In [1]:
```
import pandas as pd
import numpy as np
import glob
import os

import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns

import locale
def getpreferredencoding(do_setlocale = True):
   return "utf-8"
locale.getpreferredencoding = getpreferredencoding
import matplotlib.pyplot as plt
warnings.filterwarnings("ignore")


import warnings
import itertools
import numpy as np

plt.style.use('fivethirtyeight')
import statsmodels.api as sm
import matplotlib
matplotlib.rcParams['axes.labelsize'] = 14
matplotlib.rcParams['xtick.labelsize'] = 12
matplotlib.rcParams['ytick.labelsize'] = 12
matplotlib.rcParams['text.color'] = 'k'
```

In [2]:
```
os.getcwd()
```

Out[2]:
```
'/Users/vishnumohan'
```

LOADING DATA SETS

In [4]:
```
accidents_info = pd.read_csv('/Users/vishnumohan/Downloads/ML_DATASET/Accident_Information.csv',low_memory=False)
```

In [5]:
```
vehicles_info = pd.read_csv("/Users/vishnumohan/Downloads/ML_DATASET/Vehicle_Information.csv", encoding = 'unicode_escape')
```

In [6]:
```
accidents_info.head()
```

Out[6]:

	Accident_Index	1st_Road_Class	1st_Road_Number	2nd_Road_Class	2nd_Road_Number
0	200501BS00001	A	3218.0	NaN	0.0
1	200501BS00002	B	450.0	C	0.0
2	200501BS00003	C	0.0	NaN	0.0
3	200501BS00004	A	3220.0	NaN	0.0
4	200501BS00005	Unclassified	0.0	NaN	0.0

5 rows × 34 columns

In [7]:
```
vehicles_info.head()
```

Out[7]:

	Accident_Index	Age_Band_of_Driver	Age_of_Vehicle	Driver_Home_Area_Type	Driver_IMI
0	200401BS00001	26 - 35	3.0	Urban area	
1	200401BS00002	26 - 35	NaN	Urban area	
2	200401BS00003	26 - 35	4.0	Data missing or out of range	
3	200401BS00003	66 - 75	NaN	Data missing or out of range	
4	200401BS00004	26 - 35	1.0	Urban area	

5 rows × 24 columns

In [8]:
```
accidents_info['Date']= pd.to_datetime(accidents_info['Date'], format="%Y-%m-%d")
```

In [9]:
```
accidents_info.iloc[:, 5:13].info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2047256 entries, 0 to 2047255
Data columns (total 8 columns):
Accident_Severity                              object
Carriageway_Hazards                            object
Date                                           datetime64[ns]
Day_of_Week                                    object
Did_Police_Officer_Attend_Scene_of_Accident    float64
Junction_Control                               object
Junction_Detail                                object
Latitude                                       float64
dtypes: datetime64[ns](1), float64(2), object(5)
memory usage: 125.0+ MB
```

Converting Date and time to Time_Strap

In [10]:
```
accidents_info['Hour'] = accidents_info['Time'].str[0:2]

accidents_info['Hour'] = pd.to_numeric(accidents_info['Hour'])

accidents_info = accidents_info.dropna(subset=['Hour'])

accidents_info['Hour'] = accidents_info['Hour'].astype('int')
```

In [11]:
```
def Time_period(hour):
    if hour >= 5 and hour < 10:
        return "morning Hours (5-10)"
    elif hour >= 10 and hour < 15:
        return "office hours (10-15)"
    elif hour >= 15 and hour < 19:
        return "afternoon Hours (15-19)"
    elif hour >= 19 and hour < 23:
        return "evening Hours (19-23)"
    else:
        return "night Hours (23-5)"
```

In [12]:
```
accidents_info['Time_Strap'] = accidents_info['Hour'].apply(Time_period)
accidents_info[['Time', 'Hour', 'Time_Strap']].head()
```

Out[12]:

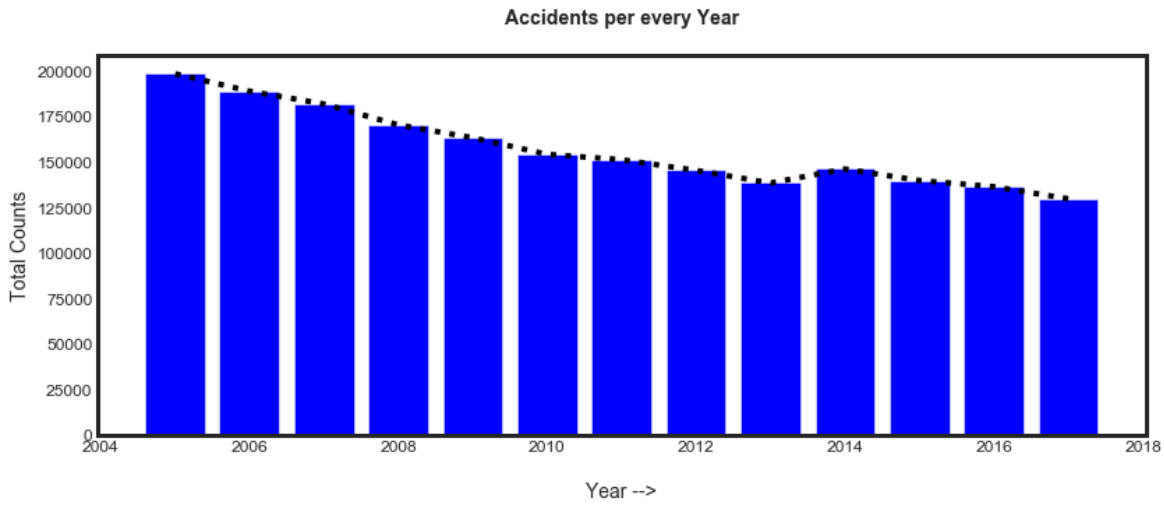
	Time	Hour	Time_Strap
0	17:42	17	afternoon Hours (15-19)
1	17:36	17	afternoon Hours (15-19)
2	00:15	0	night Hours (23-5)
3	10:35	10	office hours (10-15)
4	21:13	21	evening Hours (19-23)

Dropping Time and Hour Columns

In [13]:
```
accidents_info = accidents_info.drop(columns=['Time', 'Hour'])
```

In [14]:
```
yearly_count = accidents_info['Date'].dt.year.value_counts().sort_index(ascending=False)
sns.set_style('white')
fig, ax = plt.subplots(figsize=(12,5))
ax.bar(yearly_count.index, yearly_count.values, color='blue')
ax.plot(yearly_count, linestyle=':', color='black')
ax.set_title('\nAccidents per every Year\n', fontsize=14, fontweight='bold')
ax.set(xlabel='\nYear -->')
ax.set(ylabel='\nTotal Counts')
```

Out[14]:
```
[Text(0, 0.5, '\nTotal Counts')]
```



Merging Accident_info And Vehicle_info

In [15]:
```
merged_df = pd.merge(vehicles_info, accidents_info, how = 'inner',
on = 'Accident_Index')
```

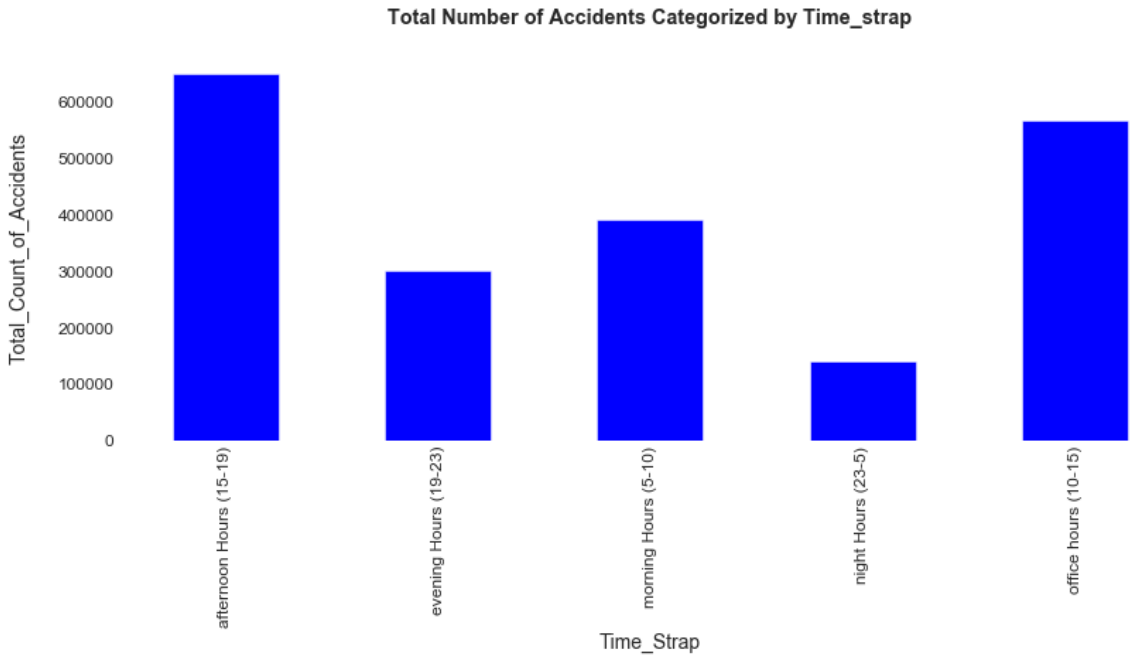
In [16]:
```
merged_df.head()
```

Out[16]:

	Accident_Index	Age_Band_of_Driver	Age_of_Vehicle	Driver_Home_Area_Type	Driver_IMI
0	200501BS00002	36 - 45	3.0	Data missing or out of range	
1	200501BS00003	26 - 35	5.0	Urban area	
2	200501BS00004	46 - 55	4.0	Urban area	
3	200501BS00005	46 - 55	10.0	Data missing or out of range	
4	200501BS00006	46 - 55	1.0	Urban area	

5 rows × 57 columns

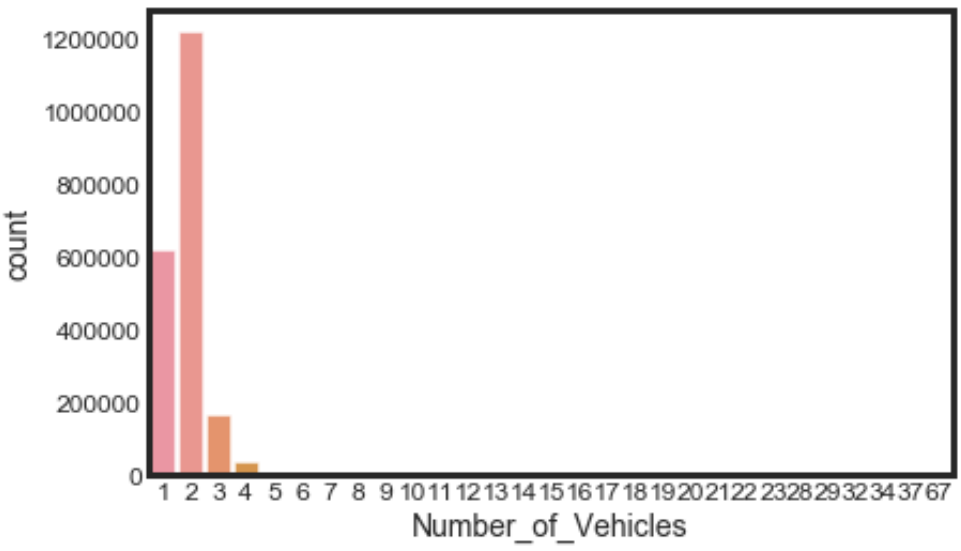
In [17]:
```
accidents_info.groupby('Time_Strap').size().plot(kind='bar', color=
'Blue', figsize=(12,5), grid=False)
plt.xlabel('Time_Strap',rotation='horizontal')
plt.ylabel('Total_Count_of_Accidents\n')
plt.title('\nTotal Number of Accidents Categorized by Time_strap\n'
, fontweight='bold')
sns.despine(top=True, right=True, left=True, bottom=True);
```



OUTLIERS

In [18]:
```
sns.countplot(accidents_info['Number_of_Vehicles'])
```

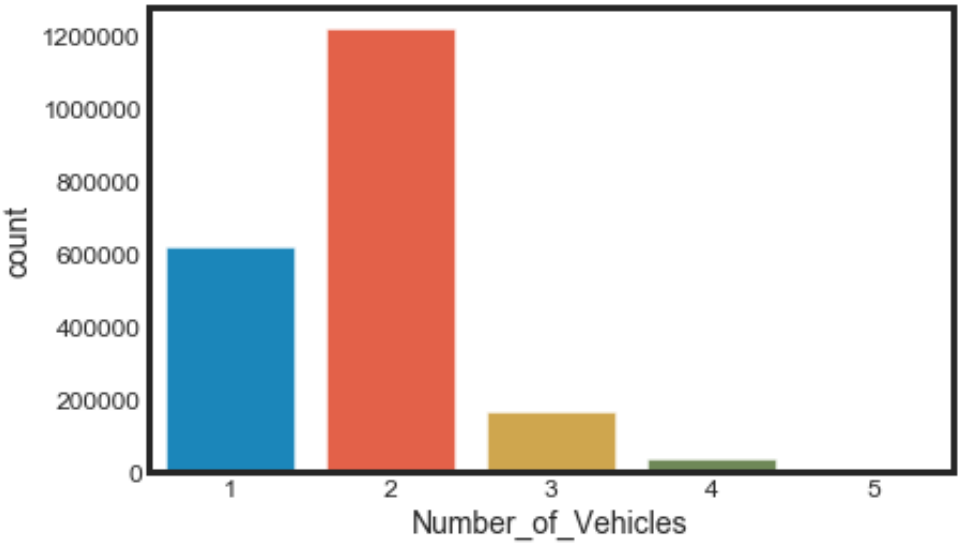
Out[18]: <matplotlib.axes._subplots.AxesSubplot at 0x1c3635a978>



In [19]:
```
accidents_info = accidents_info[accidents_info.Number_of_Vehicles.astype(int) <= 5]
```

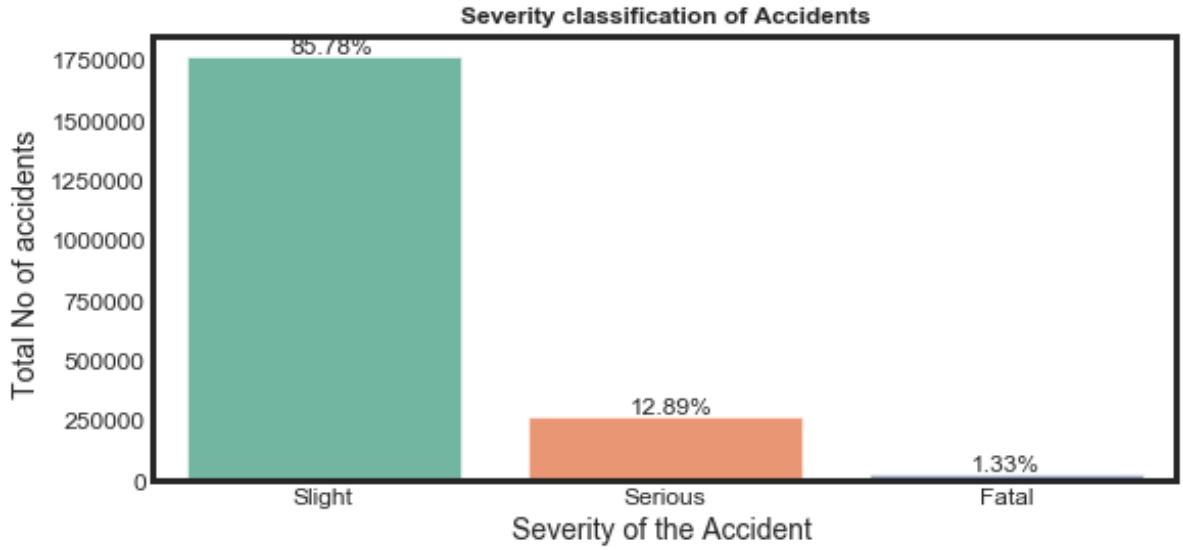
In [20]:
```
sns.countplot(accidents_info['Number_of_Vehicles'])
```

