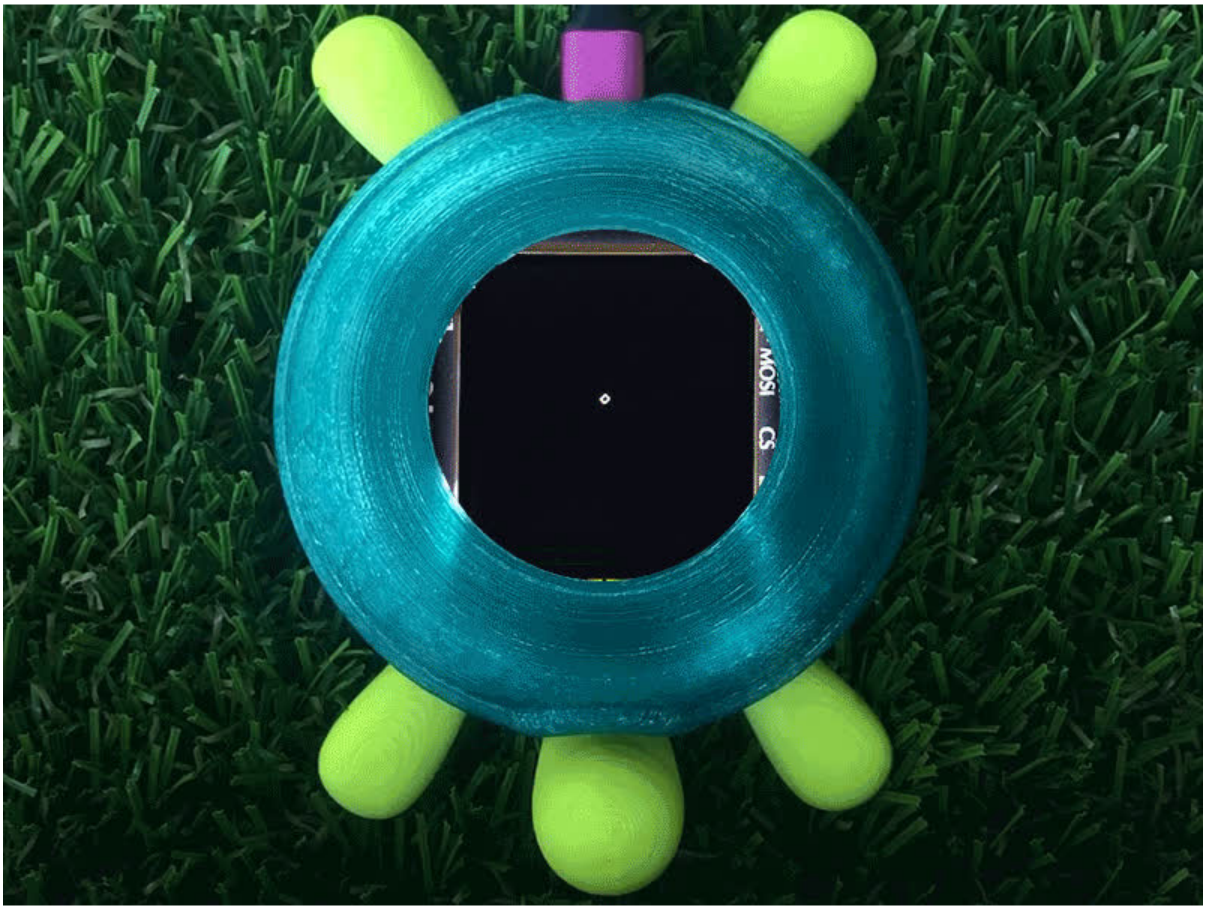
Turtle Graphics in CircuitPython on TFT Gizmo

Created by John Park



https://learn.adafruit.com/turtle-graphics-gizmo

Last updated on 2024-06-03 02:57:22 PM EDT

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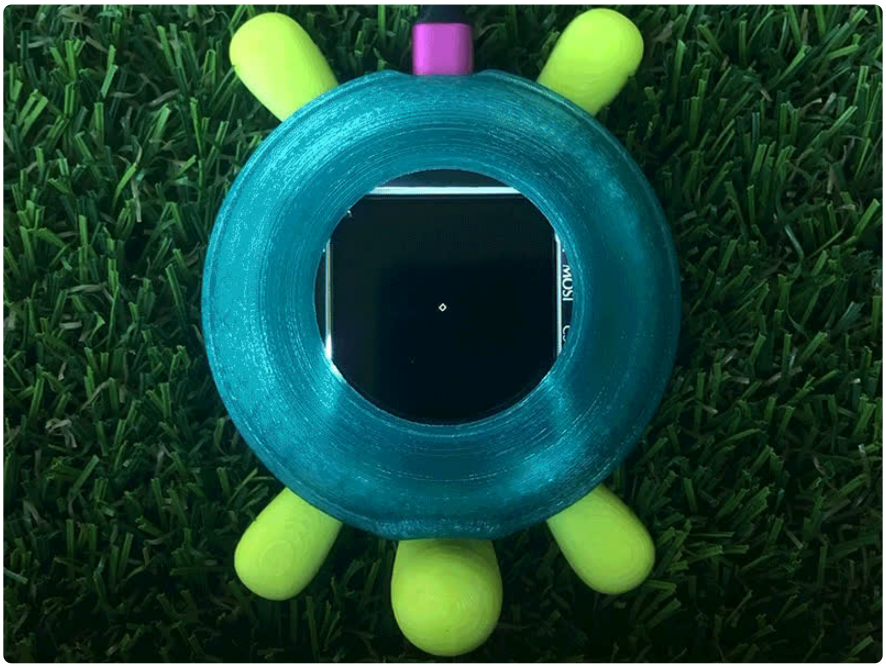
Overview



Learn to create your own graphics programs with Turtle Graphics on the Circuit Playground Bluefruit!

The legendary Turtle graphics of the Logo programming language has made their way to CircuitPython! Now, you can learn to program your own graphics right on the TFT Gizmo screen attached to a Circuit Playground Bluefruit board!

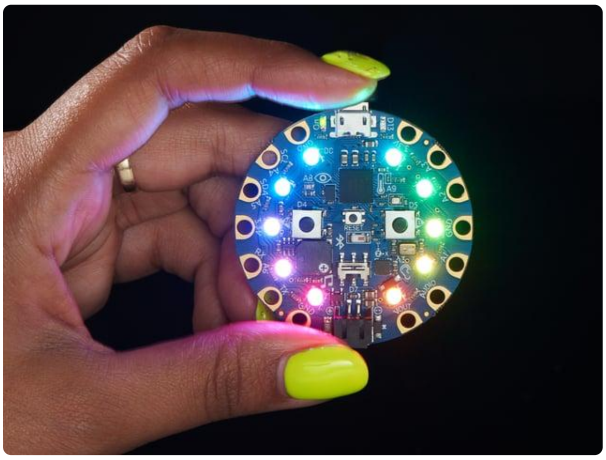
In this guide, we'll look at some general Turtle commands, then we'll set up the Circuit Playground Bluefruit and TFT Gizmo to use Turtle in CircuitPython, and then we'll run some example programs to draw sweet graphics on the display!

Besides the CPB with TFT Gizmo, the adafruit_turtle library will run on most of the M4 based boards, such as the Hallowing M4, but will require some fine tuning of the pin assignments and other details.

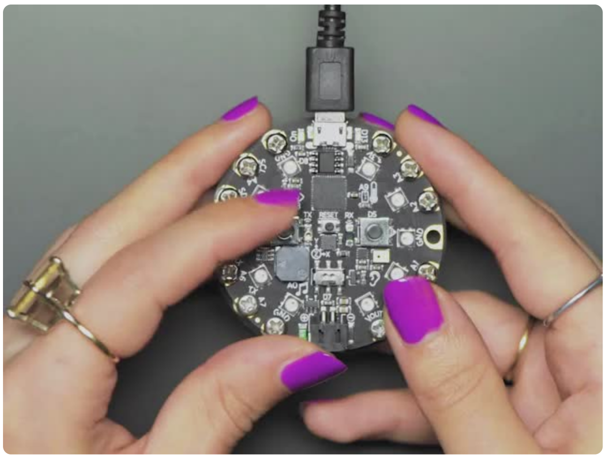
You may have heard of, or even played around with, turtle graphics (https://adafru.it/FaL). Simply put, this is a metaphor for drawing vector images where you control a turtle that can drag a pen along with it. Commands to the turtle include things like move forward some distance, turn left or right by some angle, lift the pen off the paper (so that moving won't make a mark), or put it on the paper (so that moving will make a mark).

There have been many on-screen implementations of turtle graphics, most notably the LOGO (https://adafru.it/FaM) programming language. Versions have also been made that control a robot that has a pen so as to create on-paper copies of turtle drawings.

