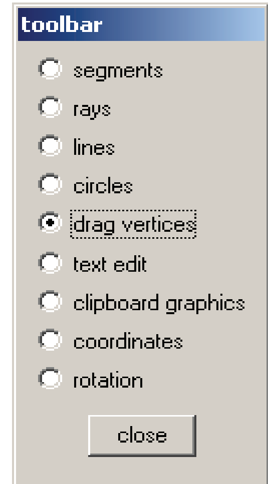
Getting Started: Basics for 2-dim

First lets discuss the basics of Wingeom. We need to know how to build geometric objects. Choose 2-dim from menu window. Maximize screen if desired. Right click to make a point. You can offset the labels by **edit-labels-offset.** Now go to **btns-toolbar**.

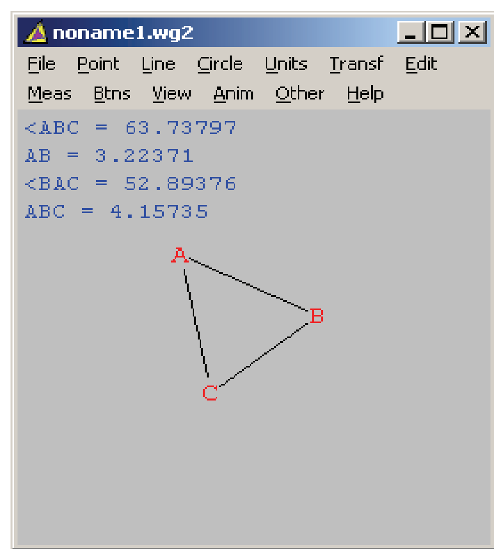


The following is now available for quick access (note: left click for these):

1. **Segments**: Allows you to connect the points. Click on a point and drag the curser to another.
2. **Rays**: Allow you to have infinite rays that start at one point and go on passed another. Click on a point and drag it to another.
3. **Lines**: Same was rays except they extend past both points chosen.
4. **Circles**: Click on a point and that will become the center of a circle with desired size. This will also add another point on the circle.
5. **Drag Vertices**: Changes location of the point. Left-click on the point and drag.
6. **Text Edit:** Moves the labels of the vertices.
7. **Clipboard Graphics:**
8. **Coordinates:** Allows you to see the numerical value of the coordinate on a coordinate sys tem.
9. **Rotations:**

Starting exercises: Making a triangle, quadrilaterals, circles, polygons, etc…. Using these objects students can better understand angles, lengths and areas.

Exercise 1: Make a triangle and find the lengths of the sides, angle measurements, perimeters, area and answer some questions that relate them.



1. Plot three points.
2. Using the **btns-toolbar-segments** make a triangle
3. At this point, drag the vertices and explore what the triangle does.
4. **To take measurements**: Click on **meas** to open the measurement dialog box.
   a. For angles: **<ABC, enter**
   b. Lengths: **AB, enter**
   c. Sum of angles**: <ABC + <BCA + <CAB, enter**
   d. Sum of lengths**: AB+BC+AC, enter**
   e. Perimeter: **[PER](ABC), enter**
   f. Area: **ABC, enter**

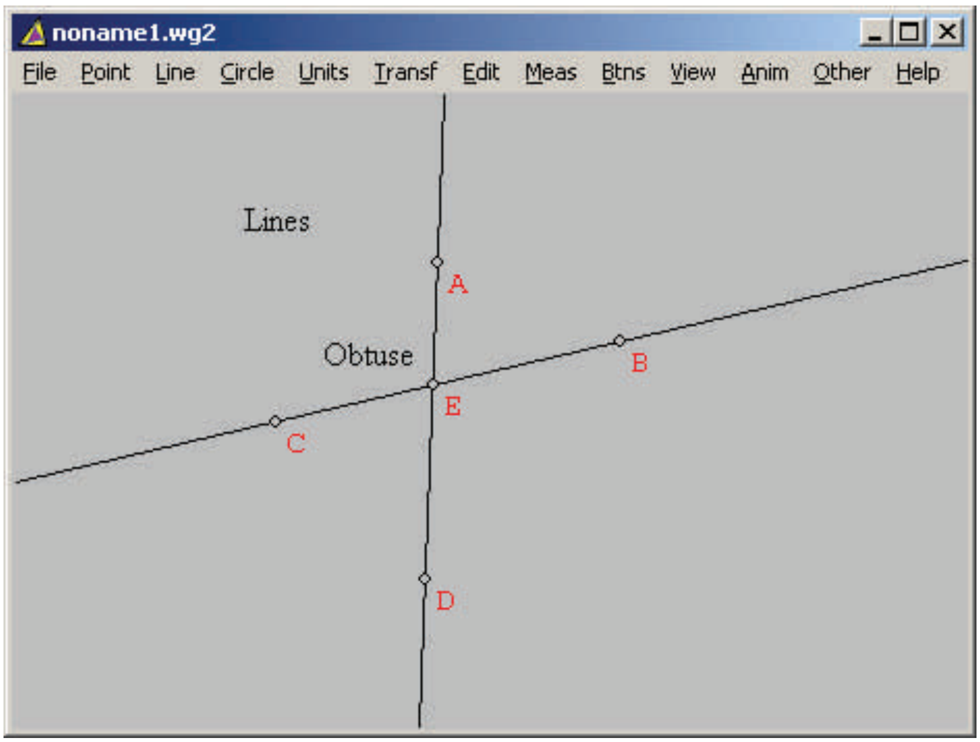
Now you will have your calculations on the main screen. These will stay up and if you move the triangle around you will see the calculations adjust. Here is the chance to ask your students questions and see what conjectures they come up with. Make a right triangle. ***What is the sum of the angles now?*** Make the triangle have two sides that are the same length. ***What do you see about the sum of these angles?***

