T3 International Conference 2010 – Atlanta, GA

Building rich content with TI-Nspire

Abstract: The TI-Nspire learning handheld has an impressive set of features that allow creating highly complex documents. In this session we'll explore some of the tools that allow us to create those "professional looking" .tns fles we see published in numerous sites.

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Introduction

TI-Nspire is a very powerful graphing technology. It features an unprecedented set of tools that allow the creation of highly complex and rich classroom activities. We went from “key-by-key” intructions that were commonplace with the TI-84 Plus and previous models of graphing calculators to creating fully featured documents with user interaction that were previously available only to programming experts.

But creating content isn't easy. The set of tools available to us is immense and even greater is the set of techniques using these tools to create outstanding documents. Some documents available over the internet are extremely complex, using dozens of geometric objects, linked spreadsheets, small programs and everything else TI-Nspire has to offer.

This document serves a very specific purpose: to give the reader an introductory level text about some of the most common (and some not that common) tools of the TI-Nspire in a mathematically rich context and also providing some insight about the way advanced users create the complex documents we saw or read about.

Throughout this text you'll find step by step instructions, more detailed in the beginning and more scarse around the end, as to how to use the TI-Nspire power to out advantage, instead of being intimidated by it and finding ourselves using this century's technology with last century's practices and techniques

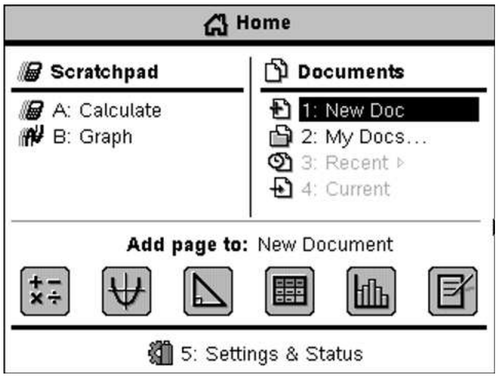
> Sometimes you'll find parts of the text inside boxes such as this one. The information in those boxes usually complements the main text but other times contains important warnings and tips. Read them carefully.

I hope you find this document useful.

Nelson Sousa

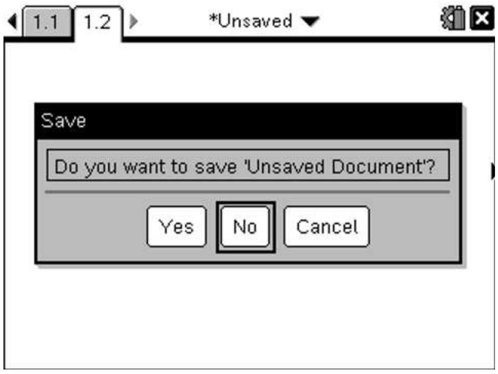
Part I: the basics

TI-Nspire works based on documents. Much more like a computer application and unlike any other graphing calculator.

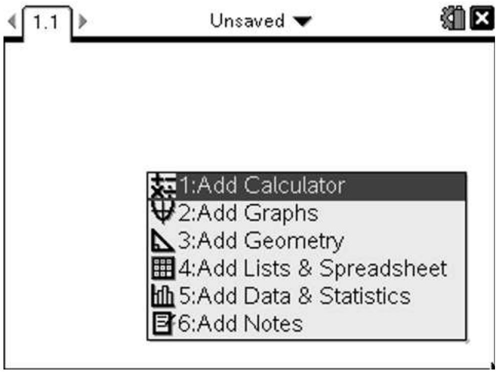


So, the first thing we do is create a new document. Press ⌂on and then navigate to option **1:New Doc**.

> **Remark:** Usually there's more than one way of doing things on the TI-Nspire. For example, we can create a new document using the shortcut ctrl+N.

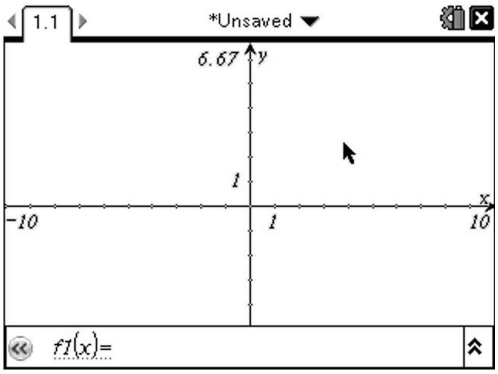


If prompted to save changes to a previous document use the cursor keys to select No (TI-Nspire can only work with 1 document at a time. So if a document is open and has changes TI-Nspire gives us the option to save the changes, discard them or cance the operation.



When a new document is created a blank page is displayed and a menu gives us the option to add a new application.

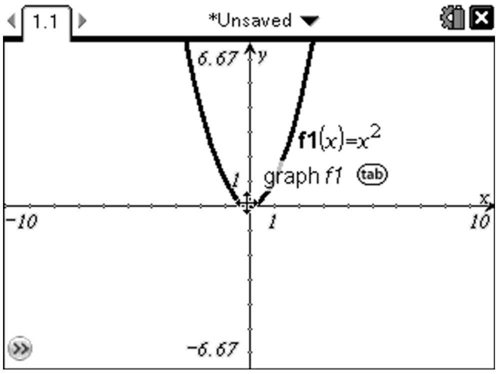
> **Remark:** on the upper left corner of the screen you see a tab with the indication 1.1. This means we're on page 1 of problem 1.

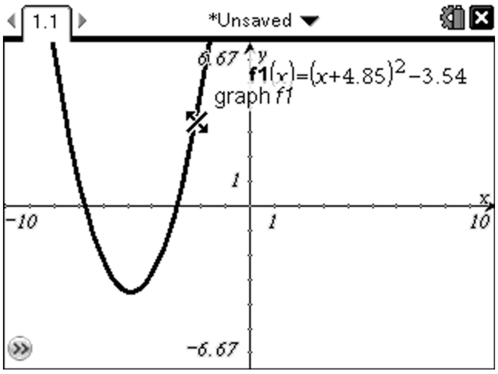


After selecting the application we want we may start working. Let's start by selecting option **2:Add Graphs**. The screen now displays an entry line and the axes.

