EE1003 Introduction to Computer I

Programming Assignment 1: Antibody Calculator

Due Date: 2022/10/19 (Wed.) 23:59:59

-Version: 20220923v3

Background

The coronavirus outbreak is continuing to grow. Many people choose to get vaccinated to maintain higher antibody concentration and adequate protection. Usually, after getting shots for about two weeks, the antibody concentration will reach the highest point. However, the antibody concentration will start dropping as time goes by. Figure 1 shows antibody concentration over time of three different brand of vaccines. Moreover, literal has shown that the antibody concentration will be influenced by not only the duration after one got vaccinated but also the brands of vaccine, the age of a person, and whether one is infected or not. Therefore, to get more accurate antibody concentration under certain condition, an antibody concentration calculator is in demand.

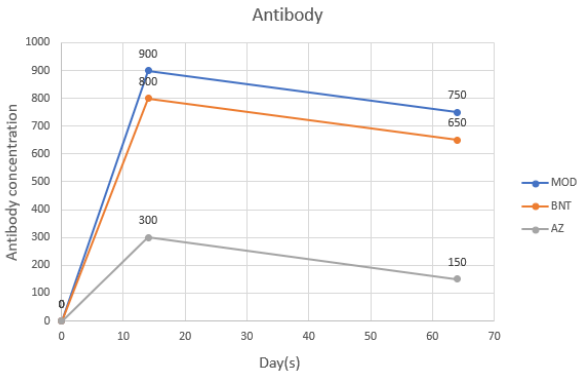

Figure 1. antibody concentration over time of three different brand of vaccines where x-axis represents time and y-axis gives antibody concentration. This model is modified and simplified from [2].

In this programming assignment, you are asked to write a program for antibody concentration calculation based on a given antibody concentration model.

Description

Antibody Concentration Model

The antibody concentration of a person will be decided based on three factors: age, vaccine data, and prior infection. Once a person gets vaccinated, the antibody concentration will rise to peak at the 14^{th} day. Note that different brands of vaccine will reach different peak point. After that, the antibody concentration will start to drop and

the dropping slope is different with different age ranges. Moreover, if a person is infected before, the slope will become half as its original value.

Based on the description above, here we use the following model for computing antibody concentration:

$$Antibody = \begin{cases} baseline * (1 + \alpha_{age}) * \frac{day}{14}, & day \leq 14 \\ baseline * (1 + \alpha_{age}) + slope * (day - 14) * \beta_{infect}, & day > 14 \end{cases}$$

where the "baseline" is an anchor of antibody concentration and varies with different vaccine brands; The "α_{age}" is a parameter that can reflect the influence of age; The "*day*" is the duration (in days) from the vaccinated date; The "*slope*" is also decided based on the age range; The "β_{infect}" is used to reflect the prior infected. Table 1 gives the values of the above parameters.

Table 1. Parameters of antibody concentration Model

Factor	**Parameter**		
	Range	α_{age}	*slope*
Age	1-40	+0.05	-2
	41-80	0	-3
	81-120	-0.05	-3.5
Vaccine data	Brand	*baseline*	
	AZ	300	
	BNT	800	
	Moderna	900	
Prior infection	β_{infect}(Not infected)	β_{infect}(Infected)	
	1	0.5	

Here we use an example to explain the computation of antibody concentration. Assume a 22-year-old person had been infected before and got AZ vaccinated 114 days ago, the antibody concentration can be obtained as

$$\text{Antibody} = baseline * (1 + \alpha_{age}) + slope * (day - 14) * \beta_{infect}$$
$$= 300 * (1 + 0.05) + (-2) * (114 - 14) * 0.5 = 315 - 100 = 215$$

It has been shown that if the antibody concentration is larger than or equal to 50, the person is considered as well protected. Otherwise, the person is under the risk of infection. Note that to simplify the difficulty of this PA, here we ignore the order of vaccinated date and infected date. We only consider whether a person is infected before or not, no matter the infected date is before or after the vaccinated date.

Program requirements

In this programming assignment, you are asked to write an antibody concentration calculator based on the model described above. The program main menu will provide 5 options for the user: input body data, input vaccine data, input prior infection, calculate antibody, and exit system. A prompt information will show up for user to enter their choice. If **input body data** is chosen, the program will take an integer from standard input as the age. If **input vaccine data** is chosen, the program will ask the user to input two kinds of information: the duration (in days) after last vaccinated and the brand of the vaccine. When enter the brand, input *A* for AZ, *B* for BNT, and *M* for Moderna. If **input prior infection** is selected, the program will ask the user to provide prior infection information where *y* for YES and *n* for NO. Note that the order of providing the above three input data can be arbitrary. Then, if **calculate antibody** is selected, the program will firstly provide the antibody concentration and then give a warning based on the antibody concentration value. If the antibody concentration is equal to or higher than 50, the program should show "*You are safe!*" at next line; If the antibody concentration is lower than 50, the program should show "*Watch out! Antibody is low.*" at next line; If the user didn't provide enough information for calculating the antibody concentration, the program should show "*Data is not enough.*". After complete the tasks of the above 4 options, the program will go back to the main menu and wait for the next input from user. The user can update the corresponding information by selecting the option at main menu again. Always keep the last updated values. When at main menu, if the user selects **exit system**, the program will show "*Bye~*" and terminate its execution. Table 2 gives the detail information of the program. Please follow the input/output format shown in Table 2.

