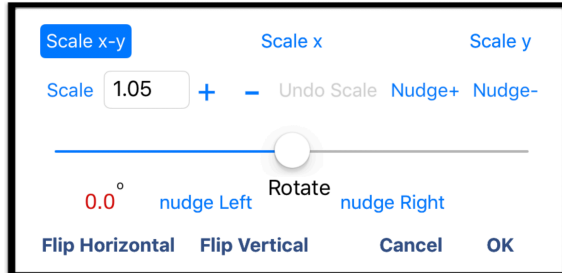


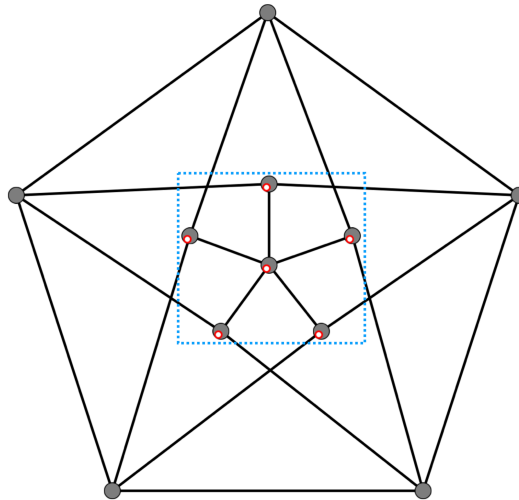
# The Transform Popover

After selecting a collection of vertices, tapping on the *Transform* button brings up the dialog box below.



## How does this work?

Graph Theorist bases all its transformations on the *Selection Rectangle*, which is the smallest rectangle that encloses all the selected vertices. This rectangle is not visible on the screen, but the transformations are actually applied to it and the selected vertices go along for the ride.



The dotted blue box bounds the selected vertices.  
All transformations are applied to this box.  
This box is invisible to the user.

## Scaling

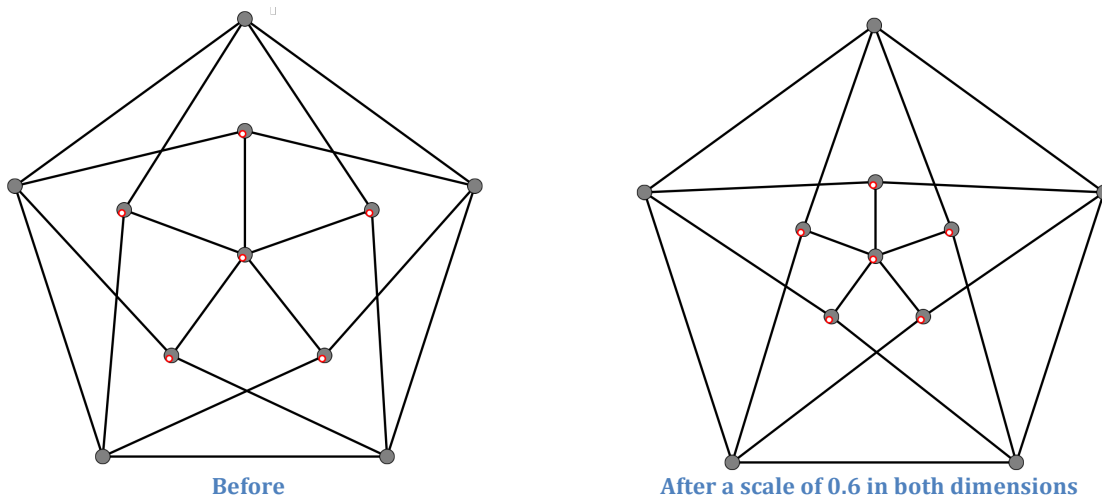
You can choose to scale the set of selected vertices in three ways:

- Both vertically and horizontally (Scale  $x-y$ ).
- Horizontally only (Scale  $x$ ).
- Vertically Only (Scale  $y$ ).

First click on the scale type on the top row, and then enter the desired scaling constant – as a convenience, you can modify the current scaling value up/down by .05 by tapping with the + or – buttons next to the scaling value.

Then after, selecting the scale value, tap the Scale button to actually perform the scaling.

In each case, the Selection Rectangle is altered in one or both dimensions in order to produce the scaling effect.



If the scale is not exactly what you want, you can modify it slightly by tapping the *nudge+* button (respectively the *nudge-* button) to slightly increase (respectively decrease) the scale.

## Rotation

You may rotate the set of selected vertices by dragging the bottom slider to the right for positive rotation and to the left for negative rotation. The rotation is measured in degrees and the number of degrees in the rotation is shown in red just below the slider and to the right. Degrees are measured in tenths of a degree.

The vertices are actually rotated about the center of the Selection Rectangle (as shown above, the rotation is actually applied to the scaling rectangle itself and the selected vertices are carried along with it).

It may be difficult to get the rotation exactly as you want it by dragging the slider. However, if you get reasonably close to the degree of rotation that you want, you can tap the *nudge right/left* buttons to obtain the accuracy you desire.

