DATA 119 Final Project

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Project A

```
import numpy as np
import pandas as pd
import plotnine as p9
import statsmodels.api as sm
import sklearn.metrics as metrics
```

```
df = pd.read_csv("marketing_campaign.csv", sep="\t")
pd.set_option('display.max_rows', None)
df.head(5)
```

	ID	Year_Birth	Education	Marital_Status	Income	Kidhome	Teenhome	Dt_Customer	Rec
0	5524	1957	Graduation	Single	58138.0	0	0	04-09-2012	58
1	2174	1954	Graduation	Single	46344.0	1	1	08-03-2014	38
2	4141	1965	Graduation	Together	71613.0	0	0	21-08-2013	26
3	6182	1984	Graduation	Together	26646.0	1	0	10-02-2014	26
4	5324	1981	PhD	Married	58293.0	1	0	19-01-2014	94

```
df.columns
```

```
Index(['ID', 'Year_Birth', 'Education', 'Marital_Status', 'Income', 'Kidhome',
       'Teenhome', 'Dt_Customer', 'Recency', 'MntWines', 'MntFruits',
       'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts',
       'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases',
       'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
```

```
       'AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmp1',
       'AcceptedCmp2', 'Complain', 'Z_CostContact', 'Z_Revenue', 'Response'],
      dtype='object')
```

```
#These variables are meaningless
#so we decide to delete them

df = df.drop(columns=['ID', 'Z_CostContact','Z_Revenue'])
df.columns
```

```
Index(['Year_Birth', 'Education', 'Marital_Status', 'Income', 'Kidhome',
       'Teenhome', 'Dt_Customer', 'Recency', 'MntWines', 'MntFruits',
       'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts',
       'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases',
       'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
       'AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmp1',
       'AcceptedCmp2', 'Complain', 'Response'],
      dtype='object')
```

```
# Name the variables in a more meaning way

df = df.rename(columns={"Response": "AcceptedLastCmp"})
df.columns
```

```
Index(['Year_Birth', 'Education', 'Marital_Status', 'Income', 'Kidhome',
       'Teenhome', 'Dt_Customer', 'Recency', 'MntWines', 'MntFruits',
       'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts',
       'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases',
       'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
       'AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmp1',
       'AcceptedCmp2', 'Complain', 'AcceptedLastCmp'],
      dtype='object')
```

```
df['Income'].isna().sum() / df.shape[0]
#only 1% missing data, so let's drop it
df = df.dropna()
```

```
#Summary statistics for variables
print(df['Year_Birth'].describe())
```

```
count    2216.000000
mean     1968.820397
std        11.985554
min      1893.000000
25%      1959.000000
50%      1970.000000
75%      1977.000000
max      1996.000000
Name: Year_Birth, dtype: float64
```

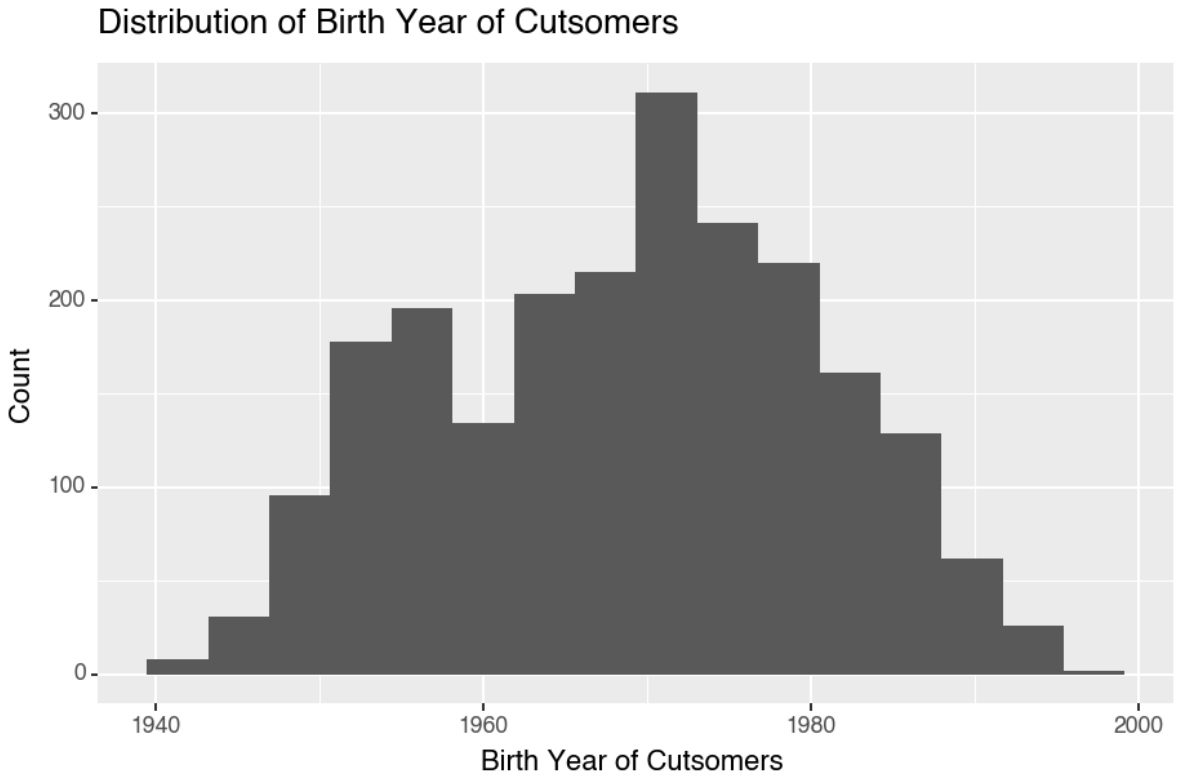
```
print(df[df['Year_Birth'] < 1920]['Dt_Customer'])
print("It looks like some data entry error")
print("because it is quite impossible to be born that early \nand become a customer for th
print("So we can delete the data")

index = df[df['Year_Birth'] < 1920].index
df = df.drop(index)
```

```
192    26-09-2013
239    17-05-2014
339    26-09-2013
Name: Dt_Customer, dtype: object
It looks like some data entry error
because it is quite impossible to be born that early
and become a customer for the first time in 2010s.
So we can delete the data
```

```
#Summary statistics for variables
print(df['Year_Birth'].describe())
```

```
count    2213.000000
mean     1968.917307
std        11.700216
min      1940.000000
25%      1959.000000
50%      1970.000000
75%      1977.000000
max      1996.000000
Name: Year_Birth, dtype: float64
```

```
# Visualize the distirbution of variables
(p9.ggplot(df) +
 p9.aes (x = 'Year_Birth') +
 p9.geom_histogram(bins=16)+
 p9.labs(x = "Birth Year of Cutsomers \n", y = "Count",title= "Distribution of Birth Year
         caption = "This histogram shows the distribution of Birth Year of Cutsomers.\n" +
          "The distribution is centered at approximately 1970, and roughly ranges from 194
          "It is an unimodal, left skewed distribution. There are no obvious unusual value
```




```
<Figure Size: (460 x 345)>
```

```
print(df['Income'].describe())
```

