GeoGebra Applets

GeoGebra is a GNUed software package for mathematics visualization. The home for the applications is http://www.geogebra.at.

Educational material for GeoGebra is available at http://www.geogebra.at/en/wiki

The following are some Applets pages I have created with the software.

Some of the applet pages look at standard constructions from calculus, making the pictures dynamics and subject to manipulation by the instructor.

- The tangent as the limit of secant lines.
- The slope of tangents and the derivative of a function.
- The graph of a function and its first and second derivatives in the same window.
- The Newton's Method page illustrates the use of tangent lines to find roots of functions. It also gives examples where the technique fails. A variation of this is the Newton-Raphson page which uses a different tecnique with sequences.
- The Taylor polynomial approximation of a function.

Some pages look at precalculus material to allow a quick review,

- The Linear Equations page connects the normal ways of defining a line, either by giving two points, or by giving a point and a slope, or by giving the slope and intercept. Each window connects a set of information with a line and derives the other presentations of the line.
- The Quadratic Equations applet allows you to make connections between the graph of a quadratic function, and various ways to write the equation, focusing either on roots or the vertex of the parabola.
- Conic Sections - The Ellipses and Hyperbolas applet lets you specify a conic section by specifying the length from the center to a vertex on the major axis and the length to a focus. You get either an ellipse or a hyperbola, depending on which length is bigger. The Parabolas applet looks at Parabolas defined by a focus and a directrix. The General Conic Sections applet lets you explore the graph of a quadratic relation in general format.
- Graphs of related functions -The family of curves applet lets you graph a function with three parameters and then vary those parameters with a slider. The Translations and Compressions Applet lets you compare the graph of a function with the graph of a function transformed by translations and compressions or expansions.
- Trigonometric Functions - The Trig Review applet connects the values of the 6 basic trig functions with segments on the unit circle. The Sin Curve Fitting applet lets you fit a sinusoidal curve to a pair of specified points.

Some of the applet pages look at standard results in the construction of triangles.

- The side-side-side applet, lets you construct a triangle by specifying the lengths of the three

sides. If such a triangle can be constructed, it is unique.

- The side-angle-side applet, lets you construct a triangle by specifying the lengths of two of the sides and the included angle. If such a triangle can be constructed, it is unique.
- The angle-side-angle applet, lets you construct a triangle by specifying the lengths of two of the sides and the included angle. If such a triangle can be constructed, it is unique.
- The side-side-angle applet, lets you construct a triangle by specifying the lengths of two of the sides and an non-included angle. If such a triangle can be constructed, it may not be unique.
- The angle bisector applet looks at the theorem that the three angle bisectors of a triangle all meet in a single point. The first frame lets the student explore the result with various triangles.   A second construction adds details that give a framework for a proof.
- The side bisector applet looks at the theorem that the three perpendicular bisectors of the sides of a triangle all meet in a single point. The first frame lets the student explore the result with various triangles. A second construction adds details that give a framework for a proof.
- The concurrent medians applet looks at the theorem that the three medians of a triangle all meet in a single point. The first frame lets the student explore the result with various triangles. A second construction gives a framework for establishing a lemma about tiling an area with congruent triangles. The third construction uses the lemma to adds details that give a framework for a proof.
- The concurrent altitudes applet looks at the theorem that the three altitudes of a triangle all meet in a single point. The first frame lets the student explore the result with various triangles. A second construction adds details that give a framework for a proof.
- The Pythagorean theorem applets walks through a visual proof of the Pythagorean theorem.

One page collects standard Ruler and Compass constructions. These include:

- The construction of a line bisecting an angle
- The construction of the bisector of a line segment
- The construction of a line perpendicular to a segment from a point on the segment
- The construction of a line perpendicular to a segment from a point not on the segment
- The construction a line through a given point parallel to a given line
- The construction of a segment that is an integer multiple of the length of a segment
- The division of a segment in an integer number of pieces, all of the same length

Some of the pages are of interest to explore some of the features of GeoGebra.

The Regular Polygon and Circle applet looks at constructions with sequences.

The applet on constructing triangles and quadrilaterals has two copies of the applet running on the same page.