Exercise 2: Labeling Angles

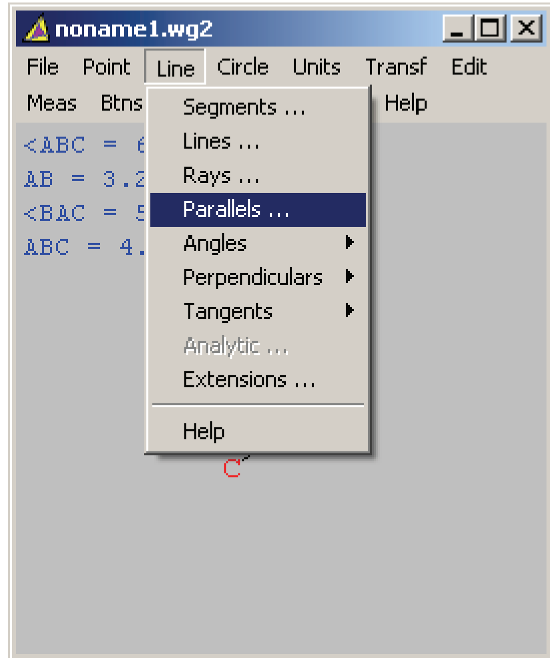
You can label angles, figures, sides, etc using the text box.

1. Plot 4 points and offset the labels.
2. Click on lines and make a line between any two points.
3. **Toolbar-text, right click** on the figure (anywhere). The dialog box will appear. Type what you need and click **ok.** At this point we have a text box on the figure to which you may move around and label what is needed.

Below is a completed example of labeling.

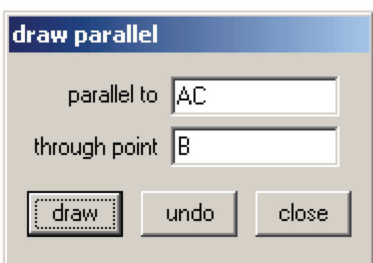


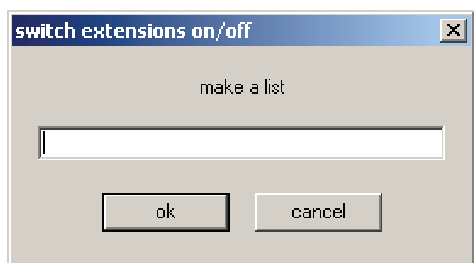
Exploring the Line option



If you have nothing in your figure **Line** does not give you very many choices. But if you at least plot two points you will have some options.

1. **Lines, Segments and Rays** : This is the same as from the tool bar except you get to plug in your points.
2. Once you have a line you can experiment a little. For example you can choose **parallels** and a dialog box will appear as below. The same thing can be accomplished by clicking on **perpendiculars-general.**
3. Within **perpendiculars-general** there are other options such as altitudes and perpendicular bisectors. You can even create an angle from a certain line as desired.
4. The options **extensions** allows you to remove a portion of a line (or add it back!). Click on extensions then input a line say AB. The extension of the line from B will be erase. If you input BA the opposite will occur. You can go back and replace these with the same procedure.



