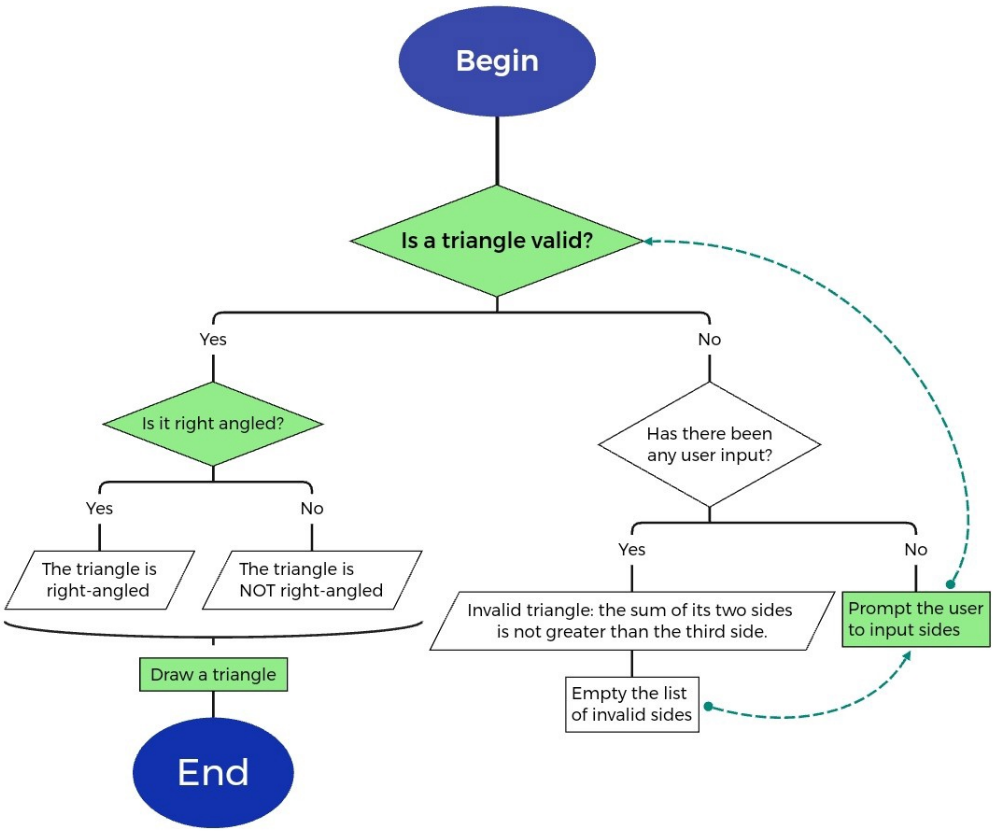
1 Analysis

- **The outline of the problem:** user inputs three sides of a triangle, the program identifies whether it is right angled and draws it.
- **Stakeholders:** the client is the Head of Mathematics at DLD College London.
- **Research:** how to use turtle graphics in python in order to draw a triangle.
- **Success criteria & features:** the program will be successful if it will correctly identify a triangle, draw it, handle any input, be user friendly and intuitive to use, readable and well-documented (the code), follow the PEP-8 convention, will not crash, contain severe bugs or cause any frustration to a user.

2 Design

- Flow-chart:


Begin
Is a triangle valid?
Yes
No
Is it right angled?
Yes
No
The triangle is right-angled
The triangle is NOT right-angled
Draw a triangle
End
Has there been any user input?
Yes
No
Invalid triangle: the sum of its two sides is not greater than the third side.
Prompt the user to input sides
Empty the list of invalid sides

- Rhomboids represent choices, parallelograms – outputs, green background means function, rectangles are actions.
- The lengths entered by a user will be stored in a list as strings, which after all the validation checks will be converted into integers and sorted in the descending order.
- The function which prompts the user to input sides includes another function that determines whether the input is a positive integer.

