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## Vertex

Simulate a quadratic function with relative maximum  $y=1000$  at  $x=45$

Using the vertex-form of a quadratic function which defines a quadratic function having a vertex at  $x=b$  showing a value  $y=c$ . If  $a < 0$  then it is a maximum while  $a > 0$  leads to a minimum

$$y = a \cdot (x-b)^2 + c$$

\*/

**\* Simulate**

clear

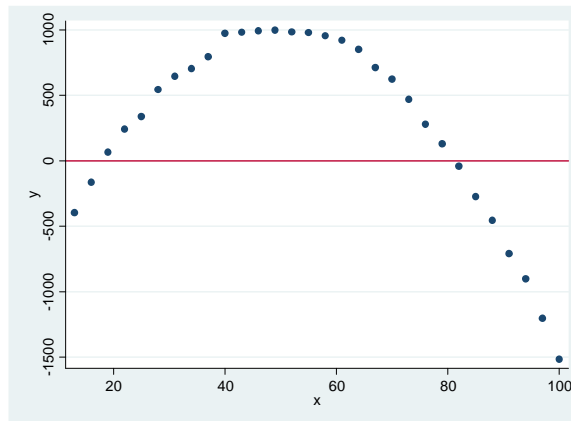
set obs 30

gen x=10+3\*\_n

set seed 12345

gen y= -1\*(x-45)^2 + 1000 + rnormal(0,30)

twoway (scatter y x), yline(0)



**\* Find**

nl ( y={a}\*(x-{b})^2+{c} )

/\*

Iteration 0: residual SS = 6819863

...

Iteration 6: residual SS = 24953.77

Source	SS	df	MS		
Model	21988286.9	2	10994143.5	Number of obs =	30
Residual	24953.7741	27	924.213855	R-squared =	0.9989
				Adj R-squared =	0.9988
				Root MSE =	30.40089
Total	22013240.7	29	759077.266	Res. dev. =	286.8438

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
/a	-1.011935	.009219	-109.77	0.000	-1.03085	-.9930187
/b	45.05492	.1484141	303.58	0.000	44.7504	45.35944
/c	1009.029	7.866105	128.28	0.000	992.889	1025.169

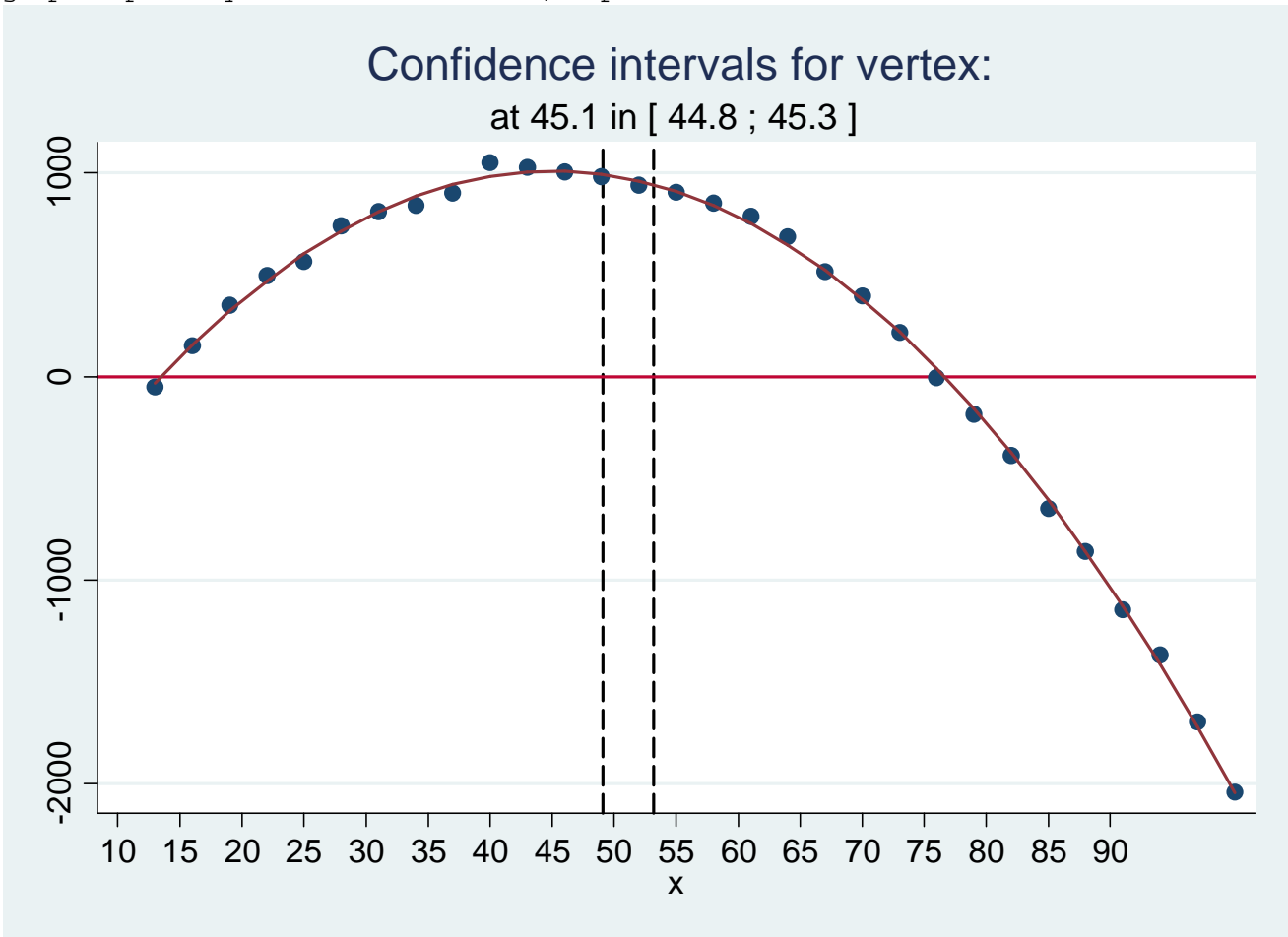
Parameter c taken as constant term in model & ANOVA table