As long as we have a graphs page...

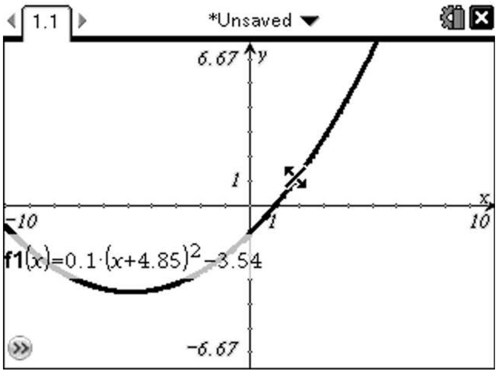
Lets play around with it. Type in x^2 (X+x^2) and press enter. The graph is drawn immediately and the entry line disappears. Use the touchpad to navigate to the graph near the vertex of the parabola. You can see that the cursor changes to ✥ and **graph f1** is displayed. Click the center of the touchpad for about a second until the cursor changes to ☝ then move the cursor. The graph will be dragged along and the graph label will update accordingly.



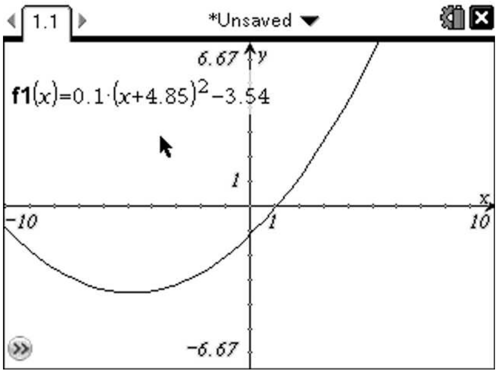


> The TI-Nspire allows us to manipulate a function by dragging its graph. Not all functions though, only linear, quadratic, sine, cosine, tangent, exponential and logarithmic allow this type of manipulation.

Click again to release the graph and move the cursor to one of the arms of the parabola. The cursor changes to ⤡. If you grab the graph here it will change the parabola's curvature, either opening or closing it. Everytime we manipulate the graph the expression will be updated automatically.

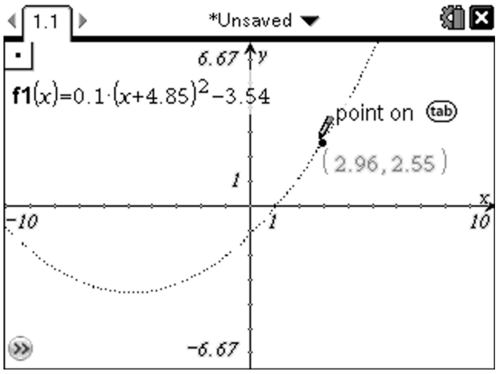


Note that the label of the function is moving too. We may want to keep it fixed on a specific part of the screen. So, move the cursor to the label until the cursor changes to ☝ and you see the message **Label**. This means you can grab the label and move it to another place.



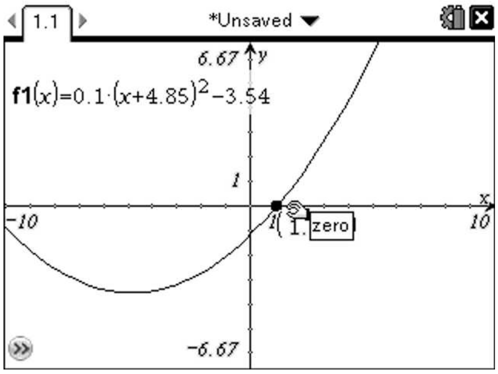
This is commonplace throughout the Graphs and Geometry applications: objects can be moved around and placed anywhere we want them to.

Building over graphs



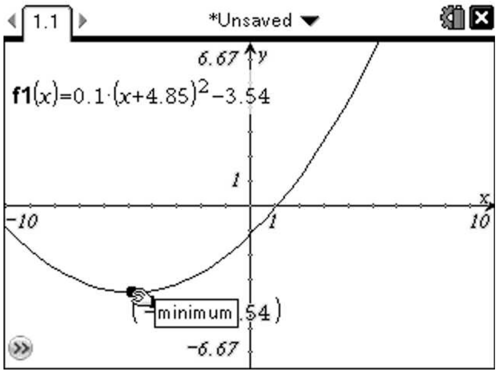
It's possible to build geometric objects over the graphs of functions. For example, lets build a point over the graph. Press menu then choose options **7:Points and Lines** and **1:Point**. Place the cursor over the graph and click to build a point.

> When you hover over the graph you the cursor should change to and the message **Point on** should display, meaning you're about to build a point over an existing object.

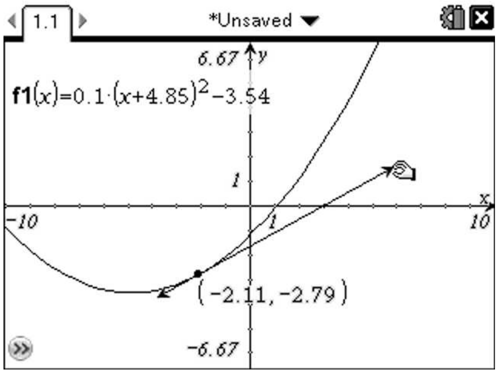


After building the point press esc to cancel the Point tool.

Now move the point. Move the cursor to the point and click for about 1 second until the cursor displays a closed hand. Move the point and notice that when you reach a zero or the mininum of the function the messages **zero** or **minimum** will pop-up.



