

DYNAMIC PORTFOLIO REBALANCING USING GENETIC ALGORITHM AND REINFORCEMENT LEARNING

OBJECTIVE:

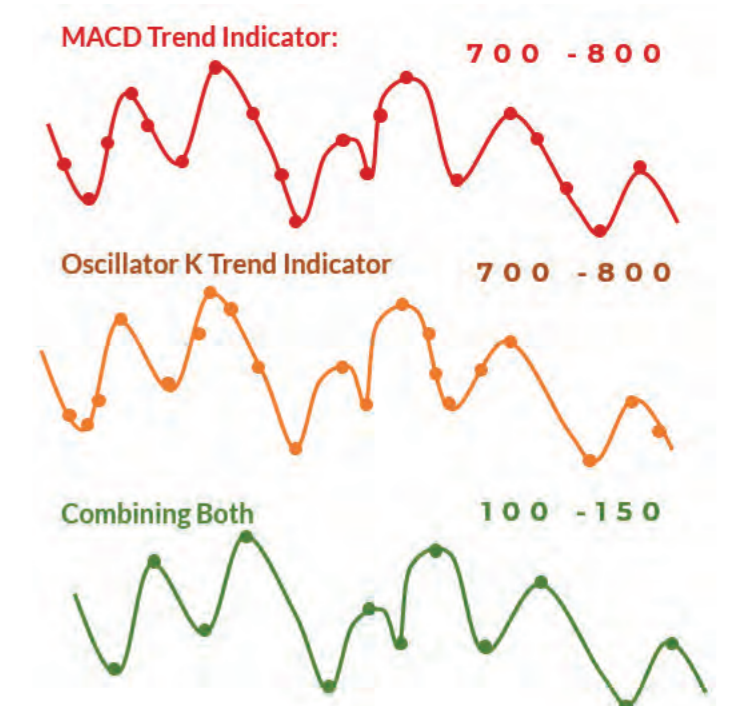
Our aim is to develop **Intelligent Agents** capable of **tactical portfolio management** over a **long investment horizon** (e.g. 10 years), after training on historical stock prices. We studied the feasibility of AI algorithms, conducted experiments and made analytical tools to study the data. Finally, we tested our **GA and RL agents** on test data in **various markets**, each having a **high, medium and low risk index**.

We find that our agents reaped returns comparable to the best equity in each market, and comparable to returns to asset firms over the same period

*ALL STOCK PRICES CONVERTED TO USD, COMMISSION CHARGES AND CURRENCY CONVERSION ACCOUNTED FOR.

