MECH/ELEC/COMP 498/598: INTRODUCTION TO ROBOTICS

Lab #0
Python/Gradescope Primer: Investing Life Lesson

Due Thursday, Jan 22nd at midnight

Assignment Description
This is a fun, intentionally low effort assignment that is intended to get you setup for success on the labs for the remainder of the class while also teaching you about the concept of investing in 401k's, which most of you will deal with when you leave school and start work.

This assignment is intended to:
- Ensure you get setup with Python on your machine properly
- Familiarize yourself with elements of Python we will use in the labs in the course.
- Give you an opportunity to practice using the auto-grader, GradeScope
- Teach you a little bit about 401K investing that no one seems to teach you

This lab has the instructions for getting Python running on your Windows machine (Mac users will need to setup a VM through the Mac interface and follow similar steps). Once you have your Python environment setup, you can then download the student code for the lab and complete the assignment described below.

In this course, we will be using Gradescope for auto-grading assignments. You will be able to submit your code to the website at any time and it will run a series of tests to determine what you have done correctly and incorrectly and give you a corresponding score. This lab should help you get familiar with the interface. This auto-grader is new this semester, and the intention is to make troubleshooting more straightforward and your grade clearer to understand. If the auto-grader says you get 92.5/100, that's what you'll get.

This lab must be done individually to ensure everyone is familiar with the Python setup and gradescope.

Final notes:
Struggling with Python setup on your machine is common, do not be alarmed if you have a few issues. (Even seasoned software developers sometimes run into issues with computer setup)

Warning – if you struggle with the Python *code* in this assignment and do not understand what it's doing or why, then this course's labs may be very difficult. Please talk with me to determine if you want to remain in the course.

Submission Instructions
Your submission for this assignment will be purely electronic through Gradescrope. You must zip all of your code into one .zip file for submission. You may submit as many times as you want before the deadline.
This submission will also include a few multiple choice/fill-in questions to help you better understand the workings of a 401K.

Assignment:
As mentioned, this lab is intended to ensure your Python setup is ready for the labs, you are familiar with the Python concepts necessary, and you are familiar with Gradescope.
We have obviously not covered any robot content to include in this lab, so we will focus on a life skills lesson rather than a robotics lesson. (Consider it a robotics lesson because if you go into robotics you will get paid enough to care about a 401K!)

Background:
401K investing is a standard investment tool offered by most companies that you will ever work for. I am sure most of you have heard of them and the concept of compounding interest, but few have probably been taught about them. A 401K is a **pre-tax** investment fund. This means that the salary that goes into the fund does not count towards your taxes. In addition, many companies offer a "matching" program into your 401K. For instance, a company may match "up to 3% of your salary" into your 401K. Typically, it includes some sort of scheme such as this – "Exact match up to 2% with a 0.5% match on any additional contribution up to a total match of 4%." Here is an example of what you contribute versus what the company contributes in a scheme such as this. This table assumes a salary of $100k/year.

Salary Contribution	Match	Ind. Contribution $	Company Contribution $	Total Contribution $
1%	1.0%	$1,000	$1,000	$2,000
2%	2.0%	$2,000	$2,000	$4,000
3%	2.5%	$3,000	$2,500	$5,500
4%	3.0%	$4,000	$3,000	$7,000
5%	3.5%	$5,000	$3,500	$8,500
6%	4.0%	$6,000	$4,000	$10,000
7%	4.0%	$7,000	$4,000	$11,000

The important takeaway is that the company match is in addition to your salary. If you contribute 6%, your total income earned that year moves from your base salary of $100k to $104k. It is rarely advised to contribute less than the match to your 401K at any time if you can avoid it.

Fun Fact– why do companies offer a match?
This is an equal opportunity to participate incentive. If there is no matching, 401k's are typically only used by the higher earners in a company and are a disproportionate benefit to the higher income people. There are laws in place to ensure equitable access to these benefits across a company. So a company must either
A) Prove that a certain percentage of the workforce is taking part in the 401k program across the income spectrum of the company OR
B) Provide a matching program to provide benefit to all in the company.