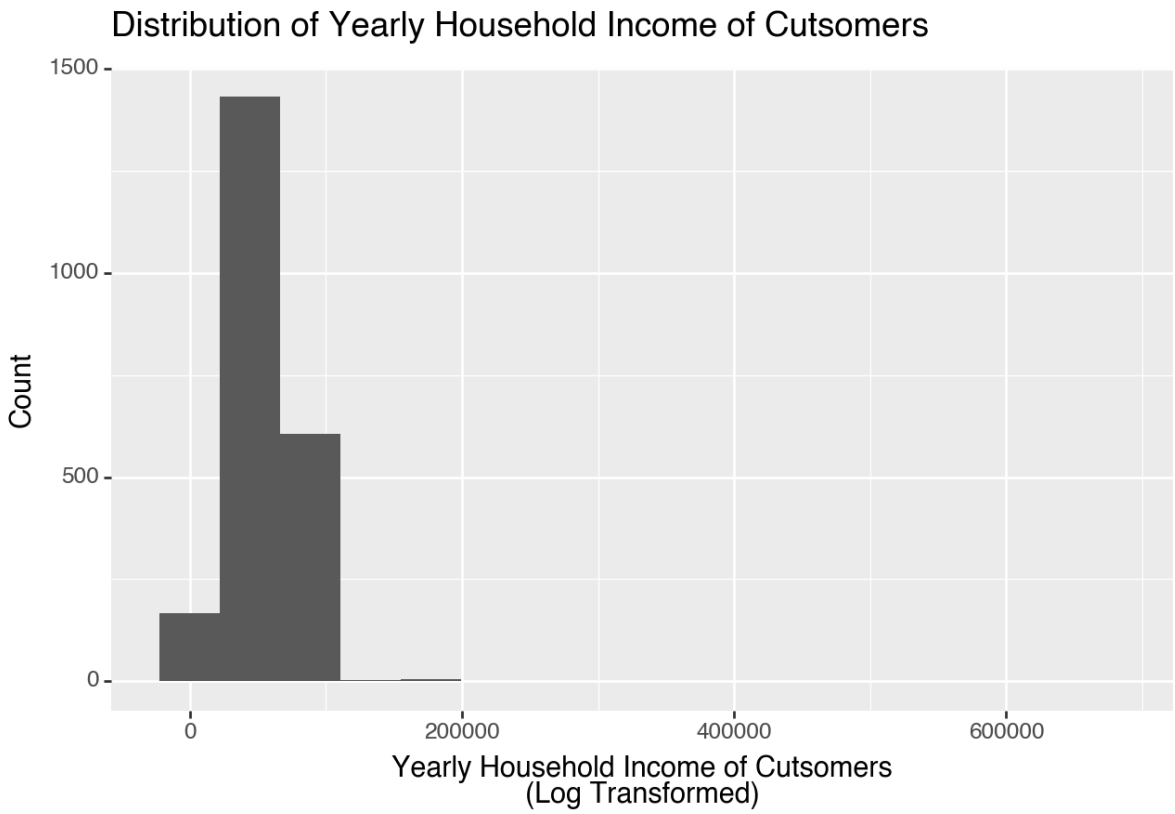
```
count       2213.000000
```

```
mean      52236.581563
std       25178.603047
min        1730.000000
25%       35246.000000
50%       51373.000000
75%       68487.000000
max      666666.000000
Name: Income, dtype: float64
```

```
print(df['Income'].describe())
```

```
count      2213.000000
mean      52236.581563
std       25178.603047
min        1730.000000
25%       35246.000000
50%       51373.000000
75%       68487.000000
max      666666.000000
Name: Income, dtype: float64
```

```
# Visualize the distirbution of variables
(p9.ggplot(df) +
 p9.aes (x = 'Income') +
 p9.geom_histogram(bins=16)+
 p9.labs(x = "Yearly Household Income of Cutsomers\n(Log Transformed)", y = "Count",title=
         caption = "This histogram shows the distribution of yearly household income of cu
          "The distribution is centered at approximately 50,000, and roughly ranges from 1
          "It is an unimodal, left skewed distribution. There are unusually high values.")
```



This histogram shows the distribution of yearly household income of cutsomers.
The distribution is centered at approximately 50,000, and roughly ranges from 1000 to 700,000.
It is an unimodal, left skewed distribution. There are unusually high values.

```
<Figure Size: (640 x 480)>
```

```
print(df['Dt_Customer'].describe())
```

```
count           2213
unique           662
top       31-08-2012
freq              12
Name: Dt_Customer, dtype: object
```