Out[20]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c26df6978>
```



Severity_Classification

In [21]:
```
ax = sns.countplot(x = merged_df.Accident_Severity ,palette="Set2")
sns.set(font_scale=1)
ax.set_xlabel('Severity of the Accident ')
ax.set_ylabel('Total No of accidents ')
ax.set_title('Severity classification of Accidents',fontweight='bold' )
fig = plt.gcf()
fig.set_size_inches(8,4)
for p in ax.patches:
    ax.annotate('{:.2f}%'.format(100*p.get_height()/len(merged_df.Accident_Severity)), (p.get_x()+ 0.3, p.get_height()+10000))
```



In [22]:
```
null_count = merged_df.isnull().sum()
```

In [23]:
```
null_count[null_count>0]
```

Out[23]:
```
Age_of_Vehicle                                 337926
Driver_IMD_Decile                              689154
Engine_Capacity_.CC.                           250292
make                                           110832
model                                          299328
Propulsion_Code                                233574
Vehicle_Location.Restricted_Lane                 1124
1st_Road_Number                                     1
2nd_Road_Class                                 827862
2nd_Road_Number                                 18917
Did_Police_Officer_Attend_Scene_of_Accident       112
Latitude                                          124
Location_Easting_OSGR                             124
Location_Northing_OSGR                            124
Longitude                                         125
LSOA_of_Accident_Location                      139096
Pedestrian_Crossing-Human_Control                 652
Pedestrian_Crossing-Physical_Facilities          1368
Speed_limit                                        65
InScotland                                         44
dtype: int64
```

Considering the Attributes which actually contributes to the prediction and leaving out others.

In [25]:
```
df = merged_df[['Accident_Index', '1st_Road_Class','Day_of_Week', '
Junction_Detail','Light_Conditions', 'Number_of_Casualties',
          'Number_of_Vehicles', 'Road_Surface_Conditions', 'Road_Ty
pe', 'Special_Conditions_at_Site', 'Speed_limit',
          'Time_Strap', 'Urban_or_Rural_Area', 'Weather_Conditions'
, 'Age_Band_of_Driver', 'Age_of_Vehicle',
          'Hit_Object_in_Carriageway', 'Hit_Object_off_Carriageway'
, 'make', 'Engine_Capacity_.CC.', 'Sex_of_Driver',
          'Skidding_and_Overturning', 'Vehicle_Manoeuvre', 'Vehicle
_Type', 'Accident_Severity'
         ]]
```

In [26]:
```
df.head()
```

Out[26]:

	Accident_Index	1st_Road_Class	Day_of_Week	Junction_Detail	Light_Conditions	Numb
0	200501BS00002	B	Wednesday	Crossroads	Darkness - lights lit	
1	200501BS00003	C	Thursday	Not at junction or within 20 metres	Darkness - lights lit	
2	200501BS00004	A	Friday	Not at junction or within 20 metres	Daylight	
3	200501BS00005	Unclassified	Monday	Not at junction or within 20 metres	Darkness - lighting unknown	
4	200501BS00006	Unclassified	Tuesday	Not at junction or within 20 metres	Daylight	

5 rows × 25 columns

In [27]:
```
df.isnull().any()
```

Out[27]:
```
Accident_Index               False
1st_Road_Class               False
Day_of_Week                  False
Junction_Detail              False
Light_Conditions             False
Number_of_Casualties         False
Number_of_Vehicles           False
Road_Surface_Conditions      False
Road_Type                    False
Special_Conditions_at_Site   False
Speed_limit                   True
Time_Strap                   False
Urban_or_Rural_Area          False
Weather_Conditions           False
Age_Band_of_Driver           False
Age_of_Vehicle                True
Hit_Object_in_Carriageway    False
Hit_Object_off_Carriageway   False
make                          True
Engine_Capacity_.CC.          True
Sex_of_Driver                False
Skidding_and_Overturning     False
Vehicle_Manoeuvre            False
Vehicle_Type                 False
Accident_Severity            False
dtype: bool
```

In [28]:
```
df.describe()
```

Out[28]:

	Number_of_Casualties	Number_of_Vehicles	Speed_limit	Age_of_Vehicle	Engine_C
count	2.058262e+06	2.058262e+06	2.058197e+06	1.720336e+06	1
mean	1.449619e+00	2.124039e+00	3.975690e+01	7.143342e+00	2
std	1.033511e+00	9.641712e-01	1.460913e+01	4.728791e+00	1
min	1.000000e+00	1.000000e+00	0.000000e+00	1.000000e+00	1
25%	1.000000e+00	2.000000e+00	3.000000e+01	3.000000e+00	1
50%	1.000000e+00	2.000000e+00	3.000000e+01	7.000000e+00	1
75%	2.000000e+00	2.000000e+00	5.000000e+01	1.000000e+01	1
max	9.300000e+01	6.700000e+01	7.000000e+01	1.110000e+02	9

Missing Value Propportions in both the Data Sets:

In [29]:
```
print('Missing Values % in Accidents_info :',
      round(accidents_info.isna().sum().sum()/len(accidents_info),3
), '%')
```

```
Missing Values % in Accidents_info : 0.495 %
```

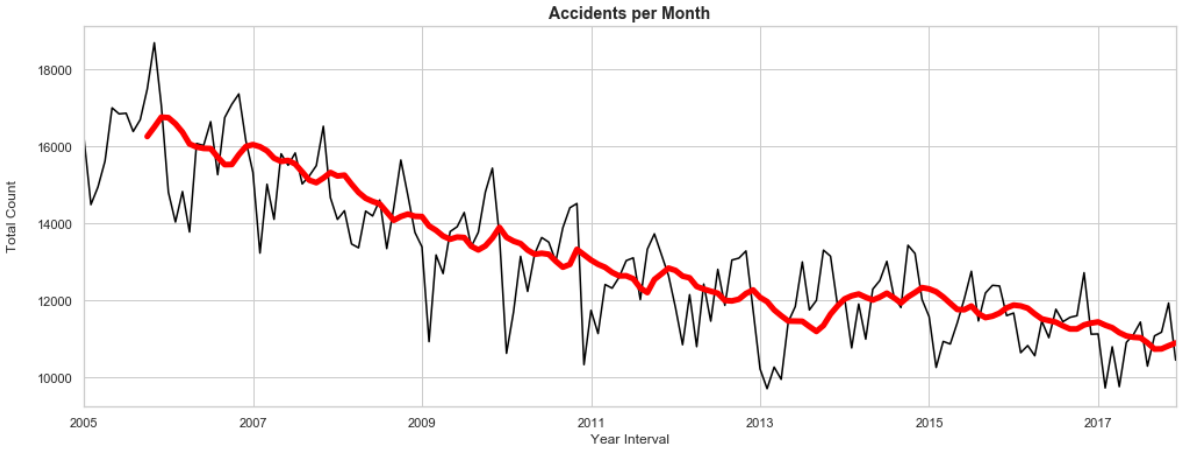
In [30]:
```
print('Missing Values % in vehicles_info :',
      round(vehicles_info .isna().sum().sum()/len(vehicles_info),3)
, '%')
```

```
Missing Values % in vehicles_info : 0.938 %
```

TIME SERIES ANALYSIS

In [31]:
```
sns.set_style('whitegrid')
fig, ax = plt.subplots(figsize=(15,6))
y=accidents_info.set_index('Date').resample('M').size().plot(label=
'Total Accidents per Month', color='black', ax=ax)
z=accidents_info.set_index('Date').resample('M').size().rolling(win
dow=10).mean()\
                            .plot(color='red', linewidth=5, label='A
verage for every 10 months', ax=ax)
ax.set_title('Accidents per Month', fontsize=14, fontweight='bold')
ax.set(ylabel='Total Count\n')
ax.set(xlabel='Year Interval\n')
```

Out[31]:
```
[Text(0.5, 0, 'Year Interval\n')]
```

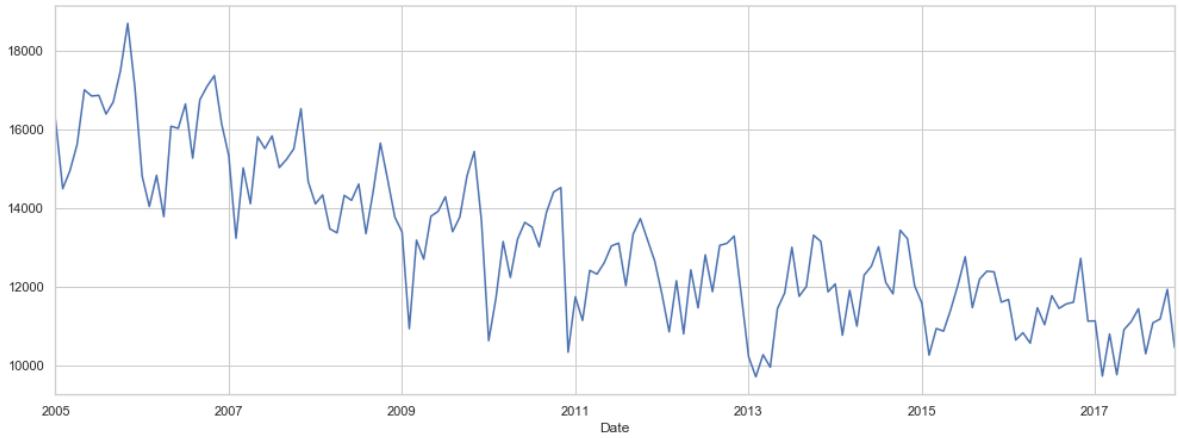


In [32]:
```
accidents = accidents_info.groupby('Date')['Accident_Severity'].sum
().reset_index()
```

In [33]:
```
accidents = accidents.set_index('Date')
accidents.index
```

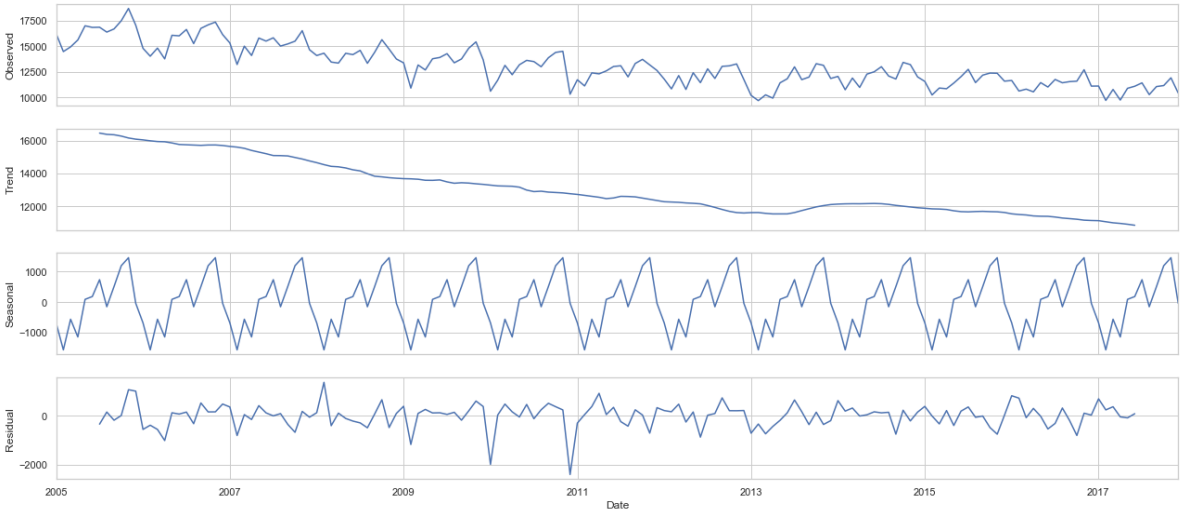
Out[33]:
```
DatetimeIndex(['2005-01-01', '2005-01-02', '2005-01-03', '2005-01-
04',
               '2005-01-05', '2005-01-06', '2005-01-07', '2005-01-
08',
               '2005-01-09', '2005-01-10',
               ...
               '2017-12-22', '2017-12-23', '2017-12-24', '2017-12-
25',
               '2017-12-26', '2017-12-27', '2017-12-28', '2017-12-
29',
               '2017-12-30', '2017-12-31'],
              dtype='datetime64[ns]', name='Date', length=4748, fr
eq=None)
```

In [34]:
```
y=accidents_info.set_index('Date').resample('M').size()
y.plot(figsize=(15, 6))
plt.show()
```



Decomposotion into Distinct Components - Trend, Seasonality, Noise

In [35]:
```
from pylab import rcParams
rcParams['figure.figsize'] = 18, 8
decomposition = sm.tsa.seasonal_decompose(y, model='additive')
fig = decomposition.plot()
plt.show()
```



TIME SERIES FORECASTING - ARIMA:

In [36]:
```
p = d = q = range(0, 2)
pdq = list(itertools.product(p, d, q))
seasonal_pdq = [(x[0], x[1], x[2], 12) for x in list(itertools.prod
uct(p, d, q))]
print('Examples of parameter combinations for Seasonal ARIMA...')
print('SARIMAX: {} x {}'.format(pdq[1], seasonal_pdq[1]))
print('SARIMAX: {} x {}'.format(pdq[1], seasonal_pdq[2]))
print('SARIMAX: {} x {}'.format(pdq[2], seasonal_pdq[3]))
print('SARIMAX: {} x {}'.format(pdq[2], seasonal_pdq[4]))
```

