```
* MSBA 635 - Data Analytics II;

* print data;

proc print data=tmp1.case_cost;
run;
```


Obs	tc	q
1	493	8.20
2	410	7.39
3	451	7.68
4	723	9.88
5	329	5.65
6	432	7.10
7	294	5.17
8	270	3.34
9	311	5.63
10	194	1.39
11	640	9.30
12	217	2.21
13	272	2.88
14	401	6.94
15	196	3.17
16	238	2.36
17	269	2.33
18	256	2.76
19	605	8.97
20	246	2.77
21	222	3.14
22	204	2.47
23	356	6.77
24	378	7.00
25	177	1.69
26	263	4.41
27	549	8.60
28	267	4.71

```
* display data attributes;

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


The CONTENTS Procedure

Data Set Name	TMP1.CASE_COST	Observations	28
Member Type	DATA	Variables	2
Engine	V9	Indexes	0
Created	10/26/2018 13:01:31	Observation Length	12
Last Modified	10/26/2018 13:01:31	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label	case_cost 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	335
Obs in First Data Page	28
Number of Data Set Repairs	0
Filename	C:\Users\nxnguy01\Desktop\case_cost.sas7bdat
Release Created	9.0000M0
Host Created	WIN

Alphabetic List of Variables and Attributes

#	Variable	Type	Len
2	q	Num	8
1	tc	Num	4

```
* construct new variables;

data cost;
set tmp1.case_cost;
q2=q*q;
q3=q2*q;
run;

* estimate regression using proc reg;

proc reg data=work.cost;
model tc = q q2 q3;
run;
quit;
```


The REG Procedure
Model: MODEL1
Dependent Variable: tc

Number of Observations Read	28
Number of Observations Used	28

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	564209	188070	391.22	<.0001
Error	24	11537	480.72697		
Corrected Total	27	575747			

Root MSE	21.92549	R-Square	0.9800
Dependent Mean	345.10714	Adj R-Sq	0.9775
Coeff Var	6.35324		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	134.65598	44.80010	3.01	0.0061
q	1	57.97021	29.97024	1.93	0.0650
q2	1	-11.02893	5.76461	-1.91	0.0677
q3	1	1.14312	0.33591	3.40	0.0023

```
* create total cost function from regression and graph the total cost
function;

data tcfuncdata;
do q = 0 to 10 by .1;
   tc = 134.65598 + 57.97021*q - 11.02893*q*q + 1.14312*q*q*q;
   output;
end;
run;

