ACCIDENT DATA ANALYSIS:

Introduction

The Fatal Accidents 2007 dataset consists all fatal accidents on public roads reported to the national highway transportation safety administration. I am using R for analyzing dataset by using different graphical interpretations and prediction model to find the solutions for the following research questions.

1.Fatalities by month, day of week, hour, state
2.Crash counts by Roadway function class, Route, Relation to road, Speed limit, light conditions,
3.Pedestrians involved in accident, Number of hit and run cases in accidents
4.Which type of accidents are more frequent in different road types
5.Accidents by alignment and number of lanes, Surrounding conditions and traffic controls functioning, weather conditions and roadway traffic flow.
6.Predict fatalities by different characteristic of accident data.

Dataset

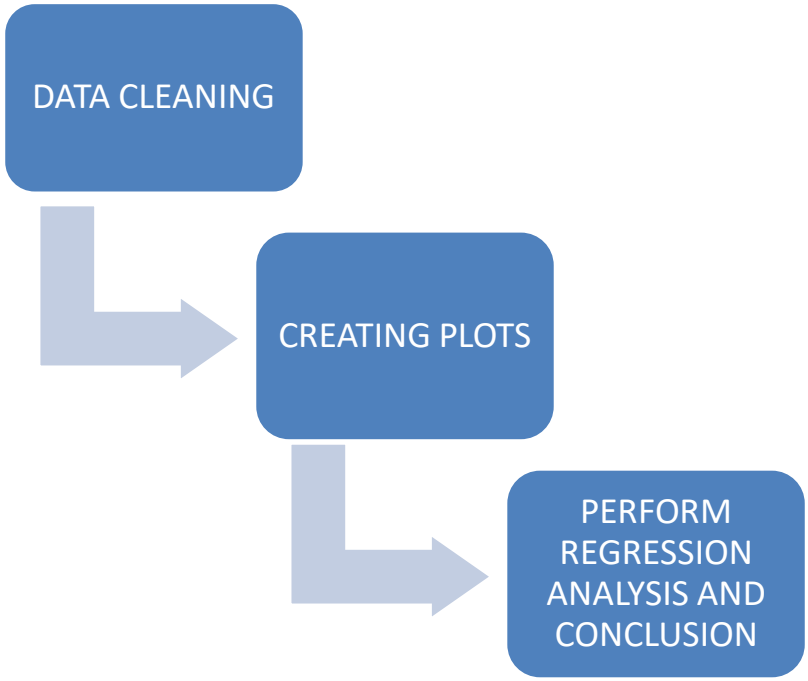
The Fatality Analysis Reporting System (FARS) contains data on all vehicle crashes in the United States that occur on a public roadway and involve a fatality. The Fatal accident dataset downloaded from https://wiki.csc.calpoly.edu/datasets/wiki/HighwayAccidents. It has 32248 instances and 55 attributes. I used 25 variables.

ACCIDENT2007-FullDataSet.csv

1.STATE: State in U.S
2.MONTH: Month of the year
3. HOUR: Hour of the day
4.VE_TOTAL: Vehicles involved in accident
5. PERSONS: Persons involved in accident
6. PEDS: Persons which are not occupants of motor vehicle involved in accident
7. ROAD_FNC: Function class of road
8. ROUTE: Route Type
9.MAN_COLL: Manner of collision
10.REL_ROAD: Relation to road
11.TRAF_FLO: Traffic way flow
12. NO_LANES: Number of lanes
13.SP_LIMIT: Speed limit
14.ALIGNMENT: Road way alignment
15.PAVE_TYP: Road way surface type
16:SUR_COND:Road way surrounding conditions

17:T_CONT_F: Traffic controls functioning
18.HIT_RUN: Hit and run
19:LGT_COND: Light condition
20:WEATHER1: Weather condition.
21:C_M_ZONE: Construction and maintenance zone
22:SCH_BUS: School bus related vehicle
23:FATALS: Number of fatalities
24:DAY_WEEK: Day of week
25:DRUNK_DR: drunk and driver

Approach



Step 1: Data cleaning:

Created a subset with variables using for this project. Creating factors of variable and removing the unknown and null values.

Step 2: Creating plots:

Generating plots by using ggplot2 library.

Step 3: Perform Regression analysis:

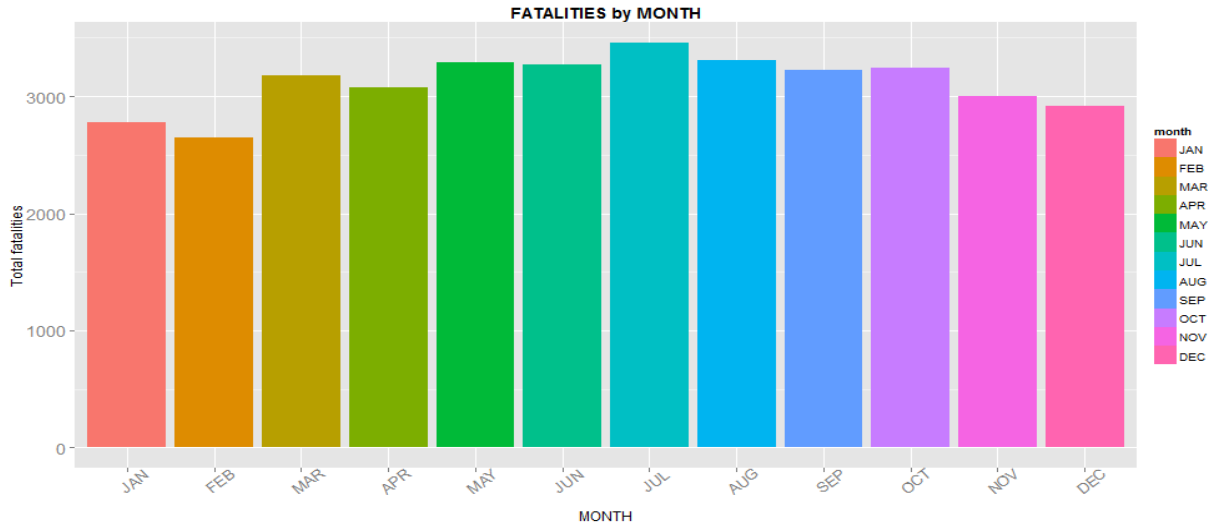
Selecting best subset of variables to perform regression analysis by using regularized linear regression method. Split data into two parts train and test. Creating multivariate regression model by using train data set and test this model with test dataset and finally conclusion.

RESULTS:

1.Which month of year have highest fatalities?