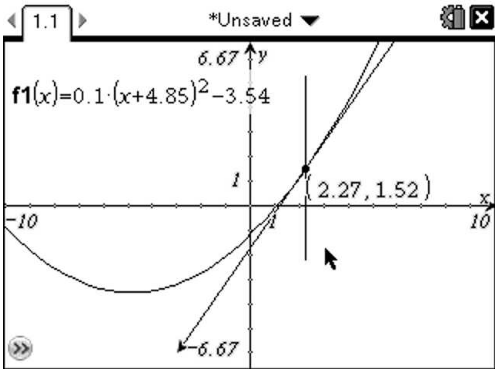
One object that we can build over the graph of a function is a tangent line. Select the Tangent tool (menu, 7, 5), then click on the previously created point. The tangent to the graph by that point is built (remember to press esc after building the tangent). When we move the point the tangent line will move accordingly.



Note that the tangent doesn't go all the way to the edge of the screen. To enlarge it place the cursor over the arrows, grab them (click for 1 second) then move them.

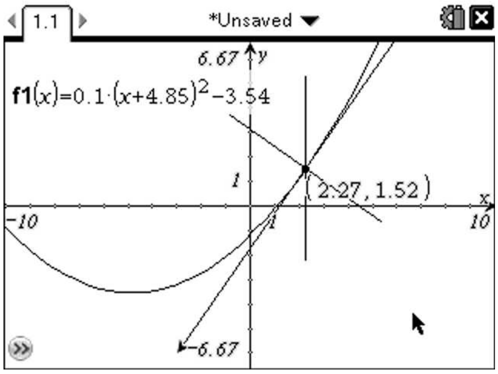
Focus, focus, focus

A parabolic dish is a parabola shaped object that reflects a satellite signal and gathers it all on a single point (the focus). Lets try to demonstrate this.

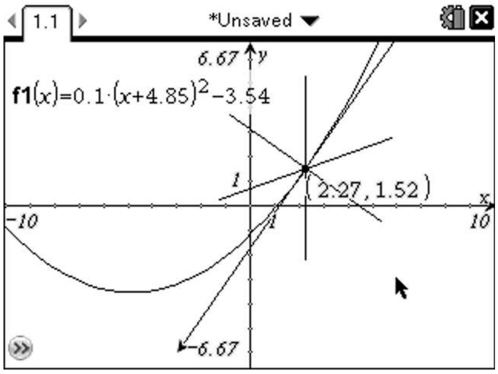


Select the Perpendicular tool (menu A, 1) and click on the point then on the x axis. This will create a vertical line passing by that point.

> If the two objects to be selected are of different types, the order by which they're selected is irrelevant.

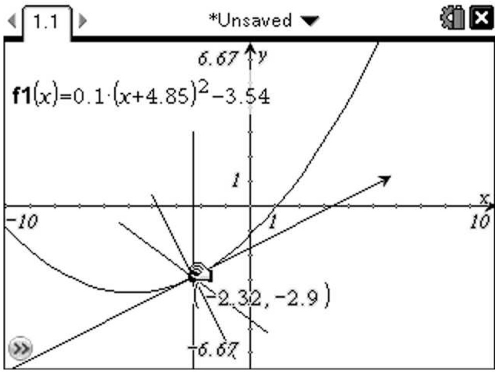


Now build a perpendicular to the tangent passing by the same point. You don't need to select the tool again, unless you pressed esc. Click on the point, then on the tangent line.



The next step is building the reflected line. Select the Relection tool (menu B, 2), click on the axis of symmetric first, then on the vertical line.

> If the two to be selected are of the same type the order in which they're selected matters.

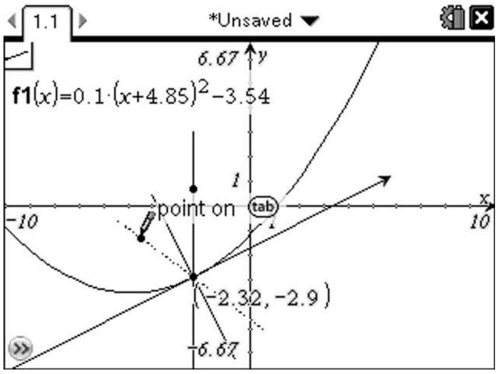


Now drag the point. The construction is updated accordingly.

> As with tangents, lines aren't drawn all the way to the edge of the screen.

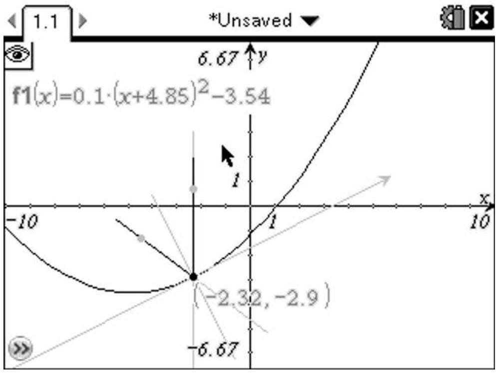
Embelishments

After the construction is finished we can change it to look nicer. We dont need those two lines, all we need are rays starting at the point over the parabola and with the same direction.

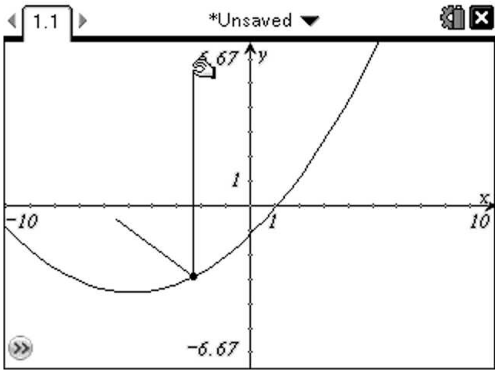


So select the Ray tool (menu 7, 5), click on the point to set the origin then click on a point over the vertical line to create the first ray. Do the same over the reflected line.