Parts



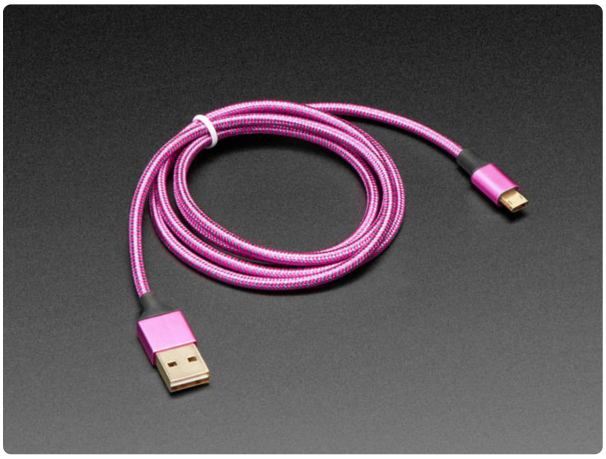
Circuit Playground Bluefruit - Bluetooth Low Energy
Circuit Playground Bluefruit is our third board in the Circuit Playground series, another step towards a perfect introduction to electronics and programming. We've...
https://www.adafruit.com/product/4333



[Circuit Playground TFT Gizmo - Bolt-on Display + Audio Amplifier](https://www.adafruit.com/product/4367)

Extend and expand your Circuit Playground projects with a bolt on TFT Gizmo that lets you add a lovely color display in a sturdy and reliable fashion. This PCB looks just like a round...

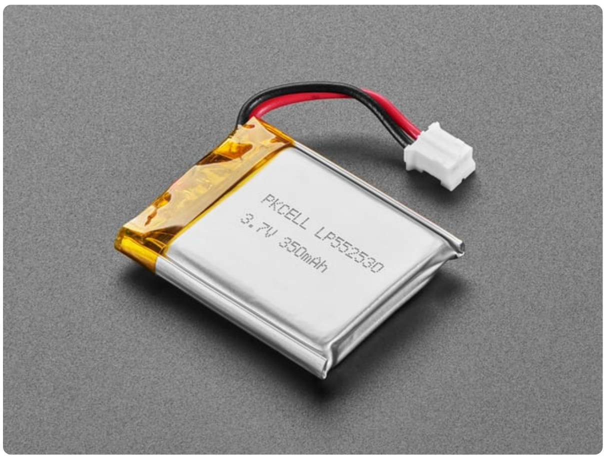
https://www.adafruit.com/product/4367



[Fully Reversible Pink/Purple USB A to micro B Cable - 1m long](https://www.adafruit.com/product/4111)

This cable is not only super-fashionable, with a woven pink and purple Blinka-like pattern, it's also fully reversible! That's right, you will save seconds a day by...

https://www.adafruit.com/product/4111

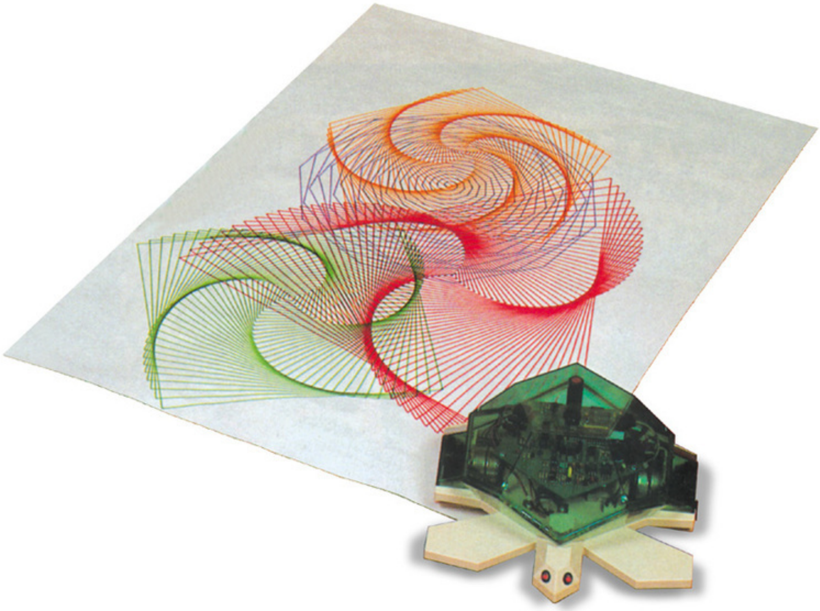


[Lithium Ion Polymer Battery with Short Cable - 3.7V 350mAh](https://www.adafruit.com/product/4237)

Lithium-ion polymer (also known as 'lipo' or 'lipoly') batteries are thin, light, and powerful. The output ranges from 4.2V when completely charged to 3.7V. This...

https://www.adafruit.com/product/4237

The Turtle API



Controlling the Pen

`pendown()`

Lower the pen, causing subsequent commands will draw.

Aliases: `pd()` , `down()`

`penup()`

Raise the pen, causing subsequent commands to not draw.

Alaises: `pu()` , `up()`

`pencolor(color=None)`

The form without an argument will return the current pen color as a 24-bit integer. The other form sets the pen color to the specified value. The Color class should be used for this value: `WHITE` , `BLACK` , `RED` , `ORANGE` , `YELLOW` , `GREEN` , `BLUE` , `PURPLE` , `PINK` .

E.g. `turtle.pencolor(adafruit_turtle.Color.RED)`

Moving

`forward(distance)`

Move the turtle forward (on its current heading) by the specified distance. The distance is a number of pixels if the turtle is moving exactly vertically or horizontally.

Alias: `fd`

`backward(distance)`

Move the turtle backward (opposite its current heading) by the specified distance. The distance is a number of pixels if the turtle is moving exactly vertically or horizontally.

Aliases: `bk`, `back`

`setx(x)`

Set the turtle's horizontal coordinate.

`sety(y)`

Set the turtle's vertical coordinate.

`goto(x, y)`

Set both coordinates of the turtle.

Heading

Drawing in a straight line isn't that interesting, so the direction that the turtle is facing (and thus moving) can be changed. This is called its heading. The first two functions below set what it means to change the heading by some value. The result of calling these methods stay in effect until the next call to one of them. By default, degrees are used, with a change of 1 corresponding to 1 degree.

`degrees(fullcircle=360)`

A full circle is 360 degrees and, by default, changing the heading by 1 means changing it by one degree. Supplying a different value will serve to scale those incremental heading changes. For example, if you call `degrees(180)`, changing the heading by 1 will change it by 2 degrees.

`radians()`

Use radians to turn the turtle. Changing the heading by 1 now means changing it by 1 radian (about 57.3 degrees).

The remaining methods change the turtle's heading.

`left(angle)`

Turn the turtle left by angle (what that means is subject to the above methods).

Alias: **`lt`**

`right(angle)`

Turn the turtle right by angle (what that means is subject to the above methods).

Alias: **`rt`**

`setheading(angle)`

Set the heading of the turtle to angle. Up is an angle of 0, right is 90.

Alias: **`seth`**

Shapes

`dot(radius=None, color=None)`

Draw a filled-in circle centered on the turtle's current position. Turtle position and heading are unchanged.

If radius is omitted a reasonable one is used, otherwise radius is used as the radius of the dot. If color is omitted the current pen color is used, otherwise color is used. This does not change the pen's color. As above, colors are available from the `Color` class.

`circle(radius, extent=None, steps=None)`

Draw a unfilled circle using the turtle's current pen color. This uses a computed sequence of calls to `forward` and `left` so the turtle's position and heading are changed. Since the circle drawing uses `left`, it draws counterclockwise by default. If radius is negative (i.e. < 0) drawing is done clockwise.

The radius of the desired circle is specified by radius, which is a number of pixels from the center to the edge.

The argument extent specifies what portion of the circle to draw and is specified in the same units as calls to `left` and `right`, as determined by the most recent call to `degrees` or `radians`. The default is to draw the complete circle. Calling `circle(10, extent=180)` will draw half a circle of radius 10, assuming that `radians` hasn't been called and neither has `degrees` with an argument other than 360. The turtle's heading is always what it was after drawing the last part of the circle, regardless extent. This will always be at the tangent to the circle. You can use this in your drawings. E.g. to draw a closed half-circle:

```
turtle.circle(20, extent=180)
turtle.left(90)
turtle.forward(40)
```

The final argument, steps, determines how many sides the circle has. By default (steps is `None`) as many are used as required to create a smooth circle. Specifying a value for steps has the effect of drawing that many line segments instead. So circle(radius r, steps=6) will draw a hexagon.

If you draw a full circle, the turtle will end up back where it started with the heading it started with. By drawing circles (of other polygons by using steps) repeatedly and turning between each, some interesting designs can be created.

```
for _ in range(36):
  turtle.circle(50, steps=6)
  turtle.left(10)
```

More control

`home()`

Move the turtle to its initial position and heading.

`clear()`

Clear the screen, the position and heading of the turtle is unaffected.

Queries

These methods let you ask the turtle about aspects of it's current state.

`pos()`

Returns the turtle's (x, y) position.

`xcor()`

Returns the turtle's x coordinate.

`ycor()`

Returns the turtle's y coordinate.

`heading()`

Returns the turtle's heading.

`isdown()`

Returns whether the pen is down (i.e. drawing).

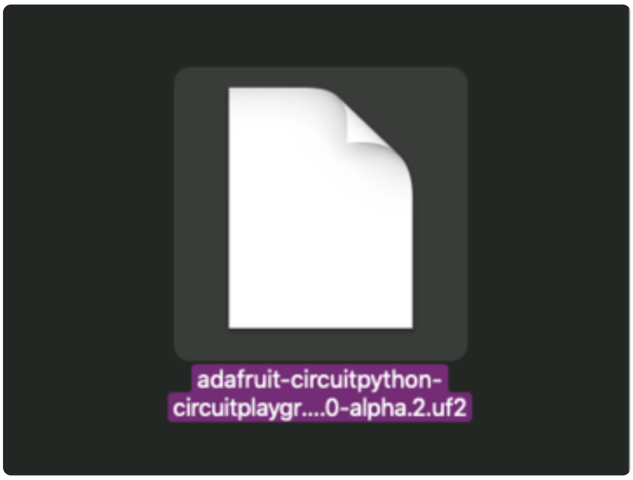
CircuitPython on Circuit Playground Bluefruit

Install or Update CircuitPython

Follow this quick step-by-step to install or update CircuitPython on your Circuit Playground Bluefruit.