Summary of Month Variable:

```
JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
2493 2384 2855 2780 2992 2960 3142 2996 2910 2985 2732 2623
```

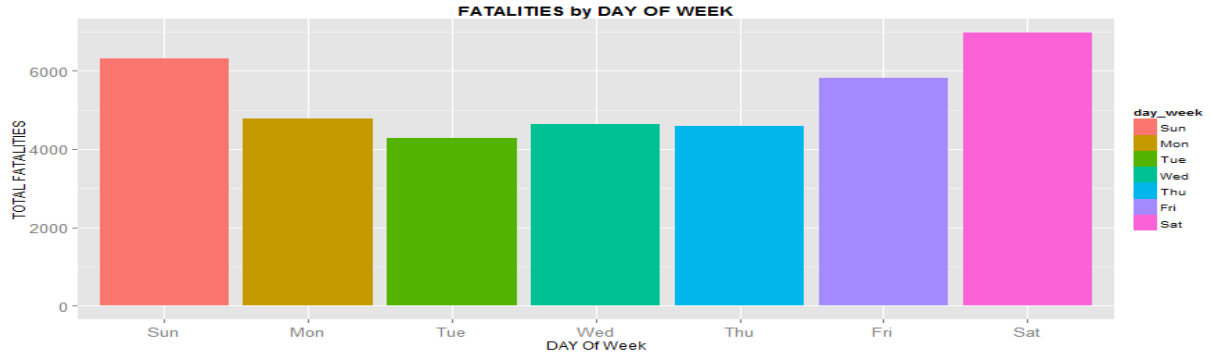


Fatalities are more in July. BY seeing this we can say accidents are more in summer than winter.

2.Which Day of week have highest fatalities

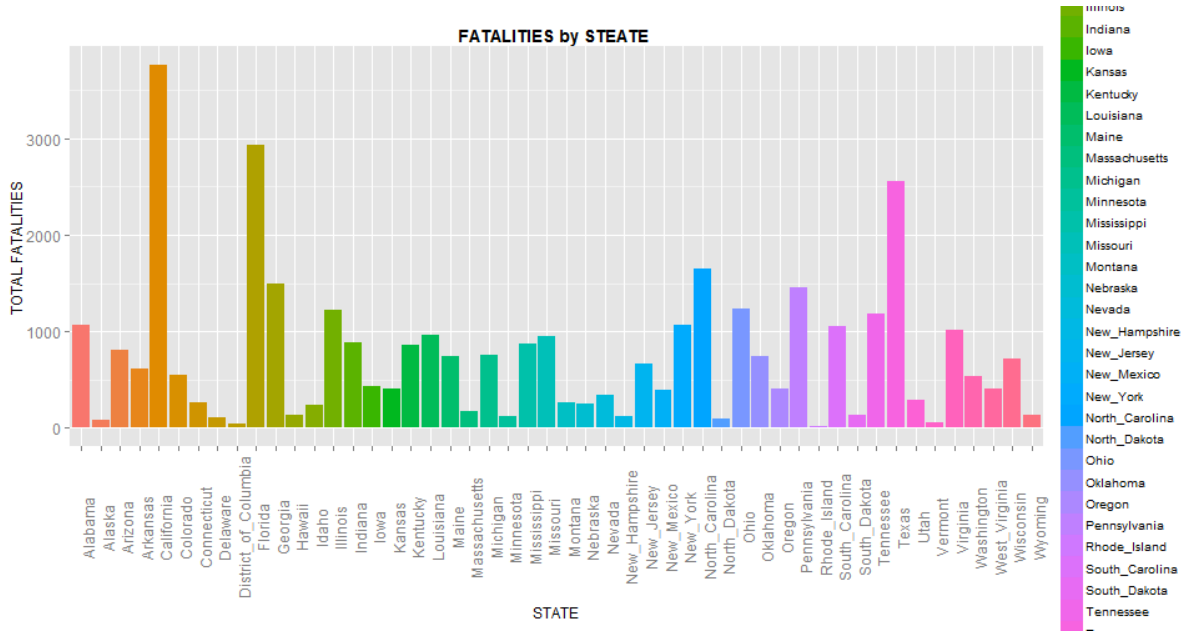
Summary of DAYOFWEEK Variable:

```
Sun  Mon  Tue  Wed  Thu  Fri  Sat
5617 4355 3953 4225 4206 5243 6253
```



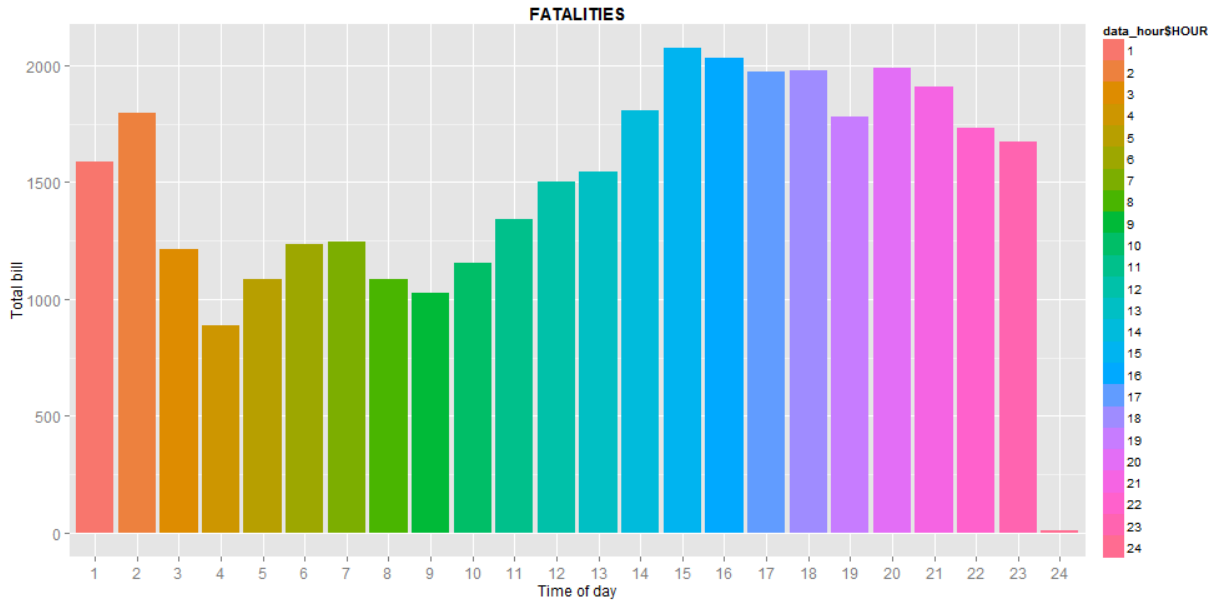
Fatalities are more in Saturday, Sunday, Friday. Accidents are more in Weekends.

