```
library(caret)
> library(ISLR)
  # install.packages("e1071") #install first
> library(e1071)
> library(pROC)
> library("gmodels")
> FlightDelays <- read_csv("C:/Users/Ghirghir/Desktop/Mashine Learning/Assign ment/FlightDelays.csv")</pre>
Parsed with column specification:
cols(
  CRS_DEP_TIME = col_double(),
  CARRIER = col_character(),
  DEP_TIME = col_double(),
  DEST = col_character(),
  DISTANCE = col_double(),
FL_DATE = col_character(),
  FL_NUM = col_double();
  ORIGIN = col_character(),
Weather = col_double(),
  DAY_WEEK = col_double()
  DAY_OF_MONTH = col_double().
  TAIL_NUM = col_character();
  FlightStatus = col_character()
  summary(FlightDelays)
  CRS_DEP_TIME
                                          DEP_TIME
                                                            DEST
                                                                                DISTA
                    CARRIER
NCE
                  Length: 2201
 Min.
         : 600
                                       Min.
                                               : 10
                                                        Length:2201
                                                                             Min.
169.0
 1st Qu.:1000
                  Class:character
                                       1st Qu.:1004
                                                        Class :character
                                                                             1st Qu.:
213.0
                                       Median:1450
                                                        Mode :character
                                                                             Median:
 Median :1455
                  Mode :character
214.0
         :1372
                                       Mean
                                               :1369
 Mean
                                                                             Mean
211.9
 3rd Qu.:1710
                                       3rd Qu.:1709
                                                                             3rd Qu.:
214.0
                                               :2330
         :2130
                                       Max.
                                                                             Max.
 Max.
229.0
                           FL_NUM
                                          ORIGIN
                                                               Weather
   FL_DATE
                                                                                    DA
Y_WEEK
 Length:2201
                      Min.
                              : 746
                                       Length: 2201
                                                            Min.
                                                                    :0.00000
                                                                                Min.
:1.0ŎO
                      1st Qu.:2156
                                       Class :character
                                                            1st Qu.:0.00000
 Class :character
                                                                                1st Q
u.:2.000
 Mode :character
                      Median:2385
                                       Mode :character
                                                            Median :0.00000
                                                                                Media
n:4.000
                      Mean
                              :3815
                                                            Mean
                                                                    :0.01454
                                                                                Mean
:3.905
                                                            3rd Qu.:0.00000
                      3rd Qu.:6155
                                                                                3rd Q
u.:5.000
                              :7924
                                                                    :1.00000
                      Max.
                                                            Max.
                                                                                Max.
:7.000
  DAY_OF_MONTH
                     TAIL_NUM
                                        FlightStatus
         : 1.00
                   Length:2201
                                        Length:2201
 Min.
 1st Qu.: 8.00
                   Class :character
                                        Class:character
 Median :16.00
                   Mode :character
                                        Mode
                                              :character
 Mean
         :16.02
 3rd Qu.:23.00
         :31.00
 Max.
> str(FlightDelays)
Classes 'spec_tbl_df', 'tbl_df', 'tbl' and 'data.frame':
                                                                    2201 obs. of 13
variables:
 $ CRS_DEP_TIME: num 1455 1640 1245 1715 1039 ...
```

```
"OH" "DH" "DH" "DH"
                 : chr
 $ CARRIER
                         1455 1640 1245 1709 1035 ...
 $ DEP_TIME
                 : num
                         "JFK" "JFK" "LGA" "LGA" ...
184 213 229 229 228 228 228 228 228 ...
"01/01/2004" "01/01/2004" "01/01/2004" ...
 $ DEST
                 : chr
  DISTANCE
                 : num
 $ FL_DATE
                 : chr
                         5935 6155 7208 7215 7792 ...
"BWI" "DCA" "IAD" "IAD" ...
  FL_NUM
                 : num
 $ ORIGIN
                   chr
                         0 0 0 0 0 0 0 0 0 0 ...
 $ Weather
                  : num
                         4 4 4 4 4 4 4 4 4 . . .
 $ DAY_WEEK
                  : num
                         1 1 1 1 1 1 1 1 1 1 1 ...
"N940CA" "N405FJ" "N695BR" "N662BR"
 $ DAY_OF_MONTH: num
 $ TAIL_NUM
                : chr
                         "ontime" "ontime" "ontime" ...
 $ FlightStatus: chr
 - attr(*,
             "spec")=
  .. cols(
        CRS_DEP_TIME = col_double(),
  . .
        CARRIER = col_character(),
  . .
        DEP\_TIME = col_double(),
  . .
        DEST = col_character()
  . .
        DISTANCE = col_double()
        FL_DATE = col_character(),
  . .
        FL_NUM = col_double()
  . .
        ORIGIN = col_character(),
        Weather = col_double(),
        DAY_WEEK = col_double()
        DAY_OF_MONTH = col_double(),
  . .
        TAIL_NUM = col_character(),
  . .
        FlightStatus = col_character()
  . .
> FlightDelays$CRS_DEP_TIME <- as.factor(FlightDelays$CRS_DEP_TIME)</pre>
> FlightDelays$DEP_TIME <- as.factor(FlightDelays$DEP_TIME)</pre>
> FlightDelays$DAY_WEEK <- as.factor(FlightDelays$DAY_WEEK)</pre>
> FlightDelays$FlightStatus <- as.factor(FlightDelays$FlightStatus)</pre>
> Elham <- FlightDelays[,c(10,3,8,4,2,13)]
> str(Elham)
Classes 'tbl_df', 'tbl' and 'data.frame': 2201 obs. of 6 variables: $ DAY_WEEK : Factor w/ 7 levels "1","2","3","4",..: 4 4 4 4 4 4 4 4 4 .
                 : Factor w/ 633 levels "10", "109", "548", ...: 314 404 225 433 17
 $ DEP_TIME
0 102 223 408 434 605
                         "BWI" "DCA" "IAD" "IAD"
 $ ORIGIN
                 : chr
                 : chr "JFK" "JFK" "LGA" "LGA" : chr "OH" "DH" "DH" "DH" ...
 $ DEST
 $ FlightStatus: Factor w/ 2 levels "delayed", "ontime": 2 2 2 2 2 2 2 2 2 2 .
> set.seed(123)
> Index_Train<-createDataPartition(Elham$FlightStatus, p=0.6, list=FALSE)</pre>
> Train <-Elham[Index_Train,]</pre>
> Validation<-Elham[-Index_Train,]</pre>
> nb_model <- naiveBayes (Train$flightStatus~., data = Train)</pre>
> nb_model
Naive Bayes Classifier for Discrete Predictors
naiveBayes.default(x = X, y = Y, laplace = laplace)
A-priori probabilities:
  delayed
               ontime
0.1945496 0.8054504
Conditional probabilities:
          DAY_WEEK
```

