Deep Reinforcement Learning for Statistical Arbitrage

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1.0 Introduction:

1.1 Computational Finance:

The concept of applying rudimentary statistical and computational tools to financial markets has been around for numerous decades. More recently, with the development of advanced statistical and artificial intelligence methods such as deep reinforcement learning, there has been renewed interest in exploring the applications of computational finance.

1.2 Statistical Arbitrage & Pairs Trading:

Despite high levels of volatility and unpredictability in financial markets, one of the oldest and most supported theories in finance is the idea that all financial instruments (i.e. equities, options, etc.) are mean-reverting, meaning they will return to an average baseline, given enough time. One mathematical trading strategy that takes advantage of this theory is statistical arbitrage, which leverages statistical models to gauge when financial instruments stray away from their average behavior; oftentimes observed in the form of improper pricing. More specifically, one technique within statistical arbitrage is pairs trading. Pairs trading is a financial trading strategy that involves strategically buying and selling two historically correlated stocks. The crux of the strategy is to profit from the divergence of the two prices, protecting oneself against market risk and profiting from market volatility. For example if Apple and Microsoft have stock prices that historically move in conjunction, they could be candidates for pairs trading. If there is a brief period of time where Apple goes up and Microsoft goes down, one would buy Microsoft and sell/short Apple, with the anticipation that they will converge at some point in the future when the markets revert back to their normal behavior, allowing the investor to profit on both ends.

1.3 Problem Statement:

Given the unpredictability correlation between the two prices, an extension of the stochastic nature of financial markets, using statistical, mathematical, and computational techniques to implement pairs trading is well-suited for a decision making under uncertainty problem. It requires making sequential decisions and predictions in a situation containing a high

degree of uncertainty, while trying to maximize a reward (i.e. profits). Therefore, we propose the use of a deep reinforcement learning agent in order to attempt to maximize the potential profits observed in statistical arbitrage scenarios. We will run statistical simulations (i.e. correlation and cointegration testing) of dozens of stocks in order to find a few pairs trading candidates that we will train our deep reinforcement learning agent on.