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Computing Future Investment Value

Problem Description:
Write a method that computes future investment value at a given interest rate for a specified number of years. We can also assume this model will not have to handle zero or negative numbers since we are not expecting a zero percent return or a zero number of years. Also, the model requires capital to operate so we can also assume we will not have to test zero or negative numbers for principal.

Analysis
Describe the problem:

The goal of this project is to create a method to calculate the compounded returns of an investment made or simulated by the user. The formula used to calculate this is:

$$P * (1 + R / 12)^{years*12}$$

Part I: Program and test a functioning method

To begin programming my method I am going to take my variables from the method header. I plugged in the proper formulas with print statements to see what would be returned before I proceeded. All was going accordingly after executing

```
//return = investmentAmount × (1 + monthlyInterestRate) ^ numberOfYears×12
public static double futureInvestmentValue(double investmentAmount,
double monthlyInterestRate,
int years){

   double future_Investment_Value = investmentAmount *
   Math.pow((1 + monthlyInterestRate), years*12);

   return future_Investment_Value;

}
```

And calling this method by:

```
public static void main(String[] args) {
```

```
    double i = futureInvestmentValue(10000,
    0.05/12, 5);
    System.out.println("i: " + i);

  }
```

My output after calling this method was 12833.586785035119 so I knew my method functioned properly. My steps for designing this method were to copy the formula given, which was

Return = investmentAmount × (1 + monthlyInterestRate) ^ numberOfYears×12

To raise to the power of numberOfYears*12 I used the method *Math.pow*

All was running fine at this point.

Part II: Clean up method and add variables to prepare it for a loop

If we are going to simulate 30 years of this investment compounding it would make much more sense to set up a loop rather than copy and paste many times. Also a loop adds robustness to the program because a different output can be received if the user wants to switch how many years they want to let their investment perform.

I first ran into trouble when I created variables for the input

```
public static void main(String[] args) {

    double principal = 10000;
    double interest = 0.05;
    int t = 5; //t = time



    double i = futureInvestmentValue(principal,
    interest, t);
    System.out.println("i: " + i);

  }
```

My output here was i: 2.9753582081680648E16

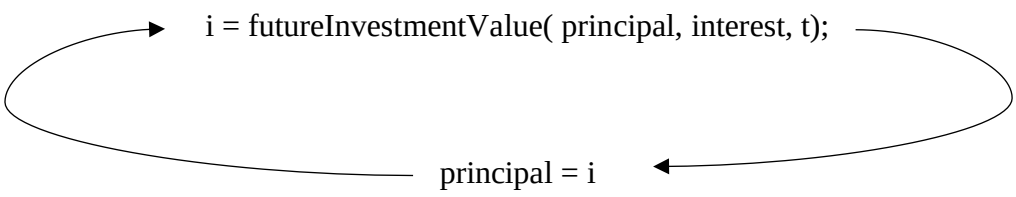
I then realized my mistake when I read the original formula and saw it was monthly interest, so with a quick tweak to monthlyinterestRate in my method all was well once again.

```
//return = investmentAmount × (1 + monthlyInterestRate) ^ numberOfYears×12
   public static double futureInvestmentValue(double investmentAmount,
   double monthlyInterestRate,
   int years){

      double future_Investment_Value = investmentAmount *
      Math.pow((1 + (monthlyInterestRate/12)), years*12);

      return future_Investment_Value;

   }
```

Part III: Create loop

Now I had to begin my loop to match the example output. Now the only change that had to be made was the amount invested, since we are compounding returns. Now since we are showing the yearly returns we are going to have to set years to 1 while we are executing our loop.

The logic I am going to use for my loop is



This would count as one repetition. We want to repeat this for as many years we would like to compound the capital for.