## Flipping

You can also transform the set of selected vertices by flipping them vertically or horizontally.

The vertical flip is about the horizontal line through the selection rectangle's center, and correspondingly, a horizontal flip is about the vertical line through the selection rectangle's center.

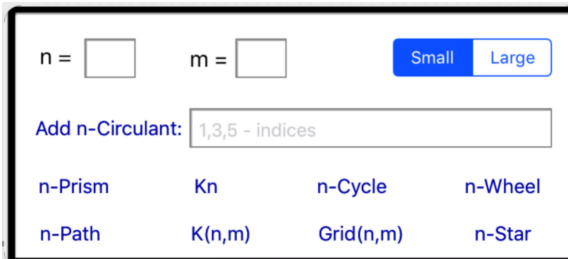
You can get a better idea of how the transforms work by just playing with them or see the demo at <http://www.graphtheorist.com>

After performing whatever transforms you like, tap *OK* to keep the effect or *Cancel* to undo all current transforms, and revert to the original graph.

*All Transforms can be undone after the Transform Window closes.*

## Extra Add-ons

Tapping the Load/Save button at the bottom of the display brings up the dialog box below:



n = <input type="text"/>	m = <input type="text"/>	<input checked="" type="button" value="Small"/>	<input type="button" value="Large"/>
Add n-Circulant: <input type="text" value="1,3,5 - indices"/>			
n-Prism	Kn	n-Cycle	n-Wheel
n-Path	K(n,m)	Grid(n,m)	n-Star

The Add-ons Box

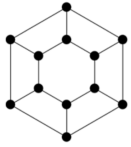
This provides you with the option to add many special graph types to the current graph. When you append any such graph, the vertices appear as selected vertices so that you may immediately modify them as you see fit, for example by applying an appropriate transform or setting vertex properties with the *Vertex Inspector*.

In addition, because it is likely that you will want to drag the new subgraph to a special location, adding an add-on also unlocks the graph canvas.

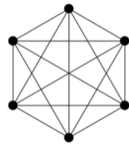
For each choice of graph, you may choose to have the graph load as a *Small* copy in the case where you plan on associating it as part of a larger graph – after dragging to where you want it, you can then scale the graph up to an appropriate size,.. You may want to choose *Large* if it is unlikely to overlap existing parts of the current graph.

The special graphs that you can load are:

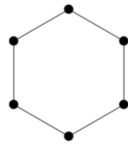
n-Prism       $K_n$       n-Cycle      n-Wheel  
n-Path       $K(n,m)$       Grid(n,m)      n-Star



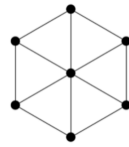
6-prism



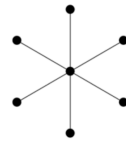
$K_6$



6-cycle



6-wheel



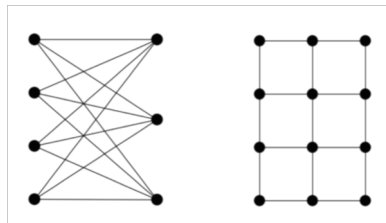
6-star



6-path

Example: For  $n = 6$

To load any of the graphs above, just enter 6 into the “ $n =$ ” text field, and tap the appropriate button.



$K(4,3)$

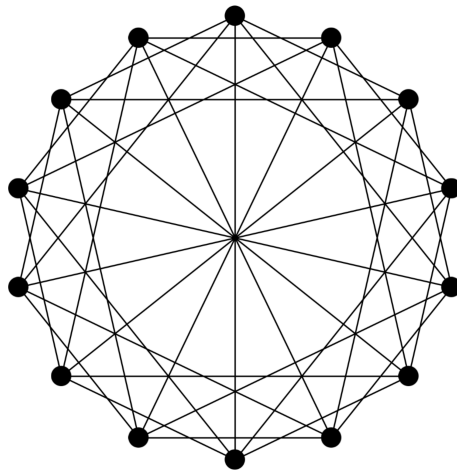
Grid(4,3)

To load either of the graphs above, just enter 4 into the “ $n =$ ” text field, enter 3 into the “ $m =$ ” text field and tap the appropriate button.

### Circulants

The last kind of graph that you can add using the save/load dialog box is a *circulant*.

### Example:



Circulant with  $n = 14$ , and indices 2, 4, 7.

To load the 14-circulant above, enter 14 into the “ $n$  = ” text box and enter “2, 4, 7” into the indices text box as shown below. Then *tap* the *Add  $n$ -Circulant* button.

How to add a 14-circulant with indices 2,4,7

## What is an $n$ -Circulant?

An  $n$ -circulant with indices  $a_1, a_2, \dots, a_k$  consists of  $n$  independent vertices  $\{v_1, v_2, \dots, v_n\}$  (i.e., no two of the vertices are adjacent) arranged around a circle and for each index  $a_j$ , add all the edges from each vertex  $v_i$  to the vertex  $v_{i+a_j}$ , where the subscripts are reduced modulo  $n$ . So in the example above, for instance, vertex #2 is adjacent to vertices #4, 6, 9; and vertex #11 is adjacent to vertices #13, 1, 4 (since  $11 + 4 = 15$  which is 1 modulo 7, and  $11 + 7 = 18$  which is 4 modulo 7).

