Assignment 2: due **11:59 pm** on **Saturday, October 5, 2024**

Summary of Instructions

Note	**Read the instructions carefully and follow them exactly**
Assignment Weight	**As outlined in the syllabus, this assignment is worth 2.5% of your final grade**
Due Date	**This assignment is due 11:59 on Saturday, October 5, 2024**
Important	**As outlined in the syllabus, late submissions will not be accepted**
	Any files with syntax errors automatically be excluded from grading. Be sure to test your code before you submit it
	For all functions, make sure you've written good docstrings that include type contract, function description and the preconditions if any. That includes functions you write both in Part 1 and Part 2.

This is an individual assignment. Please review the Plagiarism and Academic Integrity policy presented in the first class, i.e. read in detail pages 16-20 of course outline (i.e. slides of Lecture 1). You can find that file on Brightspace under Lecture 1. While at it, also review Course Policy on missing assignments on page 14.

The goal of this assignment is to learn and practice the concepts covered thus far: function design, function calls, branching (i.e. if statements), strings. You can make multiple submissions, but only the last submission before the deadline will be graded. What needs to be submitted is explained next.

Your grade will partially be determined by automatic (unit) tests that will test your functions. All the specified requirements below are mandatory (including function names). Any requirement that is specified and not met may/will result in deduction of points.

Submit your assignment by the deadline via Brightspace (as instructed and practiced in the first lab.) You can make multiple submissions, but only the last submission before the deadline will be graded. For this assignment you must submit 5 files as described below. For each missing file there will be a grade deduction:

The assignment has two parts. Each part explains what needs to be submitted. Put all those required documents into a folder called `a2_xxxxxx` where you changed `xxxxxx` to your student number, zip that folder (do not use `rar` compression format) and submit it as explained in Lab 1. In particular, the folder must have the following 5 files:
– for Part 1: `a2_part1_xxxxxx.py`, `a2_part1_xxxxxx.txt`
– for Part 2: `a2_part2_xxxxxx.py` `a2_part2_xxxxxx.txt` and
– `references-YOUR-FULL-NAME.txt`

I suggest you do part 2 first and then do part 1.

Both of your programs/parts must run without syntax errors. In particular, when grading your assignment, TAs will first open your file `a2_part1_xxxxxx.py` with IDLE and press Run Module. If pressing Run Module causes any syntax error, the grade for Part 1 becomes zero. The same applies to Part 2, when they open and run file `a2_part2_xxxxxx.py`.

Furthermore, for each of the functions (in Part 1 and Part 2), I have provided one or more tests to test your functions with. For example, you should test function `high_school_quiz` from Part 1 by making a call in Python shell with `high_school_quiz(3,2,15)` To obtain a partial mark your function may not necessarily give the correct answer on these tests. But if your function gives any kind of python error when run on the tests provided below, that question will be marked with zero points.

Section 3, contains tests for Part 1. Tests for Part 2 are provided after each question in Part 2. To determine your grade, your functions will be tested both with examples provided in Part 2 and Section 3 and with some other examples. Thus you too should test your functions with more example than what I provided in Part 2 and Section 3.

Each function has to be documented with docstrings.

Global variables are not allowed. If you do not know what that means, for now, interpret this to mean that inside of your functions you can only use variables that are created in that function. For example, this is not allowed, since variable `x` is not a parameter of function `a_times(a)` nor is it a variable created in function `a_times(a)`. It is a global variable created outside of all functions.

```
def a_times(a):
   result=x*a
   return result

x=float(input("Give me a number: "))
print(a_times(10))
```

About `references-YOUR-FULL-NAME.txt` file:

The file must be a plain text file. The file must contain references to any code you used that you did not write yourself, including any code you got from a friend, internet, AI engines like chatGPT, social media/forums (including Stack Overflow and discord) or any other source or a person. The only exclusion from that rule is the code that we did in class, the code done as part the lab work, or the code in your textbook. So here is what needs to be written in that file. For every question where you used code from somebody else:

- Write the question number
- Copy-paste all parts of the code that were written by somebody else. That includes the code you found/were-given and that you then slightly modified.
- Source of the copied code: name of the person or the place on the internet/book where you found it.

