COMP1021
Introduction to Computer Science

An Example of a Nested Loop

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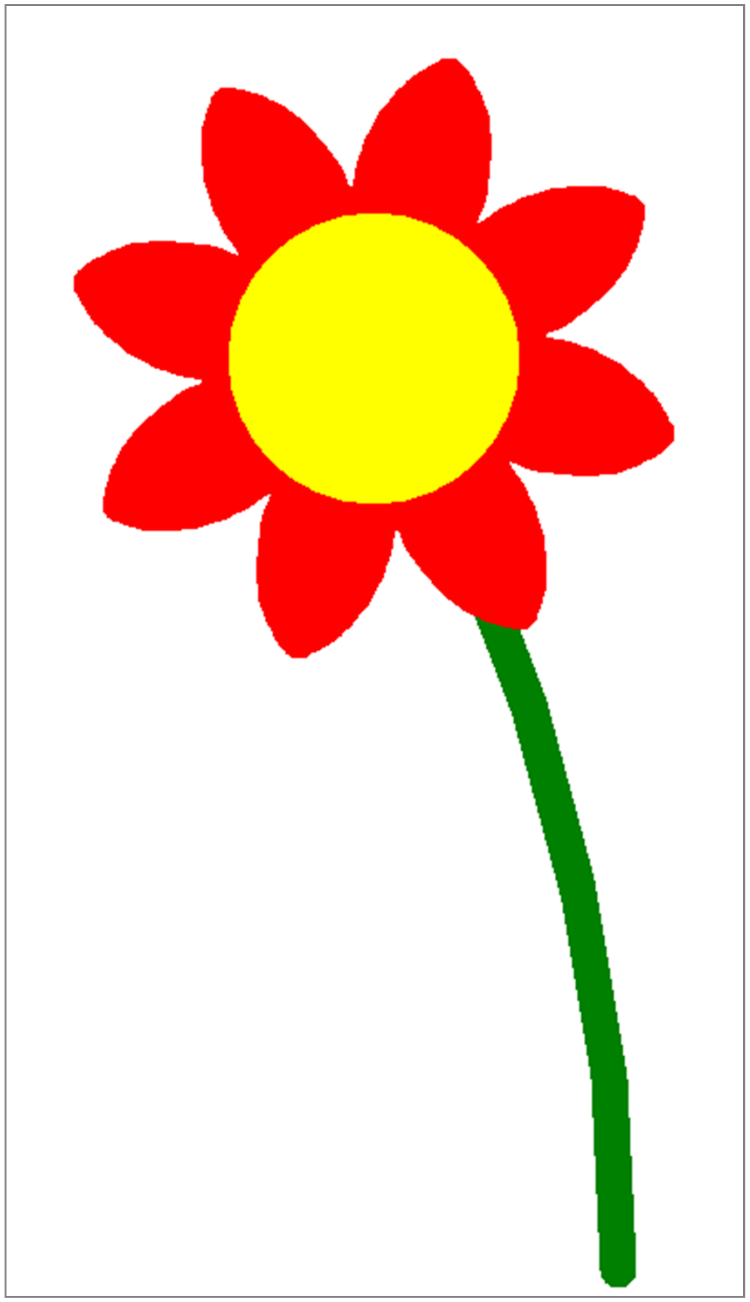
Outcomes

- After completing this presentation, you are expected to be able to:
  1. Use nested while loops to create a target pattern

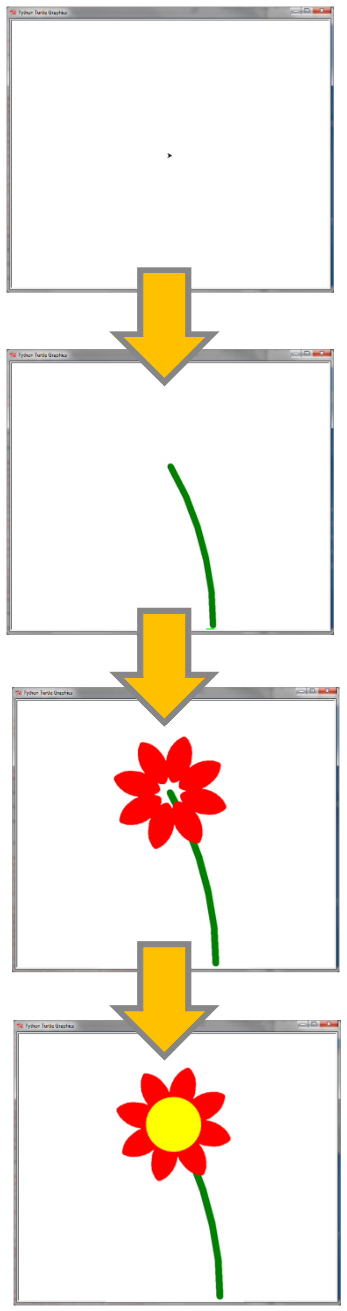
Using Nested Loops

- On the right is a flower image created by a single program
- The petals are a good example of using nested loops