For more information on circulants see:

<http://mathworld.wolfram.com/CirculantGraph.html>.

## The Vertex/Label Inspector

Tapping the *Vertex Inspector button* at the bottom of the display brings up the *Vertex Inspector*. All the actions in the Vertex Inspector apply only to the currently selected vertices. However, you can select and deselect vertices while the inspector is open.

The Vertex Inspector

When the *Vertex Inspector* is open you can use it to change the color, size, and type of the selected vertices as well as set or modify the labels for the vertices.

To adjust these properties, just tap on the appropriate control in the inspector's window and the effect takes place at once on all the selected vertices.

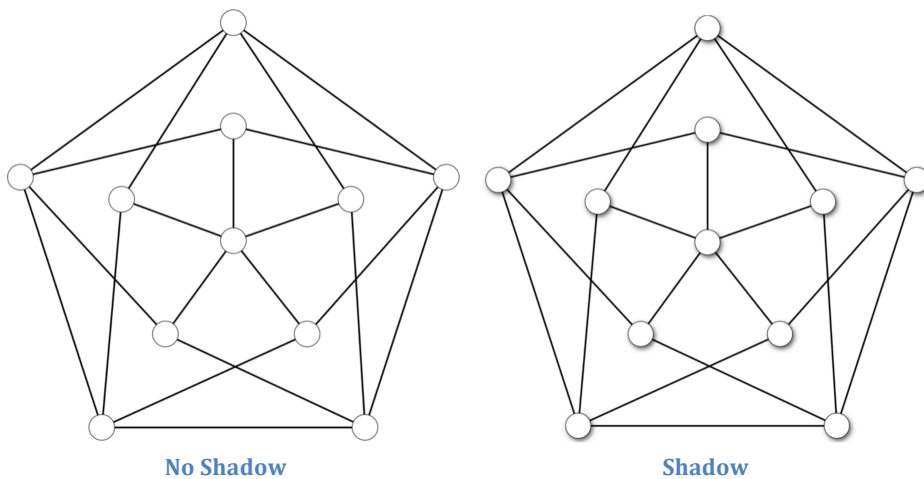
You can drag the inspector window around the display. Even so, it's possible that the window could block your view of the vertices you're editing. If this happens, then tap the *Alpha* button the view becomes transparent; tap *Alpha* again to restore the view to opaque.

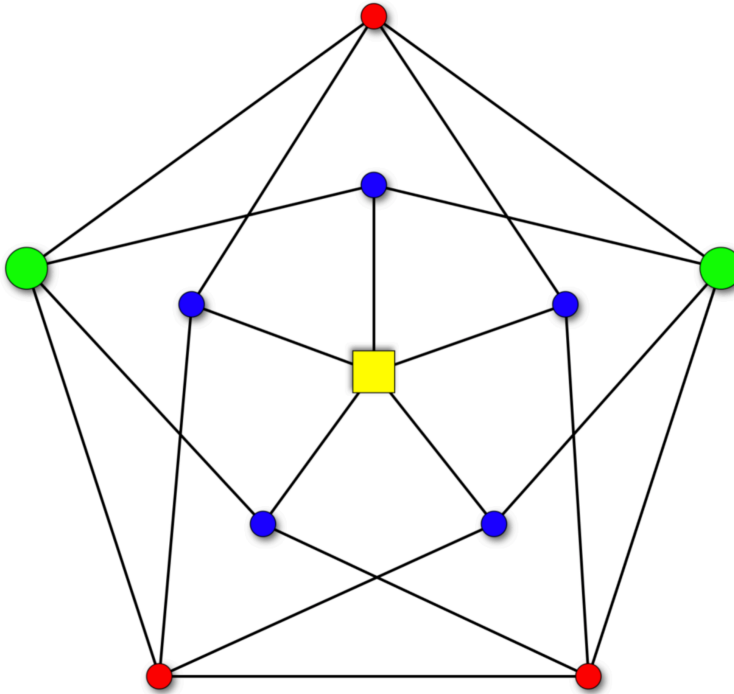
## Vertex Properties

It's worth a moment's discussion to explain some of the vertex properties. The size of a vertex is the radius of its circumscribed circle. There are four possible sizes, *small*, *normal*, *large*, and *very large*.

## Toggle Shadow

Tapping the Toggle Shadow button shows/hides a shadow effect on the selected vertices.

