```
* MSBA 635 - Data Analytics II;

* print data;

proc print data=tmp1.case_demand (obs=5);
run;
```

```
                        Obs     q1      p1      p2      income

                         1     81.7    1.78    1.11     25088
                         2     56.9    2.27    0.67     26561
                         3     64.1    2.21    0.83     25510
                         4     65.4    2.15    0.75     27158
                         5     64.1    2.26    1.06     27162
```

```
* display data attributes;

proc contents data=tmp1.case_demand;
run;
```

                              The CONTENTS Procedure

Data Set Name	TMP1.CASE_DEMAND	Observations	29
Member Type	DATA	Variables	4
Engine	V9	Indexes	0
Created	10/26/2018 12:40:35	Observation Length	30
Last Modified	10/26/2018 12:40:35	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label	case_demand dataset written by Stat/Transfer Ver. 14.1.1016.0801		

Data Representation	WINDOWS_64
Encoding	wlatin1 Western (Windows)

                         Engine/Host Dependent Information

           Data Set Page Size   4096
           Number of Data Set Pages   1
           First Data Page   1
           Max Obs per Page   135

```
Obs in First Data Page      29
Number of Data Set Repairs  0
Filename                    C:\Users\nxnguy01\Desktop\case_demand.sas7bdat
Release Created             9.0000M0
Host Created                WIN
```

Alphabetic List of Variables and Attributes

#	Variable	Type	Len
4	income	Num	6
2	p1	Num	8
3	p2	Num	8
1	q1	Num	8

3. **What is the mean of Q1?**

56.327559

```
* obtain descriptive statistics;

proc univariate data=tmp1.case_demand;
run;
```

                            The UNIVARIATE Procedure
                              Variable: q1

                                   Moments

        N   29   Sum Weights   29
        Mean   56.3275862   Sum Observations   1633.5
        Std Deviation   7.90677361   Variance   62.517069
        Skewness   1.1334015   Kurtosis   2.30586893
        Uncorrected SS   93761.59   Corrected SS   1750.47793
        Coeff Variation 14.0371249   Std Error Mean   1.468251

                          Basic Statistical Measures

              Location   Variability

        Mean   56.32759   Std Deviation   7.90677
        Median   55.60000   Variance   62.51707
        Mode   51.60000   Range   37.40000
                               Interquartile Range   10.10000

      Note: The mode displayed is the smallest of 3 modes with a count of 2.

                          Tests for Location: Mu0=0

            Test   -Statistic-   -----p Value------

            Student's t   t 38.36373   Pr > |t| <.0001
            Sign   M   14.5   Pr >= |M| <.0001
            Signed Rank   S   217.5   Pr >= |S| <.0001

                          Quantiles (Definition 5)

                         Level   Quantile

                         100% Max   81.7
                         99%   81.7
                         95%   65.9
                         90%   65.4
                         75% Q3   61.7
                         50% Median   55.6
                         25% Q1   51.6
                         10%   46.8

```
          5%                 46.3
          1%                 44.3
          0% Min             44.3
```

The UNIVARIATE Procedure
Variable: q1

Extreme Observations

```
----Lowest----        ----Highest---

Value      Obs        Value      Obs

44.3        22        64.1        5
46.3        27        65.3        8
46.8        28        65.4        4
47.9        14        65.9       11
48.3        12        81.7        1
```

4. What is the mean of P1?

3.04586207

The UNIVARIATE Procedure
Variable: p1

Moments

N	29	Sum Weights	29
Mean	3.04586207	Sum Observations	88.33
Std Deviation	0.62524576	Variance	0.39093227
Skewness	-0.2083987	Kurtosis	-1.1121355
Uncorrected SS	279.9871	Corrected SS	10.9461034
Coeff Variation	20.527711	Std Error Mean	0.11610522

Basic Statistical Measures

Location		Variability	
Mean	3.045862	Std Deviation	0.62525
Median	3.110000	Variance	0.39093
Mode	3.110000	Range	2.21000
		Interquartile Range	1.09000

Note: The mode displayed is the smallest of 2 modes with a count of 2.

