Loan repayment plan using `R` and `Python`

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The following example illustrates creating a loan repayment plan using `R` and `Python`.

Loan inputs:

```
#loan amount
amount <- 5000
#maturity (in months)
maturity <- 18
#yearly interest rate
ir.y <- 0.0649
#monthly interest rate
ir.m <- ir.y / 12
```

User-defined function that generates the loan repayment plan:

```
create.repayment.plan <- function(p, r, m) {
      #p - loan amount
      #r - monthly interest rate
      #m - loan maturity in months

      #annuity
      annuity <- p * r / (1 - (1 + r)^(-m))
      #prepare the repayment plan data frame
      rp <- data.frame(month = 1:m,
                       remaining.principal = NA,
                       monthly.principal = NA,
                       monthly.interest = NA,
                       annuity = rep(annuity, m))
      #assign the loan amount as a starting principal
      rp$remaining.principal[1] <- p
      #construct the repaymen plan
      for   (i in 1:m) {
            if    (i == m) {
                  rp$monthly.principal[i] <- rp$remaining.principal[i]
                  rp$monthly.interest[i] <- rp$annuity[i] -
                                            rp$monthly.principal[i]
                  } else {
                  rp$monthly.interest[i] <- rp$remaining.principal[i] * r
                  rp$monthly.principal[i] <- rp$annuity[i] -
                                             rp$monthly.interest[i]
                  rp$remaining.principal[i + 1] <- rp$remaining.principal[i] -
```

```
                                                    rp$monthly.principal[i]
                }
            }
return(rp)
}
```

Loan repayment plan:

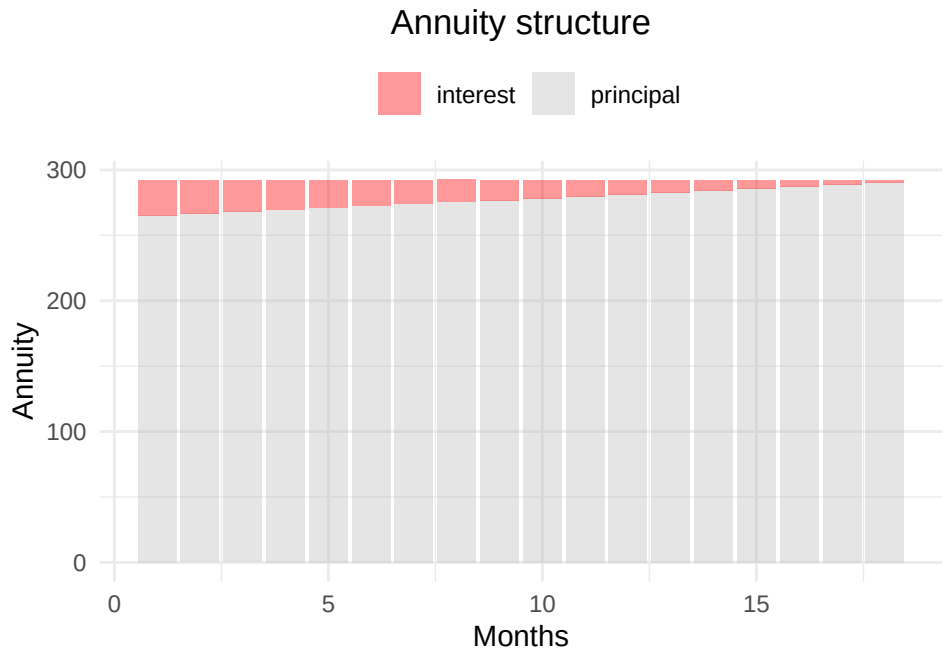
```
rp <- create.repayment.plan(p = amount,
                            r = ir.m,
                            m = maturity)
rp
```

```
##    month remaining.principal monthly.principal monthly.interest  annuity
## 1      1           5000.0000          265.2262        27.041667 292.2678
## 2      2           4734.7738          266.6606        25.607235 292.2678
## 3      3           4468.1132          268.1028        24.165046 292.2678
## 4      4           4200.0104          269.5528        22.715056 292.2678
## 5      5           3930.4576          271.0106        21.257225 292.2678
## 6      6           3659.4470          272.4763        19.791509 292.2678
## 7      7           3386.9707          273.9500        18.317866 292.2678
## 8      8           3113.0207          275.4316        16.836254 292.2678
## 9      9           2837.5891          276.9212        15.346628 292.2678
## 10    10           2560.6679          278.4189        13.848946 292.2678
## 11    11           2282.2490          279.9247        12.343163 292.2678
## 12    12           2002.3243          281.4386        10.829237 292.2678
## 13    13           1720.8857          282.9607         9.307124 292.2678
## 14    14           1437.9250          284.4911         7.776778 292.2678
## 15    15           1153.4339          286.0297         6.238155 292.2678
## 16    16            867.4042          287.5766         4.691211 292.2678
## 17    17            579.8276          289.1319         3.135901 292.2678
## 18    18            290.6957          290.6957         1.572179 292.2678
```

```
#check net present value of the cash flow
sum(rp$annuity / ((1 + ir.m)^(1:maturity)))
```

```
## [1] 5000
```