- Test data:
  - 1, 1, 1 **[PASSED]**
  - 3, 4, 5 **[PASSED]**
  - 4, 3, 5 **[PASSED]**
  - 5, 4, 3 **[PASSED]**
  - 7, 9, 8 **[PASSED]**
  - 8, 14, 8 **[PASSED]**
  - 0 **[PASSED]**
  - 1.5 **[PASSED]**
  - -3 **[PASSED]**
  - abc **[PASSED]**
  - *&#@ **[PASSED]**
  - <CR> **[PASSED]**
  - 1, 2, 999 **[PASSED]**
  - 300000, 400000, 500000 **[PASSED]**
  - 100, 99, 98 **[PASSED]**
  - 1, 100, 1 **[PASSED]**

3 Development

- The program is well-documented with a sufficient use of comments and documentation strings for functions, so it is easy to understand and navigate.
- It is separated into smaller functions to ensure code re-usability and readability, therefore the entire logic of the program can be observed in the main function:

```python
import math
import turtle

def main():
    sides = []
    # Prompt the user to enter lengths until all the requirements are met.
    while not triangle_is_valid(sides):
        # Don't show the error message on the
        # first try (if the list is empty).
        if sides:
            sides.clear()
            print('Invalid triangle: the sum of its two sides '
                  'is not greater than the third side.')
        sides = input_sides(sides)

    if is_right_angled(sides):
        print(f'The triangle with sides {sides[0]}, '  # The use of f-strings.
              f'{sides[1]} and {sides[2]} IS right angled.')
    else:
        print(f'The triangle with sides {sides[0]}, '
              f'{sides[1]} and {sides[2]} is NOT right angled.')

    draw_triangle(sides)


if __name__ == '__main__':
    main()
```

- The program starts with a loop that ensures that a correct input has been provided. It will continue prompting the user until numerous validation checks are passed:

```python
def input_sides(sides):
    """Get a valid input from the user and format it appropriately."""
    i = 0
    while i < 3:
        sides.append(input(f'Please enter the length of the #{i+1} side: '))
        if side_is_valid(sides[i]):
            i += 1
        else:
            sides.pop()
    # Convert strings to integers.
    sides = [int(i) for i in sides]  # The use of list comprehension.
    sides.sort()
    return sides


def side_is_valid(side_len):
    """Check if the entered length is a positive integer."""
    # Check if it's an integer.
    try:  # The use of exception handling.
        int(side_len)
    except ValueError:
        print('The length must be an integer.')
        return False

    # Check if it's positive.
    if int(side_len) <= 0:
        print('The length must be positive.')
        return False
    else:
        return True


def triangle_is_valid(sides):
    """
    Check if the user has entered three
    lengths that meet the triangle inequality.
    """
    try:
        a = sides[0]
        b = sides[1]
        c = sides[2]
    except IndexError:
        return False

    # The triangle inequality.
    if a+b>c and a+c>b and b+c>a:
        return True
    else:
        return False
```

- Next, it is determined whether a triangle is right-angled or not:

```python
def is_right_angled(sides):
    """Check if the triangle is right angled or not."""
    short_cathetus = sides[0]
    long_cathetus = sides[1]
    hypotenuse = float(sides[2])  # math.sqrt returns float.
    # The Pythagorean theorem.
    if hypotenuse == math.sqrt(short_cathetus**2 + long_cathetus**2):
        return True
    else:
        return False
```

- Lastly, the triangle is drawn. This function incorporates the law of cosines to find the angles and it automatically sets the scale based on the user's input, so that both big (i.e. 300, 400, 500) and small (i.e. 1, 1, 1) triangles could be clearly visible:

```python
def draw_triangle(sides):
    """Draw a triangle."""  # The use of a documentation string.
    a = sides[0]
    b = sides[1]
    c = sides[2]
    # Use the law of cosines to find the angles.
    b_angle = math.degrees(math.acos((a**2 + b**2 - c**2) / (2*a*b)))
    c_angle = math.degrees(math.acos((b**2 + c**2 - a**2) / (2*b*c)))

    t = turtle.Turtle()
    # Set the scale based on the largest length.
    scale_factor = 10**len(str(c))
    turtle.setworldcoordinates(0, 0, scale_factor, scale_factor)
    # Set the speed of drawing to maximum.
    t.speed(10)

    # Draw side a.
    t.forward(a)
    t.left(180 - b_angle)
    # Draw side b.
    t.forward(b)
    t.left(180 - c_angle)
    # Draw side c.
    t.forward(c)

    turtle.done()
```

4 Evaluation

- The program has successfully met all the criteria and features set in the Analysis section, and passed every test in the Design section.
- Potential maintenance problems could occur if something happens to the external libraries used or in case more users test the program on different devices. Since I am neither maintaining the libraries, nor have resources to conduct such a thorough testing, I am currently unable to prevent these potential issues.
- One of the limitations of the program is that while it has auto-scaling, it lacks user control. For instance, one might want to manually decrease the scale in real time or move/rotate the triangle in order to better inspect it. More details can be provided on the drawing and in the output (i.e. angles). Moreover, a system of saving the results in a file (both drawing and parameters) may be implemented.