This Blank GeoGebra page applet opens with a blank page, but double clicking on the page launches the application on your machine. From there you can make clean constructions and save them yourself.

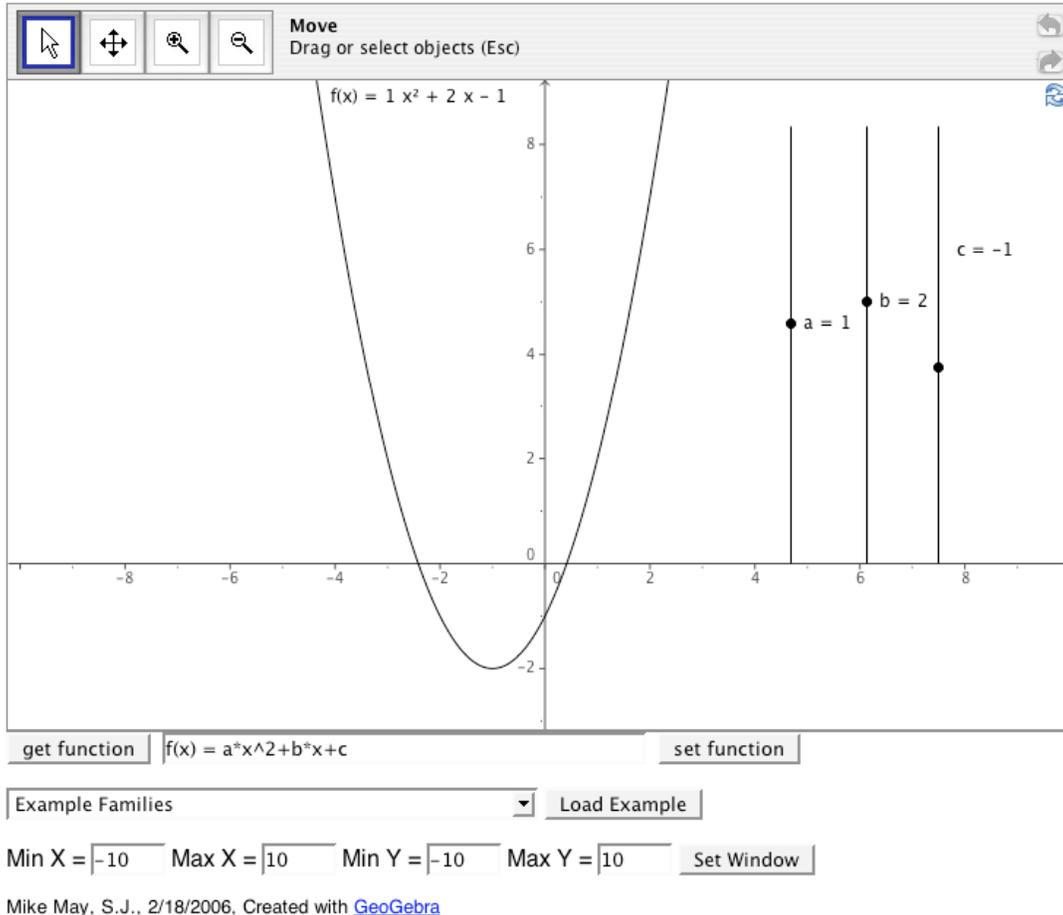Return to the [Applets for courses below calculus page](#).

Return to the [Calculus Applet page](#).

Last updated By [Mike May, S.J.](#), September 11, 2008.

Family of Functions

This applet is designed to allow a visual exploration of a family of function, or how shifting a parameter changes the graph.

The applet opens with the function f(x) = a*x^2 + b*x + c. The sliders on the side let you change the parameters. To change the function, right-click (control-click for mac people) on the formula and choose "redefine" from the context menu that pops up. To change the viewing area, right-click on bank space in the graphing pad and choose "properties".

Move
Drag or select objects (Esc)

f(x) = 1 x² + 2 x − 1

c = −1

b = 2

a = 1

| get function | f(x) = a*x^2+b*x+c | set function |

Example Families ▾ Load Example

Min X = -10   Max X = 10   Min Y = -10   Max Y = 10   Set Window

Mike May, S.J., 2/18/2006, Created with GeoGebra

Some interesting families of curves to examine:

Items to note:
1) Sliders with dynamic control of values.
2) Javascript line for controlling viewing window
3) Javascript line that gets and returns function definition, using parameters
4) Javascript line for drop down menu of examples
5) Customizations - Restricted toolbar with only 4 tools available; No command line; No algebra window.