Next we can hide unnecessary objects. Select the Hide/show tool (menu 1, 3). Then click on the objects you wish to hide: the function's label, the point's coordinates, the two newly created points and all the lines.

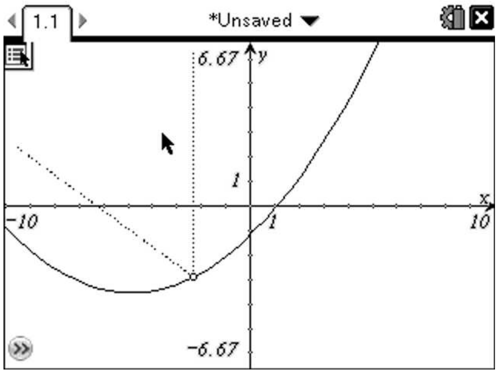


> Look closely at the pop-up messages: if two or more objects are under the current cursor position the message will indicate which object will be hidden. Press tab if necessary to select another object.



Hidden objects will be displayed in gray, while visible objects remain black. After hiding all objects press esc and they'll disappear from sight.

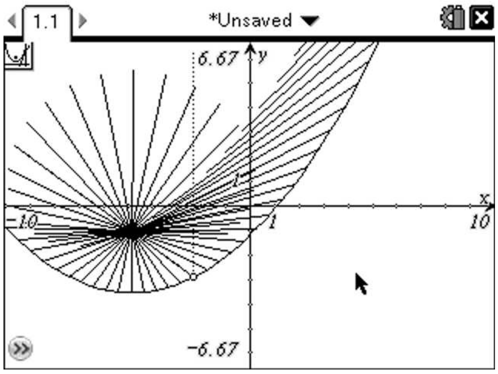
Next we can enlarge the rays, by dragging their endpoints. This will make our construction look nicer.



Finally we use the Attributes tool (menu 1, 4) to change the look of the visible objects. Click on the rays and the point and use the arrow keys to change the way they're drawn.

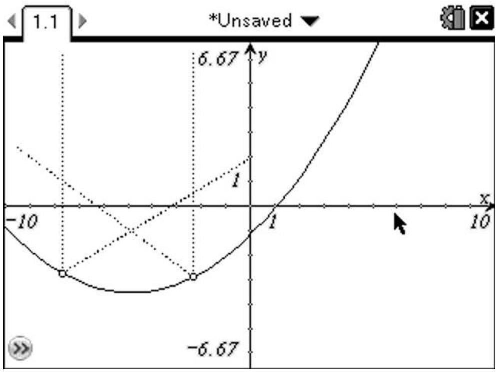
Final touches

To verify our claim that all reflected lines converge to a single point, the focus, we use the Locus tool (menu A, 6). Click first on the point (which is the independent object) then on the reflected line (the dependent object).



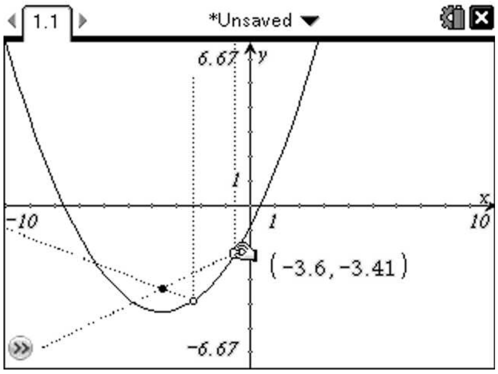
The locus of the reflected line appears and we can see all reflected lines intersect.

Lets go one step further and determine the coordinates of the focus. To avoid cluttering the screen, first hide the locus (menu 1, 3). Then create a second reflected by a different point.



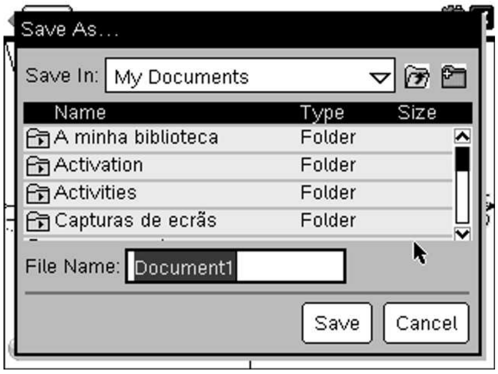
Go back and follow all the steps once again to build the second reflected line.

Now find the intersection point of the two reflected rays by selecting the Point(s) of intersection tool (menu 7, 3) then clicking on the two rays.



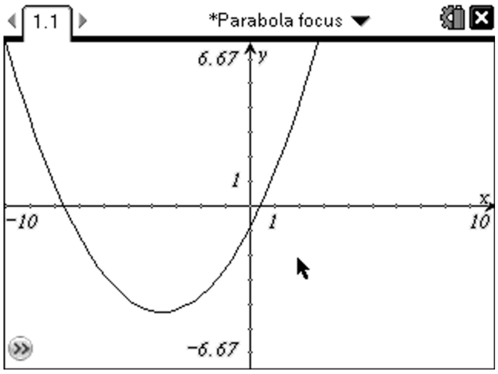
Now display the coordinates of the intersection point with the Coordinates and Equations tool (menu 1, 7): click once over the point then again anywhere on the screen to place the coordinates.

Now move any of the two points and notice the coordinates don't change. Finally, do the same for other parabolas, by dragging the vertex or the arms of the curve and see that this property is true for any parabola.



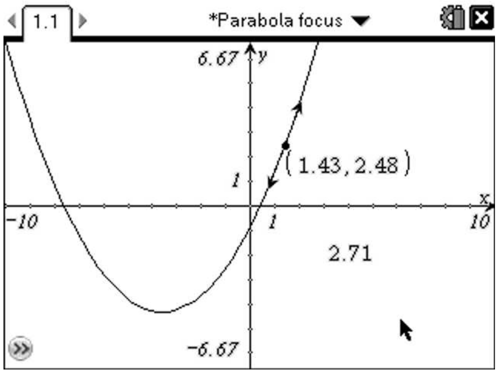
After the construction is finished we can save our document via the doc menu (option 1:File then 4:Save). Give your document a name and press enter.

