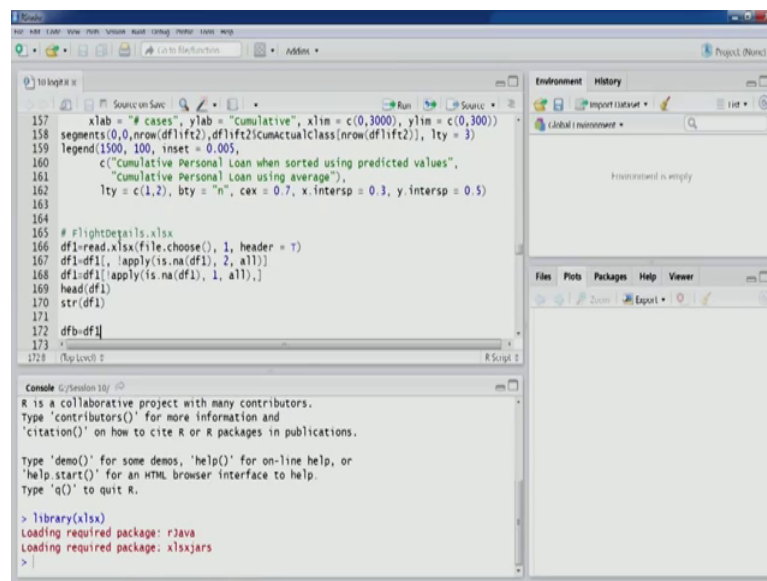


Business Analytics & Data Mining Modeling Using R
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Lecture - 50
Logistic Regression - Part V

Welcome to welcome to the course Business Analytics and Data Mining Modeling Using R. So in previous few lectures we have been discussing Logistic Regression. So let us start our discussion from the same point where we left in previous lecture. So we were doing an exercise in R environment and we completed that exercise so that was using promotional offers; a data set. So what we are going to do in this particular lecture is we will use another data set and other problem and we will go through the complete analysis that is required in logistic regression.

(Refer Slide Time: 00:49)



```
157 xlab = "# cases", ylab = "cumulative", xlim = c(0,3000), ylim = c(0,300))
158 segments(0,0,nrow(df1$ft2),df1$ft2$cumactualClass(nrow(df1$ft2)), lty = 3)
159 legend(1500, 100, inset = 0.005,
160       c("Cumulative Personal Loan when sorted using predicted values",
161         "Cumulative Personal Loan using average"),
162       lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # flightDetails.xlsx
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, !apply(is.na(df1), 2, all)]
168 df1<-df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173
174
175
```

Console

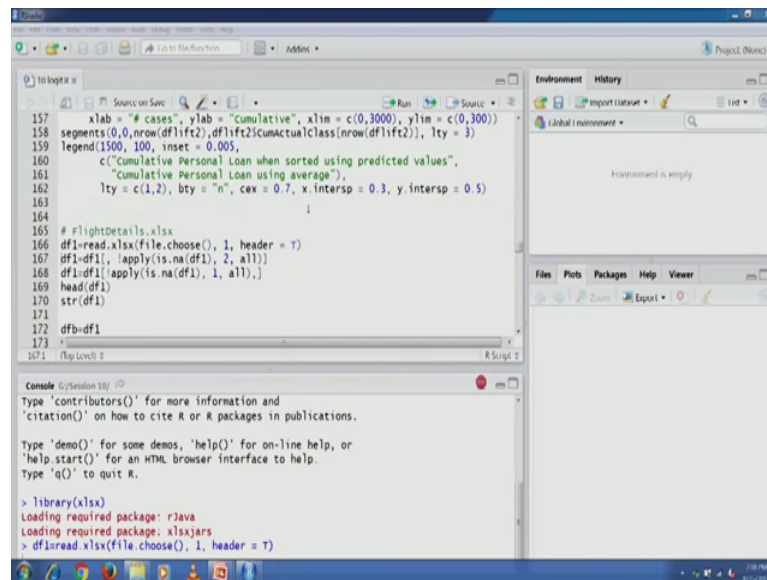
```
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> library(xlsx)
Loading required package: rJava
Loading required package: xlsxjars
>
```

So the data set that we are going to use for this lectures exercise is on flight details. So this particular data set we have a used before as well. So let us so this is the data set; flight details dot xlsx. So, this particular data set have been used before. So let us load this, import this data set into R environment.

(Refer Slide Time: 01:26)



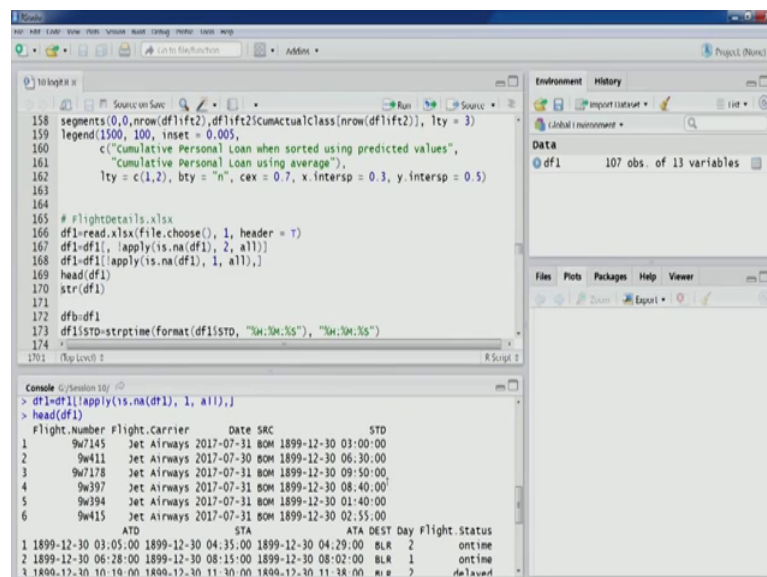
```
157 xlab = "# cases", ylab = "cumulative", xlim = c(0,3000), ylim = c(0,300))
158 segments(0,0,nrow(df1),df1$ft2,cumactualClass(nrow(df1),ft2)), lty = 3)
159 legend(1500, 100, inset = 0.005,
160       c("Cumulative Personal Loan when sorted using predicted values",
161         "Cumulative Personal Loan using average"),
162       lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # FlightDetails.xlsx
166 df1=read.xlsx(file.choose(), 1, header = T)
167 df1=df1[, !apply(is.na(df1), 2, all)]
168 df1=df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb=df1
173
174
```

Console

```
> library(xlsx)
Loading required package: rJava
Loading required package: xlsxjars
> df1=read.xlsx(file.choose(), 1, header = T)
```

So we have 108 observation 13 variables; however, there are some na rows and na columns. So let us get rid of them. So let us first remove na columns then na rows and you would see 107 observation 13 variables. Let us look at the first six observations. So this particular dataset we had used before when we discuss naïve Bayes.

(Refer Slide Time: 01:50)



```
158 segments(0,0,nrow(df1),df1$ft2,cumactualClass(nrow(df1),ft2)), lty = 3)
159 legend(1500, 100, inset = 0.005,
160       c("Cumulative Personal Loan when sorted using predicted values",
161         "Cumulative Personal Loan using average"),
162       lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # FlightDetails.xlsx
166 df1=read.xlsx(file.choose(), 1, header = T)
167 df1=df1[, !apply(is.na(df1), 2, all)]
168 df1=df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb=df1
173 df1$STD=strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174
175
```

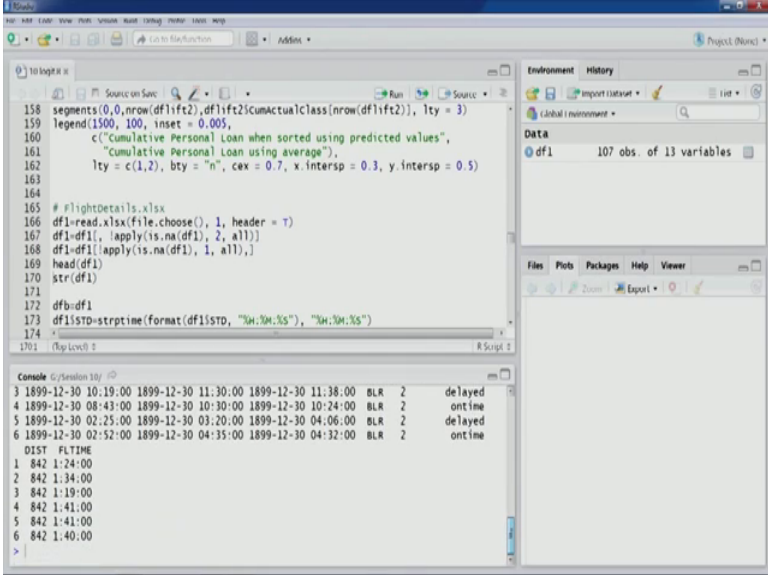
Console

```
> df1=df1[!apply(is.na(df1), 1, all),]
> head(df1)
  Flight.Number Flight.Carrier   Date SRC      STD
1      9w7145      Jet Airways 2017-07-31 BOM 1899-12-30 03:00:00
2      9w411      Jet Airways 2017-07-30 BOM 1899-12-30 06:30:00
3      9w7178      Jet Airways 2017-07-31 BOM 1899-12-30 09:50:00
4      9w397      Jet Airways 2017-07-31 BOM 1899-12-30 08:40:00
5      9w394      Jet Airways 2017-07-31 BOM 1899-12-30 01:40:00
6      9w415      Jet Airways 2017-07-31 BOM 1899-12-30 02:55:00
  ATD      STA      ATA DEST Day Flight status
1 1899-12-30 03:05:00 1899-12-30 04:35:00 1899-12-30 04:29:00 BLR 2 ontime
2 1899-12-30 06:28:00 1899-12-30 08:15:00 1899-12-30 08:02:00 BLR 1 ontime
3 1899-12-30 10:19:00 1899-12-30 11:30:00 1899-12-30 11:38:00 MUM 2 delayed
```

So now again we will understand; so this particular dataset most of the variables that we have they are factor variable, as you can see in first six observation. We have flight number, flight carrier, then date, then source and schedule time of departure, then we

have actual time of departure, then we have scheduled time of arrival, then actual time of arrival, then a destination, then we have day whether it was Sunday or Monday.