symbol1 value=none interpol=join color=red;
proc gplot data=work.tcfuncdata;
plot tc*q=1;
run;
quit;
```

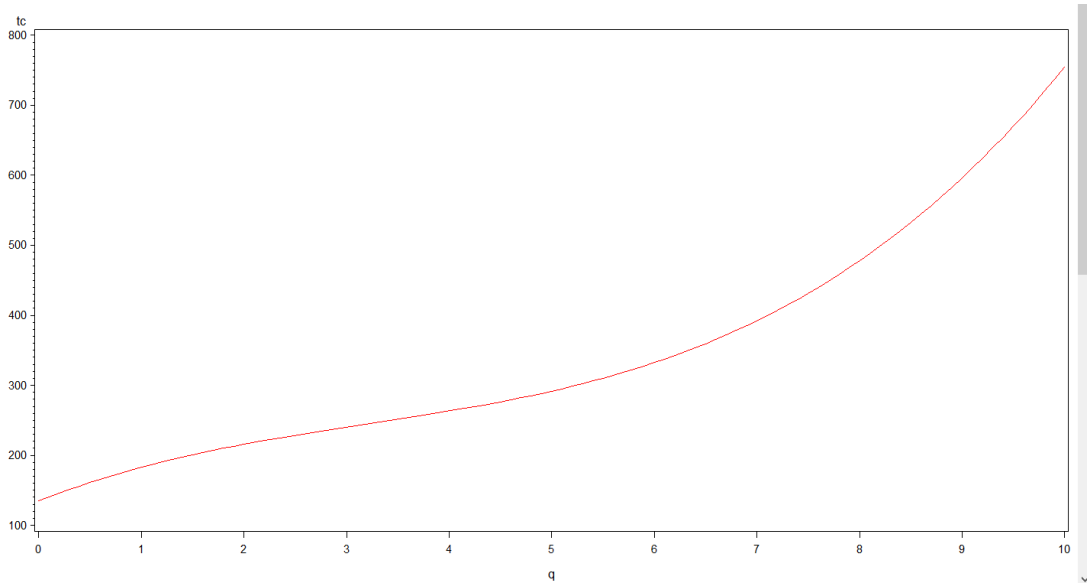

The OPTMODEL Procedure

Problem Summary

Objective Sense	Minimization
Objective Function	f
Objective Type	Nonlinear
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

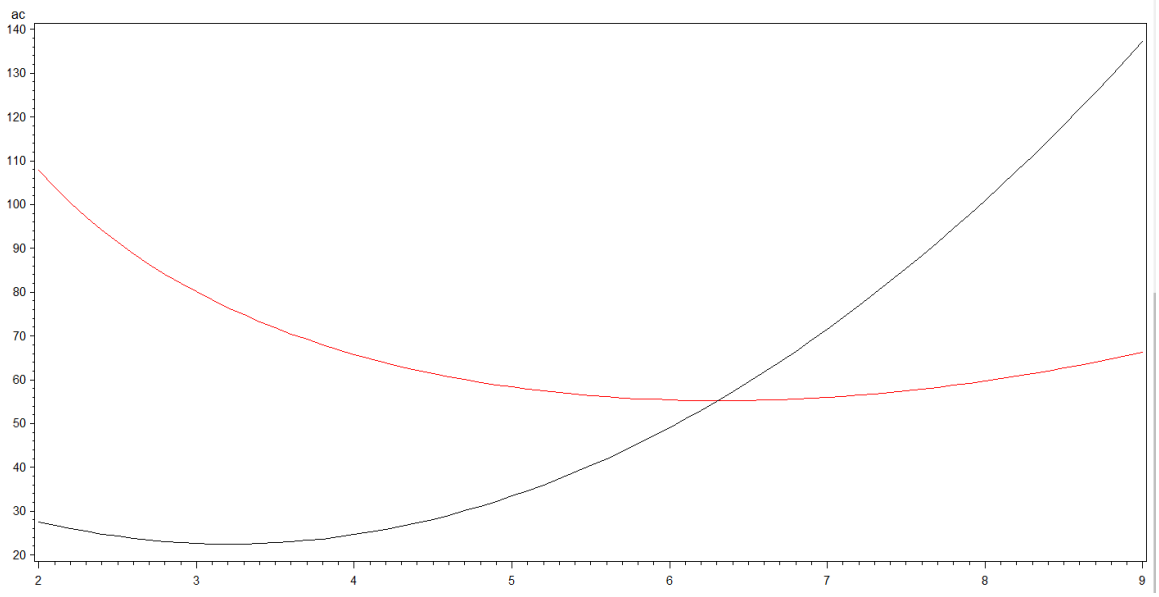
Execution Mode	Single-Machine
Number of Threads	2




```
* create average and marginal cost functions from regression and graph them;

data acmcfuncdata;
do q = 2 to 9 by .1;
   tc = 134.65598 + 57.97021*q - 11.02893*q*q + 1.14312*q*q*q;
   ac = tc/q;
   mc = 57.97021 - 2*(11.02893*q) + 3*(1.14312*q*q);
   output;
end;
run;

symbol1 value=none interpol=join color=red;
symbol2 value=none interpol=join color=black;
proc gplot data=work.acmcfuncdata;
plot ac*q=1 mc*q=2 / overlay;
run;
quit;
```



```
* solve for ac minimizing level of q;

proc optmodel;
   var q >= 0;
   minimize f = (134.65598 + 57.97021*q - 11.02893*q*q + 1.14312*q*q*q)/q;

   /* starting value for optimization */
   q=2;

   solve with NLP;
   print q;
quit;
```


The OPTMODEL Procedure

Solution Summary

Solver	NLP
Algorithm	Interior Point
Objective Function	f
Solution Status	Optimal
Objective Value	55.23229902
Optimality Error	5E-7
Infeasibility	0
Iterations	4
Presolve Time	0.00
Solution Time	0.06

q
6.3054