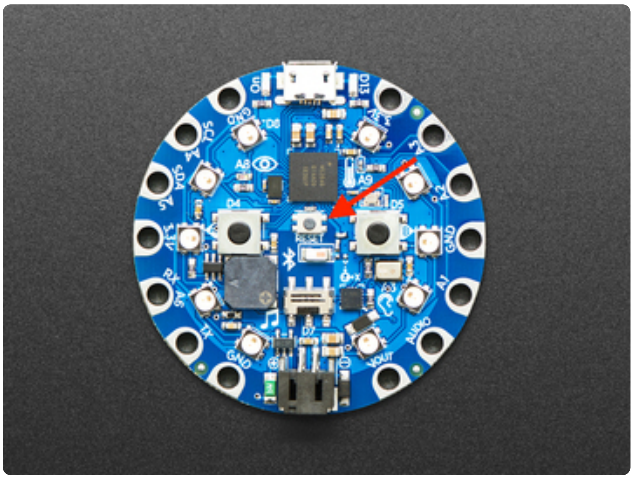
Download the latest version of CircuitPython for this board via circuitpython.org

https://adafru.it/FNK



Click the link above and download the latest UF2 file

Download and save it to your Desktop (or wherever is handy)



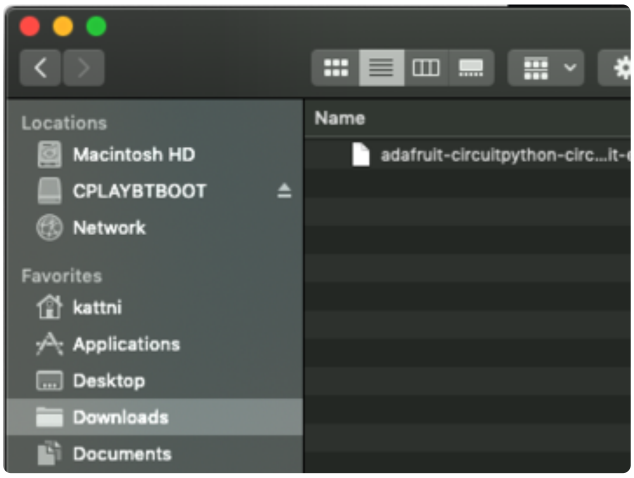
Plug your Circuit Playground Bluefruit into your computer using a known-good data-capable USB cable.

A lot of people end up using charge-only USB cables and it is very frustrating! So make sure you have a USB cable you know is good for data sync.

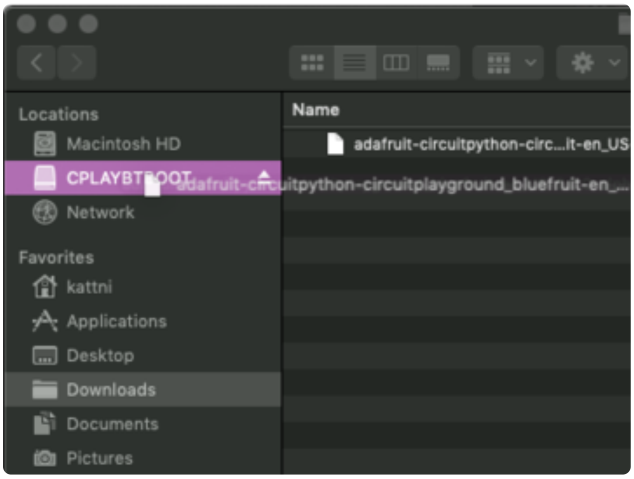
Double-click the small **Reset** button in the middle of the CPB (indicated by the red arrow in the image). The ten NeoPixel LEDs will all turn red, and then will all turn green. If they turn all red and stay red, check the USB cable, try another USB port, etc. The little red LED next to the USB connector will pulse red - this is ok!

If double-clicking doesn't work the first time, try again. Sometimes it can take a few tries to get the rhythm right!

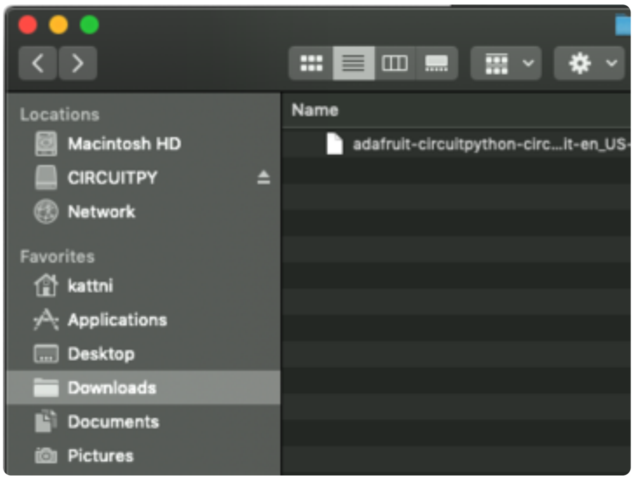
(If double-clicking doesn't do it, try a single-click!)



You will see a new disk drive appear called **CPLAYBTBOOT**.



Drag the **adafruit_circuitpython_etc.uf2** file to **CPLAYBTBOOT.**



The LEDs will turn red. Then, the **CPLAYBTBOOT** drive will disappear and a new disk drive called **CIRCUITPY** will appear.

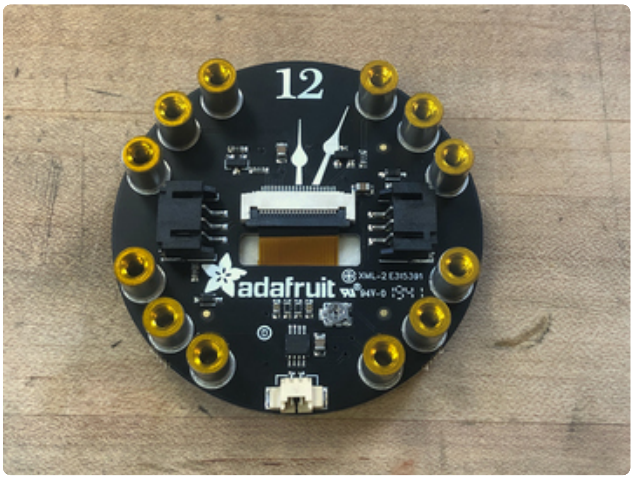
That's it, you're done! :)

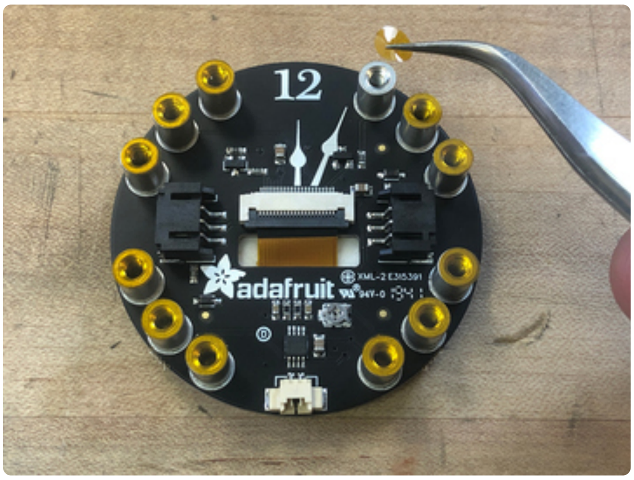
Assembly

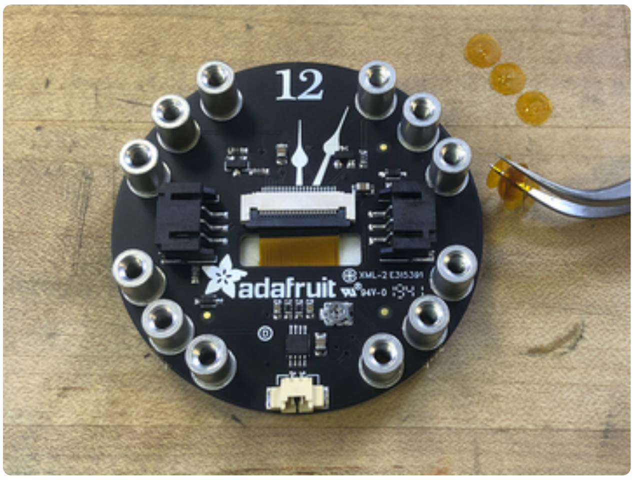
This page shows assembling the Circuit Playground TFT Gizmo, but the process is identical for the E-Ink Gizmo.

Placing the Circuit Playground TFT Gizmo on the Circuit Playground Express or Circuit Playground Bluefruit is pretty straightforward. All you need is a #2 Phillips screwdriver.

There may be plastic covers over the screw holes on the TFT Gizmo, which you will need to remove before assembly.