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```
* Plot
predict yp

twoway (scatter y x) ///
       (line yp x), ///
       yline(0) ///
       xlabel(10(5)90) ///
       xline(49.1 53.2, lcol(black) lpat(dash)) ///
       legend(off) ///
       title("Confidence intervals for vertex:") ///
       subtitle("at 45.1 in [ 44.8 ; 45.3 ]")
```

graph export "quadratic vertex.wmf", replace



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## Roots

Simulate a quadratic function with roots at x=15 and x=80 and downward direction

Using the factor-form of a quadratic function which defines a quadratic function having roots at a and b and direction c

$$y = c \cdot (x-a) \cdot (x-b)$$

\*/

**\* Simulate**

clear

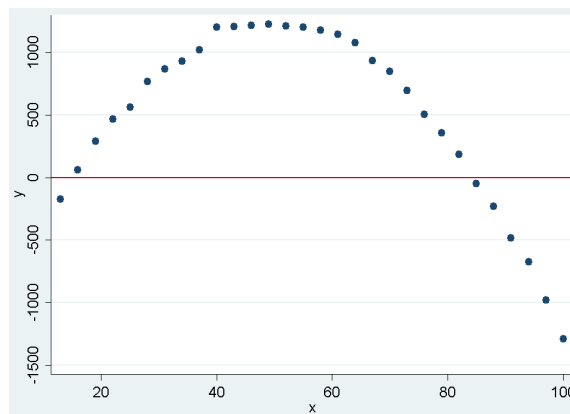
set obs 30

gen x=10+3\*\_n

set seed 12345

gen y= -1\*(x-15)\*(x-85) + rnormal(0,30)

twoway (scatter y x), yline(0)



**\* Find**

nl ( y={c}\*(x-{a})\*(x-{b}) )

/\*

Iteration 0: residual SS = 2.20e+07

...

Iteration 16: residual SS = 24953.76

Source	SS	df	MS		
Model	22418200	3	7472733.32	Number of obs =	30
Residual	24953.7633	27	924.213457	R-squared =	0.9989
				Adj R-squared =	0.9988
				Root MSE =	30.40088
Total	22443153.7	30	748105.124	Res. dev. =	286.8438

	y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
/c		-1.011935	.009219	-109.77	0.000	-1.03085 - .9930187
/a		15.07137	.200839	75.04	0.000	14.65928 15.48346
/b		84.92053	.117713	721.42	0.000	84.679 85.16206

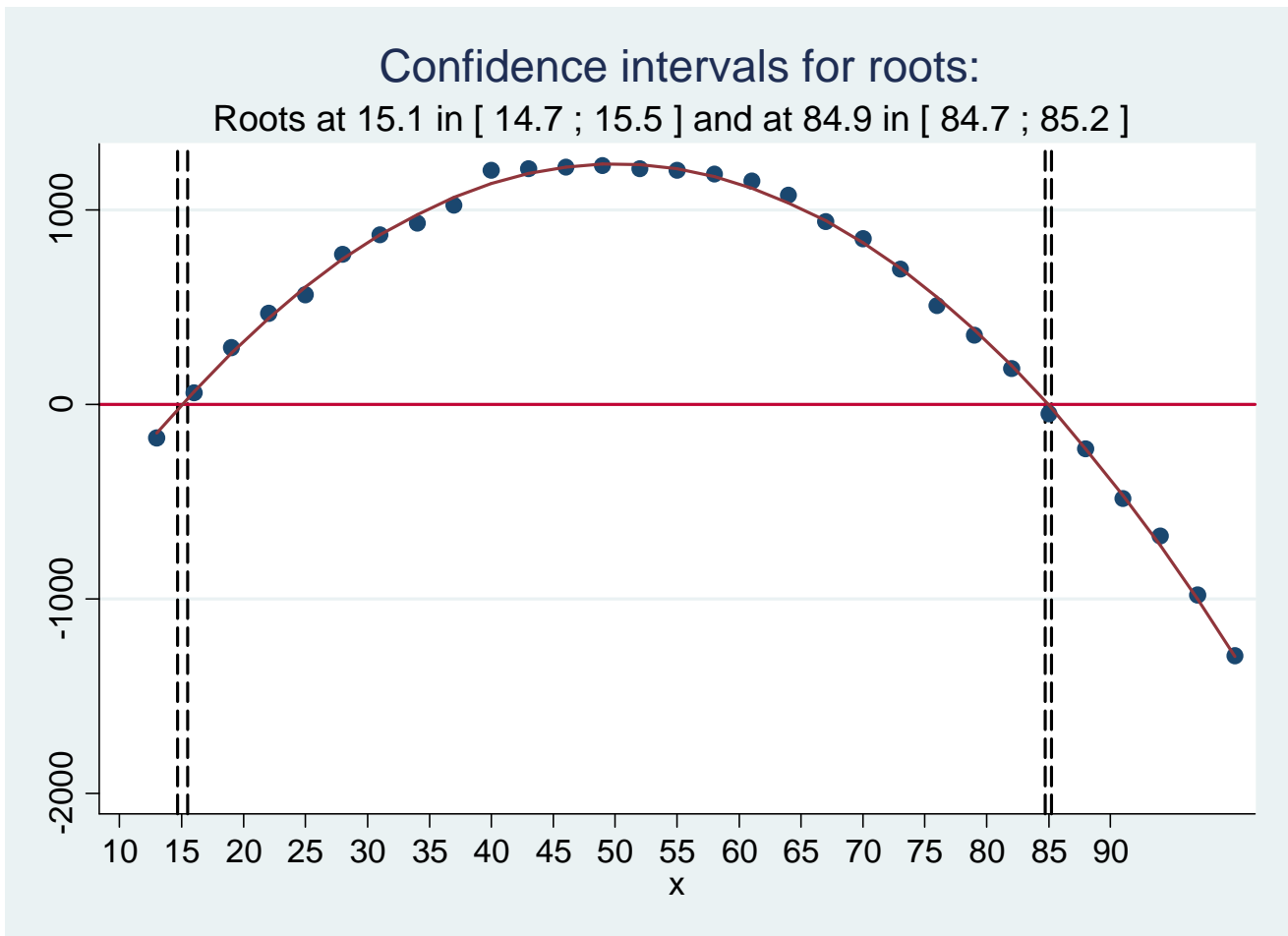
\*/

**\* Plot**

predict yp

