

# Logistic Regression Project

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## 1 Logistic Regression Project - Solutions

In this project we will be working with a fake advertising data set, indicating whether or not a particular internet user clicked on an Advertisement on a company website. We will try to create a model that will predict whether or not they will click on an ad based off the features of that user.

This data set contains the following features:

- 'Daily Time Spent on Site': consumer time on site in minutes
- 'Age': customer age in years
- 'Area Income': Avg. Income of geographical area of consumer
- 'Daily Internet Usage': Avg. minutes a day consumer is on the internet
- 'Ad Topic Line': Headline of the advertisement
- 'City': City of consumer
- 'Male': Whether or not consumer was male
- 'Country': Country of consumer
- 'Timestamp': Time at which consumer clicked on Ad or closed window
- 'Clicked on Ad': 0 or 1 indicated clicking on Ad

### 1.1 Import Libraries

Import a few libraries you think you'll need (Or just import them as you go along!)

```
In [97]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

### 1.2 Get the Data

Read in the advertising.csv file and set it to a data frame called ad\_data.

```
In [98]: ad_data = pd.read_csv('advertising.csv')
```

Check the head of ad\_data

```
In [40]: ad_data.head()
```

```
Out[40]:
```

	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

**\*\* Use info and describe() on ad\_data\*\***

```
In [41]: 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
```

```
In [42]: ad_data.describe()
```

```
Out[42]:
```

	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	1000.000000
mean	180.000100	0.481000	0.500000
std	43.902339	0.499889	0.500250
min	104.780000	0.000000	0.000000
25%	138.830000	0.000000	0.000000
50%	183.130000	0.000000	0.500000
75%	218.792500	1.000000	1.000000
max	269.960000	1.000000	1.000000

### 1.3 Exploratory Data Analysis

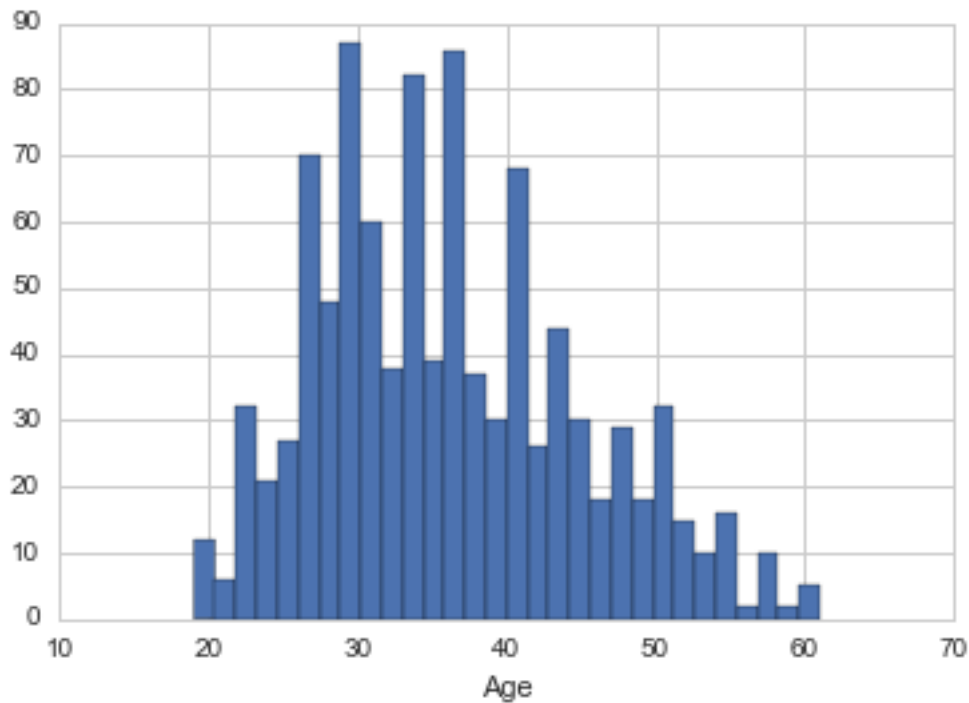
Let's use seaborn to explore the data!

Try recreating the plots shown below!

**\*\* Create a histogram of the Age\*\***

