Practical Financial Optimization (PFO) - final project 2025

Introduction and motivation:

Your grandparents are retiring within the next year. They have some pension savings as well as a million DKK in free savings (cash). Their financial advisor has told them that they should use their free savings within the next 10 years, in approximately equal annual amounts, as part of their retirement allowance. She has suggested investing the money in a rather low risk portfolio. They have talked with their bank (Jyske Bank), that has suggested that they can invest their money in one or more of their standard portfolios:

1- Jyske Portefølje Vækst Akk KL
2- Jyske Portefølje Balanceret Akk KL
3- Jyske Portefølje Stabil Akk KL
4- Jyske Portefølje Dæmpet Akk KL

Annual Returns and Standard Deviation of Returns from 2013-01-09 to 2025-07-23
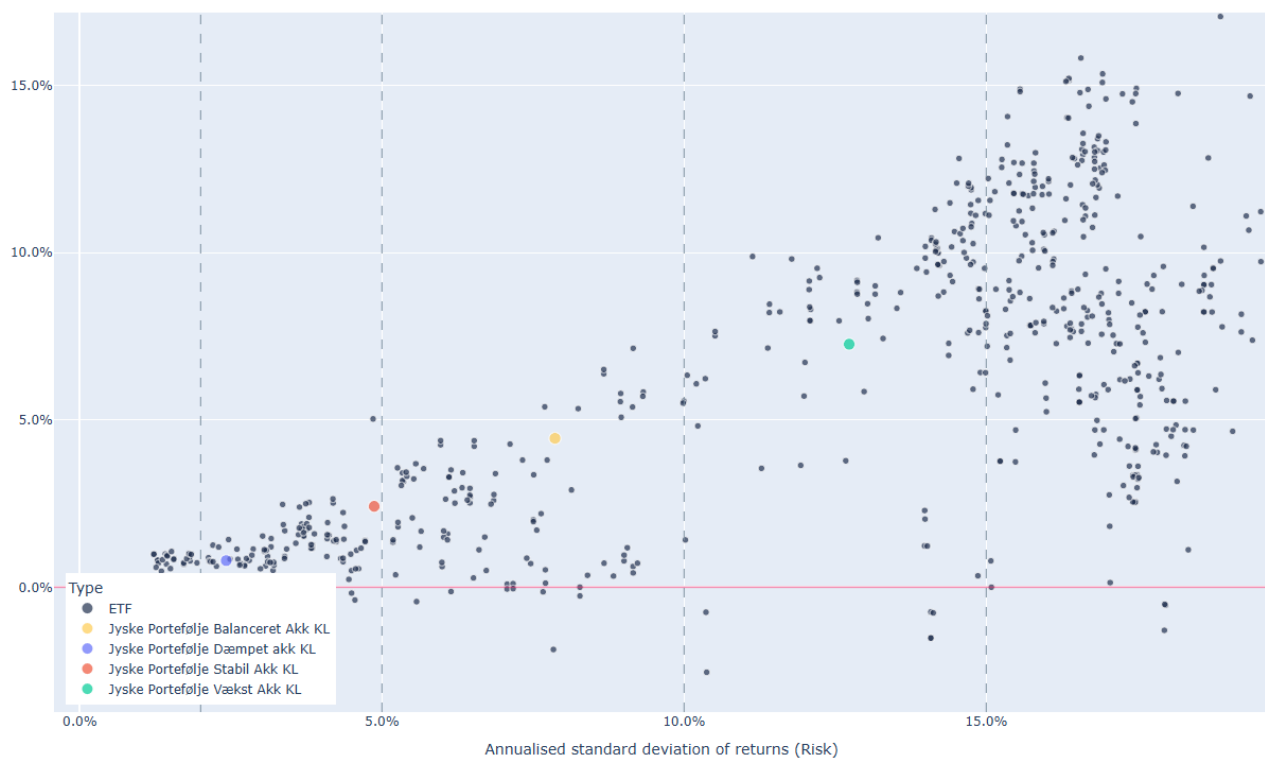
Knowing that you have attended PFO25 (a world class summer course in Investment planning and optimization 😎), they ask you your second opinion on whether they should go with the Jyske Bank portfolios or invest in low-cost ETFs and/or mutual funds via a platform like Nordnet themselves.

Steps:

During the first week of the course, all we did was aimed to equip you with knowledge and technology which should help you come up with a qualified answer. As we went along the first week of the course, you had lectures and assignments that you need in order to complete the final project. We will also provide you with the relevant data to work with. **Your final report (due for delivery Saturday 16th of August 2025 before midnight) should include clear answers to the questions in the following steps.** You are, however, very welcome to use your prior knowledge, your innovative thinking skills, and any way you can get a hold of extra help, to come up with any advice that your grandparents would consider. As far as you can succinctly describe the rationale behind your strategy and how you've tested it, they couldn't care less how you came to your answers.

Step 1: Jyske Banks portfolios (10 points)

For any of the four Jyske Bank standard portfolios find:
- Their total annual expense ratio, given as a percentage of the AUM (Asset Under Management).