The Program Stages

- Stage 1: Get the graphics started
  - Import the turtle module, fast speed
- Stage 2: Create the curved stem
  - Draw a small part of a circle
- Stage 3: Draw the petals
  - Uses a nested loop
- Stage 4: Draw the flower centre
  - Draw a yellow circle

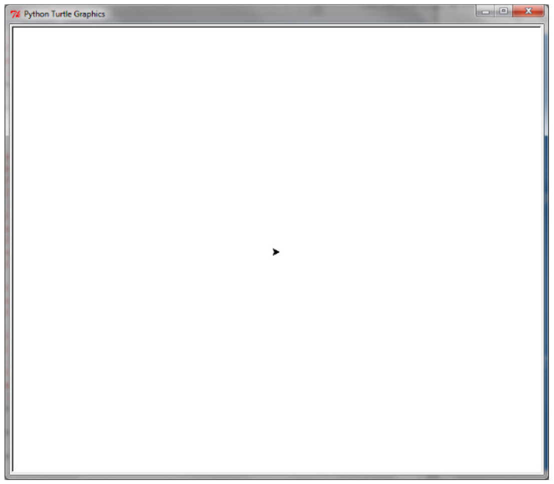


Stage 1 – Get the Graphics Started

- Like many of the programs we have seen, the first step is to import the turtle module and set some initial parameters i.e.:

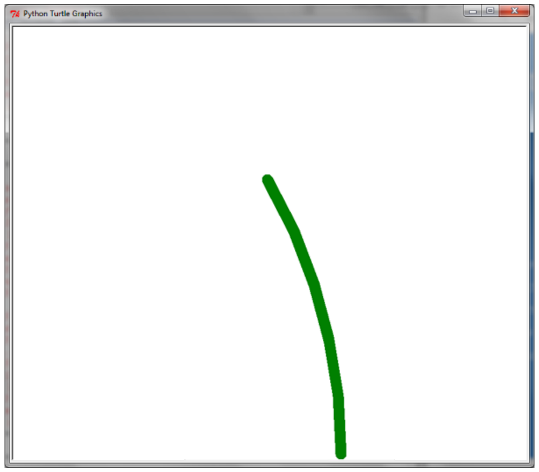
```
import turtle

turtle.speed(0)
```



Stage 2 – Create the Curved Stem

- We can create the stem of the flower using the `turtle.circle()` command:

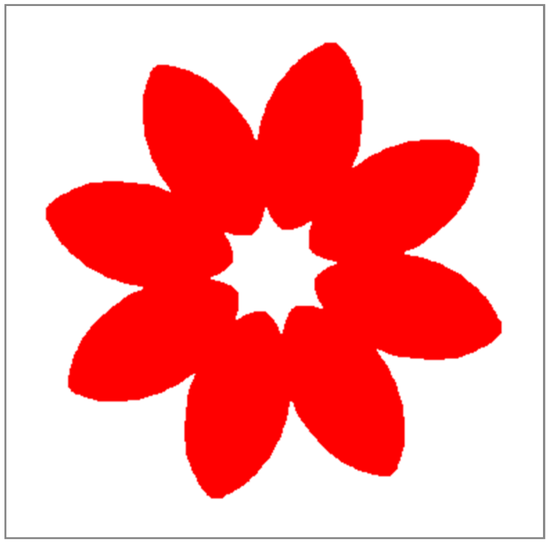


```
turtle.width(20)
turtle.color("green")

turtle.up()                # Don't draw while we move
turtle.goto(100, -400)     # Move the turtle to bottom right
turtle.left(90)            # Point the turtle upwards
turtle.down()              # Start drawing from now onwards
turtle.circle(1000, 30)    # Draw part of a large circle
```

Stage 3 – Draw the Petals

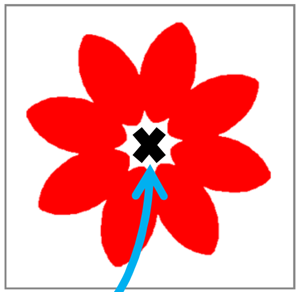
```
while ...condition... :
    ...statement(s)...
    while ...condition... :
        ...statement(s)...
```