While you may not get points for copied parts of the question, you will not be in the position of being accused of plagiarism. Any student caught in plagiarism will receive zero for the whole assignment and will be reported to the dean.

Showing/giving any part of your assignment code to a friend also constitutes plagiarism and the same penalties will apply. If you have nothing to declare/reference, then just write a sentence stating that and put your first and last name under that sentence in your references-YOUR-FULL-NAME.txt file.

Not including references-YOUR-FULL-NAME.txt file, will be taken as you declaring that all the code in the assignment was written by you. Recall though that not submitting that file, comes with a grade penalty.

1 Part 1: Math quiz-generator / equation-solver - 40 points

You would like to help in your community center teach elementary and high school students math. To reach as many kids as possible, you decided to write some software that can automate some tasks for you. As starting point, you decided to make an automatic quiz generator and grader for elementary school pupils and a quadratic equation solver for highschool pupils – but unlike the solver you did in your Lab 2, this quadratic equation solver needs to handle all possible cases including those when the given quadratic equation has complex numbers for solutions. In case of elementary school pupils, your understanding is that they already know well addition and multiplication but that they struggle with exponentiation and its inverse.

For this part, I provided you with starter code in file called `a2_part1_xxxxxx.py`. Begin by replacing `xxxxxx` in file name with your student number. Then open the file. Your solution (code) for this part must go into that file in clearly indicated spaces. You are not allowed to delete or comment-out any parts of the provided code except for the keywords `pass`.

For this part you need to submit two files: `a2_part1_xxxxxx.py` and `a2_part1_xxxxxx.txt`

`a2_part1_xxxxxx.py` needs to contain your program for Part 1 as explained above and `a2_part1_xxxxxx.txt` needs to contain the proof that you tested your two core functions from this part, namely `elementary_school_quiz` and `high_school_quiz`

1.1 The Core Functions

Your solution in `a2_part1_xxxxxx.py` must have two functions called: `elementary_school_quiz` and `high_school_quiz`.

You should design and test these functions first before moving onto the `main` part of the program. Here are specifications for the two functions:

`elementary_school_quiz`**:** This function has two parameters, namely an integer `flag` that takes only values 0 or 1 and an integer `n` that takes only values 1 or 2. If `flag` is `0`, `elementary_school_quiz` helps practice the inverse of exponentiation i.e. logarithm. But if `flag` is `1`, `elementary_school_quiz` helps practice exponentiation. In both cases only questins with base 2 will be asked. The function, `elementary_school_quiz` then generates `n` math problems that a pupil must answer in turn. For each question, it generates one random number between 0 and 10 inclusively (check out python's `random` module to see if there's a useful function in there) and asks the pupil for the

answer to the math problem with the random number. Specifically, if `flag` is `0` and random number generated is, for example, 5 the question asked should be: "2 to what is 32 i.e. what is the result of $\log_2(32)$?". (The reason 32 is picked is because $2^5 = 32$. See section 3 for more examples. If `flag` is `1` and random number generated is, for example, 6 the question asked should be: "What is the result of 2^6?"

`elementary_school_quiz` then prompts the pupil for the answer, and checks if her answer is correct. At the end of `n` questions, `elementary_school_quiz` returns the number of questions answered correctly.

`high_school_quiz`: This function has three parameters representing three real numbers for the coefficients of the quadratic equation $ax^2 + bx + c = 0$. The function displays/prints the equation frist and then prints its solutions. The function must display correct and meaningful solutions given any three real numbers for coefficients a, b and c. See examples in Section 3 to understand what that means. Please consider the examples to be a part of the function/program specifications that must be followed.

Do not use Python's complex numbers class to solve this problem.

1.2 The User Interaction i.e. the `main` part of the program

Now that you have the two functions that perform the core functionality, you want to make it more user friendly for the pupils (after all, alas, the pupil may not know how to write code and call functions in Python shell). In the `main` part of your program, write your code in specified places. You code must follow the behaviour indicated in the example runs in Section 3.