Annuity structure:



An alternative approach is available for those seeking a more advanced solution that offers precise values for the remaining principal, principal, and interest portion in an annuity at a certain period. The subsequent code demonstrates the calculation of the principal portion in the annuity for the 5^{th} month. The remaining steps in the repayment plan calculation are straightforward and are left for the reader to complete.

```
#annuity
a <-  amount * ir.m / (1 - (1 + ir.m)^(-maturity))
#define the nth period
n <- 5
#principal portion in the annuity at the 5th period
(a - amount * ir.m) * ((1 + ir.m)^(n - 1))
```

```
## [1] 271.0106
```

Loan repayment plan in `Python`:

```
import pandas as pd
import numpy as np

#input parameters
#loan amount
amount = 5000
#maturity (in months)
```

```
maturity = 18
#yearly interest rate
ir_y = 0.0649
#monthly interest rate
ir_m = ir_y / 12

#loan repayment function
def create_repayment_plan(p, r, m):
    #p - loan amount
    #r - monthly interest rate
    #m - loan maturity in months

    #annuity
    annuity = p * r / (1 - (1 + r)**(-m))
    #prepare the repayment plan data frame
    rp = pd.DataFrame({"month" : [*range(1, m + 1)],
                       "remaining_principal" : [None]*m,
                       "monthly_principal" : [None]*m,
                       "monthly_interest" : [None]*m,
                       "annuity" : [annuity]*m
                      })
    #assign loan amount as a starting principal
    rp.loc[0, "remaining_principal"] = p
    #construct the repaymen plan
    for i in rp.index:
        if (i == rp.index[-1]):
            rp.loc[i, "monthly_principal"] = rp.remaining_principal[i]
            rp.loc[i, "monthly_interest"] = rp.annuity[i] - \
                                            rp.monthly_principal[i]
        else:
            rp.loc[i, "monthly_interest"] = rp.remaining_principal[i] * r
            rp.loc[i, "monthly_principal"] = rp.annuity[i] - \
                                             rp.monthly_interest[i]
            rp.loc[i + 1, "remaining_principal"] = rp.remaining_principal[i] - \
                                                   rp.monthly_principal[i]
    return(rp)


#create repayment plan
```

```
rp = create_repayment_plan(p = amount,
                           r = ir_m,
                           m = maturity)
rp
```

```
##     month remaining_principal monthly_principal monthly_interest     annuity
## 0       1                5000        265.226177        27.041667  292.267843
## 1       2         4734.773823        266.660608        25.607235  292.267843
## 2       3         4468.113215        268.102798        24.165046  292.267843
## 3       4         4200.010417        269.552787        22.715056  292.267843
## 4       5          3930.45763        271.010618        21.257225  292.267843
## 5       6         3659.447012        272.476334        19.791509  292.267843
## 6       7         3386.970678        273.949977        18.317866  292.267843
## 7       8         3113.020701         275.43159        16.836254  292.267843
## 8       9         2837.589112        276.921216        15.346628  292.267843
## 9      10         2560.667896        278.418898        13.848946  292.267843
## 10     11         2282.248998         279.92468        12.343163  292.267843
## 11     12         2002.324318        281.438606        10.829237  292.267843
## 12     13         1720.885712         282.96072         9.307124  292.267843
## 13     14         1437.924992        284.491066         7.776778  292.267843
## 14     15         1153.433927        286.029688         6.238155  292.267843
## 15     16          867.404239        287.576632         4.691211  292.267843
## 16     17          579.827607        289.131942         3.135901  292.267843
## 17     18          290.695664        290.695664         1.572179  292.267843
```

```
#check net present value of the cash flow
np.sum(rp["annuity"] / (1 + ir_m) ** np.arange(1, maturity + 1))
```

```
## 5000.000000000088
```

```
#annuity
a = amount * ir_m / (1 - (1 + ir_m)**(-maturity))
#define the nth period
n = 5
#principal portion in the annuity at the nth period
(a - amount * ir_m) * ((1 + ir_m)**(n - 1))
```

```
## 271.0106182999124
```