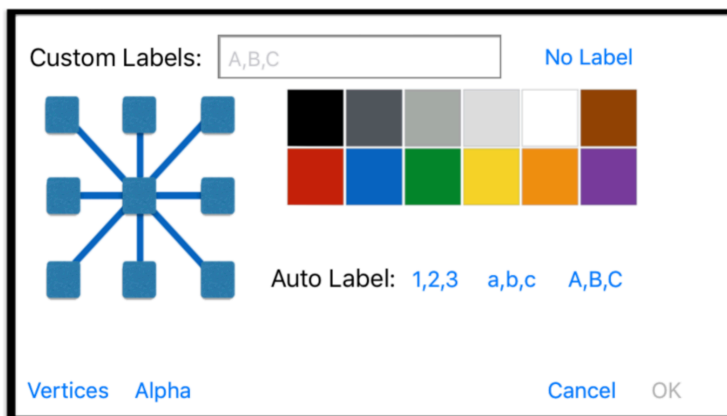




Several vertex options for the same graph

## Vertex Labels

The Vertex inspector also lets you modify, add, or edit the labels for the vertices. Tap the *Labels* button to switch to this option.




The Labels option in the Vertex Inspector

By default, vertex labels do not appear, and if you choose to make them visible then they are automatically assigned numerical values, or alphabetical values (determined by the current settings) based upon the order in which they were created.

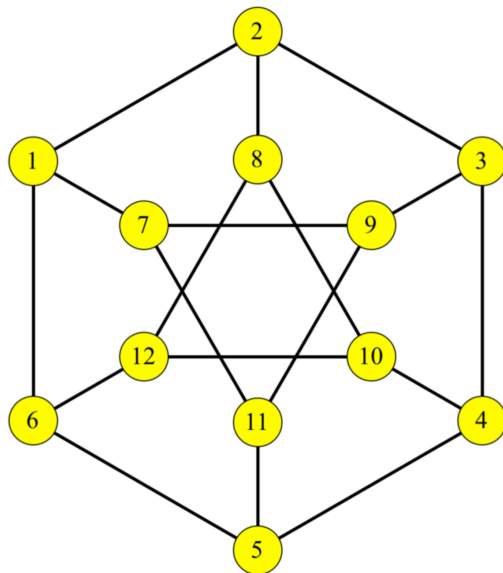
You can set the color of labels by tapping the appropriate color swatch in the inspector window.

## Positioning Labels

The label view of the Inspector Window has a special tool for positioning labels.

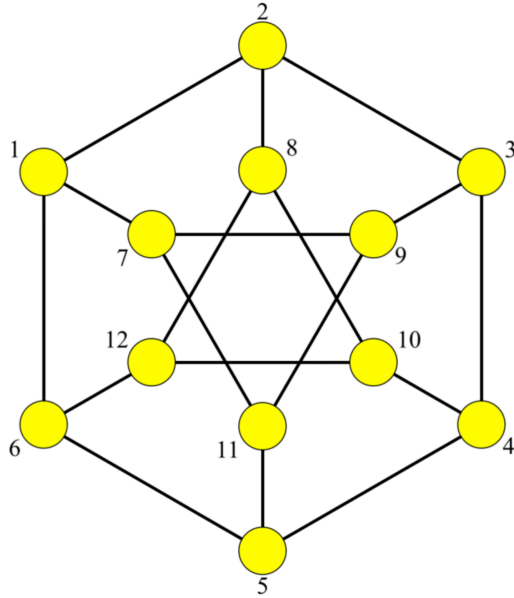
	<p>This tool gives you a great deal of flexibility in setting the position of the labels relative to the corresponding vertex.</p> <p>Tap the center square to set the label as center, the top right square to set the label just above and to the right of the vertex, etc.</p>
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To see how this works, choose any graph from the custom database (i.e., by tapping the Graph button at the top left of the display), tap the *Select All* button so that you can modify all the vertices at once, then in the labels display tap the center button.



A graph with the default labels in the center

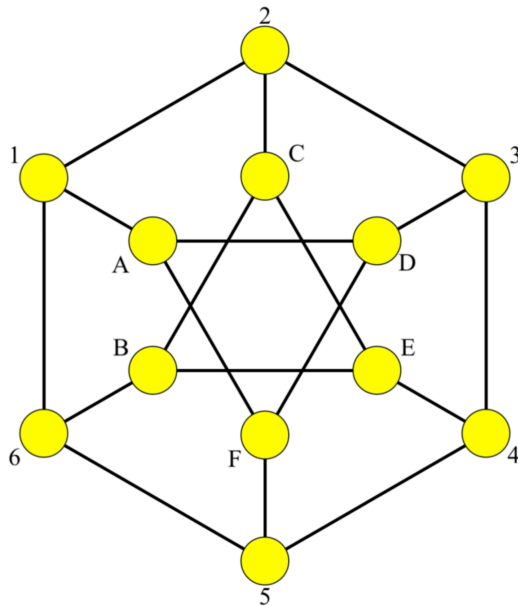




The same graph above, with the labels in red and outside the vertices

### Custom Labels

You can easily assign custom labels to your vertices. First select the vertices you want to modify – and the order of selection matters! Suppose, for example, that you want to label the inside six vertices of the graph below as *A, B, C, D, E, F*. Then select the vertex for label *A*, first, then the vertex for label *B*, etc. Then choose the *Vertex Inspector* and enter the labels separated by commas and press enter.