For example, for elementary school pupils, called Mia, you will first ask her whether she would like to practice exponentiation or its inverse. Then ask her how many practice questions she'd like (if she says `0`, then your code should not ask her to solve any math questions). Using her responses, call the `elementary_school_quiz` function with the appropriate values. When it returns the number of correct answers, display a message to the pupil:

- If she go all questions correctly display on screen: `Congratulations Mia! You'll probably get an A tomorrow. Good bye Mia!`
- If she got half of them correctly display on screen: `You did ok Mia, but I know you can do better. Good bye Mia!`
- If she did all incorrectly, display on screen: `I think you need some more practice Mia. Good bye Mia!`

For high school pupils, in the `main` part of your program in the specified places, you need to write some code that asks the pupil for the coefficients a, b and c. Then you need to make the call to `high_school_quiz` to display the solutions. After that your program should ask the pupil if they would like another quadratic equation solved. If the pupil says anything but `yes` the program terminates by printing a good bye message as in the examples. Otherwise, as long as pupil answers `yes` (and any form of typing `yes` should be acceptable, including with lots of white space before and after, and with capital letters and lower case letter etc), she should be asked for the coefficients again and the resulting new quadratic equation should be solved. Since you have not seen while loops yet, I provided the code for that in `a2_part1_xxxxxx.py`.

The rest of the specifications for your program in Part 1 can be inferred from examples in Section 3. You will notice that the program is required to display greetings surrounded with stars. You may write a separate function for that.

2 Part 2: A Library of Functions

For this part of the assignment, you are required to write and test four functions (as you did in Assignment 1). You need to save all functions in `part2_xxxxxx.py` where you replace xxxxxx by your student number. You need to test your functions (like you did in Assignment 1) and copy/paste your tests in `part2_xxxxxx.txt`. Thus, for this part you need to submit two files: `a2_part2_xxxxxx.py` and `a2_part2_xxxxxx.txt`

2.1 `min_enclosing_rectangle(radius, x, y)` - 5 points

Computing a smallest (axis-aligned) rectangle that encloses a set of objects in the plane is a very common computational problem arising in graphics and thus game development too. Write a function, called `min_enclosing_rectangle`, that has 3 input parameters. The first is a number representing a radius of a circle and the next two are two numbers representing the x- and y-coordinates of its center. Consider the smallest axis-aligned rectangle that contains that circle. The function should return the x- and y-coordinates of the bottom-left corner of that rectangle. If `radius` is a negative number, `min_enclosing_rectangle` should return `None`.

```
>>> min_enclosing_rectangle(1,1,1)
(0, 0)
>>> min_enclosing_rectangle(4.5, 10, 2)
(5.5, -2.5)
>>> min_enclosing_rectangle(-1, 10, 2)
>>> min_enclosing_rectangle(500, 1000, 2000)
(500, 1500)
```

2.2 vote_percentage (results) - 5 points

Write a function called `vote_percentage` that takes a string as input. The function has one input parameter, called results. Your function should count the number of substrings 'yes' in the string results and the number of substrings 'no' in the string results, and it should return the percentage of 'yes' (among all 'yes' and 'no'). (You may assume that string results has at least one yes or no and that the only words present are yes, no and/or abstained).
Hint: you may use `count` method from Python's str module/library.

```
>>> vote_percentage('yes yes yes yes yes abstained abstained yes yes yes yes')
1.0
>>> vote_percentage('yes,yes, no,  yes, no, yes, abstained, yes,  yes,no')
0.6666666666666666
>>> vote_percentage('abstained no abstained yes no yes no yes yes yes no')
0.5555555555555556
>>> vote_percentage('no yes no no no, yes yes yes no')
0.4444444444444444
```

2.3 vote() - 5 points

If there is a vote at a meeting, there are several possible outcomes based on the number of yes and no votes (abstains are not counted). If all the votes are yes, then the proposal passes "unanimously", if at least 2/3 of the votes are yes, then the proposal passes with "super majority", if at least 1/2 of the votes are yes, then the proposal passes by "simple majority", and otherwise it fails. Write a function called vote that asks a user to enter all yes-s and no-s and abstained-s and then press enter. The function then prints the outcome of the vote. You solution must involve making a call to function vote_percentage (You may assume that the user will enter at least one yes or no and that the only words present are yes, no and/or abstained)

```
>>> vote()
Enter the yes, no, abstained votes one by one and then press enter:
 yes yes yes yes yes abstained abstained yes yes yes yes
proposal passes unanimously
>>> vote()
Enter the yes, no, abstained votes one by one and then press enter:
 yes,yes, no,  yes, no, yes, abstained, yes,  yes,no
proposal passes with super majority
>>> vote()
Enter the yes, no, abstained votes one by one and then press enter:
 abstained no abstained yes no yes no yes yes yes no
proposal passes with simple majority
>>> vote()
Enter the yes, no, abstain votes one by one and then press enter:
 no yes no no no, yes yes yes no
proposal fails
```

