60
> total_time_bw
[1] 3.666831
> #Displaying the law of large nos. chart for Beth Isarel Hospital
> bi_ln <- bi
> b_avg <- function(n) {
+   mean(sample(bi_ln, size = n, replace = TRUE))
+ }
> b_avg
function(n) {
  mean(sample(bi_ln, size = n, replace = TRUE))
}
> #Plotting for displaying the law of large nos. chart for Beth Isarel Hos
pital
> plot(sapply(1:5000, b_avg), type = "l", xlab = "No. of victims", ylab =
"average")
> abline(h = 0.2)
> #Calculating the +/- 95% confidence interval  for time taken by a patien
t for reaching the Beth Isarel Hospital
> EV1 = (mean(bi)+1.96*sd(bi))/sqrt(5000)
> EV1
[1] 1.06512
> EV2 = (mean(bi)-1.96*sd(bi))/sqrt(5000)
> EV2
[1] 0.06585834
> #Probability distribution that best fits the total transport time
> bi_probdis <- rnorm(5000, mean = mean(bi), sd = sd(bi))
> round(bi_probdis)
   [1]  29  32  25  55  65  49  41  40  76  48  22  44  38  42  24  39  68
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2  30
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50  74
 [989]  46  39  48  50  25  55  42  20  63  66  33  45
 [ reached getOption("max.print") -- omitted 4000 entries ]
> hist(bi_probdis, prob = TRUE)
> #Frequency distribution of the total travel time to and from Beth Isarel
Hospital
> bi_freqdist <- as.data.frame(table(round(bi_probdis)))
> bi_freqdist
    Var1 Freq
1    -32    1
2    -26    1
3    -17    2
4    -16    1
5    -15    3
6    -13    1
7    -12    2
8    -11    2
9    -10    2
10    -9    1
11    -8    3
12    -7    1
13    -6    1
14    -5    9
15    -4    6
16    -3    5
17    -2    5
18    -1   10
19     0    3
20     1    5
21     2   10
22     3    9
23     4   17
24     5   13
25     6   18
26     7   16
27     8   23
28     9   28
29    10   32
30    11   27
31    12   30
```

32	13	30
33	14	36
34	15	43
35	16	44
36	17	43
37	18	52
38	19	54
39	20	56
40	21	63
41	22	59
42	23	74
43	24	68
44	25	90
45	26	86
46	27	85
47	28	109
48	29	67
49	30	99
50	31	108
51	32	124
52	33	123
53	34	104
54	35	97
55	36	109
56	37	112
57	38	102
58	39	108
59	40	125
60	41	113
61	42	112
62	43	98
63	44	118
64	45	108
65	46	110
66	47	114
67	48	103
68	49	92
69	50	84
70	51	90
71	52	86
72	53	89
73	54	74
74	55	81
75	56	64
76	57	71
77	58	63
78	59	63
79	60	47
80	61	51
81	62	56
82	63	47
83	64	50
84	65	47
85	66	41
86	67	39
87	68	30
88	69	38
89	70	28
90	71	34
91	72	22
92	73	24
93	74	17
94	75	28
95	76	14
96	77	17
97	78	10
98	79	6
99	80	8
100	81	9

```
101   82    7
102   83    6
103   84    2
104   85    3
105   86    4
106   87    2
107   88    3
108   89    3
109   90    3
110   91    5
111   92    3
112   93    3
113   94    2
114  108    1
> plot(bi_freqdist)
> #Performing a Chi-squared Goodness of fit test for the total travel time
to and from Beth Isarel Hospital
> summary(bi_freqdist)
      Var1          Freq
 -32    :  1   Min.   :  1.00
 -26    :  1   1st Qu.:  5.25
 -17    :  1   Median : 31.00
 -16    :  1   Mean   : 43.86
 -15    :  1   3rd Qu.: 79.25
 -13    :  1   Max.   :125.00
 (Other):108
> breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 11
5)
> tags <- c("[-25--15)","[-15--5)", "[-5-5)", "[5-15)", "[15-25)", "[25-35
)","[35-45)", "[45-55)","[55-65)", "[65-75)", "[75-85)", "[85-95)", "[95-1
05)", "[105-115)")
> group_tags <- cut(bi_freqdist$Freq, breaks=breaks,
+                   include.lowest=TRUE,
+                   right=FALSE,
+                   labels=tags )
> summary(group_tags)
[-25--15)  [-15--5)    [-5-5)    [5-15)   [15-25)   [25-35)   [35-45)   [4
5-55)
        0         0        25        17         8         9         7
7
  [55-65)   [65-75)   [75-85)   [85-95)  [95-105) [105-115)      NA's
        7         5         2         7         6        10         4
> #Performing the exploratory data analysis of 't'
> #Installing the following Packages
> install.packages("tidyverse")
> install.packages("funModeling")
> install.packages("Hmisc")
> #Loading the needed libraries
> library(funModeling)
> library(tidyverse)
> library(Hmisc)
> #Printing the status of 't'
> print(status(t))
  variable q_zeros p_zeros q_na p_na q_inf p_inf    type unique
1      var       0       0    0    0     0     0 numeric      1
> #Calculating the frequency of 't'
> freq(t)
            var frequency percentage cumulative_perc
1 4.3848229235633         1        100             100
> #Printing the profiling number of 't'
> print(profiling_num(t))
  variable     mean std_dev variation_coef     p_01     p_05     p_25
p_50
1      var 4.384823      NA             NA 4.384823 4.384823 4.384823 4.38
4823
      p_75     p_95     p_99 skewness kurtosis iqr
1 4.384823 4.384823 4.384823      NaN      NaN   0
                            range_98                           range_80
1 [4.3848229235633, 4.3848229235633] [4.3848229235633, 4.3848229235633]
```