Part II: Multiple pages



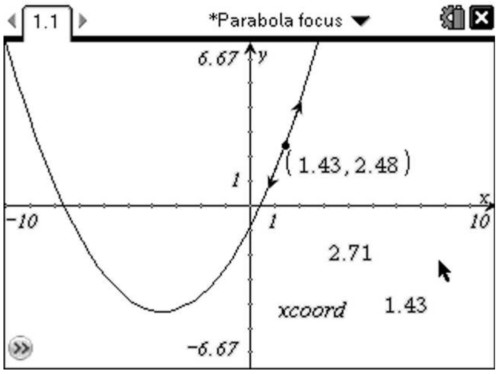
For this activity we go back to our document and begin by deleting all objects except the function graph. There are many objects to delete, but in fact we only need to delete two of the: the two points. As all other objects are dependent of these two they will all be deleted.

To delete an object click on it then press the del key.

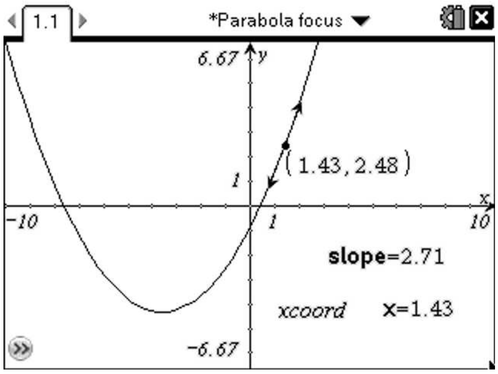


This time we want to study the slope of the tangent lines to a parabola. So we create a new point over the parabola and the tangent line (menu 7, 6) by that point. Then we measure its slope with the Slope tool (menu 8, 3). Click on the tangent line then on an empty region of the screen to display the slope.

With the text tool (menu 1, 6), click on an empty region of the screen type “xcoord” and press enter.

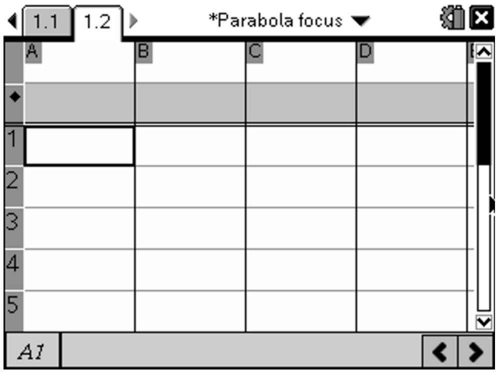


Now use the Calculate tool (menu 1, 8), click once over the “xcoord” text box then once on the x coordinate of the point. Finish the calculation by clicking on an empty region of the screen where you want the result to appear.



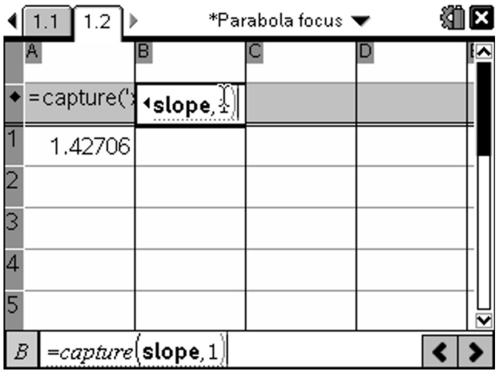
To study how the slope varies when the point is moved we need to store both the x coordinate of the point and the slope as variables. After pressing esc to deactivate any tools click on the slope and press var. Select Store var and type in “Slope”. Press enter to confirm. Do the same with the x coordinate of the point (typing x as the variable name). Hide the text box and the point's coordinates, as they're not needed anymore. Your screen should look like the one at the right.

Capturing data

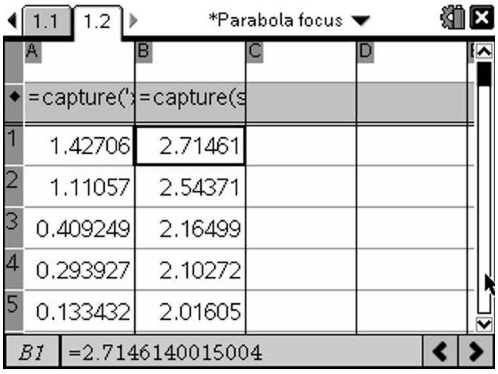


One thing the TI-Nspire allows us to do is capturing data. If we have measurements stored as variables in a Graphs application we can capture them in a spreadsheet. So insert a new spreadsheet page (either through the on menu or using the shortcut ctrl+I).

> The TI-Nspire spreadsheet is much similar to other spreadsheets (Open Office, MS Excel), but, of course, limited.

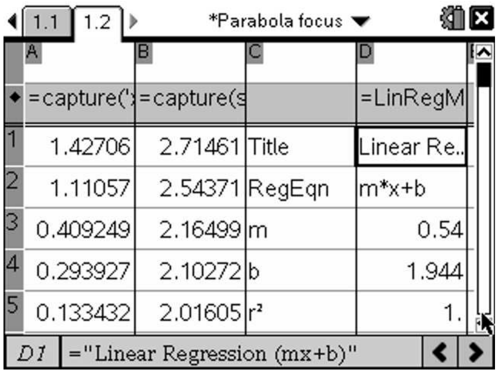


On the spreadsheet we can define capture data from other applications. Move the cursor to the gray cell over cell A1 and define an automated data capture (menu 3, 2, 1). Type in the name of the variable you want to capture, x, and press enter. Go to column B and do the same for variable slope.