Notes on use:

Derivatives and Tangent Lines

This applet is designed to build the intuition between the idea of a derivative being the slope of the line tangent to a curve and the idea of a derivative as a function symbolically computed form the formula of the original function.

The main viewing window gives the graph of a function f(x), a point T, the tangent line at a the point T, and a point with that turns the slope into the height of a point. The main viewing window also graphs a guessed derivative for the function.
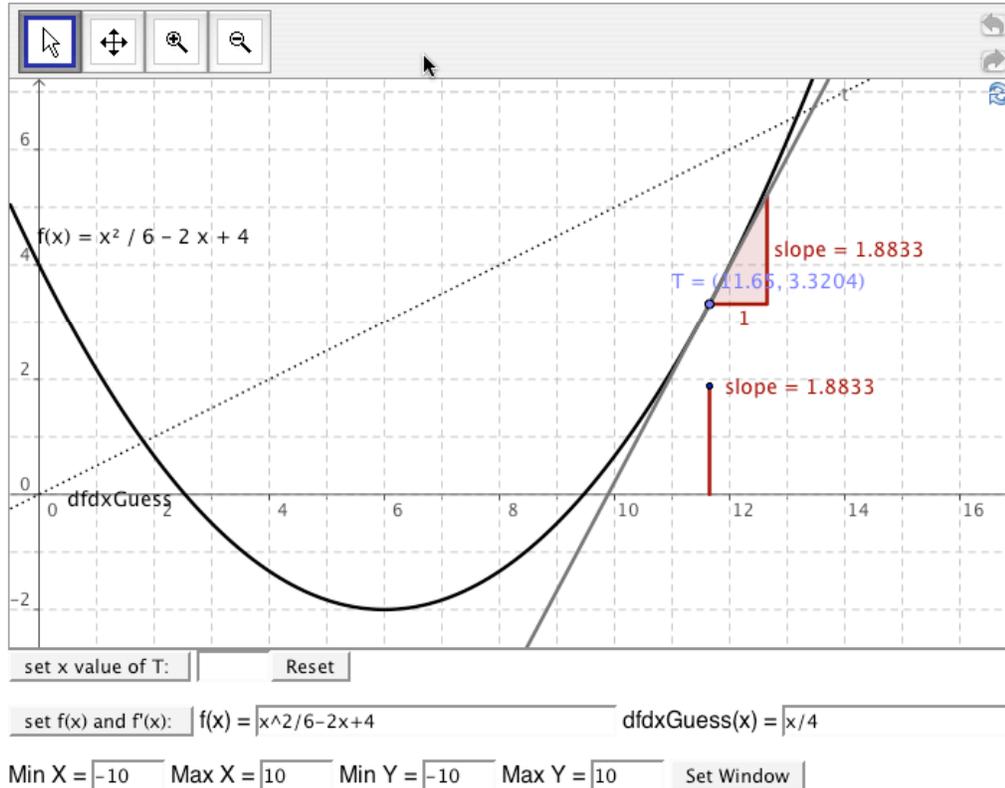
The applet opens using the function f(x)=x^2/6 - 2x + 4.

Items to note:
1) The Javascript line for controlling viewing window has been repeated as have the customizations.
2) The Javascript line for the function has a second input for guessing the derivative. (This is the dotted line in the default picture. It has been set incorrectly so the students need to produce it.)
3) The value of the point T is in a separate Javascript line since the point and functions will be changed at different times.

Taylor Polynomial Approximation

An applet to look at Taylor polynomial approximation of a function f(x). The function is in black, the Taylor polynomial is in green, and the error is in red.

Move
Drag or select objects (Esc)

TaylorPoly(x) = 1.59 + 5.375 (x + 0.94) − 2.609 (x + 0.94)² / 2! − 4.372 (x + 0.94)...
$x_0 = -0.94$

$x_1 = -3$

$n = 4$

$P_0 = (-0.94, 1.59)$

f(x) = 3 sin(x / 2) + 5 cos(x)

$E_1 = (-3, -1.443)$

ErrorTerm(x) = 3 sin(x / 2) + 5 cos(x) − (1.59 + 5.375 (x + 0.94) − 2.609 (x + 0...