Setting up the loop there is an immediate issue.

```
double principal = 1000;
double interest = 0.09;
int t = 30; //t = time

for(int years = 1; t <= years ; years++){
        double i = futureInvestmentValue(principal,
        interest, t);
        System.out.println(years + " " + i);

        principal = i;
    }
```

If we let t = 30 for this loop, the loop would assume a 30 year investment period for each loop. The output for this would be

```
1 14730.576123040439
2 216989.87291668908
3 3196385.8409281597
4 4.7084604948400885E7
5 6.935833574157058E8
6 1.021688244408602E10
7 1.5050056458276456E11
```

```
11 7.086259627890763E15
12 1.04384686876273104E17
13 1.53764657611068134E18
14 2.2650419939730887E19
15 3.336537351410389E20
16 4.914911744231846E21
17 7.23994815864326 7E22
```

```
21 3.408900988966207E27
22 5.0215075513874544E28
23 7.39696992381353E29
24 1.0896162854257583E31
25 1.605067563736869E32
26 2.3643569930249012E33
27 3.4828340667796297E34
```

To fix this, we simply fix our method to 1 rather than t, basically allowing t = 1. The resulting output for this fix would give us the correct output.

1 1093.8068976709837
2 1196.413529392622
3 1308.6453709165362
4 1431.4053333137103
5 1565.68102694157
6 1712.552706821279

11 2681.3112807075054
12 2932.836773640889
13 3207.9570927515183
14 3508.885595484167
15 3838.0432674789395
16 4198.078199528145

21 6572.851386618246
22 7189.430184049327
23 7863.848325637125
24 8601.531540820304
25 9408.414529883774
26 10290.988708934778

To further clean our data, we need to round our output to dollar amounts which would be two decimal places. The formula we will use for this is:

```
//round to dollars
i = Math.round(i * 100.0)/100.0;
```

Our output is now:

1 1093.81	11 2681.31	21 6572.87
2 1196.42	12 2932.84	22 7189.45
3 1308.65	13 3207.96	23 7863.87
4 1431.41	14 3508.89	24 8601.56
5 1565.69	15 3838.05	25 9408.45
6 1712.56	16 4198.09	26 10291.03

7 1873.21	17 4591.9	27 11256.4
8 2048.93	18 5022.65	28 12312.33
9 2241.13	19 5493.81	29 13467.31
10 2451.36	20 6009.17	30 14730.64

However, the issue here is this does not match the example output. To fix this I will only print the rounded number, but I will not use it in any of the model calculations.
The code correction I made is:

```
//round to dollars
double answer = Math.round(i * 100.0)/100.0;
System.out.println(years + " " + answer);
```

Now there is no rounding in *i* and we have allocated memory to a variable only for printing the result for that year, which will get replaced every "year". Here is the updated output:

1 1093.81	11 2681.31	21 6572.85
2 1196.41	12 2932.84	22 7189.43
3 1308.65	13 3207.96	23 7863.85
4 1431.41	14 3508.89	24 8601.53
5 1565.68	15 3838.04	25 9408.41
6 1712.55	16 4198.08	26 10290.99
7 1873.2	17 4591.89	27 11256.35
8 2048.92	18 5022.64	28 12312.28
9 2241.12	19 5493.8	29 13467.25
10 2451.36	20 6009.15	30 14730.58

Testing: Functionality

Add print statements to confirm there are no arithmetic errors.

If we calculate by hand the initial example given, with the parameters

principal = 1000
interest = 0.09
t = 30

$P * (1 + interest/12)^{t*12}$

Step 1: Inside of parenthesis

$1 + interest/12$ ⟶ $1 + 0.09/12$

$1 + 0.09/12 =$
$1 + 0.0075 =$
1.0075

Step 2: Raise to power

1.0075^{t*12} ⟶ 1.0075^{30*12}
$1.0075^{30*12} =$
$1.0075^{360} =$
14.73057612304044

Step 3: Multiply by principal

$P * 14.73057612304044$ ⟶ $1000 * 14.73057612304044$
$1000 * 14.73057612304044 =$
14730.576123040439

Since this is the same output we received in the first example, we now know our method works arithmetically with the numbers provided. Since we can also assume this model will not have to handle zero or negative integers, we will not have to test any special variables as we would with other model testing under different circumstances.