2.4 l2lo(w) - 5 points

Write a function called `l2lo(w)` that takes a non-negative number `w` as input and returns a pair of numbers `(l,o)` such that `w = l + o/16` and `l` is an integer and `o` is a non-negative number smaller than 16. Note that the solution `l` and `o` are unique.

```
>>> l2lo(7.5)
(7, 8.0)
>>>
>>> l2lo(9.25)
(9, 4.0)
>>>
```

3 Testing your code in Part 1

Here is how you should test your two functions from Part 1 in Python shell.

```
>>> elementary_school_quiz(0,2)
Question 1:
2 to what is 256 i.e. what is the result of log_2 (256)? 7
Question 2:
2 to what is 8 i.e. what is the result of log_2 (8)? 3
1
>>> elementary_school_quiz(0,1)
Question 1:
2 to what is 64 i.e. what is the result of log_2 (64)? 5
0
>>> elementary_school_quiz(0,1)
Question 1:
2 to what is 16 i.e. what is the result of log_2 (16)? 4
1
>>> elementary_school_quiz(1,1)
Question 1:
What is the result of 2^10? 512
0
>>> elementary_school_quiz(1,1)
Question 1:
What is the result of 2^1? 2
1
>>> elementary_school_quiz(1,2)
Question 1:
What is the result of 2^9? 512
Question 2:
What is the result of 2^8? 256
2
>>>
>>> high_school_quiz(1,3,1)
The quadratic equation 1·x^2 + 3·x + 1 = 0
has the following real roots:
-0.3819660112501051  and -2.618033988749895
>>>
>>>
>>> high_school_quiz(3,2,15)
The quadratic equation 3·x^2 + 2·x + 15 = 0
has the following two complex roots:
-0.3333333333333333 + i 2.2110831935702664
 and
-0.3333333333333333 - i 2.2110831935702664
>>>
>>>
>>> high_school_quiz(3,2,-15)
The quadratic equation 3·x^2 + 2·x + -15 = 0
has the following real roots:
1.9274433277084226  and -2.5941099943750894
>>>
>>>
>>> high_school_quiz(1,2,1)
The quadratic equation 1·x^2 + 2·x + 1 = 0
has only one solution, a real root:
-1.0
>>>
>>>
>>> high_school_quiz(0,2,4)
The linear equation 2·x + 4 = 0
has the following root/solution: -2.0
>>>
>>>
>>> high_school_quiz(0,0,0)
The quadratic equation 0·x + 0 = 0
is satisfied for all numbers x
>>>
>>>
>>> high_school_quiz(0,0,10)
The quadratic equation 0·x + 10 = 0
is satisfied for no number x
```

Here is what pressing Run on your program (Part 1) should look like:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name? Vida
Hi Vida. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
1

*************************************************************************
*                                                                       *
*  __Vida, welcome to my quiz-generator for elementary school students.__  *
*                                                                       *
*************************************************************************

Vida what would you like to practice? Enter
0 for inverse of exponentiation
1 for exponentiation
0
How many practice questions would you like to do? Enter 0, 1, or 2: 2
Vida, here is your 2 questions:
Question 1:
2 to what is 2 i.e. what is the result of log_2 (2)? 1
Question 2:
2 to what is 16 i.e. what is the result of log_2 (16)? 4
Congratulations Vida! You'll probably get an A tomorrow.
Good bye Vida!
```

Another example run:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name? Vida Dujmovic
Hi Vida Dujmovic. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
Ah
Vida Dujmovic you are not a target audience for this software.
Good bye Vida Dujmovic!
```