Min X = -10   Max X = 10   Min Y = -10   Max Y = 10   Set Window

set values   f(x) = 3*sin(x/2)+5*cos(x)
Degree of Approximation = 4   , x_0 = 1   , x_1 = 2

Get output

```
We are looking at the Taylor polynomial of degree 4
centered at x_0 = -0.9399999999999995
At x_1 = -3 the function has value -7.94244744281439
while the polynomial approximation is -6.4998269806902425
giving an error of -1.4426204621241476
TaylorPoly(x) = 1.59 + 5.375 (x + 0.94) - 2.609 (x + 0.94)² / 2! - 4.372 (x + 0.94)³ / 3! +
2.864 (x + 0.94)⁴  / 4!
```
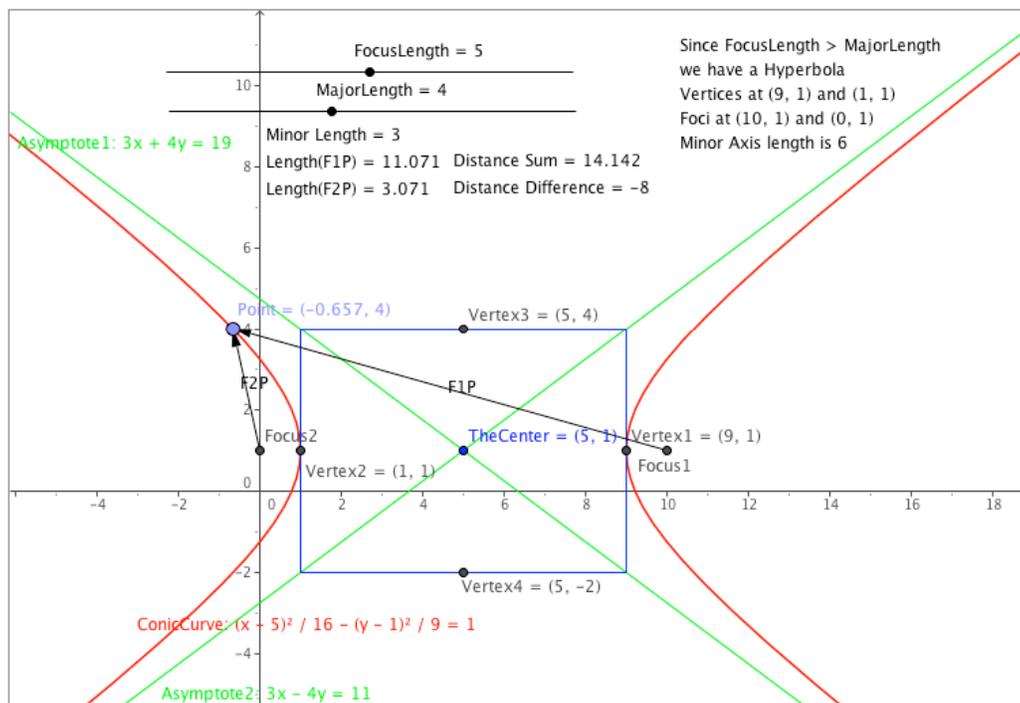
Items to note:
1) The Javascript line for controlling viewing window has been repeated as have the customizations.
2) The Javascript line for the function has extra information that one would want in doing taylor polynomials.
3) The text area gives a lot of textual information.

Ellipse and Hyperbola Review

The applet lets you review constructions for parabolas and hyperbolas.

The center of the conic can be moved by dragging. The major axis is parallel to the x-axis.
The distance from the center to a vertex on the major axs and the distance from the center to a focus are controlled by sliders.
The point on the conic can be moved by dragging

An ellipse is the set of points for which the sum of the distances from the foci is a fixed constant.
A hyperbola is the set of points for which the difference of the distances from the foci is a fixed constant.

