Jacobs University
Fall 2019

September 09, 2019

Stochastic Methods + Lab

Assignment Sheet 1

Due on September 16, 2019

Note: The work is to be submitted via `git`, as announced in class. The coding language is Python. Please make sure that your code actually runs and produces the requested output. Please make your code readable for the TA, and include comments wherever necessary. Theoretical questions may be submitted as a scan of handwritten notes or typed up (e.g., using LaTeX).

Problem 1 [8 points]

An investment is guaranteeing a cash flow $C_1, \ldots, C_N$ at the end of each period. The period interest rate is r. Write Python functions to compute the present value of the investment in four different ways, using

1. an explicit Python loop summing up each summand;
2. an explicit Python loop using Horner's scheme;
3. the `polyval` function;
4. the dot product of vectors.

Compare the run-time of the four implementations on the following test case, using `timeit` (as shown in class) with 1 000 evaluations:

```
C = 100.0 * arange(1000,1800)
r = 0.03
```

Problem 2 [4 points]

An individual who plans to retire in 10 years has decided to put an amount A in the bank at the beginning of each of the next 120 months, after which she will withdraw 1500 \$ at the beginning of each of the following 360 months. Assuming a nominal yearly interest rate of 2% compounded monthly, how large does A need to be? (Note: You can either solve this exercise with a python program or by hand.)

Problem 3 [5 points]

Write a Python program which prints out an amortization schedule for a mortgage.

The program should take as input the nominal yearly interest rate r, the amount of the loan P, the number of compounding periods per year m, and the term of the mortgage n in years. Assume that the mortgage is fully redeemed at the end of the term.

The program should compute the monthly payment and the effective annual interest rate. Furthermore, it should display a detailed payment schedule, i.e., for each month the interest and principal parts of the payment, and the remaining principal.

Run your program with $P = 400\,000$, $r = 0.02$, $m = 12$, and $n = 20$.

Problem 4 [3 points]

An investment sold at price P is guaranteeing a cash flow $C_1, \ldots, C_N$ at the end of each year. Write a program to compute its IRR (internal rate of return). Run your program on the following test case:

```
N = 40
C = 100.0 * arange(42,N+42)
P = 80000.0
```