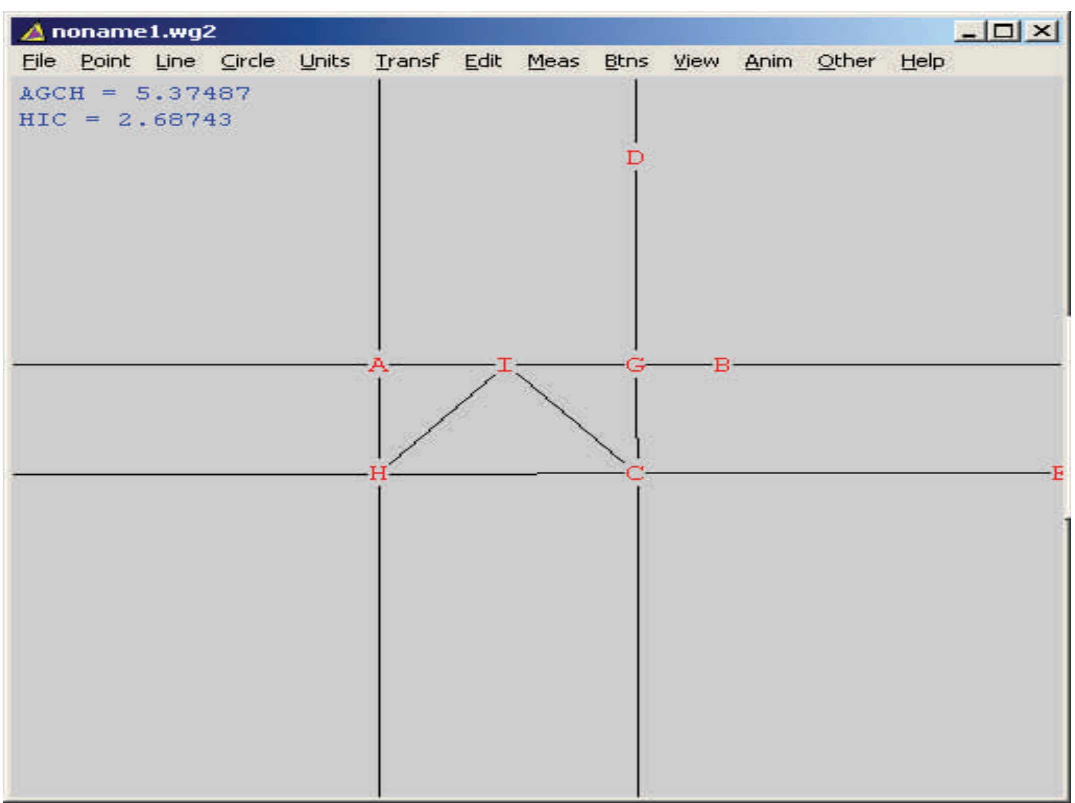


Exercise: Create a triangle inside a rectangle.

1. Place three points on the window with A, B across the top and C below.
2. In the toolbox click on **lines** and create a line between A and B.
3. Click on **lines-perpendicular-general** to display a dialog box. Make a line perpendicular to AB through C.
4. Click on **lines-parallel** and make a line parallel to AB through C.
5. Click on **lines-perpendicular-general** and make a line perpendicular to AB through A.
6. Now you have a rectangle! If you have any intersections that have not been marked you can go to **point-intersection-(line-line)-mark**.
7. Click on **drag vertices** and drag either A or C and see what happens. You will keep the perpendicular lines intact.
8. At this point you want to add another vertex to make a triangle. Make sure you are in the **segments** option of the toolbar and right click on the line AB to get the top of the triangle. The base of the triangle will be the base of the triangle.
9. You now have a good set up and can take measurements and ask questions!

For example: Bring up the measure dialog box **(meas).** Type in **AGHC** (or what you may have for the vertices of the rectangle) and **HIC** for the triangle. This will measure the area. Also type in **2*HIC**. Now drag I and the points A or C.

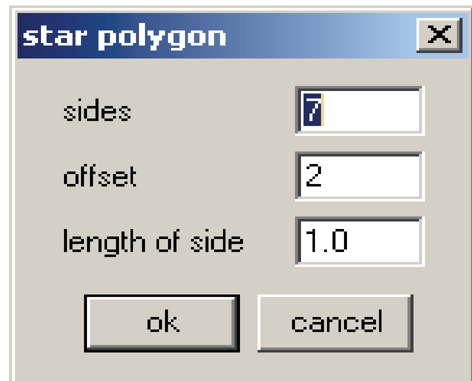
Questions*: *Does moving I change the shape of the rectangle? Does moving A or C change the areas? (both triangle and rectangle) What can you conclude about the area of the triangle compared to square?

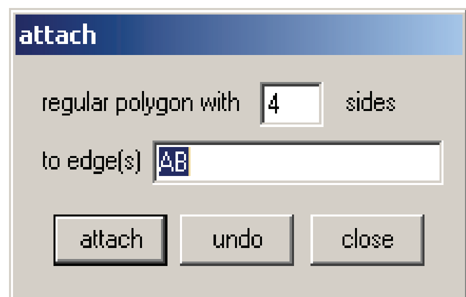


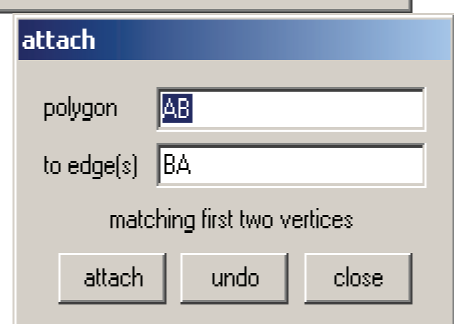
Exploring the Units option

To start, plot a point or two on your window. Open up the toolbar and click on **units.** You will see many options, here is a quick overview:

1. **Triangle**: If you select this you will be given three options; SAS, SSS, ASA. These will allow you to draw the triangles above by choosing the side length and angle.
2. **Polygon:**
   a. *Regular***:** You have a choices of the number of sides and the length of sides.
   b. *Parallelogram***:** Gives you the choice of side, angle and side.
   c. *Kite***:** Gives you the choice of side, angle and side.
   d. *Star***:** Gives you the choice of side, offset and length of side. Looking to your right you will see your options.
   e. *Attach***:** You have to choose regular or figure. There are sample windows right below. The program will attach the polygon to segments in a counterclockwise sense hence there is a difference in attaching it to AB or BA.