Y 7	1	2		3		4		5	6	5
-	0.18677043	0.15953307 (0.11	1284047	0.1517	75097	0.175097	728 0.054	147471	L 0
ontime .10526316	0.14473684	0.12687970 (0.13	3439850	0.1813	39098	0.184210	053 0.123	312030	0 0
Y	DEP_TIME	.0 1	109		548		550		552	
553		0 0.00000000		0 00000		0 000		0 000000		0.
0000000000		0.0000000	300	0.00000	00000	0.000	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0.00000	,,,,,,	0.
Y 559	55	4 5	555		556		557		558	
delayed 0000000000		0 0.00000000	000	0.00000	00000	0.000	00000000	0.000000	00000	0.
Y 626	61	3 6	522		623		624		625	
		0.00000000	000	0.00000	00000	0.000	0000000	0.00000	00000	0.
	DEP_TIME 62	7 6	528		629		630		631	
632		6 0.00000000		0 00000		0 000		0.00000		0.
0000000000		0.0000000	500	0.00000	00000	0.000	,0000000	0.000000	00000	0.
Y 641	63	3 6	634		635		638		640	
		0.00000000	000	0.00000	00000	0.000	0000000	0.000000	00000	0.
Ι	DEP_TIME	2 4	543		644		645		646	
Y 648	64			0.00000		0 000		0 003803		0
0000000000)	0.00000000	JUU	0.00000	00000	0.000	0000000	0.00389.	10306	0.
Υ	DEP_TIME 65	0 6	651		652		653		654	
		6 0.00000000	000	0.00000	00000	0.000	0000000	0.003893	10506	0.
	DEP_TIME	C (^ F 7		CEO		CEO		700	
Y 702	65		557	0.00000	658	0 007	659	0 003803	700	0
0000000000)	0 0.01556420	J23	0.00000	00000	0.003	88910206	0.00389.	10306	0.
Υ	DEP_TIME 70	3 7	704		706		707		708	
		0.00000000	000	0.00000	00000	0.000	0000000	0.003892	10506	0.
	DEP_TIME									
Y 728	71		721		722		726		727	
0000000000)	0 0.00000000)00	0.00000	00000	0.000	00000000	0.000000	00000	0.
Υ	DEP_TIME 72	9 7	730		731		732		733	
734 delayed	0.003891050	6 0.00389105	506	0.00389	10506	0.000	0000000	0.000000	00000	0.
0000000000) DEP_TIME									

Y 739	741	744	745	746	
747 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 749	750	753	754	755	
756 delayed 0.0000000000 0000000000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 757	758	759	800	801	
810 delayed 0.0000000000 0000000000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 815	817	822	824	826	
827 delayed 0.0038910506 0038910506	0.000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 828	829	830	831	832	
833 delayed 0.0000000000 0000000000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 834	835	836	837	838	
839 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.000000000	0.
DEP_TIME Y 840	841	842	843	844	
845 delayed 0.0038910506 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 846	847	848	849	850	
851 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 852	853	854	855	856	
857 delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 858	859	900	901	904	
906 delayed 0.0000000000	0.0038910506	0.000000000	0.0000000000	0.0038910506	0.
0000000000 DEP_TIME Y 911	912	913	915	917	
918 delayed 0.0000000000					0.
0000000000 DEP_TIME Y 919	920	921	924	925	
926 delayed 0.0000000000					0.
0000000000 DEP_TIME Y 927	928	929	930	931	
932 delayed 0.0000000000					0.
000000000					

