IAM 550 Introduction to Engineering Computing, J. Raeder, Fall 2019
Homework 03
Investing
Due: Monday, November 18, 5pm, in the IAM550 drop box

Objectives:

- Learn a bit about investing principles
- Be able to analyze and solve a problem start to finish.
- Be able to read data files.
- Be able to deal with large data sets.
- Structured code development.
- Learn how to properly document code with comments.

Deliverables:

- A homework report in the same format as a lab report summarizing your results and including all required files (scripts, plots), but **not any data files**. The report should address the structured development of the code as discussed in class in the "Methods" section. Make sure your name is on *all* pages of your report. Document your scripts profusely with comments. This will be emphasized when grading.

Investing:

Since 'get rich fast' schemes never work, the only good option to accumulate enough wealth to retire without being broke is early and continuous investing. This is also how so-called 'defined contribution' retirement plans a set up (401(k), 403(b), IRA, etc.). The other form, 'defined benefit' (where the retiree receives a predetermined fixed monthly payout like with Social Security) plans virtually no longer exist in the private sector. The risk is all with the employee. It is thus important to understand how the stock market works and what the investment risks are. In this homework you will take a (probably) first look at this. Note that simulations like this are common in engineering to test out different scenarios.

Data:

I have gathered data spanning about the last 70 years for the stock market (the S&P 500 index), Treasury bond yields, and inflation. The data files ore on the web site (homework03_SP500.txt, homework03_inflation.txt, homework03_yield.txt).

The data are monthly, starting from 1946, simple text files, and can be loaded into MATLAB with statements like `sp500=importdata('homework03_SP500.txt').` Normalize the sp500 data so that the first value is 1. This will later make comparisons easier. Although the index is not a stock itself, one can treat it as such, because there are funds that exactly mimic the index' price movement and trade like stocks.

Task 1 of 2:

The stock data don't give the complete investment return, because companies also pay out profits as dividends. The current average dividend yield of the S&P 500 companies is about 1.88% but has been larger in the past. For our calculations let's assume a yield of 2%, that is, that there is a payout every month of 2%/12 of the index' value. For all our calculations scale all time series such that the first value is one. Calculate a sp500 index with dividend (call it spdiv) that includes the dividend payouts such that it rises/falls proportional to the sp500, and also rises every month due to the dividends by 2%/12. Next, calculate a time series that shows how $1 would grow if invested in bonds, such that the increase in value is only due to the interest income specified in the 'yield' time series. Call this 'bond1'. Then calculate how $1 would grow if the interest income is reinvested (so you get the compound interest). Call this 'bond2'. Finally, calculate the inflation time series. Again, start with $1 and calculate how much you would later need for the same purchase. This is basically the same as compound interest.

Next, make a plot (Figure 1) with all the time series. Because they are all normalized, they must all start out at 1. You will find that the plot is not very telling, because all the growth seems to be all at the end. Explain the reason. Next, plot the data (Figure 2) with a logarithmic y-axis (MATLAB semilogy). Make sure the plot has proper labels and legends. Explain why the plot looks so different. Also, explain what the plot tells you about investing.

Task 2 of 2:

Start a new script and write a function `function r=invest(timeseries,m1,m2)`, which takes as input one of the time series like `sp500`, a starting month `m1` and an ending month `m2`. You invest $1 every month, which means you are buying shares (they can be fractions) for that $1 and add them to your portfolio. In the last month, you sell all those shares at the current price, and return that value. For example, if you start investing at month 150 for 10 years, `invest(spdiv,150,150+12*10)` should return how much $$ you have at the end of that period if invested in SP 500 with dividend reinvestment. Now consider all possible investment periods of a given length L. Let's say L=10y, one could have [1,120], [2,121], [3,122], and so on until the last index hits the end of the time series. For each such

period, call invest, and calculate your effective rate of return from *final = invested * (1+rate)^years*, where *final* is what you have at the end, *invested* is the total amount you put in, and *rate* is your effective rate. If the latter was zero, you would just get out what you put in (no gain), but it's also not simply how much the stock rose or fell, because you did not invest everything at the beginning of the interval as a lump sum. However, this is the number that really matters, because it tells you how much better (or worse) you do as compared to keeping the $$ under the mattress. Store all rate of return values in an array and plot a histogram of the possible returns. They obviously vary over time and also depend on L. You may use the MATLAB function `histogram`, but make sure you label your plots properly. Do this calculation for L=2,10,30 years and for the investment options `sp500`, `spdiv`, and `bond2`. Discuss what that means for investing.