```
Examples of parameter combinations for Seasonal ARIMA...
SARIMAX: (0, 0, 1) x (0, 0, 1, 12)
SARIMAX: (0, 0, 1) x (0, 1, 0, 12)
SARIMAX: (0, 1, 0) x (0, 1, 1, 12)
SARIMAX: (0, 1, 0) x (1, 0, 0, 12)
```

In [37]:
```
for param in pdq:
    for param_seasonal in seasonal_pdq:
        try:
            mod = sm.tsa.statespace.SARIMAX(y,
                                            order=param,
                                            seasonal_order=param_se
asonal,
                                            enforce_stationarity=Fa
lse,
                                            enforce_invertibility=F
alse)
            results = mod.fit()

            print('ARIMA{}x{}12 - AIC:{}'.format(param, param_seaso
nal, results.aic))
        except:
            continue
```

```
ARIMA(0, 0, 0)x(0, 0, 0, 12)12 - AIC:3383.639496276718
ARIMA(0, 0, 0)x(0, 0, 1, 12)12 - AIC:3011.6686203347153
ARIMA(0, 0, 0)x(0, 1, 0, 12)12 - AIC:2365.8143250890926
ARIMA(0, 0, 0)x(0, 1, 1, 12)12 - AIC:2169.243205818666
ARIMA(0, 0, 0)x(1, 0, 0, 12)12 - AIC:2333.552354554812
ARIMA(0, 0, 0)x(1, 0, 1, 12)12 - AIC:2310.5084410360355
ARIMA(0, 0, 0)x(1, 1, 0, 12)12 - AIC:2185.2221757540956
ARIMA(0, 0, 0)x(1, 1, 1, 12)12 - AIC:2170.963442220043
ARIMA(0, 0, 1)x(0, 0, 0, 12)12 - AIC:3256.3871113388054
ARIMA(0, 0, 1)x(0, 0, 1, 12)12 - AIC:2975.888580958688
ARIMA(0, 0, 1)x(0, 1, 0, 12)12 - AIC:2339.835205408486
ARIMA(0, 0, 1)x(0, 1, 1, 12)12 - AIC:2128.3375737383085
ARIMA(0, 0, 1)x(1, 0, 0, 12)12 - AIC:2335.3026444619472
ARIMA(0, 0, 1)x(1, 0, 1, 12)12 - AIC:2294.985196999611
ARIMA(0, 0, 1)x(1, 1, 0, 12)12 - AIC:2164.2075294276874
ARIMA(0, 0, 1)x(1, 1, 1, 12)12 - AIC:2129.2363269545135
ARIMA(0, 1, 0)x(0, 0, 0, 12)12 - AIC:2584.735548004559
ARIMA(0, 1, 0)x(0, 0, 1, 12)12 - AIC:2366.6051436542148
ARIMA(0, 1, 0)x(0, 1, 0, 12)12 - AIC:2386.6785168754977
ARIMA(0, 1, 0)x(0, 1, 1, 12)12 - AIC:2088.452789467971
ARIMA(0, 1, 0)x(1, 0, 0, 12)12 - AIC:2361.418763859867
ARIMA(0, 1, 0)x(1, 0, 1, 12)12 - AIC:2284.4350913056146
ARIMA(0, 1, 0)x(1, 1, 0, 12)12 - AIC:2141.0160038944196
ARIMA(0, 1, 0)x(1, 1, 1, 12)12 - AIC:2084.3468706535728
ARIMA(0, 1, 1)x(0, 0, 0, 12)12 - AIC:2560.0216595251923
ARIMA(0, 1, 1)x(0, 0, 1, 12)12 - AIC:2322.7295866414256
ARIMA(0, 1, 1)x(0, 1, 0, 12)12 - AIC:2302.93045427617
ARIMA(0, 1, 1)x(0, 1, 1, 12)12 - AIC:2026.3635386121737
ARIMA(0, 1, 1)x(1, 0, 0, 12)12 - AIC:2317.523876887344
ARIMA(0, 1, 1)x(1, 0, 1, 12)12 - AIC:2207.061625631035
ARIMA(0, 1, 1)x(1, 1, 0, 12)12 - AIC:2095.9980274096515
ARIMA(0, 1, 1)x(1, 1, 1, 12)12 - AIC:2027.0905266173415
ARIMA(1, 0, 0)x(0, 0, 0, 12)12 - AIC:2604.350153388389
ARIMA(1, 0, 0)x(0, 0, 1, 12)12 - AIC:2384.6498663164957
ARIMA(1, 0, 0)x(0, 1, 0, 12)12 - AIC:2348.6404863791295
ARIMA(1, 0, 0)x(0, 1, 1, 12)12 - AIC:2110.9457608076527
ARIMA(1, 0, 0)x(1, 0, 0, 12)12 - AIC:2317.4759118331353
ARIMA(1, 0, 0)x(1, 0, 1, 12)12 - AIC:2337.860239265575
ARIMA(1, 0, 0)x(1, 1, 0, 12)12 - AIC:2120.3907226309943
ARIMA(1, 0, 0)x(1, 1, 1, 12)12 - AIC:2108.5171794000516
ARIMA(1, 0, 1)x(0, 0, 0, 12)12 - AIC:2577.2151151343237
```

```
/Users/vishnumohan/anaconda3/lib/python3.7/site-packages/statsmode
ls/base/model.py:508: ConvergenceWarning: Maximum Likelihood optim
ization failed to converge. Check mle_retvals
  "Check mle_retvals", ConvergenceWarning)
```

```
ARIMA(1, 0, 1)x(0, 0, 1, 12)12 - AIC:2344.322722044792
ARIMA(1, 0, 1)x(0, 1, 0, 12)12 - AIC:2322.9019143736487
ARIMA(1, 0, 1)x(0, 1, 1, 12)12 - AIC:2050.196496517372
ARIMA(1, 0, 1)x(1, 0, 0, 12)12 - AIC:2317.0361225741935
```

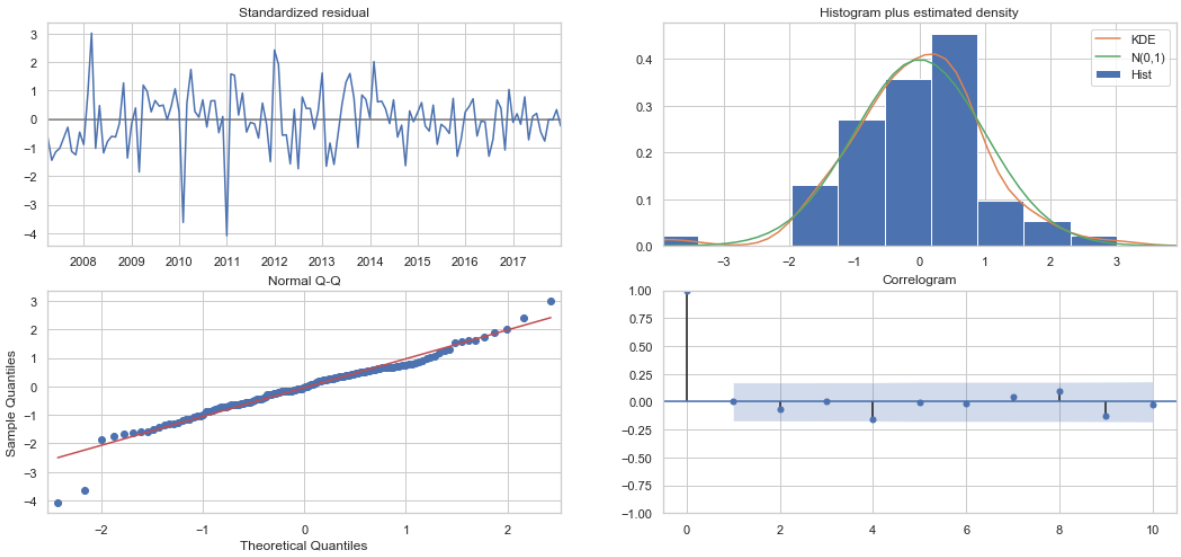
```
/Users/vishnumohan/anaconda3/lib/python3.7/site-packages/statsmode
ls/base/model.py:508: ConvergenceWarning: Maximum Likelihood optim
ization failed to converge. Check mle_retvals
  "Check mle_retvals", ConvergenceWarning)

