Introduction:

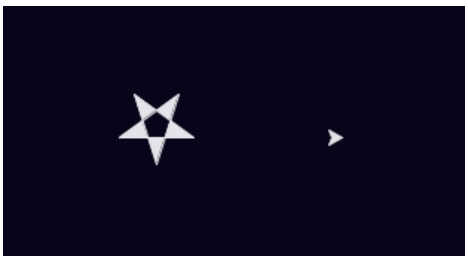
In this project, you'll learn how *functions* can make writing your programs easier .

Step 1: Drawing stars

Activity Checklist

- [ ] Let's start by using what you already know about turtles to draw a star. Run this program, but make sure *not* to name the program `turtle.py` - any other name is fine!

```
from turtle import *

#this will draw a light grey star on a dark blue background
color("WhiteSmoke")
bgcolor("MidnightBlue")

pendown()
begin_fill()

#draw the star shape
for side in range(5):
    left(144)
    forward(50)

end_fill()
penup()

forward(100)
done()
```



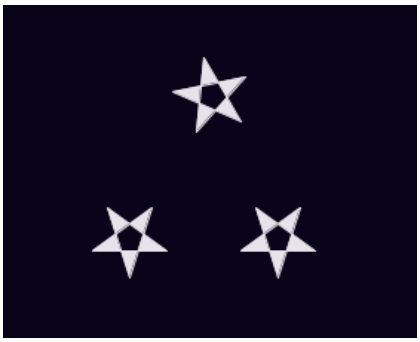
screenshot

The only new commands here are `begin_fill()` and `end_fill()` . These commands are used to colour in a shape. Also notice that there is no pen line between the star and the turtle in the image above, as you have used the `penup()` function to stop the turtle drawing.

Also, you might have noticed the names of some new colours! You can also use hex colour codes, just like you did when making web pages.

- [ ] If you wanted to draw 3 stars at different positions around the screen, then you can define your own new function called `drawStar()` , and then just call this new function 3 times:

```
from turtle import *

#a function for drawing a star
#'def' means 'define'
def drawStar():
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(50)
    end_fill()
    penup()

#this will draw a light grey star on a dark blue background
color("WhiteSmoke")
bgcolor("MidnightBlue")

#use the function to draw stars!
drawStar()
forward(100)
drawStar()
left(120)
forward(150)
drawStar()

hideturtle()
done()
```



screenshot

You've seen and used functions before. For example, `penup()` and `pendown()` are functions. When using these functions, you didn't need to know exactly how they worked, you could just use them whenever you needed them.

Your new `drawStar()` function works in the same way. Now that you have a function for drawing a star, you don't have to worry about exactly how to draw a star every time, you can just call the function which does all the hard work for you!

Save Your Project

Challenge: More functions

Define and use a function for drawing another shape, like a square or a triangle, or anything else you want to draw!

Save Your Project

Step 2: Passing data to functions

You now have a function for drawing stars, but what if you wanted to draw lots of stars that are different sizes? One way would be to create

lots of different functions, like `drawBigStar()`, `drawMediumStar()` and `drawSmallStar()`.

A better way is to *pass data* to your `drawStar()` function, to tell it what size star you want! You've already used lots of functions that receive data before, such as:

```
forward(100)
```

…which tells the **forward** function to move 100 pixels, and:

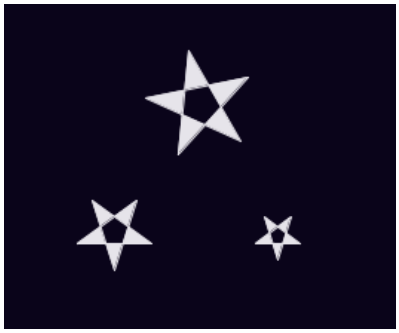
```
print("Hello")
```

…which tells the `print` function to print "Hello" to the screen.

Activity Checklist

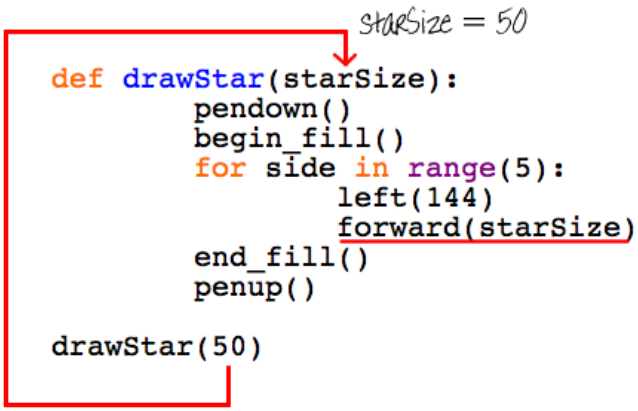
- [ ] Here's a program with a `drawStar()` function that can draw stars of different sizes, using whatever number is passed to it.

```
from turtle import *

#a function for drawing a star of a particular size
def drawStar(starSize):
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#this will draw a light grey star on a dark blue background
color("WhiteSmoke")
bgcolor("MidnightBlue")

#use the function to draw stars of different sizes!
drawStar(50)
forward(100)
drawStar(30)
left(120)
forward(150)
drawStar(70)

hideturtle()
done()
```



screenshot

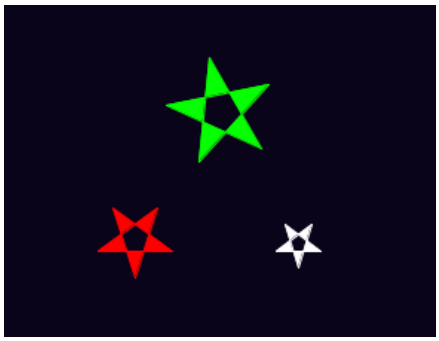
When your program runs the line `drawStar(50)`, the number `50` is passed to the `drawStar()` function, and so the value of `starSize` is set to `50`. This means that the line `forward(starSize)` draws a line 50 pixels long.



screenshot

You can pass as much data to your `drawStar()` function as you want. For example, you could also pass the colour of the star you want to draw:

```
from turtle import *

#a function for drawing a star of a particular size
def drawStar(starSize, starColour):
    color(starColour)
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#this will draw a dark blue background
bgcolor("MidnightBlue")

#use the function to draw stars of different sizes!
drawStar(50, "Red")
forward(100)
drawStar(30, "White")
left(120)
forward(150)
drawStar(70, "Green")

hideturtle()
done()
```



screenshot
Calling the function `drawStar(50, "red")` works in the same way as before, except now the first piece of data (`50`) becomes the value of `starSize`, and the second piece of data (`"Red"`) becomes the value of `starColour`.

Save Your Project

Challenge: Drawing planets

Create a function for drawing a planet called `drawPlanet()`. Pass data to the function, so that you can specify the size and colour of the planet you want to draw.

Save Your Project

Step 3: Random stars

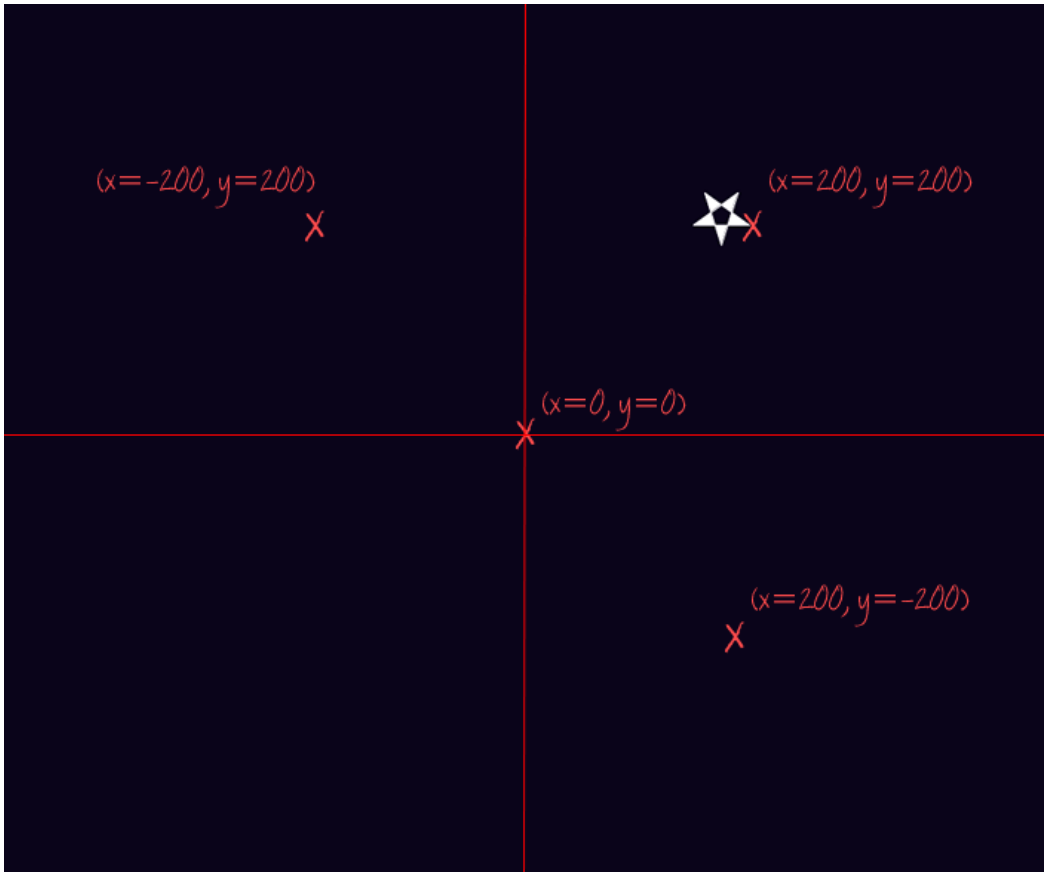
Let's use the `drawStar()` function to draw different sized stars randomly around the screen.

Activity Checklist

- [ ] Run this program, which moves the turtle to a new position, and then draws a white star:

```
from turtle import *

#a function for drawing a star of a particular size
def drawStar(starSize, starColour):
    color(starColour)
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#this will draw a dark blue background
bgcolor("MidnightBlue")

#move to a different location (x=200,y=200)
penup()
setpos(200 , 200)
pendown()

#use the function to draw a large red star
drawStar(50, "White")

hideturtle()
done()
```

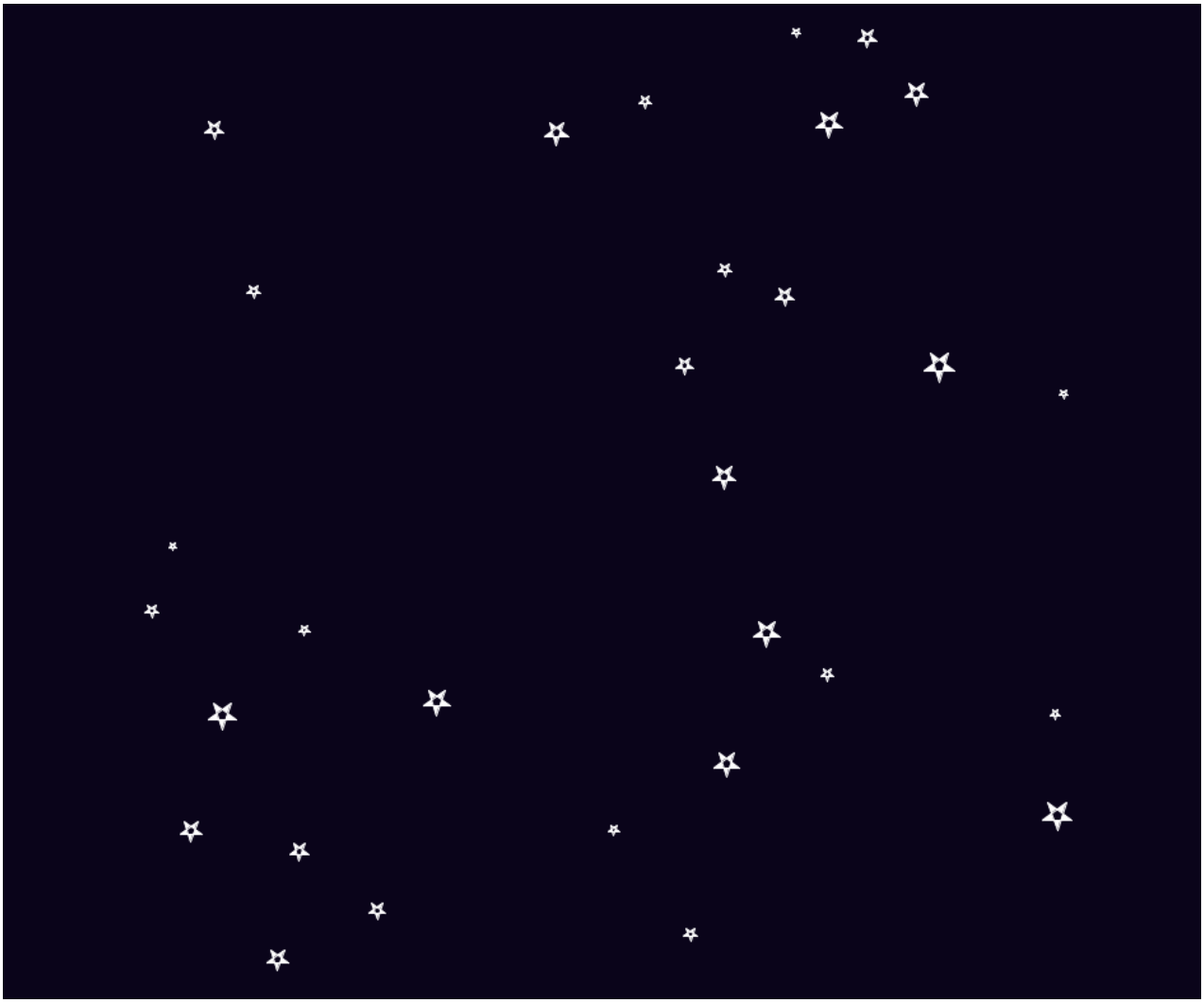
The `setpos()` function moves the turtle to whatever x and y coordinates are passed to it. In the program above, the code `setpos(200 , 200)` moves the turtle to the point x=200, y=200 on the screen. What would happen if you changed the numbers passed to the `setpos()` function?



screenshot

You'll be using code to move to a random location a lot, so let's define another function called `moveToRandomLocation()`, which, well, moves the turtle to a random location (obviously)!

```
from turtle import *
from random import *

#a function for moving the turtle to a random location
def moveToRandomLocation():
    penup()
    setpos( randint(-400,400) , randint(-400,400) )
    pendown()

#a function for drawing a star of a particular size
def drawStar(starSize, starColour):
    color(starColour)
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#this will draw a dark blue background
bgcolor("MidnightBlue")

#draw 30 stars (random sizes/locations)
for star in range(30):
    moveToRandomLocation()
    drawStar( randint(5,25) , "White")

hideturtle()
done()
```



screenshot
As you can see, this program draws 30 stars, each time moving to a random location and then drawing a star with a random size between 5 and 25 pixels. Remember that the code `randint(5,25)` chooses a random number between 5 and 25.

Save Your Project

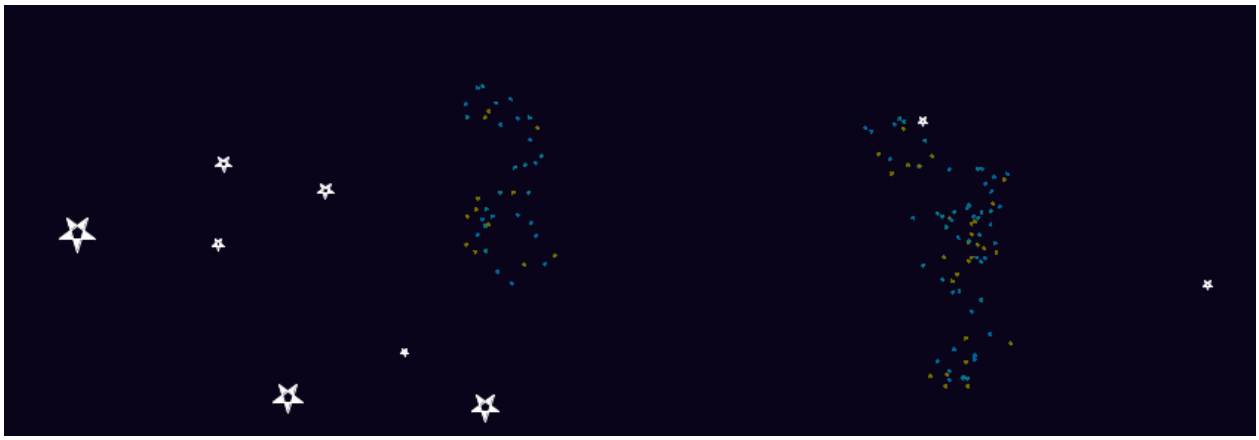
Step 4: Functions within functions

You can write functions that make use of other functions, to make writing large programs even easier!

Activity Checklist

- [ ] It would be great if we could add a galaxy of small multi-coloured stars to our drawing. As we already have a function to draw stars, we can create another function called `drawGalaxy()` that makes use of the `drawStar()` function that we already have:

```
from turtle import *
from random import *

#a function for moving the turtle to a random location
def moveToRandomLocation():
    penup()
    setpos( randint(-400,400) , randint(-400,400) )
    pendown()

#a function for drawing a star of a particular size
def drawStar(starSize, starColour):
    color(starColour)
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#a function for drawing a small galaxy of stars
def drawGalaxy(numberOfStars):
    starColours = ["#058396","#0275A6","#827E01"]
    moveToRandomLocation()
    #draw lots of small coloured stars
    for star in range(numberOfStars):
        penup()
        left( randint(-180,180) )
        forward( randint(5,20) )
        pendown()
        #draw a small star in a random colour
        drawStar( 2, choice(starColours) )

speed(11)

#this will draw a dark blue background
bgcolor("MidnightBlue")

#draw 30 white stars (random sizes/locations)
for star in range(30):
    moveToRandomLocation()
    drawStar( randint(5,25) , "White")

#draw 3 small galaxies of 40 stars
for galaxy in range(3):
    drawGalaxy(40)

hideturtle()
done()
```



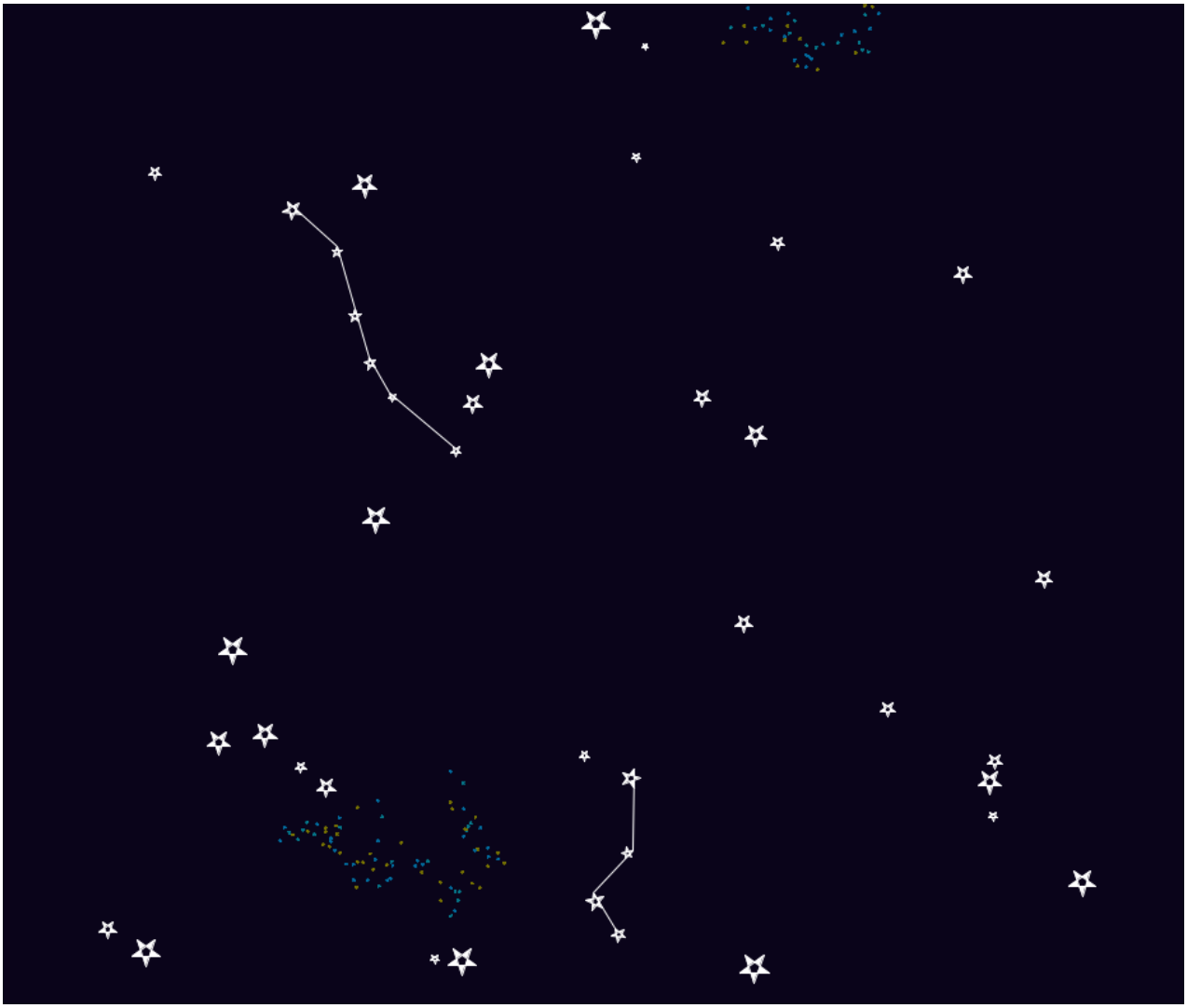
screenshot

Calling `drawGalaxy(40)` 3 times means that 3 new galaxies are drawn, each containing 40 stars. For each galaxy, the `drawStar()` function is run 40 times, each time moving a small random amount before drawing a really small random colour star.

The code `speed(11)` has also been added to speed up the turtle!

- [ ] You can also draw constellations made up of stars, joined together with white lines. Again, this is really easy to do, because you already have the function to draw stars!

```
from turtle import *
from random import *

#a function for moving the turtle to a random location
def moveToRandomLocation():
    penup()
    setpos( randint(-400,400) , randint(-400,400) )
    pendown()

#a function for drawing a star of a particular size
def drawStar(starSize, starColour):
    color(starColour)
    pendown()
    begin_fill()
    for side in range(5):
        left(144)
        forward(starSize)
    end_fill()
    penup()

#a function for drawing a small galaxy of stars
def drawGalaxy(numberOfStars):
    starColours = ["#058396","#0275A6","#827E01"]
    moveToRandomLocation()
    #draw lots of small coloured stars
    for star in range(numberOfStars):
        penup()
        left( randint(-180,180) )
        forward( randint(5,20) )
        pendown()
        #draw a small star in a random colour
        drawStar( 2, choice(starColours) )

#a function for drawing a joined constellation of stars
def drawConstellation(numberOfStars):
    moveToRandomLocation()
    #first draw all stars except the last one,
    #joined by lines, like this: *--*--*--
    for star in range(numberOfStars-1):
        drawStar( randint(7,15) , "white")
        pendown()
        left( randint(-90,90) )
        forward( randint(30,70) )
    #now draw the last star
    drawStar( randint(7,15) , "White")

speed(11)

#this will draw a dark blue background
bgcolor("MidnightBlue")

#draw 30 white stars (random sizes/locations)
for star in range(30):
    moveToRandomLocation()
    drawStar( randint(5,25) , "White")

#draw 3 small galaxies of 40 stars
for galaxy in range(3):
    drawGalaxy(40)

#draw 2 constellations, each with a random number of stars
for constellation in range(2):
    drawConstellation(randint(4,7))

hideturtle()
done()
```



screenshot

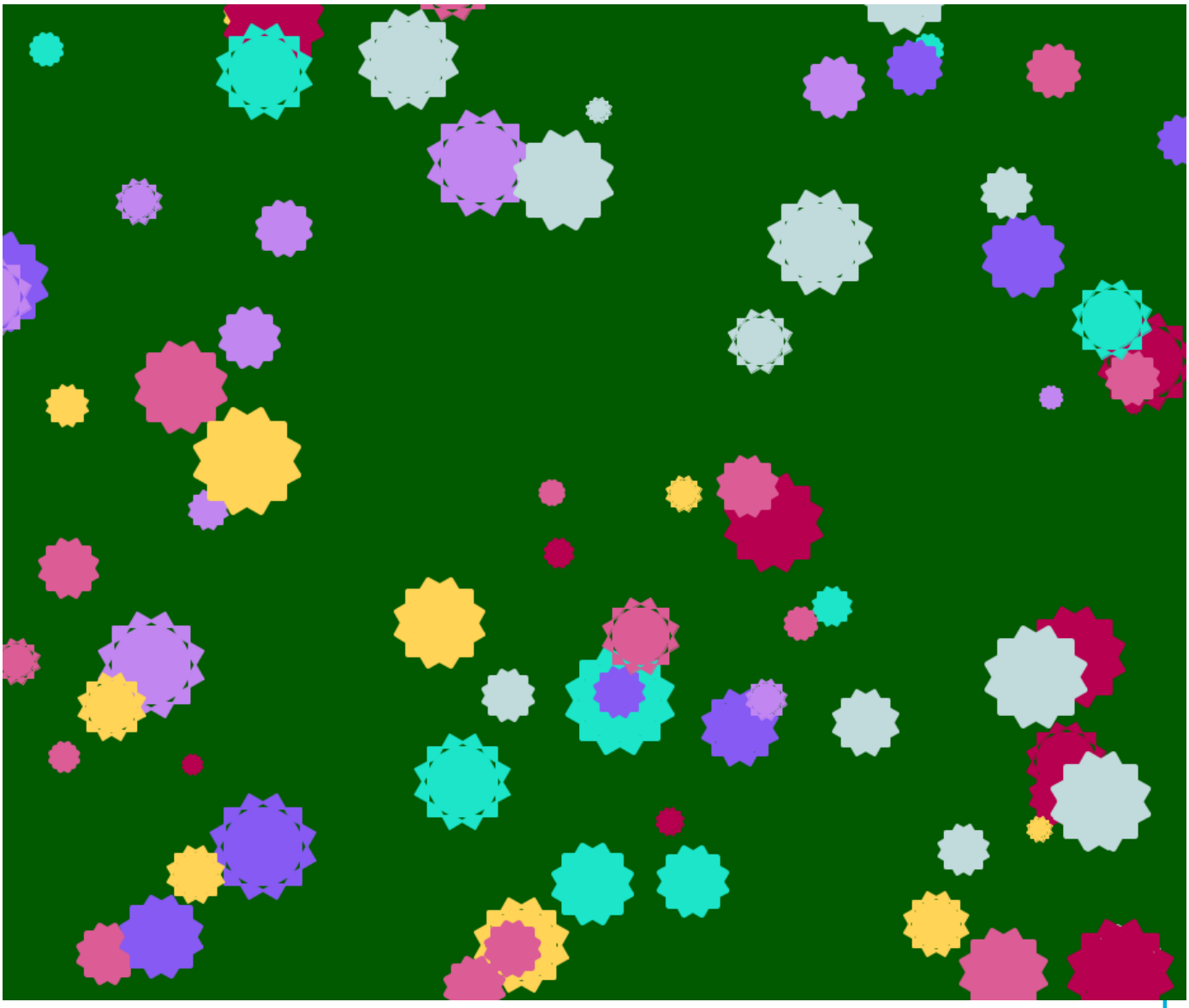
Save Your Project

Challenge: Functions everywhere!

Program the turtle to draw your own picture. Try to use functions wherever possible, to draw any shapes that you'll use a lot.

For example, you could draw a house, using `drawSquare()` and `drawTriangle()` functions.

You could even pass data to your functions, to allow you to draw shapes in different sizes and colours! Here are some examples:



Save Your Project