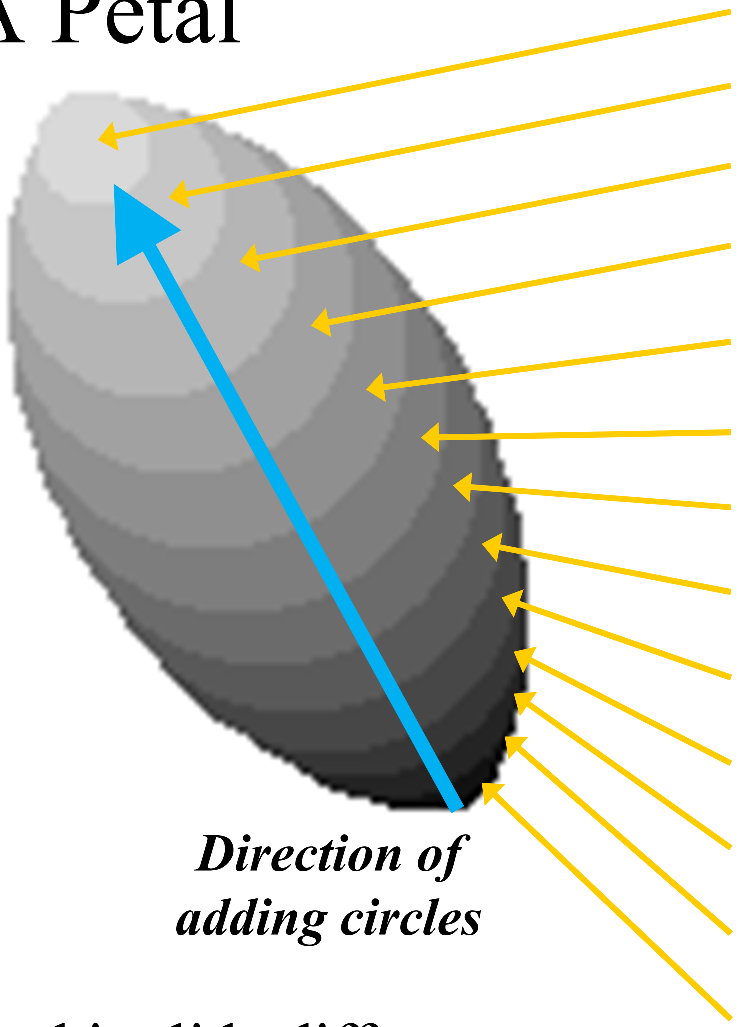
- As you already know, a loop inside another loop is called a *nested loop*
- It doesn’t matter what type of loop it is; any type of loop inside any type of loop is called a nested loop
- So far we know about *while* loops, in another presentation we will learn about *for* loops

Designing the Nested Loop Structure

- Let's consider how we can use a nested loop
  - **Outer loop:** repeat 8 times, for drawing 8 petals
    - Move to the position of the first circle
    - **Inner loop:** repeat 13 times, for drawing 13 circles
      - Draw a circle of the appropriate size
      - Move to the position of the next circle
    - Go backwards, to the centre position of the flower
    - Rotate the turtle by 45 degrees, ready for the next petal
- We will first show the inner loop, then the outer loop



A Petal



circle_number= 12	diameter= 19.5
circle_number= 11	diameter= 36.0
circle_number= 10	diameter= 49.5
circle_number= 9	diameter= 60.0
circle_number= 8	diameter= 67.5
circle_number= 7	diameter= 72.0
circle_number= 6	diameter= 73.5
circle_number= 5	diameter= 72.0
circle_number= 4	diameter= 67.5
circle_number= 3	diameter= 60.0
circle_number= 2	diameter= 49.5
circle_number= 1	diameter= 36.0
circle_number= 0	diameter= 19.5

- In this slide different shades of grey are used just to help you see the different circles
- To make the leaf shape a clever formula is used which uses the circle number to determine an appropriate diameter

The Inner Loop

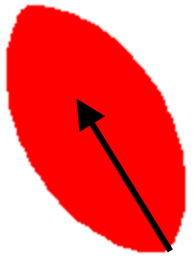
```
gap_between_circle = 10
total_circles = 13

circle_number = 0
while circle_number < total_circles:

    diameter = (circle_number + 1) * 1.5
        * (total_circles - circle_number)

    turtle.dot(diameter)
    turtle.forward(gap_between_circle)
    circle_number = circle_number + 1
```

These 3 variables are used in the following code



Repeat 13 times

Calculate the diameter using a clever formula, based on the circle number (you don't need to understand the maths)

Draw a circle and then move forward
(away from the center of the flower) to get in position for the next circle

```
starting_distance = 40
total_petals = 8

petal_number = 0
while petal_number < total_petals:
    turtle.forward(starting_distance)
```

These 3 variables are used in the following code

The code shown in the previous slide goes here

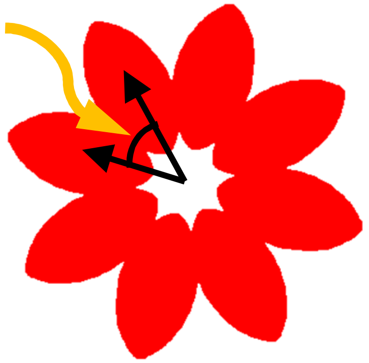
```
    turtle.backward(starting_distance
      + (total_circles * gap_between_circle) )

    turtle.left(360/ total_petals)

    petal_number = petal_number + 1
```

The turtle moves forward when it makes a petal; now go backwards to reach the flower center once again, ready for the creating the next petal

If there's 8 petals this angle will be 360/8 = 45 degrees



The Outer Loop

Stage 4 – Draw the Flower Centre

```
# Set the turtle drawing colour
turtle.color("yellow")

# Make a circle, using the drawing colour
turtle.dot(160)

# Sometimes we need this:
turtle.done()
```