Now everytime you change the geometric construction the values of x and slope will be automatically captured.

Go back to the graphs page and move the point around. Then go to the spreadsheet and notice the data.

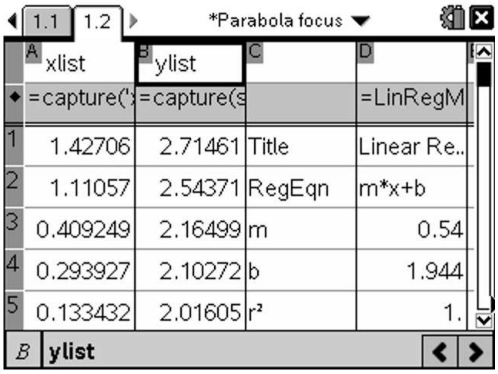


A record of all the positions of the point as well as the slope of the tangent is kept.

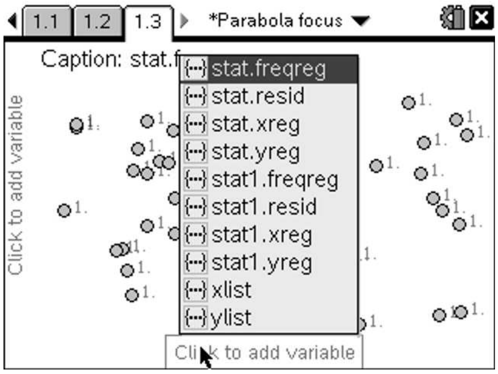
Now select linear regression (menu 4, 1, 3) and define columns a and b as the x and y lists (use tab to navigate). As expected, $r^2=1$.

Displaying data

Although useful to perform calculations, a spreadsheet isn't the best way to display data. A much more convenient way is using graphs. To do so we first need to name the columns. The empty cell over the column definition is where we name the columns (much like lists on the TI-84 Plus). Navigate there and name columns A and B as xlist and ylist, for example.

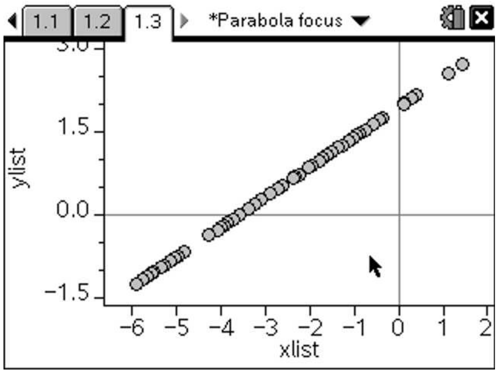


Add a new Data & Statistics and move the cursor to the bottom of the screen, where the message “Click to add variable” is displayed, click there and select xlist.

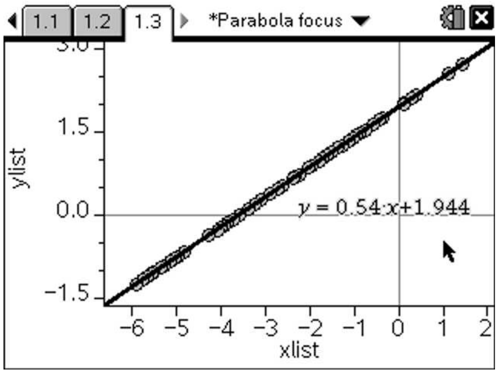


> The other variables displayed are the lists created automatically when a statistical calculation is performed.

Then move the cursor to the left and select ylist as the second list. A scatter plot will be displayed and the window settings automatically set to fit the data.



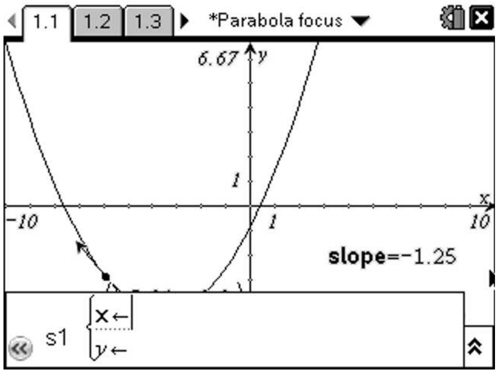
We can now add a linear regression line to this plot (menu 4, 6, 1) and the line will be added to the scatter plot, giving us a visual confirmation that the slope of the tangent varies linearly with the x coordinate.



> When you click anywhere on the graph the equation of the line will disappear. Click over the line again to display it.

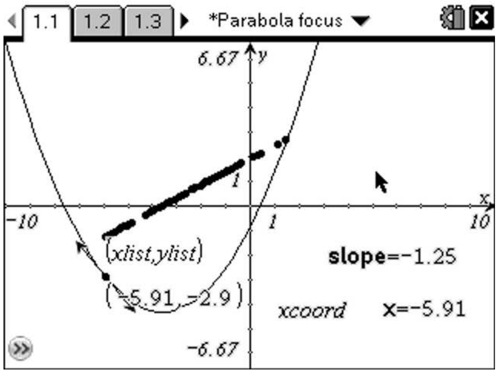
Linking between applications

Although manipulating a construction, capturing the data and then displaying a graphical visualization of the data is a good thing, we can do this in real time defining a scatter plot on the graphs page.



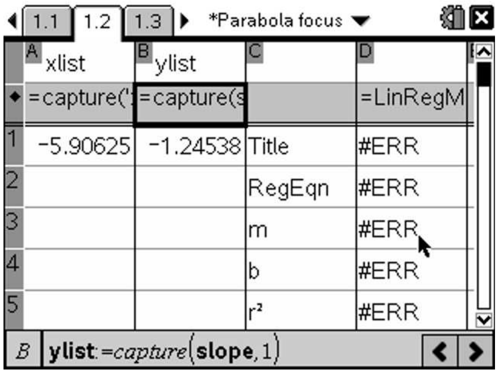
Go back to page 1.1 and change the graph type to scatter plot (menu 3, 4). Enter the name of the lists, xlist and ylist and press enter.