FocusLength = 5
MajorLength = 4
Minor Length = 3
Length(F1P) = 11.071   Distance Sum = 14.142
Length(F2P) = 3.071   Distance Difference = -8

Since FocusLength > MajorLength we have a Hyperbola
Vertices at (9, 1) and (1, 1)
Foci at (10, 1) and (0, 1)
Minor Axis length is 6

Asymptote1: 3x + 4y = 19

Point = (-0.657, 4)   Vertex3 = (5, 4)

F2P   F1P

Focus2   TheCenter = (5, 1)   Vertex1 = (9, 1)
Vertex2 = (1, 1)   Focus1

Vertex4 = (5, -2)

ConicCurve: $(x - 5)^2 / 16 - (y - 1)^2 / 9 = 1$

Asymptote2: 3x - 4y = 11

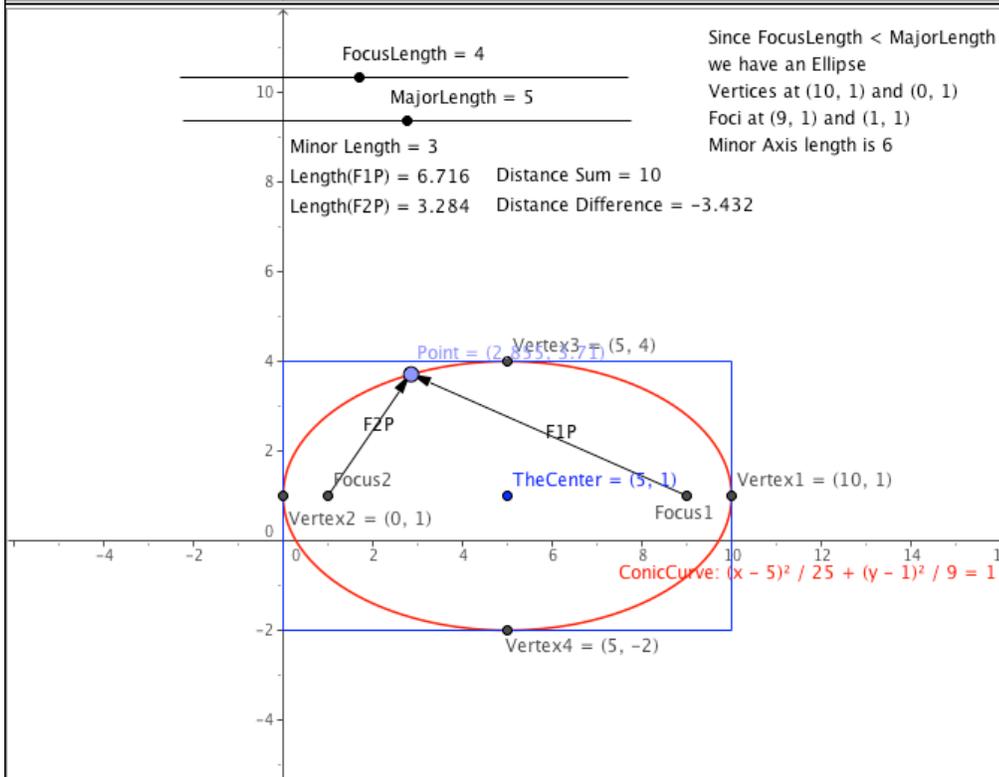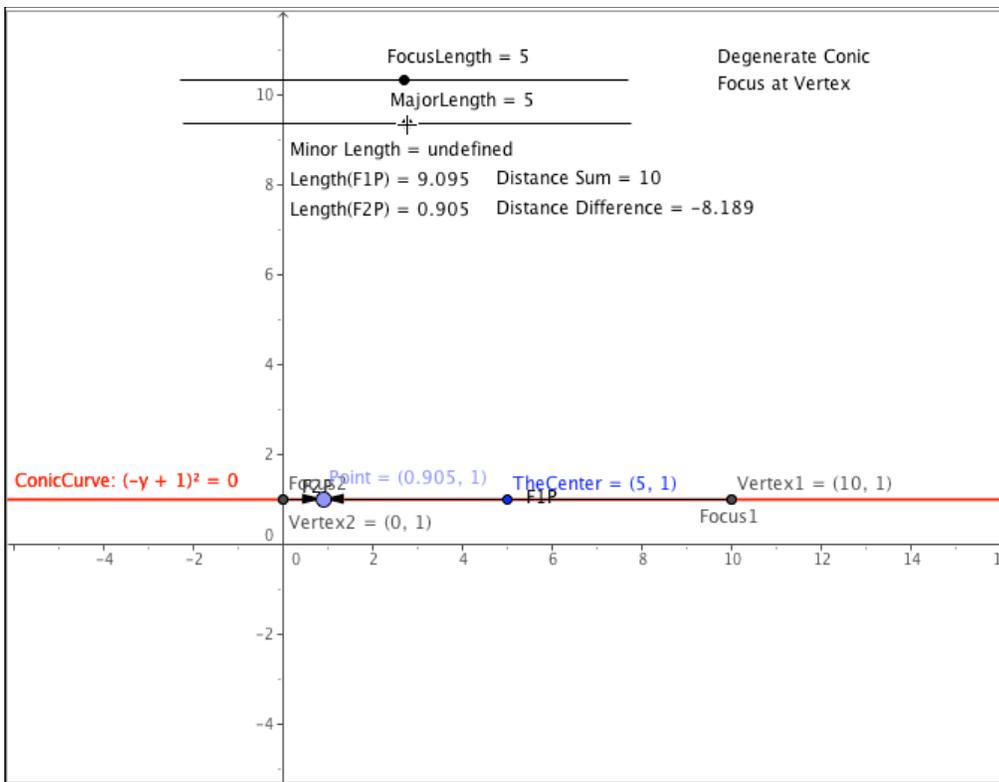Mike May, S.J., 2/14/06, Created with GeoGebra