Y	DEP_TIME	941	943	946	954	955	
956	1 0 00000						0
00000000	00	50000	0.000000000	0.0038910506	0.000000000	0.0038910306	υ.
Y	DEP_TIME	957	958	1000	1001	1004	
1005 delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
Y 1027	DEP_TIME	1017	1019	1022	1025	1026	
1027 delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Υ	DEP_TIME	1028	1029	1030	1031	1032	
1033 delaye	d 0.00000	00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
00000000	00 DEP_TIME						
Y 1040	2 = 1 = 1 = 1	1034	1035	1036	1037	1038	
		00000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Υ	DEP_TIME	1044	1047	1048	1050	1053	
1054	4 U UU380.			0.000000000			0.
00000000	00	10300	0.000000000	0.000000000	0.000000000	0.0038910300	υ.
Y 1100	DEP_TIME	1055	1056	1057	1058	1059	
		00000	0.0000000000	0.0038910506	0.000000000	0.0000000000	0.
0000000	DEP_TIME	1100	1100	1100	4400		
Y 1128_		1102	1103	1106	1108	1111	
delaye 00000000	00	00000	0.0000000000	0.000000000	0.0000000000	0.0038910506	0.
Υ	DEP_TIME	1129	1130	1131	1132	1137	
1141 delaye	d 0.00000	00000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
00389105	06 DEP_TIME						
Y 1158		1151	1153	1155	1156	1157	
delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
Υ	DEP_TIME	1159	1202	1217	1221	1227	
1228 delaye	d 0.00000	00000	0.000000000	0.0000000000	0.0000000000	0.000000000	0.
00000000	00 DEP_TIME						
Y 1236		1229	1230	1231	1232	1235	
		00000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Y 1242	DEP_TIME	1237	1238	1239	1240	1241	

delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1243 1248	1244	1245	1246	1247	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.000000000	0.
DEP_TIME Y 1249 1254	1250	1251	1252	1253	
delayed 0.0000000000 000000000000000000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1255	1256	1257	1258	1259	
1300 delayed 0.0000000000 0000000000	0.000000000	0.0077821012	0.000000000	0.0038910506	0.
DEP_TIME Y 1301 1306	1302	1303	1304	1305	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1307	1309	1310	1312	1313	
1314 delayed 0.0000000000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
0000000000 DEP_TIME Y 1315	1319	1320	1321	1324	
1326 delayed 0.0000000000					0.
0038910506 DEP_TIME	1220	1220	1220	1221	
Y 1327 1332	1328	1329	1330	1331	0
delayed 0.0000000000 0000000000 DEP_TIME	0.0000000000	0.0038910506	0.0000000000	0.0038910506	0.
Y 1338 1349	1341	1342	1345	1348	
delayed 0.0000000000 000000000000000000000000	0.0038910506	0.0038910506	0.0038910506	0.0038910506	0.
DEP_TIME Y 1350	1351	1352	1353	1354	
1355 delayed 0.0038910506 0000000000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1356	1357	1358	1359	1400	
1401 delayed 0.0000000000	0.0038910506		0.0038910506	0.000000000	0.
0000000000 DEP_TIME	1403	1405	1408	1409	
Y 1402 1416					•
delayed 0.0000000000 0038910506 DEP_TIME	0.0000000000	0.0038910506	0.0000000000	0.0038910506	0.
Y 1421 1427	1423	1424	1425	1426	
delayed 0.0038910506 0000000000 DEP_TIME	0.0038910506	0.0038910506	0.000000000	0.000000000	0.

1428	3 1429	1430	1431	1432	
.433 delayed 0.0038910500 0038910506	0.0000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME / 143!	5 1439	1442	1444	1445	
446 delayed 0.0000000000			0.0038910506		0.
0000000000 DEP_TIME					
′ 1448 L453		1450	1451	1452	
delayed 0.00000000000000000000000000000000000	0.0000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME ' 1454	1455	1456	1457	1458	
.459 delayed 0.00000000000 038910506	0.0000000000	0.0116731518	0.0116731518	0.0038910506	0.
DEP_TIME / 1500) 1501	1502	1503	1504	
1300 1505 delayed 0.0077821012					0
077821012 DEP_TIME	0.0030310300	0.000000000	0.000000000	0.000000000	0.
/ 1500 L512	5 1508	1509	1510	1511	
delayed 0.00000000000000000000000000000000000	0.0000000000	0.0077821012	0.000000000	0.0038910506	0.
DEP_TIME 1513	3 1514	1515	1516	1517	
.519 _delayed_0.0038910500	5 0.0038910506	0.000000000	0.000000000	0.000000000	0.
0000000000 DEP_TIME		4.500	4.500		
/ 1520 1525	-	1522	1523	1524	_
delayed 0.0077821017 0000000000	2 0.0038910506	0.0000000000	0.0000000000	0.0000000000	0.
DEP_TIME ' 1520	5 1527	1528	1529	1530	
.531 delayed 0.0000000000 0000000000	0.0077821012	0.0116731518	0.000000000	0.0038910506	0.
DEP_TIME / 1532	2 1533	1534	1535	1536	
.537 delayed 0.0000000000					٥
0000000000 DEP_TIME	0.0030310300	0.000000000	0.0110731310	0.0030310300	0.
/ 1538 L549	3 1539	1540	1545	1548	
delayed 0.00000000000000000000000000000000000	0.0038910506	0.0038910506	0.0038910506	0.000000000	0.
DEP_TIME 1552	L 1552	1554	1555	1556	
.557 delayed 0.0038910500	5 0.0000000000	0.000000000	0.0116731518	0.000000000	0.
0038910506 DEP_TIME	1550	1000	1001	1.000	
(1558 1603		1600	1601	1602	^
delayed 0.0000000000 0000000000	0.0000000000	0.0116/31518	0.0038910506	0.0000000000	υ.