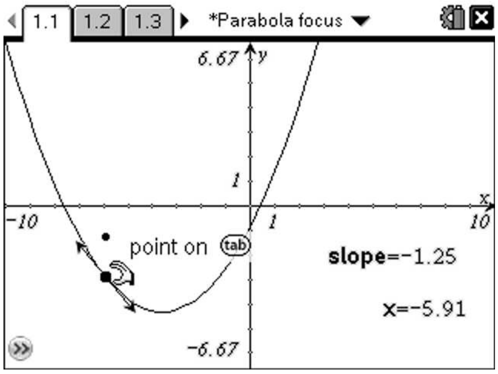
We get the scatter plot displaying on the same page as the parabola's graph.



> Tip: hide the scatter plot's label and the point's coordinates to avoid a messy screen. Information on screen should be kept to a minimum for readability.

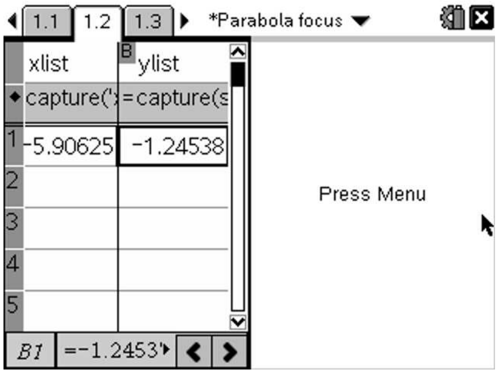
To get a better visual impact of what we're doing we should delete all recorded data and then move the point to see what happens. Go to the spreadsheet and move the cursor back to the definition of the data capture. Press enter twice to delete all previously saved data. Then go back to the graphs page and move the point.





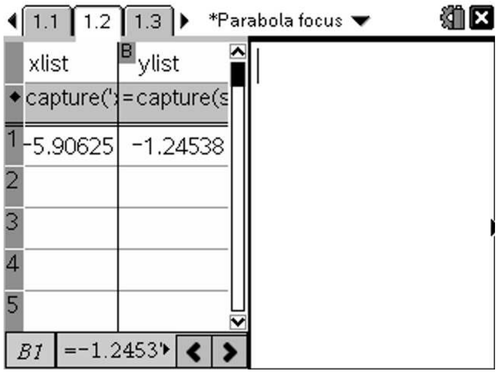
> The two error messages displayed should be ignored. The first one occurs because a statistical calculation is being performed and the two lists have different dimensions; the second is because now the lists have only 1 element and a linear regression requires at least 2.

Adding instructions



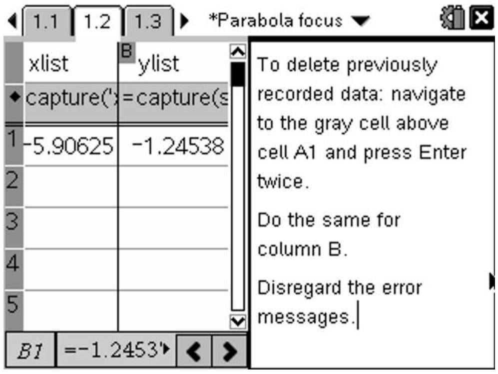
If this document was a classroom activity we should probably add some instructions for the students. This can be done in quite an elegant way using split screens.

Go to the spreadsheet and from the documents menu choose a vertical split screen layout (doc▾ 5, 2, 2).



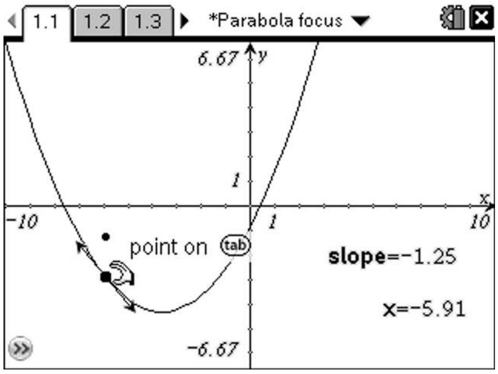
> From the layout options available we can see that up to 4 applications can be added to one page. However, on the handheld screen usually no more than two should be used.

Navigate to the application on the right, pressing ctrl + tab and press menu to add a Notes application.



Use this application to add instructions, for example about reseting the data.

> Tip: the text to the right was written with subscript formatting, so that more text fits in one screen without having to scroll down.

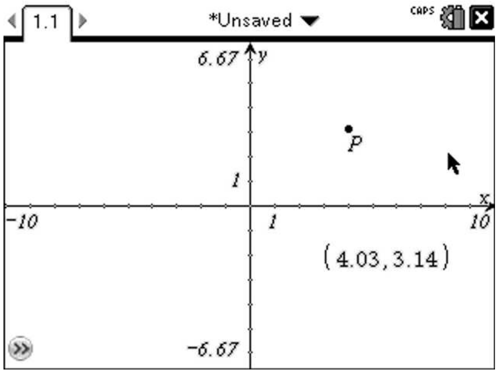


Our document is now ready. It features a Graphs page, a Spreadsheet and a Data page with a linear regression over the captured data.

To save the document go to the doc▾ menu and choose Save As... (to avoid overwriting the previous document. Name your document and press enter.

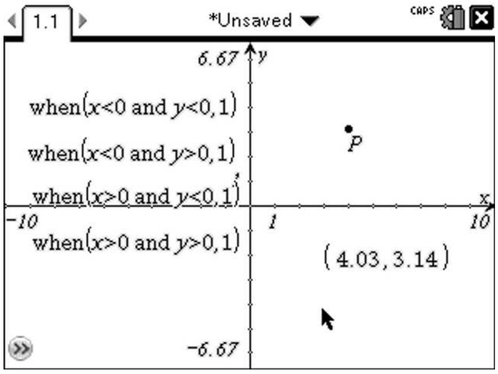
Bonus track: a kind of magic

Creating complex documents on the TI-Nspire can be some sort of an art. It takes technique, of course, but most important it takes creativity to discover new ways to use old tools.

