Cryptocurrency Arbitrage

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Motivation:

With the recent rise in mainstream media coverage of Bitcoin and other crypto-currencies, there has been significant uncertainty in the value, validity, and future of these crypto-currencies. This volatility provides the perfect opportunity for arbitrage among exchanges. Inter-exchange arbitrage typical involves:

- Buying commodity C1 on Exchange E1 at Xt0
- Shorting commodity C2 on Exchange E2 at Xt0
- Selling C1 on E1 at Xt1, Buying C2 on E2 at Xt1
- X is the percent difference in price between E1 and E2

Using a dynamic investment model, generated from an MDP, we produced returns of 9% over 1 week (12/1/17 – 12/8/17)

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Capital ← constant amount willing to invest
Profit ← 0
Eps ← total cost of fees
While(True):
        Cap_used = 0
        X ← percent difference between exchanges
        While( X > Eps):
                X1 ← Get_X_max_Estimate(Volume, Price, X1_log)
                Policy ← Get_Optimal_Policy(X, X1, Cap_used)
                Profit, Cap_used = Execute_Arbitrage(Policy, X, X1, Cap_used, Profit)
Return Profit
```

Figure 1: Overhead Algorithm Implemented

Data:

For crypto-currencies, bitcoincharts.com contains minute-by-minute data from 2009, the conception of Bitcoin, to date for nearly 100 different exchanges. Then, using the Python Selenium Package, we wrote a script to copy all of this data onto a massive CSV file.

For training throughout this paper, we will use the difference in GDAX and Bitstamp from 12/1/16 to 12/1/17, which is a vector of 381,600 differentials.

Methods & Results:

- First we implement a Naïve Bayesian Model to predict the Xt0 value: [Figure 2]
  - Mean: 2.3% Standard Error: 0.64%
- If all capital is invested at Xt0, max return was 11% over 2 months, need dynamic strategy [F. 3]
- Thus, we found the optimal dynamic investment policy with Modified Policy Iteration on the MDP:
  - The State, Actions and Transition Spaces are shown in Figure 4 (bottom right)
- Finally we simulated this new dynamic investment strategy on a week of simulated data and received:
  - 9% ROI over the week 12/1-8/17

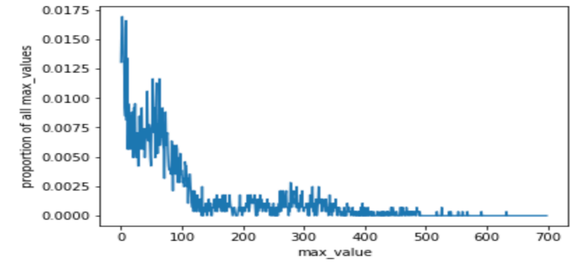

Figure 2: Distribution of Xt0 Values across the 6 month period

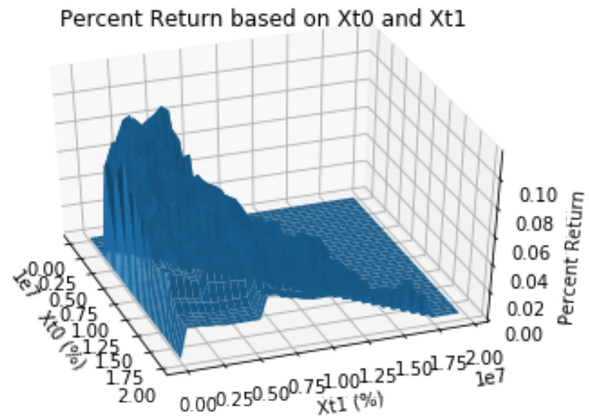

Figure 3: Percent Return based on static investment strategy

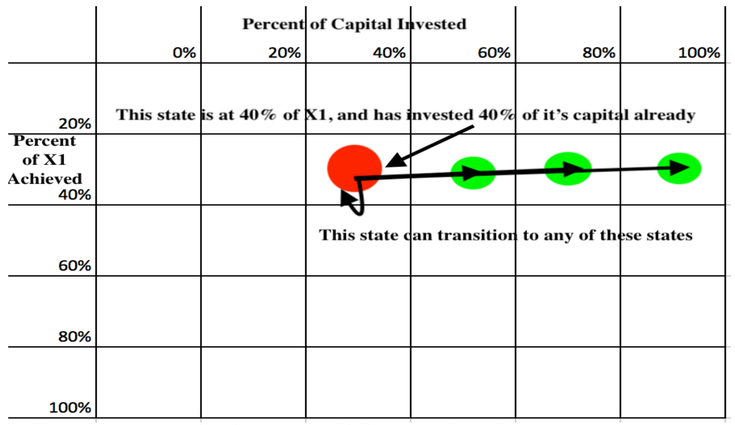

Figure 4: Architecture of MDP for policy finding

Future Model:

- Create unique policies for different levels of volatility
- Based off of live data, dynamically update investment strategy throughout investment
- Analysis into Xt1, the optimal value at which to complete the order.

References:

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