GeoGebra is a GNUed software package for mathematics visualization. The home for the applications is http://www.geogebra.at.

Return to the GeoGebra Applet page.

Return to the Applets for courses below calculus page.

Items to note:
1) The Javascript line for controlling viewing window has been repeated as have the customizations.
2) The center, the lengths of the major and minor axes, and the point on the conic can be changed by dragging.
3) A lot of information about the conic is given as text with an organization of regions as controls, measurements, and summary data.
4) (Below) Changing the focus lenth and major length changes the kind of conic, with different text showing up using conditional definitions.

FocusLength = 5

MajorLength = 5

Minor Length = undefined

Length(F1P) = 9.095   Distance Sum = 10

Length(F2P) = 0.905   Distance Difference = −8.189

Degenerate Conic
Focus at Vertex

ConicCurve: $(-y + 1)^2 = 0$

Point = (0.905, 1)   TheCenter = (5, 1)   Vertex1 = (10, 1)

Focus2   F2P   F1P   Focus1

Vertex2 = (0, 1)

FocusLength = 4

MajorLength = 5

Minor Length = 3

Length(F1P) = 6.716   Distance Sum = 10

Length(F2P) = 3.284   Distance Difference = −3.432

Since FocusLength < MajorLength
we have an Ellipse
Vertices at (10, 1) and (0, 1)
Foci at (9, 1) and (1, 1)
Minor Axis length is 6

Point = (2.855, 3.71)   Vertex3 = (5, 4)

F2P   F1P

Focus2   TheCenter = (5, 1)   Vertex1 = (10, 1)

Focus1

Vertex2 = (0, 1)

ConicCurve: $(x − 5)^2 / 25 + (y − 1)^2 / 9 = 1$

Vertex4 = (5, −2)

can be solved, we also want to look at the equation in factored form.

A second algebraic approach uses the method of completing the square to find the vertex of the parabola. This is given in blue. If the vertex is the point (h,k), then the equation can also be written in the form y = a(x-h)^2 + k.