```
In [48]: sns.set_style('whitegrid')
ad_data['Age'].hist(bins=30)
plt.xlabel('Age')
```

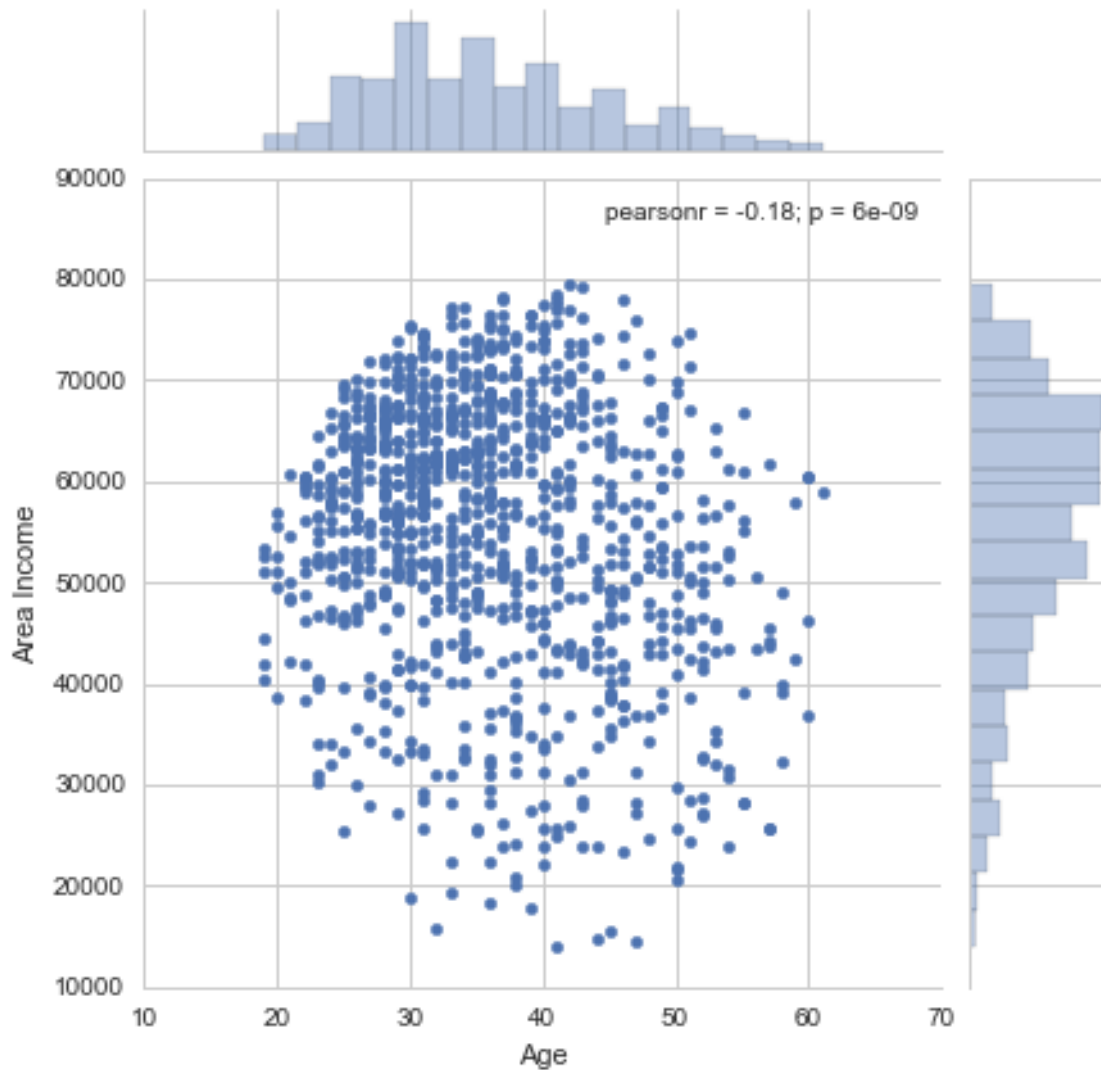
Out[48]: <matplotlib.text.Text at 0x11a05b908>



Create a jointplot showing Area Income versus Age.

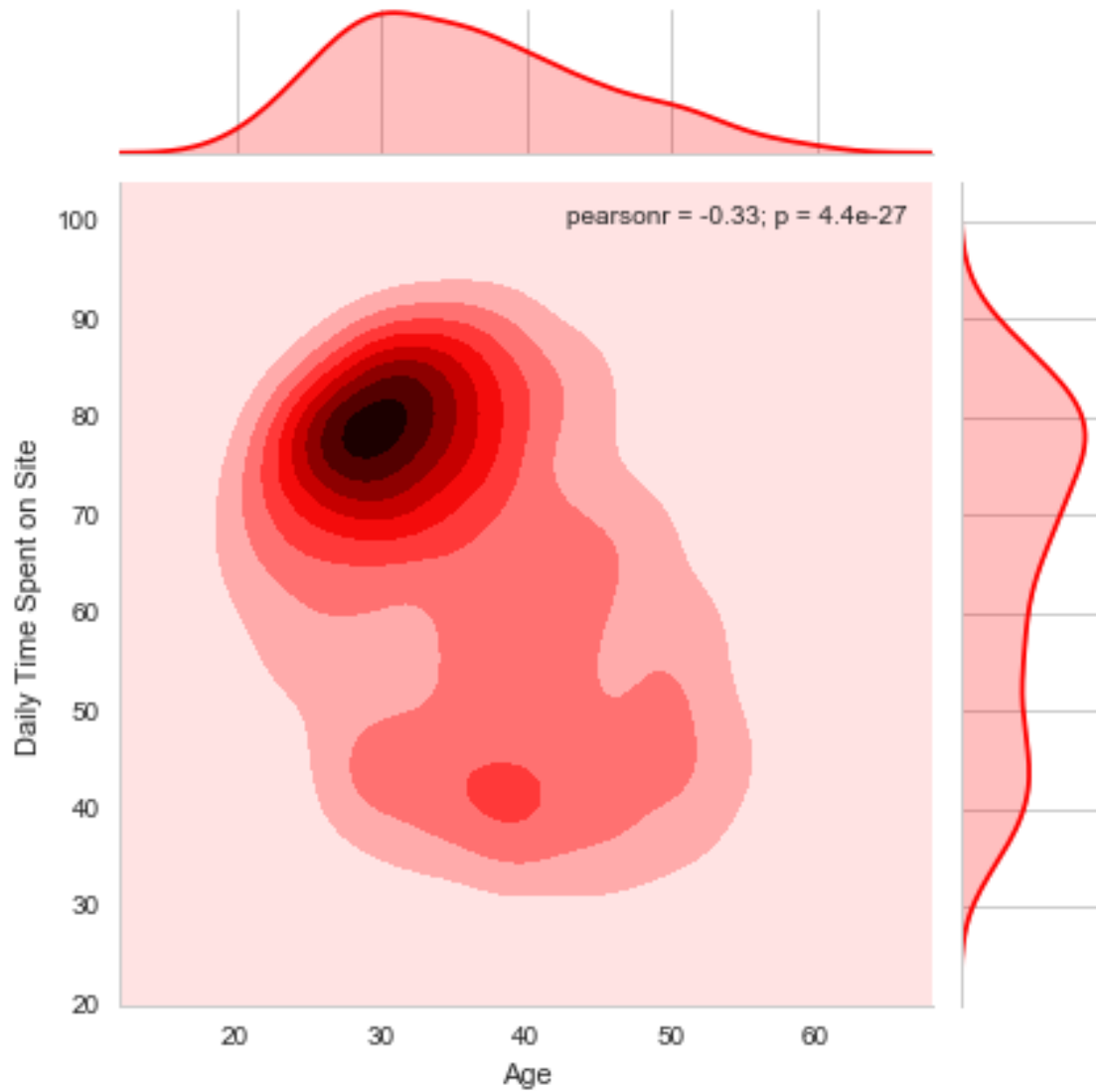
```
In [64]: sns.jointplot(x='Age',y='Area Income',data=ad_data)
```