Another example run:

```
>>>

****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name?  Arya Stark
Hi  Arya Stark. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
2

*********************************************************************
*                                                                   *
*  __quadratic equation, a·x^2 + b·x + c= 0, solver for  Arya Stark__  *
*                                                                   *
```

```
**************************************************************************

Arya Stark, would you like a quadratic equation solved?    YeS
Good choice!
Enter a number the coefficient a: 1
Enter a number the coefficient b: 2
Enter a number the coefficient c: 3
The quadratic equation 1.0·x^2 + 2.0·x + 3.0 = 0
has the following two complex roots:
-1.0 + i 1.4142135623730951
 and
-1.0 - i 1.4142135623730951
Arya Stark, would you like a quadratic equation solved?            yeS
Good choice!
Enter a number the coefficient a: -1
Enter a number the coefficient b: 10
Enter a number the coefficient c: 36
The quadratic equation -1.0·x^2 + 10.0·x + 36.0 = 0
has the following real roots:
-2.810249675906654  and 12.810249675906654
Arya Stark, would you like a quadratic equation solved? YES
Good choice!
Enter a number the coefficient a: 0
Enter a number the coefficient b: 2.5
Enter a number the coefficient c: 3.246
The linear equation 2.5·x + 3.246 = 0
has the following root/solution: -1.2984
Arya Stark, would you like a quadratic equation solved? yes
Good choice!
Enter a number the coefficient a: 0
Enter a number the coefficient b: 0
Enter a number the coefficient c: 2.5
The quadratic equation 0.0·x + 2.5 = 0
is satisfied for no number x
Arya Stark, would you like a quadratic equation solved? yes
Good choice!
Enter a number the coefficient a: 0
Enter a number the coefficient b: 0
Enter a number the coefficient c: 0
The quadratic equation 0.0·x + 0.0 = 0
is satisfied for all numbers x
Arya Stark, would you like a quadratic equation solved? NO
Good bye  Arya Stark!
```

Another example run:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name?  Ji-Ah
Hi  Ji-Ah. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
1

*****************************************************************************
*                                                                           *
*  __ Ji-Ah, welcome to my quiz-generator for elementary school students.__  *
*                                                                           *
*****************************************************************************

 Ji-Ah what would you like to practice? Enter
0 for inverse of exponentiation
1 for exponentiation
5
Invalid chose. Only 0 or 1 is accepted.
Good bye  Ji-Ah!
```

Another example run:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name? Hippolyta
Hi Hippolyta. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
1

*********************************************************************************
*                                                                               *
*  __Hippolyta, welcome to my quiz-generator for elementary school students.__  *
*                                                                               *
*********************************************************************************

Hippolyta what would you like to practice? Enter
0 for inverse of exponentiation
1 for exponentiation
0
How many practice questions would you like to do? Enter 0, 1, or 2: 0
Zero questions. OK. Good bye
Good bye Hippolyta!
```

Another example run:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name? Leti
Hi Leti. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
1

***************************************************************************
*                                                                         *
*  __Leti, welcome to my quiz-generator for elementary school students.__  *
*                                                                         *
***************************************************************************

Leti what would you like to practice? Enter
0 for inverse of exponentiation
1 for exponentiation
1
How many practice questions would you like to do? Enter 0, 1, or 2: 5
Only 0,1, or 2 are valid choices for the number of questions.
Good bye Leti!
```

Another example run:

```
****************************************
*                                      *
*  __Welcome to my math quiz-generator__  *
*                                      *
****************************************

What is your name? Wolf
Hi Wolf. Are you in? Enter
1 for elementary school
2 for high school or
3 or other character(s) for none of the above?
1

***************************************************************************
```

```
*                                                                            *
*  __Wolf, welcome to my quiz-generator for elementary school students.__    *
*                                                                            *
******************************************************************************

Wolf what would you like to practice? Enter
0 for inverse of exponentiation
1 for exponentiation
1
How many practice questions would you like to do? Enter 0, 1, or 2: 1
Wolf, here is your 1 questions:
Question 1:
What is the result of 2^6? 64
Congratulations Wolf! You'll probably get an A tomorrow.
Good bye Wolf!
```