Problem 2

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PART A

0 points possible (ungraded)

An investor has \$5000 and two potential investments. Let x_j for $j = 1$ and $j = 2$ denote his allocation to investment j in thousands of dollars. From historical data, investments 1 and 2 have an expected annual return of 20 and 16 percent, respectively. Also, the total risk involved with investments 1 and 2, as measured by the variance of total return, is given by $2x_1^2 + x_2^2 + (x_1 + x_2)^2$, so that risk increases with total investment and with the amount of each individual investment. The investor would like to maximize his expected return and at the same time minimize his risk. Clearly, both of these objectives cannot, in general, be satisfied simultaneously. There are several possible approaches. For example, he can minimize risk subject to a constraint imposing a lower bound on expected return. Alternatively, expected return and risk can be combined in an objective function, to give the model:

$$\left.\begin{array}{ll} \max & f(x) = 20x_1 + 16x_2 - \theta[2x_1^2 + x_2^2 + (x_1 + x_2)^2] \\ \text{s.t.:} & \\ & x_1 + x_2 \leq 5 \\ & x_1, x_2 \geq 0 \\ & 0 \leq x_i \leq 5, i \in \{1, 2\} \end{array}\right\}$$

Suppose $\theta = 1$. To two decimals, what is the objective value?

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You can solve using spreadsheet optimization or using Julia. If you use Julia, you will need the following additional syntax:

```
Pkg.add("NLopt")
yourModelVariable=Model(solver=NLoptSolver(algorithm=:LD_MMA))
@NLobjective(yourModelVariable, Max/Min, Function)
@NLconstraint(yourModelVariable, Inequality))
```

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PART B

0 points possible (ungraded)

Next, we would like to study the objective for different values of θ. Specifically, for $\theta \in \{0, 1, \ldots, 5\}$, we would like to determine where the objective is maximized.

For which of these six values value of θ is the optimum objective value maximized?

If you use Julia and JuMP, then create a vector containing the values of θ, and then use a loop. If you use a spreadsheet, solve the problem six times and record your answers.

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✔ Correct

PART C

0 points possible (ungraded)

Next, we would like to plot the expected return as a function of θ for $\theta \in \{0, \ldots, 5\}$.

If you use Julia and JuMP, you will need the following additional syntax

```
Pkg.add("PyPlot")
using PyPlot
plot(xVector, yVector, label="your label", xlabel="...", ylabel="...")
```

◉ I am ready to have the answer shown. ✔

Solution

See R6P2C_sol.ipynb for the Julia solution

See R6P2c_sol.xlsx for the Excel solution

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✔ Correct