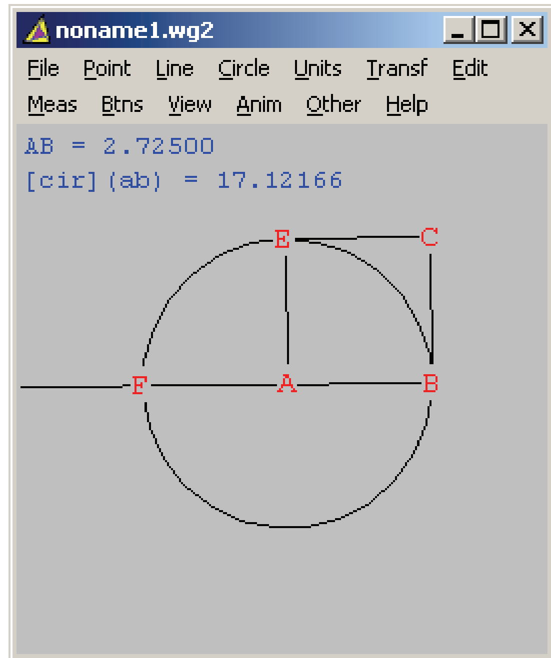


3. **Random:** circles, polygons, triangle, right triangle, parallelogram, kite, trapezoid, rhombus, convex, or cyclic, with a given number of sides
4. **Segments:** Segment of given length and inclination with respect to the x-axis (whether it is visible or not).
5. **Grid:** A grid is a rectangular lattice whose dimensions, dot count and angular position can be specified.
6. **3-Point Conic sections:** If **ellipse** or **hyperbola** is checked, the first two points are focal points and the third point is on the curve. If **eccentricity** is checked, the first two points define the directrix and the third is the focus, and the conic is defined by its eccentricity, which must be nonnegative. Each example can be given its own color, and it is put into the inventory when you click **draw**. Click **delete one** to remove a selected example from the inventory. You can also "mark" points at definite locations on a selected example. If **ellipse** or **hyperbola** is checked, points are defined by a coordinate that varies from 0 to 1 as the curve is traced, starting at the vertex nearest the second focal point. If **eccentricity** is checked, the focus-vertex distance is used as a unit, and the coordinate 0 corresponds to the vertex closest to the directrix. This system recognizes only half the points of a non-parabola.
7. **5-point Conic sections**: Except for special situations, any five points on the screen define a conic section that goes through all of them. Type the five vertex names into the edit box and click "draw".
8. **Array of Circles:** You can create rectangular, triangle and chains of circles.

9. **Duplicate:** You can duplicate what you have on your window by imputing the vertices and the magnitude you would like.
10. **Help:** You can click this button at any time in the program and it will give you a general overview like we have here.

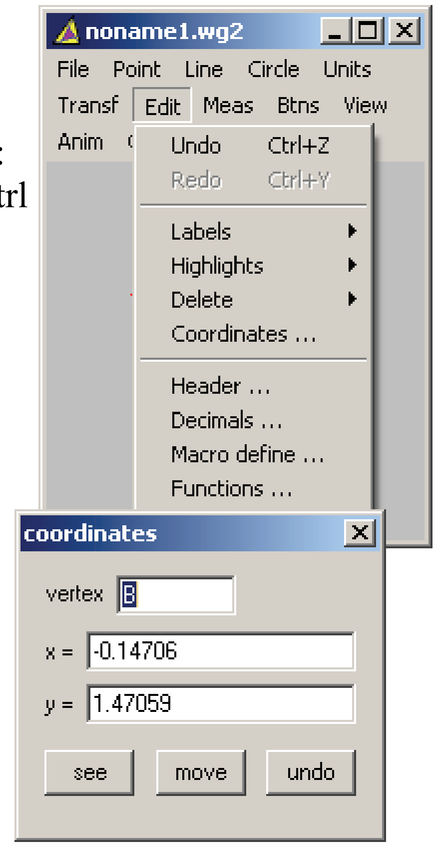
Now that you have seen how things work, lets look at what we can use to help with teaching.

Exercise: Create a square and a circle both based on the length of a segment A to B. This helps to understand the area and circumference of a circle.



1. Make two points A and B and create a **segment.**
2. We will now use this segment as a side of a square. To do this click on **units-polygon-attach-regular** you want to attach a regular polygon with 4 sides to AB and click **attach.**
3. Now you insert a circle with radius AB. Click on **circles** (toolbar) then position your curser over A and drag the circle B. We now have a circle of radius AB centered at A.
4. Now you can click on drag vertices and choose one to see what happens. Notice that A and B are the only vertices that change the size of the shape but we have the square and circle intact.
5. Now we will take some measurements. Click **meas** and type in **ABCD** to find the area of the square. Type in **[PIE](AB)** to find the area of the circle.
6. Drag either A or B. ***What do you notice about the area of the circle compared to the square?***
7. Draw a **line** from B to A using the toolbar. Use **line-extensions** and type in BA to erase that portion of the line.
8. Mark the intersection of this line with the circle using the following: **Point-intersections-mixed** enter line BA and circle AB then click **mark** to create F. Now we have a diameter for the circle.
9. Try to find the length of the diameter using **meas.** To find the circumference **[CIR](AB)** and press enter. Now you can once again drag the vertices to see what happens to the measurements. ***What do you notice about the circumference of the circle compared to the length of the diameter?***
10. Now we can confirm some conjectures we have made from the questions and actions above. Click **meas** on the menu bar and type in **[PIE](AB)/ABCD**. ***What happens to your ratio? What can you conclude about the circumference of any circle if you know its diameter?***