(Refer Slide Time: 02:16)



The screenshot shows the R Studio environment. The script editor contains R code for data manipulation and visualization. The environment pane on the right shows a data frame 'df1' with 107 observations and 13 variables. The console at the bottom displays the output of the code, including a table of flight data with columns for flight number, origin, departure time, arrival time, distance, and flight time.

```
158 segments(0,0,nrow(df1),df1$CumActualClass[nrow(df1)], lty = 3)
159 legend(1500, 100, inset = 0.005,
160       c("Cumulative Personal Loan when sorted using predicted values",
161         "Cumulative Personal Loan using average"),
162       lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # flightDetails.xlsx
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, apply(is.na(df1), 2, all)]
168 df1<-df1[apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174
175
```

Environment: Global environment

Data: df1 107 obs. of 13 variables

Files: Plots: Packages: Help: Viewer

Console: C:\Session 10\

	FLIGHT	ORIGIN	DEPART	ARRIVE	DIST	FLTIME
3	1899-12-30 10:19:00	1899-12-30 11:30:00	1899-12-30 11:38:00	BLR	2	delayed
4	1899-12-30 08:43:00	1899-12-30 10:30:00	1899-12-30 10:24:00	BLR	2	ontime
5	1899-12-30 02:25:00	1899-12-30 03:20:00	1899-12-30 04:06:00	BLR	2	delayed
6	1899-12-30 02:52:00	1899-12-30 04:35:00	1899-12-30 04:32:00	BLR	2	ontime

So we had information on just 2 days; data on just 2 days; then flight status and then two additional variables. So when we use this particular data set in a naïve Bayes technique, we did not have these two variables; distance and flight time. So we have added these two variables distance between the source and destination and also flight time.

So this particular data set, so let us look at the structure and then we will discuss further. So let us look at this information. So, flight number if we see that the flight number is something that we are going not going to use in this particular analysis.

(Refer Slide Time: 03:07)

```

160 c("Cumulative Personal Loan when sorted using predicted values",
161    "Cumulative Personal Loan using average"),
162    lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # FlightDetails.xlsx
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, !apply(is.na(df1), 2, all)]
168 df1<-df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$IATD<-strptime(format(df1$IATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$IATA<-strptime(format(df1$IATA, "%H:%M:%S"), "%H:%M:%S")
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```

> str(df1)
'data.frame': 107 obs. of 13 variables:
 $ Flight.Number: Factor w/ 97 levels "6E 234","6E 254",...: 74 63 75 62 61 64 68 72 67 70 ...
 $ Flight.Carrier: Factor w/ 3 levels "Air India","Indigo",...: 3 3 3 3 3 3 3 3 3 ...
 $ Date: Date, format: "2017-07-31" "2017-07-30" ...
 $ SRC: Factor w/ 3 levels "BOM","DEL","MAA": 1 1 1 1 1 1 1 1 1 ...
 $ STD: POSIXct, format: "1899-12-30 03:00:00" "1899-12-30 06:30:00" ...
 $ ATD: POSIXct, format: "1899-12-30 03:05:00" "1899-12-30 06:28:00" ...
 $ STA: POSIXct, format: "1899-12-30 04:35:00" "1899-12-30 08:15:00" ...
 $ ATA: POSIXct, format: "1899-12-30 04:29:00" "1899-12-30 08:02:00" ...
 $ DEST: Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 1 ...

```

However, flight numbers for each of the you know flights that we have with us right; 97 of them out of 107 observations, some of them must be repeating. So then we have flight carrier so we have 3 carriers; Air India, Indigo and Jet Airways. So we will discuss them. Then we have date; so a data flight. We have flights on 2 days that is 30th July 2017 and 31st July 2017.

(Refer Slide Time: 03:35)

```

160 c("Cumulative Personal Loan when sorted using predicted values",
161    "Cumulative Personal Loan using average"),
162    lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # FlightDetails.xlsx
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, !apply(is.na(df1), 2, all)]
168 df1<-df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$IATD<-strptime(format(df1$IATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$IATA<-strptime(format(df1$IATA, "%H:%M:%S"), "%H:%M:%S")
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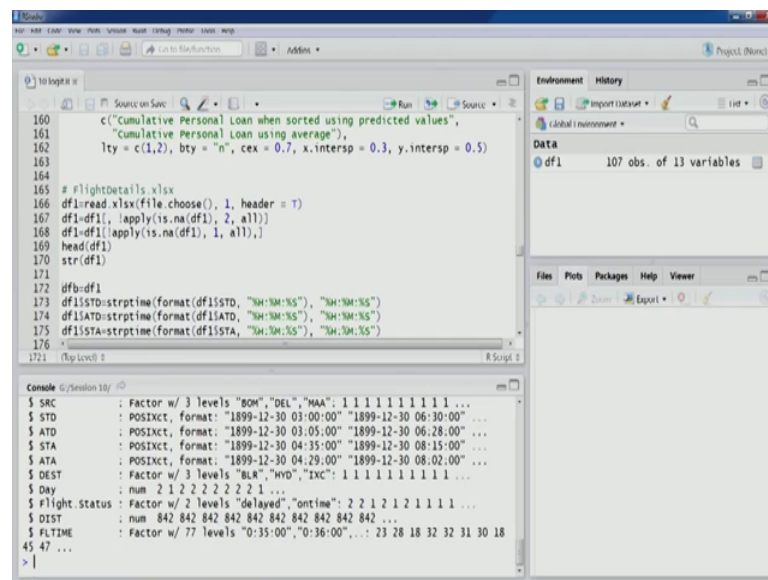
> str(df1)
'data.frame': 107 obs. of 13 variables:
 $ Flight.Number: Factor w/ 97 levels "6E 234","6E 254",...: 74 63 75 62 61 64 68 72 67 70 ...
 $ Flight.Carrier: Factor w/ 3 levels "Air India","Indigo",...: 3 3 3 3 3 3 3 3 3 ...
 $ Date: Date, format: "2017-07-31" "2017-07-30" ...
 $ SRC: Factor w/ 3 levels "BOM","DEL","MAA": 1 1 1 1 1 1 1 1 1 ...
 $ STD: POSIXct, format: "1899-12-30 03:00:00" "1899-12-30 06:30:00" ...
 $ ATD: POSIXct, format: "1899-12-30 03:05:00" "1899-12-30 06:28:00" ...
 $ STA: POSIXct, format: "1899-12-30 04:35:00" "1899-12-30 08:15:00" ...
 $ ATA: POSIXct, format: "1899-12-30 04:29:00" "1899-12-30 08:02:00" ...
 $ DEST: Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 1 ...
 $ Day: num 2 1 2 2 2 2 2 2 1 ...
 $ Flight status: Factor w/ 2 levels "delayed","ontime": 2 2 1 2 1 2 1 1 1 ...
 $ DIST: num 842 842 842 842 842 842 842 842 ...
 $ FLTIME: Factor w/ 77 levels "0:35:00","0:36:00",...: 23 28 18 32 32 31 30 18

```

However, as we did in naïve Bayes.`we would like we would not like to use this information and date is not important for our analysis and we will consider them you

know we will not considered date and we look at the time intervals of this specific time intervals, departure intervals of flights. So the main problem remains same. So this is a classification problem that we are going to model using logistic regression modeling. So where we would like to predict the delays of flights right.

(Refer Slide Time: 04:30)



```
160 c("Cumulative Personal Loan when sorted using predicted values",
161   "Cumulative Personal Loan using average"),
162   lty = c(1,2), bty = "n", cex = 0.7, x.intersp = 0.3, y.intersp = 0.5)
163
164
165 # FlightDetails.xlsx
166 df1=read.xlsx(file.choose(), 1, header = T)
167 df1=df1[, !apply(is.na(df1), 2, all)]
168 df1=df1[!apply(is.na(df1), 1, all),]
169 head(df1)
170 str(df1)
171
172 dftb=df1
173 df1$STD=strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$ATD=strptime(format(df1$ATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$STA=strptime(format(df1$STA, "%H:%M:%S"), "%H:%M:%S")
176
177
178 (Up Level) 8 Script 1
```

```
$ SRC      : Factor w/ 3 levels "BOM","DEL","MAA": 1 1 1 1 1 1 1 1 ...
$ STD      : POSIXct, format: "1899-12-30 03:00:00" "1899-12-30 06:30:00" ...
$ ATD      : POSIXct, format: "1899-12-30 03:05:00" "1899-12-30 06:28:00" ...
$ STA      : POSIXct, format: "1899-12-30 04:35:00" "1899-12-30 08:15:00" ...
$ ATA      : POSIXct, format: "1899-12-30 04:29:00" "1899-12-30 08:02:00" ...
$ DEST     : Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 ...
$ Day      : num 2 1 2 2 2 2 2 2 1 ...
$ Flight status : Factor w/ 2 levels "delayed","ontime": 2 2 1 2 1 2 1 1 1 ...
$ DIST     : num 842 842 842 842 842 842 842 842 ...
$ FLTIME   : Factor w/ 77 levels "0:35:00","0:36:00",...: 23 28 18 32 32 31 30 18
45 47 ...
> |
```

So other variables we are familiar with a day and flight status, distance, flight time. So these are the other variables flight time. As you can see this is right now it is Factor, so this has to be converted into a numeric variable distances flight status is also ok. However, we would like to change the labels, you can see this is a delayed and on time. However, since we are modeling for delayed, so we are trying to predict delays. So therefore, our reference category has to be on time and modeling has to be done with respect to delayed. So we need to change these labels for our outcome variable that is flight status. So we would like to predict the flight status whether particular flight is going to be on time or delayed; focus is on delayed. So the on time is going to be our reference category. Just like we used to have other techniques other examples, just like we used to have 1 and 0. So a focus was on always class 1; members belonging to class 1. So we always look to identify build a model which would be classify an observation into class 1.

