Approach for Tutorial 2

Problem Statement:

Currency Exchange problem - Find the currency exchanges $X*$ that minimize the currency exchange cost for the data in currency_exchange_data*.

The goal is to exchange currencies on a market so that, after the exchanges, we hold at least c_i^{req} units of each currency i.

Approach

We are given the exchange rates given by $F \in \mathbb{R}^{nxn}$ with appropriate values for F_{ij}, F_{ji}. We are also given c_{init} and c_{req} in the dataset.

Let $X \in \mathbb{R}_+^{nxn}$ denote the currency exchange matrix. Since we need to minimize this cost (in USD), let us take the matrix X as a cp variable of order nxn.

It is given that after the currency exchange, we need to end up with at least c_i^{req} of currency i. Let us denote this as c_i^{final}. The value X_{ij}/F_{ij} of currency i, the amount of currency j we exchange on the market for currency i, is to be required in the c_i^{final} expression. All the currency holdings are in USD, so from the matrices X and F, the first row is to be taken into consideration.

Thus the expression of c_{final} would be

$$c_{final} = c_{init} + (X/F) * \begin{bmatrix} 1 \\ 1 \\ \cdot \\ \cdot \\ \cdot \\ 1 \end{bmatrix} - X^T * \begin{bmatrix} 1 \\ 1 \\ \cdot \\ \cdot \\ \cdot \\ 1 \end{bmatrix}$$

And according to the problem statement, the constraints are

- $X_{ij} \geq 0$
- Diagonal Elements of matrix $X = 0$
- $c_{final} \geq c_{req}$
- $$X^T * \begin{bmatrix} 1 \\ 1 \\ \cdot \\ \cdot \\ 1 \end{bmatrix} \leq c_{init}$$

Since our objective is to minimize the currency exchange, the “objective” expression would be

$$objective = cp.Minimize\left((c_{init} - c_{final}) * \Sigma\left(F_{1j}/F_{j1}\right)\right)$$

Finally, using the “$cvxpy$” python module, this problem can be solved directly with properly mentioning the above “objective” and “constraints”.

$$cp.Problem(objective,\ constraints).solve()$$