```
Out[64]: <seaborn.axisgrid.JointGrid at 0x120bbb390>
```



Create a jointplot showing the kde distributions of Daily Time spent on site vs. Age.

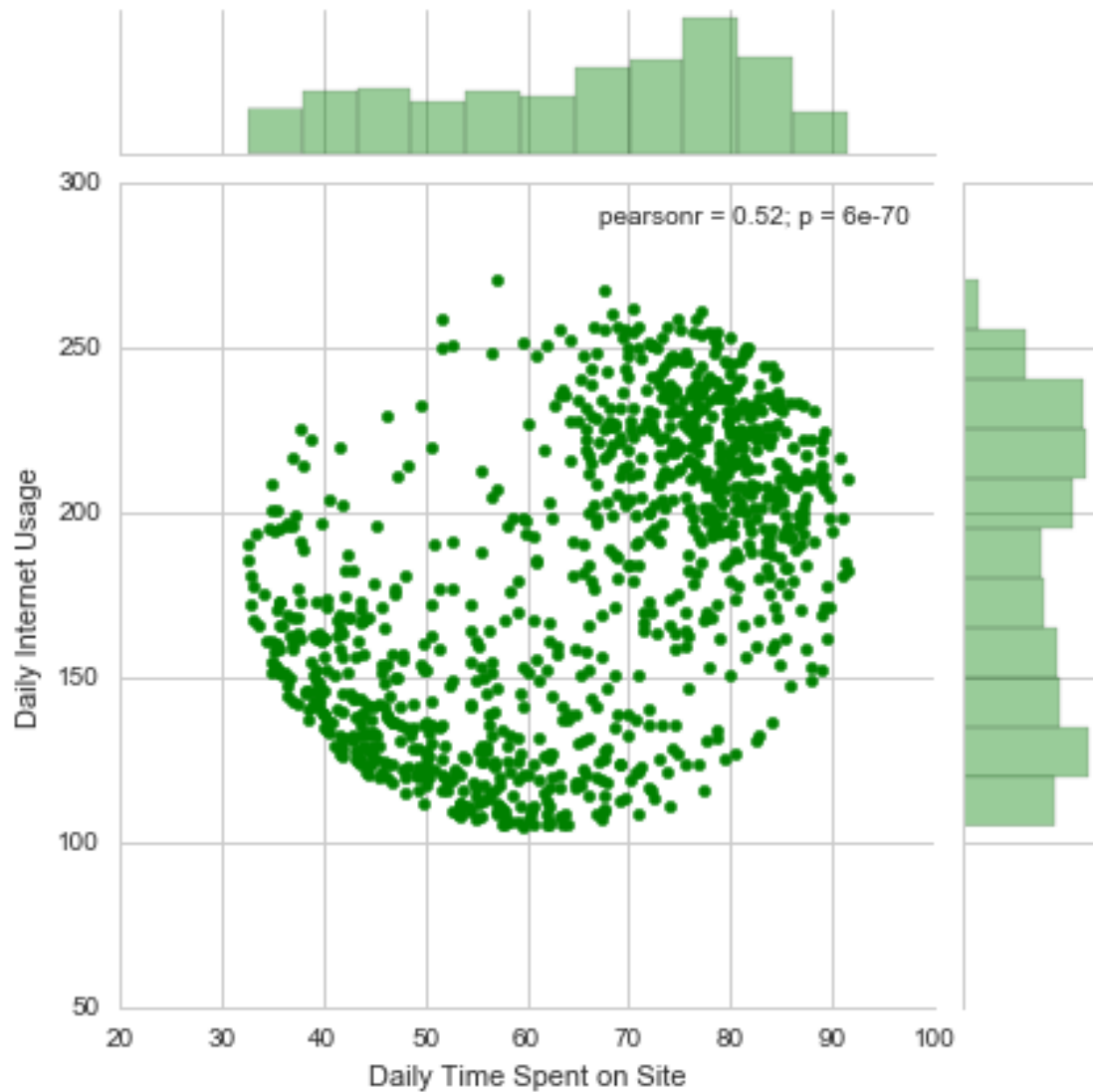
```
In [66]: sns.jointplot(x='Age',y='Daily Time Spent on Site',data=ad_data,color='red',kind='kde')
```



**\*\* Create a jointplot of 'Daily Time Spent on Site' vs. 'Daily Internet Usage'\*\***