Move
Drag or select objects (Esc)

$f(x) = ax^2 + bx + c = 1x^2 + 2x - 3.5$

$\text{discriminant} = b^2 - 4ac = 18$

$\text{Root1} = \dfrac{-b + \sqrt{b^2 - 4ac}}{2a} = 1.121$

$\text{Root2} = \dfrac{-b - \sqrt{b^2 - 4ac}}{2a} = -3.121$

$f(x) = a(x - \text{Root1})(x - \text{Root2}) = 1(x - 1.121)(x + 3.121)$

$f(x) = a\left(x + \dfrac{b}{2a}\right)^2 + c - \dfrac{b^2}{4a} = 1(x + 1)^2 - 4.5$

$\text{Vertex} = \left(\dfrac{-b}{2a}, c - \dfrac{b^2}{4a}\right) = (-1, -4.5)$

$a = 1$ $b = 2$ $c = -3.5$

Min X = -10   Max X = 10   Min Y = -10   Max Y = 10   Set Window
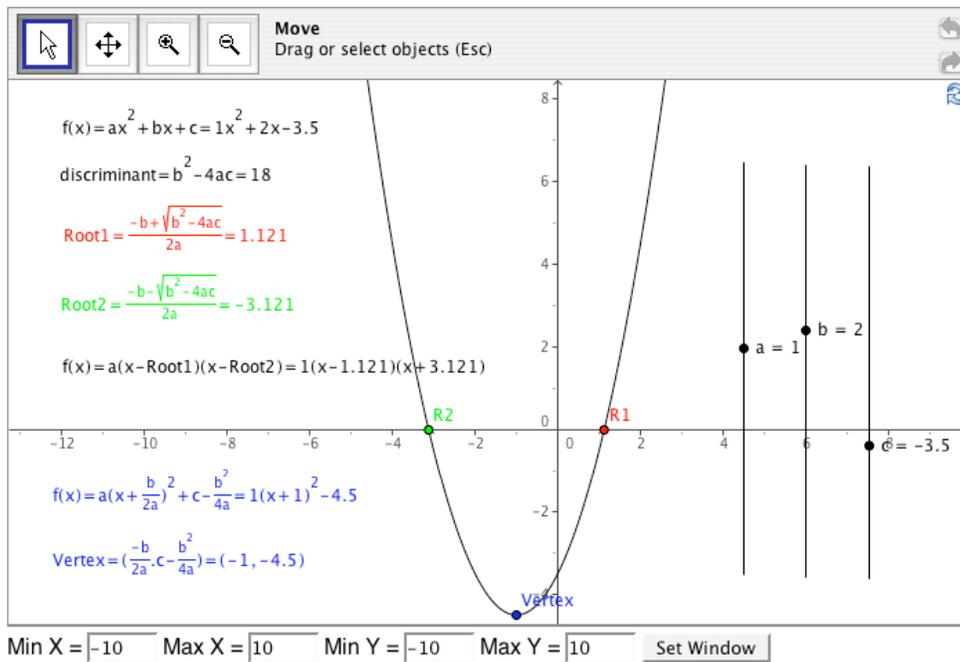
The method of completing the square deserves more attention, so we look at it in more detail in the next window. Once again, sliders let us control a, b, and c, and we can see how the method of completing the square works out for various quadratic polynomials
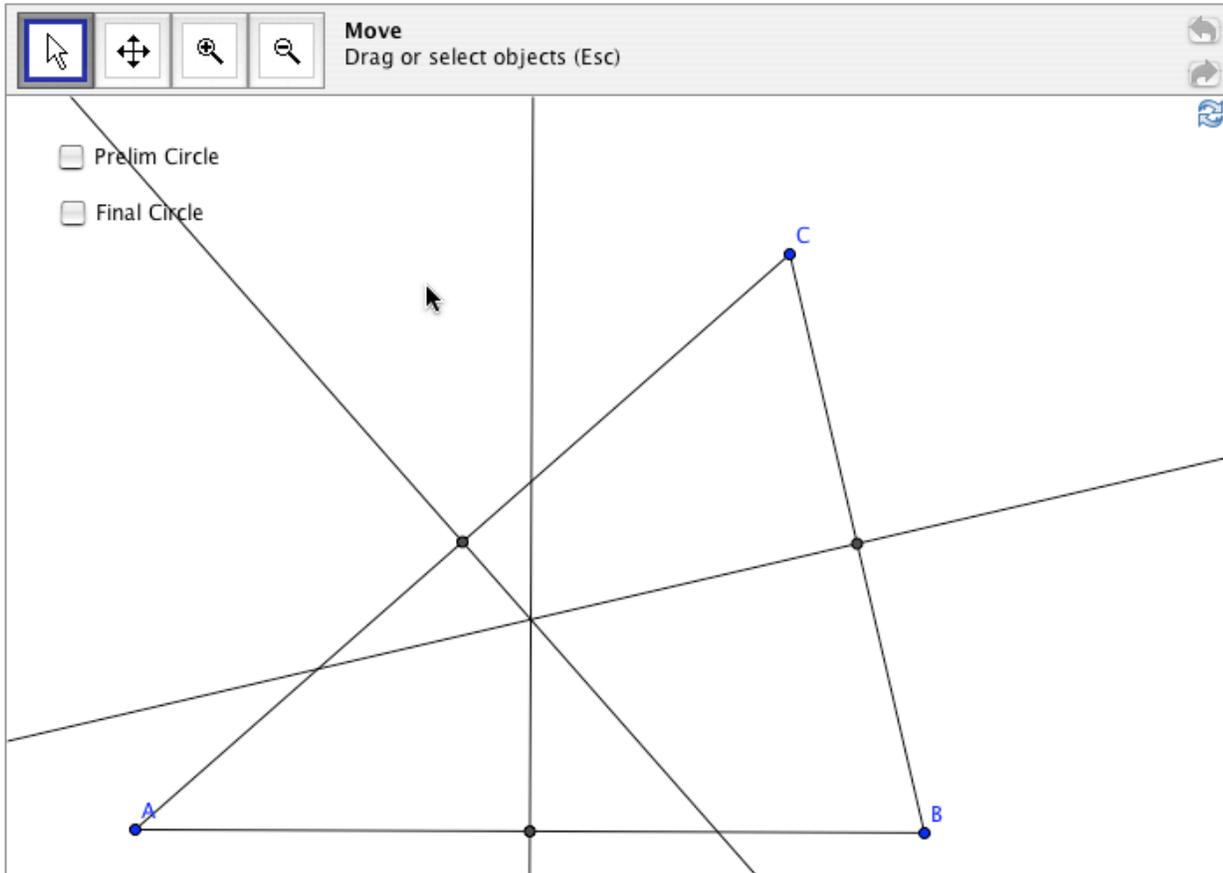

