

GeoGebra - Lesson 11

Title: Polygons, Translations and Checkboxes

based on Glossary Plus Interactivity:






<http://mathcasts.org/mtwiki/GlossaryT/Translation>

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<http://math247.pbwiki.com/GeoGebra>

Key Concepts from GeoGebra

- Already discussed: , , 
- Point capturing and grid
- Polygons 
- Checkboxes  and boolean values

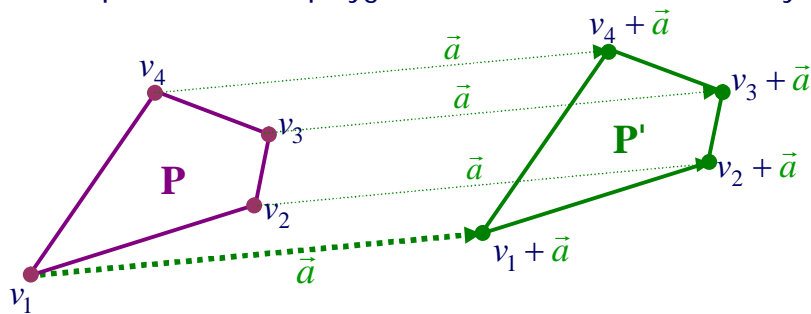
Key Concepts from Mathematics for Polygons and Translation

- Let \vec{a} be a vector and let P be a polygon with vertices $\{v_1, v_2, \dots, v_n\}$.

The *translation of P by \vec{a}* is the polygon P' with vertices $\{v_1 + \vec{a}, v_2 + \vec{a}, \dots, v_n + \vec{a}\}$.

Translation of geometric figures are congruent (same perimeter, area, etc.).

Example 1: In the picture below, polygon P' is the translation of P by



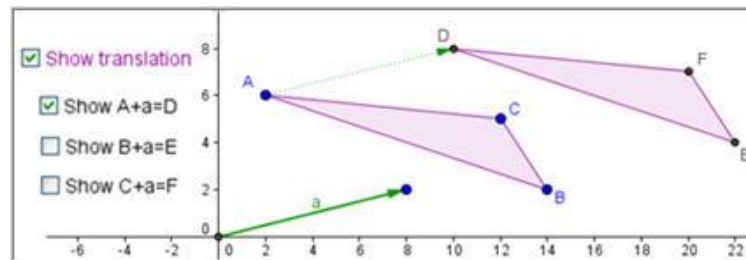
Example 2: (see picture below) Let \vec{a} be the vector \overrightarrow{OT} where $T=(8,2)$ and the polygon is the triangle: $\triangle ABC$ where $A=(2,6)$, $B=(14,2)$ and $C=(12,5)$. Then triangle $\triangle DEF$ is the translation of $\triangle ABC$ by \overrightarrow{OT} where

$$D = A + \overrightarrow{OT} = (2+8, 6+2) = (10,8)$$

$$E = B + \overrightarrow{OT} = (14+8, 2+2) = (22,4)$$

$$F = C + \overrightarrow{OT} = (12+8, 5+2) = (20,7)$$

Goal: To make the following GeoGebra interactivity

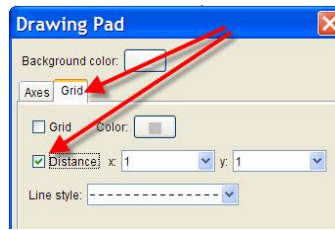
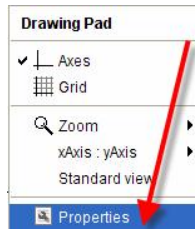


where

- the vertices A, B and C of the triangle and the endpoint of \vec{a} are “free points”,
- triangle DEF is the translation of triangle ABC by \vec{a} and
- the checkboxes allow showing and hiding of the translation and translation vectors.


Script-o-matic

- Setup GeoGebra.
 - Open GeoGebra.
 - Open the Algebra Window
 - Click View -> Algebra Window.
 - The Algebra window will appear at left.
- Make point capturing to 1x1 grid
 - Point Capturing to Grid
 - Click Options -> Point Capturing -> on (Grid)
 - Check grid is 1x1 – usually not necessary!
 - Right-click in blank part of drawing space.
 - Select Properties from drop-down menu (see below left)
 - Click on second tab “grid” (see below right)
(By default the grid should be 1x1. Select distance to change.)




iv. Click on close.

3. Make the polygon $\triangle ABC$.

- Select  and then click in the drawing space – point A will be drawn.
- Click down and to the right to get point B (you will see the segment AB)
- Click up and to the left to get point C (you will see the polygon forming...)
- Click on A again to finish the polygon - triangle.
- Notice that 7 objects are created –




3 free points A, B and C, 1 polygon poly1 and 3 line segments a, b and c.

