Evaluation of the Parameterized-Response Differential Evolution Trader-Agent

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***Abstract*—This paper evaluates the Paramaterized-Response Differential Evolution (PRDE) trader-agent.**

***Index Terms*—Automated Trading, Financial Markets, Adaptive Trader-Agents**

I. Introduction

Parameterized-Response Zero Intelligence (PRZI) [1] traders are a nonadaptive generalisation of ZIC [2] traders—the difference lies in the probability mass function (PMF) used to generate quote prices. Each individual ZIC trader samples their quote price from a fixed uniform distribution, whereas each PRZI trader is governed by a strategy parameter $s \in [-1, 1] \in \mathbb{R}$ that determines the PMF the trader samples from; the shape of this PMF determines how 'urgent' or 'relaxed' the trader acts. As $s \to 1$ the distribution is evermore biased towards 'urgent' quote prices—those closest to the least profitable price for the trader, but most likely to attract a willing counterparty—conversely, as $s \to -1$, the distribution is biased towards 'relaxed' quote prices—those that generate the most profit for the trader, but are considerably less likely to attract a counterparty. When $s = 0$, the PMF is uniform, identical to that of a ZIC trader.

PRZI Stochastic Hillclimber (PRSH) [3] is an extension to the PRZI automated-trader algorithm. The strategy parameter s is dynamically altered by the algorithm in an attempt to increase profitability. Each PRSH trader maintains a private local population $\mathcal{K}$ of k strategy parameters; each of which it evaluates for a specific period of time via a loop to identify which is most profitable. The most profitable strategy s_0 is 'mutated' $k - 1$ times—these k values comprise the new elements of set $\mathcal{K}$.

Parameterized-Response Zero Intelligence (PRDE) [4] is further extension of the PRZI algorithm, and a successor to PRSH; it replaces the simple stochastic hill-climber with a differential evolution (DE) optimisation system [5]. Each PRDE trader maintains its own DE system with a population of candidate s-values of size $\mathrm{NP} \geq 4$, which for trader i can be denoted by $s_{i,1}, s_{i,2}, ..., s_{i,\mathrm{NP}}$. Once a particular strategy $s_{i,x}$ has been evaluated, three other distinct s-value are chosen at random from the population maintained by trader i: $s_{i,a}$, $s_{i,b}$ and $s_{i,c}$ such that $x \neq a \neq b \neq c$. A new candidate strategy $s_{i,y}$ is constructed as follows:

$$s_{i,y} = \max(\min(s_{i,a} + F_i(s_{i,b} - s_{i,c}), 1), -1)$$

where F_i is the trader's differential weight coefficient. This is very similar to the standard DE/rand/1 algorithm, with addition $\max$ and $\min$ functions to constrain the output $s_{i,y} \in [-1, 1]$. The fitness of $s_{i,y}$ is evaluated and if it performs better than $s_{i,x}$ then $s_{i,y}$ replaces $s_{i,x}$; otherwise, it is discarded and then the next strategy is evaluated. Cliff made one additional modification to the implementation of DE/rand/1 algorithm in PRDE to deal with convergence issues that arised from $s_{i,b} - s_{i,c}$ tending very close to zero. He introduced a simple vector-perbutation mechanism: if at any time the standard deviation of candidate s-value's in trader i's private population is less than 0.0001, then a randomly selected candidate is selected and provided a value drawn at random from the uniform distribution $U(-1, 1)$.

Current experiments published by Cliff did not deviate from $F = 0.8$ and $\mathrm{NP} = 4$ (i.e. the minimum viable value). Current experiments ran by Cliff have been performed on the Bristol Stock Exchange (*BSE*) (see [6], [7]).

II. Exploration of k and F

III. Extending PRDE

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