ARIMA(1, 0, 1)x(1, 0, 1, 12)12 - AIC:2241.4574471475535
ARIMA(1, 0, 1)x(1, 1, 0, 12)12 - AIC:2112.4370356266118
ARIMA(1, 0, 1)x(1, 1, 1, 12)12 - AIC:2052.1690846509896
ARIMA(1, 1, 0)x(0, 0, 0, 12)12 - AIC:2576.3188929994726
ARIMA(1, 1, 0)x(0, 0, 1, 12)12 - AIC:2341.336423902169
ARIMA(1, 1, 0)x(0, 1, 0, 12)12 - AIC:2342.9135959229643
ARIMA(1, 1, 0)x(0, 1, 1, 12)12 - AIC:2062.1178808947016
ARIMA(1, 1, 0)x(1, 0, 0, 12)12 - AIC:2308.485537902895
ARIMA(1, 1, 0)x(1, 0, 1, 12)12 - AIC:2257.147459286515
ARIMA(1, 1, 0)x(1, 1, 0, 12)12 - AIC:2096.1071251406743
ARIMA(1, 1, 0)x(1, 1, 1, 12)12 - AIC:2062.4453522210742
ARIMA(1, 1, 1)x(0, 0, 0, 12)12 - AIC:2551.4884457509957
ARIMA(1, 1, 1)x(0, 0, 1, 12)12 - AIC:2315.5505912306453
ARIMA(1, 1, 1)x(0, 1, 0, 12)12 - AIC:2303.1346085216182
ARIMA(1, 1, 1)x(0, 1, 1, 12)12 - AIC:2026.5052818749045
ARIMA(1, 1, 1)x(1, 0, 0, 12)12 - AIC:2283.091867325319
ARIMA(1, 1, 1)x(1, 0, 1, 12)12 - AIC:2209.021061432174
ARIMA(1, 1, 1)x(1, 1, 0, 12)12 - AIC:2077.6869917456115
ARIMA(1, 1, 1)x(1, 1, 1, 12)12 - AIC:2027.0669447423975
```

In [38]:
```
mod = sm.tsa.statespace.SARIMAX(y,
                                order=(1, 1, 1),
                                seasonal_order=(1, 1, 0, 12),
                                enforce_stationarity=False,
                                enforce_invertibility=False)
results = mod.fit()
print(results.summary().tables[1])
```

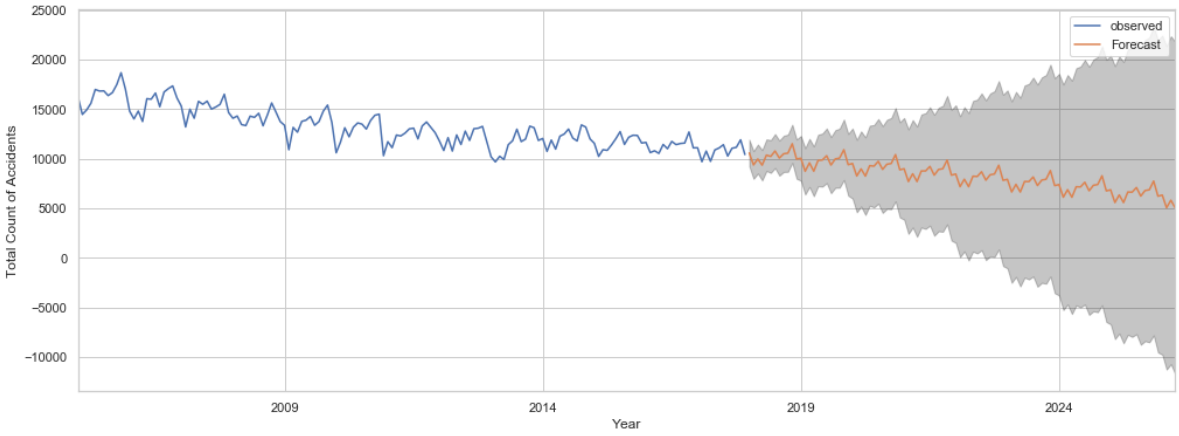
```
==============================================================================
                 coef    std err          z      P>|z|      [0.025
0.975]
------------------------------------------------------------------------------
ar.L1         -0.0488      0.116     -0.422      0.673      -0.275
0.178
ma.L1         -0.6527      0.087     -7.476      0.000      -0.824
-0.482
ar.S.L12      -0.5295      0.062     -8.569      0.000      -0.651
-0.408
sigma2       4.67e+05   4.23e+04     11.032      0.000    3.84e+05
5.5e+05
==============================================================================
```

In [39]:
```
results.plot_diagnostics(figsize=(16, 8))
plt.show()
```



Forecast Predictions:

In [40]:
```
pred_uc = results.get_forecast(steps=100)
pred_ci = pred_uc.conf_int()
ax = y.plot(label='observed', figsize=(15, 6))
pred_uc.predicted_mean.plot(ax=ax, label='Forecast')
ax.fill_between(pred_ci.index,
                pred_ci.iloc[:, 0],
                pred_ci.iloc[:, 1], color='k', alpha=.25)
ax.set_xlabel('Year')
ax.set_ylabel('Total Count of Accidents')
plt.legend()
plt.show()
```



Driver_Details VS Sex_of_Driver

In [43]:
```
vehicles_info.Sex_of_Driver.value_counts(normalize=True)
```

Out[43]:
```
Male                            0.674296
Female                          0.290742
Not known                       0.034931
Data missing or out of range    0.000031
Name: Sex_of_Driver, dtype: float64
```

In [44]:
```
driver_details = vehicles_info.groupby(['Age_Band_of_Driver', 'Sex_
of_Driver']).size().reset_index()
```

In [45]:
```
driver_details.drop(driver_details[(driver_details['Age_Band_of_Dri
ver'] == 'Data missing or out of range') | \
                    (driver_details['Sex_of_Driver'] == 'Not known
') | \
                    (driver_details['Sex_of_Driver'] == 'Data miss
ing or out of range')]\
                    .index, axis=0, inplace=True)
```

In [46]:
```
driver_details.columns = ['Age_Band_of_Driver', 'Sex_of_Driver', 'C
ount']
```

In [47]:
```
driver_details.head()
```

Out[47]:

	Age_Band_of_Driver	Sex_of_Driver	Count
0	0 - 5	Female	27
1	0 - 5	Male	94
3	11 - 15	Female	399
4	11 - 15	Male	3254
6	16 - 20	Female	53326

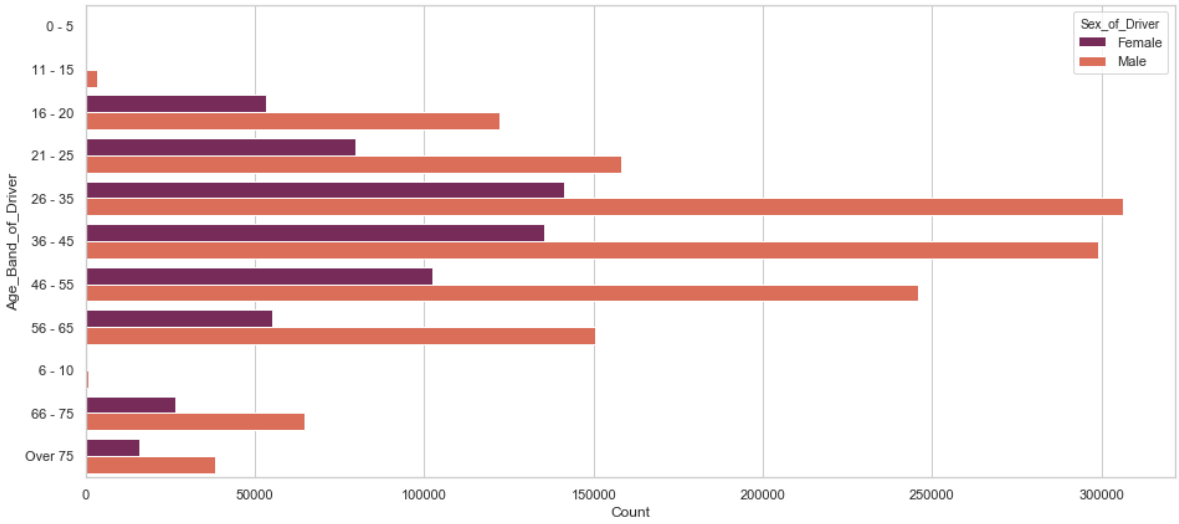
In [48]:
```
driver_details
```

Out[48]:

	Age_Band_of_Driver	Sex_of_Driver	Count
0	0 - 5	Female	27
1	0 - 5	Male	94
3	11 - 15	Female	399
4	11 - 15	Male	3254
6	16 - 20	Female	53326
7	16 - 20	Male	122115
10	21 - 25	Female	79778
11	21 - 25	Male	158333
14	26 - 35	Female	141470
15	26 - 35	Male	306282
17	36 - 45	Female	135352
18	36 - 45	Male	298961
21	46 - 55	Female	102294
22	46 - 55	Male	245660
25	56 - 65	Female	55229
26	56 - 65	Male	150529
28	6 - 10	Female	195
29	6 - 10	Male	688
32	66 - 75	Female	26610
33	66 - 75	Male	64648
39	Over 75	Female	15740
40	Over 75	Male	38403

In [50]:
```
ax = plt.subplots(figsize=(14, 7))
sns.barplot(y='Age_Band_of_Driver', x='Count', hue='Sex_of_Driver',
data=driver_details, palette='rocket')
```

Out[50]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c27f49710>
```