```
> #Describing the variable 't'
> describe(t)
t
       n  missing distinct     Info     Mean      Gmd 
       1        0        1        0    4.385       NA 
                   
Value      4.384823
Frequency         1
Proportion        1
#Part 2
> #Generating 5000 variables for analysis with mean = 150 and SD=50
> m <- rnorm(5000, mean=150, sd=50)
> #Displaying the 5000 variables
> m
   [1] 113.090075 148.014963 144.272645 169.710340 158.246821  42.100538 1
58.178147
   [8] 124.112852 102.449937 179.719117 162.472317 170.773016  94.483590 1
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  [15] 171.511582 100.940050 188.010584   8.987785  73.680176 130.996715 1
82.436315
  [22] 128.712292  44.573494 165.366639 137.034347  31.510937  66.895688 1
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> #Calculating the mean of patients at the Beth Isarel Hospital
> mean_bi_m = mean(bi_m)
> mean_bi_m
[1] 44.97171
> #Calculating the mean of patients at the Tufts Medical Hospital
> mean_tm_m = mean(tm_m)
> mean_tm_m
[1] 22.48585
> #Calculating the mean of patients at the Mass General Hospital
> mean_mg_m = mean(mg_m)
> mean_mg_m
[1] 29.98114
> #Calculating the mean of patients at the Boston Medical Hospital
> mean_bm_m = mean(bm_m)
> mean_bm_m
[1] 37.47642
> #Calculating the mean of patients at the Brigham and Women's Hospital
> mean_bw_m = mean(bw_m)
> mean_bw_m
[1] 14.99057
#The average total time needed to transport all victims
      total_time_bi_m =sum(rexp( bi_m[1], 1/7))
      total_time_bi_m <- total_time_bi_m/60
      total_time_bi_m
      #The average total time needed to transport all victims
      total_time_tm_m =sum(rexp( tm_m[1], 1/10))
      total_time_tm_m <- total_time_tm_m/60
      total_time_tm_m
      #The average total time needed to transport all victims
```

```
      total_time_mg_m =sum(rexp( mg_m[1], 1/15))
      total_time_mg_m <- total_time_mg_m/60
      total_time_mg_m
      #The average total time needed to transport all victims
      total_time_bm_m =sum(rexp( bm_m[1], 1/15))
      total_time_bm_m <- total_time_bm_m/60
      total_time_bm_m
      #The average total time needed to transport all victims
      total_time_bw_m =sum(rexp( bw_m[1], 1/20))
      total_time_bw_m <- total_time_bw_m/60
      total_time_bw_m
> #Plotting for displaying the law of large nos. chart for Beth Isarel Hos
pital
> plot(sapply(1:5000, bi_avg_m), type = "l", xlab = "No. of victims", ylab
= "average")
> abline(h = 0.5, col = "red")
>
> #Calculating the +/- 95% confidence interval  for time taken by a patien
t for reaching the Beth Isarel Hospital
> EV1 = (mean(bi_m)+1.96*sd(bi))/sqrt(5000)
> EV1
[1] 1.135627
> EV2 = (mean(bi_m)-1.96*sd(bi))/sqrt(5000)
> EV2
[1] 0.1363651
> #Probability distribution that best fits the total transport time
> bi_probdis_m <- rnorm(5000, mean = mean(bi_m), sd = sd(bi_m))
> round(bi_probdis_m)
   [1] 21 64 50 17 56 29 66 53 70 55 41 57 60 35 50 25 54 59 40 25 60 34 5
4 52 57 26
  [27] 62 25 62 47 49 66 56 35 27 40 34 59 41 55 23 39 26 45 31 52 49 54 3
0 58 47 59
  [53] 58 52 50 56 54 58 31 34 15 50 42 51 59 43 65 33 55 78 36 76 29 31 4
9 35 46 35
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8 41 39 37
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> hist(bi_probdis_m, prob = TRUE)
> #Frequency distribution of the total travel time to and from Beth Isarel
Hospital
> bi_freqdist_m <- as.data.frame(table(round(bi_probdis_m)))
> bi_freqdist_m
   Var1 Freq
1    -6    1
2    -5    2
3     0    2
4     1    1
5     2    2
6     3    3
7     4    3
8     5    5
9     6    7
10    7    3
11    8    6
12    9    5
13   10    9
14   11    9
15   12   16
16   13   10
17   14   13
18   15   18
19   16   21
20   17   22
21   18   16
22   19   33
23   20   44
24   21   41
25   22   33
```

26	23	40
27	24	46
28	25	60
29	26	55
30	27	62
31	28	64
32	29	75
33	30	88
34	31	95
35	32	76
36	33	87
37	34	97
38	35	98
39	36	111
40	37	105
41	38	111
42	39	124
43	40	120
44	41	139
45	42	122
46	43	133
47	44	140
48	45	131
49	46	133
50	47	149
51	48	138
52	49	120
53	50	131
54	51	131
55	52	129
56	53	125
57	54	119
58	55	106
59	56	96
60	57	102
61	58	100
62	59	89
63	60	77
64	61	64
65	62	89
66	63	64
67	64	59
68	65	52
69	66	45
70	67	44
71	68	57
72	69	31
73	70	33
74	71	34
75	72	23
76	73	19
77	74	19
78	75	18
79	76	21
80	77	14
81	78	9
82	79	7
83	80	8
84	81	5
85	82	6
86	83	4
87	84	5
88	85	8
89	86	2
90	87	2
91	88	3
92	90	1
93	93	1
94	94	3

```
95   98    1
> plot(bi_freqdist_m)
> #Performing a Chi-squared Goodness of fit test for the total travel time
to and from Beth Isarel Hospital
> summary(bi_freqdist_m)
      Var1          Freq
 -6      : 1   Min.   :  1.00
 -5      : 1   1st Qu.:  7.50
 0       : 1   Median : 40.00
 1       : 1   Mean   : 52.63
 2       : 1   3rd Qu.: 96.50
 3       : 1   Max.   :149.00
 (Other):89
> breaks <- c(-25, -15, -5, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 11
5)
> tags <- c("[-25--15)","[-15--5)", "[-5-5)", "[5-15)", "[15-25)", "[25-35
)","[35-45)", "[45-55)","[55-65)", "[65-75)", "[75-85)", "[85-95)", "[95-1
05)", "[105-115)")
> group_tags_m <- cut(bi_freqdist_m$Freq, breaks=breaks,
+                     include.lowest=TRUE,
+                     right=FALSE,
+                     labels=tags )
> summary(group_tags_m)
[-25--15)  [-15--5)    [-5-5)    [5-15)   [15-25)   [25-35)   [35-45)   [4
5-55)
        0         0        16        16        10         5         4
3
  [55-65)   [65-75)   [75-85)   [85-95)  [95-105) [105-115)      NA's
        8         0         3         4         6         4        16
>
> #chisq.test(table(group_tags_m), p = c(19,18,6,6,15,4,4,8,4,3,3,5,4)/99)
>
> #Assigning the avg total travel time of victims to 't_m'
> t_m <- total_time_bi_m
> t_m
[1] 4.396368
> #Printing the status of 't_m'
> print(status(t_m))
  variable q_zeros p_zeros q_na p_na q_inf p_inf    type unique
1      var       0       0    0    0     0     0 numeric      1
> #Calculating the frequency of 't_m'
> freq(t_m)
> #Printing the profiling number of 't_m'
> print(profiling_num(t_m))
  variable     mean std_dev variation_coef     p_01     p_05     p_25
p_50
1      var 4.396368      NA             NA 4.396368 4.396368 4.396368 4.39
6368
      p_75     p_95     p_99 skewness kurtosis iqr
1 4.396368 4.396368 4.396368      NaN      NaN   0
                              range_98                                range_8
0
1 [4.39636791472975, 4.39636791472975] [4.39636791472975, 4.39636791472975
]
> #Describing the variable 't_m'
> describe(t_m)
t_m
       n  missing distinct     Info     Mean      Gmd
       1        0        1        0    4.396       NA

Value      4.396368
Frequency         1
Proportion        1
```