3.Which state of U.S have highest fatalities?



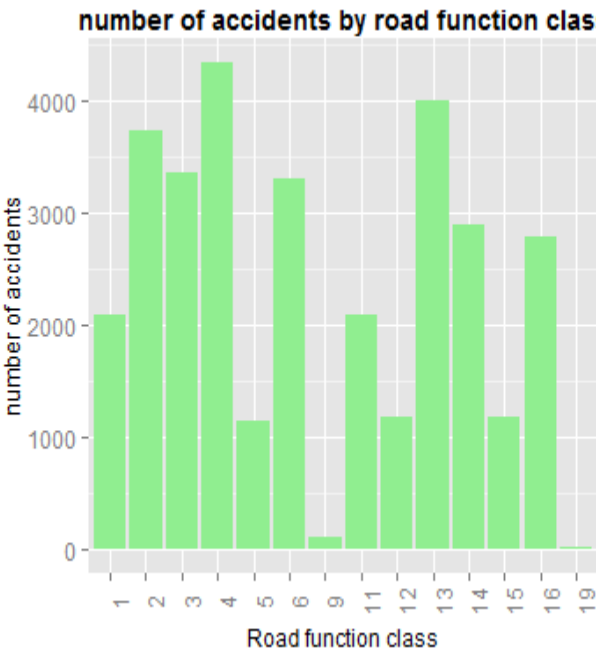
From this we can see California, Florida and Texas has highest fatalities.

4.Which Hour of day has highest fatalities?



From this we can say accidents are more in evenings and less in morning.

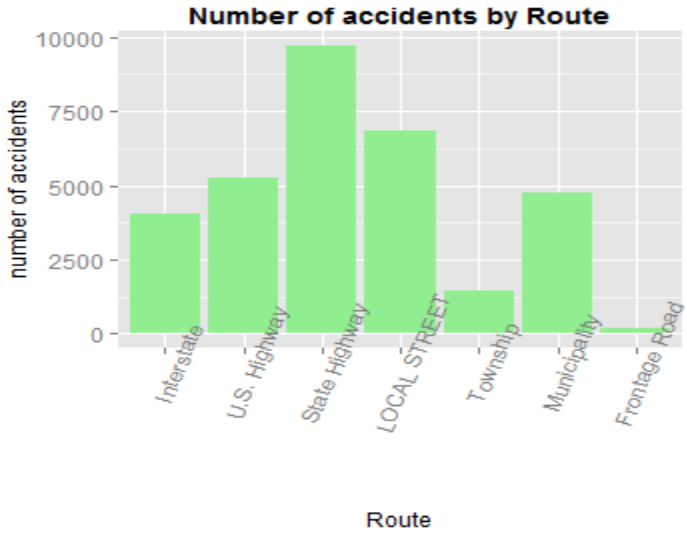
5.Number of accidents by road function class



1.Rural Principal Arterial-Interstate
2.Rural Principal Arterial-Other
3.Rural Minor Arterial
4.Rural Major Collector
5.Rural Minor Collector
6.Rural Local Road or Street
9.Rural Unknown
11.Urban Principal Arterial - Interstate
12.Urban Principal Arterial - Other Freeways or Expressways
13.Urban Other Principal Arterial
14.Urban Minor Arterial
15.Urban Collector
16.Urban Local Road or Street
19-Urban Unknown

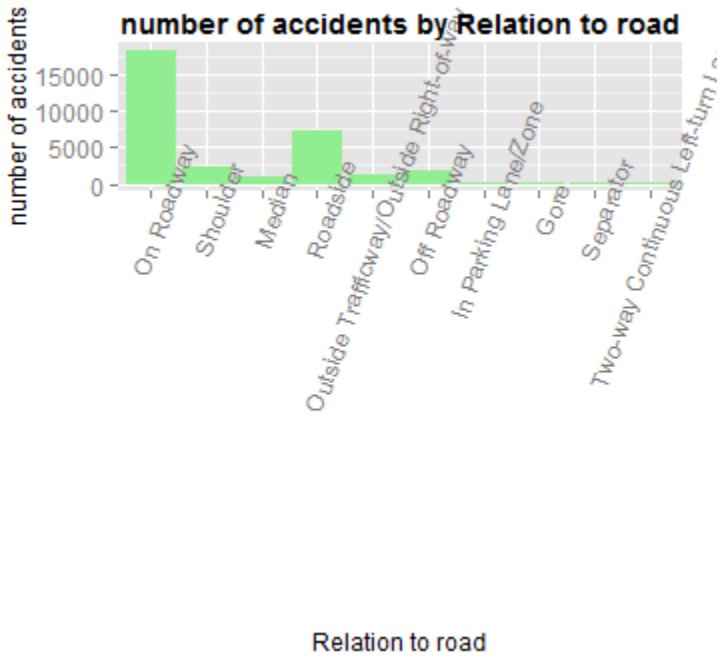
Accidents are more in Rural Major collector, Urban Other Principal Arterial, Rural Principal Arterial-Other, Rural Minor Arterial, Rural Local Road or Street, Urban Other Principal Arterial, Urban Minor Arterial, Urban Local Road or Street.

6.Number of accidents by Route:



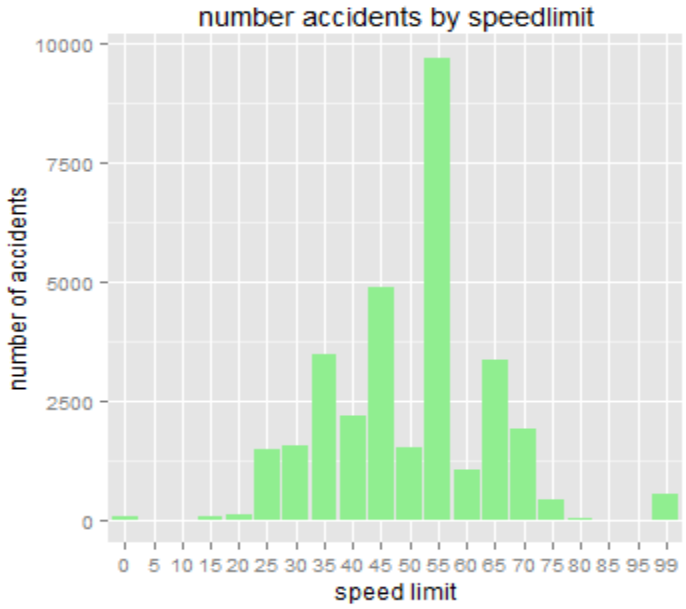
Accidents are more in State Highways

7.Number of accidents by relation to road:



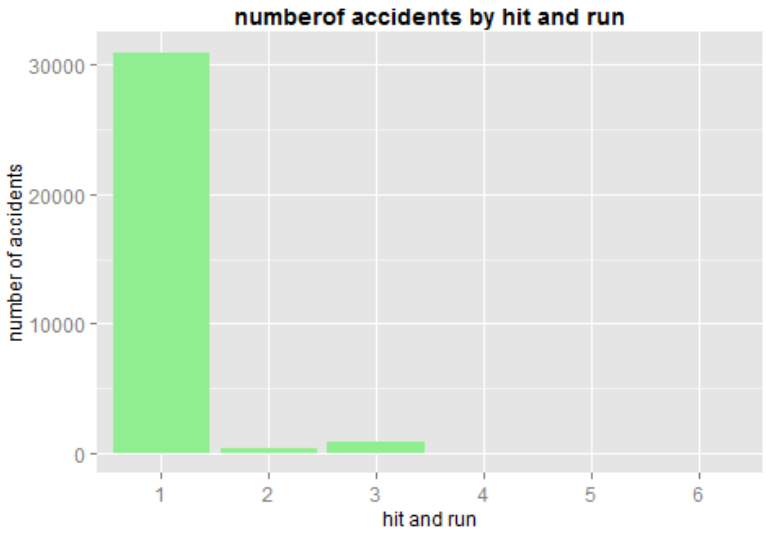
Accidents are more in On Roadway

8.Number of accidents by speed limit:



Accidents are more at 55 speed limit

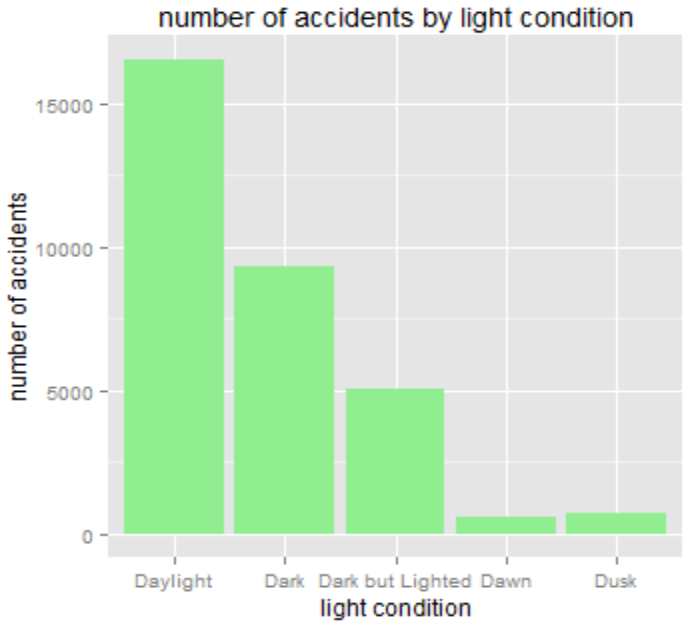
9.Number of hit and run in accidents:



1.No Hit-and-Run
2.Hit Motor Vehicle
3.Hit Pedestrian
4.Hit Parked Vehicle
5.Driver Leaves Scene after Non-Collision Event
6.Hit-and-Run, Other Involved Person Left Scene

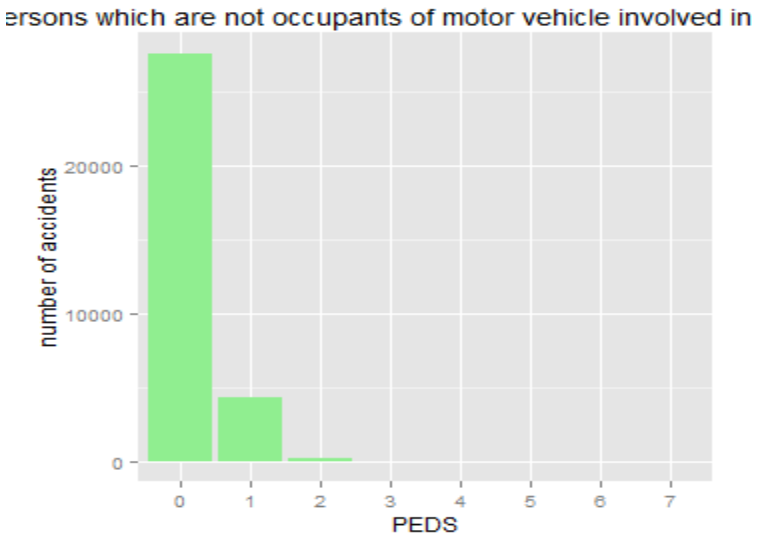
almost all accidents are not Hit and run cases .

10.Number of accidents by light condition:



Accidents are more in Daylight

11. persons which are not occupants of motor vehicle involved in accident

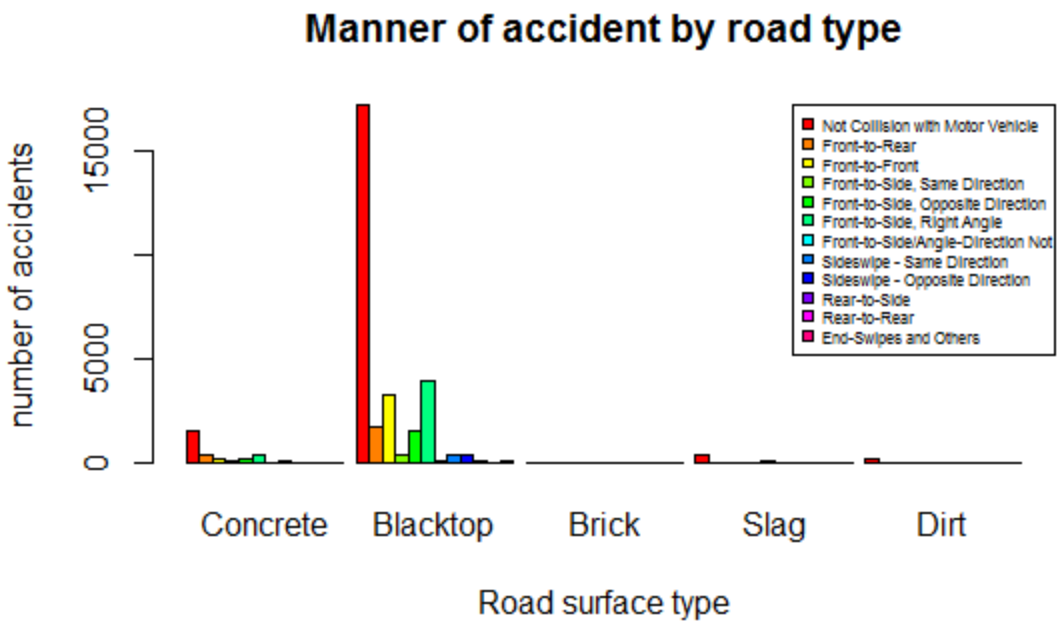


Very less pedestrians involved in accidents.

