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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.

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Everyone likes saving money. If you isolate yourself to only making orders from one currency directly to the target currency, then you are stuck with the ratio whatever it may be at the time. Instead if you take into account other currencies, meaning trade initial currency through multiple other currencies until reaching the target currency. For example, if we just take into account the US Dollar, the Pound, and the Canadian Dollar, we can see that trading through another country will ultimately leave you with a better exchange ratio and more money. We see that the USD to Pound rate is .77, the Pound to CAD is 1.75, and the CAD to USD rate is .75. So let's say you were trying to put in an order to exchange 100 CAD to Pounds. At the direct ratio of 1.75, you would end up with 57.14 Pounds ($CAD/1.75$). Instead, however, if we exchanged 100 CAD to USD, we would end up with 75 USD ($CAD * 1.75$). Now if we take these USD and convert them to Pounds we would get 57.75 Pounds. This shows that by going through multiple other currencies and using those rate ratios, you can ultimately save money than going directly through to the target currency. This could mean big savings for large buy/sell orders. The more currencies we can analyze, the better path we can find. There are many good algorithms that we can use like Dijkstra's Shortest Path Algorithm. This will use the rate ratios between currencies as the "size" of the path and the software should be able to determine the the best path with the smallest overall ratio. Because making these orders is almost instantaneous, we do not have to worry about the risk of losing time when going through multiple other currencies as opposed to making a direct exchange. So we can focus on 100 percent accuracy when finding us the most money efficient path.