Exploring the Edit options



When you open the edit window you will see the following options:

1. **Undo/Redo:** This is pretty self explanatory. You can also use ctrl Z for undo.
2. **Labels:** (below)
3. **Highlights:** (below)
4. **Delete:** Points, Circles, Lines are subjected to the following: A point cannot be deleted if it is needed to define a circle or a line. If a line is deleted the points on it remain.
5. **Coordinates:** You can move points to precise locations in xy-coordinates.
6. **Header:** The header is a 60-character text that appears at the top of history.
7. **Decimals:** Displayed decimals.
8. **Macro define:** (below)
9. **Functions:**Useful for defining long formulas when edit boxes only allow a small number of characters. This dialog accepts 9-character names and 60-character formulas, which must be written using the dummy variable x. References to your functions must be enclosed in square brackets.
10. **Randomize**: The program redraws the figure, making new random decisions wherever requested.

The **labels** options has a submenu:

1. **Individual Labels** dialog box to alter the label for a single vertex, or for a group of vertices. You can turn the alphabetic label on or off, and mark with circle, bul let, hor-ver cross, diag cross, or nothing. Consecutive labels can be listed by using a hyphen: K-P means K,L,M,N,O,P. (See Labels under general remarks for more.)
2. Click **Letters** to hide/show all letters.
3. Click **Offset** to move all labels away from their vertices.
4. Click **Home** to bring all labels back to their vertices.
5. Click **Dot Mode** to change all vertex icons (circle, bullet, nothing, hv cross, diag cross). Labels that are centered on their vertices hide the icon.
6. The label **Color** and **Font** can be changed, and the label background can be made Opaque. To change the alphabetic labels, put the mouse into Text mode (See But tons menu).
7. Click **Move Color** to change the color that appears when the mouse is in Drag Vertex mode.
7. Click **Swap** to exchange labels for two vertices (useful when the program has assigned a letter to a dormant vertex).

The highlights has a submenu you will see line attributes and circle attributes the following describes the options within them and then the remaining commands:

1. Click **Color Line/Circle** to recolor individual lines and circles. Left-click the desired color, then Click Apply to use it on the indicated items. You can hide lines and circles (without deleting them) by coloring them with the background color. A circle is named by a center-point ray.

2. Click **Style Line/Circle** to apply new styles (dotted, dashed, etc). As with re-coloring, the indicated change applies to entire lines or circles. If you want to have different segments on a line have different attributes, the diagram must be drawn so that the program does not know of the co linearity; erasing the line and reconnecting individual segments takes care of that.

3. Click **Fill** region to color the interiors of polygons or sectors. Type the polygon name into the edit box (if the "mouse" box is checked, you can instead click the desired vertices in the drawing), or select the circle or sector in the list box. Check the appropriate radio button to indicate which type, choose color and pattern, then click Fill. Each region can be covered by those after it in the list, which you might therefore have to edit (by deleting some items and reinserting them). New items are placed in the list according to the insertion instructions. If no item is selected, new items go to the bottom of the list.

4. Click **Markings** to put arrows on parallel segments or ticks on segments of equal length, or arcs on angles of the same size, etc. Select the type of marking, the number, the relative size, and the location, then click Mark. To remove a marking, select it in the inventory and click Delete.

5. Click **Arc Radius, Tick Length, Arrow Length, or Bracket Length** to set the sizes of these markings. Sizes are given as a percentage of the screen width, which means that they may seem too large in a small window.

Exploring the Point options

1. **Segment :** Points on a segment AB are described linearly by a coordinate t, where t=0 means A, t=1 means B, t=0.5 means the midpoint of AB, and t-values that are not between 0 and 1 will extend the segment. When Mark is clicked, a new label appears at the requested location. If you set t=CP/CD, the new point appears in the same relative position on AB that P occupies on CD. If you set t=2/AB, the new point appears 2 (absolute) units from A. You can enter a list of segments, which will all be marked using the same coordinate t.
2. **Circle** : Uses the same pattern as the preceding, except that t runs from 0 to 360, both values assigned to the same reference point on the circle.
3. **Triangle**: As above, except that two coordinates are needed.
4. There are two ways to mark a point on a **Polygon** (1) it slides along the polygon sides when the mouse is in Drag vertices mode; (2) it is determined by a numerical coordinate (which can be animated), which runs from 0 to 1 as the point moves around the polygon.

   To mark points on segments, circles, triangles, or conics in precise, variable locations, use #, $, or @ as the numerical coordinate. When a parameter value is changed (see **Animation),** all points whose positions depend on this parameter are adjusted accordingly.