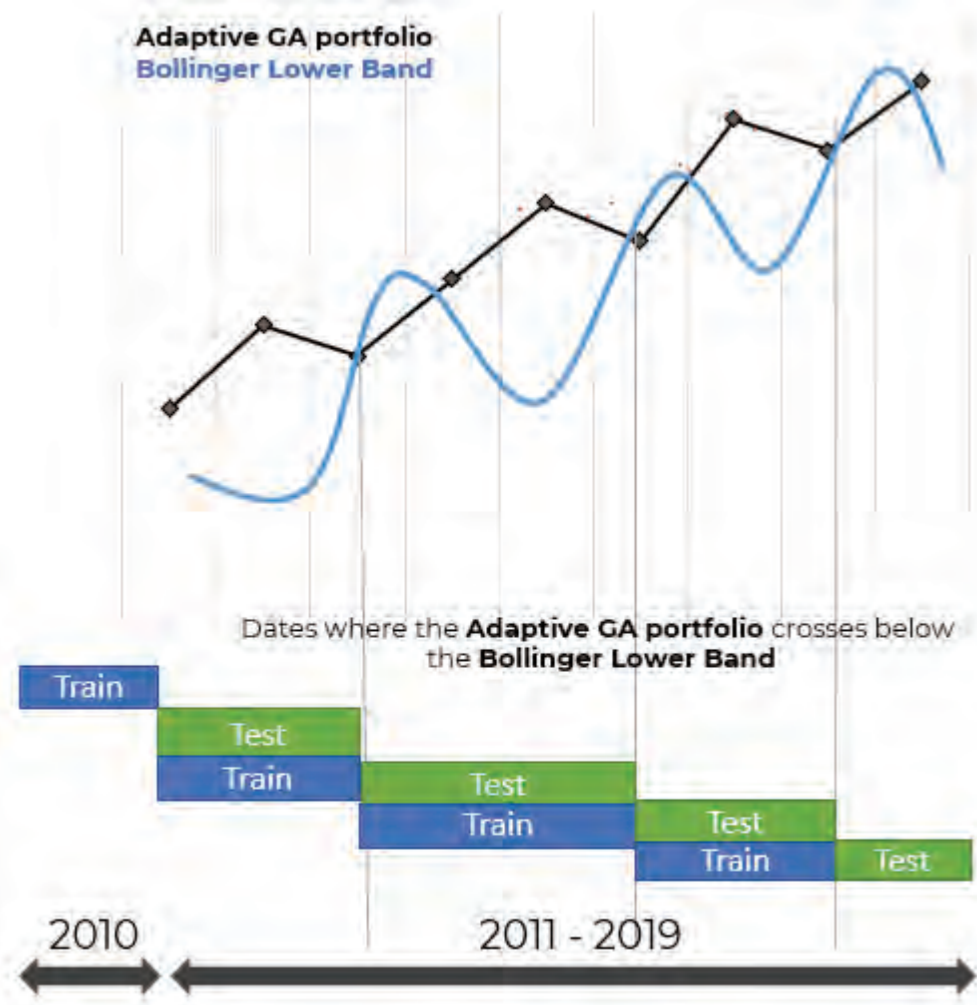
1. Reduce Trend Reversals

To reduce unnecessary trading and commission amount lost.



GENETIC ALGORITHM

2. Proposed Novel 'Adaptive' Approach to convert **GA** into a *pseudo-online learning* algorithm for portfolio balancing, by using a **Bollinger Band moving stop loss**



3. Improved risk equation determining portfolio allocations, to **incorporate Currency Risk**, and upgraded to be effective with **'Adaptive' GA approach** for portfolio rebalancing **on test sets**.

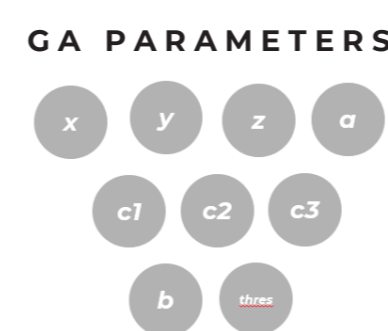
$$\sum_{s \in S} sig_b(f_{MC_x}(s_{p,t}) \times (1 - (f_{MR_y}(s_{p,t}) + c_2 \times f_{CR_a}(s_{p,t}))) \times (f_{SP_z}(s_{p,t}) + c_3)) = 1$$

$$F_{MC}(x) = Z(MACD\ LINE(X) - MACD\ SIGNAL(X)) + c_1$$

$$F_{SP}(x) = \frac{\sum EMA(x)}{N}$$

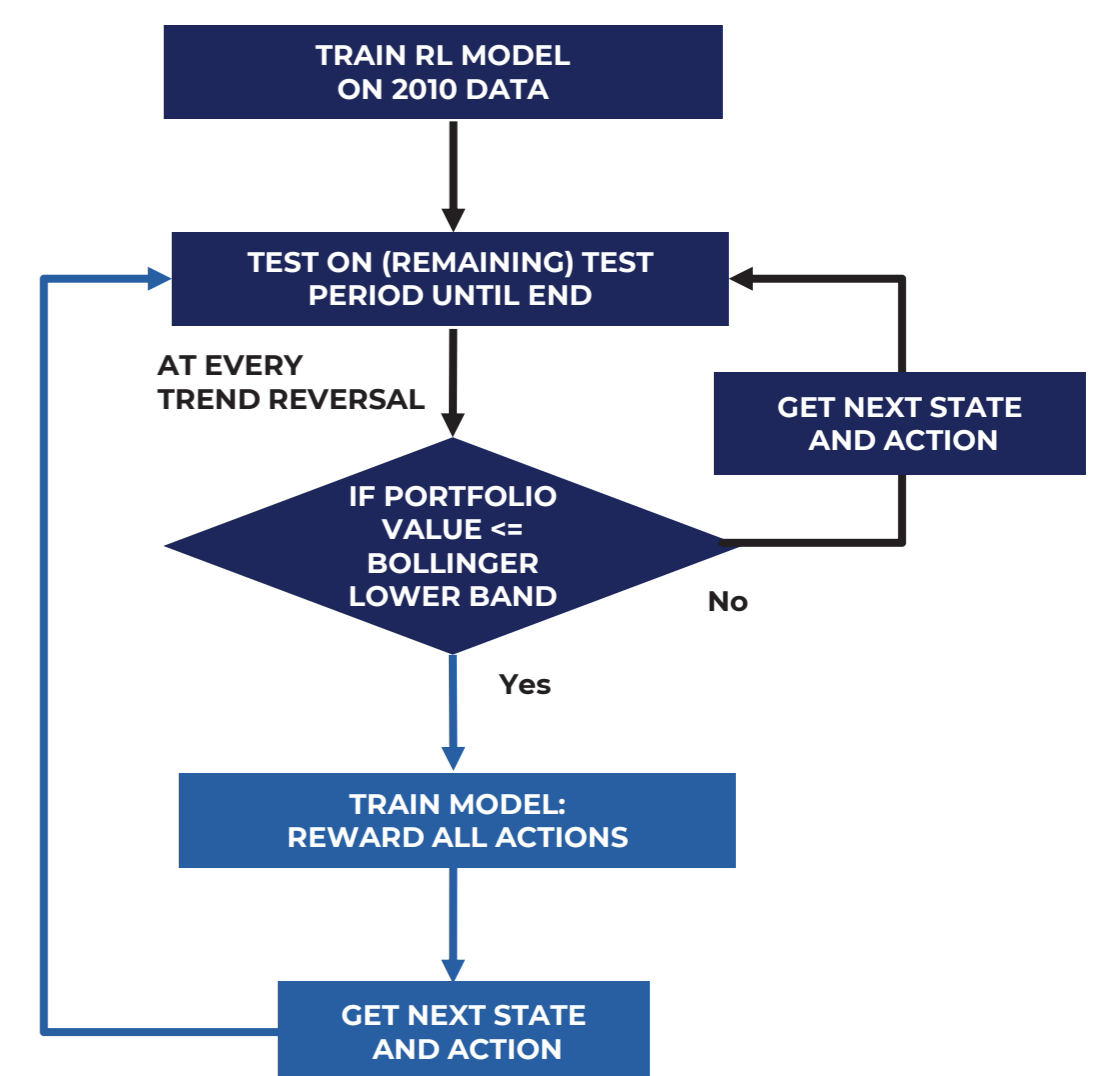
$$F_{MR}(x) = \text{Annualized Downside Volatility}(x)$$