12. which type of accidents are more frequent in different road types

	PAVE_TYP				
MAN_COLL	Concrete	Blacktop	Brick	Slag	Dirt
Not Collision with Motor Vehicle	1543	17172	6	330	176
Front-to-Rear	349	1704	0	1	1
Front-to-Front	213	3224	0	15	15
Front-to-Side, Same Direction	51	378	0	1	0
Front-to-Side, Opposite Direction	128	1510	0	3	3
Front-to-Side, Right Angle	379	3923	0	36	6
Front-to-Side/Angle-Direction Not Specified	2	123	0	0	1
Sideswipe - Same Direction	64	365	0	0	0
Sideswipe - Opposite Direction	20	375	0	0	0
Rear-to-Side	11	54	0	0	0
Rear-to-Rear	1	1	0	0	0
End-Swipes and Others	6	53	0	1	2

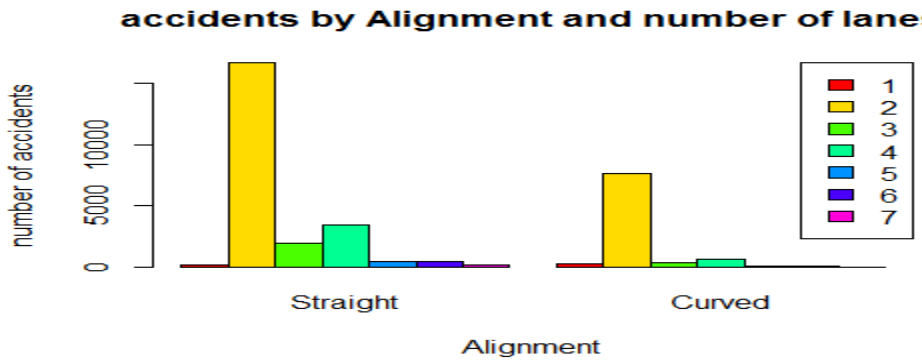
```
This is significant because p value is less than 0.05

        Pearson's Chi-squared test

data:  tbl
X-squared = 465.01, df = 44, p-value < 2.2e-16
```



Accidents are more in Blacktop road surface. More accidents are not collision with motor vehicle and front to side(right angle),Front to Front collisions are more.

13.Accidents by alignment and number of lanes:

```
          no. of lanes
alignment Straight Curved
        1      174    283
        2    16673   7609
        3     1941    379
        4     3435    611
        5      451     64
        6      445     28
        7      136     17
Chi-square test:
        Pearson's Chi-squared test

data:  tbl
X-squared = 1086, df = 6, p-value < 2.2e-16
```



Accidents are more in straight single lane and curved double lanes roads.

14. Accidents by surrounding conditions and traffic controls functioning.

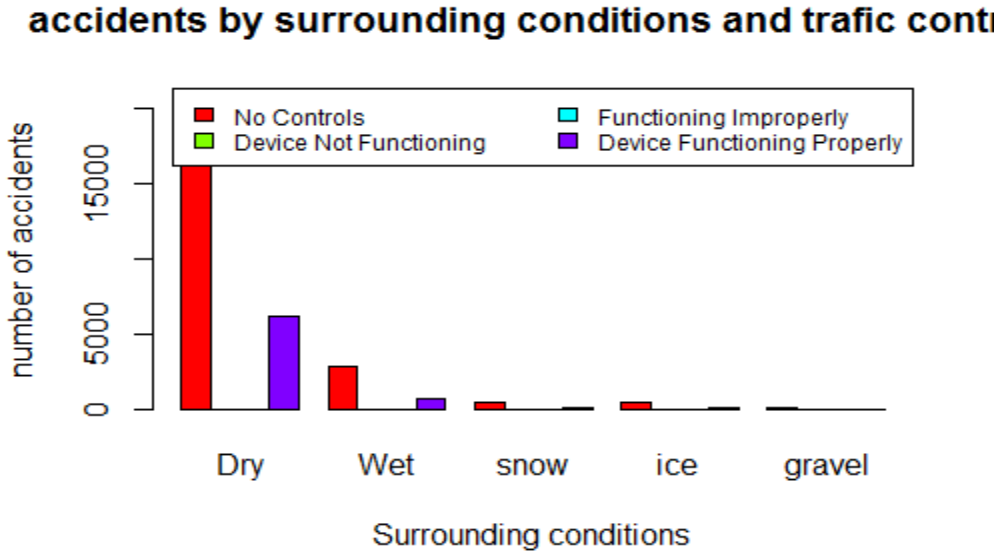
SUR_COND	T_CONT_F Dry	Wet	snow	ice	gravel
No Controls	21249	2881	502	443	52
Device Not Functioning	20	4	1	0	0
Functioning Improperly	21	2	0	0	0
Device Functioning Properly	6209	746	65	42	9

chi-square test:

Pearson's Chi-squared test

data: tbl

X-squared = 102.09, df = 12, p-value < 2.2e-16

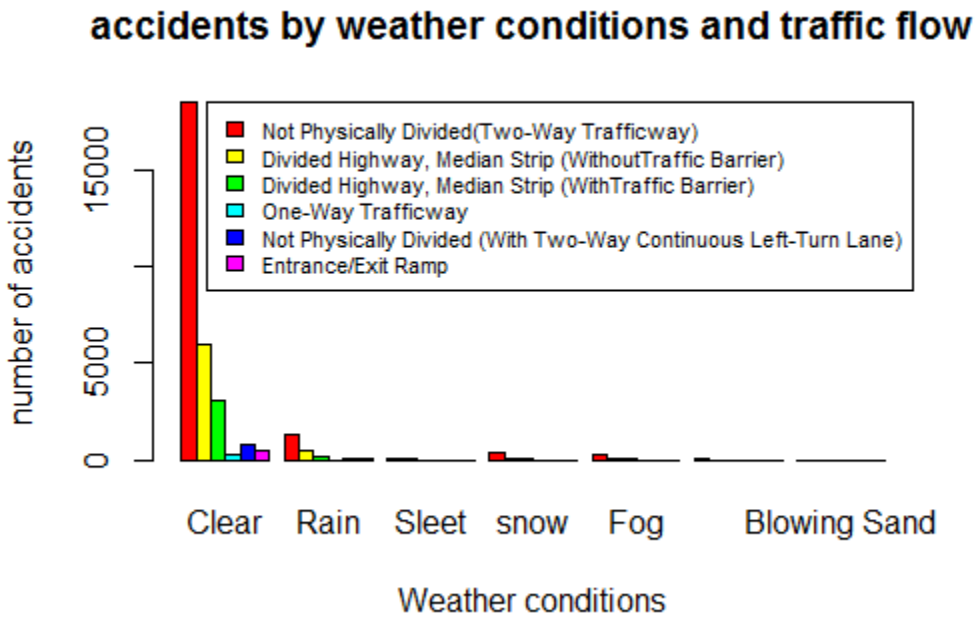


Accidents are more in Dry with no traffic signals.