	DEP_TIME	1604	1.005	1606	1607	1.000	
Y 1609		1604	1605	1606	1607	1608	
delaye 00389105	06	10506	0.000000000	0.000000000	0.000000000	0.000000000	0.
Y 1619	DEP_TIME	1610	1612	1613	1615	1617	
1618 delaye 00389105		10506	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Υ	DEP_TIME	1619	1620	1622	1623	1624	
		10506	0.0038910506	0.0077821012	0.0000000000	0.000000000	0.
00000000	OO DEP_TIME		4.000	4.000	4.000		
Y 1632		1627	1628	1629	1630	1631	
00000000	00	00000	0.0000000000	0.0000000000	0.0038910506	0.000000000	0.
Y 1620	DEP_TIME	1633	1634	1635	1636	1637	
		21012	0.0038910506	0.000000000	0.000000000	0.000000000	0.
00778210	DEP_TIME	1620	1040	1641	1042	1042	
Y 1644	-1 0 00000	1639	1640	1641	1642	1643	•
00000000	00	50000	0.0000000000	0.0000000000	0.0038310300	0.0038910506	υ.
Y 1650	DEP_TIME	1645	1646	1647	1648	1649	
1650 delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
	DEP_TIME	1651	1652	1653	1654	1655	
Y 1656	4 U UUS8U.				0.000000000		٥
00778210		10306	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.
Y 1702	DEL_ITME	1657	1658	1659	1700	1701	
		00000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
Y	DEP_TIME	1703	1704	1705	1706	1707	
1708	4 0 00389 [.]					0.000000000	0
00000000		10300	0.0000000000	0.0030310300	0.0077021012	0.000000000	٠.
Y 1714	DEI _IIME	1709	1710	1711	1712	1713	
	00	00000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Y 1720	DEP_TIME	1715	1716	1717	1718	1719	
		10506	0.000000000	0.0038910506	0.000000000	0.000000000	0.
00389105 Y 1727	DEP_TIME	1721	1722	1723	1725	1726	
1161							

delayed 0.0038910506 0000000000	0.0000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1728 1733	1729	1730	1731	1732	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.0038910506	0.0077821012	0.
DEP_TIME Y 1735 1740	1736	1737	1738	1739	
delayed 0.0038910506 0077821012	0.000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 1741	1744	1745	1748	1750	
1751 delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 1752 1757	1753	1754	1755	1756	
delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
DEP_TIME Y 1758	1759	1800	1802	1803	
1808 delayed 0.0038910506 0038910506	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1811	1812	1813	1816	1818	
1819 delayed 0.0038910506 0000000000	0.0000000000	0.0038910506	0.0038910506	0.0038910506	0.
DEP_TIME Y 1820	1822	1823	1824	1825	
1826 delayed 0.0038910506 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1827	1828	1829	1830	1831	
1832 delayed 0.0038910506 0038910506	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1833	1834	1837	1842	1843	
1844 delayed 0.0038910506			0.0000000000		0.
0000000000 DEP_TIME					
Y 1846 1851	1847	1848	1849	1850	
delayed 0.0038910506 0077821012 DEP TIME	0.000000000	0.0038910506	0.0077821012	0.000000000	0.
Y 1852 1857	1853	1854	1855	1856	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
DEP_TIME Y 1858	1859	1900	1901	1902	
1903 delayed 0.0077821012 0000000000 DEP_TIME	0.0038910506	0.0038910506	0.0038910506	0.000000000	0.