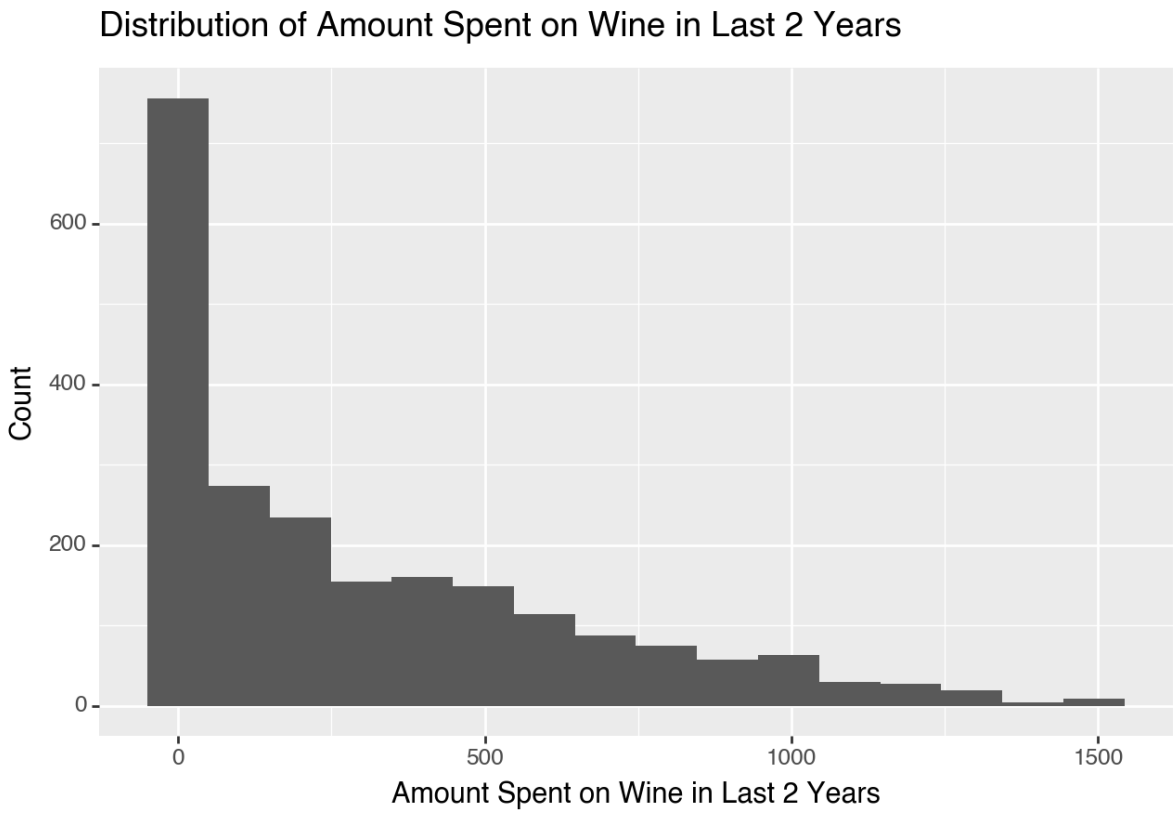
```
print(df['Recency'].describe())
```

```
count    2213.000000
mean       49.007682
std        28.941864
min         0.000000
25%        24.000000
50%        49.000000
75%        74.000000
max        99.000000
Name: Recency, dtype: float64
```

```
print(df['MntWines'].describe())
```

```
count    2213.000000
mean      305.153638
std       337.305490
min         0.000000
25%        24.000000
50%       175.000000
75%       505.000000
max      1493.000000
Name: MntWines, dtype: float64
```

```
# Visualize the distirbution of variables
(p9.ggplot(df) +
 p9.aes (x = 'MntWines') +
 p9.geom_histogram(bins=16)+
 p9.labs(x = "Amount Spent on Wine in Last 2 Years", y = "Count",title= "Distribution of A
         caption = "This histogram shows the distribution of amount spent on wine in last
          "The distribution is centered at approximately 0, and roughly ranges from 0 to 1
          "It is an unimodal, right skewed distribution. There are no unusual values."))
```




```
<Figure Size: (640 x 480)>
```

```
print(df['MntFruits'].describe())
```

```
count    2213.000000
mean       26.323995
std        39.735932
min         0.000000
25%         2.000000
50%         8.000000
75%        33.000000
max       199.000000
Name: MntFruits, dtype: float64
```

```
print(df['MntMeatProducts'].describe())
```

```
count    2213.000000
mean      166.962494
std       224.226178
min         0.000000
25%        16.000000
50%        68.000000
75%       232.000000
max      1725.000000
Name: MntMeatProducts, dtype: float64
```

```
print(df['MntFishProducts'].describe())
```

```
count    2213.000000
mean       37.635337
std        54.763278
min         0.000000
25%         3.000000
50%        12.000000
75%        50.000000
max       259.000000
Name: MntFishProducts, dtype: float64
```

```
print(df['MntSweetProducts'].describe())
```

```
count    2213.000000
mean       27.034794
std        41.085433
min         0.000000
25%         1.000000
50%         8.000000
75%        33.000000
max       262.000000
Name: MntSweetProducts, dtype: float64
```

```
print(df['MntGoldProds'].describe())
```

```
count    2213.000000
mean       43.911432
std        51.699746
min         0.000000
25%         9.000000
50%        24.000000
75%        56.000000
max       321.000000
Name: MntGoldProds, dtype: float64
```

```
print(df['NumDealsPurchases'].describe())
```

```
count    2213.000000
mean        2.325350
std         1.924402
min         0.000000
25%         1.000000
50%         2.000000
75%         3.000000
max        15.000000
Name: NumDealsPurchases, dtype: float64
```

```
print(df['NumWebPurchases'].describe())
```

```
count    2213.000000
mean        4.087664
std         2.741664
min         0.000000
25%         2.000000
50%         4.000000
75%         6.000000
max        27.000000
Name: NumWebPurchases, dtype: float64
```

```
print(df['NumCatalogPurchases'].describe())
```

```
count    2213.000000
mean        2.671487
```

```
std         2.927096
min         0.000000
25%         0.000000
50%         2.000000
75%         4.000000
max        28.000000
Name: NumCatalogPurchases, dtype: float64
```

```
print(df['NumStorePurchases'].describe())
```

```
count    2213.000000
mean        5.805242
std         3.250752
min         0.000000
25%         3.000000
50%         5.000000
75%         8.000000
max        13.000000
Name: NumStorePurchases, dtype: float64
```

