Logistic Regression

January 8, 2021

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

[2]:
```
ad_data=pd.read_csv('advertising.csv')
```

[3]:
```
ad_data.head()
```

[3]:
```
   Daily Time Spent on Site  Age  Area Income  Daily Internet Usage  \
0                     68.95   35     61833.90                256.09
1                     80.23   31     68441.85                193.77
2                     69.47   26     59785.94                236.50
3                     74.15   29     54806.18                245.89
4                     68.37   35     73889.99                225.58

                           Ad Topic Line            City  Male     Country  \
0     Cloned 5thgeneration orchestration     Wrightburgh     0     Tunisia
1     Monitored national standardization       West Jodi     1       Nauru
2       Organic bottom-line service-desk        Davidton     0  San Marino
3  Triple-buffered reciprocal time-frame  West Terrifurt     1       Italy
4          Robust logistical utilization    South Manuel     0     Iceland

             Timestamp  Clicked on Ad
0  2016-03-27 00:53:11              0
1  2016-04-04 01:39:02              0
2  2016-03-13 20:35:42              0
3  2016-01-10 02:31:19              0
4  2016-06-03 03:36:18              0
```

[4]:
```
ad_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 10 columns):
Daily Time Spent on Site    1000 non-null float64
```

```
Age                           1000 non-null int64
Area Income                   1000 non-null float64
Daily Internet Usage          1000 non-null float64
Ad Topic Line                 1000 non-null object
City                          1000 non-null object
Male                          1000 non-null int64
Country                       1000 non-null object
Timestamp                     1000 non-null object
Clicked on Ad                 1000 non-null int64
dtypes: float64(3), int64(3), object(4)
memory usage: 78.2+ KB
```

[5]:

```python
ad_data.describe()
```

[5]:

```
       Daily Time Spent on Site          Age   Area Income  \
count               1000.000000  1000.000000   1000.000000
mean                  65.000200    36.009000  55000.000080
std                   15.853615     8.785562  13414.634022
min                   32.600000    19.000000  13996.500000
25%                   51.360000    29.000000  47031.802500
50%                   68.215000    35.000000  57012.300000
75%                   78.547500    42.000000  65470.635000
max                   91.430000    61.000000  79484.800000

       Daily Internet Usage         Male  Clicked on Ad
count           1000.000000  1000.000000     1000.00000
mean             180.000100     0.481000        0.50000
std               43.902339     0.499889        0.50025
min              104.780000     0.000000        0.00000
25%              138.830000     0.000000        0.00000
50%              183.130000     0.000000        0.50000
75%              218.792500     1.000000        1.00000
max              269.960000     1.000000        1.00000
```

