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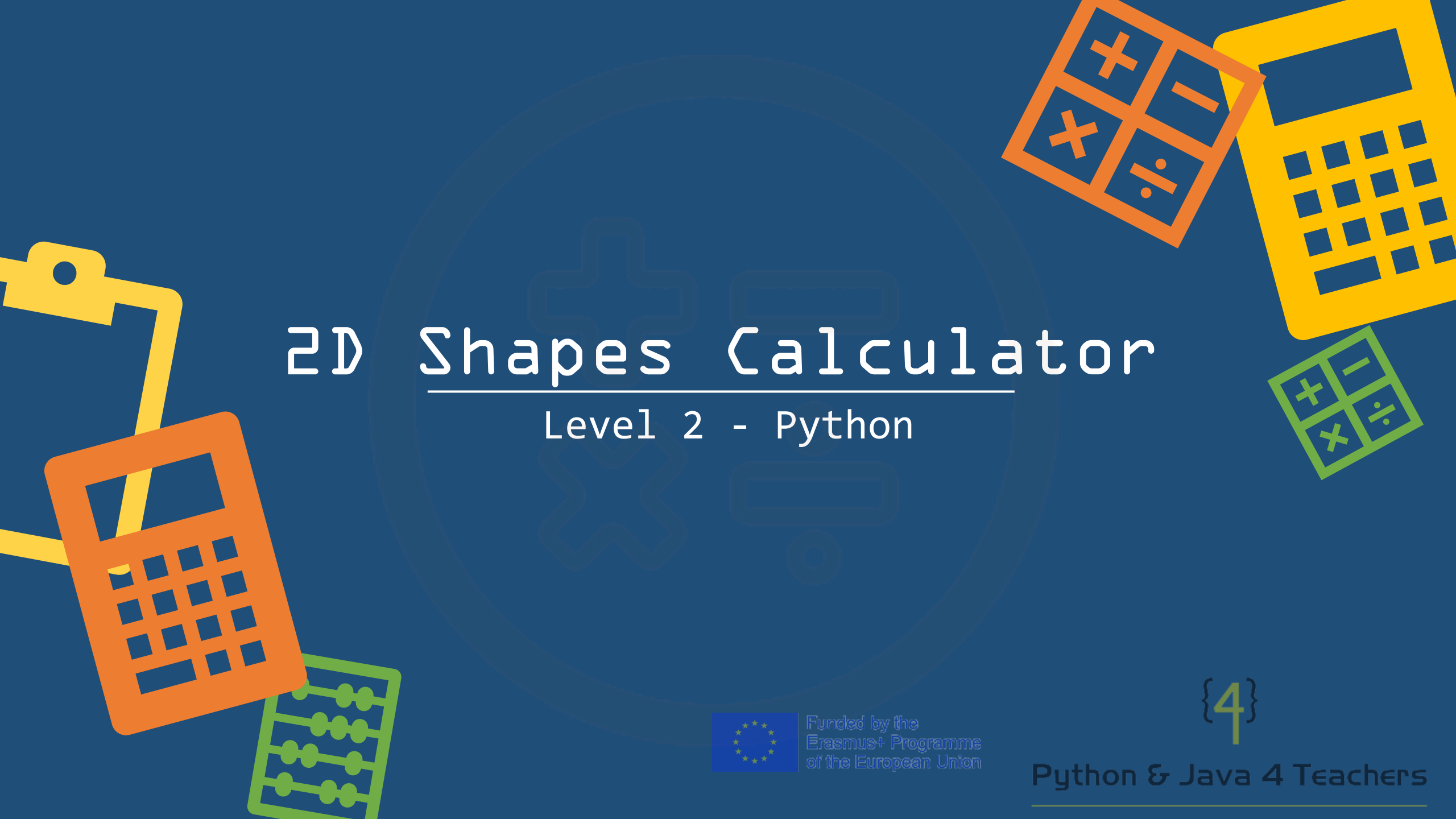

2D Shapes Calculator

Level 2 - Python

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Introduction

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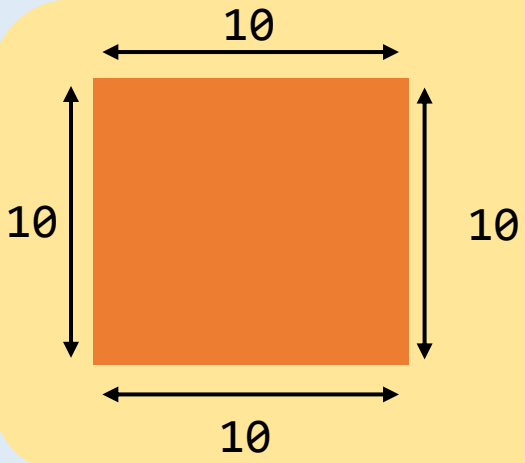
Before we can calculate the perimeters and areas of shapes, we need to understand the maths behind it.

To find the perimeter of a polygon, add all the side lengths up together

To find the area of a square, we do `length * width`

To find the area of triangle, we do `½ * base * height`



perimeter = 10 + 10 + 10 + 10

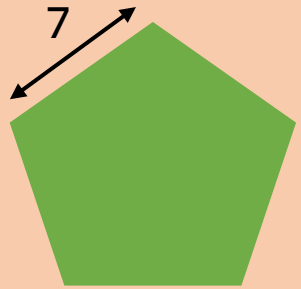
perimeter = 40

area = 100 m²

We can find the area of any regular polygon using the following formula:

$$area = n * a^2 * \cot(\pi/n) / 4$$

Where n = number of sides and a = the side length



area = 5 * (7)² * cot(π/5) / 4

area = 84.3034 m²

Task

A tiling company is developing a new range of kitchen and bathroom tiles.

The tiles vary in shape and size, and to know how much everything is going to cost, they need a piece of software that can help them quickly find the area and perimeter of polygons.

You've been tasked with creating a 2D polygon calculator!

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Process

In this project we will be making a 2D shape calculator and will:

- Let the user find the area and perimeter of triangles
- Let the user find the area and perimeter of squares

(this will only work for regular polygons)

Extension

- Allow the user to find the area and perimeter of any 2D regular polygon

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What it will look like…

```
--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
3) Other Regular Polygon
Enter a choice: 2
Enter the base of your triangle: 45
The area of a triangle is 1012.5
The perimeter of a triangle is 135
```

```
--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
3) Other Regular Polygon
Enter a choice: 3
Enter the number of sides: 7
Enter the side length: 2
The perimeter of this polygon is 14.535649776006357
```

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Subroutines

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Subroutines are sets of instructions designed to perform a frequently used operation within a program.

```
1
2 def greeting():
3     print("Hello World!")
4     print("How are you today?")
5
6
7 greeting()
8
```

```
Hello World!
How are you?
```

Subroutines can store code and will only be run when ‘called’.

There are two main types of subroutine: procedures and functions.

Procedures are not required to return a value, whereas functions must return a value.

Subroutines are great ways of writing more maintainable code and leads to more structured, organised and understandable programs.

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Parameters and Arguments

Information can be passed into subroutines using parameters, which act as placeholders for the real values assigned when called

```
1
2 def addition(num1, num2):
3     result = num1 + num2
4     print(num1,"+",num2,"=",result)
5
6 num1 = input("Enter a number: ")
7 num2 = input("Enter a number: ")
8
9 addition(num1, num2)
```

```
Enter a number: 10
Enter a number: 9
10 + 9 = 19
```

The values put in the brackets when the subroutine is called are called arguments.

Step 1

Find the area and perimeters of squares

We declare two subroutines: ‘areaOfSquare()’ and ‘perimeterOfSquare()’ which both have a ‘length’ parameter.

```
1
2  #Defining subroutines
3
4  def areaOfSquare(length):
5      print("The area of the square is", (length*length))
6
7  def perimeterOfSquare(length):
8      print("The perimeter of the square is", (length*4))
9
10
11
12 #Main
13
14 length = int(input("Enter the length of your square: "))
15
16 areaOfSquare(length)
17 perimeterOfSquare(length)
```

```
Enter the length of your square: 5
The area of the square is 25
The perimeter of the square is 20
```

We get user input from the ‘MAIN’ section of our program, where we use the user input as an argument for both called subroutines

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Step 2

Find the area and perimeters of triangles

```
10
11 def areaOfTriangle(base):
12     print("The area of a triangle is", (0.5 * base * base))
13
14 def perimeterOfTriangle(base):
15     print("The area of a triangle is", (base * 3))
16
```

```
26 perimeterOfTriangle(3)
27 areaOfTriangle(3)
```

```
The area of a triangle is 9
The area of a triangle is 4.5
```

Next we write subroutines to calculate the areaOfTriangle() and the perimeterOfTriangle()

Make sure to test your subroutines by calling them and passing in a value!

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Step 3

Creating a basic menu

```
18 #Main#
19
20 while True:
21     print("\n--- 2D Regular Polygon Calculator ---")
22     print("1) Square ")
23     print("2) Triangle")
24
25     choice = input("Enter a choice: ")
26
27     if choice == "1":
28         length = int(input("Enter the length of your square: "))
29
30         areaOfSquare(length)
31         perimeterOfSquare(length)
32
33     elif choice == "2":
34
35         base = int(input("Enter the base of your triangle: "))
36
37         areaOfTriangle(base)
38         perimeterOfTriangle(base)
39
40     else:
41         print("Invalid input - try again.")
```

```
--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
Enter a choice: 2
Enter the base of your triangle: 3
The area of a triangle is 4.5
The area of a triangle is 9

--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
Enter a choice:
```

Here we make a basic console menu that responds to user input using an IF ELIF ELSE statement.