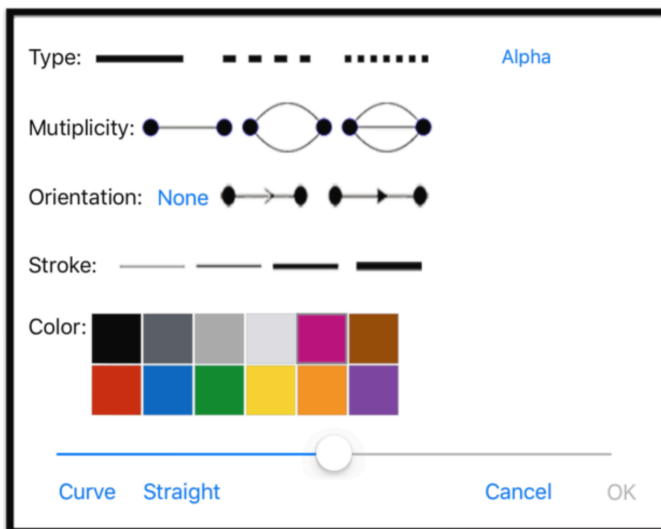
The same graph above with custom labels for the central six vertices

# The Edge Inspector

You can modify the edges of a graph as well as the vertices. To select an edge, simply select the two vertices that it joins. If you select a collection of vertices, then any actions in the *Edge Inspector* will apply to *all the edges that join any two of them*.

## The Basics

Bring up the *Edge Inspector* by tapping on the *Edge Inspector* button at the bottom of the display.



The Edge Inspector Window

From the *Edge Inspector*, you can change an edge's:

- Color (any of 12 colors) – Just tap on any color in the color array and the currently selected edges will be colored appropriately.
- Stroke (i.e., thickness). There are four levels of thickness.
- Type (either solid, dashed, or dotted).
- Orientation (either none, open arrow, or closed arrow).  
Currently, the arrows may only appear at the ends of edges.  
Note that the orientation of an edge is based upon how it was drawn.  
If the edge was drawn from *A* to *B* then the edge will be oriented from *A* to *B*.
- Multiplicity (single, dual-edge, or tri-edge).

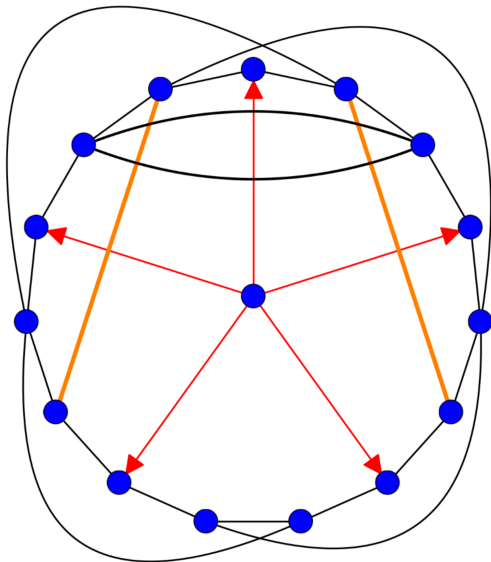
## Curved Edges

You can also choose to make the edge curved and adjust the curvature. To curve an edge (or group of edges), tap the *Curve* button, and adjust the slider as you see fit.

**Note:** There is a special case for when you just want to alter the appearance of all the edges that are incident with a particular vertex.

If you select just one vertex then the *Edge Inspector's* actions will apply to all edges incident with that vertex.

### Example:



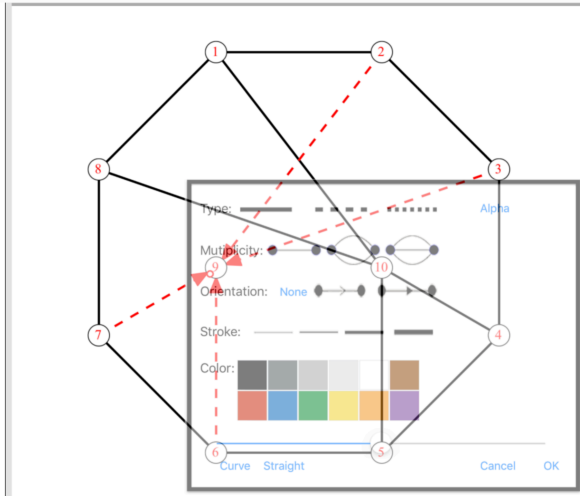
A little gaudy, but this graph illustrates some of the edge formatting options

**Note:** When you drag a vertex, or collection of vertices, all the edge properties such as curvature and orientation adjust appropriately.

## The Transparent Property of the Edge Inspector

Sometimes the edge inspector will cover up the edges that you want to modify. Graph Theorist has you covered – by uncovering the inspector.

Just tap on the *alpha* button in the *Edge Inspector* window and the view will become partially transparent, allowing you to see the effects of you actions.



Tapping *Alpha* makes the Inspector partially transparent.