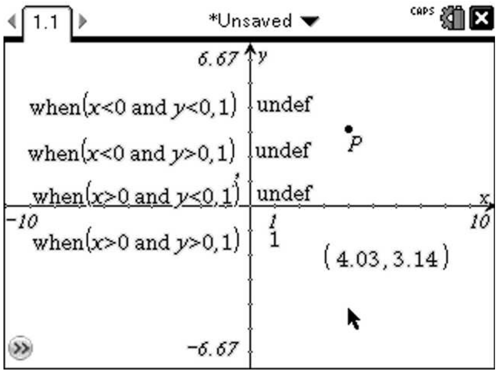


So start by creating a new document and add a graphs page. Create a point P on the first quadrant (except the axes) and display its coordinates.

> You can label a point by pressing any letter key when you create it.

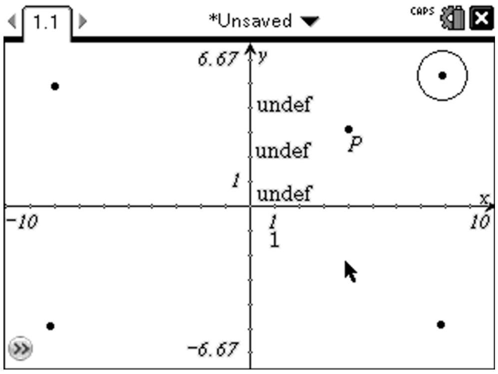


With the text tool enter the following formulas:
when(x<0 and y<0,1)
when(x<0 and y>0,1)
when(x>0 and y<0,1)
when(x>0 and y>0,1)



Calculate these formulas using the x and y coordinates of the point as parameters when prompted.

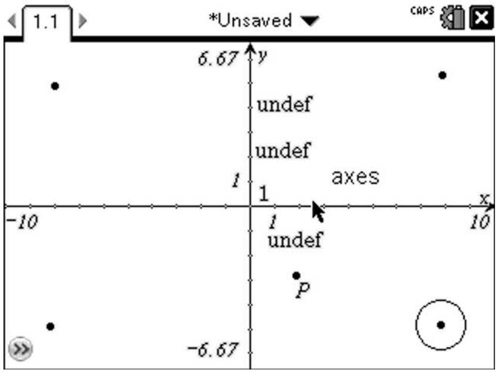
All results except 1 will be undefined. Hide the formulas and the coordinates and create a point in each corner of the screen.



Create a circle of radius 1 (using the result of the formula) around the point on the upper right corner.

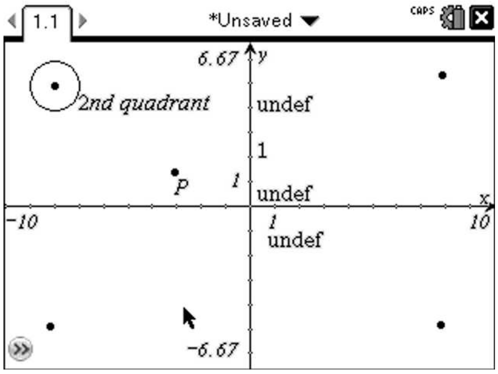
> A circle can be defined in two ways: by its center and a point or by the center and a number, which will be the radius.

Move point P to the second quadrant. The first circle will disappear and the results of the calculations will change. Create a circle around the point on the second quadrant using the 1 from the calculations as the radius.



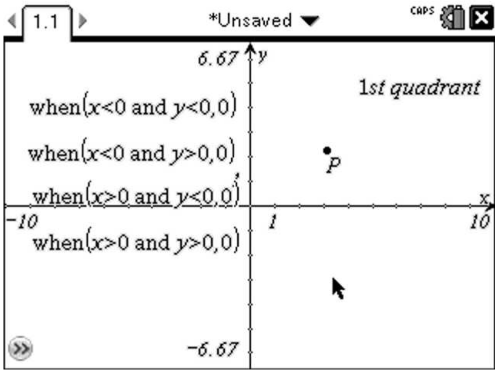
Do the same thing for the third and fourth quadrants.

As point P moves around you get a set of appearing and disappearing circles.



Label them by pressing ctrl+menu over each one (you must move point P around to display the circles and selecting Label from the menu. Label the circles “1st quadrant”, “2nd quadrant”, “3rd quadrant” and “4th quadrant” appropriately. Adjust the position of the labels so that they're entirely visible.

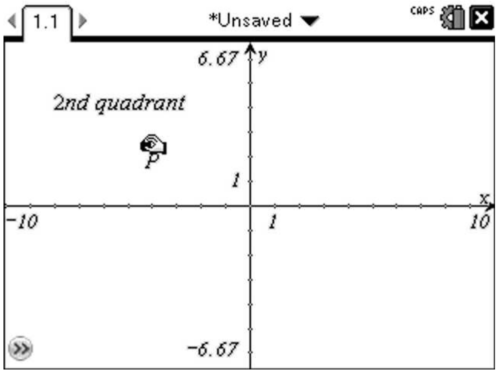
> ctrl+menu opens the context menu. Here you'll find the most useful tools for each particular situation.



Now hide the centers of each circle and the results of the calculations. Display the formulas, however. Edit them to

when(x<0 and y<0,0)
when(x<0 and y>0,0)
when(x>0 and y<0,0)
when(x>0 and y>0,0)

Then hide the formulas.



These formulas now render circles of radius 0 (invisible) so that only the labels are shown. You get a set of appearing and disappearing text boxes!

The end!