Python 3 – Turtle graphics
Today’s lecture

- The Turtle graphics package
  - Brief history
  - Basic commands
  - Drawing shapes on screen
Logo and Turtle graphics

- In 1967, Seymour Papert and Wally Feurzeig created an interpretive programming language called Logo.
- Papert added commands to Logo so that he could control a turtle robot, which drew shaped on paper, from his computer.
- Turtle graphics is now part of Python.
- Using the Turtle involves instructing the turtle to move on the screen and draw lines to create the desired shape.
The Turtle package

- Some functions are part of Python's core libraries, in other words they are 'built-in'
  - `print()`
  - `input()`
  - `float()`

- Other functions need to be imported into your Python program

- The `turtle` module needs to be imported at the start of any Python program that uses it:
  ```python
  import turtle
  ```
There are four basic turtle commands:

- `turtle.forward(x)` - Moves turtle forward in direction it is facing by x steps.
- `turtle.back(x)` - Moves turtle backward from its facing direction by x steps.
- `turtle.left(x)` - Turns the turtle x degrees counterclockwise.
- `turtle.right(x)` - Turns the turtle x degrees clockwise.
Using the Python interpreter in IDLE to demonstrate how to use Turtle graphics

First, import the `turtle` package

```python
>>> import turtle
```

```python
>>> # Code to demonstrate Turtle graphics
```

```python
>>> # End of code to demonstrate Turtle graphics
```
Turtle example

- We are going to draw a right-angled triangle

- Important information:
  - The turtle appears as an icon
  - Initial position: (0, 0)
  - Initial direction: East (0°)
  - Colour: black
  - Line width: 1 pixel
  - Pen: down (ready to draw)
Algorithm

draw a line

Turn 90 degrees left (anti-clockwise)
draw a line

Turn 135 degrees left (anti-clockwise)
draw a line
Turtle example

- **Step 1: Draw a line**

```python
>>> import turtle

>>> turtle.forward(200)
```
Turtle example

- Note how the turtle is now facing upward after being turned 90 degrees left

```python
>>> import turtle
>>> turtle.forward(200)
>>> turtle.left(90)
```
Turtle example

Step 3: draw a line

```python
>>> import turtle

>>> turtle.forward(200)

>>> turtle.left(90)

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>>> turtle.forward(200)
Turtle example

- Step 4: turn 135 degree left (anti-clockwise)

```python
>>> import turtle

>>> turtle.forward(200)
>>> turtle.left(90)
>>> turtle.forward(200)
>>> turtle.left(135)
```
Working out the length of the longest side using the Pythagoras’ formula

```python
>>> import turtle

>>> turtle.forward(200)
>>> turtle.left(90)
>>> turtle.forward(200)
>>> turtle.left(135)

>>> c = ((200**2)+(200**2))**0.5  #around 283 steps
```
Turtle example

- **Step 6: draw a line**
- **The finished image**

```python
>>> import turtle

>>> turtle.forward(200)
>>> turtle.left(90)
>>> turtle.forward(200)
>>> turtle.left(135)
```

```python
>>> c = ((200**2)+(200**2))**0.5)
>>> turtle.forward(c)
```
Turtle example

- We can use loops when drawing shapes using Turtle graphics
- Write a program that will draw a square using a loop

```
Draw a line
Turn 90 degree left
```
X 4 times
We can use loops when drawing shapes using Turtle graphics.

Write a program that will draw a square using a loop.

```python
import turtle

count = 0
while count < 4:
    turtle.forward(200)
    turtle.left(90)
    count = count + 1
```
Exercise 1

- Write a Python program that draws a rectangle. The long sides must be 300 steps long and the short sides must be 150 steps long.
Turtle example

- Write a program that will draw a circle

  - Steps:
    - Draw a short line (2 pixels)
    - Turn 1 degree
    - Repeat the above steps 360 times
Turtle example

- Write a program that will draw a circle

```python
import turtle
count = 0
while(count < 360):
    turtle.forward(2)
    turtle.left(1)
    count = count + 1
print("Finished!")
```
Question

Consider the following program:

```python
import turtle
count = 0
length = 100
while count < 4:
    turtle.forward(length)
turtle.left(90)
count = count + 1
length = length - 10
```

Which of the following pictures demonstrates the output generated by the program above?
Exercise 2

- How to draw a star?
  - How many steps do you need?
  - What is the size/length for each step? E.g. 400 pixels
  - What is the turning angle for each step?
Exercise 3

- Draw the shape that is produced by the following Python program:

```python
import turtle
count = 0
while(count < 180):
    turtle.forward(2)
    turtle.right(1)
    count = count + 1
turtle.right(45)
turtle.forward(300)
turtle.left(90)
turtle.back(150)
turtle.right(45)
turtle.back(250)
```
Exercise 4

- Draw the shape that is produced by the following Python program:

```python
import turtle
big_line = 100
little_line = 50
angle = 90

turtle.left(angle)
turtle.forward(big_line)
count = 0
while count < 4:
    turtle.right(angle//2)
    if count != 3:
        turtle.forward(little_line)
    else:
        turtle.forward(big_line)
count = count + 1

turtle.right(90)
turtle.forward(130)
```
Summary

- The Turtle package must be imported into every Python program that uses it.
- The Turtle has four basic commands: forward, back, left and right.