0.0.1 Exploratory Data Analysis

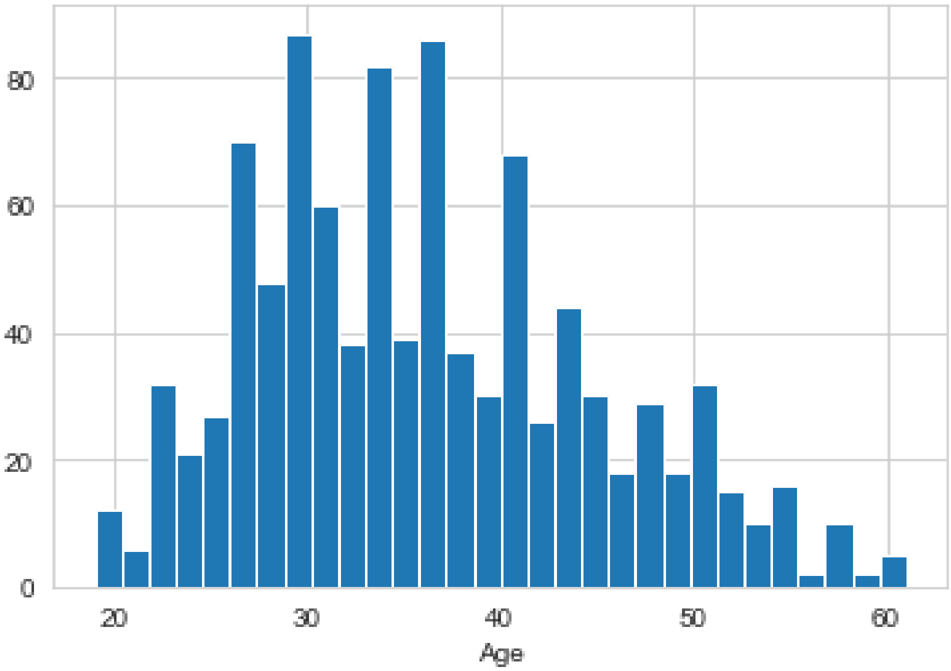
Histogram of the Age

[6]:

```python
sns.set_style('whitegrid')
ad_data['Age'].hist(bins=30)
plt.xlabel('Age')
```

[6]:

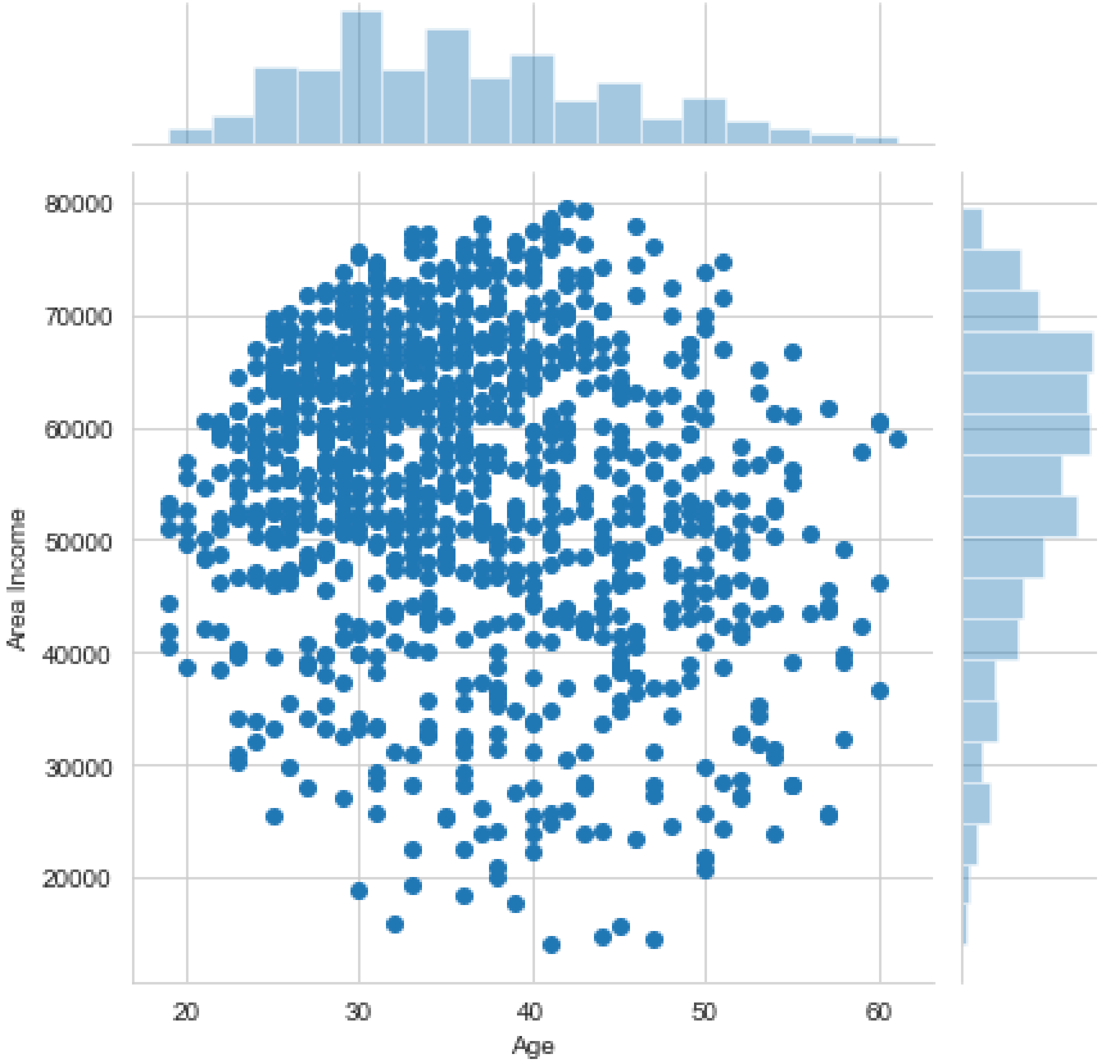
```
Text(0.5, 0, 'Age')
```



Create a jointplot showing Area Income versus Age.

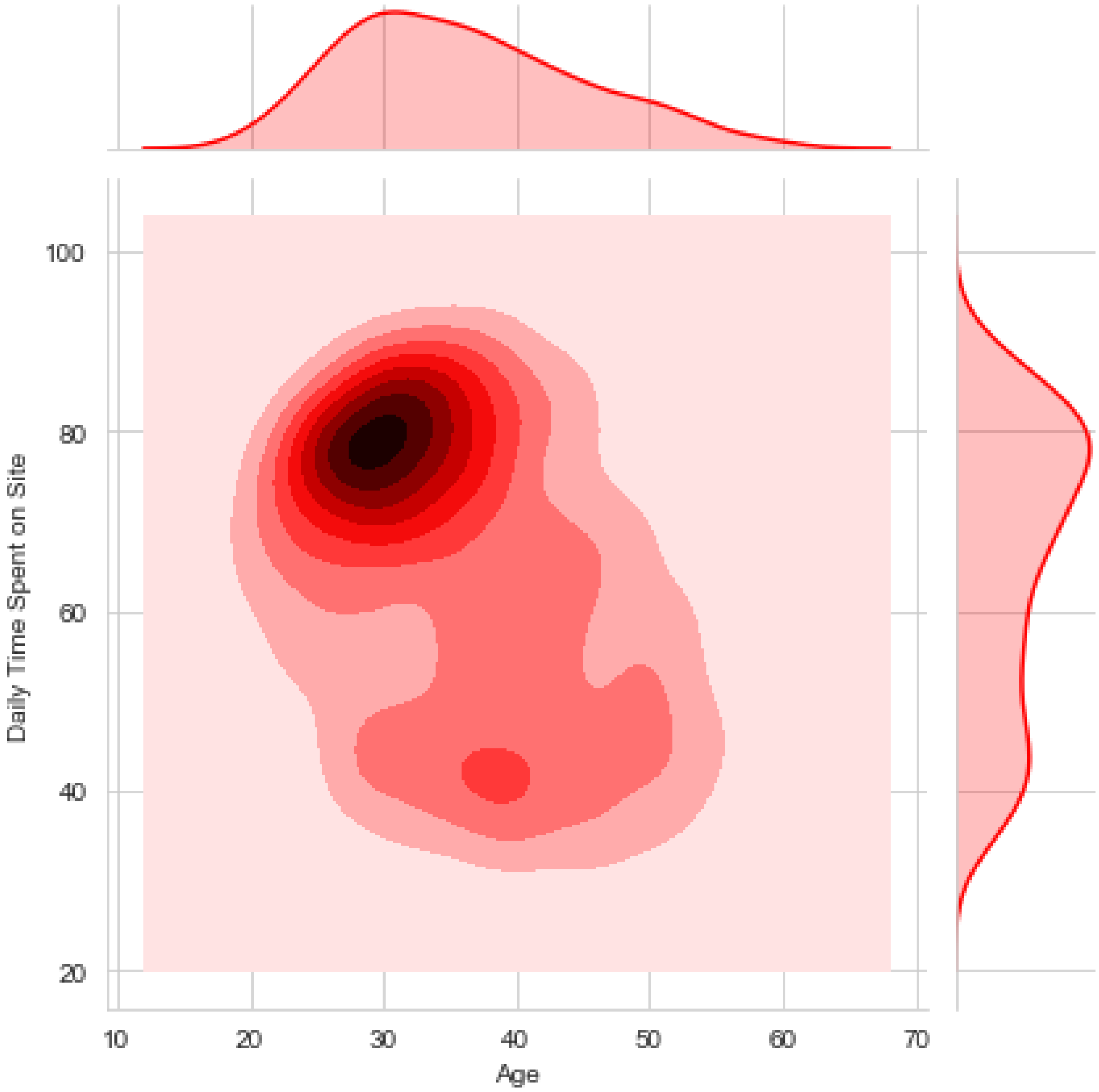
```
[7]: sns.jointplot(x='Age',y='Area Income',data=ad_data)
```

```
[7]: <seaborn.axisgrid.JointGrid at 0x21f58f13808>
```



Jointplot showing the kde distributions of Daily Time spent on site vs. Age

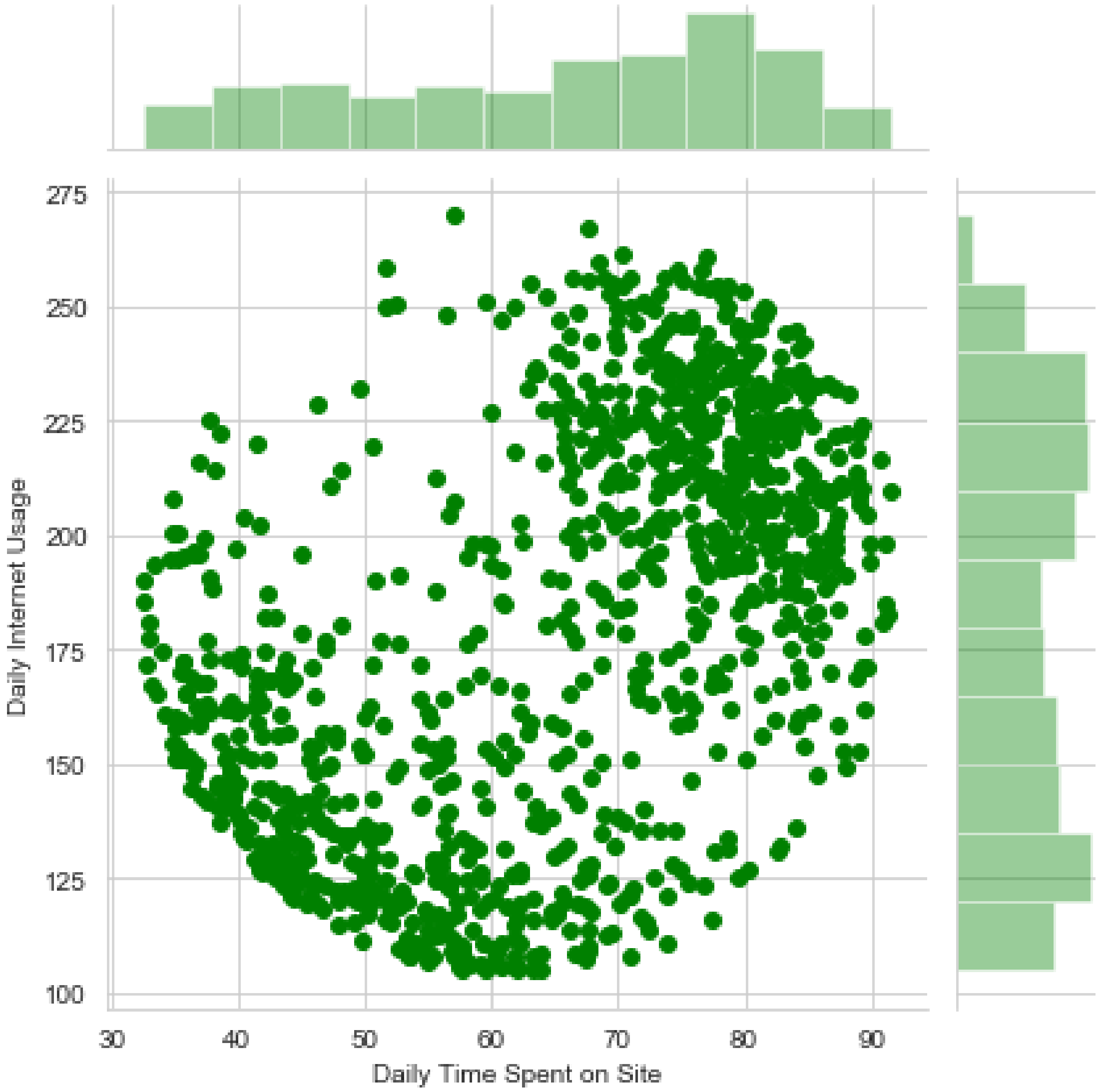
```
[8]: sns.jointplot(x='Age',y='Daily Time Spent on␣
      ↪Site',data=ad_data,color='red',kind='kde');
```



Jointplot of ‘Daily Time Spent on Site’ vs. ’Daily Internet Usage

```
[9]: sns.jointplot(x='Daily Time Spent on Site',y='Daily Internet␣
      ↪Usage',data=ad_data,color='green')
```

```
[9]: <seaborn.axisgrid.JointGrid at 0x21f5922e388>
```

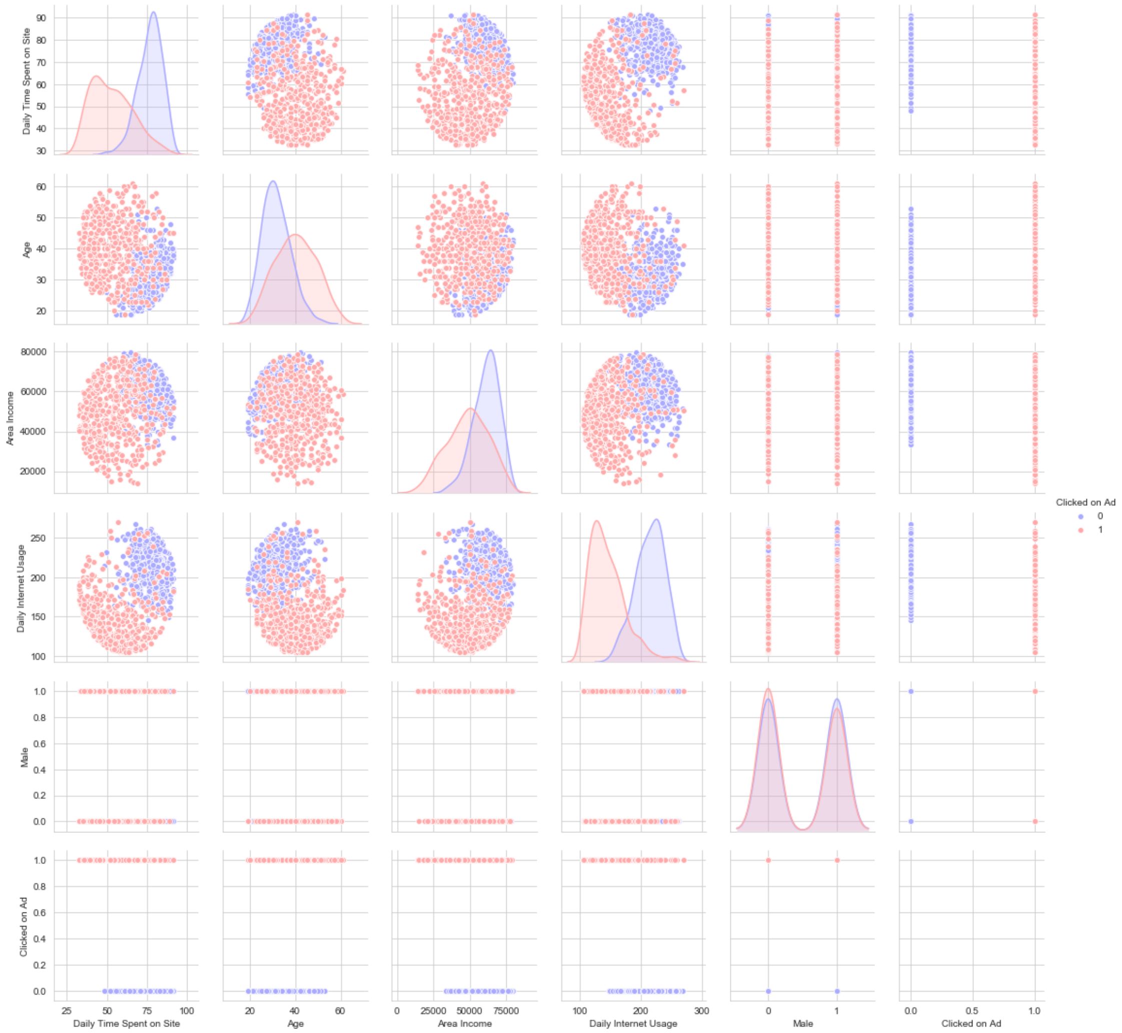


Pairplot with the hue defined by the 'Clicked on Ad'

```
[10]: sns.pairplot(ad_data,hue='Clicked on Ad',palette='bwr')
```

```
C:\Users\rajar\Anaconda3\lib\site-packages\statsmodels\nonparametric\kde.py:487:
RuntimeWarning: invalid value encountered in true_divide
  binned = fast_linbin(X, a, b, gridsize) / (delta * nobs)
C:\Users\rajar\Anaconda3\lib\site-
packages\statsmodels\nonparametric\kdetools.py:34: RuntimeWarning: invalid value
encountered in double_scalars
  FAC1 = 2*(np.pi*bw/RANGE)**2
```

```
[10]: <seaborn.axisgrid.PairGrid at 0x21f5921f948>
```



0.0.2 Training and Testing the Data

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

```
[12]: ad_data.columns
```

```
[12]: Index(['Daily Time Spent on Site', 'Age', 'Area Income',
             'Daily Internet Usage', 'Ad Topic Line', 'City', 'Male', 'Country',
             'Timestamp', 'Clicked on Ad'],
            dtype='object')
```

```
[13]: X = ad_data[['Daily Time Spent on Site', 'Age', 'Area Income','Daily Internet␣
       ↪Usage', 'Male']]
      y = ad_data['Clicked on Ad']
```

[15]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33,␣
 ↪random_state=42)
```

Training the Model

[16]:
```
from sklearn.linear_model import LogisticRegression
```

[17]:
```
logmodel = LogisticRegression()
logmodel.fit(X_train,y_train)
```

```
C:\Users\rajar\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:432:
FutureWarning: Default solver will be changed to 'lbfgs' in 0.22. Specify a
solver to silence this warning.
  FutureWarning)
```

[17]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=100,
                   multi_class='warn', n_jobs=None, penalty='l2',
                   random_state=None, solver='warn', tol=0.0001, verbose=0,
                   warm_start=False)
```

Predicting the Test Data

[19]:
```
predictions = logmodel.predict(X_test)
```

Evaluating the model

[20]:
```
from sklearn.metrics import classification_report
```

[21]:
```
print(classification_report(y_test,predictions))
```

```
              precision    recall  f1-score   support

           0       0.87      0.96      0.91       162
           1       0.96      0.86      0.91       168

    accuracy                           0.91       330
   macro avg       0.91      0.91      0.91       330
weighted avg       0.91      0.91      0.91       330
```