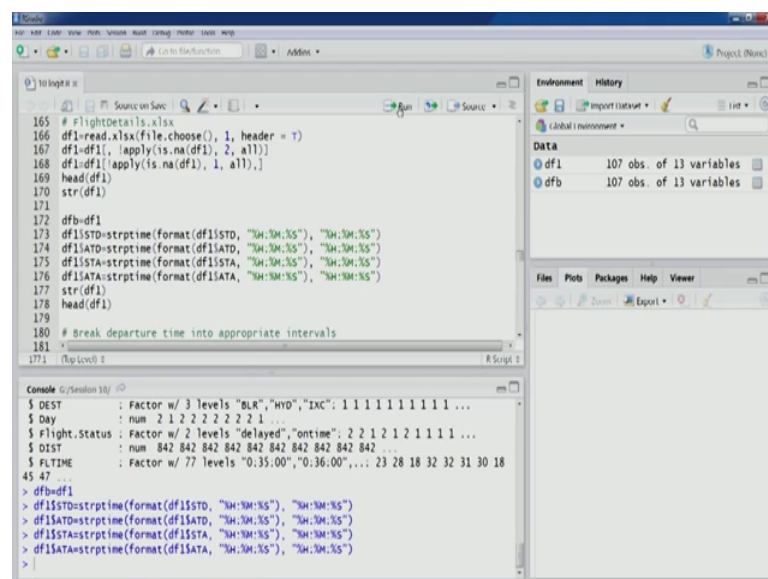
So, here in this case as I talked about we need to, we would we require to change the levels; destination is ok, day this also we would have to change. So day is factor variable,

2 days; Sunday and Monday. So right now this is numeric variable, so we will be required to change this variable as well. The schedule departure you know departure time actual time of departure and these four information only will a try to derive another variable using these four information.

So flight status has been derived already been derived using some of these variables and we will derive another variable that departure time interval using some of these variables. Other after those derivation after those variable derivation we would not be using these variables.

Source is appropriately mentioned factor, 3 levels date we would not be using, flight carrier we would we would be using appropriately mention, flight number again we would not be using. So let us start some of these transformation. So before we go ahead, let us take a backup of this particular data set. So we will take a backup and then we would because as we said, we are not interested in actual dates of those flights.

(Refer Slide Time: 06:55)

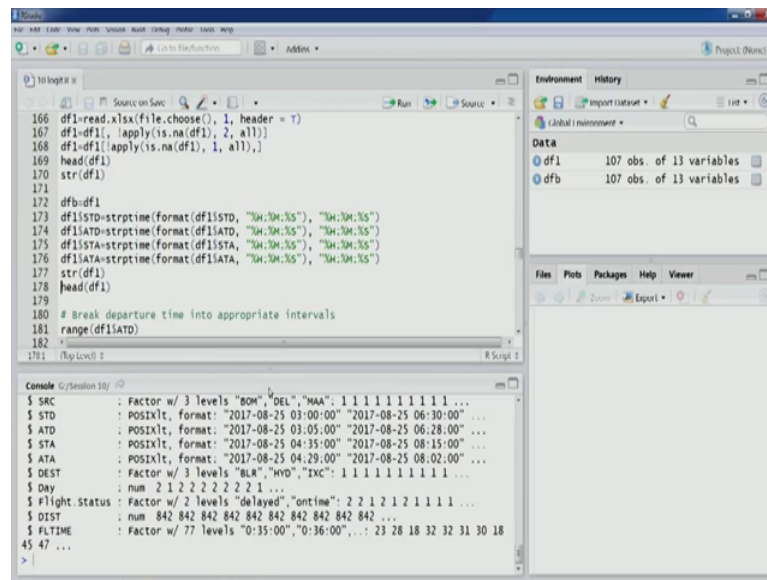


```
165 # FlightDetails.xlsx
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, !apply(is.na(df1), 2, all)]
168 df1<-df1[, !apply(is.na(df1), 1, all)]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$ATD<-strptime(format(df1$ATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$STA<-strptime(format(df1$STA, "%H:%M:%S"), "%H:%M:%S")
176 df1$ATA<-strptime(format(df1$ATA, "%H:%M:%S"), "%H:%M:%S")
177 str(df1)
178 head(df1)
179
180 # Break departure time into appropriate intervals
181
1771 (Top Level) t
```

```
$ DEST      : Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 1 ...
$ Day       : num  2 1 2 2 2 2 2 2 1 ...
$ Flight.Status: Factor w/ 2 levels "delayed","ontime": 2 2 1 2 1 2 1 1 1 ...
$ DIST      : num  842 842 842 842 842 842 842 842 ...
$ FLTIME    : Factor w/ 77 levels "0:35:00","0:36:00",...: 23 28 18 32 32 31 30 18
45 47
> dfb<-df1
> df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
> df1$ATD<-strptime(format(df1$ATD, "%H:%M:%S"), "%H:%M:%S")
> df1$STA<-strptime(format(df1$STA, "%H:%M:%S"), "%H:%M:%S")
> df1$ATA<-strptime(format(df1$ATA, "%H:%M:%S"), "%H:%M:%S")
>
```

So, I will like to change the same because we need to do, we need to use these particular columns for certain variable derivations. So we would like to change these dates to, so that it is it comes out to be the same date for all the flights and therefore, various derivation that we want to perform there are no issues in that.

(Refer Slide Time: 07:23)



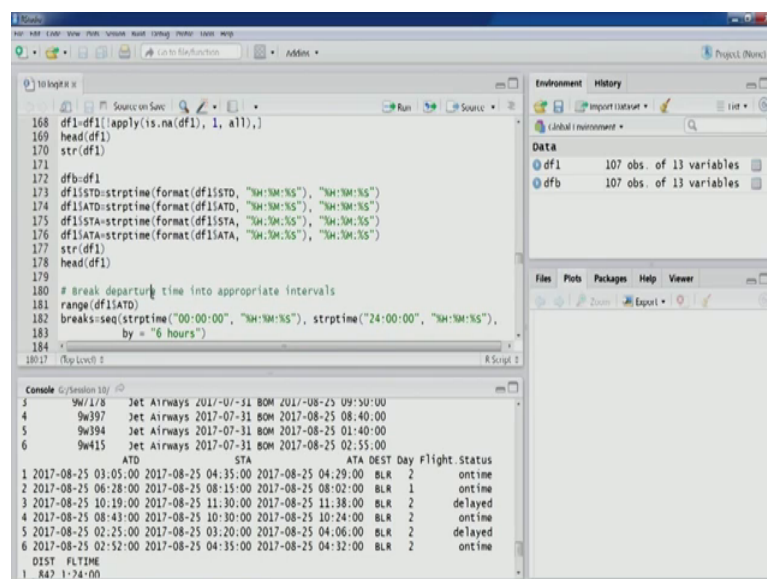
```
166 df1<-read.xlsx(file.choose(), 1, header = T)
167 df1<-df1[, !apply(is.na(df1), 2, all)]
168 df1<-df1[, !apply(is.na(df1), 1, all)]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$ATD<-strptime(format(df1$ATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$STA<-strptime(format(df1$STA, "%H:%M:%S"), "%H:%M:%S")
176 df1$ATA<-strptime(format(df1$ATA, "%H:%M:%S"), "%H:%M:%S")
177 str(df1)
178 head(df1)
179
180 # Break departure time into appropriate intervals
181 range(df1$ATD)
182
183
```

Console Output:

```
$ SRC      : Factor w/ 3 levels "BOM","DEL","MAA": 1 1 1 1 1 1 1 1 1 ...
$ STD      : POSIXlt, format: "2017-08-25 03:00:00" "2017-08-25 06:30:00" ...
$ ATD      : POSIXlt, format: "2017-08-25 03:05:00" "2017-08-25 06:28:00" ...
$ STA      : POSIXlt, format: "2017-08-25 04:35:00" "2017-08-25 08:15:00" ...
$ ATA      : POSIXlt, format: "2017-08-25 04:29:00" "2017-08-25 08:02:00" ...
$ DEST     : Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 1 ...
$ Day      : num 2 1 2 2 2 2 2 2 2 1 ...
$ Flight.status : Factor w/ 2 levels "delayed","ontime": 2 2 1 2 1 2 1 1 1 ...
$ DIST     : num 842 842 842 842 842 842 842 842 ...
$ FLTIME   : Factor w/ 77 levels "0:35:00","0:36:00",...: 23 28 18 32 32 31 30 18
45 47 ...
```

So, now you can see now in all these 4 dates, they have the dates has been changed. Earlier, it was earlier it was 1899; so this particular aspect we have already discussed during new base why 18 under 99 this particular date was coming there. Now this is what we require before we go for further variable transformation. So with this, so first six observation not much change only these four variables have been changed, dates have been change as you can see.