BTW: If you get stuck in the polygon, hit Esc. Then – if necessary click on  to undo one or more times. I am always getting stuck - see mathcast 😊

- Right-click on label a. (If visible, it is always better to click on label rather than on object itself. Then the object will not accidentally be moved.)
 - Deselect “show label”.
- Repeat for line segments b and c.

BTW^2: Depending on whether you like to turn on or off, you can change the labeling options via command: Options -> Labeling ->

4. Make the vector $\vec{a} = \overline{OT}$


- Make point O(0,0)
 - Select  and then click on the intersection of the axis.
 - Point D will be drawn. (Notice that it is NOT a free point.)
 - Right-click on label D, select rename and type in O (capital letter o) .
- Make point T (the endpoint of the translation vector)
 - Select  and then click somewhere in the drawing pad.
 - Point D will be drawn (this is a free point).
 - Right-click on label T, select rename and type in T.
- Make the vector $\vec{a} = \overline{OT}$
 - Select  (vector between 2 points).
 - Click on O and then on T. The vector u will be drawn.

- iii. Right-click on label u, select rename and type in a.
(Notice that above line segment a from B to C has now been renamed a_1 .)


5. Decorations 1:

- a. Make points A, B, C and T bigger (easier to move).
 - i. Right-click on label A.
 - ii. Select "Properties" from drop-down menu. The properties dialog box will open and point A will be selected at left.
 - iii. Click on the Style tab (basic, color, style, ...)
 - Move the slider to 4.
 - iv. In the left part of dialog box, click on point B.
 - Move the slider to 4.
 - v. Repeat for points C and T.
 - vi. While still on point T, click on Basic tab.
 - Deselect "Show Label".
 - vii. In the left part of dialog box, click on point O.
 - Deselect "Show Label".
 - viii. In the left part of dialog box, click on vector a.
 - ix. Click on the Color tab
 - Click on green square - a good visible green is (0, 153, 0) - 5th from left, 3rd from bottom.
 - x. Click on the Style tab
 - Move the slider to 4 (makes the vector line thicker).
 - xi. Click on Close (to close properties dialog window).

6. Define the vertices D, E, F of the translation of $\triangle ABC$.




- a. The easiest way is just to type in the input!
 - i. Click in the input field at the bottom of your GeoGebra screen. If you don't see the input field use command: View -> Input field.
 - ii. Type (case sensitive!) $D=A+T$ and hit enter.
 - iii. Repeat with $E=B+T$ (enter) and $F=C+T$ (enter)
 - iv. The 3 points D, E and F should be drawn as translations of A, B and C by the vector a. Check them out! That is, select  and move any of A, B, C and T. The points D, E and F should move coorespondingly.

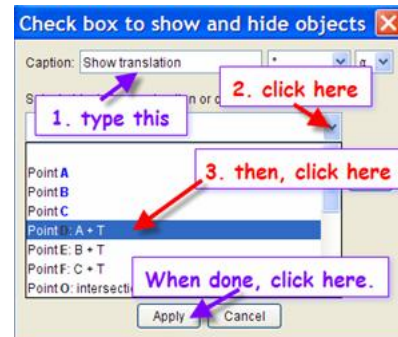
7. Make the polygon $\triangle DEF$

- a. Select  and then click (once each) on D, E, F and D. (The polygon $\triangle DEF$ will be drawn as well as the 3 line segments d, e and f.)
- b. Right-click on d and deselect "show label". Repeat for lines e and f.
- c. If you want, change the color of the triangles.
 - i. Right-click in center of a triangle and choose "properties" from menu.

- ii. Click on the **Color** tab and pick a color square. Notice that the border line segments also change color. (So if you want the lines to be a different color from the polygon, first do the polygon, then do them!)
- iii. In the left window, click on the other polygon. Now, if you want the same color, choose it from the small set of "recent" colors at right.
- iv. Click on Close.

8. Make the checkbox: **Show translation.** (boolean value S)

- a. Under  (2nd from left) find the new GGB3 checkbox icon: .
- b. Select  and click in the drawing space where you want the checkbox.
- c. Type in the caption: **Show translation.** (1)
- d. Then either:



- i. Click on arrow at right of "Select ..." (2) and then click on object name (3) and repeat until done or
- ii. Click on the objects themselves in the drawing pad (you can move the dialog box out of the way by clicking and dragging on the blue title bar "Check box to show ...").