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	26.23364	Pr > |t|	<.0001
Sign	M	14.5	Pr >= |M|	<.0001
Signed Rank	S	217.5	Pr >= |S|	<.0001

Quantiles (Definition 5)

Level	Quantile
100% Max	3.99
99%	3.99
95%	3.89
90%	3.86
75% Q3	3.61
50% Median	3.11
25% Q1	2.52
10%	2.21
5%	2.15
1%	1.78
0% Min	1.78

The UNIVARIATE Procedure
Variable: p1

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
1.78	1	3.72	24
2.15	4	3.81	26
2.21	3	3.86	27
2.26	5	3.89	29
2.27	2	3.99	28

5. **What is the price elasticity of demand for Good 1?**

-1.4641

Equation= ((change in Q1/change in P1)* mean of P1)/mean of Q1

= ((27.07630)*3.04)/56.32 = -1.4641

(Answer from #1 * answer from #4)/answer from #3

6. **Is the demand for Good 1 elastic or inelastic at the sample means of the data?**

Elastic.

If I increase price then total revenue will fall. If you decrease price then total revenue will rise.

7. **Hence, a 1 percent increase in P1 results in a**

1.4641 percent decrease in Q1

10. **What is the mean of P2?**
1.236262
11. **What is the cross price elasticity of demand of Good 1 given a change in the price of Good 2?**
0.2685. A 1% increase in price of Good 2 leads to a 0.2685 increase in the demand of Good 1, they are substitutes by definition.
(change in Q1 for P2 * mean P2)/mean Q1→ (12.23621*1.2363069)/56.32759 = **0.2685**
See these questions: (#8 * #10)/#3
12. **Are Goods 1 and 2 substitutes or complements?**
Substitutes

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The UNIVARIATE Procedure
Variable: p2

Moments

N	29	Sum Weights	29
Mean	1.2362069	Sum Observations	35.85
Std Deviation	0.29165064	Variance	0.0850601
Skewness	-0.0079007	Kurtosis	-0.7286338
Uncorrected SS	46.6997	Corrected SS	2.38168276
Coeff Variation	23.5923813	Std Error Mean	0.05415817

Basic Statistical Measures

Location		Variability	
Mean	1.236207	Std Deviation	0.29165
Median	1.180000	Variance	0.08506
Mode	1.100000	Range	1.06000
		Interquartile Range	0.32000

Note: The mode displayed is the smallest of 4 modes with a count of 2.

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	22.82586	Pr > |t|	<.0001
Sign	M	14.5	Pr >= |M|	<.0001
Signed Rank	S	217.5	Pr >= |S|	<.0001

Quantiles (Definition 5)

Level	Quantile
100% Max	1.73
99%	1.73

```
95%                   1.71
90%                   1.69
75% Q3                1.41
50% Median            1.18
25% Q1                1.09
10%                   0.83
5%                    0.75
1%                    0.67
0% Min                0.67
```

The UNIVARIATE Procedure
Variable: p2

Extreme Observations

```
----Lowest----        ----Highest---

Value      Obs        Value      Obs

0.67        2         1.60        22
0.75        4         1.62        27
0.83        3         1.69        28
0.88        9         1.71        29
0.91       13         1.73        23
```

15. What is the mean of INCOME?
32291.75

```
                        The UNIVARIATE Procedure
                          Variable:  income

                                Moments

N                         29    Sum Weights                29
Mean              32291.7586    Sum Observations        936461
Std Deviation     4287.12722    Variance            18379459.8
Skewness          -0.0287253    Kurtosis            -1.2748177
Uncorrected SS    3.07546E10    Corrected SS         514624875
Coeff Variation   13.2762271    Std Error Mean       796.09954


                        Basic Statistical Measures

            Location                        Variability

       Mean      32291.76    Std Deviation             4287
       Median    32408.00    Variance              18379460
       Mode            .     Range                    13735
                             Interquartile Range       7306


                     Tests for Location: Mu0=0

       Test           -Statistic-     -----p Value------

       Student's t    t  40.56246     Pr > |t|    <.0001
       Sign           M      14.5     Pr >= |M|   <.0001
       Signed Rank    S     217.5     Pr >= |S|   <.0001


                      Quantiles (Definition 5)

                    Level          Quantile

                    100% Max          38823
                    99%               38823
                    95%               38411
                    90%               38361
                    75% Q3            36019
                    50% Median        32408
                    25% Q1            28713
                    10%               26561
                    5%                25510
                    1%                25088
                    0% Min            25088
```

                         The UNIVARIATE Procedure
                          Variable: income

                          Extreme Observations

                -----Lowest----   ----Highest----

                Value   Obs   Value   Obs

                25088   1   37323   23
                25510   3   38054   25
                26561   2   38361   29
                27158   4   38411   27
                27162   5   38823   28