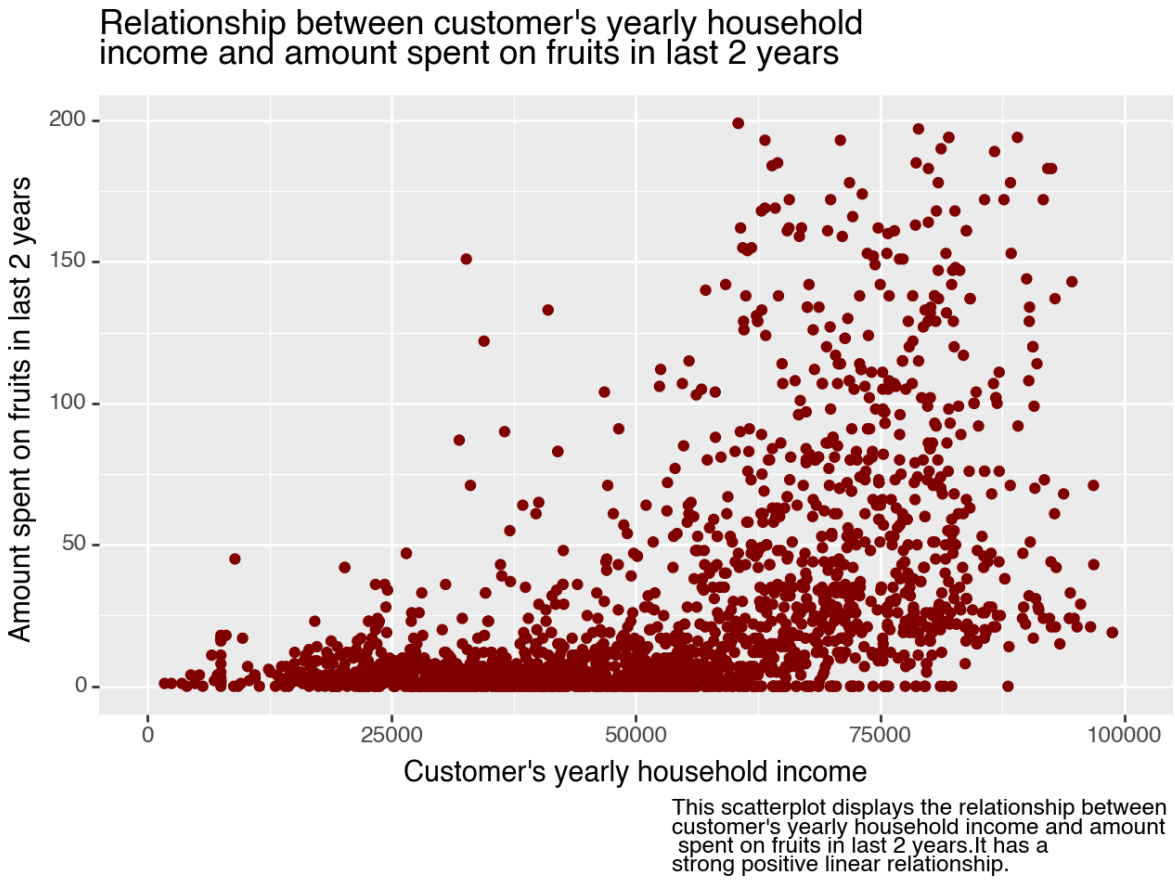
```
print(df['NumWebVisitsMonth'].describe())
```

```
count    2213.000000
mean        5.321735
std         2.425092
min         0.000000
25%         3.000000
50%         6.000000
75%         7.000000
max        20.000000
Name: NumWebVisitsMonth, dtype: float64
```

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntFruits'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on fruits in last 2 y
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
```

```
          + "It has a \nstrong positive linear relationship."))
```

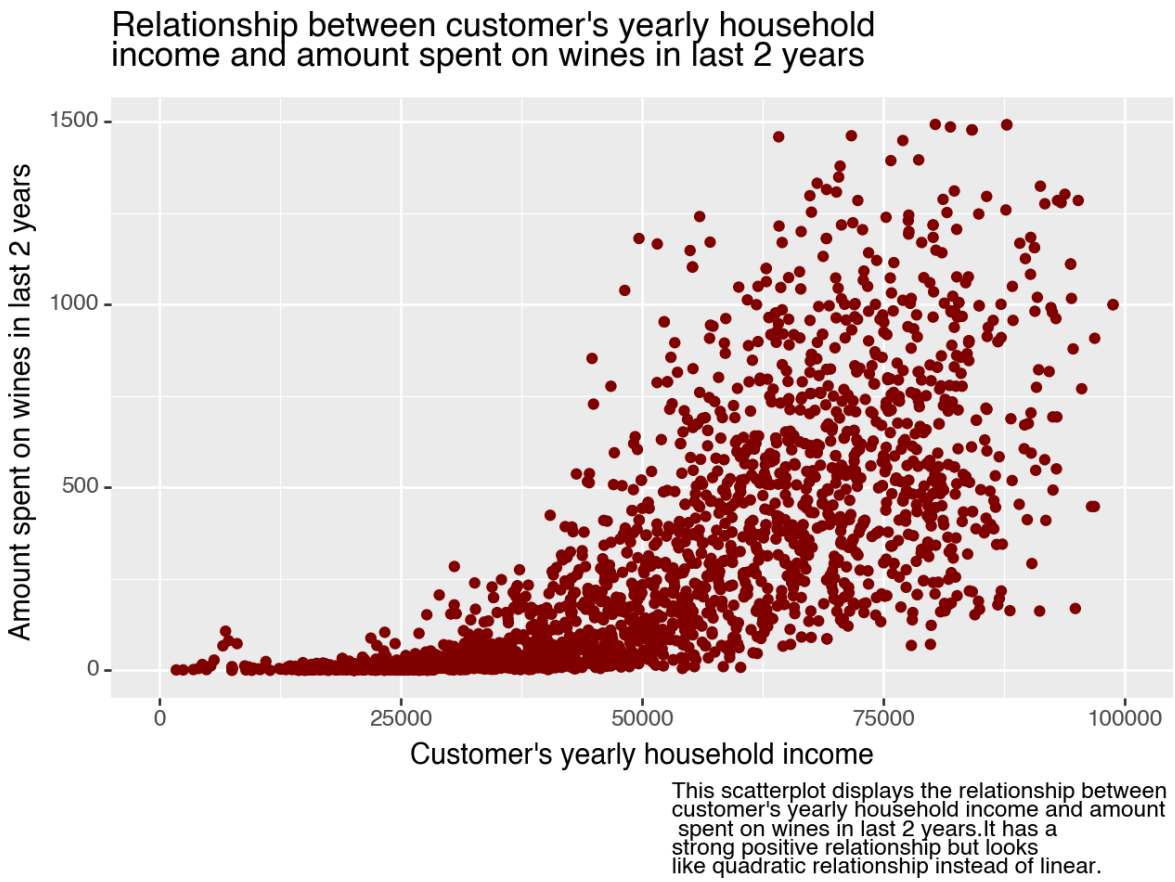
```
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point
```