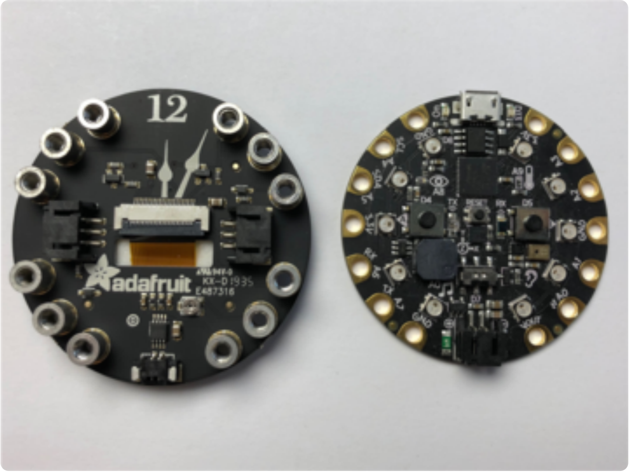




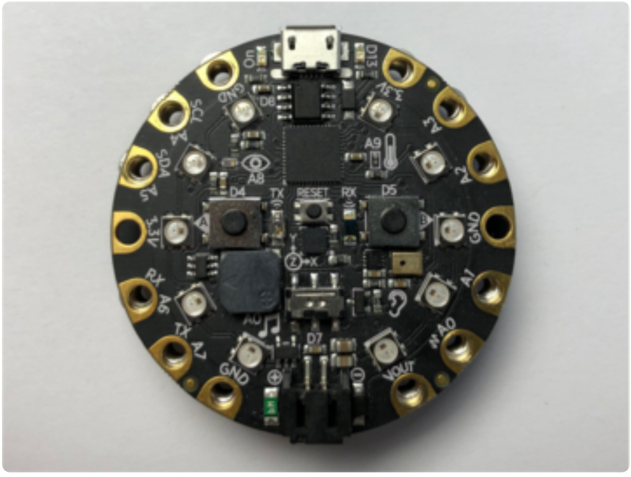


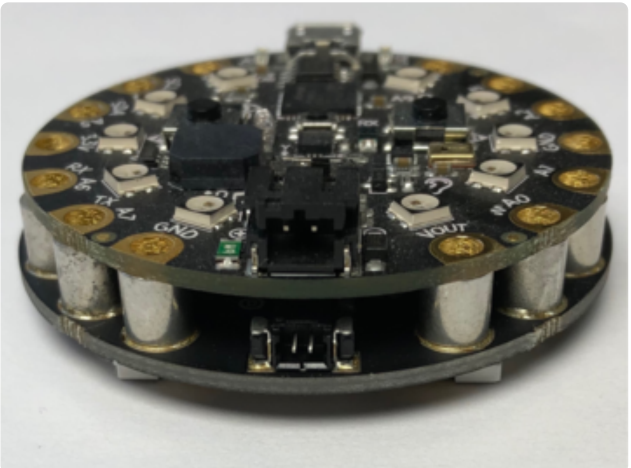
The amber colored Kapton tape dots must be removed from each of the twelve standoffs before assembling the boards. These are electrically insulating and will prevent the Gizmo from working properly if left in place.

You can use your fingernails or some tweezers or a pin to poke and lift each dot as shown here.

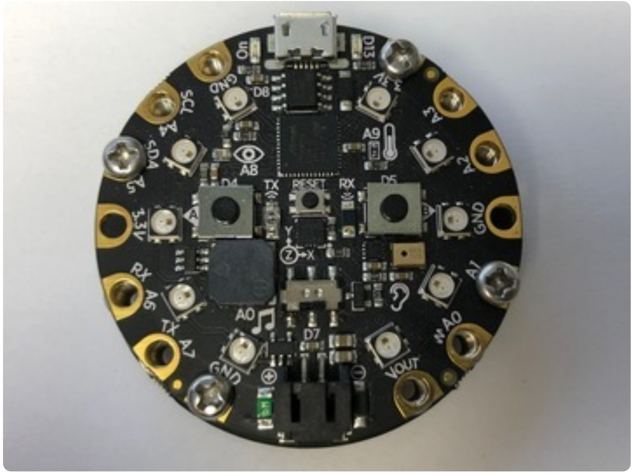


Start by aligning the two boards side by side like in the photo with the black plastic speaker connector and battery connectors pointing in the same direction.

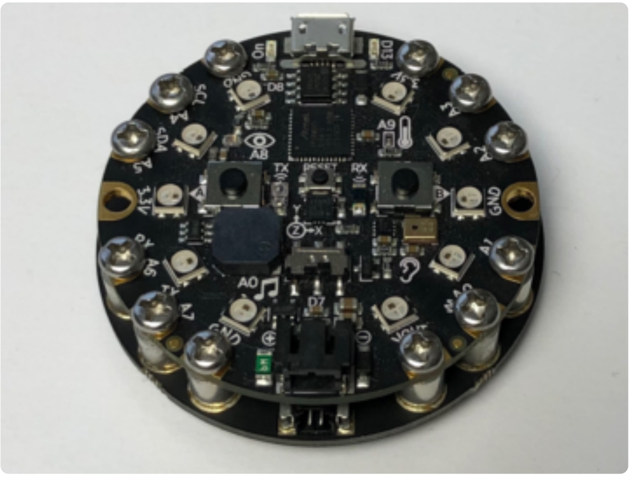




Place the Circuit Playground board on top of the Gizmo being sure that the connectors mentioned in the previous step are still aligned.

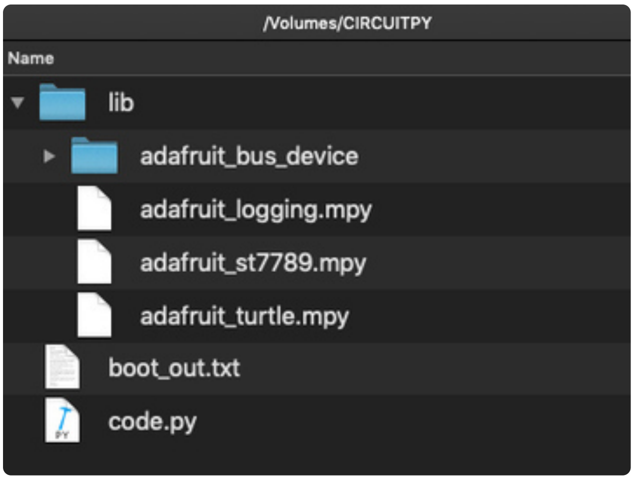


Install a few screws loosely, so that all of the holes are still aligned, before tightening them down.



Finish installing the remaining screws. After that, you're done!

Turtle Graphics on Gizmo



Libraries

Now we'll install the libraries that we need to use Turtle graphics on the Circuit Playground Bluefruit with TFT Gizmo.

Click this link (https://adafru.it/ENC) to go to the **circuitpython.org** Libraries page. Download the latest version of the Bundle library .zip file that matches the version of CircuitPython you're using on the board.

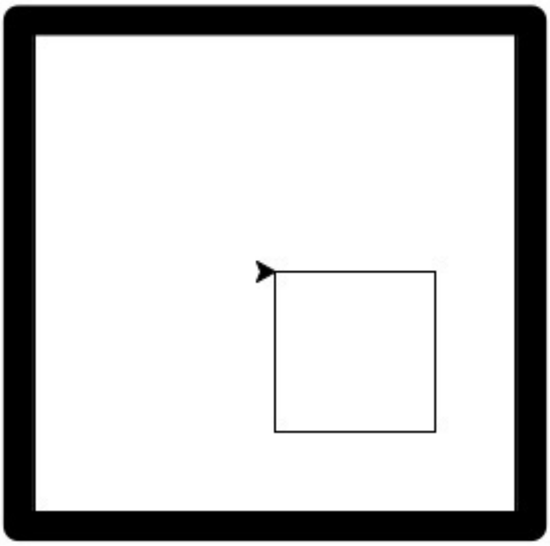
Uncompress the **.zip** file and then copy the following directory and three library **.mpy** files to the **lib** directory of the **CIRCUITPY** drive:

adafruit_bus_device
adafruit_logging.mpy
adafruit_st7789.mpy
adafruit_turtle.mpy

The Mu Editor

Adafruit recommends using the free program Mu to edit your CircuitPython programs and save them on your Circuit Playground Bluefruit. You can use any text editor, but Mu has some handy features.

See this page on the Circuit Playground Bluefruit guide (https://adafru.it/GDt) on the steps used to install Mu.



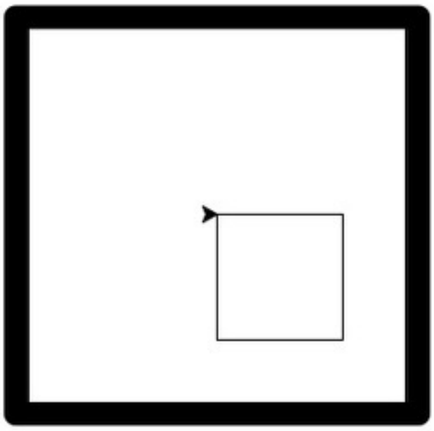
Turtle Graphics Code

Let's start of with a simple bit of code. It will draw a square on the screen.

Copy the code below and then paste it into a new document in **Mu**. Save it to the **CIRCUITPY** drive as **code.py**.