$$F_{CR}(y) = \text{Annualized Downside Volatility}(y)$$



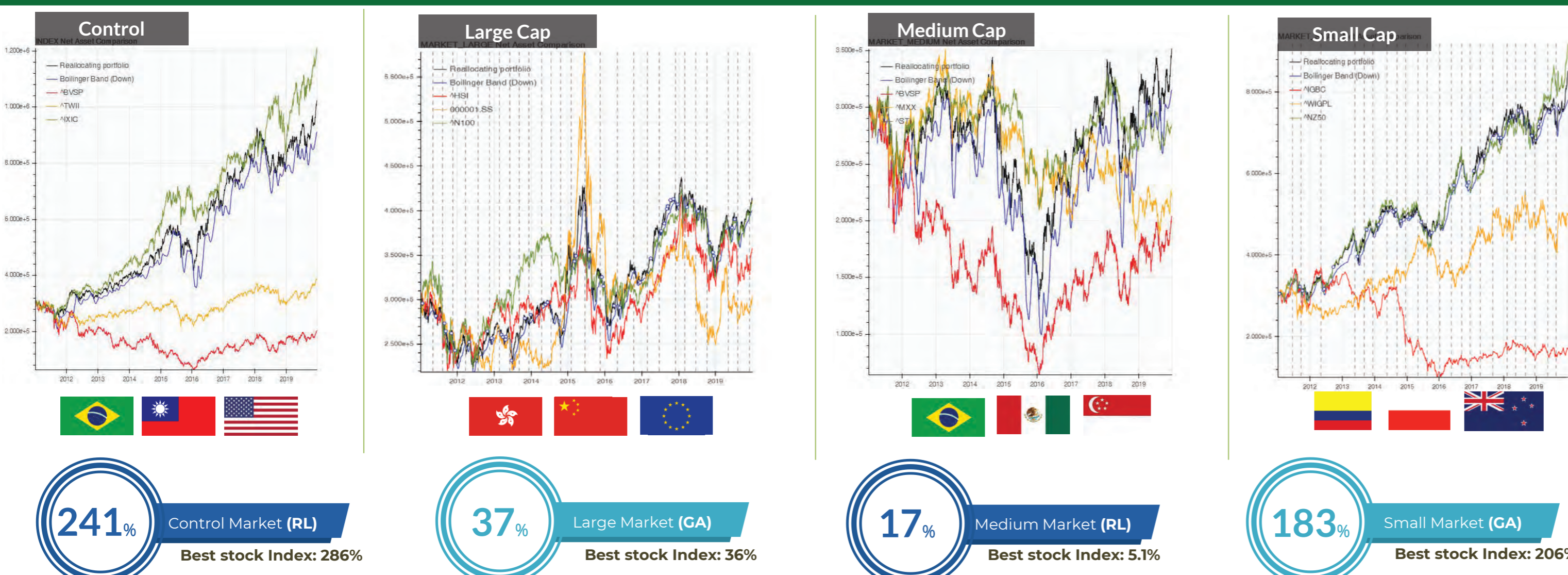
REINFORCEMENT LEARNING

4. Proposed modified Epsilon-Greedy Update Policy compatible with the reduced number of trend reversals



RETURNS: Tested on 4 markets of 3 stock indices each, investment horizon: 2011 – 2019

COMPARED TO:



Asset Management Firms
(2011 – 2019)



Goldman Sachs (GAPIX): 68.7%
BlackRock Tactical (MEALU LX): 230%
Vanguard Small-Mid Cap (VFSAX): 175%
Vanguard Global Cap (VFWAX): 33.5%