Table 2. The detail information of the program with an input example

Options	**Program Screen (*Tilt and bold font mean input from the user.*)**
Main menu	***Antibody Calculator*** Enter 1 to input body data Enter 2 to input vaccine data Enter 3 to input prior infection Enter R to calculate antibody Enter 0 to exit system >>>
Body data	>>> ***1*** Enter your age: ***22***
Vaccine data	>>> ***2*** Enter how many days pass by since you were vaccinated: ***114***

	Enter the brand(A/B/M): **A**
Prior infection	>>> ***3*** Did you have a prior infection(y/n): ***y***
Calculate antibody	>>> ***R*** Your antibody is 215.00 You are safe!
Exit system	>>> ***0*** bye~

Input

If the user inputs a wrong input, the program should show the error message "**Invalid input! Please enter again**".

The range of age is [1-120]. There is no testcases that the user will crosses different age regions before and after vaccinated date.

The range of days pass by since vaccinated is [1~2^31-1]

Output

The antibody concentration should round off to the 2nd decimal place.

Note that the lowest value of the antibody is 0.

Sample

Note: *Italic* shows the input from keyboard.

```
***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>A
Invalid input! Please enter again
>>>R
Data is not enough.

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
```

```
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>1
Enter your age: 22

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>R
Data is not enough.

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>3
Did you have a prior infection(y/n): y

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>2
Enter how many days pass by since you were vaccinated: -1
Invalid input! Please enter again
>>>114
Enter the brand(A/B/M): A

***Antibody Calculator***
Enter 1 to input body data
```

```
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>R
Your antibody is 215.00
You are safe!

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>1
Enter your age: 55

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>3
Did you have a prior infection(y/n): n

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>R
Your antibody is 0.00
Watch out! Antibody is low.

***Antibody Calculator***
Enter 1 to input body data
```

```
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>0

bye~
```

Bonus

In bonus version, you are asked to modify your program so that it can directly take date as inputs with format yyyymmdd and can compute the duration between vaccine data and current date. The range of the date is [20190101-20221231].
Please see an example below:

```
***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>1
Enter your age: 20

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>2
Enter the date you were vaccinated(yyyymmdd): 20220801
Enter the brand(A/B/M): M

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
```

```
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>3
Did you have a prior infection(y/n): y

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>R
Enter the date today(yyyymmdd): 20220830
Your antibody is 929.00
You are safe!

***Antibody Calculator***
Enter 1 to input body data
Enter 2 to input vaccine data
Enter 3 to input prior infection
Enter R to calculate antibody
Enter 0 to exit system
>>>0

bye~
```

Submission Requirement

You have to submit a source code file (not the entire project) named as StudID_PA1.cpp (ex: 9862534_PA1.cpp) and a report named StudID_Name_PA1_report.pdf (ex: 9862534_ 陳 聿 廣 _PA1_report.pdf). If you implement a bonus version, please separate it from the original version. Name your source code file of the bonus version as StudID_PA1_bonus.cpp (ex: 9862534_PA1_bonus.cpp) and upload to ee-class as a separate version to original version. Note that the only acceptable report file format is .pdf, **no .doc/.docx or other files are acceptable. BE SURE to follow the naming rule mentioned above.**

Otherwise, your program will be not graded.

We don't restrict the report format and length. In your report, you have to at least describe:

1. How to compile and execute your program; (You can use a screenshot to explain. In this PA, it can be done in one click)
2. The degree of completion of the assignment; (If you complete all requirements, just specify all)
3. The hardness of this assignment and how you overcome it;
4. Bonus function(s) you implement if any; and
5. Any suggestions about this programming assignment?

You can also put anything related to the PA in your report, such as pseudocode, control flow diagram, programming developing thought, etc.

Your program will be judged with Code::Blocks 20.03 and GNU GCC Compiler (MinGW-W64 project version 8.1.0, 32/64 bit, SHE). We will use C++ 11 standard.

Grading

The grading is as follows:

(1) Correctness of your code: 50%
(2) Readability of your code: 10%
(3) The report: 10%
(4) Demo session: 30%
(5) Bonus (at most): 10%

Please submit your assignment on time. Otherwise, the penalty rule will apply:

- Within 72hrs delay: 20% off
- More than 3 days: 0 point

Be sure to attend a demo session (the time will be announced later). If you have questions, please E-mail to both me (andyygchen@ee.ncu.edu.tw) and TA 何宜真 (gumi627@gmail.com)

Reference

[1] Chapter 2 ~ Chapter 4, Paul Deitel and Harvey Deitel, "C++ how to program late objects version," 7th edition, Person 2011.

[2] Antibody model: https://www.medrxiv.org/content/10.1101/2021.09.13.21263487v1.full