Y 1904	1912	1915	1916	1917	
1918 delayed 0.0000000000 0000000000	0.000000000	0.0077821012	0.0077821012	0.0038910506	0.
DEP_TIME Y 1920 1929	1922	1924	1927	1928	
delayed 0.0038910506 0000000000	0.0077821012	0.000000000	0.0077821012	0.0038910506	0.
DEP_TIME Y 1930 1941	1931	1936	1937	1939	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
DEP_TIME Y 1947 1953	1948	1949	1951	1952	
delayed 0.0038910506 0000000000	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1955 2000	1956	1957	1958	1959	
delayed 0.0038910506 0000000000	0.0077821012	0.000000000	0.000000000	0.0077821012	0.
DEP_TIME Y 2001 2010	2002	2004	2006	2007	
delayed 0.0000000000 0038910506	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
DEP_TIME Y 2011 2023	2012	2014	2015	2019	
delayed 0.0000000000 0038910506	0.0038910506	0.0038910506	0.0038910506	0.0038910506	0.
DEP_TIME Y 2024 2030	2026	2027	2028	2029	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
DEP_TIME Y 2031 2051	2032	2033	2045	2050	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.0038910506	0.000000000	0.
DEP_TIME Y 2052 2058	2054	2055	2056	2057	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 2059 2110	2100	2104	2105	2106	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 2111 2116	2112	2113	2114	2115	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 2117 2122	2118	2119	2120	2121	
delayed 0.0000000000 0000000000	0.0038910506	0.0038910506	0.000000000	0.000000000	0.

```
DEP_TIME
                 2124
                              2125
                                           2126
                                                       2127
                                                                    2129
2130
 000000000
        DEP_TIME
                 2133
                              2134
                                           2135
                                                       2136
                                                                    2138
2139
 delayed 0.0038910506 0.0000000000 0.000000000 0.0038910506 0.0000000000 0.
0038910506
        DEP_TIME
                 2140
                              2143
                                           2145
                                                       2150
                                                                    2151
2153
 delayed 0.0038910506 0.0000000000 0.0000000000 0.0038910506 0.0038910506 0.
0038910506
        DEP_TIME
                 2155
                              2200
                                           2211
                                                       2213
                                                                    2214
2220
 delayed 0.0038910506 0.0038910506 0.0038910506 0.0038910506 0.00000000000 0.
0038910506
        DEP_TIME
                 2221
                              2222
                                           2230
                                                       2239
                                                                    2244
2300
 delayed 0.0038910506 0.00000000000 0.0038910506 0.0038910506 0.0077821012 0.
0038910506
        DEP_TIME
                 2305
                              2312
                                           2330
 delayed 0.0000000000 0.0038910506 0.0038910506
 [ reached getOption("max.print") -- omitted 1 row ]
        ORIGIN
Υ
                           DCA
                BWT
                                      IAD
 delayed 0.07392996 0.51361868 0.41245136
 ontime 0.06109023 0.64849624 0.29041353
        DEST
               EWR
                         JFK
 delayed 0.3891051 0.2217899 0.3891051
 ontime 0.2819549 0.1823308 0.5357143
        CARRIER
                  CO
                              DH
                                          DL
                                                     MQ
                                                                 OH
           UA
 delayed 0.066147860 0.322957198 0.112840467 0.178988327 0.007782101 0.20622
5681 0.011673152
 ontime 0.037593985 0.240601504 0.186090226 0.124060150 0.013157895 0.17857
1429 0.015037594
        CARRIER
 delayed 0.093385214
 ontime 0.204887218
> nb model
Naive Bayes Classifier for Discrete Predictors
call:
naiveBayes.default(x = X, y = Y, laplace = laplace)
A-priori probabilities:
 delaved
            ontime
0.1945496 0.8054504
```

```
Conditional probabilities:
     DAY_WEEK
                 2
                        3
                                    5
                                           6
 delayed 0.18677043 0.15953307 0.11284047 0.15175097 0.17509728 0.05447471 0
.15953307
 ontime
     0.14473684 \ 0.12687970 \ 0.13439850 \ 0.18139098 \ 0.18421053 \ 0.12312030 \ 0
.10526316
     DEP_TIME
           10
                  109
                          548
                                  550
                                         552
Υ
553
 000000000
     DEP_TIME
                  555
           554
                          556
                                  557
                                         558
559
 000000000
     DEP_TIME
           613
                  622
                          623
                                  624
                                         625
626
 000000000
     DEP_TIME
           627
                  628
                          629
                                  630
                                         631
632
 000000000
     DEP_TIME
                                         640
           633
                  634
                          635
                                  638
641
 0038910506
     DEP_TIME
           642
                  643
                          644
                                  645
                                         646
648
 000000000
     DEP_TIME
           650
                  651
                          652
                                  653
                                         654
655
 000000000
     DEP_TIME
           656
                  657
                          658
                                  659
                                         700
702
 delayed 0.0000000000 0.0155642023 0.0000000000 0.0038910506 0.0038910506 0.
000000000
     DEP_TIME
           703
                  704
                          706
                                  707
                                         708
711
 0038910506
     DEP_TIME
           714
                  721
                          722
                                  726
                                         727
728
 0000000000
     DEP_TIME
                  730
           729
                          731
                                  732
                                         733
734
 delayed 0.0038910506 0.0038910506 0.0038910506 0.00000000000 0.0000000000 0.
```

Y	DEP_TIME	739	741	744	745	746	
747 delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
Y 756	DEP_TIME	749	750	753	754	755	
	00	0000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Y 810	DEP_TIME	757	758	759	800	801	
delaye 00000000		00000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Y 827	DEP_TIME	815	817	822	824	826	
	06	.0506	0.000000000	0.0038910506	0.000000000	0.000000000	0.
Y	DEP_TIME	828	829	830	831	832	
833 delaye 00000000	d 0.000000	0000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Υ	DEP_TIME	834	835	836	837	838	
		0000	0.0000000000	0.0000000000	0.0038910506	0.000000000	0.
00000000	00 DEP_TIME	0.40	0.44	2.42	2.42	244	
Y 845	J 0 002001	840	841	842	843	844	^
00000000	a 0.003891 00 DEP_TIME	.0506	0.0000000000	0.0000000000	0.000000000	0.0000000000	0.
Y 851	DEI _I IME	846	847	848	849	850	
	00	00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
Υ	DEP_TIME	852	853	854	855	856	
857 delaye 00389105		0000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Υ	DEP_TIME	858	859	900	901	904	
906 delaye 00000000	d 0.000000	00000	0.0038910506	0.000000000	0.000000000	0.0038910506	0.
Y	DEP_TIME	911	912	913	915	917	
918	d 0.000000				0.000000000		0.
00000000							
Y 926		919	920	921	924	925	
delaye 00000000	00	00000	0.0038910506	0.000000000	0.000000000	0.0038910506	0.
Y 932	DEP_TIME	927	928	929	930	931	