In [51]:
```
df.head()
```

Out[51]:

	Accident_Index	1st_Road_Class	Day_of_Week	Junction_Detail	Light_Conditions	Numb
0	200501BS00002	B	Wednesday	Crossroads	Darkness - lights lit	
1	200501BS00003	C	Thursday	Not at junction or within 20 metres	Darkness - lights lit	
2	200501BS00004	A	Friday	Not at junction or within 20 metres	Daylight	
3	200501BS00005	Unclassified	Monday	Not at junction or within 20 metres	Darkness - lighting unknown	
4	200501BS00006	Unclassified	Tuesday	Not at junction or within 20 metres	Daylight	

5 rows × 25 columns

In [52]:
```
df.describe()
```

Out[52]:

	Number_of_Casualties	Number_of_Vehicles	Speed_limit	Age_of_Vehicle	Engine_C
count	2.058262e+06	2.058262e+06	2.058197e+06	1.720336e+06	1
mean	1.449619e+00	2.124039e+00	3.975690e+01	7.143342e+00	2
std	1.033511e+00	9.641712e-01	1.460913e+01	4.728791e+00	1
min	1.000000e+00	1.000000e+00	0.000000e+00	1.000000e+00	1
25%	1.000000e+00	2.000000e+00	3.000000e+01	3.000000e+00	1
50%	1.000000e+00	2.000000e+00	3.000000e+01	7.000000e+00	1
75%	2.000000e+00	2.000000e+00	5.000000e+01	1.000000e+01	1
max	9.300000e+01	6.700000e+01	7.000000e+01	1.110000e+02	9

In [53]:
```
df.columns
```

Out[53]:
```
Index(['Accident_Index', '1st_Road_Class', 'Day_of_Week', 'Junctio
n_Detail',
       'Light_Conditions', 'Number_of_Casualties', 'Number_of_Vehi
cles',
       'Road_Surface_Conditions', 'Road_Type', 'Special_Conditions
_at_Site',
       'Speed_limit', 'Time_Strap', 'Urban_or_Rural_Area',
       'Weather_Conditions', 'Age_Band_of_Driver', 'Age_of_Vehicle
',
       'Hit_Object_in_Carriageway', 'Hit_Object_off_Carriageway',
'make',
       'Engine_Capacity_.CC.', 'Sex_of_Driver', 'Skidding_and_Over
turning',
       'Vehicle_Manoeuvre', 'Vehicle_Type', 'Accident_Severity'],
      dtype='object')
```

In [54]:
```
df.corr()
```

Out[54]:

	Number_of_Casualties	Number_of_Vehicles	Speed_limit	Age_of_Vehi
Number_of_Casualties	1.000000	0.382233	0.148501	-0.004
Number_of_Vehicles	0.382233	1.000000	0.161666	-0.041
Speed_limit	0.148501	0.161666	1.000000	-0.033
Age_of_Vehicle	-0.004052	-0.041110	-0.033289	1.000
Engine_Capacity_.CC.	0.013740	-0.004579	0.078281	-0.077

In [55]:
```
sns.heatmap(df.corr())
```

Out[55]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c28197b38>
```

In [56]:
```
df.columns
```

Out[56]:
```
Index(['Accident_Index', '1st_Road_Class', 'Day_of_Week', 'Junctio
n_Detail',
       'Light_Conditions', 'Number_of_Casualties', 'Number_of_Vehi
cles',
       'Road_Surface_Conditions', 'Road_Type', 'Special_Conditions
_at_Site',
       'Speed_limit', 'Time_Strap', 'Urban_or_Rural_Area',
       'Weather_Conditions', 'Age_Band_of_Driver', 'Age_of_Vehicle
',
       'Hit_Object_in_Carriageway', 'Hit_Object_off_Carriageway',
'make',
       'Engine_Capacity_.CC.', 'Sex_of_Driver', 'Skidding_and_Over
turning',
       'Vehicle_Manoeuvre', 'Vehicle_Type', 'Accident_Severity'],
      dtype='object')
```

In [57]:
```
X= df[['Accident_Index', '1st_Road_Class', 'Day_of_Week', 'Junction
_Detail',
       'Light_Conditions', 'Number_of_Casualties', 'Number_of_Vehic
les',
       'Road_Surface_Conditions', 'Road_Type', 'Special_Conditions_
at_Site',
       'Speed_limit', 'Time_Strap', 'Urban_or_Rural_Area',
       'Weather_Conditions', 'Age_Band_of_Driver', 'Age_of_Vehicle'
,
       'Hit_Object_in_Carriageway', 'Hit_Object_off_Carriageway', '
make',
       'Engine_Capacity_.CC.', 'Sex_of_Driver', 'Skidding_and_Overt
urning',
       'Vehicle_Manoeuvre', 'Vehicle_Type',]]
```

In [58]:
```
y = df['Accident_Severity']
```

Categorising Accident_severity to Slight & Severe

In [59]:
```
df['Accident_Severity'] = df['Accident_Severity'].replace(['Serious
', 'Fatal'], 'Serious or Fatal')
df = pd.get_dummies(df, columns=['Accident_Severity'])
df = df.drop('Accident_Severity_Serious or Fatal', axis=1)
df.Accident_Severity_Slight.value_counts(normalize=True)
```

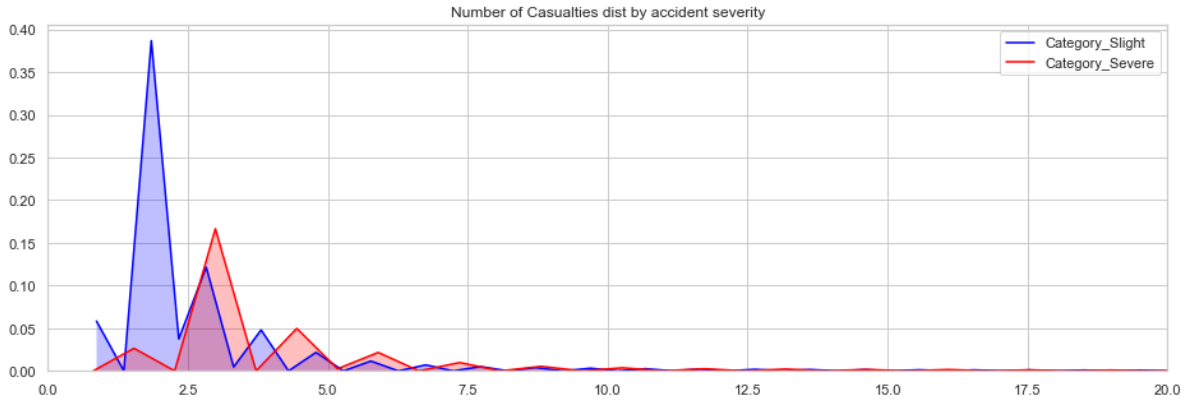
Out[59]:
```
1    0.857779
0    0.142221
Name: Accident_Severity_Slight, dtype: float64
```

In [60]:
```
plt.figure(figsize=(14,5))
acc_slight = df.Accident_Severity_Slight == 1
acc_severe = df.Accident_Severity_Slight == 0
```

```
<Figure size 1008x360 with 0 Axes>
```

In [61]:
```
plt.figure(figsize=(14,5))
acc_slight = df.Accident_Severity_Slight == 1
acc_severe = df.Accident_Severity_Slight == 0
sns.kdeplot(df.Number_of_Casualties[acc_slight],shade=True,color='B
lue', label='Category_Slight').set_xlim(0,20)
sns.kdeplot(df.Number_of_Casualties[acc_severe],shade=True,color='R
ed', label='Category_Severe').set_xlim(0,20)

plt.title('Number of Casualties dist by accident severity')
plt.show()
```



In [62]:
```
df.columns
```

Out[62]:
```
Index(['Accident_Index', '1st_Road_Class', 'Day_of_Week', 'Junctio
n_Detail',
       'Light_Conditions', 'Number_of_Casualties', 'Number_of_Vehi
cles',
       'Road_Surface_Conditions', 'Road_Type', 'Special_Conditions
_at_Site',
       'Speed_limit', 'Time_Strap', 'Urban_or_Rural_Area',
       'Weather_Conditions', 'Age_Band_of_Driver', 'Age_of_Vehicle
',
       'Hit_Object_in_Carriageway', 'Hit_Object_off_Carriageway',
'make',
       'Engine_Capacity_.CC.', 'Sex_of_Driver', 'Skidding_and_Over
turning',
       'Vehicle_Manoeuvre', 'Vehicle_Type', 'Accident_Severity_Sli
ght'],
      dtype='object')
```

In [63]:
```
X= df[['Number_of_Casualties','Number_of_Vehicles','Speed_limit','A
ge_of_Vehicle','Engine_Capacity_.CC.']]
```

In [64]:
```
y = df['Accident_Severity_Slight']
```

Linear Regression:

In [72]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test =train_test_split(X,y, test_size=0
.4, random_state=101)
from sklearn.linear_model import LinearRegression
lm = LinearRegression()
X_train.fillna(X_train.mean(), inplace=True)
```