(Refer Slide Time: 08:00)



```
168 df1<-df1[, !apply(is.na(df1), 1, all)]
169 head(df1)
170 str(df1)
171
172 dfb<-df1
173 df1$STD<-strptime(format(df1$STD, "%H:%M:%S"), "%H:%M:%S")
174 df1$ATD<-strptime(format(df1$ATD, "%H:%M:%S"), "%H:%M:%S")
175 df1$STA<-strptime(format(df1$STA, "%H:%M:%S"), "%H:%M:%S")
176 df1$ATA<-strptime(format(df1$ATA, "%H:%M:%S"), "%H:%M:%S")
177 str(df1)
178 head(df1)
179
180 # Break departure time into appropriate intervals
181 range(df1$ATD)
182 breaks<-seq(strptime("00:00:00", "%H:%M:%S"), strptime("24:00:00", "%H:%M:%S"),
183             by = "6 hours")
184
```

Console Output:

```
5 9w118 Jet Airways 2017-07-31 BOM 2017-08-25 09:30:00
4 9w397 Jet Airways 2017-07-31 BOM 2017-08-25 08:40:00
5 9w394 Jet Airways 2017-07-31 BOM 2017-08-25 01:40:00
6 9w415 Jet Airways 2017-07-31 BOM 2017-08-25 02:55:00
ATD STA ATA DEST Day Flight.status
1 2017-08-25 03:05:00 2017-08-25 04:35:00 2017-08-25 04:29:00 BLR 2 ontime
2 2017-08-25 06:28:00 2017-08-25 08:15:00 2017-08-25 08:02:00 BLR 1 ontime
3 2017-08-25 10:19:00 2017-08-25 11:30:00 2017-08-25 11:38:00 BLR 2 delayed
4 2017-08-25 08:43:00 2017-08-25 10:30:00 2017-08-25 10:24:00 BLR 2 ontime
5 2017-08-25 02:25:00 2017-08-25 03:20:00 2017-08-25 04:06:00 BLR 2 delayed
6 2017-08-25 02:52:00 2017-08-25 04:35:00 2017-08-25 04:32:00 BLR 2 ontime
DIST FLTIME
1 842 1-24-00
```

Now, let us first variable transformation that we are going to perform is on departure time. So, we would like to break departure time in to appropriate intervals. So for example, let us look at the range now because now actual time of departure now. It is now you know we have excluded that date information now for all the observation we are using the same date. So therefore, range can be appropriately captured for our analysis.

(Refer Slide Time: 08:30)

```

175 df1$TA=strftime(format(df1$TA, "%H:%M:%S"), "%H:%M:%S")
176 df1$TA=strftime(format(df1$TA, "%H:%M:%S"), "%H:%M:%S")
177 str(df1)
178 head(df1)
179
180 # Break departure time into appropriate intervals
181 range(df1$TA)
182 breaks=seq(strptime("00:00:00", "%H:%M:%S"), strptime("24:00:00", "%H:%M:%S"),
183           by = "6 hours")
184 labels=c("0-6", "6-12", "12-18", "18-24")
185 DEPT=cut(df1$TA, breaks = breaks, right = F, labels = labels)
186
187 df1=cbind(df1, DEPT)
188
189 df1$day=as.factor(df1$day)
190 levels(df1$day)
191
192
193
194
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```

Console Output:

```

5 2017-08-25 02:25:00 2017-08-25 03:20:00 2017-08-25 04:06:00 BLR 2 delayed
6 2017-08-25 02:52:00 2017-08-25 04:35:00 2017-08-25 04:32:00 BLR 2 ontime
DIST FLTIME
1 842 1:24:00
2 842 1:34:00
3 842 1:19:00
4 842 1:41:00
5 842 1:41:00
6 842 1:40:00
> range(df1$TA)
[1] "2017-08-25 00:00:00 IST" "2017-08-25 20:00:00 IST"

```

Environment:

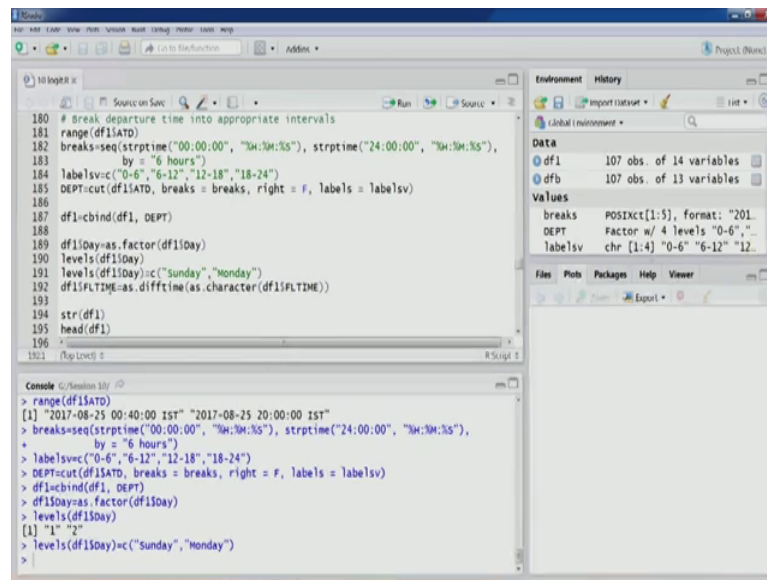
Object	Class	Attributes
df1	data.frame	107 obs. of 13 variables
dfb	data.frame	107 obs. of 13 variables

So, we have a flights ranging from flights ranging from flights ranging from 12:40 pm to 20 hours right. So, 40:00 hours 40 minutes to 20 hours right; so this is the range. Now we would like to break this time into appropriate intervals. So as we have done during naïve Bayes. we can see we would like to break this particular departure time into 4 intervals, you can see the labels also 0 to 6, 6 to 12, 12 to 18 and 18 to 24.

So, 24 hours time format; you would like to create four categories of that from 0 to 6 and 6 to 12 and 12 to 18, 18 to 12. So for this we would be requiring this particular breaks variable which would be used in the cut function as you can see in next line of code; this one that breaks is a breaks this particular variable is going to be used here and it will cut the different observation in actual time of departure using these breaks.

So let us compute this. So you would see in environment section, we will have breaks a variable and 5 values are there and let us also create labels.

(Refer Slide Time: 09:48)



The screenshot shows the RStudio environment. The main editor window contains R code for creating time intervals and a data frame. The console window shows the execution of the code. The environment pane on the right shows the variables created.

```
180 # Break departure time into appropriate intervals
181 range(df1$ATD)
182 breaks=seq(strptime("00:00:00", "%H:%M:%S"), strptime("24:00:00", "%H:%M:%S"),
183           by = "6 hours")
184 labels=c("0-6","6-12","12-18","18-24")
185 DEPT=cut(df1$ATD, breaks = breaks, right = F, labels = labels)
186
187 df1=cbind(df1, DEPT)
188 df1$day=as.factor(df1$day)
189 levels(df1$day)
190 levels(df1$day)=c("Sunday", "Monday")
191 df1$FLTIME=as.difftime(as.character(df1$FLTIME))
192
193 str(df1)
194 head(df1)
195
```

Console output:

```
> range(df1$ATD)
[1] "2017-08-25 00:40:00 IST" "2017-08-25 20:00:00 IST"
> breaks=seq(strptime("00:00:00", "%H:%M:%S"), strptime("24:00:00", "%H:%M:%S"),
+           by = "6 hours")
> labels=c("0-6","6-12","12-18","18-24")
> DEPT=cut(df1$ATD, breaks = breaks, right = F, labels = labels)
> df1=cbind(df1, DEPT)
> df1$day=as.factor(df1$day)
> levels(df1$day)
[1] "1" "2"
> levels(df1$day)=c("Sunday", "Monday")
>
```

Environment pane details:

- Global Environment
- Data
 - df1: 107 obs. of 14 variables
 - dfb: 107 obs. of 13 variables
- Values
 - breaks: POSIXct[1:5], format: "2017-08-25 00:00:00 IST"...
 - DEPT: Factor w/ 4 levels "0-6", "6-12", "12-18", "18-24": 107
 - labels: chr [1:4] "0-6" "6-12" "12-18" "18-24"

So these breaks can be used to create these 4 categories. So, let us execute this. So you would see that depth this variable has been created with it is a factor with 4 levels right. So, we get it this particular variable into appropriate formats. Let us append this particular variable into the data frame. .

Now let us focus on other variables. So we had noticed that day was also you know day was we wanted to be a factor variable, categorical variable having a Sundays and Mondays flights on 2 day. However, this was stored as numeric. So let us change it to factor. Let us look at the level 1 and 2.

So we also would like to change these level names instead of 1 and 2 we would like to have Sunday and Monday; specifically specified. So we will do that. Once this is done we will focus on another variable that is flight time. So flight time that information we had in that time notation as hours colon minutes colon seconds. So, we would like to change it into a format that could be useful for our analysis. So, we would like to change them all those that this file flight duration flight time variable into minutes. So all those values we would like to convert into minutes.

So this is the function that can be used as dot difftime. So because these are you know time intervals, so their differences between two times. So this particular function as dot difftime can be used and you would see that we would be able to change it into minutes.

So first you would see that this particular variable has been changed to this. Let us look at this structure; so if you go to fl time you see that class difftime has been created.

(Refer Slide Time: 11:51)

The screenshot shows an R script being executed. The code defines a data frame 'df1' with columns 'ATD', 'STA', 'ATA', 'DEPT', 'Day', 'Flight status', 'DIST', and 'FLTIME'. The 'FLTIME' column is created using 'difftime' on the 'FLTIME' variable. The console output shows the structure of the data frame, including the 'FLTIME' column which is of class 'difftime' and units 'mins'.