15. accidents by weather conditions and traffic flow

	TRAFFIC FLOW						
WEATHER1	Clear	Rain	Sleet	snow	Fog	Severe Crosswinds	Blowing Sand
Not Physically Divided(Two-Way Trafficway)	18454	1316	67	416	247	46	10
Divided Highway, Median Strip (WithoutTraffic Barrier)	6011	467	38	118	56	18	3
Divided Highway, Median Strip (WithTraffic Barrier)	3062	193	15	41	35	4	0
One-Way Trafficway	244	15	0	0	1	0	1
Not Physically Divided (With Two-Way Continuous Left-Turn Lane)	802	54	2	4	11	1	0
Entrance/Exit Ramp	454	31	0	1	7	1	0

```
Pearson's Chi-squared test

data:  tbl
X-squared = 71.948, df = 30, p-value = 2.65e-05
```

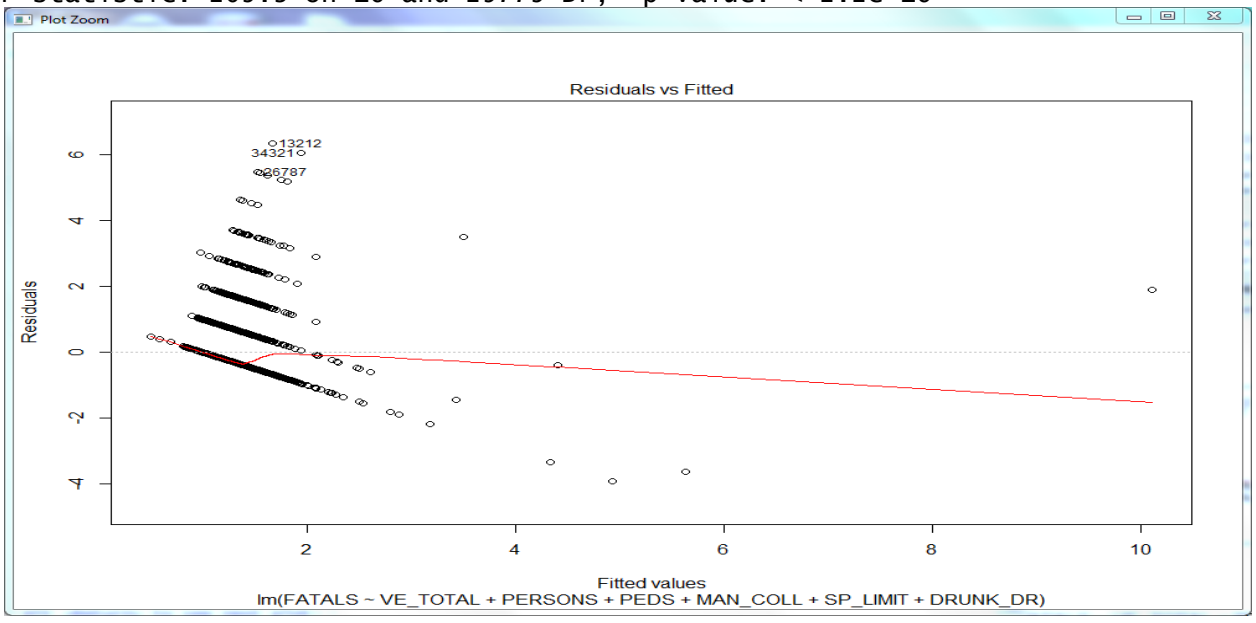


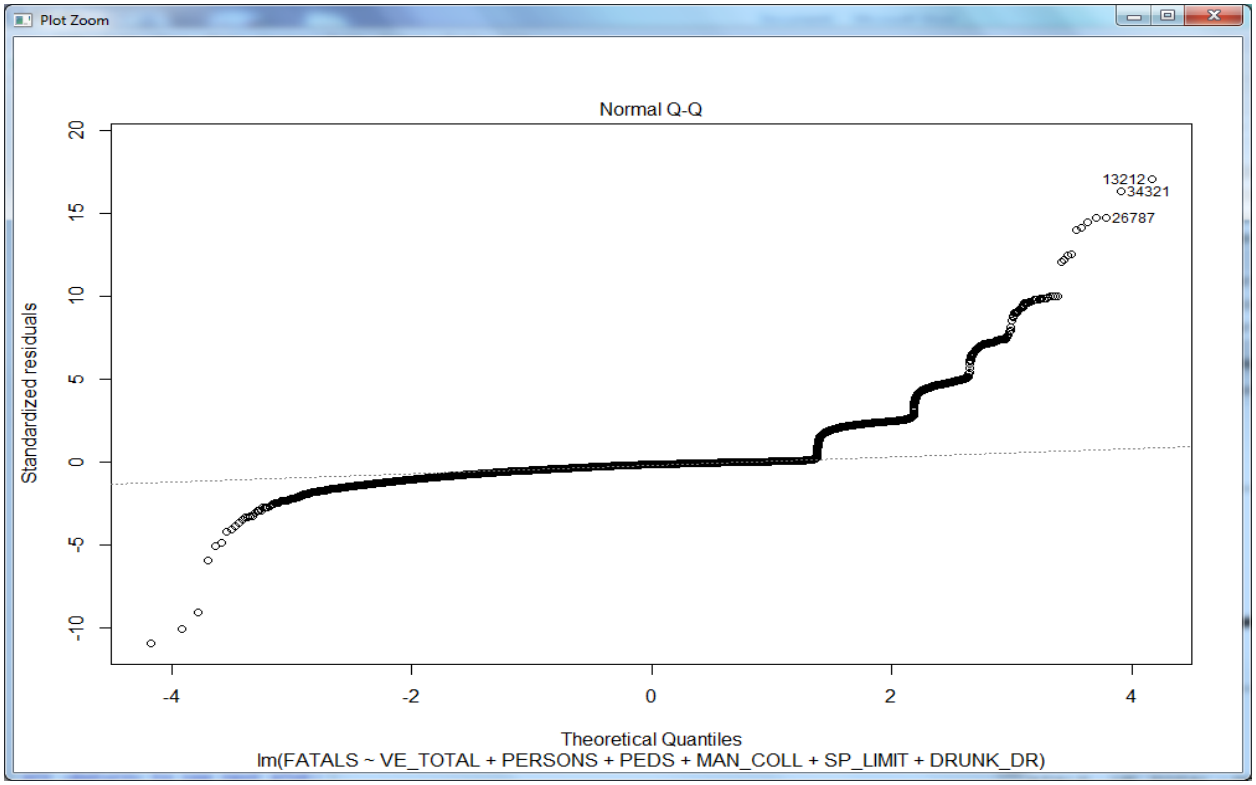
Accidents are more in clear weather and not physically divided Two way traffic ways.