```
twoway (scatter y x) ///  
       (line yp x), ///  
       yline(0) xlabel(10(5)90) ///  
       xline(14.7 15.5 84.7 85.2, lcol(black) lpat(dash)) ///  
       legend(off) ///  
       title("Confidence intervals for roots:") ///  
       subtitle("Roots at 15.1 in [ 14.7 ; 15.5 ] and at 84.9 in [ 84.7 ; 85.2 ]")
```

graph export "quadratic roots.wmf", replace



## Quadratic functions for different groups

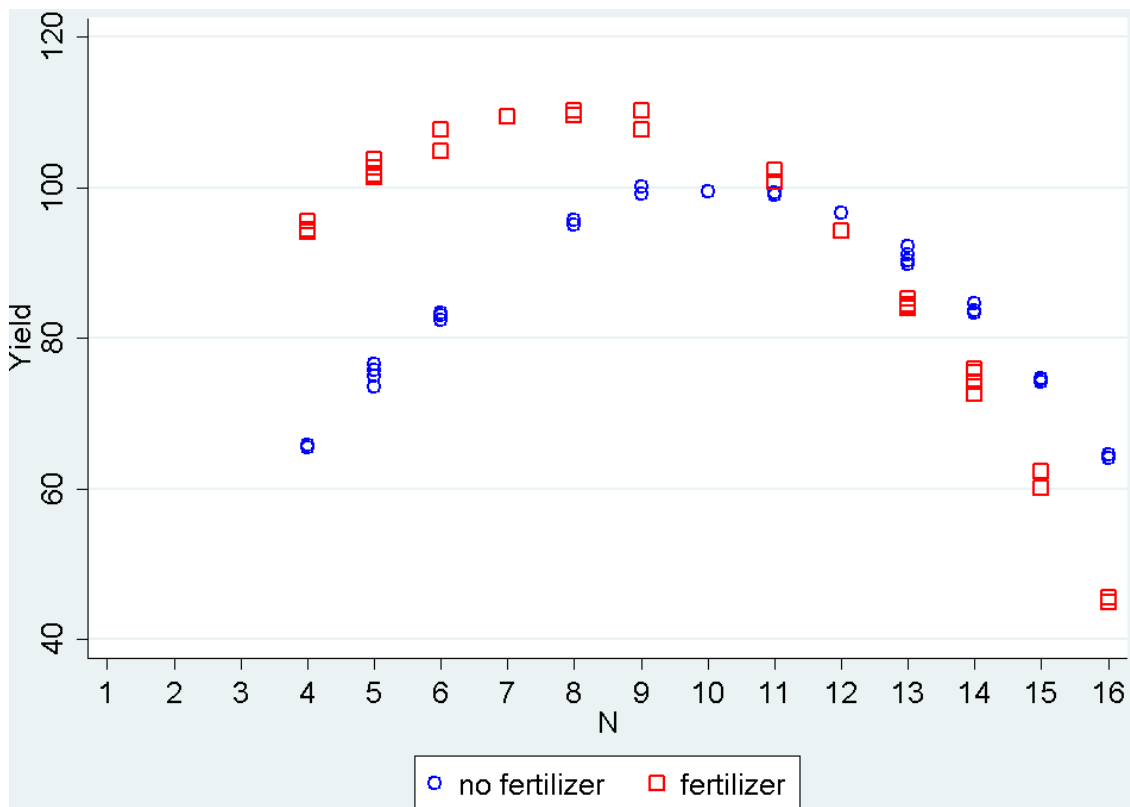
```
* Hypothetical data for two treatment groups (fert=0 and fert=1) each 30 plots  
* y=yield  
* x=n-concentration in soil  
* fert=0: maximum yield 100 at n-conc=10  
* fert=1: maximum yield 110 at n-conc= 8
```

### \* Simulate

```
clear  
set obs 60  
set seed 12345  
gen x = int(runiform()*18)  
sort x  
  
gen fert = mod(_n,2)  
gen y = -1*(x-10)^2+100 + rnormal(0,1) if fert==0  
replace y = -1*(x-8)^2 +110 + rnormal(0,1) if fert==1
```

```
label variable x "N"  
label variable y "Yield"  
label define lbfert 0 "no fertilizer" 1 "fertilizer"  
label values fert lbfert
```

```
twoway (scatter y x if fert==0, mcolor(blue) msymbol(circle_hollow)) ///  
       (scatter y x if fert==1, mcolor(red) msymbol(square_hollow)), ///  
       xlabel(1(1)16) ///  
       legend(order(1 "no fertilizer" 2 "fertilizer"))
```



\* Find

```
nl ( y = -cond(fert==0,{a0},{a1})*(x-cond(fert==0,{b0},{b1}))^2 +cond(fert==0,{c0},{c1}))
```

/\*

Iteration 0: residual SS = 6497.518

...

Iteration 10: residual SS = 51.76056

Source	SS	df	MS	Number of obs =	60
Model	467068.074	6	77844.6791	R-squared =	0.9999
Residual	51.7605568	54	.958528829	Adj R-squared =	0.9999
Total	467119.835	60	7785.33058	Root MSE =	.9790449
				Res. dev. =	161.4097

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
/a0	.9850717	.015516	63.49	0.000	.9539639 1.016179
/a1	.994106	.0155818	63.80	0.000	.9628664 1.025346
/b0	9.986666	.0225107	443.64	0.000	9.941535 10.0318
/b1	7.942381	.0353513	224.67	0.000	7.871506 8.013256
/c0	99.73735	.31102	320.68	0.000	99.11379 100.3609
/c1	110.4156	.2918788	378.29	0.000	109.8304 111.0008

\*/

\* Plot

predict yp

```
twoway (scatter y x if fert==0, sort mcolor(blue) msymbol(circle_hollow)) ///
(line yp x if fert==0, sort lcolor(blue)) ///
(scatter y x if fert==1, sort mcolor(red) msymbol(square_hollow)) ///
(line yp x if fert==1, sort lcolor(red)) , ///
xlabel(4(1)16) ///
xline(9.9 10.0 7.9 8.0, lcolor(black) lpat(dash) extend) ///
legend(order(1 "no fertilizer" 3 "fertilizer"))
```

graph export "quadratic groups.wmf", replace