```

183 by = "6 hours")
184 labels=c("0-6","6-12","12-18","18-24")
185 DEPT=cut(df1$ATD, breaks = breaks, right = F, labels = labels)
186
187 df1=cbind(df1, DEPT)
188
189 df1$Day=as.factor(df1$Day)
190 levels(df1$Day)
191 levels(df1$Day)=c("Sunday","Monday")
192 df1$FLTIME=as.difftime(as.character(df1$FLTIME))
193
194 str(df1)
195 head(df1)
196
197 dfb=df1
198 df1=df1[,c(1,3,5:8)]
199
200
201

```

```

$ ATD      : POSIXlt, format: "2017-08-25 03:05:00" "2017-08-25 06:28:00" ...
$ STA      : POSIXlt, format: "2017-08-25 04:35:00" "2017-08-25 08:15:00" ...
$ ATA      : POSIXlt, format: "2017-08-25 04:29:00" "2017-08-25 08:02:00" ...
$ DEPT     : Factor w/ 3 levels "BLR","HYD","INC": 1 1 1 1 1 1 1 1 ...
$ Day      : Factor w/ 2 levels "Sunday","Monday": 2 1 2 2 2 2 2 1 ...
$ Flight status : Factor w/ 2 levels "delayed","ontime": 2 1 2 1 2 1 1 1 ...
$ DIST     : num 842 842 842 842 842 842 842 ...
$ FLTIME   : class "difftime" atomic [1:107] 84 94 79 101 100 99 79 137 139 ...
..
.. attr(,"units")= chr "mins"
$ DEPT     : Factor w/ 4 levels "0-6","6-12","12-18",...: 1 2 2 1 1 2 2 2 ...

```

So this is now atomic factor and now all these values they are minutes right. So you can see character mins here this information, so all these values that were there time intervals. Now they have been converted into minutes.

(Refer Slide Time: 12:14)

The screenshot shows the same R script as before, but with additional code to view the first few rows of the data frame. The console output shows the first six rows of the data frame, including the 'FLTIME' column which is now in minutes.

```

185 DEPT=cut(df1$ATD, breaks = breaks, right = F, labels = labels)
186
187 df1=cbind(df1, DEPT)
188
189 df1$Day=as.factor(df1$Day)
190 levels(df1$Day)
191 levels(df1$Day)=c("Sunday","Monday")
192 df1$FLTIME=as.difftime(as.character(df1$FLTIME))
193
194 str(df1)
195 head(df1)
196
197 dfb=df1
198 df1=df1[,c(1,3,5:8)]
199 str(df1)
200 head(df1)
201
202

```

```

3 2017-08-25 10:19:00 2017-08-25 11:30:00 2017-08-25 11:38:00 BLR Monday
4 2017-08-25 08:43:00 2017-08-25 10:30:00 2017-08-25 10:24:00 BLR Monday
5 2017-08-25 02:25:00 2017-08-25 03:20:00 2017-08-25 04:06:00 BLR Monday
6 2017-08-25 02:52:00 2017-08-25 04:35:00 2017-08-25 04:32:00 BLR Monday
Flight.Status DIST FLTIME DEPT
1 ontime 842 84 mins 0-6
2 ontime 842 94 mins 6-12
3 delayed 842 79 mins 6-12
4 ontime 842 101 mins 6-12
5 delayed 842 101 mins 0-6
6 ontime 842 100 mins 0-6

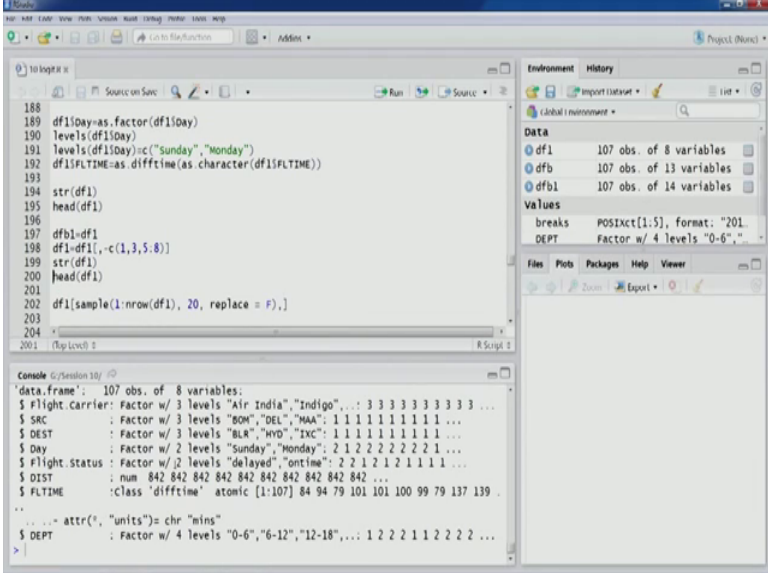
```

So with this almost we are almost there. So you can see that flight time; now you can see 84 minutes, 94 minutes, 79 minutes. So all the flight time duration have been

appropriately converted. We have created the departure variable, each of the flight has been correctly labeled as per it is newly created category in departure and so let us focus on some other transformations; so before that a let us take a backup. .

Now as we have talked about that some of these variables we would not be considering. So for example, variable 1 that is flight number, then date that is 3 column number 3; we would not consider, then from column number 5 to 8. So these are the actual dates scheduled time of departure, actual time of departure, scheduled time of arrival and actual time of arrival. So these also, these 4 columns also we would not be taking into model.

(Refer Slide Time: 13:17)



The screenshot shows the R Studio environment. The script editor on the left contains the following R code:

```
188 df1$day=as.factor(df1$day)
189 levels(df1$day)
190 levels(df1$day)=c("Sunday","Monday")
191 df1$FLTIME=as.difftime(as.character(df1$FLTIME))
192
193
194 str(df1)
195 head(df1)
196
197 df1=df1[-c(1,3,5,8)]
198 df1=df1[sample(1:nrow(df1), 20, replace = F),]
199 str(df1)
200 head(df1)
201
202
203
204
```

The console on the right displays the output of the code, showing the structure of the data frame 'df1' with 107 observations and 8 variables. The variables are: flight carrier (Factor w/ 3 levels), SRC (Factor w/ 3 levels), DEST (Factor w/ 3 levels), Day (Factor w/ 2 levels), Flight status (Factor w/ 2 levels), DIST (num), FLTIME (class 'difftime'), and DEPT (Factor w/ 4 levels).

So let us get rid of these variables, these columns. Now so these are the variables that we are left with and also they are in appropriate format. So we would like to use these variables in our logistic regression model. So we now we have flight carrier, source, destination, day, flight status, our outcome variable; however, we need to change the levels as we talked about; distance and we have flight time, minutes and then we have this departure interval.

So once this is done and these are first six observations. If we want to take you know any random sample of 20; so this is sample function can be used in this fashion. So this particular command will give us 20 randomly selected rows. So we can have a look at different values for different observations randomly drawn observations.

(Refer Slide Time: 14:12)

```

192 df1$FLTIME=as.difftime(as.character(df1$FLTIME))
193
194 str(df1)
195 head(df1)
196
197 dfb1=df1
198 df1=df1[,-c(1,3,5,8)]
199 str(df1)
200 head(df1)
201
202 df1[sample(1:nrow(df1), 20, replace = F),]
203
204 levels(df1$flight.status)
205 levels(df1$flight.status)=c(1,0)
206 head(df1$flight.status)
207 df1$flight.status=relevel(df1$flight.status, ref = "0")
208
209

```

Console Output:

81	Indigo	MAA	BLR	Monday	ontime	269	35	mins	6-12
84	Indigo	MAA	BLR	Monday	ontime	269	36	mins	0-6
22	Indigo	BOH	HYD	Monday	ontime	617	166	mins	0-6
54	Jet Airways	DEL	IXC	Monday	ontime	234	60	mins	6-12
47	Air India	DEL	HYD	Monday	ontime	1253	166	mins	6-12
29	Indigo	BOH	HYD	Monday	ontime	617	150	mins	18-24
73	Jet Airways	DEL	BLR	Sunday	delayed	1740	154	mins	0-6
49	Indigo	DEL	HYD	Monday	ontime	1253	101	mins	0-6
85	Indigo	MAA	BLR	Monday	ontime	269	44	mins	6-12
31	Air India	BOH	BLR	Monday	delayed	842	110	mins	6-12
80	Air India	DEL	BLR	Monday	delayed	1740	177	mins	0-6

(Refer Slide Time: 14:19)

```

202 df1[sample(1:nrow(df1), 20, replace = F),]
203
204 levels(df1$flight.status)
205 levels(df1$flight.status)=c(1,0)
206 head(df1$flight.status)
207 df1$flight.status=relevel(df1$flight.status, ref = "0")
208 str(df1$flight.status)
209 head(df1$flight.status)
210
211 # export excel file for pivot table
212 write.xlsx(df1, "D:/Koorkee/NPTEL/Session 10/flightdetails1.xlsx")
213
214 # Partitioning 90%-10%
215 partids=sample(1:nrow(df1), 0.9*nrow(df1), replace = F)
216 df1train=df1[partids,]
217 df1test=df1[-partids,]
218
219

```

Console Output:

```

[1] "delayed" "ontime"
> levels(df1$flight.status)=c(1,0)
> head(df1$flight.status)
[1] 0 0 1 0 1 0
Levels: 1 0
> df1$flight.status=relevel(df1$flight.status, ref = "0")
> str(df1$flight.status)
Factor w/ 2 levels "0","1": 1 1 2 1 2 1 2 2 2 ...
> head(df1$flight.status)
[1] 0 0 1 0 1 0
Levels: 0 1

```

Now, let us focus on the outcome variable. So outcome variable, the levels are delayed and on time in that particular order. Now we would like to change this into numeric code because later on the different later on our code would be a much easier to write, if we have the numeric codes right because we would be creating lift curve and cumulative lift curve we would be we would require numeric code, so that we can create the cumulative actual class. So all those things for all those things we would prefer this level for outcome variable to be 1 and 0.

So let us change this. So 1, here as you can see; 1 is corresponding to delayed and 0 is corresponding to on time. Because our task is to predict delayed flights right. So therefore, one has to be assigned to delayed right. So let us execute this. Let us look at the first six observation of this outcome variable, flight status; you can see levels have changed now 1 to 0. However, if you see that ordering is 1 and 0. So 1 would become reference category and that means the rate would become reference category. So we did not want that. So we would like to change this. So re level function can be used to perform this kind of change you can see. In the re level first you need you need to pass on the factor variable and then the second argument is for the reference. So, we can select the reference category here, the other things would be appropriately changed.

So, I be execute this code and look at the structure of this particular variable. Now you can see 0 and 1; in the correct order and 1 representing now delayed and 0 representing on time flights. So now, this particular variable; let us look at first six observations also. Now this particular variable is in the desired you know state as we want it to be. Now at this moment if we want certain analysis; descriptive analysis, we can do so as we did in naïve Bayes.as well. We can once this data is ready for logistic regression model, all the key variables are there and the data frame; final data frame. Then we can write this particular file into our disk and then we can apply you know pivot table excel, base pivot tables to write some summary to for further analysis.

So let us, so I have already created one pivot table. So let us open this. So this was the data; pivot table this particular exercise we have already done.

(Refer Slide Time: 16:58)

Flight Carrier	SRC	DEST	Day	Flight Status	DIST	FLTIME	DEPT
Jet Airways	DOM	DLR	Monday	0	812	81	0-6
Jet Airways	DOM	DLR	Sunday	0	812	91	6-12
Jet Airways	DOM	DLR	Monday	1	812	79	6-12
Jet Airways	DOM	DLR	Monday	0	812	101	6-12
Jet Airways	DOM	DLR	Monday	1	812	101	0-6
Jet Airways	DOM	DLR	Monday	0	812	100	0-6
Jet Airways	DOM	DLR	Monday	1	812	99	6-12
Jet Airways	DOM	DLR	Monday	1	812	79	6-12
Jet Airways	DOM	DLR	Monday	1	812	137	6-12
Jet Airways	DOM	DLR	Sunday	1	812	139	6-12
Jet Airways	DOM	IND	Monday	1	1251	110	6-12
Jet Airways	DOM	IND	Monday	0	1251	121	0-6
Jet Airways	DOM	IND	Monday	0	617	81	0-6
Air India	DOM	IND	Monday	0	617	89	6-12
Jet Airways	DOM	IND	Monday	0	617	119	0-6
Air India	DOM	IND	Monday	1	617	89	6-12
Jet Airways	DOM	IND	Monday	1	617	80	6-12
Jet Airways	DOM	IND	Monday	1	617	90	6-12
Jet Airways	DOM	IND	Sunday	1	617	81	0-6
Air India	DOM	IND	Sunday	1	617	86	0-6
Jet Airways	DOM	IND	Monday	1	617	171	0-6
Indigo	DOM	IND	Monday	0	617	166	0-6
Jet Airways	DOM	IND	Monday	0	617	191	0-6
Air India	DOM	IND	Monday	0	617	116	6-12
Jet Airways	DOM	IND	Monday	1	617	188	18-21
Air India	DOM	IND	Monday	1	617	212	18-21
Jet Airways	DOM	IND	Monday	0	617	106	0-6
Indigo	DOM	IND	Monday	0	617	170	12-18
Indigo	DOM	IND	Monday	0	617	150	18-21
Indigo	DOM	IND	Monday	1	617	176	18-21
Air India	DOM	DLR	Monday	1	812	110	6-12
Air India	DOM	DLR	Sunday	1	812	11	6-12
Air India	DOM	DLR	Monday	1	812	131	0-6

So we have to just select the data and you know get it into appropriate presentable format and then select all the all the columns, all the rows and then create pivot table using the insert tab and within that this pivot table option and the pivot table would be ready for us in this fashion.

(Refer Slide Time: 17:11)

SRC	Jet Airways	Air India	Indigo	Grand Total
DOM	5	2	9	16
DLR	5	3	7	15
IND	2	5	7	14
Grand Total	12	10	23	45

So, I have already selected few of the important variables here, in appropriate filters. So you can see in row levels I have, in row level I have SRC that is source; then in column level I have flight carrier those three flight carrier that we have; Air India, Indigo and Jet

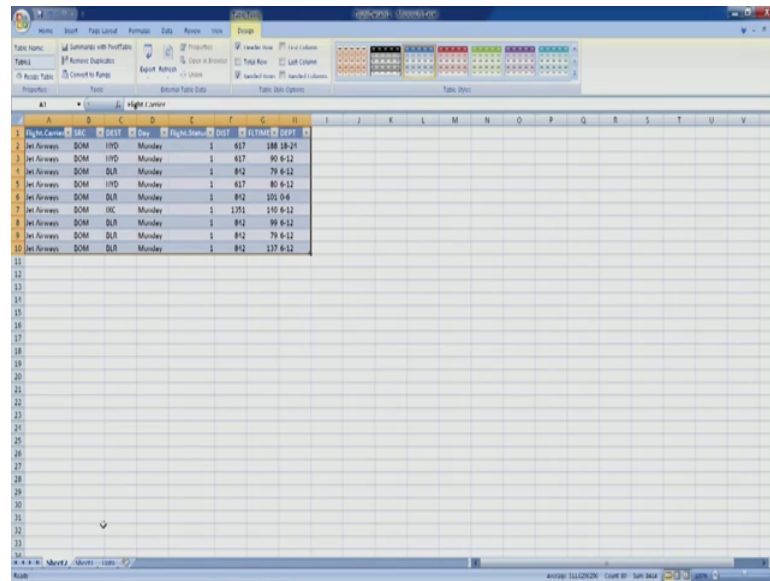
Airways and three source we have a that is BOM, DEL and MAA that is Mumbai, Delhi, Mumbai airport, Delhi airport and Madras airport. And then we have in the values areas we have account of flight status that means, how many flights are actually delayed.

So how many flights are there; count of flight. So overall, now however, in the report filter I have flight status and day as you can see here. So these are report filters point. So flight status you can see I have pre selected one. So this can be changed if we click on this filter you can see all the flights count of all the flights or delayed flight 1 representing delayed. So therefore delayed flights and 0 representing on time so that can be done. .

In day also we have a filter. So this is since this is report filter, so we are going to have a filter for all the variables. So Sunday and Monday you can see here that we can have all you know all days Sundays and Monday's together total and then either Sunday or Monday. So those numbers would be reflected. So we these this particular descriptive table will change depending on the change in levels of report filter variable.

So let us look at some of these numbers. So as we can see that when we are interested in finding the count of delayed flights, you can see the flight status is selected as 1 right here; in the filter flight status is selected as 1. Therefore, the we are interested in understanding the delayed flights from these descriptive statistics, summery statistics. So we can see that then off further we have selected Monday. So delayed flights and then Monday; so these are the numbers. So we can see when the source is Mumbai airport that is BOM, then we can see total number of delayed flights are 16 and you would see Jet Airways more number of flights of Jet ways Jet Airways are delayed.

(Refer Slide Time: 19:56)

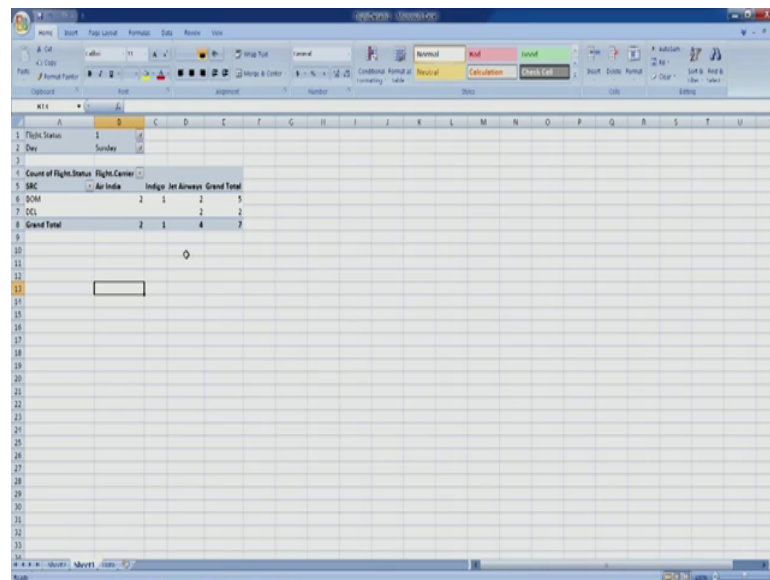


Flight Carrier	Src	Dst	Day	Flights Status	Dst	Estimated Time
Jet Airways	DOM	HYD	Monday	1	617	188 18-21
Jet Airways	DOM	HYD	Monday	1	617	90 6-12
Jet Airways	DOM	DLR	Monday	1	812	79 6-12
Jet Airways	DOM	HYD	Monday	1	617	80 6-12
Jet Airways	DOM	DLR	Monday	1	812	101 0-6
Jet Airways	DOM	DEL	Monday	1	1281	140 6-12
Jet Airways	DOM	DLR	Monday	1	812	90 6-12
Jet Airways	DOM	DLR	Monday	1	812	79 6-12
Jet Airways	DOM	DLR	Monday	1	812	137 6-12

So in this table once you click you will get the specific observations as well right. So now if we look at, if we look at the second row we see that Delhi. So overall total number of delayed flights for Mumbai and airport both these airports. So these airports are too busy airports in our country and you can see number of delayed air fights are similar number is there. And Madras airport we have just 7 delayed flights; however, across 3 carriers we see that Jet Airways we have more number of flights; in terms of number we have known more number of delayed flights.

So, in terms of just the number right; in terms of just the number and this information is for Monday. So now what we can do is a because with respect to delayed flights, let us look at the what happens during Sundays. Let us select Sunday and we do; so now you would see during Sundays we did not have any flight in our data set originating from Madras airport; so that is gone.

(Refer Slide Time: 21:04)



