# Life Insurance Mathematics: Assignment 1

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Q2. With all the given information, we can calculate the yearly loan payments from t=0 to t=23 as follows:

```
loans <- c(10000, 20000, 30000, rep(0, 20))
payments <- c(rep(0,3), 1, cumprod(0.95*rep(1,19)))
interest <- c(rep(0.06, 5), rep(0.07, 5), rep(0.08, 12))
yearly_discount_factor <- (1+interest)^(-1)
discount_factors <- c(1, cumprod(yearly_discount_factor))

pv_payments <- payments * discount_factors
pv_loans <- loans * discount_factors

k1 <- sum(pv_loans)/sum(pv_payments)

k <- k1 * payments
k
```

```
##  [1]    0.000    0.000    0.000 8177.153 7768.296 7379.881 7010.887 6660.343
##  [9] 6327.325 6010.959 5710.411 5424.891 5153.646 4895.964 4651.166 4418.607
## [17] 4197.677 3987.793 3788.403 3598.983 3419.034 3248.082 3085.678
```

Q3 a. Since there is no mention about compounding of interest rate, we examine two different cases: non-compounding and monthly compounding. First, if the interest is not compounding,

```
i<-0.055
r1<-i/12
number_payment<-15*12
payment<-c(0, rep(1,number_payment))
discount_factor<-(1+r1)^(-(0:number_payment))
PV_payment<-payment*discount_factor
K<-150000/sum(PV_payment); K
```

```
## [1] 1225.625
```

The monthly payments should be $1225.625, so it matches the result from Bloomberg Mortgage Calculator.

If the interest is monthly compounding,

```
i<-0.055
r2<-(1+i)^(1/12)-1
number_payment<-15*12
payment<-c(0, rep(1,number_payment))
discount_factor<-(1+r2)^(-(0:number_payment))
PV_payment<-payment*discount_factor
K<-150000/sum(PV_payment); K
```

```
## [1] 1214.988
```

we have a different result, $1214.988.

Q3 b. Here, we examine the two cases again. Also, since the first payment date is set as Sepember in the provided benchmark, we follow the same timeline.

With non-compounding interest rate, we get:

```
library(FinancialMath)
amortization<-amort.table(Loan=150000, n=number_payment, i=r1)
amort<-data.frame(amortization$Schedule)
x<-4
year<-1
while(x<=180){
  cat("The balance at the end of year", year, "=", amort[x, 4], "\n")
  year<-year+1
  x<-x+12
  }
```

```
## The balance at the end of year 1 = 147832.7
## The balance at the end of year 2 = 141087.6
## The balance at the end of year 3 = 133962.1
## The balance at the end of year 4 = 126434.6
## The balance at the end of year 5 = 118482.5
## The balance at the end of year 6 = 110081.9
## The balance at the end of year 7 = 101207.4
## The balance at the end of year 8 = 91832.34
## The balance at the end of year 9 = 81928.43
## The balance at the end of year 10 = 71465.86
## The balance at the end of year 11 = 60413.11
## The balance at the end of year 12 = 48736.91
## The balance at the end of year 13 = 36402.08
## The balance at the end of year 14 = 23371.47
## The balance at the end of year 15 = 9605.82
```

It shows the result just as same as the benchmark. Therefore, if the given annual interest rate is meant to be non-compounding, the Bloomberg Mortgage Calculator is indeed correct.

Now we examine the second case with monthly compounding interest rate.

```
amortization<-amort.table(Loan=150000, n=number_payment, i=r2)
amort<-data.frame(amortization$Schedule)
x<-4
year<-1
```

```r
while(x<=180){
  cat("The balance at the end of year", year, "=", amort[x, 4], "\n")
  year<-year+1
  x<-x+12
}
```

```
## The balance at the end of year 1 = 147808.4
## The balance at the end of year 2 = 140994
## The balance at the end of year 3 = 133804.9
## The balance at the end of year 4 = 126220.3
## The balance at the end of year 5 = 118218.6
## The balance at the end of year 6 = 109776.8
## The balance at the end of year 7 = 100870.6
## The balance at the end of year 8 = 91474.69
## The balance at the end of year 9 = 81561.96
## The balance at the end of year 10 = 71104.03
## The balance at the end of year 11 = 60070.91
## The balance at the end of year 12 = 48430.97
## The balance at the end of year 13 = 36150.84
## The balance at the end of year 14 = 23195.29
## The balance at the end of year 15 = 9527.2
```

As expected, we have a different results than those from the benchmark.