1. **What is the change in Q1 given a change in P1?**
   (Its asking for the parameter estimate) -27.07630
2. **Is it statistically significant at the 95% level?**
   Yes. It is significant if p-value < 0.05, the p-value = <.0001 at p1 Pr > | t |
8. **What is the change in Q1 given a change in P2?**
   12.23621
9. **Is it statistically significant at the 95% level?**
   Yes. The p-value is less than 0.05 and the t-value is greater than the t-critical
13. **What is the change in Q1 given a change in INCOME?**
   0.00185
14. **Is it statistically significant at the 95% level?**
   Yes
16. **What is the income elasticity of demand for Good 1?**
   1.0605. (change in income * Mean of income)/ Mean of Q1→(.00185*32291.75)/56.32=1.0605
17. **Is Good 1 a normal or inferior good?**
   Normal. **If normal, what type?** Luxury because it is greater than 1
18. **What is the adjusted R^2?**
   0.7882. **How do we interpret it?**
   78.82% of variability in the dependent variable is explained by this model

```
* estimate regression using proc reg;

proc reg data=tmp1.case_demand;
model q1 = p1 p2 income;
run;
quit;
```

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                                 The REG Procedure
                                   Model: MODEL1
                              Dependent Variable: q1

                         Number of Observations Read   29
                         Number of Observations Used   29

                                  Analysis of Variance

                                        Sum of   Mean
        Source   DF   Squares   Square   F Value   Pr > F

        Model   3   1419.42200   473.14067   35.73   <.0001
        Error   25   331.05593   13.24224
        Corrected Total   28   1750.47793

              Root MSE   3.63899   R-Square   0.8109
              Dependent Mean   56.32759   Adj R-Sq   0.7882
              Coeff Var   6.46040

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	64.08135	10.28625	6.23	<.0001
p1	1	-27.07630	5.26998	-5.14	<.0001
p2	1	12.23621	4.24148	2.88	0.0079
income	1	0.00185	0.00083135	2.22	0.0357

```
* create revenue function from regression and graph the revenue function;

data revfuncdata;
do q1 = 0 to 150 by 5;
   revenue = (5.7789 - .0369*q1)*(q1);
   output;
end;
run;

symbol1 value=none interpol=join color=red;
proc gplot data=work.revfuncdata;
plot revenue*q1=1;
run;
quit;
```

The OPTMODEL Procedure

Problem Summary

Objective Sense	Maximization
Objective Function	f
Objective Type	Quadratic
Number of Variables	1
Bounded Above	0
Bounded Below	1
Bounded Below and Above	0
Free	0
Fixed	0
Number of Constraints	0

Performance Information

Execution Mode	Single-Machine
Number of Threads	2
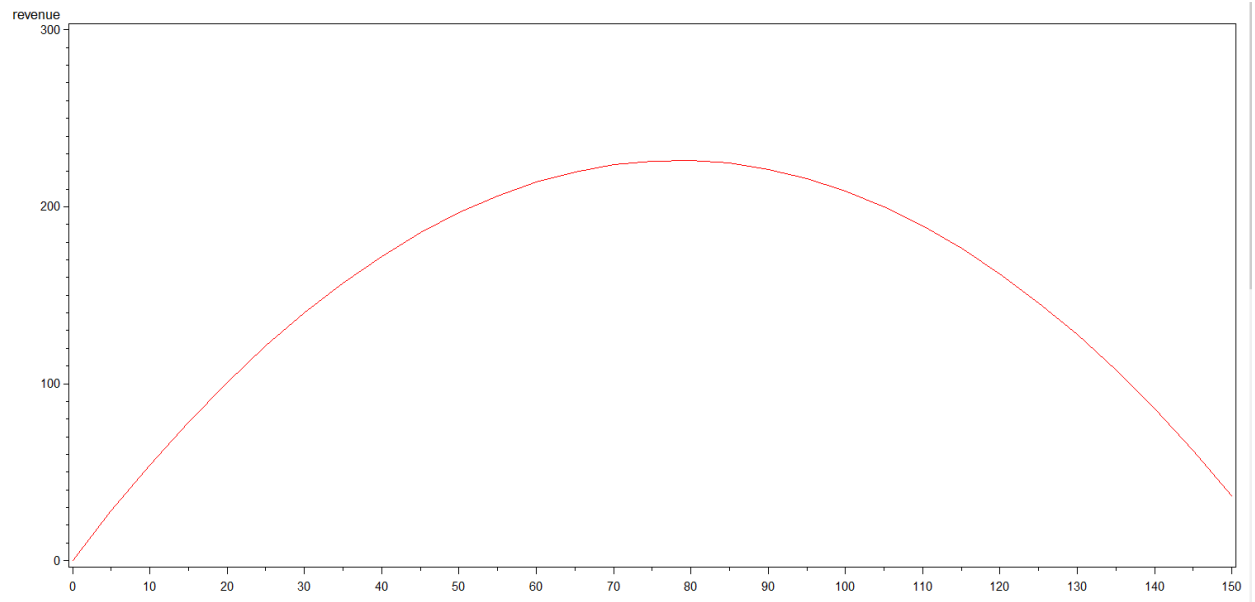
19. Given P2 = $1.65 and INCOME = $38000 what is the revenue-maximizing level of Q1?