delayed 0.0000000000 000000000000000000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 941 956	943	946	954	955	
delayed 0.0000000000 000000000000000000000000	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 957 1005	958	1000	1001	1004	
delayed 0.0000000000 000000000000000000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1017 1027	1019	1022	1025	1026	
delayed 0.0000000000 0000000000 DEP_TIME	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Y 1028 1033	1029	1030	1031	1032	
delayed 0.0000000000 000000000000000000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1034	1035	1036	1037	1038	
1040 delayed 0.0000000000 0038910506 DEP_TIME	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Y 1044	1047	1048	1050	1053	
1054 delayed 0.0038910506 0000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1055	1056	1057	1058	1059	
1100 delayed 0.0000000000 0000000000	0.0000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 1102	1103	1106	1108	1111	
1128 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1129	1130	1131	1132	1137	
1141 delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1151	1153	1155	1156	1157	
1158 delayed 0.00000000000				-	Ω
0000000000 DEP_TIME					0.
Y 1159 1228	1202	1217	1221	1227	
delayed 0.0000000000 0000000000 DEP_TIME	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.
Y 1229 1236	1230	1231	1232	1235	
delayed 0.0000000000 0038910506 DEP_TIME	0.0000000000	0.0000000000	0.0000000000	0.0038910506	0.

Y 1237	1238	1239	1240	1241	
1242 delayed 0.0000000000 0038910506	0.0000000000	0.0000000000	0.000000000	0.0000000000	0.
DEP_TIME Y 1243	1244	1245	1246	1247	
1248 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.000000000	0.
DEP_TIME Y 1249	1250	1251	1252	1253	
1254 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0000000000	0.0038910506	0.
DEP_TIME Y 1255 1300	1256	1257	1258	1259	
delayed 0.0000000000 0000000000	0.000000000	0.0077821012	0.000000000	0.0038910506	0.
DEP_TIME Y 1301 1306	1302	1303	1304	1305	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1307	1309	1310	1312	1313	
1314 delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
DEP_TIME Y 1315	1319	1320	1321	1324	
1326 delayed 0.0000000000 0038910506	0.000000000	0.0038910506	0.0077821012	0.0038910506	0.
DEP_TIME Y 1327	1328	1329	1330	1331	
1332 delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1338	1341	1342	1345	1348	
1349 delayed 0.0000000000 0000000000	0.0038910506	0.0038910506	0.0038910506	0.0038910506	0.
DEP_TIME Y 1350	1351	1352	1353	1354	
1355 delayed 0.0038910506 0000000000	0.0038910506	0.000000000	0.000000000	0.0000000000	0.
DEP_TIME Y 1356	1357	1358	1359	1400	
1401 delayed 0.0000000000 0000000000	0.0038910506	0.000000000	0.0038910506	0.000000000	0.
DEP_TIME Y 1402	1403	1405	1408	1409	
1416 delayed 0.0000000000 0038910506	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1421	1423	1424	1425	1426	
1427 delayed 0.0038910506 0000000000	0.0038910506	0.0038910506	0.000000000	0.000000000	0.

	DEP_TIME	1 420	1 420	1 420	1421	1 422	
Y 1433		1428	1429	1430	1431	1432	
delaye 00389105	06	10506	0.000000000	0.000000000	0.000000000	0.000000000	0.
Y 1446	DEP_TIME	1435	1439	1442	1444	1445	
1446 delaye 00000000	00	00000	0.000000000	0.000000000	0.0038910506	0.000000000	0.
Υ	DEP_TIME	1448	1449	1450	1451	1452	
		00000	0.000000000	0.0000000000	0.0000000000	0.000000000	0.
00000000	00 DEP_TIME						
Y 1459		1454	1455	1456	1457	1458	
delaye 00389105		00000	0.000000000	0.0116731518	0.0116731518	0.0038910506	0.
Υ	DEP_TIME	1500	1501	1502	1503	1504	
		21012	0.0038910506	0.0000000000	0.0000000000	0.000000000	0.
00778210	12 DEP_TIME						
Y 1512		1506	1508	1509	1510	1511	
delaye 00778210		00000	0.000000000	0.0077821012	0.0000000000	0.0038910506	0.
Y	DEP_TIME	1513	1514	1515	1516	1517	
		10506	0.0038910506	0.0000000000	0.0000000000	0.0000000000	0.
00000000	00 DEP_TIME						
Y 1525		1520	1521	1522	1523	1524	
delaye 00000000		21012	0.0038910506	0.000000000	0.000000000	0.000000000	0.
Y	DEP_TIME	1526	1527	1528	1529	1530	
1531 delaye	d 0.00000	00000	0.0077821012	0.0116731518	0.0000000000	0.0038910506	0.
00000000	00 DEP_TIME						
Y 1537		1532	1533	1534	1535	1536	
delaye 00000000		00000	0.0038910506	0.000000000	0.0116731518	0.0038910506	0.
Y	DEP_TIME	1538	1539	1540	1545	1548	
		00000	0.0038910506	0.0038910506	0.0038910506	0.0000000000	0.
00778210	12 DEP_TIME						
Y 1557_		1551	1552	1554	1555	1556	
delaye 00389105	06	10506	0.000000000	0.000000000	0.0116731518	0.0000000000	0.
Y	DEP_TIME	1558	1559	1600	1601	1602	
1603							

delayed 0.0000000000 0000000000	0.0000000000	0.0116731518	0.0038910506	0.0000000000	0.
DEP_TIME Y 1604 1609	1605	1606	1607	1608	
delayed 0.0038910506 0038910506	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1610 1618	1612	1613	1615	1617	
delayed 0.0038910506 0038910506	0.0000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1619	1620	1622	1623	1624	
1625 delayed 0.0038910506 0000000000	0.0038910506	0.0077821012	0.000000000	0.0000000000	0.
DEP_TIME Y 1627	1628	1629	1630	1631	
1632 delayed 0.0000000000 0000000000	0.0000000000	0.000000000	0.0038910506	0.0000000000	0.
DEP_TIME Y 1633	1634	1635	1636	1637	
1638 delayed 0.0077821012 0077821012	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1639	1640	1641	1642	1643	
1644 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
DEP_TIME Y 1645	1646	1647	1648	1649	
1650 delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1651	1652	1653	1654	1655	
1656 delayed 0.0038910506 0077821012	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1657	1658	1659	1700	1701	
1702 delayed 0.0000000000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
0038910506 DEP_TIME	4-0.	4-0-	4-00		
Y 1703 1708	1704	1705	1706	1707	
delayed 0.0038910506 0000000000 DEP TIME	0.0000000000	0.0038910506	0.0077821012	0.0000000000	0.
Y 1709	1710	1711	1712	1713	
delayed 0.0000000000 000000000000000000000000	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1715	1716	1717	1718	1719	
1720 delayed 0.0038910506 0038910506 DEP_TIME	0.000000000	0.0038910506	0.000000000	0.000000000	0.

Y 1721	1722	1723	1725	1726	
1727 delayed 0.0038910506 0000000000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
DEP_TIME Y 1728 1733	1729	1730	1731	1732	
delayed 0.0000000000 0038910506	0.000000000	0.000000000	0.0038910506	0.0077821012	0.
DEP_TIME Y 1735 1740	1736	1737	1738	1739	
delayed 0.0038910506 0077821012	0.000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 1741	1744	1745	1748	1750	
1751 delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.000000000	0.000000000	0.
DEP_TIME Y 1752 1757	1753	1754	1755	1756	
delayed 0.0000000000 0000000000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
DEP_TIME Y 1758 1808	1759	1800	1802	1803	
delayed 0.0038910506 0038910506	0.0038910506	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1811 1819	1812	1813	1816	1818	
delayed 0.0038910506 0000000000	0.000000000	0.0038910506	0.0038910506	0.0038910506	0.
DEP_TIME Y 1820 1826	1822	1823	1824	1825	
delayed 0.0038910506 0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.
DEP_TIME Y 1827 1832	1828	1829	1830	1831	
delayed 0.0038910506 0038910506	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1833 1844	1834	1837	1842	1843	
delayed 0.0038910506 0000000000	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
DEP_TIME Y 1846 1851	1847	1848	1849	1850	
delayed 0.0038910506 0077821012	0.000000000	0.0038910506	0.0077821012	0.000000000	0.
DEP_TIME Y 1852 1857	1853	1854	1855	1856	
delayed 0.0000000000 0000000000	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
DEP_TIME Y 1858 1903	1859	1900	1901	1902	
delayed 0.0077821012 0000000000	0.0038910506	0.0038910506	0.0038910506	0.000000000	0.

Y	DEP_TIME	1904	1912	1915	1916	1917	
1918 delaye 00000000		00000	0.000000000	0.0077821012	0.0077821012	0.0038910506	0.
Υ	DEP_TIME	1920	1922	1924	1927	1928	
1929 delaye 00000000		10506	0.0077821012	0.000000000	0.0077821012	0.0038910506	0.
Υ	DEP_TIME	1930	1931	1936	1937	1939	
1941 delaye 00389105		00000	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
Υ	DEP_TIME	1947	1948	1949	1951	1952	
1953 delaye 00000000	d 0.00389	10506	0.000000000	0.0038910506	0.000000000	0.0038910506	0.
Υ	DEP_TIME	1955	1956	1957	1958	1959	
2000 delaye 00000000	d 0.00389:	10506	0.0077821012	0.000000000	0.000000000	0.0077821012	0.
Y	DEP_TIME	2001	2002	2004	2006	2007	
2010 delaye 00389105		00000	0.000000000	0.0038910506	0.0038910506	0.000000000	0.
Y 2023	DEP_TIME	2011	2012	2014	2015	2019	
		00000	0.0038910506	0.0038910506	0.0038910506	0.0038910506	0.
Y 2030	DEP_TIME	2024	2026	2027	2028	2029	
	d 0.00000 06	00000	0.000000000	0.000000000	0.0038910506	0.0038910506	0.
Y 2051	DEP_TIME	2031	2032	2033	2045	2050	
	06	00000	0.000000000	0.000000000	0.0038910506	0.000000000	0.
Y 2058	DEP_TIME	2052	2054	2055	2056	2057	
delaye 00000000	00	00000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Y 2110	DEP_TIME	2059	2100	2104	2105	2106	
delaye 00389105	06	00000	0.000000000	0.000000000	0.000000000	0.0038910506	0.
Y 2116	DEP_TIME	2111	2112	2113	2114	2115	
delaye 00000000		00000	0.000000000	0.000000000	0.000000000	0.000000000	0.
Y 2122	32. <u>_</u> , znc	2117	2118	2119	2120	2121	

```
delayed 0.0000000000 0.0038910506 0.0038910506 0.0000000000 0.0000000000 0.
000000000
        DEP_TIME
                 2124
                              2125
                                           2126
                                                        2127
                                                                     2129
2130
 0000000000
        DEP_TIME
                 2133
                              2134
                                           2135
                                                        2136
                                                                     2138
2139
 delayed 0.0038910506 0.0000000000 0.000000000 0.0038910506 0.0000000000 0.
0038910506
        DEP_TIME
                 2140
                              2143
                                                        2150
                                           2145
                                                                     2151
2153
 delayed 0.0038910506 0.0000000000 0.000000000 0.0038910506 0.0038910506 0.
0038910506
        DEP_TIME
                 2155
                              2200
                                           2211
                                                        2213
                                                                     2214
2220
 delayed 0.0038910506 0.0038910506 0.0038910506 0.0038910506 0.00000000000 0.
0038910506
        DEP_TIME
                 2221
                              2222
                                           2230
                                                        2239
                                                                     2244
2300
 delayed 0.0038910506 0.0000000000 0.0038910506 0.0038910506 0.0077821012 0.
0038910506
        DEP_TIME
                  2305
                              2312
 delayed 0.0000000000 0.0038910506 0.0038910506
 [ reached getOption("max.print") -- omitted 1 row ]
        ORIGIN
                           DCA
Υ
                BWI
                                      IAD
  delayed 0.07392996 0.51361868 0.41245136
 ontime 0.06109023 0.64849624 0.29041353
        DEST
               EWR
                         JFK
 delayed 0.3891051 0.2217899 0.3891051
 ontime 0.2819549 0.1823308 0.5357143
         CARRIER
                  CO
                              DH
                                          DL
                                                      MQ
RU
 delayed 0.066147860 0.322957198 0.112840467 0.178988327 0.007782101 0.20622
5681 0.011673152
 ontime 0.037593985 0.240601504 0.186090226 0.124060150 0.013157895 0.17857
1429 0.015037594
        CARRIER
Υ
 delayed 0.093385214
 ontime 0.204887218
> # Predict the FlightStatus of Train dataset
 Predicted_Train_labels <-predict(nb_model,Train)</pre>
 Predicted_Validation_labels <-predict(nb_model, Validation)</pre>
> # Tthe confusion matrix of the classifier
> CrossTable(x=Validation$FlightStatus,y=Predicted_Validation_labels, prop.ch
isq = FALSE
   Cell Contents
```

					N	
ĺ					Total	
		Ν	/	Col	Total	
	N	/	Τā	able	Total	
						-

Total Observations in Table: 880

		/alidation_la	
Validation\$FlightStatus	delayed	ontime	Row Total
delayed	29 0.170 0.408 0.033	142 0.830 0.176 0.161	171 0.194
ontime	42 0.059 0.592 0.048	667 0.941 0.824 0.758	709 0.806
Column Total	71 0.081	809 0.919	880
			1 1

> # Tthe confusion matrix of the classifier
> CrossTable(x=Validation\$FlightStatus,y=Predicted_Validation_labels, prop.ch
isq = FALSE)

Cell Contents	
N / Row Total N / Col Total N / Table Total	

Total Observations in Table: 880

Validation\$FlightStatus	Predicted_\ delayed	/alidation_la ontime	abels Row Total
delayed	29 0.170 0.408 0.033	142 0.830 0.176 0.161	171 0.194
ontime	42 0.059 0.592 0.048	667 0.941 0.824 0.758	709 0.806
Column Total	71 0.081	809 0.919	880

```
> # The first few values
> head(Predicted_Validation_labels)
         delayed
                      ontime
[1,] 0.12956597 0.8704340
[2,] 0.52123452 0.4787655
[3,] 0.11083013 0.8891699
[4,] 0.06976684 0.9302332
[5,] 0.02439002 0.9756100
[6,] 0.08191462 0.9180854
> # The first few values
> head(Predicted_Validation_labels)
         delayed
                      ontime
[1,] 0.12956597 0.8704340
[2,] 0.52123452 0.4787655
[3,] 0.11083013 0.8891699
[4,] 0.06976684 0.9302332
[5,] 0.02439002 0.9756100
[6,] 0.08191462 0.9180854
> # Passing the second column of the predicted probabilities
> # That column contains the probability associate to 'yes'
> roc(Validation$FlightStatus, Predicted_Validation_labels[.2])
call:
roc.default(response = Validation$FlightStatus, predictor = Predicted_Validat
ion_labels[,
                   2])
Data: Predicted_Validation_labels[, 2] in 171 controls (Validation$FlightStat
us delayed) < 709 cases (Validation$FlightStatus ontime).
Area under the curve: 0.7092
> # Passing the second column of the predicted probabilities
> # That column contains the probability associate to 'yes
> roc(Validation$FlightStatus, Predicted_Validation_labels[,2])
call:
roc.default(response = Validation$FlightStatus, predictor = Predicted_Validat
ion_labels[,
                   2])
Data: Predicted_Validation_labels[, 2] in 171 controls (Validation$FlightStat
us delayed) < 709 cases (Validation$FlightStatus ontime). Area under the curve: 0.7092
> plot.roc(Validation$FlightStatus,Predicted_Validation_labels[,2])
```