ON COLORING DIFFERENT OBJECTS OF THE SAME CLASS

Juan Carlos Ponce Campuzano

School of Mathematics and Physics, The University of Queensland, Australia

Abstract

Every object created in GeoGebra has a color property that the user can easily change. Color can help identify different objects of the same class. However, if we create lists of objects of the same class (e.g., a list of circles) and try to change the color of this list, then we notice that all the objects change color. So how can we create a set of objects of the same class, such that each element has a different color? In this article, the author will show an efficient method to color different objects of the same class.

Keywords: lists, objects, colors, GeoGebra scripting, mathematical art

1 Coloring Lists of Objects

Create list of objects in GeoGebra by using the `sequence` command. See (North American GeoGebra Journal Staff, 2021; GeoGebra, 2021c) for detailed tutorials on *list and sequence* commands.

```
Sequence(<Expression>, <Variable k>, <Start Value a>, <End Value b>)
```

For example, let's create a list of circles with different radii and centers are located in the region $[0,4] \times [0,4]$. Thus, we can write in the input box the following script (see GeoGebra (2021b)):

```
L_1=Sequence(Circle((4 random(),4random()), RandomUniform(0.2,1)),i,1,10)
```

where `Circle` is the circle command and `random` is a psuedo-random number generator command.

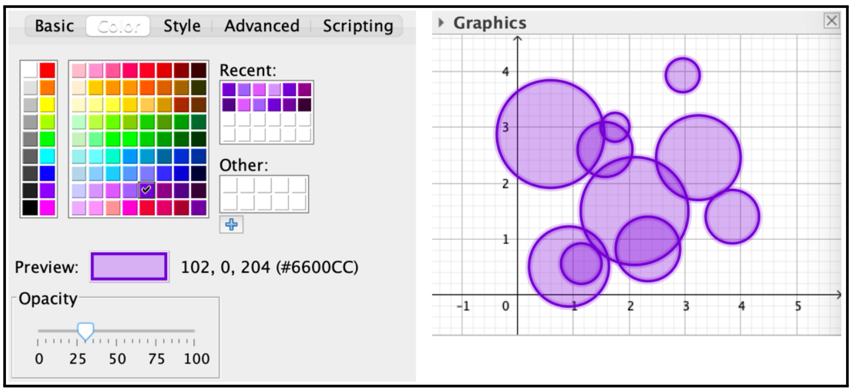


Figure 1. Select from Preferences window (left) to change the properties of the circles in the Graphics window (right).

If we change the color of the list L_1, then all the objects in that list will have the same color, as shown in Figure 1. Notice that we also can change the opacity.

If we want to use a different color for each object in the list, we can use the command

```
Element(<List>,<Position of nth Element>)
```

to select objects and change their color one at a time, however this is laborious. Instead, we can use scripting to create different objects of the same class and then apply dynamic colors.

2 Using Different colors for the same class of objects

In order to apply different colors to each object of the same class, we can use the `execute` command (GeoGebra, 2021a), to perform a list of commands entered as texts. First, we create a class of objects with specific labels. That is:

```
Execute(Sequence("C"+i+"=Circle((4random(),4random()),RandomUniform(0.2, 1))",i
    ,1,10))
```

The script above plots the same number of circles with different radius in the same region as before with a specific name to identify them (see Figure 2). Depending on the number of circles, it is possible to place these circles on individual layers (Edwards and Quinlan, 2021).

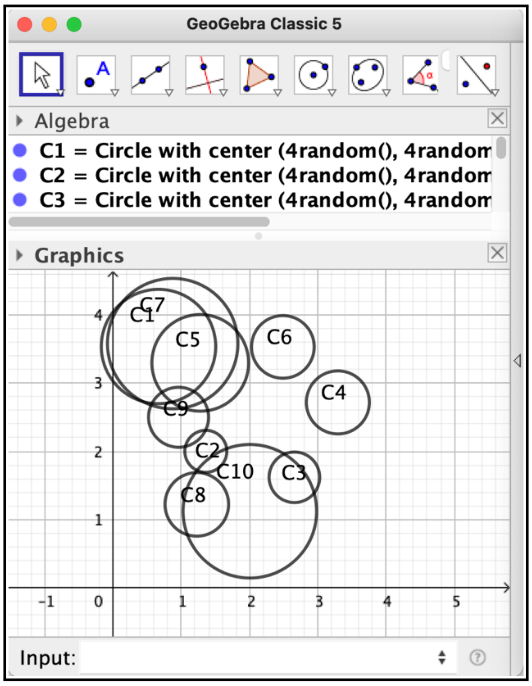


Figure 2. Circles labeled with specific names.

Now, we can use the `SetDynamicColor` command (GeoGebra, 2021d), in particular,

```
SetDynamicColor(<Object>, <Red>, <Green>, <Blue>, <Opacity>)
```

to apply different colors to each object (circles, in this case) using the RGB color scheme and change its opacity. In GeoGebra, RGB and opacity values are between 0 and 1. Thus we can write:

```
Execute(Sequence("SetDynamicColor(C"+i+",random(),random(), random(),0.5)",i
    ,1,10))
```

The previous script assigns random colors to each one of the circle objects, C, defined previously, and the value 0.5 to the opacity, see Figure 3.

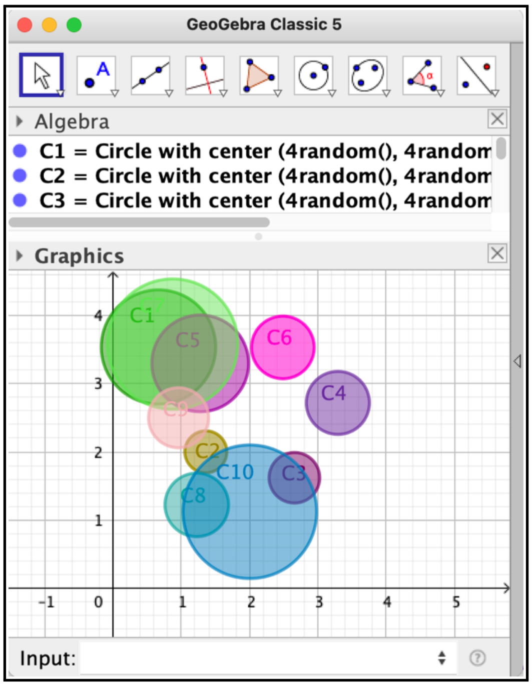


Figure 3. Random color for the same class of objects.

If we occult the labels and change the background, we can obtain a beautiful abstract geometric composition as shown in Figure 4a.

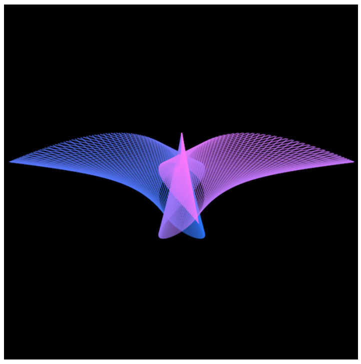
3 Final Comments

The method described in the previous section can be used to design colorful, dynamic/static mathematical art in GeoGebra since it works to create any geometric objects, in 2D or 3D, and we can easily change the colors of these objects using different patterns or methods. For example, in Figure 4b, we can appreciate a set of line segments with a colored gradient tracing a bird shape.

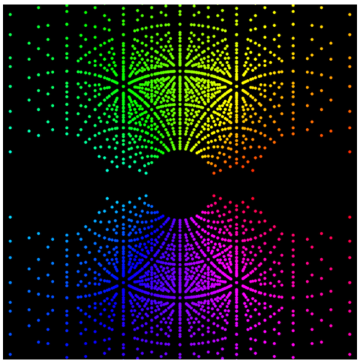
In GeoGebra it is also possible to use the HSL (Hue, Saturation, Lightness) and HSV (Hue, Saturation, Value) color schemes. In this case, it turns out to be a powerful tool to represent complex numbers by its phase (or argument). For example, Figure 4c shows the complex roots of $ax^2 + bx + c$ using the HSV scheme. The method to color classes of objects can be adapted to create 3D objects. For example, Figure 4d shows a Voronoi diagram on the sphere using the HSV color scheme.

I hope the reader finds this method of coloring objects useful to create applets in GeoGebra and colorful mathematical art. The script described in the previous section can be easily modified to create a version using other geometric objects and include other types of affine transformations such as dilations, translations, or rotations. Furthermore, figures can be exported directly from GeoGebra for use in student worksheets (see (Quinlan, 2013)). More examples of colorful, dynamic/static mathematical art in GeoGebra can be found in Ponce Campuzano (2017).

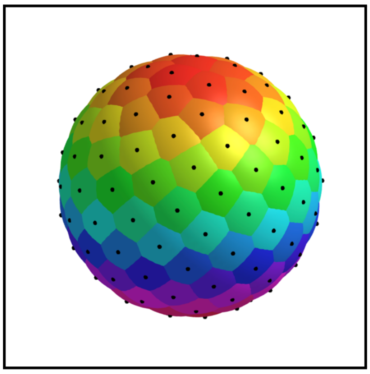
(a) Colorful random circles.



(b) Yeganeh: A bird in flight.



(c) Complex roots of $ax^2 + bx + c$.



(d) Rainbow Voronoi on sphere.

Figure 4. Mathematical art.

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Juan Carlos Ponce Campuzano, (jcponcemath@gmail.com), teaches mathematics and works on the design and integration of online learning modules and interactive mathematical applets for the School of Mathematics and Physics at the University of Queensland. Juan's professional interests include the design and construction of open source mathematics applets and online interactive books. Learn more about his projects at the following link: `https://www.jcponce.com/p/projects.html`.