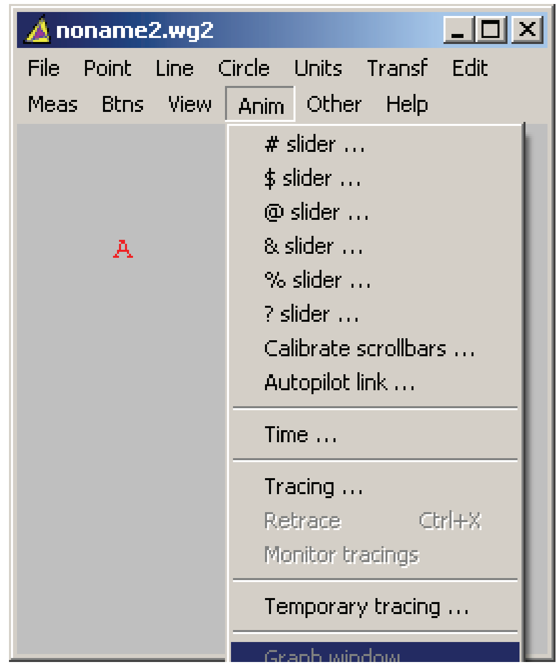
5. **Coordinate dialog:** Click Mark point to define a new point, after inserting the x- and y-coordinates into the edit boxes (at most 39 characters each). Although this point cannot be dragged with the mouse, its coordinates can be edited by right-clicking the point when the mouse is in drawing mode.

6. **Intersection dialogs:** The three types are Line-line, Circle-circle, and Mixed (line-circle). Click Mark to assign a new label to the intersection defined by the edit-box data. When circles are involved, both intersections are given labels. If Other/Auto extend is checked (see below), segments are extended to show intersections.

7. **Special points:** Circumcenter, incenter, orthocenter are well-known. The Fermat point F of ABC minimizes the sum AF+BF+CF. The Brocard point P for ABC makes the angles PAB, PBC, and PCA equal; it is interesting that the point changes if the request is made for triangle CBA. There are two centroid constructions (which agree for triangles), which apply to one polygon at a time: one simply averages coordinates of the vertices, while the other finds the center of gravity of the polygon, which is assumed to be convex (and homogeneous).

8. **Paste:** This is enabled if there is text on the clipboard. The program reads the text and extracts numerical coordinates from it -- each successive pair found is plotted as a new point.

Animation



We now look at the animation option which allows you to do many creative things. When you open this you will see many symbols and the word slider. This was briefly discussed in the point description.

Here is the description of these symbols:
The six animation parameters are #, $, @, &, %, and ?. Each has its own Slider. When one of these values is changed, any construction defined in terms of that parameter is also changed. For example, an angle of 90# degrees will open and close as the #-slider is manipulated: You can use the mouse to slide the "thumb", or click the arrow buttons, or you can type a new value into the edit box and press Enter. The range of the scroll bar is initially from 0.0 to 1.0, but it can be reset at either end (Set L or Set R) to the displayed value. The program will not let you press both reset buttons in succession, for this would reduce the range to a single value. The range is also reset by a new value that lies outside the existing range. Click Auto reverse or Auto cycle to slide automatically through the complete range of values. While the animation is running, the dialog box disappears, but you can
 press F to go faster;
 press S to go slower;
 press the spacebar to reverse direction;
 press Q to quit.
The animation will run until you press Q. The speed setting will almost surely need to be adjusted. The Auto reverse mode slides the "thumb" back and forth. The Auto cycle mode jumps from the right end back to the left end. Click New Vertex At to define a new vertex at the current position of the vertex identified in the edit box.

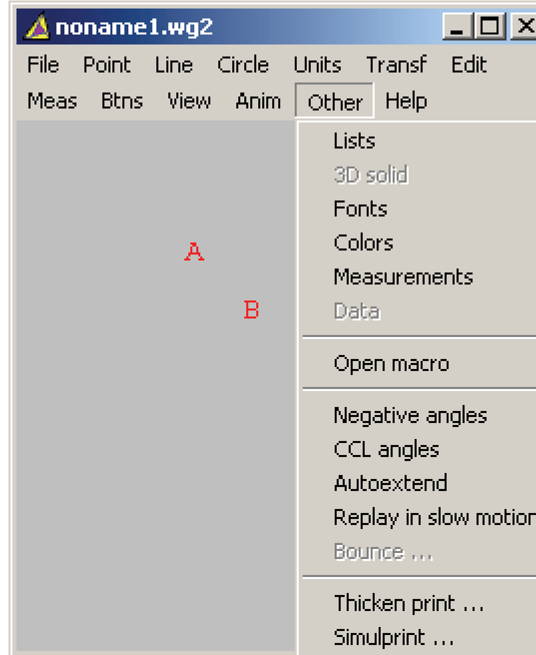
Here are the remaining descriptions:
1. Click **Scrollbar|Calibrate** to change the default increments for scrollbar movement (the default is 100 small steps and ten medium steps from one end of the bar to the other).
2. The **Autopilot Link** dialog box allows you to make two or more Sliders move together when one of them is on Autopilot.
3. The parameter **[time]** does not have a restricted range of values, thus its dialog box does not have a scrollbar. To modify the current value, type into the edit box and press Enter. If you click the "time" button, the parameter value will increase by (approximately) 1 unit per second. For example, if you mark a Point on a Circle using the coordinate "60[time]", this point will take 6 seconds to travel around the circle. Click "auto" for the usual animation, during which you can press F for faster and S for slower
4. Click **Tracing** for an inventory dialog that allows you to create, edit, or delete tracings. The

New/Edit tracing dialog works this way:

The tracing can be controlled by varying one of the parameters #, $, @, &, %, ?
(Click one of the six radio buttons); or The tracing can be controlled by sliding a random vertex along a segment or arc, or along a polygonal path. Click the Vertex radio button and type the label into the box. In any case, the controlling element is confined to the range of values indicated by Low and High, and it is incremented Steps times. The range of values 0 to 1 corresponds to moving from one end of the line (curve) to the other. For points on an n-sided polygon, the range of values 0 to n corresponds to moving the point once around the polygon (1 unit per side).

5. Click **Retrace** (press Ctrl+X) to redraw all tracings.
6. Check **Monitor** if you want the tracings to be updated when vertices are dragged or animated. The extra drawing will slow things down, however.
7. Click **Temporary tracing** and enter a list of vertices that are to leave trails whenever vertices are dragged. If a temporary trace is still on the screen, it will appear in a printout. If this item is checked, the vertex list is not empty.
8. Click **Graph** to open a secondary drawing window, in which the value of one measurement can be plotted versus another. (This window is disabled unless at least two measurements have been made.) You can define the window extent by clicking **View|View** (or pressing Ctrl+V). To select the axis labels (which are the same text descriptions that appear in the measurement list), click **Graph|Variables.**
9. Click **Graph|Draw** to make the graph. This dialog is similar to the Tracing dialog above -- the graph must be controlled by a parameter, or by a point that slides along a line or arc. Click Erase to remove previous graphs.
10. Click **Home Labels** to move the axis labels back to their default positions. (They can be dragged around the screen by using the left mouse button.) The cursor shows the current values of the chosen variables. The contents of this window depend critically on the parent window's measurement list, so this window will close automatically in certain situations, such as when the Measurement dialog is opened.

Other



We now look at the "other" options. There is a variety of options that do different things relating to the other commands.

1. Lists:
a. The **Point** list shows coordinates for all active vertices.
b. The **History** list shows a step-by-step construction of the current figure. It ends with the current values of the parameters #, $, @, &, %, and ?, and a list of user-defined functions.
c. The **Segment** list is useful for seeing which points are regarded as collinear by the program. Unless you explicitly tell the program that a specific point falls on a specific line, no assumptions are made.
d. The **Circle** list shows which vertices are regarded as being concyclic.
e. **Notebook:** A text window whose contents are saved with the rest of the file.

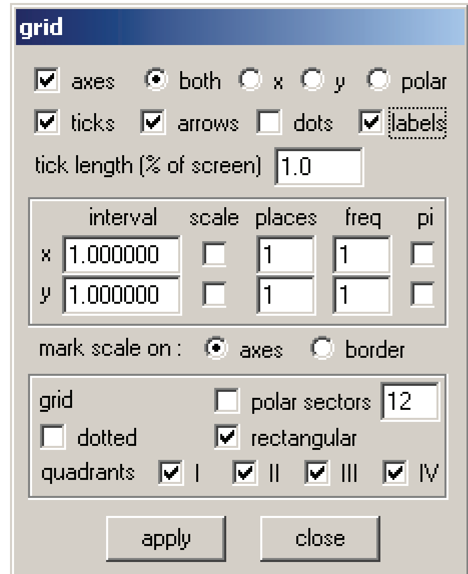
2. The 3D Solid dialog builds a prism or a pyramid using a given polygonal base. The apex of the pyramid or the upper base of the prism are defined by giving a numerical altitude and
   a. specifying a vertex to be the foot of the altitude
   b. giving a vector offset from the first vertex in the base description.

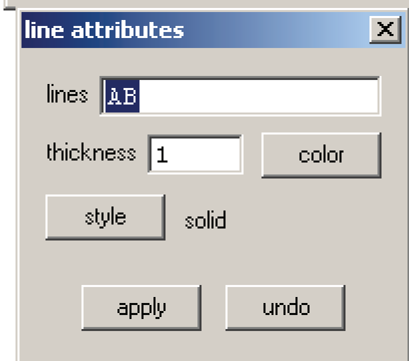
3. **Fonts:** You can change the fonts used for (1) measurements; (2) numerical scale on the coordinate axes; (3) labels on the axes; (4) tables. You want to have a TrueType font for measurements, so that it prints the way it looks on the screen. You also want to have a font that can display the special symbols that are available for measurements, as well as the usual text. The MS LineDraw font is good if it is available. The Terminal font or the default screen font will display some special characters, but they do not print properly. To make pi symbols appear on the axes, select the character value that works for the font that is used for the axis scale.
4. **Colors:** You can change colors used for (1) coordinate axes (default black); (2) background (default light gray); (3) gridlines (default medium gray); (4) bouncing-ball paths (see below). You can also replace dotted lines with colored lines.
5. **Measurements:** have home positions in the upper left corner of the window. Click this item (or press Home) to return them there. When Show units is checked, the program appends descriptions to most measurements.
6. Displayed measurements can be saved in a **Data** array. Check Collect to turn on the collector. The data array grows by one row whenever a parameter value is changed. The displayed values change color to indicate that they are being saved. You can format the array by specifying column Widths. To see the data, click Inspect. To clear the array, click Zero.

7. Open a **Macro** window: Do this to apply a saved construction to the current figure. You can open any old figure, then use its Macro menu.
8. If **Autoextend** is checked, you can slide points past the ends of segments. Non-intersecting segments will be extended if necessary to show an intersection of their lines. When Autoextend is unchecked, points that have been slid past the ends of their segments are automatically slid back.
9. Click **CCL (counter-clockwise) Angles** if you want angle sense to be taken into account when angles are measured. When this item is checked, an angle built (using **Line|Angle|New**) to copy <ABC will open in the opposite direction from an angle built to copy <CBA. If Negative Angles is checked (which automatically checks CCL Angles), the Measurement dialog will display values in the range -180 to 180 (angles that open in a counterclockwise direction are considered to be positive); otherwise, the displayed range will be either 0 .. 180 or 0 .. 360, depending on whether CCL Angles is checked.
10. **Simulprint** allows you to print several wg2 diagrams on a single sheet of paper with one print command. The figures must already have been formatted before they were put on file. Select the desired figures from the file dialog, one at a time (the program will keep prompting you for another). The printing begins when your list is complete.
11. Click **Thicken** print to increase the printed thickness of solid lines, circles, angle arcs, and perpendicular brackets Click **Replay in Slow Motion** to step through (using the spacebar) the construction of the current figure.
12. Click **Bounce** to activate (or deactivate) a bouncing-ball simulation. The initial path of the ball is defined by two vertex names you type into the first edit box, and the number of rebounds on the resulting path is read from the second box. You can set the color of the path in the Colors menu above. The size of the rolling ball is zero (so it can work its way into corners without getting stuck).

Coordinate System

Now we want to use Wingeom to create a coordinate system. Go to **point-coordinates**. You will see your window now displayed with a coordinate system. Immediately a window will pop up to label the origin, go ahead and complete that.





1. Now to set up a grid, go to **view-grid** and the window to the right will appear. Mark the needed options.
2. You can zoom in and out to change the domain and range by **view-zoom**.
3. Now lets create a line. Make two points on your grid B and C. If you want to offset the labels go to **edit-labels-offset**. You can also do this quickly by CTRL and HOME. Create a **line** using the toolbar menu from B to C.
4. Another cosmetic option is to modify the line by thickness, structure and color. This is done by selecting **edit-highlights-line attributes**
5. You can move your line by dragging the vertices.
6. If you want to view what the coordinates of your points are you can click on the **toolbar-coordinates**. Place your curser over the point and you will see it the coordinates.
7. At this point we can use the **meas** function to calculate the slope and equation of the line. Use the following commands: **[SLOPE] (B,C)** and **[EQN] (B, C).**
8. Now you can drag the vertices once more and see how the measurements change. This is the time to ask your students to perform various changes and ask questions.

a. Drag the point B to (0,2) and C to (1,3). ***What is the equation of the line?***

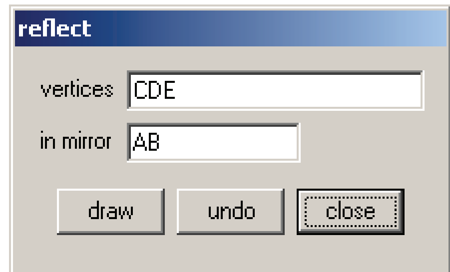
b. Drag the point B to (0, -3) and C to (1, -2). ***Is the first line parallel to this one? Why or why not? How do the equations compare?***

There are of course many other questions relating to this activity.

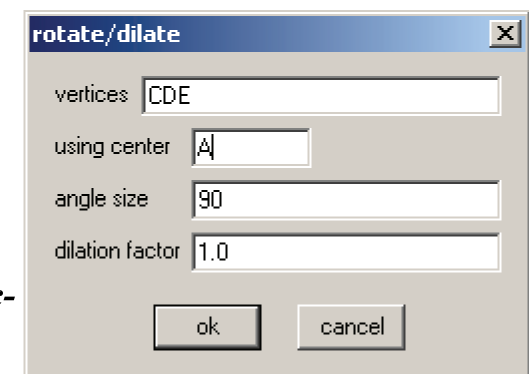
Transformations

Here we will go through some steps to construct transformations on a triangle (other objects will be similar).

1. Plot A and B on the left side of the screen and C,D, and E on the right side.
2. Make sure your toolbar is up and create a **line** between A and B. With the remaining vertices create a triangle (using **segments**).
3. Click on **transf** and **mirror**. Here you enter the vertices you want to reflect and the line. There is an example window to your right.



4. You now have a new triangle C'D'E' a reflection of CDE.
5. Make sure you mark the intersection of AB with CC' (refer to page 4)
6. Here you can experiment a little, drag some vertices to see what happens. ***What happens to the point F?***
7. Click on **meas** on the menu bar and find the measurements of CF and CF'. Now you can click on C and drag to see measurement changes. ***What is the relationship between CF and C'F. What is your prediction on the lengths of other segments (D and D' or E and E')?***
8. Now make sure your triangles are below A by dragging the vertices. Create a line perpendicular to AB through A (a review of the lines options)
9. You have a new point G created. Now click on **transf** menu and **rotate.** Here you have some options. Look to the right to see an example.



10. You now have created a new triangle $C_0D_0E_0$.
11. Now draw a segment connecting C to A and C_0 to A.
12. Click on **meas** and type in <CAC_0. Drag C to see what changes. ***What happens to CAC_0? What would your prediction be for other angles (DA and AD_0 or EA and AE_0). What is the relationship between segment CC' and AB or CC' and AG?***