```
<Figure Size: (640 x 480)>
```

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntWines'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on wines in last 2 ye
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
          + "It has a \nstrong positive relationship but looks \nlike quadratic relationsh
```

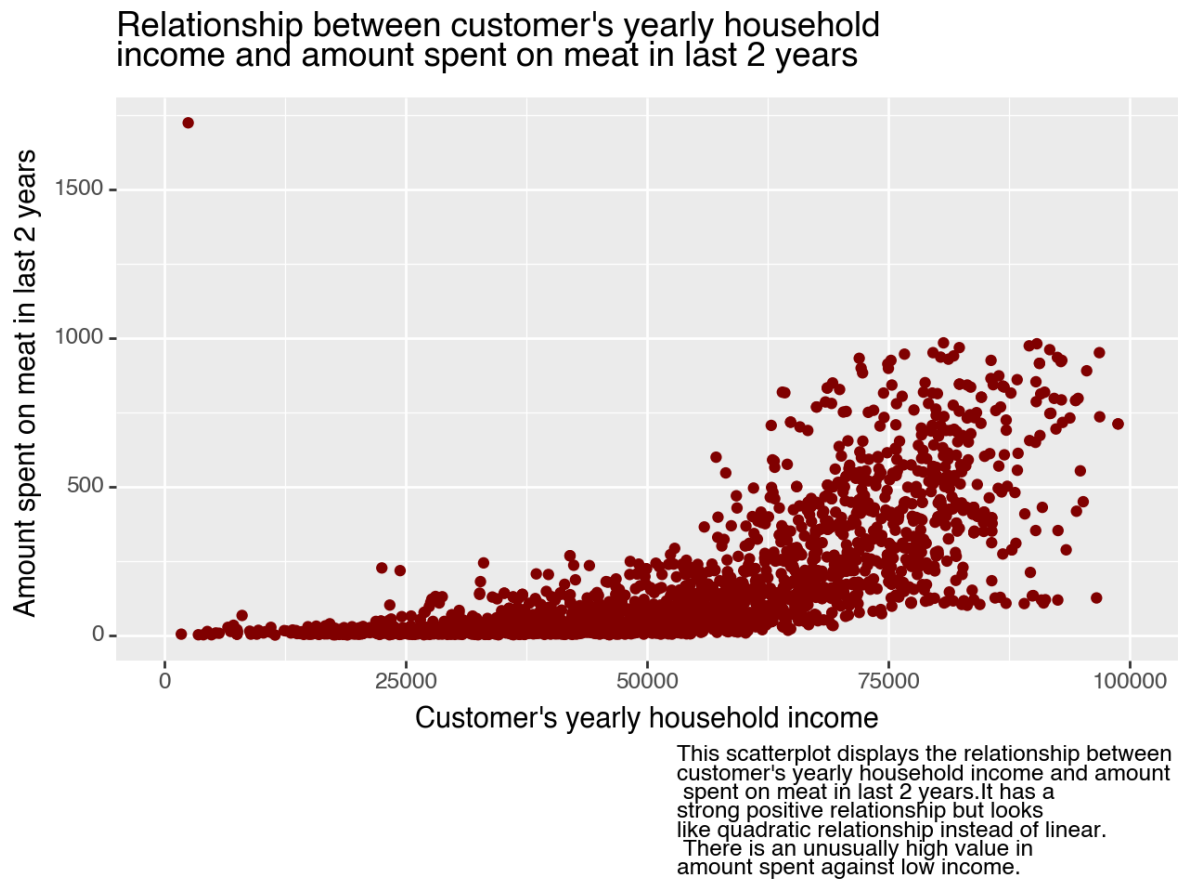
```
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point
```




```
<Figure Size: (640 x 480)>
```

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntMeatProducts'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on meat in last 2 yea
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
          + "It has a \nstrong positive relationship but looks \nlike quadratic relationsh
```

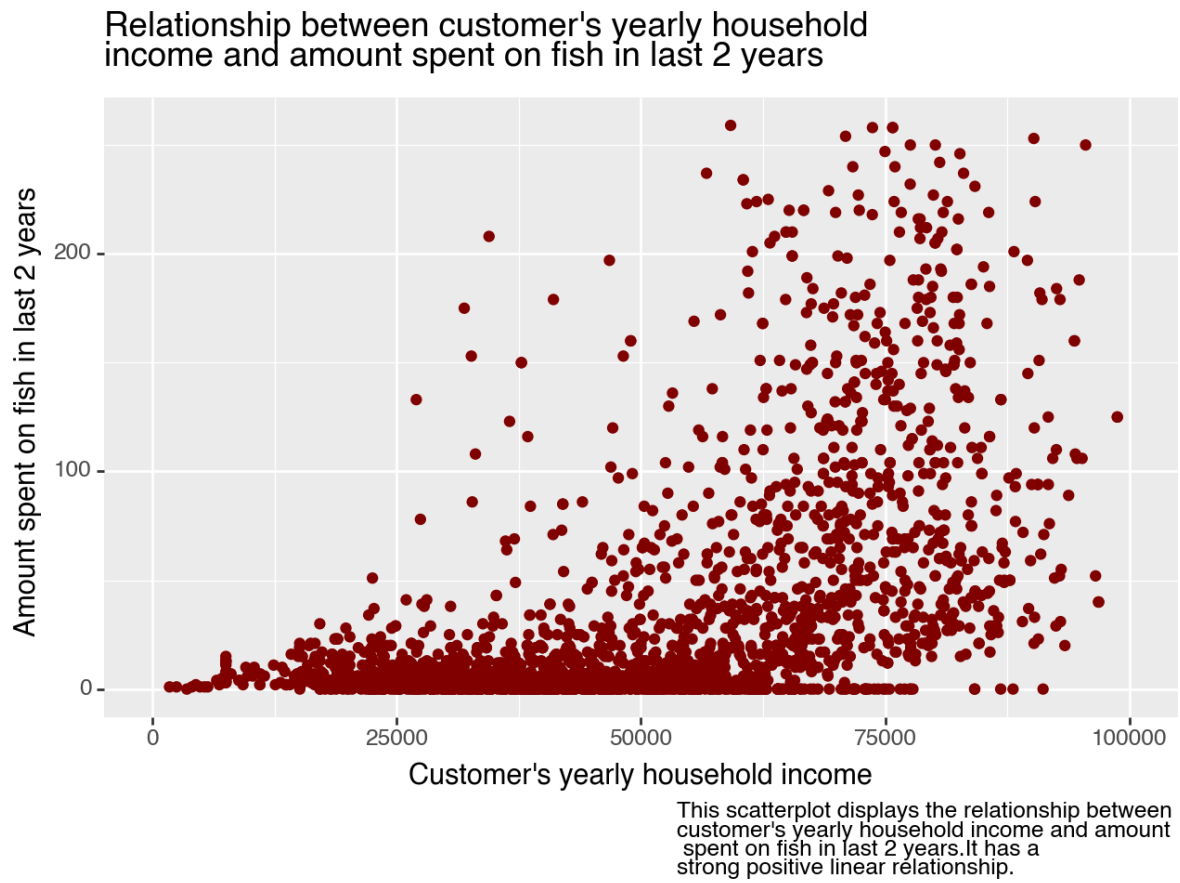
```
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point
```




```
<Figure Size: (640 x 480)>
```

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntFishProducts'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on fish in last 2 yea
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
          + "It has a \nstrong positive linear relationship."))
```

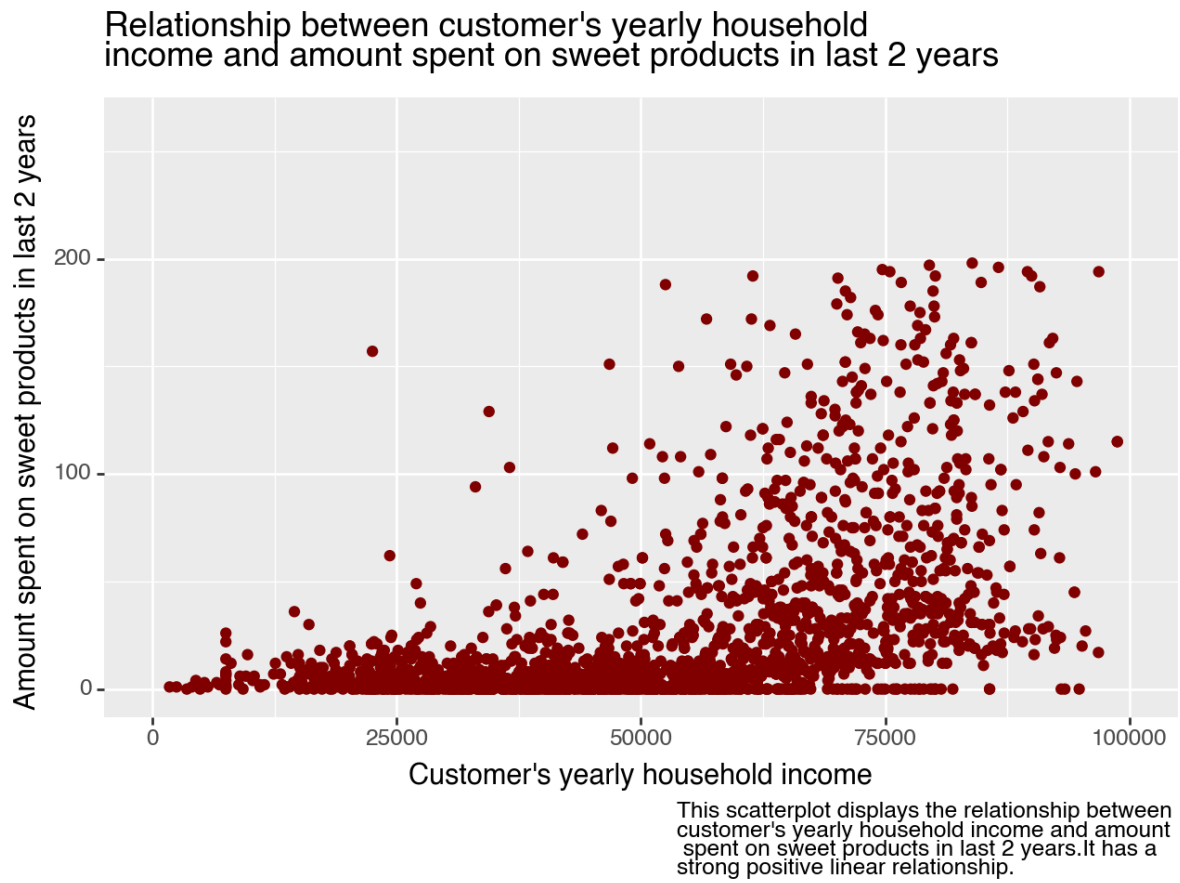
```
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point
```



<Figure Size: (640 x 480)>

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntSweetProducts'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on sweet products in
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
          + "It has a \nstrong positive linear relationship."))
```

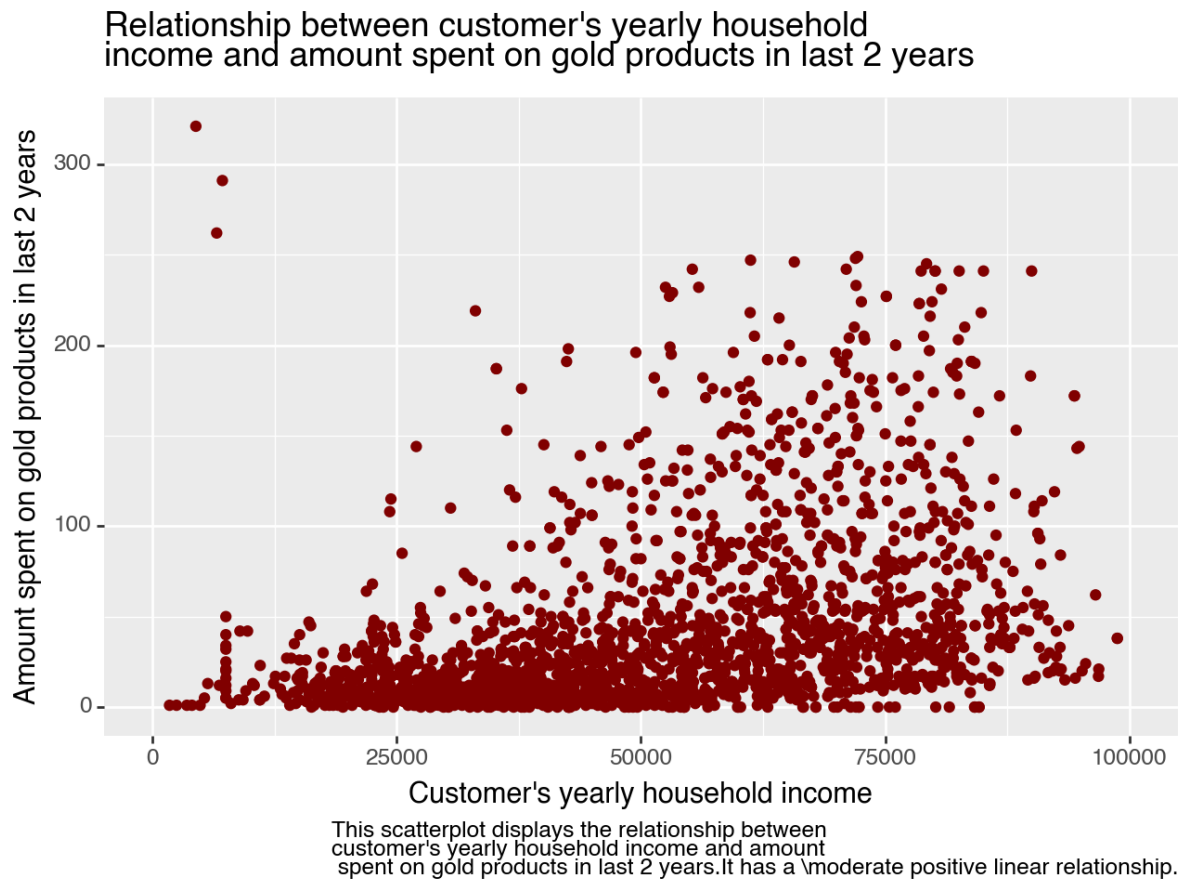
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point



<Figure Size: (640 x 480)>

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Income', y = 'MntGoldProds'))  +
 p9.geom_point(color = 'maroon') +
 p9.xlim(0,100000) +
 p9.labs(x = "Customer's yearly household income", y = "Amount spent on gold products in l
        title= "Relationship between customer's yearly household \nincome and amount spent
          caption = "This scatterplot displays the relationship between \ncustomer's yearl
          + "It has a \moderate positive linear relationship."))
```

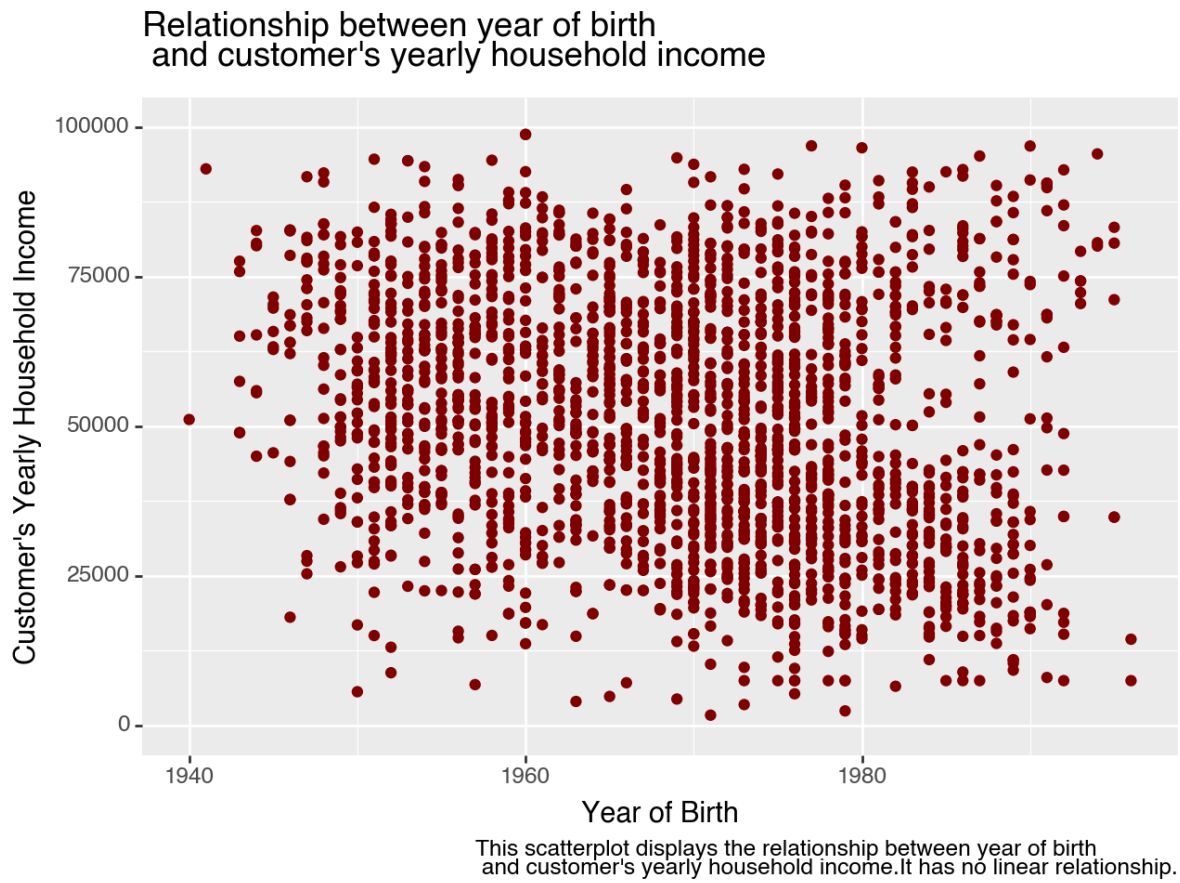
```
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point
```



<Figure Size: (640 x 480)>

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'Year_Birth', y = 'Income'))  +
 p9.geom_point(color = 'maroon') +
 p9.ylim(0,100000) +
 p9.labs(x = "Year of Birth", y = "Customer's Yearly Household Income",
        title= "Relationship between year of birth\n and customer's yearly household incom
          caption = "This scatterplot displays the relationship between year of birth\n an
          + "It has no linear relationship."))
```

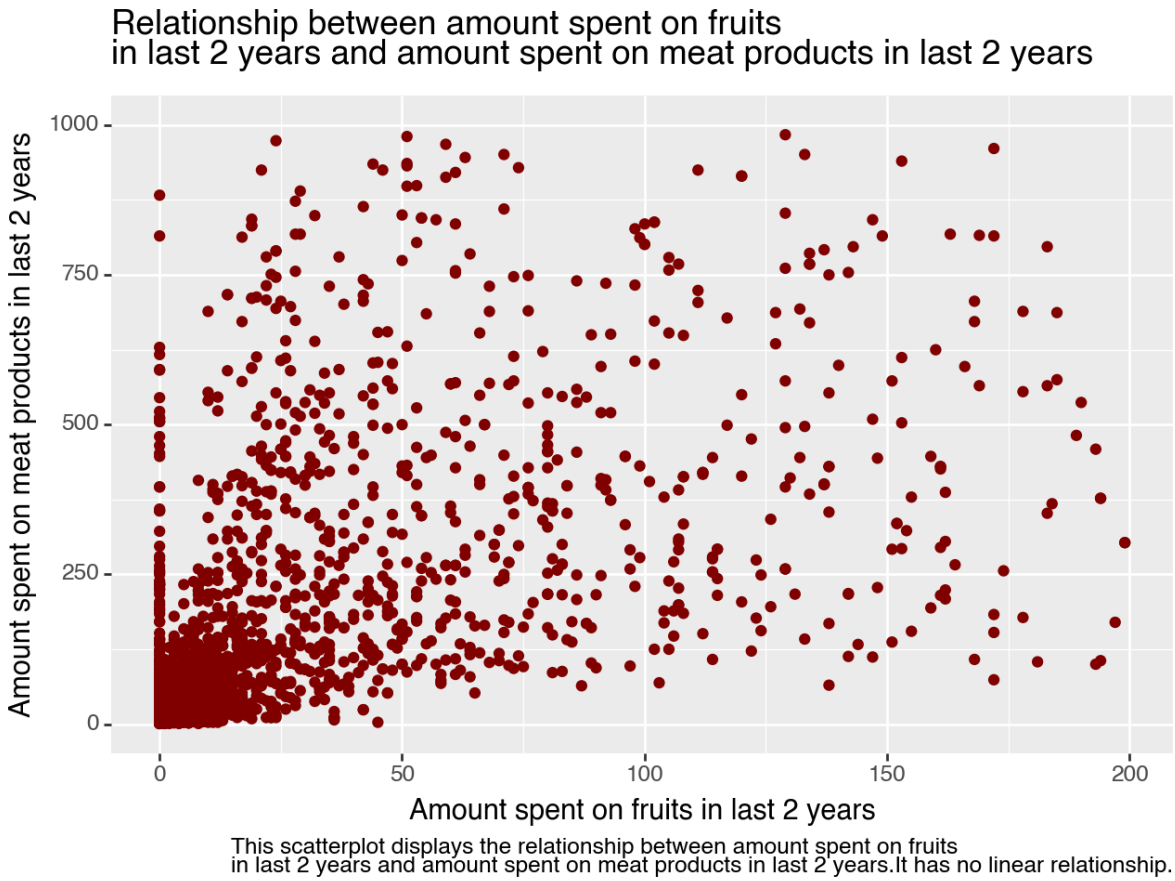
/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point



<Figure Size: (640 x 480)>

```
# create scatterplots
(p9.ggplot(df, p9.aes(x = 'MntFruits', y = 'MntMeatProducts'))  +
 p9.geom_point(color = 'maroon') +
 p9.ylim(1,1000) +
 p9.labs(x = "Amount spent on fruits in last 2 years", y = "Amount spent on meat products
        title= "Relationship between amount spent on fruits \nin last 2 years and amount s
          caption = "This scatterplot displays the relationship between amount spent on fr
          + "It has no linear relationship."))
```

/opt/homebrew/lib/python3.9/site-packages/plotnine/layer.py:364: PlotnineWarning: geom_point



<Figure Size: (640 x 480)>