Also calculate following summary statistics for each of the portfolios for the last 3 years, 5 and 12 years:
- Average annual return per portfolio.
- Annual standard deviation per portfolio.
- Annual Conditional Value at Risk per portfolio.

Show your results in a table.

Step 2: An investment with guarantee (5 points)

For simplicity let's assume that your grandparents just need 10 payments – one per year.

If you were to suggest a guaranteed investment product to them with known payments for the next 10 years, what would you suggest?
Find the product and calculate the annual payments for the next 10 years and present your results in a table. What are the pros and cons of this solution?

Step 3: Picking up a subset of assets – feature selection (15 points)

Use Investment Funnel to select between 30 to 50 ETFS (or Danish mutual funds) in such a way that they represent the variation among all the products presented to you in the investment funnel for the period 2013-2019, so that you don't lose much on the diversification effect of having more funds in your disposal for that period. Present the assets of your choice in a table with their names, ISIN codes, TER (total expense ratio), as well as summary statistics (including but not limited to average annual return, standard deviation, Sharpe ratio, CvaR, Maximum Drawdown, Time under Water, etc.) for the 6-year period. Also calculate the Variance Covariance matrix for your chosen assets. You should also argue for your choice of feature selection process.

Step 4: Your first optimization model (12 points)

4.1 Formulate and run the Markowitz model, based on parameters estimated from the period 2013-2019. Run the model twice, once maximizing expected return with portfolio STD less than a benchmark STD (**use one of Jyske portfolios for benchmarking**) and once minimizing the portfolio STD with expected annual return greater than benchmark portfolio's average annual return. Save the results for both runs.

4.2 Now draw the whole efficient frontier (using 10 points – equidistant in portfolio variance) and depict the two extra portfolios you just found on that efficient frontier, as well as the benchmark portfolio.

4.3 Test how the two strategies perform from 2019-2025, i.e. using the historical data, show the development in the portfolio value during this period. Compare the performance of the two strategies with that of the benchmark portfolio. Also give the summary statistics for the three strategies (Mean, STD, Sharpe Ratio, VaR(95%) and CvaR(95%)).

Step 5: Minimizing downside regret - the first period (12 points)

5.1 Bootstrap 1.000 scenarios (of length 4 weeks) based on the first 6 years 2013-2019.

5.2 Formulate the downside regret model, with a target of exactly 2% at all scenarios.

5.3 Run the model minimizing downside regret and constraining expected return to be greater than the expected return of the benchmark portfolio.

5.4 Run the model maximizing expected return and constraining the expected downside regret to be less than the expected downside regret of the benchmark portfolio.

5.5 Test how the two strategies perform from 2019-2025, i.e. using the historical data show the development in the portfolio value during this period. Compare the performance of the two strategies with that of the benchmark portfolio. Also give the summary statistics for the three strategies (Mean, STD, Sharpe Ratio, Expected Downside Regret and CvaR(95%)).

Step 6: Minimizing CvaR - the first period (12 points)

6.1 Bootstrap 1.000 scenarios (of length 4 weeks) based on the first 6 years 2013-2019.

6.2 Formulate the CVaR model.

6.3 Run the model minimizing CVaR and constraining the expected return to be greater than the expected return of the benchmark portfolio.

6.4 Run the model maximizing expected return and constraining CVaR to be less than the CVaR of the benchmark portfolio.

6.5 Test how the two strategies perform from 2019-2025, i.e. using the historical data show the development in the portfolio value during this period. Compare the performance of the two strategies with that of your grandparent's portfolio. Also give the summary statistics for the three strategies (Mean, STD, Sharpe Ratio, VaR(95%) and CvaR(95%)).

Step 7: Optimizations with 4-weekly revisions (24 points)

Pick up your favorite two strategies and backtest them (with steps of four weeks) from 2019-2025.

7.1 Bootstrap 1.000 scenarios (of length 4 weeks) based on the first 6 years 2013-2019. (You've already done this in the previous two assignments).

7.2 Run your optimization for the first period the usual way, as if you are back in time at the end of the first 6-year period (the training period).

7.3 Now roll forward 4 weeks and generate another 1.000 scenarios.

7.4 Run a new optimization, keeping in mind that you start with a portfolio (not just money) this time, so you need to expand the model to do portfolio revision (buying and selling of assets). Introduce a transaction cost of 0.1% of the amount sold or bought in the model.

7.5 Repeat this process (7.3 and 7.4) until you arrive to 2025 and have no more data left.

7.6 Report your back-testing results by drawing the following three graphs:
- 7.6.1 The optimal portfolio composition (normalized to total of 100%) for all the periods. This is also called a stacked graph – the idea is to see how the composition changes over time.
- 7.6.2 Actual portfolio value growth from following the strategy (ex-post). You can start with a value of 100 in the beginning. In the same graph include the average, the worst and the best case as suggested by the scenarios (ex-ante).
- 7.6.3 Compare the actual performance of your models (Your two portfolios and the benchmark) in the same graph and comment your findings.

Step 8: Conclusions and recommendations (10 points)

Write half a page of text (plus graphs and tables) presenting your recommendations to your grandparents. Explain why you recommend, as you do.