Investment Types
Alright, so you may have known everything in the information above, which is great! The next layer down is investment funds! When you put your money into a 401K, that money is invested into the market via the company managing the 401k. In almost all cases, there are actually additional options for your investment, it is not just one big pool. Different people will have different risk tolerances at different times in their life. When you are 22 and investing into your retirement for age 65, you can be incredibly risky as you have 43 years to play the market for the highest gains. But, when you are 55 and starting to look towards retirement, you need a more stable investment strategy so that a volatile market when you are 64 does not cut your investment 20% before retirement. Therefore, 401k's offer different investment funds that have different risk profiles for different people. It is important to look into this at your company when you start. Typically, the default is the **least** aggressive investment, which you do <u>not</u> want in your early years. Here is an example of different fund types for NASA's 401k

Primary TSP Funds 4/1/1987 - 11/19/2025	TSP G Fund	TSP F Fund	TSP C Fund	TSP S Fund	TSP I Fund
Last Price (11/19/2025)	19.49	20.78	106.11	95.99	52.39
Change (1-Day)	0.01%	-0.05%	0.38%	0.01%	-0.22%
YTD Return	3.9%	6.7%	14.2%	6.5%	25.0%
1-Year Return	4.5%	6.3%	13.7%	3.6%	23.0%
3-Year Return	4.4%	4.7%	20.4%	14.4%	16.2%
5-Year Return	3.4%	-0.3%	14.8%	7.5%	9.5%
10-Year Return	2.7%	2.0%	14.3%	10.3%	7.8%
Annual Return Since 4/1/1987 [1]	4.7%	5.3%	10.7%	9.8%	6.6%
Annualized Standard Deviation [2]	0.3%	4.3%	18.2%	20.3%	17.2%
Maximum Drawdown [3]	-	-18.0%	-55.2%	-57.4%	-60.9%
Sharpe Ratio [4]	-	0.16	0.40	0.34	0.19
Value of $1,000 invested on 4/1/1987	$5,860	$7,331	$51,570	$37,189	$11,651

 Note that, at times, the C, S, and I fund may be down as much as 50%! Thes are much riskier funds, but also may have much higher rates of return. It is important to balance these funds throughout your working career to match your risk profile at the time.

Lastly, note the effect of compound interest. If you invested $1,000 33 years ago, one fund would result in $5,860, the other would result in $51,570!!! This is an example of the "time value of money." The earlier you invest, the more time your money has to grow.

This lab will give you a demonstration of different investment strategies and compare the results to each other. The file *investment_funds.py* will have the investment performance of different funds, A, B, and C each with increasing risk. You will set up several investment strategies as laid out below to understand the net result at retirement for each one. Gradescope will have a few questions for you to answer to solidify understanding once you're done.

Note – the units for this lab are in dollars ($).

1. [10 points] Setup the code to run a calculation on investing in *just* the A fund.
    You will need to fill out the primary calculation methods:
    company_401k_match – given the percentage of your income that you are contributing, what is the company contributing. Please use the matching scheme in the handout.
    calculate_total_contribution – calculate the total contribution given your contribution and the company match. "Why do we need a function for this" you might ask? Well, the IRS limits the yearly contribution to $24,500. Please make the function combine your contribution and the company's contribution, then cap it at the max if necessary.
    calculate_investment_compounded_annually – Calculate the total value of the investment given the starting value, contribution, fund type, and years contributed. Return the total value of the 401k at the end of the last year. Note – consider the contribution as going in at the end of the year, not the beginning.
    Gradescope will check these three functions individually to make sure they are done properly.

2. [5 points] Next, do a simple conservative retirement calculation in **calculate_conservative_retirement**. When calculating, use the AFund and 10% of your salary each year. You can also see a graph of this result when you run the file using `python investments.py` Play with different fund types to see how the value changes!

3. [5 points] *Time Value of Money:* If you wait 10 years to begin investing in your 401k, how much have you lost out on?
   Fill in the function **calculate_first_10** investing 6% in the B fund only. (Be sure to include the company match)
   Fill in the function **calculate_last_30** investing in the B fund only. Adjust your investment percentage so that you make within 10% of what you made in the first 10 years.
   Note: Look at the difference in the total amount you had to invest over 30 years to match the same final value from investing only $60k through the first 10 years.

4. [5 points] *Retirement in a recession:* What happens if you retire during a downturn and don't modify your investment funds throughout your career?
   Fill in function **calculate_risky_retirement_2065** only investing in the riskiest fund, C at 10%/year.
   Fill in the function **calculate_risky_retirement_2066** only investing in the riskiest fund, C at 10%/year
   Note: Look at the difference in final value given the theoretical market crash in 2066!

Computer Setup Instructions:

WSL Installation:
Install Ubuntu 24.04
https://documentation.ubuntu.com/wsl/stable/howto/install-ubuntu-wsl2/

VSCode Installation:
https://learn.microsoft.com/en-us/windows/wsl/tutorials/wsl-vscode