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
#
# SPDX-License-Identifier: MIT

#Turtle Gizmo Square
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

turtle.pendown()

#top
turtle.forward(80)
turtle.right(90)

#right
turtle.forward(80)
turtle.right(90)

#bottom
turtle.forward(80)
turtle.right(90)
```

```
#left
turtle.forward(80)
turtle.right(90)

while True:
    pass
```



Square

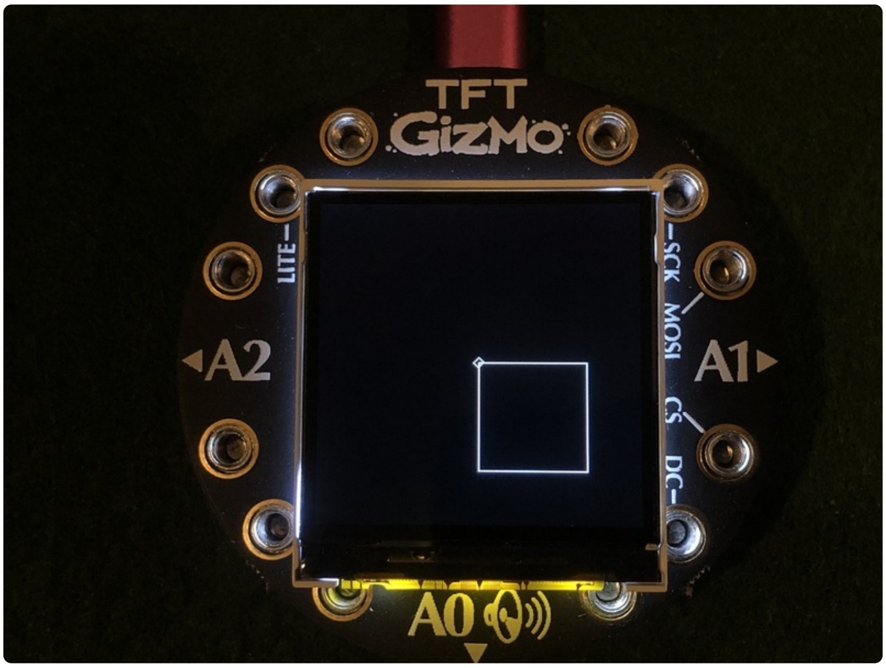
After the setup code imports libraries and configures some pins for the display, the main body of the code runs. Watch the screen on your TFT Gizmo as the board restarts and runs the code.

First, it sets the pen down with the `turtle.pendown()` command. (Later, you'll learn to lift the pen with `turtle.penup()` so you don't always draw a line then the turtle moves!)

The turtle starts out at the origin point -- `0,0` on the x- and y-axis respectively. It then moves forward `80` pixels, drawing a line as it goes using the `turtle.forward(80)` command. This draws the top of the square.

Next, the turtle turns right using the `turtle.right(90)` command.

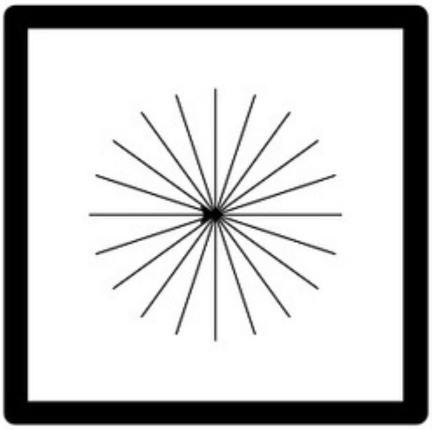
This same pair of commands -- `forward()` and `right()` -- run three more times in order to complete the square.

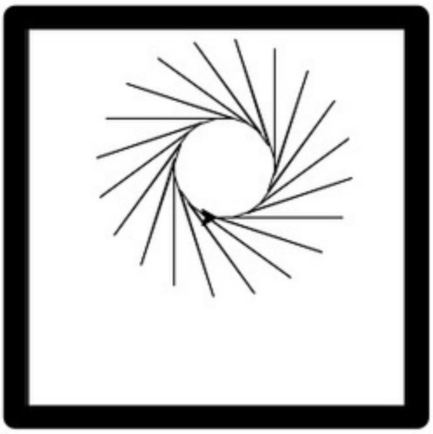


Since there are some repetitive steps in there, we can tidy up the code by iterating through a loop four times like this:

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
#
# SPDX-License-Identifier: MIT

#Turtle Gizmo Square Loop
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

turtle.pendown()
for _ in range(4):
    turtle.forward(80)
    turtle.right(90)

while True:
    pass
```

Try out that code -- it's much shorter, but you'll see the same square drawn on the screen!





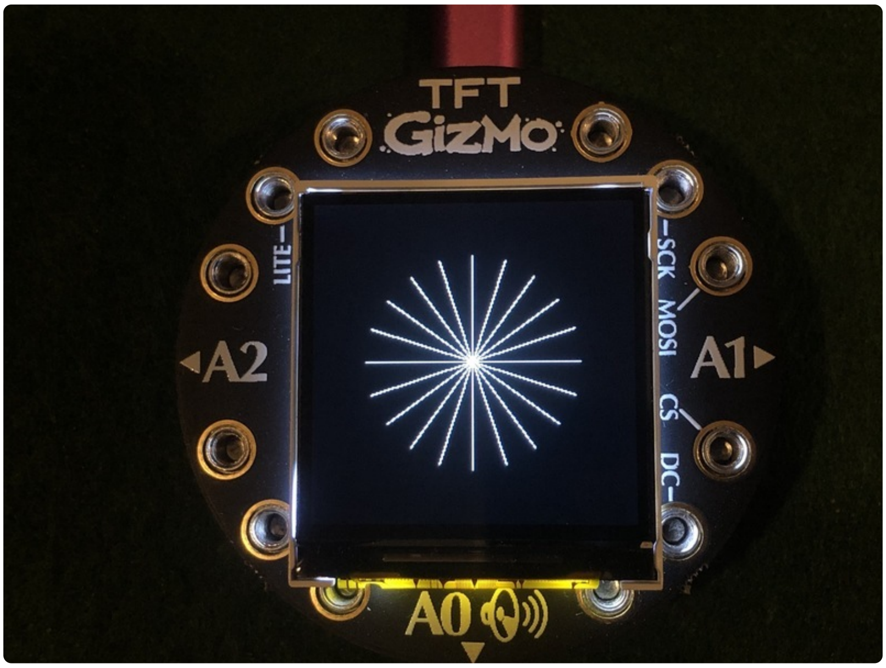
Asterisk

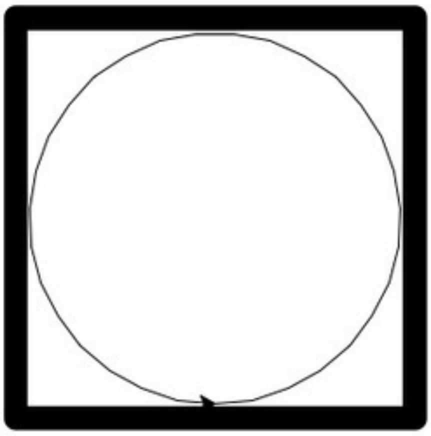
Now that we can loop through a command many times, let's add another two commands -- `turtle.back()` and `turtle.left()`

We can move forward and backward to create a line, shift the angle 18 degrees to the left, and do it all again. After twenty iterations of this we have a nice star pattern!

With a small change to the code (see the comment on line 18) we can turn this into an iris pattern!

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
#
# SPDX-License-Identifier: MIT

#Turtle Gizmo Asterix
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

turtle.pendown()
for _ in range(20):
    turtle.forward(80)
    turtle.back(80) #try changing this to 70 for an iris effect
    turtle.left(18)

while True:
    pass
```





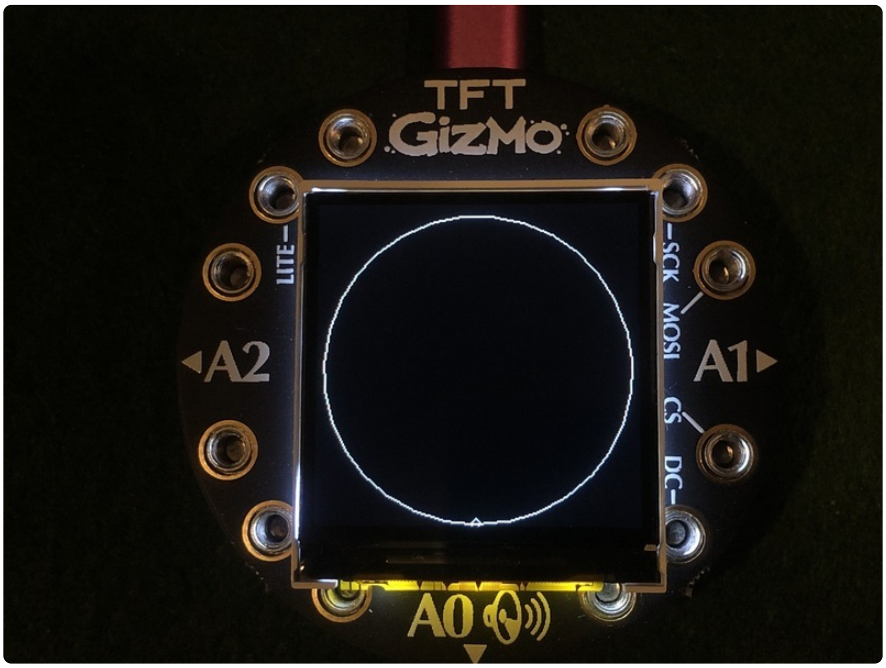
Circle

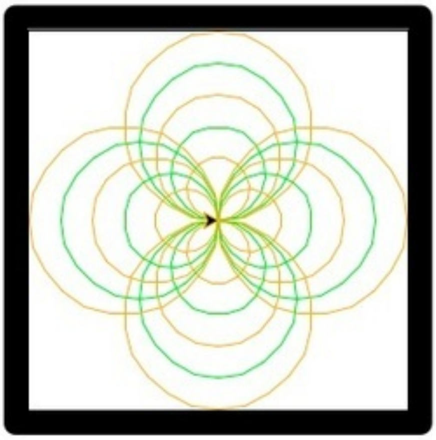
The built-in command `turtle.circle()` makes it very simple to draw a triangle. No, just kidding! It draws a **circle**!

Try out the example here, and then us some different numbers for the circle radius instead of the 118 here.

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
#
# SPDX-License-Identifier: MIT

# Turtle Gizmo Circle
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

turtle.penup()
turtle.right(90)
turtle.forward(118)
turtle.left(90)
turtle.pendown()
turtle.circle(118) #radius of the circle
```

```
while True:
    pass
```





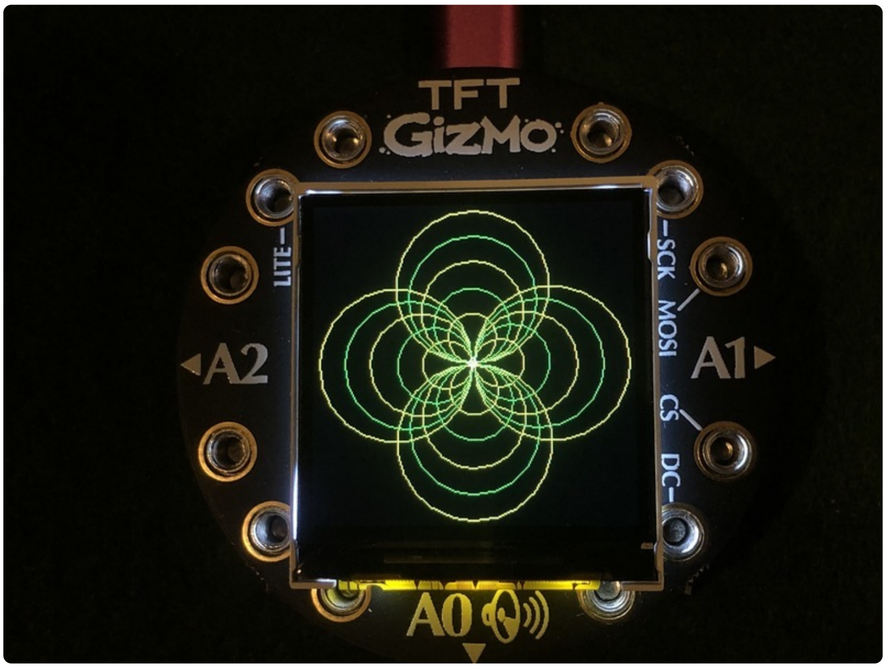
Circle Petals

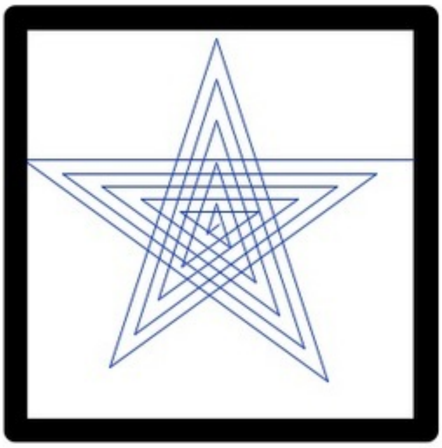
Let's get a little fancy. We will now introduce a few more techniques, including the `turtle.pencolor()` command to change the color of the line that our turtle draws, as well as iterating through multiple loops with changing variables.

This will allow us to change the size of a series of five circles, and repeat the pattern four times.

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
#
# SPDX-License-Identifier: MIT

# Turtle Circle Petals
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
```

```
#==| Turtle Gizmo Setup end |=========================================

colors = [Color.YELLOW, Color.GREEN]

for _ in range(4):
    for i in range (5):
        turtle.pencolor(colors[i % 2])
        turtle.pendown()
        turtle.circle(60 - (i*10) )
        turtle.penup()
    turtle.right(90)

while True:
    pass
```





Star

Here's a super stylish, 1970's inspired star! Note how the length of each forward command is increased as the value of `i` goes up during each of the 26 iterations of the loop.

```
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#
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# Turtle Gizmo Star Fancy
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
```
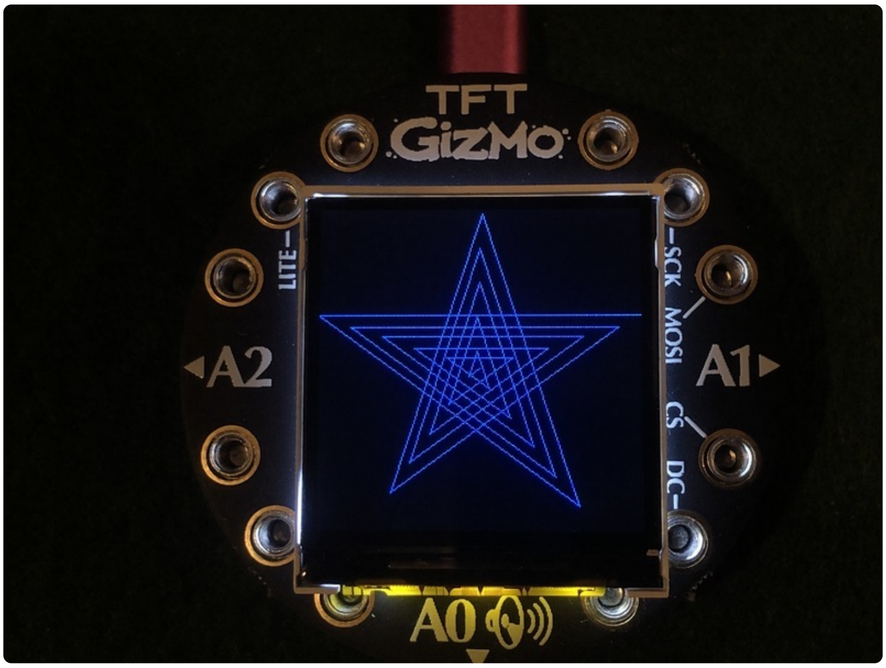
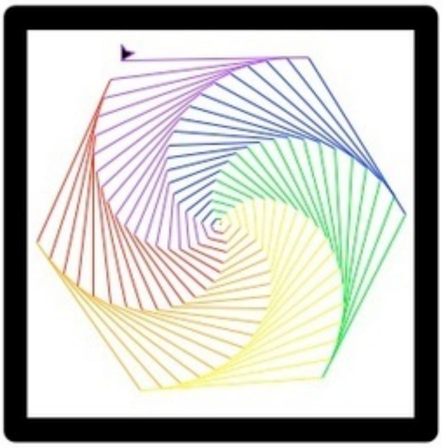

```
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

turtle.pendown()
turtle.pencolor(Color.BLUE)
for i in range(26):
    turtle.fd(i*10)
    turtle.rt(144)

while True:
    pass
```





Rainbow Benzene

Here's a classic, beautiful design. This hexagonal shape twists with each iteration, and every side of each perceived hexagon is a different color of the rainbow!

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
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# Turtle Gizmo Rainbow Benzene
```
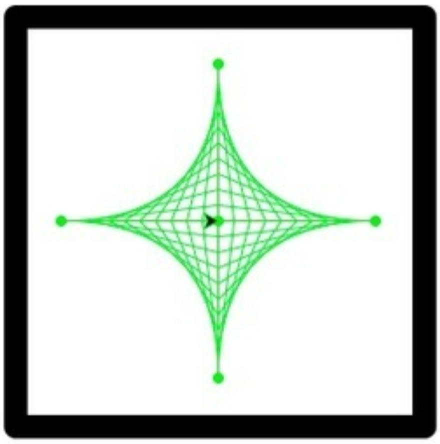

```
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

benzsize = min(display.width, display.height) * 0.5

print("Turtle time! Lets draw a rainbow benzene")

colors = (Color.RED, Color.ORANGE, Color.YELLOW, Color.GREEN, Color.BLUE,
Color.PURPLE)

turtle.pendown()
start = turtle.pos()

for x in range(benzsize):
    turtle.pencolor(colors[x%6])
    turtle.forward(x)
    turtle.left(59)

while True:
    pass
```

Parabolas



This lovely parabolic curve set creates the illusion of curvature. It is in fact made up entirely of straight line segments, just as you would with a piece of string art and some pins pushed into a canvas.

It also introduces the `turtle.dot()` command, which drops down a dot of your desired radius wherever the turtle is. In this case, the turtle is moved with `turtle.goto()` This command allows the turtle to instantly head to a coordinate point on the screen rather than needing explicit angle rotations specified along with a "forward" command.

```
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# Turtle Gizmo Parabolic Jack
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

print("Draw parabolas using straight line segments!")

def vert(x, y, size):
    turtle.goto(x, y)
    turtle.dot(size)

turtle.penup()
turtle.pencolor(Color.GREEN)

vert(0, 0, 7)
vert(0, 100, 7)
vert(100, 0, 7)
vert(0, -100, 7)
vert(-100, 0, 7)

x_quad=[10, 10, -10, -10]
y_quad=[10, -10, -10, 10]

for q in range(4):
    for i in range(0,11):
        x_from = 0
```
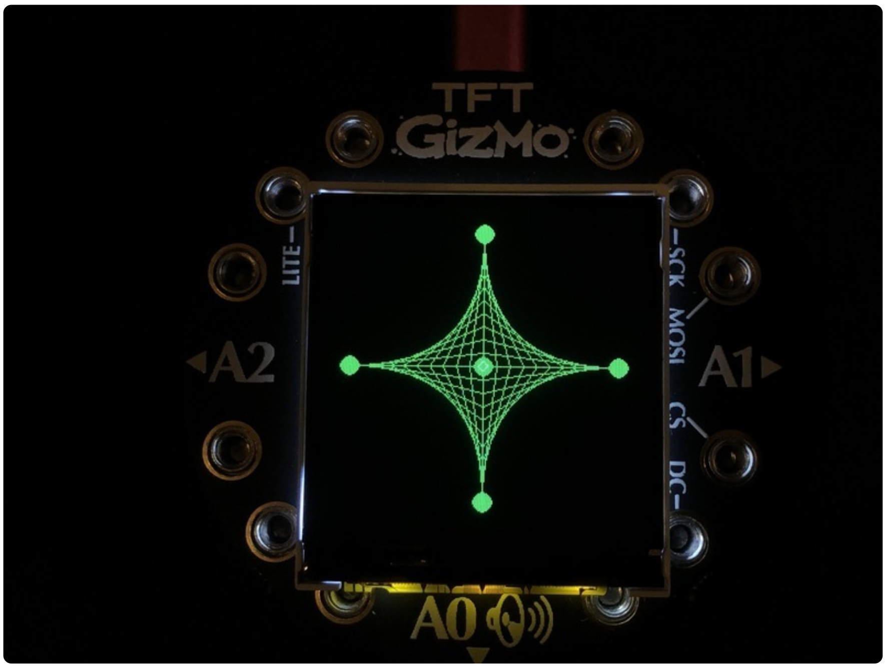
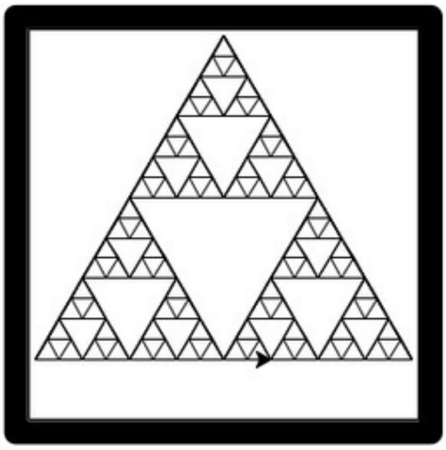

```
        y_from = (10-i) * y_quad[q]
        x_to = i * x_quad[q]
        y_to = 0
        turtle.penup()
        turtle.goto(x_from,y_from)
        turtle.pendown()
        turtle.goto(x_to,y_to)

turtle.home()


while True:
    pass
```





Sierpinski Triangle

Time to get fractal! These are recursive, equilateral triangles as described by Waclaw Sierpinski in 1915! Read more about them here (https://adafru.it/FaP).

```
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# Turtle Gizmo Sierpinski Triangle
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
```
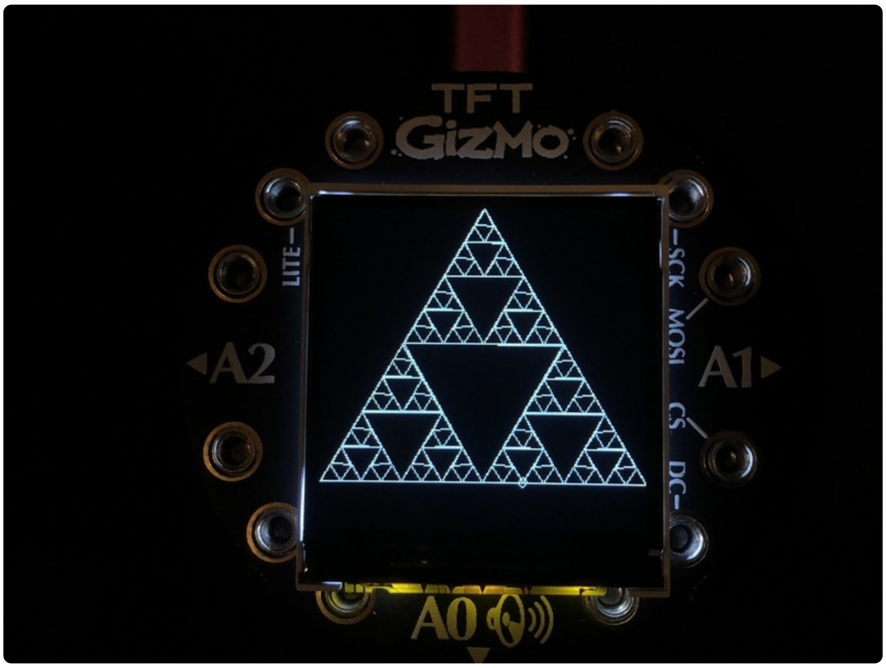
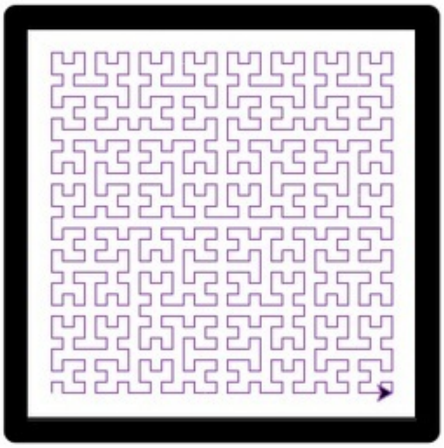

```
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

def getMid(p1, p2):
    return ((p1[0] + p2[0]) / 2, (p1[1] + p2[1]) / 2) #find midpoint

def triangle(points, depth):

    turtle.penup()
    turtle.goto(points[0][0], points[0][1])
    turtle.pendown()
    turtle.goto(points[1][0], points[1][1])
    turtle.goto(points[2][0], points[2][1])
    turtle.goto(points[0][0], points[0][1])

    if depth > 0:
        triangle([points[0],
                  getMid(points[0], points[1]),
                  getMid(points[0], points[2])],
                 depth-1)
        triangle([points[1],
                  getMid(points[0], points[1]),
                  getMid(points[1], points[2])],
                 depth-1)
        triangle([points[2],
                  getMid(points[2], points[1]),
                  getMid(points[0], points[2])],
                 depth-1)

big = min(display.width/2, display.height/2)
little = big / 1.4
seed_points = [[-big, -little], [0, big], [big, -little]] #size of triangle
triangle(seed_points, 4)

while True:
    pass
```





Hilbert Curve

Here's another interesting fractal pattern, called a Hilbert curve (https://adafru.it/FaO).

```
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# Turtle Gizmo Hilbert
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

def hilbert2(step, rule, angle, depth, t):
    if depth > 0:
        a = lambda: hilbert2(step, "a", angle, depth - 1, t)
        b = lambda: hilbert2(step, "b", angle, depth - 1, t)
        left = lambda: t.left(angle)
        right = lambda: t.right(angle)
        forward = lambda: t.forward(step)
        if rule == "a":
            left()
            b()
            forward()
            right()
            a()
            forward()
            a()
            right()
            forward()
            b()
            left()
        if rule == "b":
            right()
            a()
            forward()
            left()
            b()
            forward()
            b()
            left()
            forward()
            a()
            right()
```
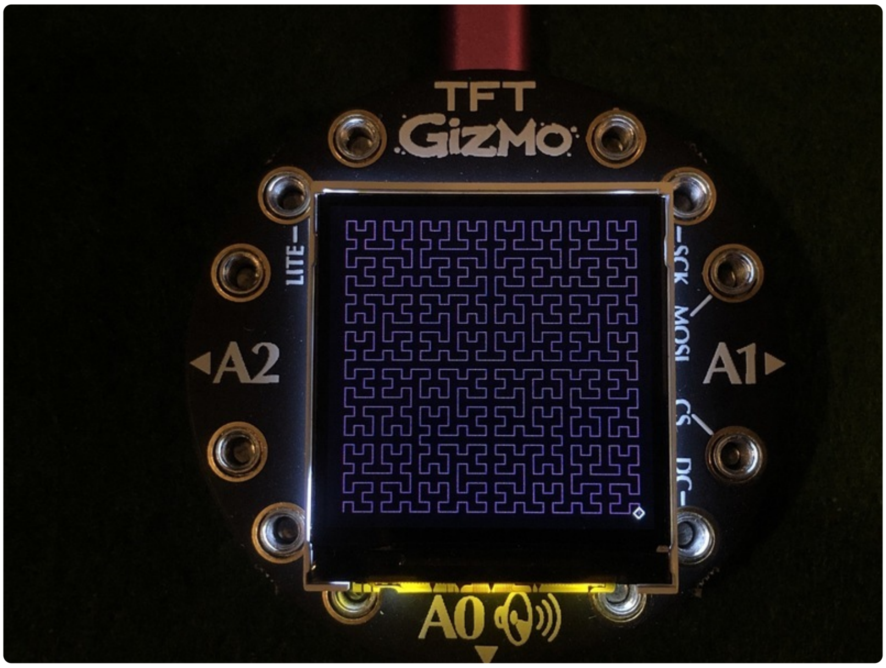
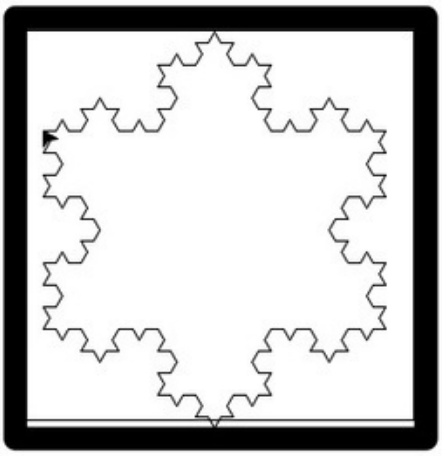

```
turtle.penup()

turtle.goto(-108, -108)
turtle.pendown()
turtle.pencolor(Color.PURPLE)
hilbert2(7, "a", 90, 5, turtle)

while True:
    pass
```