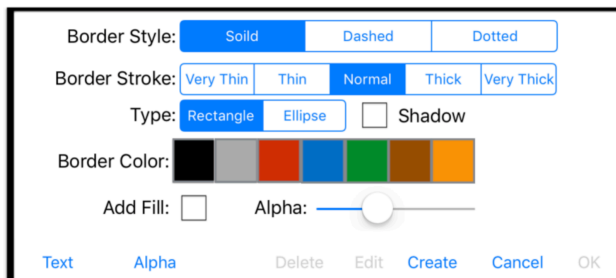
## Known Issues

- Currently, edge properties are limited in just a few ways. Edges cannot have labels (but adornments can be used as edge labels).
- Multiple edges cannot have an orientation.
- Loops are not allowed.

## Adornments

Many graph depictions have external items such as rectangles, ellipses, and special labels. Graph Theorist provides access to many such options, and more will come in future versions. These options are called *Adornments*.

To add an adornment to a graph, choose the *Adornments...* item from the *Options* drop-down menu. This will result in the following window.



## Geometric Adornments

To create a shape (i.e., rectangle or ellipse) adornment, tap on the *create* button. You may then (or even before tapping *create*, if you prefer) choose the type (rectangle or ellipse), the border color, the thickness of the border, and the style.

After tapping create, the create button changes to *Done* as shown below.



An Ellipse with a blue fill and shadow

An adornment is initially placed in the upper left of the canvas.

**Note:** The adornment will not be actually created until you press *Done*.

## Adjusting Adornment Properties

After Graph Theorist creates the figure for you, you can still modify its properties and most importantly you can stretch or compress it as you see fit. Just use the red handles to scale the figure as you like.

You probably don't want the figure to remain in its original position. You can tap anywhere inside the figure and drag it to wherever you like.

But be warned that the figure will not be finalized until you tap the *Done* button. Note that the OK button is dimmed until you tap *Done*.

You can create more adornments in any single session. But remember that **you must tap *Done* each time before the adornment will be permanently added to the canvas.**

**Important:** The figure will not be finalized **until you tap the *Done* button.**  
Note that the OK button is dimmed until you tap *Done*.

## Text Adornments

Tap the *Text* button at the bottom left of the Adornments window and the following view will greet you. Note that the *Text* button changes to *Geometry* so that you may return to the geometric adornment view.



In this case, tap inside the *Text* box and type whatever label you'd like to create. Choose a size, a color, and choose if you'd like the text italic, bold, both, or neither. Then tap create and drag the label to wherever you'd like to place it.

Just as before, **you must tap *Done*** before the adornment is officially created.

You may create as many adornments of either type as you like in one session.

## Editing Adornments

Adornments are not set in stone. Tapping on the *Edit* button allows you to edit the currently existing adornments.

Once you tap on the Edit button, you can tap on any existing adornment, and both move it about, scale it, or modify its attributes.

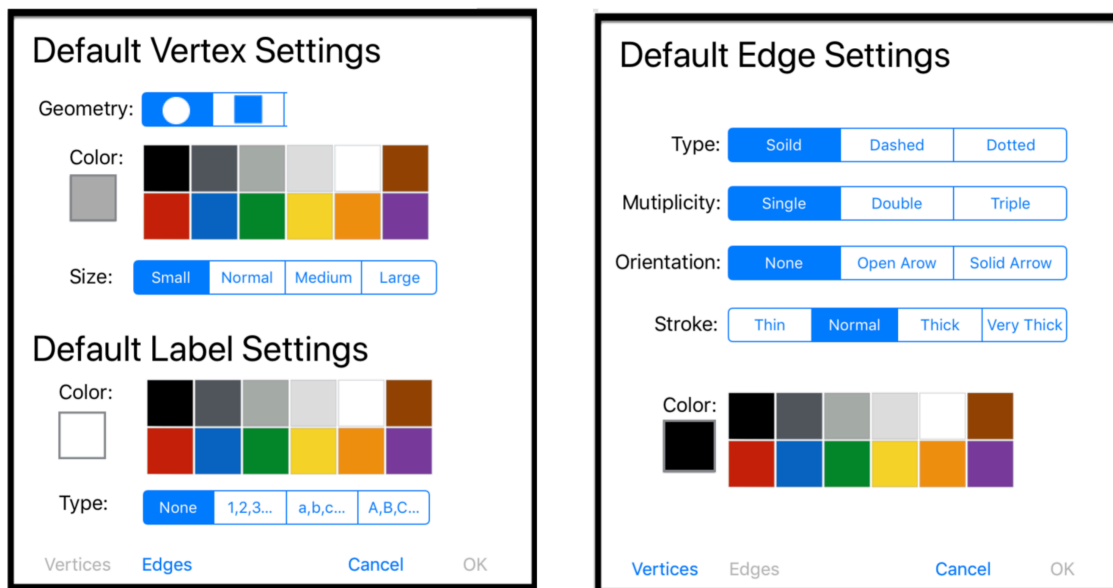
Once you tap Edit, you can edit as much as you like, but you cannot create any new adornments without tapping *OK* (or *Cancel*), and then reopening the *Adornment Inspector*.