78.305

```
* solve for revenue maximizing level of q1;

proc optmodel;
   var q1 >= 0;
   maximize f = (5.7789 - .0369*q1)*(q1);

   /* starting value for optimization */
   q1=50;

   solve with NLP;
   print q1;
quit;
```

                          The OPTMODEL Procedure

                            Solution Summary

                 Solver   NLP
                 Algorithm   Interior Point
                 Objective Function   f
                 Solution Status   Optimal
                 Objective Value   226.25802988

                 Optimality Error   0
                 Infeasibility   0

                 Iterations   2
                 Presolve Time   0.00
                 Solution Time   0.06

                              q1

                            78.305

What is the corresponding level of P1 that maximizes revenue?
2.88926

```
* apologies for hardcoded parms and spaghetti code but this approach always
works;

data revenue;
set tmp1.case_demand;
revmax_p1=5.7789 - .0369*78.31;
run;

* print revenue maximizing p1;

proc print data=work.revenue (obs=1);
var revmax_p1;
run;
quit;
```

```
                                          revmax_
                          Obs        p1

                           1    2.88926
```

```
* create revenue function from regression, let tc = 50 + 1.5q1, and graph the
profit function;

data proffuncdata;
do q1 = 0 to 150 by 5;
   profit = (5.7789 - .0369*q1)*(q1) - (50 + 1.5*q1);
   output;
end;
run;

symbol1 value=none interpol=join color=red;
proc gplot data=work.proffuncdata;
plot profit*q1=1;
run;
quit;
```

```
                              The OPTMODEL Procedure

                                Problem Summary

                   Objective Sense            Maximization
                   Objective Function                    f
                   Objective Type             Quadratic

                   Number of Variables                   1
                   Bounded Above                         0
                   Bounded Below                         1
                   Bounded Below and Above               0
```

```
                    Free                              0
                    Fixed                             0

                    Number of Constraints             0
```

20. Given P2 = $1.65, INCOME = $38000 and TC=50+1.5Q1 (i.e., a total cost function), what is the profit-maximizing level of Q1?
57.98

```
                        Performance Information

                    Execution Mode      Single-Machine
                    Number of Threads   2
```

```
* solve for profit maximizing level of q1 where tc = 50 + 1.5q1;

proc optmodel;
   var q1 >= 0;
   maximize f = (5.7789 - .0369*q1)*(q1) - (50 + 1.5*q1);

   /* starting value for optimization */
   q1=50;

   solve with NLP;
   print q1;
quit;
```

```
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                          The OPTMODEL Procedure

                            Solution Summary

            Solver                       NLP
            Algorithm            Interior Point
            Objective Function             f
            Solution Status           Optimal
            Objective Value     74.044615244

            Optimality Error               0
            Infeasibility                  0

            Iterations                     2
            Presolve Time               0.00
            Solution Time               0.01


                            q1

                          57.98
```

What is the corresponding level of P1 that maximizes profit?
    3.63944

```
* apologies for hardcoded parms and spaghetti code but this approach always
works;

data profit;
set tmp1.case_demand;
profitmax_p1=5.7789 - .0369*57.98;
run;

* print profit maximizing p1;

proc print data=work.profit (obs=1);
var profitmax_p1;
run;
quit;
```

```
                                profitmax_
                    Obs            p1

                     1          3.63944
```

21. What is the price elasticity of demand for Good 1 evaluated at the solution in question 20? Show that the absolute value of its reciprocal equals (P1 – MC)/P1.
0.196799

3.64-1.5=2.14
2.14/3.64=0.5879
Own price elasticity = -1.70

Elasticity=   -27.0763*(3.64/57.93) = -1.70

Absolute value of Reciprocal E is 1/|-1.7013| = 0.5878

0.5878