Assignment 1 – Expressions and Functions

Required Files

- `Assignment_1_template.py`

Note about grading

For each task, submit to Coursemology both your comments and the function definitions.

Each task will be graded based on (1) comments written; (2) correctness of the code. Different components in different tasks may have different weightages.

Task 1: Absolute Difference between roots of Quadratic equations [30 marks]

There are many kinds of equations to solve in algebra. One of the most common kind of equations are quadratic equations, which come in the form of $ax^2 + bx + c = 0$, where x is the variable, and a, b and c are the coefficients of the equation. In 628 AD, Brahmagupta explicitly described the general formula to be:

$$\mathrm{x} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Assuming that $b^2 \geq 4ac$ holds, the equation will have two real roots (which might be equal).

You are given an incomplete code for a Python function *rootAbsDiff* (a, b, c) that takes in the three coefficients a, b, and c of a quadratic equation. You may assume that *rootAbsDiff* is always called with the three coefficients such that $b^2 \geq 4ac$. Every time when it is called, *rootAbsDiff* calculates the two roots of the equation and returns the absolute difference between the two roots.

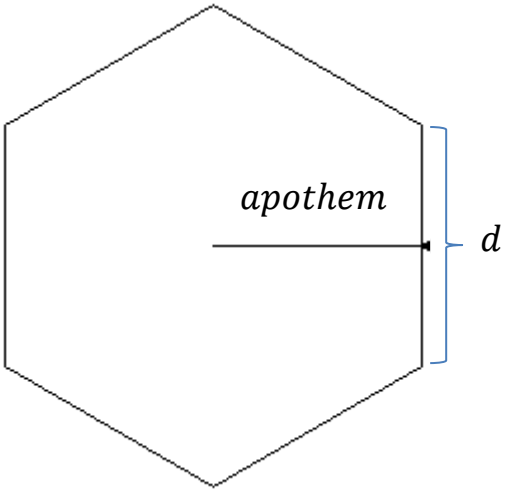
You may use the $sqrt$ function from the `math` library to help you calculate square roots. You might also use the abs function (which is a built-in function in Python to help you calculate absolute values.)

Complete the definition of *rootAbsDiff*, and test its correctness in Python shell, as follows:

```
>>> rootAbsDiff(1,2,1)
0.0
>>> rootAbsDiff(1,7,10)
3.0
>>> rootAbsDiff(3,8,3.5)
1.5634719199411435
>>>
```

Task 2: Side length of a Regular Polygon [40 marks]

The area of a regular n-sided polygon with each side of length d can be calculated by the following formula:



$$area = \frac{perimeter \times apothem}{2}$$

$$perimeter = n \times d$$

$$apothem = \frac{d}{2 \times \tan(\frac{180}{n})}$$

where $apothem$ is the shortest distance from the centre of the polygon to one of the polygon sides.

Using the above formulae, write two Python functions:

a. Write a Python function $areaPoly(n, d)$, which given the number of corners, n, in a regular polygon and the length d of one of its sides, calculate the area of the polygon. You may use some of the trigonometric functions – such as tangent function – and constant pi (π) from the math library.
b. Write a Python function $polySide(n, area)$, which given the number of corners, n, in a regular polygon and the polygon $area$, calculate the length of one of its sides.

```
>>> areaPoly(4,10)
100.00000000000001
>>> polySide(4,100)
10.0
>>> areaPoly(4,polySide(4,100))
100.00000000000001
>>>
```

Hint: What units does the tangent function tan take in? The formula for converting degrees into radians is

$$radians = degree \times \frac{\pi}{180}$$

Task 3: Simple Turtle [30 marks]

You might have learnt some of the Python Turtle functions in lecture/tutorial. Here are a few questions to really test your understanding of how they work, and a very simple drawing to get you acquainted with drawing with Turtle!

Some of the functions covered are:

- `pd()`: Pen down. Any movements thereafter will be traced
- `pu()`: Pen up. Any movements thereafter will NOT be traced
- `forward(distance)`: Moves the turtle forward a number of units specified by distance
- `backward(distance)`: Moves the turtle backward a number of units specified by distance
- `right(degrees)`: Turns the turtle right by a certain number of degrees specified
- `left(degrees)`: Turns the turtle left by a certain number of degrees specified

(Note: the direction functions `forward`, `backward`, `right` and `left` all have shorthands, which are `fd`, `bk` (or `back`), `rt` and `lt` respectively. Use any of these shorthands or full names as you prefer.)

Warmup

In the following sequences of function calls, try to imagine what will be drawn. Then, run the calls yourself on Python. Did it draw what you had expected? *(Note: This part is not graded and is only for your own practice. There is no need to copy your answers from this part to Coursemology)*

a)
```
forward(100)
backward(100)
forward(100)
backward(100)
```

b)
```
backward(100)
pu()
left(90)
forward(100)
right(90)
forward(100)
```

c)
```
backward(100)
left(90)
forward(100)
right(90)
forward(100)
```

d)
```
right(90)
left(180)
right(315)
backward(100)
right(90)
backward(100)
```

Now you try!

With the functions that you have learnt so far, write a function with function header:

$$draw\_house(height, breadth, roof\_base)$$

This function will draws a house of height (to the base of the roof) $height$ units, of breadth $breadth$ units and the roof is $root\_base$ units wide. Calling $draw\_house(100,150,200)$ will result in something like the following. It does not matter how the roof of the house looks like, but make sure your drawn house is left-and-right symmetrical.