Koch Snowflake

This is a third generation fractal Koch snowflake.

```
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# Turtle Gizmo Koch Snowflake
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
```
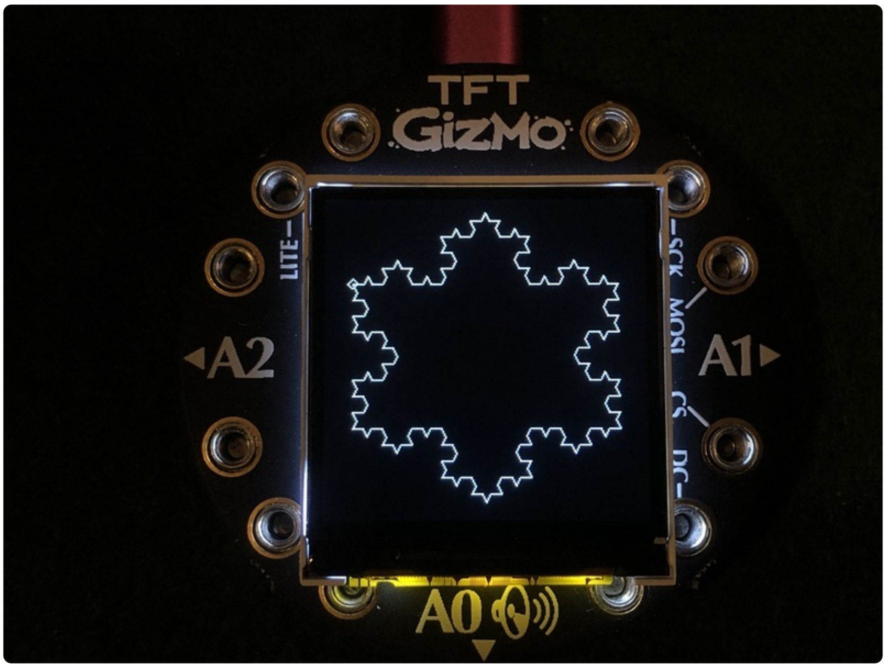

```
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

def f(side_length, depth, generation):
    if depth == 0:
        side = turtle.forward(side_length)
    else:
        side = lambda: f(side_length / 3, depth - 1, generation + 1)
        side()
        turtle.left(60)
        side()
        turtle.right(120)
        side()
        turtle.left(60)
        side()

turtle.penup()
turtle.goto(-99, 56)
turtle.pendown()

num_generations = 3
top_side = lambda: f(218, num_generations, 0)

top_side()
turtle.right(120)
top_side()
turtle.right(120)
top_side()

while True:
    pass
```



Christmas Tree

This lovely Christmas tree was adapted from this program written by Keith Randall. (https://adafru.it/GCb)

```
# SPDX-FileCopyrightText: 2019 John Edgar Park for Adafruit Industries
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# Turtle Gizmo Christmas Tree
#==| Turtle Gizmo Setup start |========================================
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import Color, turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

# Fractal Christmas Tree:
# https://codegolf.stackexchange.com/questions/15860/make-a-scalable-christmas-tree
#  by Keith Randall
n = 42  # input value for scaling the tree. note: ornaments don't scale
turtle.goto(0, -20)

#star
turtle.left(90)
turtle.forward(3*n)
turtle.pencolor(Color.YELLOW)
turtle.left(126)
turtle.pendown()
for _ in range(5):
    turtle.forward(n/5)
    turtle.right(144)
    turtle.forward(n/5)
    turtle.left(72)
turtle.right(126)

#tree
turtle.pencolor(Color.GREEN)
turtle.back(n*4.8)

def tree(d,s):
    if d <= 0:
        return
    turtle.forward(s)
    tree(d-1, s*.8)
    turtle.right(120)
    tree(d-3, s*.5)
    turtle.right(120)
```

```
    tree(d-3, s*.5)
    turtle.right(120)
    turtle.back(s)
turtle.pendown()
turtle.pencolor(Color.GREEN)
tree(15, n)
turtle.back(n/2)

#ornaments
def ornament(x, y):
    turtle.penup()
    turtle.goto(x, y)
    turtle.pencolor(Color.RED)
    turtle.pendown()
    turtle.dot(7)
    turtle.penup()

orn_pnts=[  (5, 60), (-7, 40), (10, 20), (-15, 0), (25, -20),
            (-27, -30), (7, -33), (40, -60), (-9, -63),
            (-50, -88), (62, -97) ]

for j in range(len(orn_pnts)):
    ornament(orn_pnts[j][0], orn_pnts[j][1])


turtle.penup()
turtle.goto(0, -120)

while True:
    pass
```

Snowflakes

This example will draw lots of beautiful snowflake-style patterns! If you want to get technical about the number of sides in your flakes, make some adjustments to this line:

`draw_flake(randint(5, 8)) #adjust number of arms here`

```
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# Turtle Gizmo Snowflakes
#==| Turtle Gizmo Setup start |========================================
import time
from random import randint
import board
import busio
import displayio
from adafruit_st7789 import ST7789
from adafruit_turtle import turtle
displayio.release_displays()
spi = busio.SPI(board.SCL, MOSI=board.SDA)
display_bus = displayio.FourWire(spi, command=board.TX, chip_select=board.RX)
display = ST7789(display_bus, width=240, height=240, rowstart=80,
                 backlight_pin=board.A3, rotation=180)
turtle = turtle(display)
#==| Turtle Gizmo Setup end |=========================================

def draw_arm():
    turtle.pendown()
    for angle, length in arm_data:
        turtle.forward(length)
        turtle.left(angle)
        turtle.forward(length)
        turtle.backward(length)
        turtle.right(2*angle)
        turtle.forward(length)
        turtle.backward(length)
        turtle.left(angle)
    turtle.penup()

def draw_flake(arms):
    turtle.penup()
    turtle.home()
    turtle.clear()
    angle = 0
    delta_angle = 360 // arms
    for _ in range(arms):
        turtle.home()
        turtle.setheading(angle)
        draw_arm()
        angle += delta_angle
    turtle.penup()
    turtle.home()

while True:
    arm_data = [(randint(30, 80), randint(10, 40)) for _ in range(5)]
    draw_flake(randint(5, 8)) #adjust number of arms here
    time.sleep(5)
```

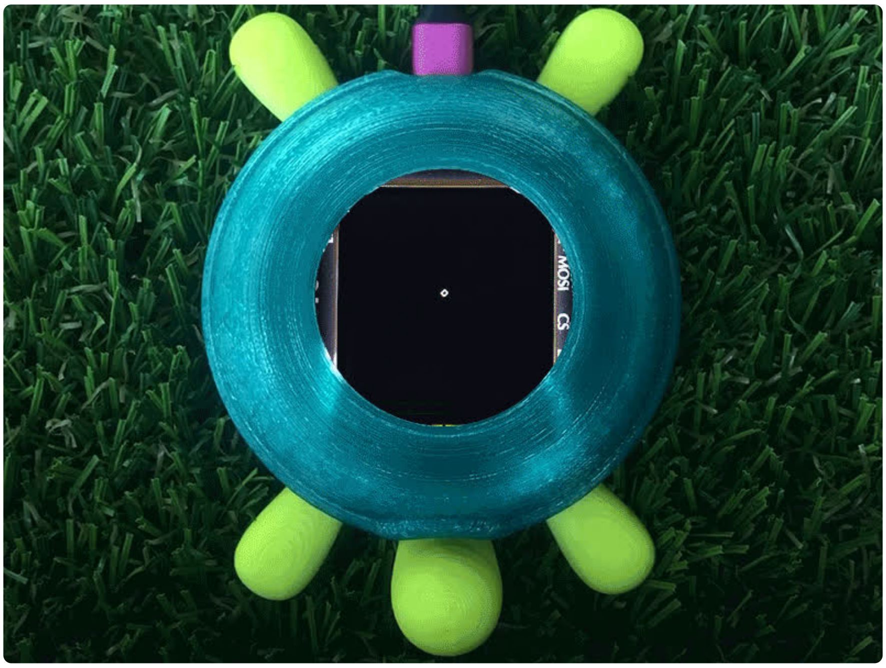

Where to Find More

You can find much more information about turtle graphics as well as example scripts through an Internet search of "turtle python graphics examples" or some variation. Since turtle graphics are mainly in terms of moving and turning they can usually be converted to CircuitPython and the **adafruit_turtle** library.

Check out these example sites:

- Michael0x2a Examples (https://adafru.it/Fd6)
- Geeks for Geeks Examples (https://adafru.it/Fd7)
- Vivax Solutions Examples (https://adafru.it/Fd8)