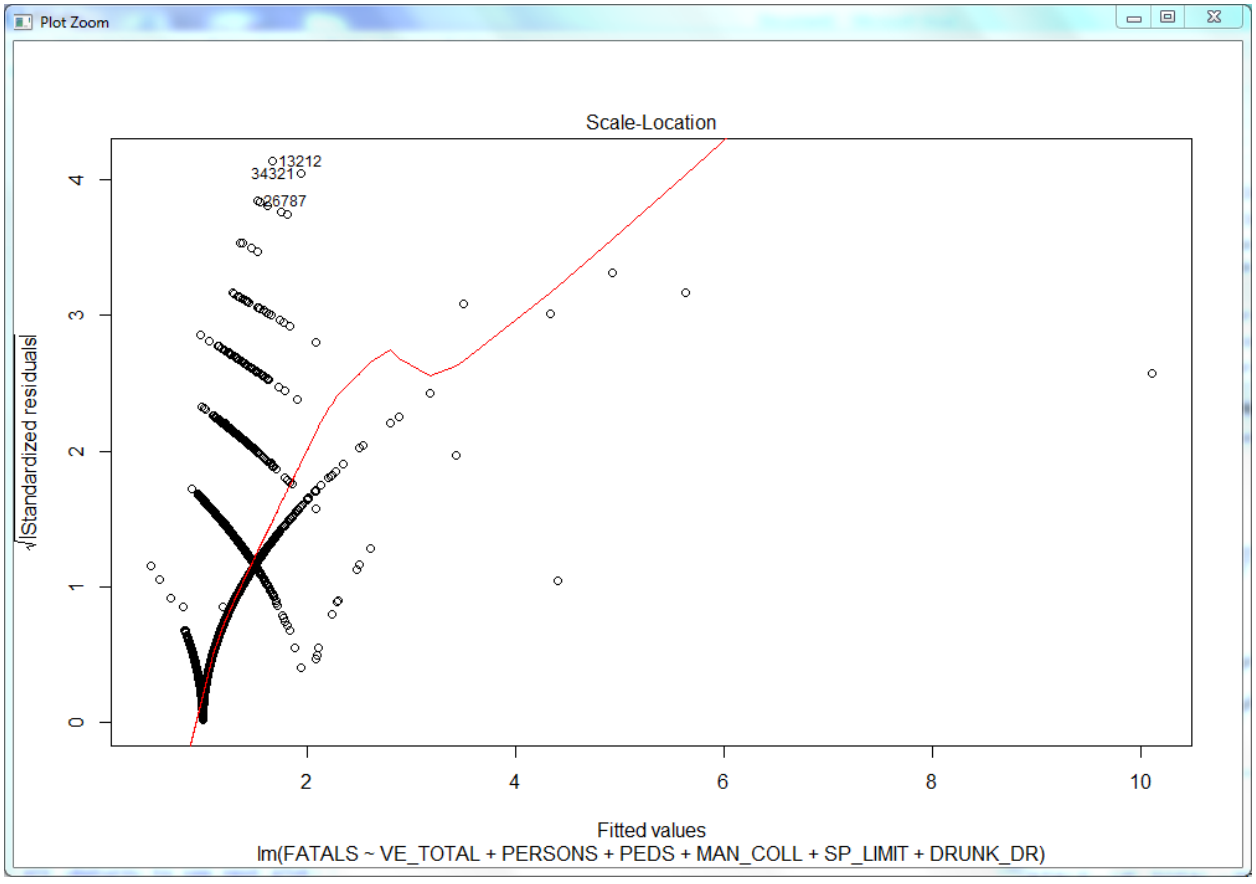
16.Predict fatalities:

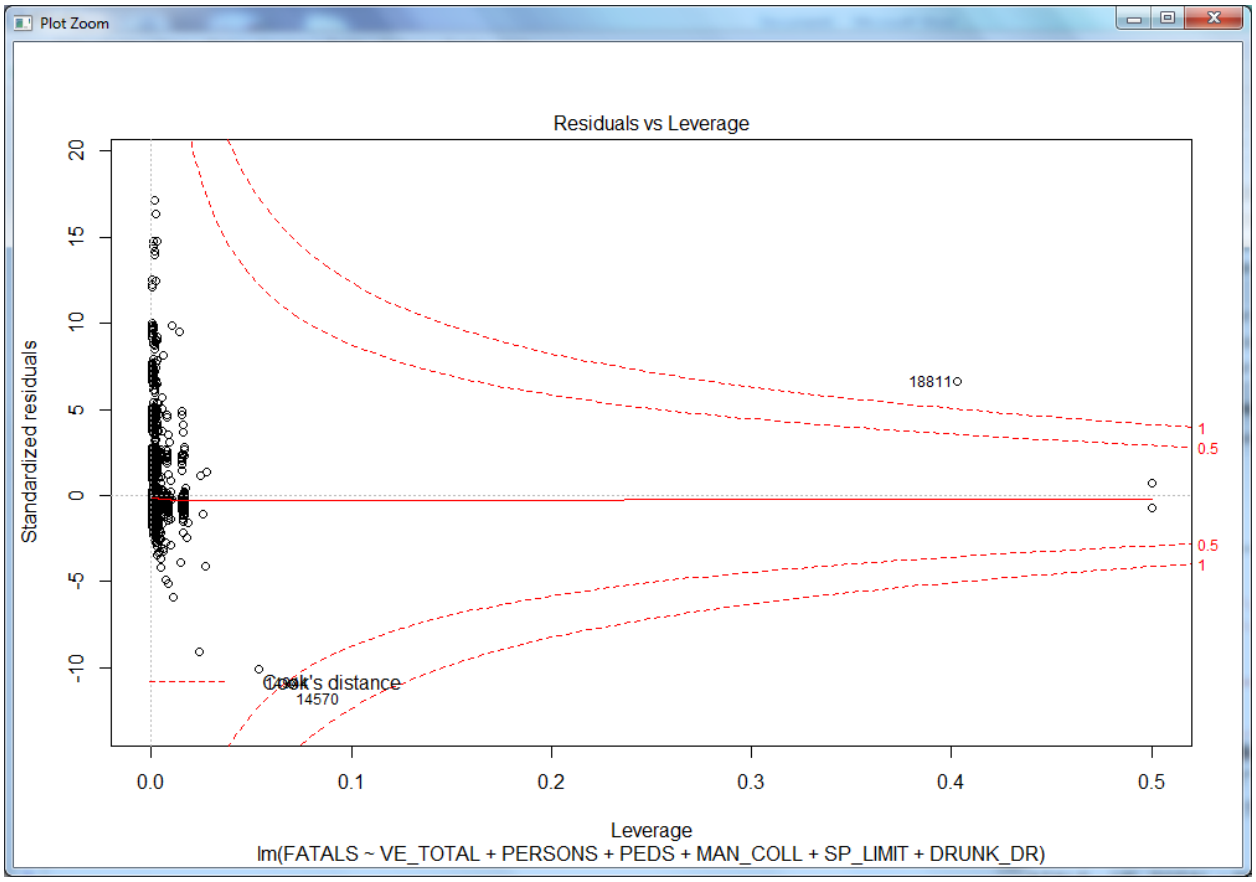
Summary of prediction meodel:

```
Call:
lm(formula = FATALS ~ VE_TOTAL + PERSONS + PEDS + MAN_COLL +
    SP_LIMIT + DRUNK_DR, data = train)

Residuals:
    Min      1Q  Median      3Q     Max
-3.7043 -0.1303 -0.0558 -0.0085  6.3945

Coefficients:                              Estimate Std. Error t value Pr(>|t|)
(Intercept)                                0.898720   0.010282  87.411  < 2e-16 ***
VE_TOTAL                                  -0.042630   0.004519  -9.434  < 2e-16 ***
PERSONS                                    0.072018   0.001504  47.899  < 2e-16 ***
PEDS                                      -0.071628   0.006161 -11.627  < 2e-16 ***
MAN_COLLFront-to-Rear                     -0.026040   0.011301  -2.304  0.02122 *
MAN_COLLFront-to-Front                     0.098751   0.008949  11.035  < 2e-16 ***
MAN_COLLFront-to-Side,Same Direction      -0.018145   0.020733  -0.875  0.38150
MAN_COLLFront-to-Side,Opposite Direction   0.034942   0.011652   2.999  0.00271 **
MAN_COLLFront-to-Side, Right Angle        -0.004556   0.008386  -0.543  0.58688
MAN_COLLFront-to-Side/Angle-Direction Not Specified 0.048630   0.036771   1.322  0.18601
MAN_COLLSideswipe - Same Direction        -0.059248   0.021057  -2.814  0.00490 **
MAN_COLLSideswipe-Opposite Direction      -0.003122   0.021407  -0.146  0.88404
MAN_COLLRear-to-Side                       0.087553   0.054307   1.612  0.10693
MAN_COLLRear-to-Rear                      -0.181951   0.370102  -0.492  0.62299
MAN_COLLEnd-Swipes and Others             -0.033808   0.053262  -0.635  0.52560
SP_LIMIT                                   0.001462   0.000166   8.811  < 2e-16 ***
DRUNK_DR                                   0.047311   0.003968  11.923  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3701 on 25779 degrees of freedom
Multiple R-squared:  0.115,    Adjusted R-squared:  0.1144
F-statistic: 209.3 on 16 and 25779 DF,  p-value: < 2.2e-16
```




Plot Zoom
Normal Q-Q
Standardized residuals
20
15
10
5
0
-5
-10
13212
34321
26787
-4
-2
0
2
4
Theoretical Quantiles
lm(FATALS ~ VE_TOTAL + PERSONS + PEDS + MAN_COLL + SP_LIMIT + DRUNK_DR)


Plot Zoom
Scale-Location
√|Standardized residuals|
4
3
2
1
0
13212
34321
26787
2
4
6
8
10
Fitted values
lm(FATALS ~ VE_TOTAL + PERSONS + PEDS + MAN_COLL + SP_LIMIT + DRUNK_DR)



R Square of 13% percent suggests that Number of fatalities shows 13% of Variance explained by the Linear Model.

Intercept suggests if there are no accidents, fatality is 0.877, hypothetically wrong. But for any accident within specified conditions, fatality sums up by 0.877.

From the Coefficients, it depicts that -ve coefficients indicate that fatalities will be less when coefficients are -ve fatalities increases with higher +ve coefficients.

For eg: Front to rear collision decreases the changes of fatalities by 0.034.

Front to rear, Front to Side Same Direction, From to Side Right Angle, Sideswipe Opposite Direction has little effect on the number of fatalities and it decreases the effect of number of fatalities.

Rear to Rear accident has very less number of fatalities as explained by the coefficient at -0.38. As per regression model it has very less number of fatalities.

Every increase in pedestrians, it decreases the number of fatalities by -0.06. Each vehicle involvement decreases the number of fatalities by 0.028. But these conditions as derived by linear regression model is not agreed to confirm that fatalities decreases by increase in pedestrians and number of vehicles. These situations should sum up with different conditions.

Number of persons involved in an accident increases the fatality rate by 0.071.

Front to Front, Front to side, rear to side increases the fatality rate.

Speed Limit and Drunken Drive will also increase the fatality rate.

RMSE:

```
sqrt(sum((prediction[,"fit"] - test$FATALS)^2)/nrow(test))
[1] 0.3742685
```

errors:

```
errors <- prediction[,"fit"] - test$FATALS
hist(errors)
Histogram of errors:
```

relative change:

```
rel_change <- 1 - ((test$FATALS - abs(errors)) / test$FATALS)
table(rel_change<0.10)["TRUE"] / nrow(test)
     TRUE
0.5871318
```

Confusion matrix:

```
          Reference
Prediction    1    2    3    4    5    7   12
        1  5909  437   75   21    6    1    1
        2     0    0    0    0    0    0    0
        3     0    0    0    0    0    0    0
        4     0    0    0    0    0    0    0
        5     0    0    0    0    0    0    0
        7     0    0    0    0    0    0    0
        12    0    0    0    0    0    0    0
```

Conclusion:

Based on theses analysis Fatalities are more in California , summer ,weekends, and evenings . accidents are more in Straight Rural Major collector with black top surface and not physically divided two way traffic Road at 55 speed limit with Clear daylight weather.

By taking precautions based on these analysis accidents may reduce. For example accidents are more in summer so drivers should be more careful in summer.

In some areas fatalities are more so if more fatalities occur they can send extra ambulance and increase the emergency services at that particular area and particular time.