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CSCI 3104, Algorithms **Profs. Grochow & Layer**
Explain-It-Back 9 **Spring 2019, CU-Boulder**

A finance colleague asks for your help in developing software that will help her automate some of the buy and sell orders that she receives. Simplifying things a bit, she describes buy orders as target asset and a dollar amount to spend and sell orders as target asset and an amount of the asset to sell. As you develop this application you see a funny pattern. The US dollar (USD) to Pound sterling rate is 0.77 (GBP), the GBP to Canadian dollar (CAD) rate it 1.75, and the CAD to USD rate is 0.75. You get very excited by this observation and immediately stop work on the automated buy/sell tool and start implementing a shortest path algorithm. After a few tests you are confident in your idea, now you pitch this new method to your friend.

Dear esteemed fiance colleague,

I'm delighted that you considered me when looking for someone to help develop an automated buy and sell system. Through my work so far in developing this system, I've noticed an opportunity for arbitrage. Simply put, this opportunity for arbitrage takes advantage of being able to buy and sell different currencies and increasingly better exchange rates so that we can sell a given currency for a higher rate than we initially bought it at. Further detail regarding the ins and outs of arbitrage can be found in the link below. Now, through the work I've done so far, I've discovered that one can exploit this arbitrage opportunity by using a methodology that executes buy and sell orders between currencies when the given relationship between two currencies is the shortest distance, or path of least resistance, among other currency relationship pairs. By using some fancy math to find this shortest path between two currencies among a basket of currencies with various relational exchange rates, we can determine what the best exchange sequence is and iterate on this process until we are able to make an exchange where we can sell a certain currency for more than we bought another one for. Please see the example below for more clarity.

Example:

1oz.gold ⇒ $327.25
1oz.gold ⇒ £208.10 ⇒ 208.10(1.5714) ⇒ $327.00
1oz.gold ⇒ 455.2Francs ⇒ 304.39Euros⇒ $327.28

In this example, the ultimate shortest path, or least cost, pathway to convert an ounce of gold into $ is to first purchase Francs, then Euros, and then Dollars. This yields a higher return than simply converting an ounce of gold into Dollars or first into pounds and then dollars.

https://www.globalsoftwaresupport.com/forex-arbitrage-bellman-ford/

As always, please let me know if you have any questions. I look forward to implementing this system with you and making some money.

All the best,
Trevor Stanley

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