Retirement Calculations

In your next assignment, you are going to be writing a simplified retirement calculator. Before you do that assignment, we want to make sure that you have the required domain knowledge for that programming task.

In general, when people are saving for retirement, they invest their money in some form of account that gives them returns on their investments (such as stocks and/or bonds). Prior to retirement (while the person is still working), they contribute to their retirement account on a regular basis (e.g., monthly), depositing some portion of their paycheck into the account. The money in the account grows through these contributions as well as the returns on investment, which are typically represented as a percentage of the value.

After a person retires, they no longer work, and instead of having a paycheck, withdraw funds from their retirement accounts to pay for their expenses. We note that removing money is the same as a negative contribution (i.e. taking $2000 out is like a “negative $2000” contribution to the account). During this time, the remaining balance in the retirement account still receives returns on investments. However, people generally shift their investment strategy to be more conservative once they retire, so the rates of return may be different than while they were working.

At this point, we want to briefly note that we are making several simplifying assumptions:

- The contribution amount is the same every month for the period the person works. In reality, this contribution amount varies as the person changes jobs, gets promotions or raises, or otherwise changes their financial situation.
- The withdrawal amount per month is the same every month for the period the person is retired. In reality, this amount varies based on the person’s financial needs and may be larger or smaller depending on their expenses in a given time period.
- The rate of returns is one constant value over the working period, and another constant value over the retired period. In reality, the rates of returns change based on a variety of complex financial conditions (such as the stock market’s behavior). Additionally, people are more likely to gradually shift their investment strategy over time, slowly making it more conservative as they approach retirement. We instead simplify this to an abrupt shift at retirement, so that there are only two values to think about.

To illustrate how this simplified process works, suppose a person starts with $10,000 in their retirement account, and has the following information about their working and retired time periods:

	Duration (months)	Contribution (per month)	Rate of Return (annual)
Working	3	$1,000	12%
Retired	2	$-3,000	1.2%

Note that a 12% annual rate of return is 1% per month, and likewise 1.2% translates into 0.1% per month. Also please note that these values are not intended to be realistic—they are just intended to give us a short example with relatively simple numbers to work with.

This means that at the start of month 0, this person has $10,000. During month 0, they earn 1% of $10,000 (which is $100) in investment returns, and also deposit $1,000 into their account. Accordingly, at the start of month 1, they have $10,000 + $100 + $1,000 = $11,100 in their account.

During month 1, this person earns 1% of $11,100 which is $111 in investment returns. They also deposit their monthly $1,000 into the account, giving them a total of $11,100 + $111 + $1,000 = $12,211 at the start of month 2.

During month 2, this person earns 1% of $12,211 which is $122.11 in investment returns. They also deposit their monthly $1,000 into the account giving them a total of $12,211 + $122.11 + $1,000 = $13,333.11 at the start of month 3.

At this point, our hypothetical person retires. They have finished the number of months that we specified they will work for (3 months). We now switch to their retired numbers.

During month 3, this person earns 0.1% of $13,333.11 which is $13.33311. They also withdraw $3,000. This means they now have $13,333.11 + $13.33311 + $-3,000 = $10,346.44311 at the start of month 4. You may think it is weird that we wrote “+ $-3,000” (plus a negative number) rather than just “ - $3,000” (minus a number). The two are equivalent, but we wrote it with a plus so that it looks more like what we did in the working months—making things look more similar helps find patterns!

We also want to note that a real bank would round off the fractional pennies: $10,346.44311 would become $10,346.44. For simplicity, your program is going to keep the account balance to the full precision of Python’s fractional numbers. That is, your program’s balance going into the next month will be $10,346.44311. However, when you print things out, you will use a format string which specifies to print only two decimal places (which we will describe in the assignment). So your program will print the balance as $10,346.44, but will “remember” the fractional pennies for the next month’s calculations.

During month 4, this person earns 0.1% on $10,346.44311 which is $10.34644311. They also withdraw another $3,000, leaving them with $10,346.44311 + $10.24644311 + $-3,000 = $7,356.68955311.

At this point, our calculations are done, as we have done two months of retirement.

Day 4, Part 4

Finally, it is time to do **06_retirement** on the Mastery Learning Platform. Login to the server, go to **06_retirement** and read the README for directions. When you have passed that assignment, return to Sakai and continue with the content here.