Fall 2021
Peking University
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Computer Programming in Financial Engineering

Problem Set 1

Due by 1pm, Oct 14th. Use any resource you like. Each of you hand in your own solutions to `cpfe_pku@126.com`. You solutions consist of both your answers, written or submitted as a Word or pdf file, and computer codes. You must submit both.

1. Matrix indexation. Let A be the matrix that is created by the following command *A=reshape(1:18,3,6)*; Use one command to change elements with values of $2, 4, 8, 16$ to NaN. Also, use one command to change the last two columns of matrix A to be Inf.

2. Character array: Create a character array with the following command: *A='Hello World'*; Use the command *whos A*; *size(A);* to inspect properties of A. Also, use array commands to add an exclamation mark ! to the end of array A. What is the data type of A if we use double quotation mark *A="Hello World"*; Are you still able to use the array commands to add the exclamation mark to A? What do you get from the command *size(A)* in this case?

3. Use commands *rng('default'); A=randn(5);* to generate a 5 by 5 matrix. Find the list of elements which are larger than 0.5. Use one command to find the list under either the single indexation or double indexation (Hint: read the documentation of the command *find* or use *sub2ind* and *ind2sub* functions in MATLAB).

4. Calculate the sum of $1+2+3...+99+100$. Achieve this goal using as many methods as possible. For example, you could use loops, array operations... Also, use *tic* and *toc* commands to compare the speed of different methods. (Hint: you could store the time elapsed using command *b=toc*)

5. Hilbert matrix: A Kth-order Hilbert matrix is a K by K matrix such that the (m, n)th element of the matrix $A(m, n) = 1/(m + n - 1)$. You may generate this matrix using a double loop. Also try generating this matrix only by array operations.

6. NaN and Inf: Create an array as follows *A=[nan, inf]'* . Evaluate the logical operation of *A==A* and explain the outcome.

7. Generate a series of random numbers drawn from a normal distribution with mean 4 and standard deviation 2. Use commands *hist* and *histfit* to plot the histogram of this array. Except for the fitted line, can you make the histogram look the same using these two commands?

8. 'Banana' (Rosenbrock) function: $f(x) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2$. Use MATLAB function *mesh* to plot it over region $[-1.5, 1.5], [-6, 2.8]$; [1] Also finds the local minimum of this function function over the region using *fmincon* The optimization algorithm needs to have 'MaxIter' set as 2000, 'TolFun' set to $1e$-4

9. Write out a function *dcount.m* that calculates the present value of a series of riskfree cash flows which are received at the yearly frequency. The discount rate, however, depends on how return r is quoted. The discount rate for the cash flow in year t ahead is e^{-rt} if r is continuously quoted. However, if r is quoted over the year horizon, the corresponding discount rate is $1/(1 + r)^t$. Construct a flexible function that produces the present value with three function inputs (cashflow, r, indicator). Also, this feature is required for the function: if the indicator input is missing or indicator=='cp', r is treated as continuously quoted. Otherwise, the discount rate is $1/(1 + r)^t$.

10. Function handles: let the future cash flows be [5,5,105]. Use *fsolve* function to find the discount rate that makes the present value of the cash flows

[1] mesh: MATLAB defines a mesh surface by the z-coordinates of points above a rectangular grid in the x–y plane. It forms a mesh plot by joining adjacent points with straight lines. The result looks like a fishing net with knots at the data points

equal to 95, assuming the return is quoted over the year horizon. The corresponding discount rate is $1/(1+r)^t$ for the cash flow to be received in t years ahead. Also, you are constrained to use the *dcount* function written in the previous question.