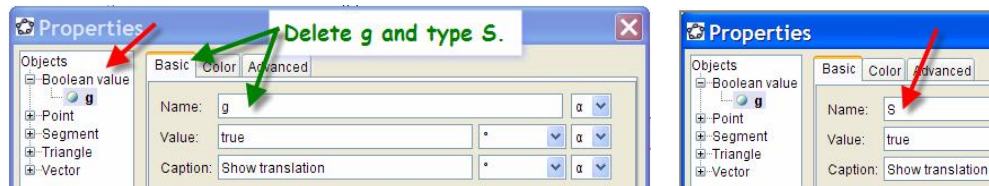
- e. Finally, click on "Apply".

If you forget an object - see below 11. Adding objects to a checkbox.

- f. Try it out - select and deselect the checkbox to see if the translation appears and disappears.


The actual object we have created is a boolean value with 2 values "true" (selected) or "false" (not selected). So we can understand this a bit better, we are going to rename this object.

- g. Right-click on the checkbox and choose "properties". On the left side of the properties dialog box, it says **Boolean value** and the object name is "g".
 - i. On the right, select the **Basic** tab. In name field, delete g and type S.




- ii. While we are here, click on the **Color** tab and change the color to match that of the **polygons**.
- iii. Click on Close.

9. Make the translation vectors u , v and w .

- a. Select  (vector between 2 points).
 - i. Click on A and then on D (makes vector u)
 - ii. Click on B and then on E (makes vector v)
 - iii. Click on C and then on F (makes vector w)
 - iv. Decorations 2: Click on label u and select "properties"
For each of u , v and w :
 - In the "basic" tab, deselect "show label".
 - In the "color" tab, select green (from recent).
 - In the "style" tab, click on arrow to the right of Line style and select dotted line (see right)
 - v. Click on Close.

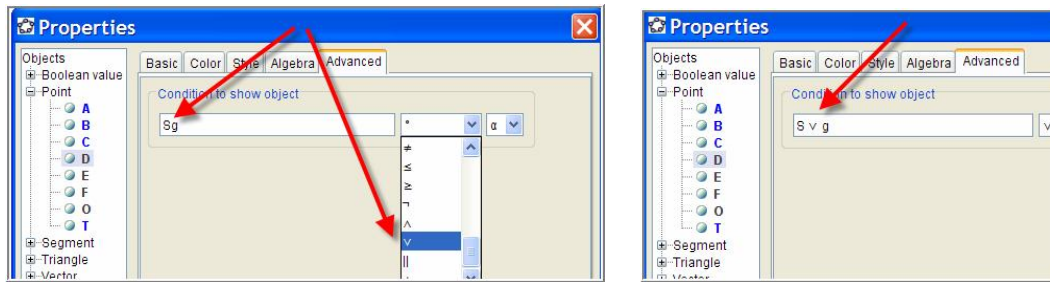


10. Make the translation checkboxes (boolean values g , h and i)


- a. Select  and click in the drawing space where you want the checkbox g .
- b. Type in the caption: $Show D=A+a$.
- c. Then, click on vector u and point D and finally click on Apply.
- d. Repeat a, b and c above for checkboxes h and i with captions: $Show E=B+a$ and $Show F=C+a$.

11. Adding objects to a checkbox

- a. You may notice that after doing 10, the points D, E and F do not appear when the first checkbox "Show translation" is selected. This is because they have now been "moved to" the translation checkboxes.
However, we can make them appear for both checkboxes.
- b. Right-click on point D and select "properties".
 - i. CHECK that ONLY point D is selected in the properties box!
GeoGebra may get stuck on boolean values.
 - ii. Select the Advanced tab. You should see " g ". This means that the point D will be shown if g is true, that is if " $Show D=A+a$ " is selected.
 - iii. We also want D to show if S is true, that is if " $Show translation$ " is selected. This means we want D to show if either S or g is true.
In boolean, we write this: $S \vee g$.
Think "union" – that is, an element is a member of the union if it is either in the first set or in the second set. This makes sense for the other boolean: $S \wedge g$ which means both S and g must be true or "intersection".
 - iv. Type in S and select the symbol \vee from the \circ list at right (see below).
- c. Select E at left and repeat from ii. Do the same for F.
- d. Click on Close.



12. Fix the checkboxes.

- It is really a pain if every time you try to select or deselect a checkbox it moves. So we are going to fix them in place. This is also nice if you want to move the drawing pad to get different translations.
- First, use  and put all four checkboxes where you want them to be.
- Right-click on **Show translation** and select "properties".
- Click on the **Basic** tab and select "Fix checkbox".
- Click on (the boolean value) g and again select "Fix checkbox". Do the same for h and i .
- While we are here, you can also click on the **Color** tab and change the color of g , h and i to **green** to match the **translation vector** a .
- Click on Close.

Save your file.

Here is our result with all checkboxes selected:

