CSE 231 **Fall 2023**

Computer Project #3

Assignment Overview

This assignment focuses on the design, implementation and testing of a Python program to calculate values related to the purchase of a home using a traditional mortgage loan system (see below).

It is worth 20 points (4% of course grade) and must be completed no later than 11:59 PM on Monday, September 18, 2023. **After the due date, your score will be deducted by 25% for every 6 hours late or a fraction of it.**

Assignment Deliverable

The deliverable for this assignment is the following file:

`proj03.py` – the source code for your Python program

Be sure to use the specified file name and to submit it for grading via the **Codio system** before the project deadline.

Assignment Background

When prospective home buyers wish to purchase a new home, they can take out a loan from a bank to allow them to buy the home without having the full purchase price. This is called a mortgage. The mortgage loan is paid back to the bank over time with interest. When looking at available homes, it is helpful to understand how various factors impact the mortgage. A buyer must be aware of the principal loan amount, the down payment, the annual percentage rate (APR) of the loan, the length of the loan, the property taxes, the cost of living within a given area, the cost of homeowner's insurance, and realtor costs. We will ignore a few of these factors to simplify the problem space.

For this assignment, you will design a program that asks the users to provide some of the following details: the desired location of the house, the desired size of the house in square feet, the desired maximum monthly payment, the expected down payment, and the current APR. Using this information, the program will compute and output either the estimated monthly payment or the maximum square footage that the buyer should consider given the values provided.

Assignment Specifications

1. You will develop a Python program which calculates details for a mortgage loan for one or more houses based on the input variables described in detail below.

2. The program will first print a simple welcome message and the main prompt (both messages are stored in the variables `WELCOME_TEXT` and `MAIN_PROMPT` in the starter code), and then repeatedly ask if the user wishes to process another mortgage. If the user's response is the letter `Y` or the letter `y`, the program will proceed with the steps to calculate the values associated with a new set of inputs for a mortgage loan. If the user's response is anything else, the program will quit.

3. When the user chooses to process a mortgage loan, the program will prompt the user to enter the desired location of the house, the desired square footage of the house, the user's maximum monthly payment, the user's expected down payment, and the current APR. You should use the prompts provided for each of these inputs in

the file “strings.txt” or in the starter code (zip file) and defined as `LOCATIONS_TEXT`, `SQUARE_FOOTAGE_TEXT`, `MAX_MONTHLY_PAYMENT_TEXT`, `DOWN_PAYMENT_TEXT`, and `APR_TEXT`, respectively. Users will be advised to enter as much information as possible or “NA” if they don’t have a value to input. The program will behave in response to which values are present and which are missing.

4. For each of the inputs, handle the input as follows.

   For location, the user must provide one of the following cities: Seattle, San Francisco, Austin, East Lansing. The starter file contains the corresponding property tax rates and real estate prices per square foot for each of these locations. If the user enters any other value, use the average national values for those two metrics (defined as `AVERAGE_NATIONAL_PROPERTY_TAX_RATE` and `AVERAGE_NATIONAL_PRICE_PER_SQ_FOOT`) and display the unknown location message (the message is stored in the variable `LOCATION_NOT_KNOWN_TEXT` in the starter code).

   For this project, we assume that all inputs are valid:
   - For square footage, you may assume the user has entered a positive value or “NA”. If the value is numerical, convert it to a float; Otherwise, it means the user did not provide a square footage.
   - For maximum monthly payment, you may assume the user has typed a positive value or “NA”. If the value is numerical, convert it to a float; Otherwise, it means the user did not provide a monthly payment.
   - For down payment, you may assume the user has typed a positive value or “NA”. If the value is numerical, convert it to a float; Otherwise, you should assign the variable a float value of 0.0
   - For APR, you may assume the user has typed a positive value between 0 and 100 or “NA”. If it is numerical, convert it to a float and store it for use in your calculations as a fraction instead of percentage (i.e., not as you would display it, nor as the user typed it); otherwise, assign the value stored in the `APR_2023` constant that has been provided.

   What kind of calculations and what results to display depends on if the user entered the square footage only (case 1), the square footage and the maximum monthly payment (case 2), the maximum monthly payment only (case 3), or neither the square footage nor the maximum monthly payment were provided (case 4).

   <u>Case 1:</u> square footage only
   If the user has provided the square footage only, you will compute the details of the mortgage loan given the values of the other variables (presuming those values are valid). You should first estimate the home cost for the given location based on the corresponding values. You will also need to calculate the principal value based on the estimated home cost and the down payment. Check the “assignment notes” section below for all the necessary formulas.
   Mortgage loan information will be displayed containing all the provided information as well as the monthly taxes and the monthly payment. The message should be displayed like the one shown below. In the starter code, we provide an incomplete string that you need to fill with the correct formatting for numbers using the example message below (in red). You can use either the `.format()` method or `fstrings`.

```
In Austin, an average 1,000 sq. foot house would cost $349,000.
A 30-year fixed rate mortgage with a down payment of $50,000 at 4.0% APR results
  in an expected monthly payment of $526.41 (taxes) + $1,427.47 (mortgage payment) = $1,953.88
```

   Finally, ask the user if they wish to see the amortization table for the mortgage loan (using the string stored in the variable `AMORTIZATION_TEXT`). An amortization table shows how the monthly payment will be allocated each month. Some of the payment is directed to pay off the interest owed on the loan, and the rest goes to reduce the overall balance of the loan. The amount of interest is based on the current balance remaining and the monthly interest rate. Use proper formatting for the amortization table with a

header and well-spaced values for month number, interest payment, principal payment, and remaining balance (see examples). Below is the formatting information that you need to complete:

Header : `"\n{}|{}|{}|{}"`

The order of the strings is as follows:

`"Month"` is a centered 7 characters long field.
`"Interest"` is a centered 12 characters long field
`"Payment"` is a centered 13 characters long field
`"Balance"` is a centered 14 characters long field

Separator: 48 times "="

Data: `"{}| ${} | ${} | ${}"`

The order of the numbers in the table is as follows:

`Month`: the payment number which is an integer centered in a 7-characters long field.
`Interest`: the "payment to interest" which is a float right justified in a 9-characters long field with precision 2 and the comma for the thousands.
`Payment`: the "payment to loan" which is a float right justified in a 10-characters long field with precision 2 and the comma for the thousands.
`Balance`: the "remaining loan amount" a float right justified in an 11-characters field long with precision 2 and the comma for the thousands.

Case 2: maximum monthly payment

If the user has provided a maximum monthly payment in addition to the square footage, in addition to the message displayed in Case 1 and before you prompt the user if they wish to see the amortization table, print a message telling the user whether they can or cannot purchase the home described given their maximum monthly payment amount given. An example is shown below. In the starter code, we provide an incomplete string that you need to fill in with the correct formatting for numbers using the example message below (in red).

```
Based on your maximum monthly payment of $2,200.00 you can afford this house.
```

Case 3: maximum monthly payment and square footage

If the user has not provided the square footage but has provided the maximum monthly payment, calculate the maximum square footage that their monthly payment can afford in the location specified. You will need to account for the amount of tax owed per month in determining how big a house the monthly payment allows for. While there is an algebraic solution for this problem, it gets a bit messy and because of numerical errors/precision can sometimes provide not accurate results. Instead, we recommend that you estimate the maximum square footage that the individual can afford using an approximation method. To do this, follow the algorithm shown below.

- Start with an initial estimate for the maximum square footage (e.g. 100 ft^2)
- While the maximum square footage has not been found:
  - Calculate the estimated home cost, the principal loan amount, the monthly payment towards the loan, and the monthly payment for the annual taxes.
  - If the two monthly payments sum to a value greater than the maximum monthly payment provided by the user, reduce the maximum square footage by 1 ft^2 and exit the loop; otherwise, increase the maximum square footage by 1 ft^2.
- Calculate the final monthly payments based on the maximum square footage estimated and report this value to the user.

Report the max monthly payment as shown below. In the starter code, we provide an incomplete string that you need to fill with the correct formatting for numbers using the example message below (in red).

```
In East Lansing, a maximum monthly payment of $3,200.00 allows the purchase of a house of 2,708 sq. feet for $460,360
        assuming a 30-year fixed rate mortgage with a $60,000 down payment at 6.7% APR.
```

Case 4: Neither

Note: if neither desired square footage nor maximum monthly payment have been provided, display the message for not enough information (stored in the variable `NOT_ENOUGH_INFORMATION_TEXT`).

5. Then, the program should ask the user if they want to make another attempt (the prompt to display is provided in the starter code as KEEP_GOING_TEXT). If the user's response is the letter `Y` or the letter `y`, the program will print the welcome message and the main prompt again (`WELCOME_TEXT` and `MAIN_PROMPT`); then, proceed to repeat steps 3 through 4. Otherwise, the program stop.

Assignment Notes

1. The coding standard for CSE 231 is posted on the course website:

http://www.cse.msu.edu/~cse231/General/coding.standard.html

Items 1-7 of the Coding Standard will be enforced for this project.

2. The important information related to the calculation of the mortgage loan appears below. The formula for calculating the monthly payment owed (before considering taxes or other associated costs) is:

$$M = \frac{P(I(1+I)^N)}{((1+I)^N - 1)}$$

Where M = the monthly payment; P = the principal amount or current loan balance; I = the interest rate (note the APR is annual and you need a monthly rate for this calculation); N = the number of payments in the loan term (defined as `NUMBER_OF_PAYMENTS` in the starter code).

The formula for determining the amount of the mortgage loan (principal amount or *P*) is:

$$\text{P} = \text{home\_cost} - \text{down\_payment}$$

The formula for calculating the cost of a home (home_cost) from the desired square footage and price per square foot for a given location is:

$$\text{home\_cost} = \text{square footage} \times \text{price per square foot}$$

The formula for calculating the property taxes and the estimated monthly taxes from the desired home cost and the property taxes (tax_rate) for a given location is:

$$\text{property taxes} = \text{home\_cost} \times \text{tax\_rate}$$

$$\text{monthly taxes} = \frac{\text{property taxes}}{12}$$

When creating the amortization table, you will need to multiply the remaining loan amount by the monthly contribution to the annual percentage rate. Once you have determined the amount of your payment that is used

to pay for the loan interest, you can then calculate the amount of your payment that should be deducted from the remaining loan amount. It is an iterative process, your starting "remaining loan amount" is the loan amount (P)

payment to interest = remaining loan amount * APR / 12
payment to loan = monthly payment – payment to interest
remaining loan amount = remaining loan amount – payment to loan

4. The program will produce a reasonable and readable output, with appropriate labels for all values displayed. Dollar amounts should be rounded to two decimal places, and percentages should be shown as a user expects (ex. the APR may be 3.5%, which in your program should be stored as 0.035).

5. When asked to format tabular data, you should consider using the string formatting descriptors. These can be found on p. 211-214 of the text.

Suggested Procedure

- *Solve the problem using pencil and paper first.* You cannot write a program until you have figured out how to solve the problem. This first step can be done collaboratively with another student. However, once the discussion turns to Python specifics and the subsequent writing of Python statements, you must work on your own.

- Cycle through the following steps to incrementally develop your program:

    - Edit your program to add new capabilities.
    - Run the program and fix any errors.
    - Use the **Codio** system to submit the current version of your program.

- Be sure to use the **Codio** system to submit the final version of your program.

- Be sure to log out when you leave the room, if you're working in a public lab.

The last version of your solution is the program which will be graded by your TA.

*You should use the **Codio** system to back up your partial solutions, especially if you are working close to the project deadline. That is the easiest way to ensure that you won't lose significant portions of your work if your machine fails or there are other last-minute problems.*

*You would also be wise to save a copy of your completed program in your local computer **before** the project deadline.*

*In case of problems with electronic submission, an archived copy in the **Codio** system is the only acceptable evidence of completion.*

Hints

1. Your program should branch based on which inputs it receives. Identify the possible cases (which inputs it has available to use), and then define the behavior based on those outcomes.

2. To resolve some of the cases with missing data, you will need to rearrange the mathematical formulas provided. This is a good pencil and paper task that you should perform before writing the code. Then make sure to test your results to make sure that you have translated the rearranged formula to Python Code correctly.

3. Later in the course, we will show you different ways to test input from the user. For this assignment, make sure to consider the type before trying to convert what the user has entered into a numerical type.

4. When designing the amortization table, consider which values should change on each iteration of a loop and design your code to update them in a clear way. Loops that don't update variables related to their test condition are often the source of issues down the line.

Grading Rubric

```
Computer Project #03                                Scoring Summary
General Requirements:
  ( 3 pts) Coding Standard 1-7
             (descriptive comments, mnemonic identifiers, format, etc...)

Implementation:
 (2 pts) Test Case 1:
 (2 pts) Test Case 2:
 (3 pts) Test Case 3:
 (3 pts) Test Case 4:
 (0 pts) Test Case 5 (visible to help with the blind test):
 (7 pts) Test Case 6 (blind test):
```

Test 1

```
MORTGAGE PLANNING CALCULATOR
============================

Enter a value for each of the following items or type 'NA' if unknown

Where is the house you are considering (Seattle, San Francisco, Austin, East Lansing)? East Lansing

What is the maximum square footage you are considering? NA

What is the maximum monthly payment you can afford? 1200

How much money can you put down as a down payment? 25000

What is the current annual percentage rate? NA


In East Lansing, a maximum monthly payment of $1,200.00 allows the purchase of a house of 1,027 sq. feet for $174,590
         assuming a 30-year fixed rate mortgage with a $25,000 down payment at 6.7% APR.

Would you like to make another attempt (Y or N)? N
```

Test 2

```
MORTGAGE PLANNING CALCULATOR
============================

Enter a value for each of the following items or type 'NA' if unknown

Where is the house you are considering (Seattle, San Francisco, Austin, East Lansing)? East Lansing

What is the maximum square footage you are considering? 1000

What is the maximum monthly payment you can afford? NA

How much money can you put down as a down payment? 40000

What is the current annual percentage rate? 3.25


In East Lansing, an average 1,000 sq. foot house would cost $170,000.
A 30-year fixed rate mortgage with a down payment of $40,000 at 3.2% APR results
        in an expected monthly payment of $229.50 (taxes) + $565.77 (mortgage payment) = $795.27

Would you like to print the monthly payment schedule (Y or N)? N

Would you like to make another attempt (Y or N)? n
```

Test 3

```
MORTGAGE PLANNING CALCULATOR
============================

Enter a value for each of the following items or type 'NA' if unknown

Where is the house you are considering (Seattle, San Francisco, Austin, East Lansing)? Austin

What is the maximum square footage you are considering? 1200

What is the maximum monthly payment you can afford? 2250

How much money can you put down as a down payment? 50000

What is the current annual percentage rate? 4


In Austin, an average 1,200 sq. foot house would cost $418,800.
A 30-year fixed rate mortgage with a down payment of $50,000 at 4.0% APR results
        in an expected monthly payment of $631.69 (taxes) + $1,760.71 (mortgage payment) = $2,392.40
Based on your maximum monthly payment of $2,250.00 you cannot afford this house.

Would you like to print the monthly payment schedule (Y or N)? N

Would you like to make another attempt (Y or N)? N
```

Test 4

Check Test4.txt file for the output

Test 5

Check Test5.txt file for the output

Test 6 (hidden)

This is a hidden test. Yu will not see the inputs or the output.