In [73]:
```
X_train, X_test, y_train, y_test =train_test_split(X,y, test_size=0
.4, random_state=101)
```

In [74]:
```
from sklearn.linear_model import LinearRegression
```

In [75]:
```
lm = LinearRegression()
X_train.fillna(X_train.mean(), inplace=True)
```

In [76]:
```
lm.fit(X_train, y_train)
```

Out[76]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [77]:
```
print(lm.intercept_)
```

```
0.9407455679067871
```

In [78]:
```
lm.coef_
```

Out[78]:
```
array([-3.37454688e-02,  2.52886605e-02, -1.89415178e-03, -1.58353
156e-03,
       -4.44271916e-07])
```

In [79]:
```
cdf= pd.DataFrame(lm.coef_,X.columns,columns=['Coeff'])
```

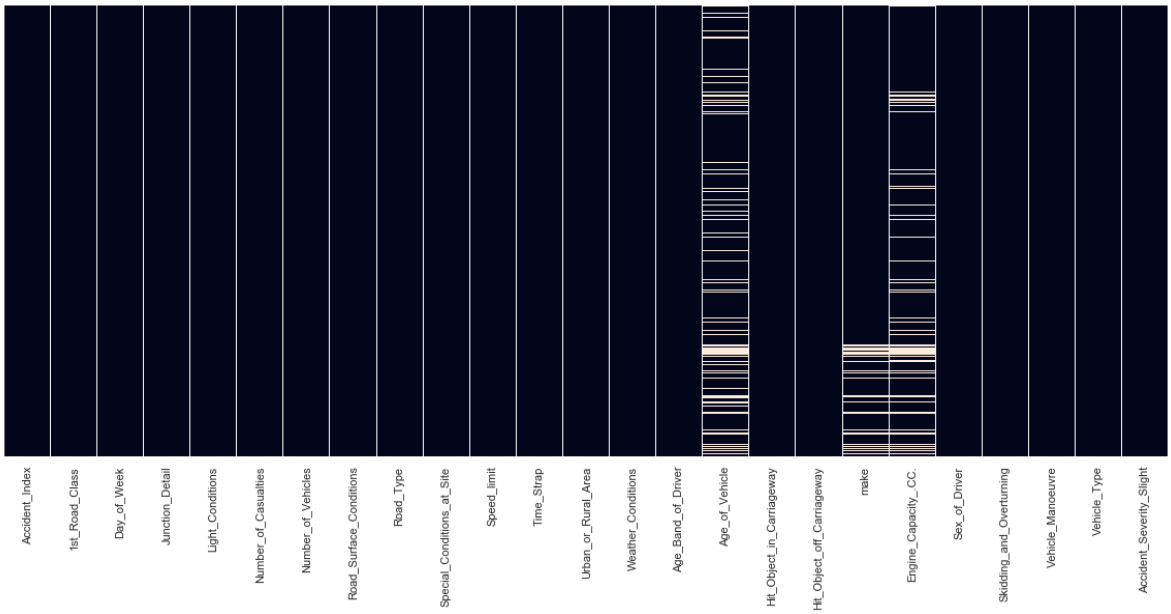
In [80]:
```
cdf
```

Out[80]:

	Coeff
Number_of_Casualties	-3.374547e-02
Number_of_Vehicles	2.528866e-02
Speed_limit	-1.894152e-03
Age_of_Vehicle	-1.583532e-03
Engine_Capacity_.CC.	-4.442719e-07

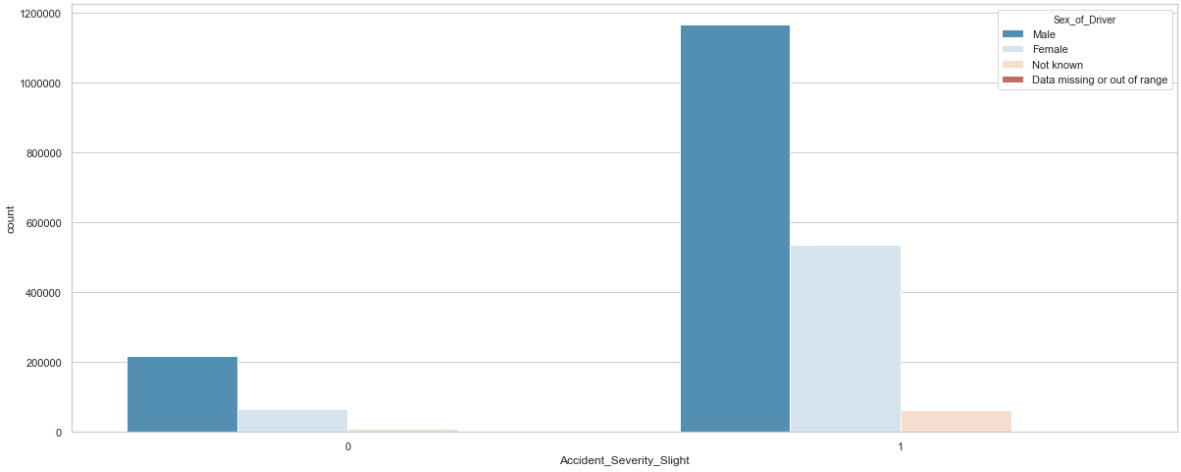
In [65]:
```
sns.heatmap(df.isnull(),yticklabels=False,cbar=False)
```

Out[65]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c2624ff28>
```



In [66]:
```
sns.countplot(x='Accident_Severity_Slight',hue='Sex_of_Driver',data
=df, palette='RdBu_r')
```

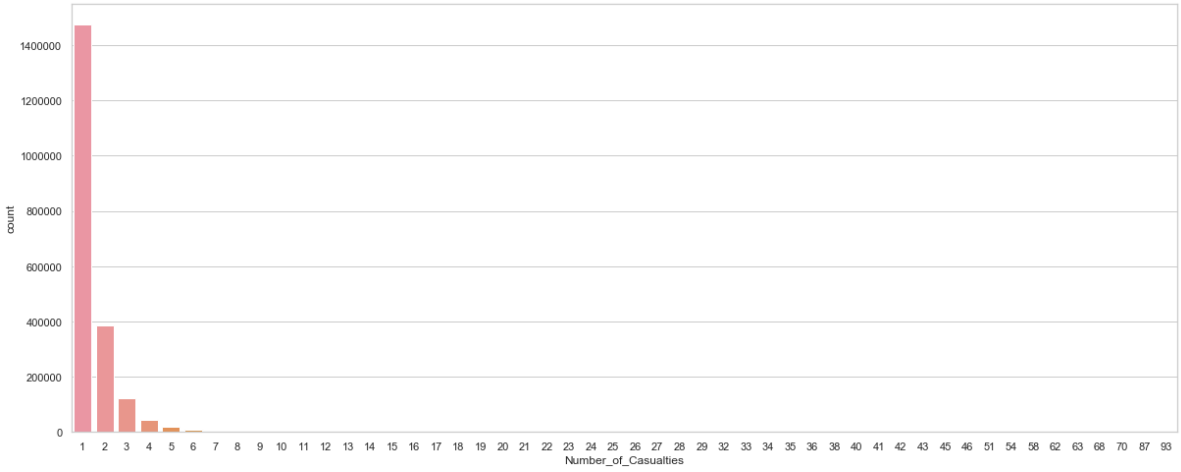
Out[66]: <matplotlib.axes._subplots.AxesSubplot at 0x1c269a46d8>



In [67]:
```
df = df[df.Sex_of_Driver.notnull()]
```

In [68]:
```
sns.countplot(x='Number_of_Casualties',data=df)
```

Out[68]: <matplotlib.axes._subplots.AxesSubplot at 0x1c26178128>



In [69]:
```
df.head()
```

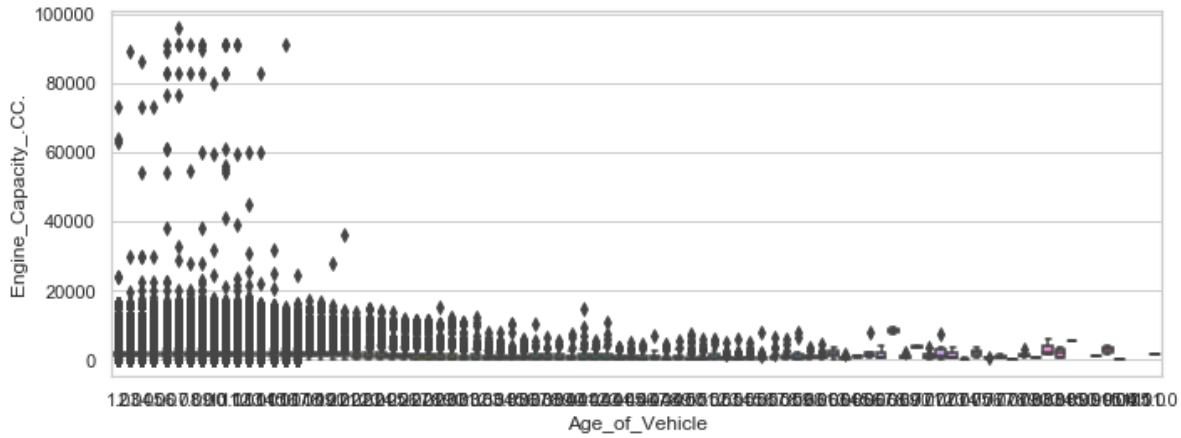
Out[69]:

	Accident_Index	1st_Road_Class	Day_of_Week	Junction_Detail	Light_Conditions	Numb
0	200501BS00002	B	Wednesday	Crossroads	Darkness - lights lit	
1	200501BS00003	C	Thursday	Not at junction or within 20 metres	Darkness - lights lit	
2	200501BS00004	A	Friday	Not at junction or within 20 metres	Daylight	
3	200501BS00005	Unclassified	Monday	Not at junction or within 20 metres	Darkness - lighting unknown	
4	200501BS00006	Unclassified	Tuesday	Not at junction or within 20 metres	Daylight	

5 rows × 25 columns

In [70]:
```
plt.figure(figsize=(10,4))
sns.boxplot(x='Age_of_Vehicle',y='Engine_Capacity_.CC.',data=df)
```

Out[70]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c26a16940>
```



Note: Since the Dataset is large Computation took lot of time and gets interrrupted at times. Hence i have computed the prediction values and uploaded the screenshots of the respective models in the report.