While in edit mode, tapping on an adornment, sets the *Adornment Inspector's* properties to reflect those of the selected adornment.

Note that if you are currently editing in the Geometry view of the Adornment Inspector, then tapping on a Text adornment will open the Text view with all the adornment's properties selected.

# Default Settings

Tapping on the gear icon on the upper left of the screen, brings up the *Default Settings Inspector*.



These settings determine the default properties for new vertices and edges. Thus, if you select red, and normal size for vertices, then all vertices created after that will default to normal size, red vertices.

Also graphs loaded from the classical database and variants from the classical database load with properties determined by the global settings.

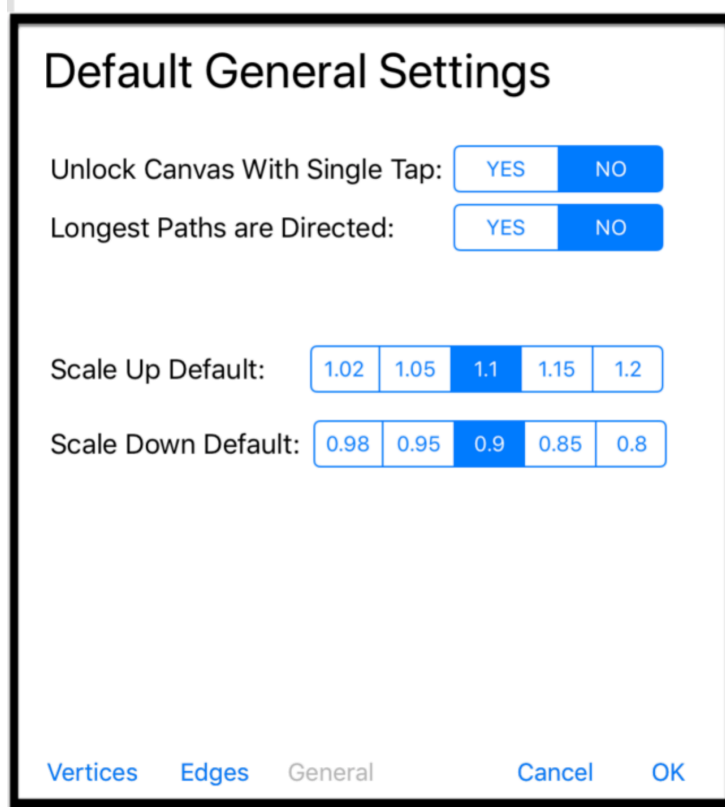
However, graphs loaded from the Custom database (and all user-created variants) load with the properties set at the time they were created.

Note that there is no default setting for the position of a label – this automatically defaults to the center since there is no way to know what other position of a label would be appropriate.

For this reason, when choosing “Set Graph to Defaults” from the option menu, all label properties are set to the default values unless a label has a non-central value set. In this case, the position of a label is left unchanged.

## General Default Settings

There are other optional settings available as well. These add convenience and customization to Graph Theorist.



The General Settings Option

You can choose the scale up and scale down default settings. The default scaling up value is 1.1, and the default scaling down value so 0.9

You may choose to determine if searches for longest paths (and induced paths) are directed or undirected. Paths are undirected by default.

Also you may choose to have single taps on the canvas unlock the canvas. This can be a great convenience in many circumstances so that you don't have to tap the lock button when you're doing something in the middle of the canvas. This option is off by default.

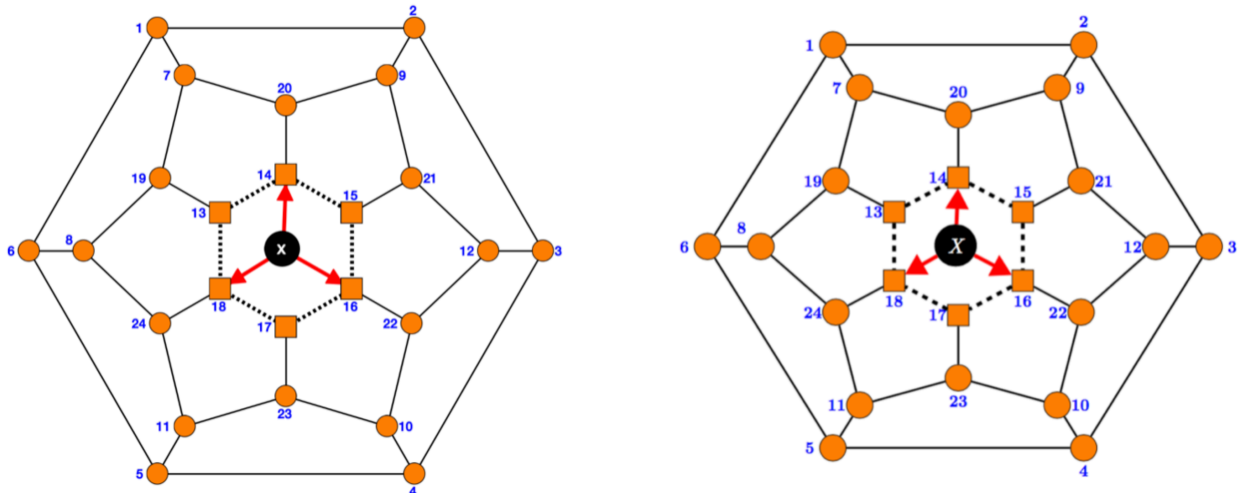
## TikZ Output and LaTeX

Perhaps you'd like to include an image of your graph in a LaTeX document. One of the most popular ways of doing this is with a TikZ file.

