COMP1021
Introduction to Computer Science

# Using For Loops with Turtle Graphics

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## Outcomes

- After completing this presentation, you are expected to be able to:
  1. Explain the difference between while loops and for loops
  2. Use for loops to create patterns with graphics programming
  3. Use nested for loops to create patterns with graphics programming



## For Loops in Turtle Graphics

- Let's look at using for loops with graphics
- The basic difference between while loops and for loops:
- While loops – sometimes you don't know how many times the loop will repeat
- For loops – you exactly control the start value, end value and increment value, so you can work out exactly how many times the loop will repeat

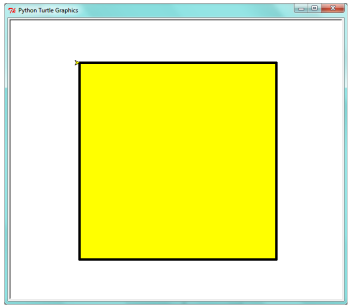


## Drawing a Square Using a For Loop

- Let's use a for loop to make a square:

```
for i in range(4):
    turtle.forward(400)
    turtle.right(90)
```

*The content of the loop is executed four times, to draw four sides of the square*

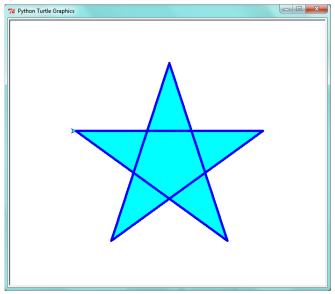



*The letter 'i' is quite commonly used for the loop variable of a loop ('i' for 'index'), although you can use any variable name*

# Drawing a Star Shape Using a For Loop

- You can alter the program to draw a star shape
- This for loop runs five times to create the five lines of the star:

```
for i in range(5):
    turtle.forward(400)
    turtle.right(144)
```



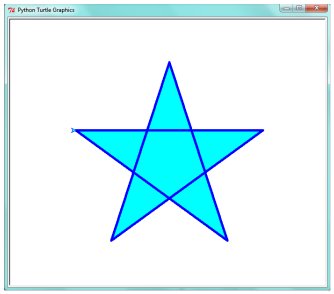


# Drawing a Star Shape Using a For Loop

- You can alter the program to draw a star shape
- This for loop runs five times to create the five lines of the star:

```
for _ in range(5):
    turtle.forward(400)
    turtle.right(144)
```

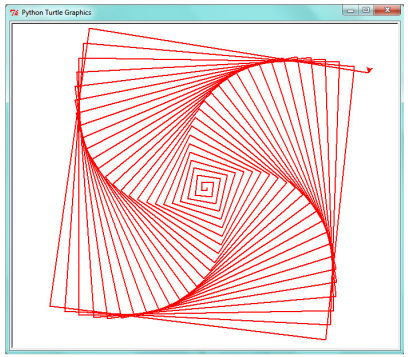
*You can use an '_' instead of a variable here because the items (i.e. the numbers) are not referred to anywhere inside the loop*

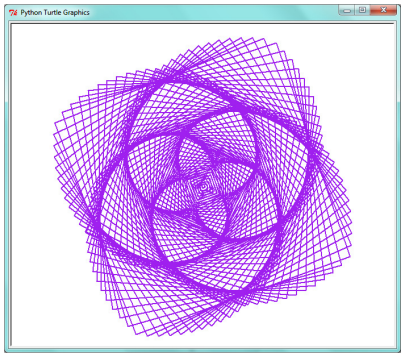




# Spiral Patterns Created Using Turtle

- In the following two examples patterns are created using for loops with some cleverly chosen numbers



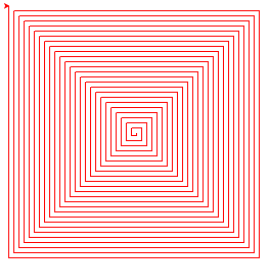


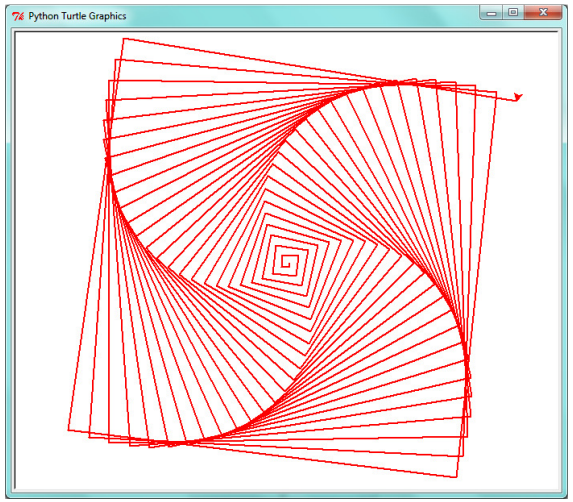
```
for i in range(0, 500, 5):
    turtle.forward(i)
    turtle.right(91)
```

Run 100 times, where i = 0, 5, …, 495

# Spiral Pattern 1

Turning by 91 degrees creates a kind of spiral pattern whereas turning by 90 degrees will produce this:





# Spiral Pattern 2

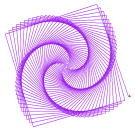
```
for i in range(0, 400, 2):
    turtle.forward(i)
    turtle.right(89)
```

Run 200 times, where i = 0, 2, …, 398

```
for i in range(401, 0, -2):
    turtle.forward(i)
    turtle.right(89)
```

Run 201 times

The first loop makes this:



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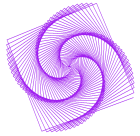
The second loop makes this:



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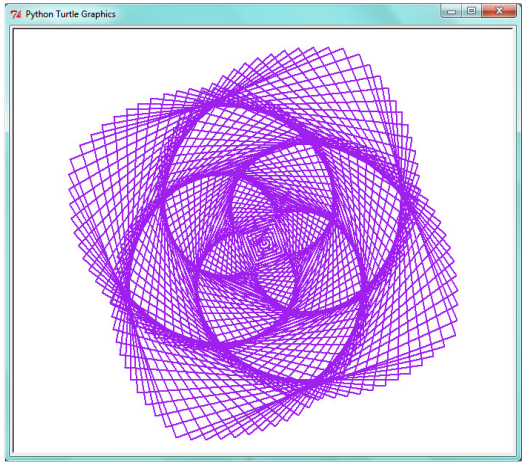
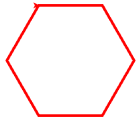



# Drawing a 'Flower' Using a Nested Loop

- In this example, a nested for loop (a for loop inside another for loop) is used to draw a flower
- The inner loop draws a hexagon and the outer loop uses the inner loop ten times to draw the flower:

Draw a single hexagon using the inner loop

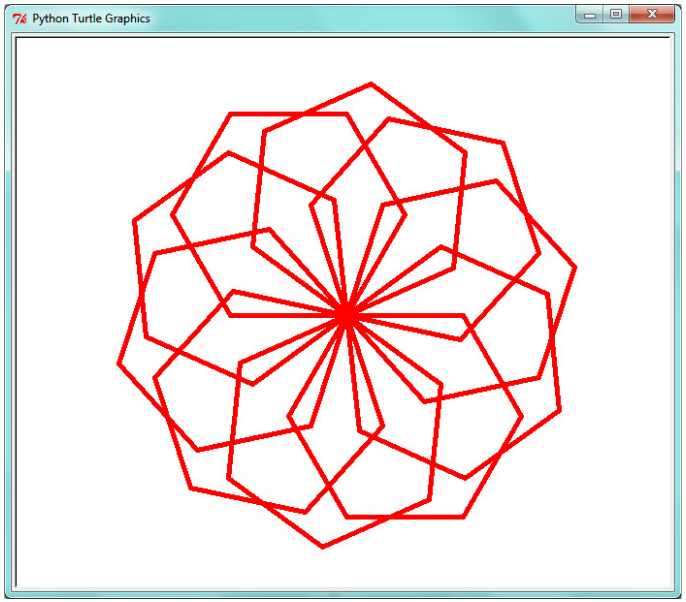


```
for _ in range(10):
    for _ in range(6):
        turtle.forward(120)
        turtle.right(60)
    turtle.right(36)
```

The outer loop draws hexagons around one full circle (10 * 36 = 360)



# The Flower Pattern Created By Hexagons




# Drawing a Pyramid of Dots

- In this example, a nested loop draws a pyramid of turtle dots using `turtle.dot()`
- The code is shown below:

```
size = 20
for i in range(0, 15, 2):
    for j in range(i + 1):
        turtle.dot(size)
        turtle.forward(size)
    turtle.backward(size * (i + 2))
    turtle.right(90)
    turtle.forward(size)
    turtle.left(90)
```

Create a single row of dots in the inner loop, e.g.:

Move the turtle to the starting point of the next row

# Drawing the Rows of Dots

```
for i in range(0, 15, 2):
    for j in range( i + 1 ):
        ...
```

- As you can see from the loops, the inner loop runs a number of times based on the value of the outer loop
  - The first time the inner loop runs, it draws 1 dot
  - The second time it runs, it draws 3 dots

    …
  - The last time it runs, it draws 15 dots



# turtle.dot() and turtle.up()

- You have learned that the turtle does not draw lines when you run `turtle.up()` before you move the turtle
- However, `turtle.dot()` is not affected by `turtle.up()` or `turtle.down()`
- In our example, `turtle.up()` has been used at the start of the program but the dots can still be drawn

```
import turtle

turtle.color("brown")
turtle.speed(0)
turtle.up()
turtle.hideturtle()
...
```

# A Pyramid of Dots