Move
Drag or select objects (Esc)

$b = 5.2$
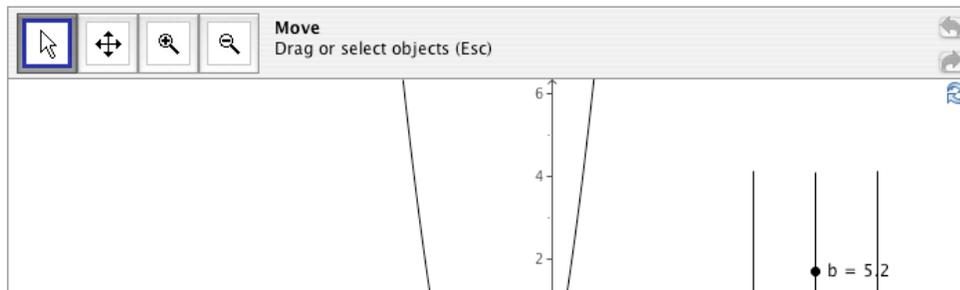
Items to note:
1) Several GeoGebra windows are used in a single page.
2) Text, objects, and labels are connected by use of color.

Side Bisectors construction

An applet to show that the three perpendicular bisectors of the sides of a triangle all meet in a single point.

| Move |
| Drag or select objects (Esc) |

Prelim Circle

Final Circle

C

A

B

The three vertices of the triangle above can each be dragged to show that the perpendicular bisectors of the

Items to note:
1) Check boxes are used to make items appear and disappear.

Proof of Pythagoras' Theorem

Drag the steps slider to be taken through a proof of the pythagorean theorem

Move
Drag or select objects (Esc)

Steps

Step 0 – Move the points around and convince yourself the theorem remains true for all right triangles.

Length a = 3
Length b = 4
Length c = 5

B

a

c

A

C

b

Mike May, S.J., September 5, 2007, Created with GeoGebra

Items to note:
1) The slider walks students through the steps of a proof.
2) The vertices are dynamic and can be changed by dragging.