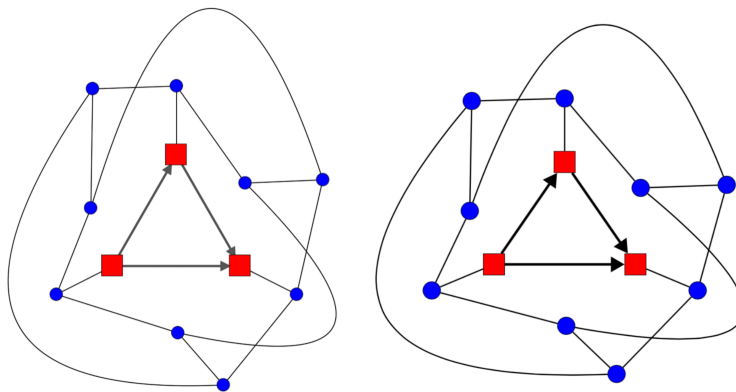
Graph Theorist is cable of producing a TikZ file that very closely replicates any graph you've drawn. As of this version of Graph Theorist, the only drawing features that do not have a counter-part in the resulting TikZ file are the shadow effects on vertices and adornments.



## Examples:



A graph and its equivalent in LaTeX (from TeXShop on a Macintosh)



A graph and its equivalent in LaTeX (from TeXShop on a Macintosh)

You can access this TikZ file from your desktop computer so that you can use it with your TeX editing software. There are also numerous TeX programs for the iPad, and you may load saved files directly in them as well.

Although Graph Theorist does a fine job of mimicking the appearance of the graph in TikZ code, you can tweak the TikZ code to suit your purposes.

## Copy TikZ Code

Rather than save the TikZ code to an external file, you may alternatively choose to copy the TikZ Picture file and then paste it into a Tex program on the iPad.

Just choose the *Copy TikZ Code* option from the *Options* menu.

**Note:** Other optional output will be coming in a future version.

You can of course modify the TikZ code as you see fit, perhaps adding features that are not currently in Graph Theorist.

## Creating a New Graph

To create a new graph, just choose *New Graph* from the *Options* menu. If the current graph has unsaved changes, you will be asked if you want to save the current graph before continuing.

Be careful, because deleting the current graph cannot be undone.

If you choose to continue, the current graph will be deleted, and the canvas and the variant list will be cleared.

If all you want to do is clear the canvas, but keep the current set of variants, then tap the *Clear Canvas* button at the top left of the screen. This is a much less volatile action. The canvas clears, but all the variants remain. Also this action *can be undone*.

**Warning:** If you just want to clear the current canvas, but keep the current variants and such, use the *Clear Canvas* button at the top left of the screen.

*New Graph* is destructive and also removes all variants and cannot be undone. *Clear Canvas* keeps the current variants and it can be undone.

## Saving/Loading Graphs

When you want to create a new graph, you may well want to keep the current graph available for future use. You can save the current graph and all its variants by choosing *Save to Local Database* from the *Options* menu.

You will then be asked to name the graph and the graph's thumbnail will appear in the Local Database table.

**Tip:** *Graph Theorist* creates a thumbnail based on the current image in the canvas. To make sure that the thumbnail is sufficiently large, you may want to resize the graph to fit the canvas before saving.

## Saving/Loading Datasets

You may want to save the current set of Custom Graphs and start from scratch. You can choose to save the entire set of current graphs as a *Dataset* as an external file. Just choose the option *Backup Custom Database* from the *Options* menu.

Later you can replace the current database with a previously saved one.

## Support and Email

To use email simply tap the *Support* button from the top, and enter the email address for the recipient.

The default email address is to Graph Theorist's support – please use it whenever you have a question, issue, or comment – we want to hear from you, and *we respond promptly!*

## Graph Images

### Sharing Graph Images

Choose *Share Graph Image* from the *Options* menu and follow the resulting window messages to share the image of the current graph via Messages, Email, Facebook, or Twitter.

This option also allows you to save the image of the current graph to Photos.

### Copy Graph Image

Choosing *Copy Graph Image* from the *Options* menu will place the current graph's image into the clipboard. Then you can paste this image into another application or an email.

## More...

You can learn much more (and quickly too!) about how to use Graph Theorist's options by looking at the demos <http://www.graphtheorist.com>