```
In [72]: sns.jointplot(x='Daily Time Spent on Site',y='Daily Internet Usage',data=ad_data,color='red')
```

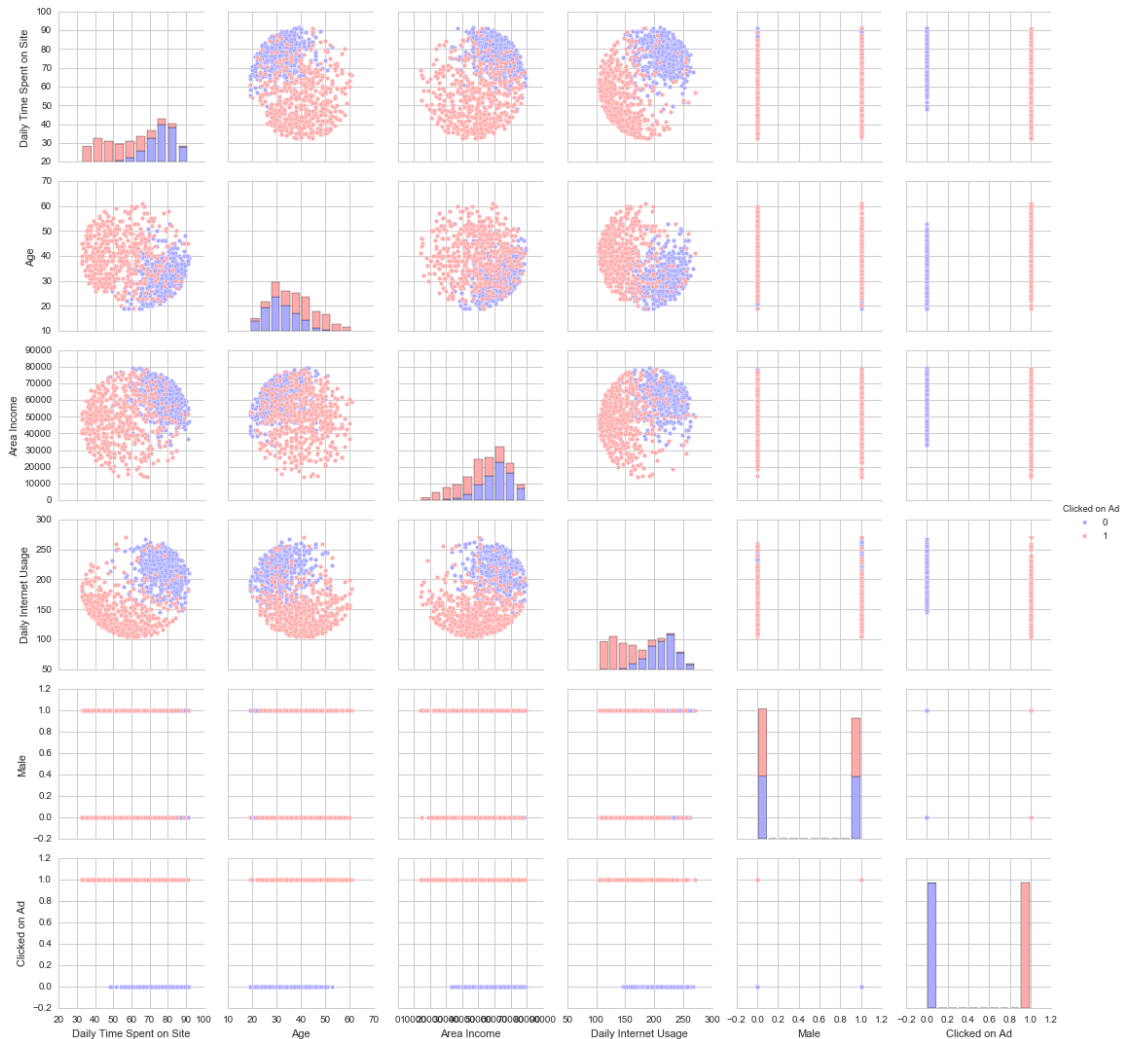
```
Out[72]: <seaborn.axisgrid.JointGrid at 0x121e8cb00>
```



**\*\* Finally, create a pairplot with the hue defined by the 'Clicked on Ad' column feature.\*\***

```
In [84]: sns.pairplot(ad_data,hue='Clicked on Ad',palette='bwr')
```

```
Out[84]: <seaborn.axisgrid.PairGrid at 0x12a97fdd8>
```



## 2 Logistic Regression

Now it's time to do a train test split, and train our model!

You'll have the freedom here to choose columns that you want to train on!

**\*\* Split the data into training set and testing set using train\_test\_split\*\***

```
In [85]: from sklearn.model_selection import train_test_split
```

```
In [88]: X = ad_data[['Daily Time Spent on Site', 'Age', 'Area Income', 'Daily Internet Usage',
y = ad_data['Clicked on Ad']
```

```
In [89]: X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, random_state=42)
```

**\*\* Train and fit a logistic regression model on the training set.\*\***

```
In [91]: from sklearn.linear_model import LogisticRegression
```

```
In [92]: logmodel = LogisticRegression()  
logmodel.fit(X_train,y_train)
```

```
Out[92]: LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,  
    intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,  
    penalty='l2', random_state=None, solver='liblinear', tol=0.0001,  
    verbose=0, warm_start=False)
```

## 2.1 Predictions and Evaluations

**\*\* Now predict values for the testing data.\*\***

```
In [94]: predictions = logmodel.predict(X_test)
```

**\*\* Create a classification report for the model.\*\***

```
In [95]: from sklearn.metrics import classification_report
```

```
In [96]: 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
avg / total	0.91	0.91	0.91	330

## 2.2 Great Job!