Code for models are as follows

Logistic Regression

In [82]:
```
X_train.head()
```

Out[82]:

	Number_of_Casualties	Number_of_Vehicles	Speed_limit	Age_of_Vehicle	Engine_C
630252	2	2	40.0	2.000000	
1675331	1	2	30.0	7.143055	
1770064	1	2	30.0	12.000000	
1265899	1	4	30.0	4.000000	
1808199	1	2	30.0	6.000000	

In [83]:
```
y_train.head()
```

Out[83]:
```
630252     0
1675331    1
1770064    1
1265899    0
1808199    1
Name: Accident_Severity_Slight, dtype: uint8
```

In [84]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test =train_test_split(X,y, test_size=0
.3, random_state=101)
from sklearn.linear_model import LogisticRegression
```

In [85]:
```
logmodel=LogisticRegression()
X_train.fillna(X_train.mean(), inplace=True)
X_test = X_test.fillna(X_train.mean())
X_test.fillna(X_train.mean(), inplace=True)
```

In [86]:
```
logmodel.fit(X_train,y_train)
```

Out[86]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_inter
cept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='wa
rn',
          tol=0.0001, verbose=0, warm_start=False)
```

In [87]:
```
X_test.fillna(X_train.mean(), inplace=True)
```

In [88]:
```
predictions = logmodel.predict(X_test)
from sklearn.metrics import classification_report
print(classification_report(y_test,predictions))
```

```
              precision    recall  f1-score   support

           0       0.45      0.00      0.01     87846
           1       0.86      1.00      0.92    529633

   micro avg       0.86      0.86      0.86    617479
   macro avg       0.66      0.50      0.46    617479
weighted avg       0.80      0.86      0.79    617479
```

In [89]:
```
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
```

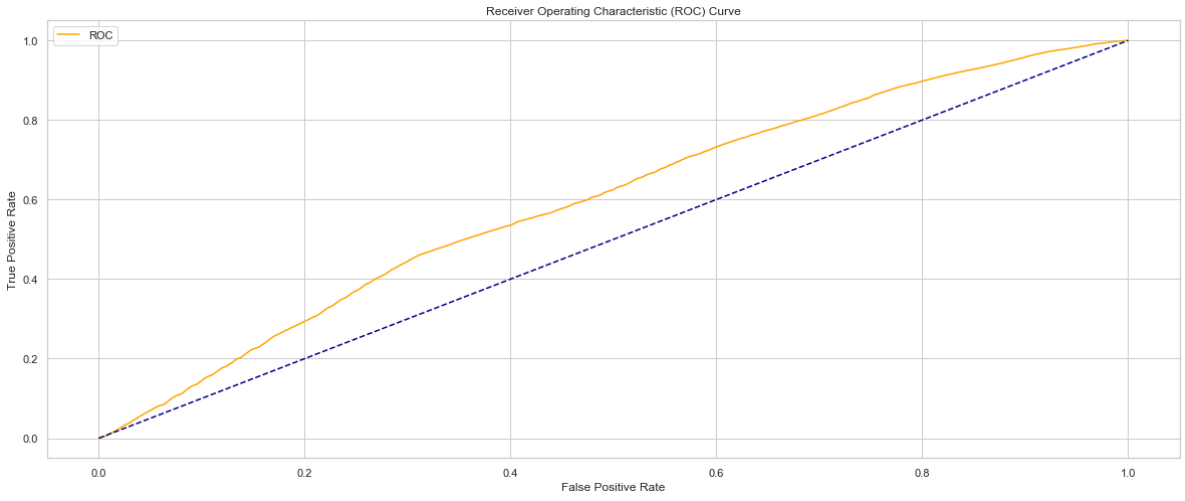
In [90]:
```
def plot_roc_curve(fpr, tpr):
    plt.plot(fpr, tpr, color='orange', label='ROC')
    plt.plot([0, 1], [0, 1], color='darkblue', linestyle='--')
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver Operating Characteristic (ROC) Curve')
    plt.legend()
    plt.show()
```

In [91]:
```
probs = logmodel.predict_proba(X_test)
probs = probs[:, 1]
auc = roc_auc_score(y_test, probs)
print('AUC: %.2f' % auc)
```

```
AUC: 0.60
```

In [92]:
```
fpr, tpr, thresholds = roc_curve(y_test, probs)
```

In [93]:
```
plot_roc_curve(fpr, tpr)
```



KNeighbors Classifier

In [94]:
```
from sklearn.preprocessing import StandardScaler
scaler= StandardScaler()
scaler.fit(X)
```

Out[94]:
```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

In [95]:
```
scaled_features = scaler.transform(X)
```

In [96]:
```
X_feat = pd.DataFrame(scaled_features,columns=X.columns)
```

In [97]:
```
X_feat.head()
```

Out[97]:

	Number_of_Casualties	Number_of_Vehicles	Speed_limit	Age_of_Vehicle	Engine_Capacity
0	-0.435041	-1.165809	-0.667863	-0.876195	3.2
1	-0.435041	-0.128648	-0.667863	-0.453254	3.2
2	-0.435041	-1.165809	-0.667863	-0.664724	-0.1
3	-0.435041	-1.165809	-0.667863	0.604099	-1.0
4	-0.435041	-0.128648	-0.667863	-1.299136	0.4

In [98]:
```
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
```

In [99]:
```
X = X_feat
y = df['Accident_Severity_Slight']
X_train, X_test, y_train, y_test =train_test_split(X,y, test_size=0
.3, random_state=101)
```

In [100]:
```
from sklearn.neighbors import KNeighborsClassifier
knn= KNeighborsClassifier(n_neighbors=2)
```

In [101]:
```
X_train.fillna(X_train.mean(), inplace=True)
X_test = X_test.fillna(X_train.mean())
```

In [ ]:
```
knn.fit(X_train,y_train)
```

In [ ]:
```
pred = knn.predict(X_test)
```

In [ ]:
```
from sklearn.metrics import classification_report, confusion_matrix
```

In [ ]:
```
print(confusion_matrix(y_test,pred))
print(classification_report(y_test,pred))
```

Decision Tree Classifier

In [ ]:
```
df.head()
```

In [ ]:
```
from sklearn.model_selection import train_test_split
```

In [ ]:
```
X = X_feat
y = df['Accident_Severity_Slight']
X_train, X_test, y_train, y_test =train_test_split(X,y, test_size=0
.3, random_state=101)
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier()
```

In [ ]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [ ]:
```
dtree = DecisionTreeClassifier()
```

In [ ]:
```
X_train.fillna(X_train.mean(), inplace=True)
X_test = X_test.fillna(X_train.mean())
```

In [ ]:
```
dtree.fit(X_train,y_train)
```

In [ ]:
```
predictions = dtree.predict(X_test)
from sklearn.metrics import classification_report,confusion_matrix
```

In [ ]:
```
from sklearn.metrics import classification_report,confusion_matrix
```

In [ ]:
```
predictions = dtree.predict(X_test)
from sklearn.metrics import classification_report,confusion_matrix
print(confusion_matrix(y_test,predictions))
print('\n')
print(classification_report(y_test,predictions))
```

In [ ]:
```
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
def plot_roc_curve(fpr, tpr):
    plt.plot(fpr, tpr, color='orange', label='ROC')
    plt.plot([0, 1], [0, 1], color='darkblue', linestyle='--')
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver Operating Characteristic (ROC) Curve')
    plt.legend()
    plt.show()
```

In [ ]:
```
probs = dtree.predict_proba(X_test)
probs = probs[:, 1]
auc = roc_auc_score(y_test, probs)
print('AUC: %.2f' % auc)
```

In [ ]:
```
fpr, tpr, thresholds = roc_curve(y_test, probs)
```

In [ ]:
```
plot_roc_curve(fpr, tpr)
```

RANDOM FOREST CLASSIFIER

In [ ]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.pipeline import Pipeline, FeatureUnion
from sklearn.preprocessing import MinMaxScaler, FunctionTransformer
, OneHotEncoder, KBinsDiscretizer, MaxAbsScaler
```

In [ ]:
```
rfc = Pipeline([("Min_Max_Transformer", MaxAbsScaler()),("Clf",Rand
omForestClassifier(n_estimators=100, n_jobs=3))])
```

In [ ]:
```
rfc.fit(X_train, y_train)
```

In [ ]:
```
rfc.pred = rfc.predict(X_test)
```

In [ ]:
```
print(confusion_matrix(y_test,rfc.pred))
print('\n')
print(classification_report(y_test,rfc.pred))
```