We surround the code in a WHILE (True) statement so the code will repeat forever

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What we have so far…

```
1
2  #Defining subroutines
3
4  def areaOfSquare(length):
5      print("The area of the square is", (length*length))
6
7  def perimeterOfSquare(length):
8      print("The perimeter of the square is", (length*4))
9
10
11 def areaOfTriangle(base):
12     print("The area of a triangle is", (0.5 * base * base))
13
14 def perimeterOfTriangle(base):
15     print("The perimeter of a triangle is", (base * 3))
16
```

```
18 #Main#
19
20 while True:
21     print("\n--- 2D Regular Polygon Calculator ---")
22     print("1) Square ")
23     print("2) Triangle")
24
25     choice = input("Enter a choice: ")
26
27     if choice == "1":
28         length = int(input("Enter the length of your square: "))
29
30         areaOfSquare(length)
31         perimeterOfSquare(length)
32
33     elif choice == "2":
34
35         base = int(input("Enter the base of your triangle: "))
36
37         areaOfTriangle(base)
38         perimeterOfTriangle(base)
39
40     else:
41         print("Invalid input - try again.")
```

```
--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
Enter a choice: 2
Enter the base of your triangle: 3
The area of a triangle is 4.5
The area of a triangle is 9

--- 2D Regular Polygon Calculator ---
1) Square
2) Triangle
Enter a choice:
```

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Extension

To expand out program, lets make it so the user can find the perimeter and area of any regular polygon.

We can find the area of any regular polygon using the following formula:

$$area = n * a^2 * \cot(\pi/n) / 4$$

Where n = number of sides and a = the side length

Because this formula is slightly complicated, we will be importing and using the 'math' Python library

```
1
2 import math
3
```

```
19 def areaOfPolygon(n, a):
20     area = n * (a*a) * (1/math.tan(math.pi / n)) / 4
21     print("The perimeter of this polygon is", area)
```

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Extension

Make sure to add in an ELIF statement and update our menu!

```
26 while True:
27     print("\n--- 2D Regular Polygon Calculator ---")
28     print("1) Square ")
29     print("2) Triangle")
30     print("3) Other Regular Polygon")
31
32     choice = input("Enter a choice: ")
```

```
47     elif choice == "3":
48         numberOfSides = int(input("Enter the number of sides: "))
49         sideLength = int(input("Enter the side length: "))
50
51         areaOfPolygon(numberOfSides, sideLength)
52
```

Challenge: Can you make a subroutine to calculate the perimeter of any given regular polygon?

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Final product…

```python

import math

#Defining subroutines

def areaOfSquare(length):
    print("The area of the square is", (length*length))

def perimeterOfSquare(length):
    print("The perimeter of the square is", (length*4))


def areaOfTriangle(base):
    print("The area of a triangle is", (0.5 * base * base))

def perimeterOfTriangle(base):
    print("The perimeter of a triangle is", (base * 3))

def areaOfPolygon(n, a):
    area = n * (a*a) * (1/math.tan(math.pi / n)) / 4
    print("The perimeter of this polygon is", area)

```

```python
while True:
    print("\n--- 2D Regular Polygon Calculator ---")
    print("1) Square ")
    print("2) Triangle")
    print("3) Other Regular Polygon")

    choice = input("Enter a choice: ")

    if choice == "1":
        length = int(input("Enter the length of your square: "))

        areaOfSquare(length)
        perimeterOfSquare(length)

    elif choice == "2":

        base = int(input("Enter the base of your triangle: "))

        areaOfTriangle(base)
        perimeterOfTriangle(base)

    elif choice == "3":
        numberOfSides = int(input("Enter the number of sides: "))
        sideLength = int(input("Enter the side length: "))

        areaOfPolygon(numberOfSides, sideLength)

    else:
        print("Invalid input - try again.")

```

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Conclusion…

Learning Outcomes:

- ✓ Learn how to use subroutines
- ✓ Apply programming skills to a real life problem
- ✓ Create a menu that the user can interact with

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Links to Everyday Life…

At Work

Geometry is a really key part of many industries. Being able to rapidly calculate perimeter and area could be crucial

Architects, trades people, engineers – so many professions require geometry. Our programs could make their lives easier!

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Congratulations!

You have created your own 2D shapes calculator using Python!

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