Flight Status	Day	SRC	Air India	Indigo	Jet Airways	Grand Total
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49
50	51	52	53	54	55	56
57	58	59	60	61	62	63
64	65	66	67	68	69	70
71	72	73	74	75	76	77
78	79	80	81	82	83	84
85	86	87	88	89	90	91
92	93	94	95	96	97	98
99	100	101	102	103	104	105
106	107	108	109	110	111	112
113	114	115	116	117	118	119
120	121	122	123	124	125	126
127	128	129	130	131	132	133
134	135	136	137	138	139	140
141	142	143	144	145	146	147
148	149	150	151	152	153	154
155	156	157	158	159	160	161
162	163	164	165	166	167	168
169	170	171	172	173	174	175
176	177	178	179	180	181	182
183	184	185	186	187	188	189
190	191	192	193	194	195	196
197	198	199	200	201	202	203
204	205	206	207	208	209	210
211	212	213	214	215	216	217
218	219	220	221	222	223	224
225	226	227	228	229	230	231
232	233	234	235	236	237	238
239	240	241	242	243	244	245
246	247	248	249	250	251	252
253	254	255	256	257	258	259
260	261	262	263	264	265	266
267	268	269	270	271	272	273
274	275	276	277	278	279	280
281	282	283	284	285	286	287
288	289	290	291	292	293	294
295	296	297	298	299	300	301
302	303	304	305	306	307	308
309	310	311	312	313	314	315
316	317	318	319	320	321	322
323	324	325	326	327	328	329
330	331	332	333	334	335	336
337	338	339	340	341	342	343
344	345	346	347	348	349	350
351	352	353	354	355	356	357
358	359	360	361	362	363	364
365	366	367	368	369	370	371
372	373	374	375	376	377	378
379	380	381	382	383	384	385
386	387	388	389	390	391	392
393	394	395	396	397	398	399
400	401	402	403	404	405	406
407	408	409	410	411	412	413
414	415	416	417	418	419	420
421	422	423	424	425	426	427
428	429	430	431	432	433	434
435	436	437	438	439	440	441
442	443	444	445	446	447	448
449	450	451	452	453	454	455
456	457	458	459	460	461	462
463	464	465	466	467	468	469
470	471	472	473	474	475	476
477	478	479	480	481	482	483
484	485	486	487	488	489	490
491	492	493	494	495	496	497
498	499	500	501	502	503	504
505	506	507	508	509	510	511
512	513	514	515	516	517	518
519	520	521	522	523	524	525
526	527	528	529	530	531	532
533	534	535	536	537	538	539
540	541	542	543	544	545	546
547	548	549	550	551	552	553
554	555	556	557	558	559	560
561	562	563	564	565	566	567
568	569	570	571	572	573	574
575	576	577	578	579	580	581
582	583	584	585	586	587	588
589	590	591	592	593	594	595
596	597	598	599	600	601	602
603	604	605	606	607	608	609
610	611	612	613	614	615	616
617	618	619	620	621	622	623
624	625	626	627	628	629	630
631	632	633	634	635	636	637
638	639	640	641	642	643	644
645	646	647	648	649	650	651
652	653	654	655	656	657	658
659	660	661	662	663	664	665
666	667	668	669	670	671	672
673	674	675	676	677	678	679
680	681	682	683	684	685	686
687	688	689	690	691	692	693
694	695	696	697	698	699	700
701	702	703	704	705	706	707
708	709	710	711	712	713	714
715	716	717	718	719	720	721
722	723	724	725	726	727	728
729	730	731	732	733	734	735
736	737	738	739	740	741	742
743	744	745	746	747	748	749
750	751	752	753	754	755	756
757	758	759	760	761	762	763
764	765	766	767	768	769	770
771	772	773	774	775	776	777
778	779	780	781	782	783	784
785	786	787	788	789	790	791
792	793	794	795	796	797	798
799	800	801	802	803	804	805
806	807	808	809	810	811	812
813	814	815	816	817	818	819
820	821	822	823	824	825	826
827	828	829	830	831	832	833
834	835	836	837	838	839	840
841	842	843	844	845	846	847
848	849	850	851	852	853	854
855	856	857	858	859	860	861
862	863	864	865	866	867	868
869	870	871	872	873	874	875
876	877	878	879	880	881	882
883	884	885	886	887	888	889
890	891	892	893	894	895	896
897	898	899	900	901	902	903
904	905	906	907	908	909	910
911	912	913	914	915	916	917
918	919	920	921	922	923	924
925	926	927	928	929	930	931
932	933	934	935	936	937	938
939	940	941	942	943	944	945
946	947	948	949	950	951	952
953	954	955	956	957	958	959
960	961	962	963	964	965	966
967	968	969	970	971	972	973
974	975	976	977	978	979	980
981	982	983	984	985	986	987
988	989	990	991	992	993	994
995	996	997	998	999	1000	1001

So that is also one problem in modeling exercise as I have I have talked about in previous lectures as well; that if some of the combinations are not covered then that could be a problem when we go about predicting new observation because if that observation falls into that zone and in our training partition that was not covered; some of those combinations were not covered in our training partitions then prediction would not be possible.

So the same thing is reflected here. For example, Sunday we do not have resource destination MMA Madras. We do not have any flights from that source and if we look at the number of flights are quite few in comparison to Monday. However, if we look at again more number of delayed flights or from Mumbai and again more number of delayed flights are from Jet Airways. So, in terms of numbers total number of flights are also less and during Sundays and total number of therefore total number of delayed flights are also less.

So, if we look proportion wise then the that does not seem to be much difference between Sunday and Monday. So the same thing we should expect when we build our logistic regression model, the same thing we should be expecting in our results as well; that there in terms of you know we look proportion wise.

Then there is seem to be any difference in delayed flights, you know whether it is Sunday or Monday. The similar kind of exercise can also be performed for on time

flights. So we can go to flight status report filter, we can select 0 and that would represent the on time flights. Now we can see the Sunday numbers here and Bombay 3 flights on time, Delhi 2 flights on time and the Madras 1 flight on time. So we did have a flight on Sunday from Madras, but that was on time.

So we can change the day filter as well to a Monday to see the difference. So we expect more number of flights during Monday. So that is the case. So we see that a more number of flights; 15, 22, 19. However, if we really look at these numbers during Mondays we see that there are more number of flights, there are more number of flights from Indigo which seem to be on time. However proportional wise our number of flights that they are running on Mondays are also more; are also higher, so that could be the region.

So this kind of analysis we can do using pivot tables and that would give us some insights when we go into former technique like logistic regression, what we should be expecting. So this kind of analysis can also help us in grouping as we have been talking about in previous lecture; grouping some of the categories on this we would be able to understand that which source destination can be grouped or which days can be grouped here, we just have 2 days. So therefore, the question would be whether we should incorporate day at all? If it is, the if does not seem to be a significant predictor for delayed flights as per the descriptive stats that we saw.

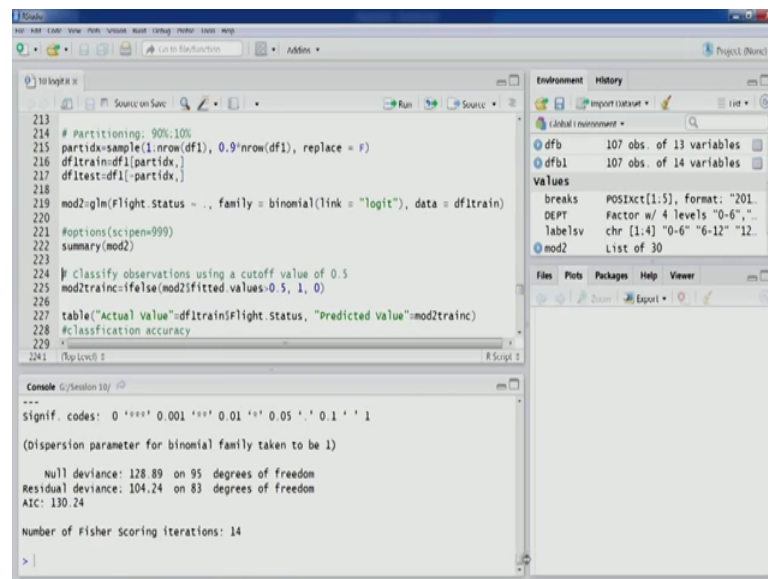
So these kind of decisions can be these kind of insights can be derived from descriptive stats. So what we will do? We will go back to R environment and we will move to our next step that is a partitioning. So because this particular data set is quite small; just 107 observations and for training partition you would like to have more number of observations; so that the model is slightly a more stable, more number of combinations because we are using a factor in many.

There are you know majority of the predictors that have they are factor they are categorical. So there you know there are going to be more combinations of values that you would like to cover in our model. So more observation we would like to have in the training partition because of this small sample size.

So let us do this partition partitioning; 90 percent for training partition and the remaining 10 percent for testing. You can see our partitions are created; 96 observation in the

training partition and 11 observation, remaining 11 observations in test partition. Now as we did in previous lecture, the same function glm can be used. Flight status is our outcome variable, other variables are going to be going to be used as predictors other things remain same. So let us run this code. You get the model. Let us look at the summary.

(Refer Slide Time: 26:11)



```

213 # Partitioning: 90%:10%
214 partidx=sample(1:nrow(df1), 0.9*nrow(df1), replace = F)
215 dfitrain=df1[partidx,]
216 dfitest=df1[-partidx,]
217
218 mod2=glm(Flight.Status ~ ., family = binomial(link = "logit"), data = dfitrain)
219
220 #options(scipen=999)
221 summary(mod2)
222
223 # Classify observations using a cutoff value of 0.5
224 mod2trainc=ifelse(mod2$fitted.values>0.5, 1, 0)
225
226 table("Actual Value"=dfitrain$Flight.status, "Predicted Value"=mod2trainc)
227 #classification accuracy
228
229
230
231
232
233
234
235
236
237
238
239
240
241

```

Console Output:

```

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

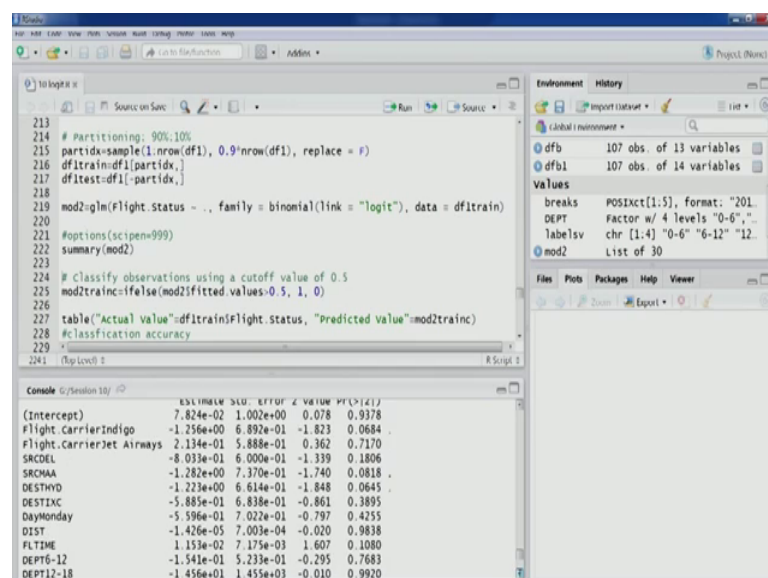
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 128.89  on 95  degrees of freedom
Residual deviance: 104.24  on 83  degrees of freedom
AIC: 130.24

Number of Fisher Scoring iterations: 14

```

(Refer Slide Time: 26:16)



```

213 # Partitioning: 90%:10%
214 partidx=sample(1:nrow(df1), 0.9*nrow(df1), replace = F)
215 dfitrain=df1[partidx,]
216 dfitest=df1[-partidx,]
217
218 mod2=glm(Flight.Status ~ ., family = binomial(link = "logit"), data = dfitrain)
219
220 #options(scipen=999)
221 summary(mod2)
222
223 # Classify observations using a cutoff value of 0.5
224 mod2trainc=ifelse(mod2$fitted.values>0.5, 1, 0)
225
226 table("Actual Value"=dfitrain$Flight.status, "Predicted Value"=mod2trainc)
227 #classification accuracy
228
229
230
231
232
233
234
235
236
237
238
239
240
241

```

Console Output:

```

              (Intercept)      Flight.carrierIndigo      Flight.carrierJet Airways      SRCDL      SRCHMA      DESTHYD      DESTLXC      DayMonday      DIST      FLTIME      DEPT6-12      DEPT12-18
              7.824e-02      -1.256e+00      2.134e-01      -8.033e-01      -1.282e+00      -1.223e+00      -5.885e-01      -5.596e-01      -1.426e-05      1.153e-02      -1.541e-01      -1.456e+01
              1.002e+00      6.892e-01      5.888e-01      6.000e-01      7.370e-01      6.614e-01      6.838e-01      7.022e-01      7.003e-04      7.175e-03      5.233e-01      1.455e+03
              0.078      -1.823      0.362      -1.339      -1.740      -1.848      -0.861      -0.797      -0.020      1.607      -0.295      -0.010
              0.9378      0.0684      0.7170      0.1806      0.0818      0.0645      0.3895      0.4255      0.9838      0.1080      0.7683      0.9920

```

So if we look at the results of this logistic regression model that we have just created. We can see the results most of the variables because of this smaller data size, we do not

see much significance. However, we do see three variables to be significant at 90 percent confidence interval. You can see small dot here that is for 90 percent confidence interval. So, these three variables seem to be significant; first one is Flight Carrier Indigo.

So, the estimate is negative. So this seems to be significant at 90 percent confidence interval and so therefore what we can understand is with reference to Indigo, with reference to Air India which is the reference category for flight carrier; Indigo of flights from Indigo flights from indigo carrier. They seem to be less delayed because remember this particular modeling exercise with respect to delayed flights.

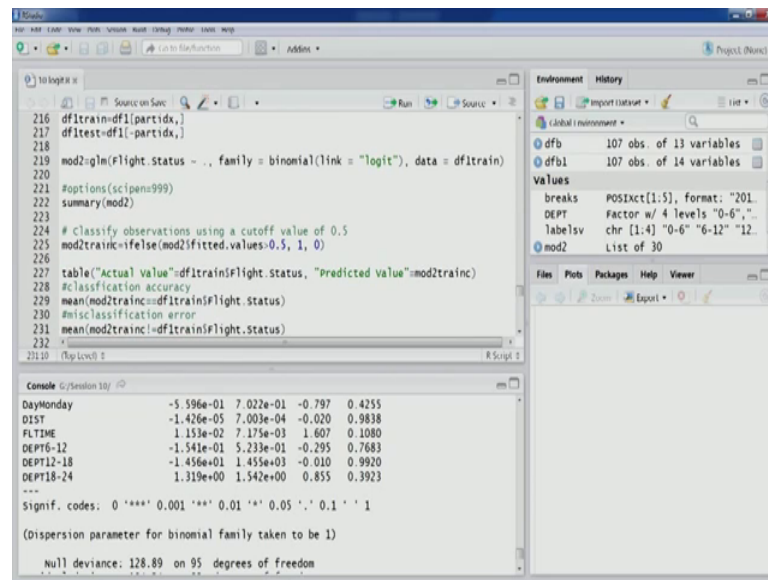
So therefore, if the coefficient is negative, so therefore we should expect that logit values are going to be that logit value there is going to be less cost, there is going to be decrease and therefore there is decrease in probabilities value and therefore there is more chance for it to be on time rather than delayed.

So, in this fashion we can interpret. However, the append be interpret these results. We should also look at first whether the variable is significant. So we have to check the significance as per our accepted level of confidence interval. We can look at the significance and once the variables are a significant then we can look at their coefficient values to understand the level of impact that they have. .

So flight from Indigo they seem to be less delayed or more on time in comparison to Air India right. The same cannot be said about Jet Airways because this is insignificant relationship. Now, other very other significant coefficient is source that is from Madras airport. So it seems that flights which originate from a Madras airport they also seem to be you know a less delayed right so more on time.

So this is also again at 90 percent confidence interval. Similarly we have another significant variable that is destination Hyderabad. So this is dummy code for Hyderabad. So airport, so we can see here also that the flights which arrive at Hyderabad; so where the destination is Hyderabad. They seem to be less delayed or more on time with respect to our reference category. Same is also that Madras airport was also with respect to the reference category.

(Refer Slide Time: 29:19)



The screenshot shows the RStudio interface. The script editor contains the following R code:

```
216 dfitrain=df1[partidx,]
217 dfitest=df1[-partidx,]
218
219 mod2=glm(Flight.Status ~ ., family = binomial(link = "logit"), data = dfitrain)
220
221 #options(scipens=999)
222 summary(mod2)
223
224 # Classify observations using a cutoff value of 0.5
225 mod2train=ifelse(mod2$fitted.values>0.5, 1, 0)
226
227 table("Actual Value"=dfitrain$Flight.Status, "Predicted Value"=mod2train)
228 #classification accuracy
229 mean(mod2train==dfitrain$Flight.Status)
230 #misclassification error
231 mean(mod2train!=dfitrain$Flight.Status)
232
```

The console output shows the results of the logistic regression model:

```
Console: 6/Session 10/
DayMonday      -5.596e-01  7.022e-01  -0.797  0.4255
DIST           -1.426e-05  7.003e-04  -0.020  0.9838
FLTIME          1.153e-02  7.175e-03   1.607  0.1080
DEPT6-12        -1.541e-01  5.233e-01  -0.295  0.7683
DEPT12-18       -1.456e+01  1.455e+03  -0.010  0.9920
DEPT18-24       1.319e+00  1.542e+00   0.855  0.3923
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 128.89  on 95  degrees of freedom
```

The Environment pane on the right shows the following objects:

- dfb: 107 obs. of 13 variables
- dfb1: 107 obs. of 14 variables
- mod2: List of 30

Now other variables we can see they do not seem to be significant. For example, day Monday; so as we saw in our pivot table that a proportion wise there did not seem to be much difference on in on flights during Mondays or Sundays. So this also, in the results also logistic regression model results also this particular variable dummy variable does not come out to be significant.

So we can see that what we expected from our pivot table exercise, is the same thing is reflected here in the model. A distance this also is highly insignificant; so distance is not a the key predictor here. So this can also we so from this we can also understand which variable can be dropped and another modeling could be done. For example, distance is highly insignificant. So probably this variable can be dropped.

However, as I have pointed out in earlier lectures also, in data mining modeling our goal is prediction. So we are not even if a particular predictor is insignificant, but it is of practical importance in terms of predicting tasks, you know prediction or classification tasks or other data mining tasks; we would still like to keep it in the model.

However, in this case distance does not seem to be of much practical importance and highly insignificant. So probably this can be dropped. Flight time we can see that it was you know quite close to being significant at 90 percent confidence interval. So probably a flight time is also quite practical in terms of predicting delayed flights. So this we should anyway keep there and the then this next one is departure time interval.

So, with respect to the reference category that is 0 to 6 and these 3 departure interval they do not seem to be significant.

So probably at the departure time intervals also do not matter with respect to the data set that we have. So what we can do? We can look at the another modeling approach. So from this model we can further understand which variables are important; which variable are insignificant and if they are significant what is the impact that they have and whether another model with only the important variables can be done. Even if a particular variable is insignificant as we talked about it can still be kept in the model, if it is it provides some practical importance. So with this we will stop here and we will continue our discussion on this particular modeling exercise on flight delays.

Thank you.