

An Approach of Bio-inspired Hybrid Model for Financial Markets

Dragan Simić^{1,2}, Vladeta Gajić¹, Svetlana Simić³

¹ University of Novi Sad, Faculty of Technical Sciences, Serbia

² Novi Sad Fair, Serbia

³ University of Novi Sad, Faculty of Medicine, Serbia

dsimic@eunet.rs, itil@uns.ac.yu, dsimic@uns.ac.rs

TOC

- **Introduction**
- **Modelling Financial Markets**
- **Bio-inspired Models**
- **Grammatical Evolution**
- **Hybrid Trading Model**
- **Conclusion**

Introduction

Biologically inspired methodologies have their metaphorical roots in models on biological and social processes.

Do not seek to perfectly imitate the complex working of these systems; rather they draw metaphorical inspiration from them to create mathematical algorithms, which can be used in an attempt to solve real-world problems

modelling financial markets

Challenges in the Financial Modelling

Many factors that plausibly impact financial markets include **interest rates, exchange rates,** and the **rate of economic growth.**

There is **no hard theory** as to how exactly these factors effect prices of financial assets, partly because the effects are complex, non-linear and time-lagged.

Financial modelling is that unlike modelling of physical systems, **a controlled experiment cannot be conducted in this case.**

Only one simple path through time is available for the examination, as we only have one history of market events.

Some factors which can have effect on financial markets are inherently unpredictable: **earthquakes, weather, or political events.**

Bio-inspired Models (1)

Artificial neural networks are a non-parametric modelling methodology whose inspiration arises from a simplified model of the way the **human brain operates**.

The social models are drawn from swarm metaphor. Two popular variants of swarm models exist, those inspired by the flocking behaviour of **birds** and **fishes**, and those inspired by the behaviour of social insects such as **ants** and **honey bees**.

The essence of these systems is that they exhibit **flexibility**, **self-organisation**, and **communication** between individual members of the population.

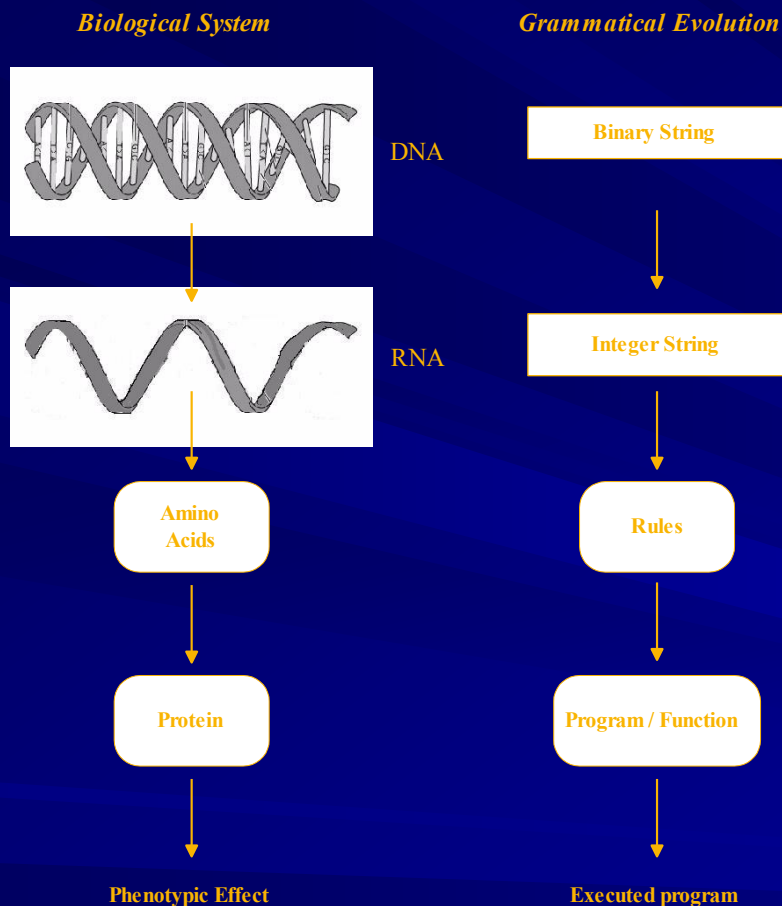
Bio-inspired Models (2)

The **natural immune system** has capabilities to **recognise**, **destroy** and **remember** almost unlimited number of foreign bodies. **Artificial immune systems** draw inspiration from the workings of the natural immune system, comprised of an intricate network of **specialised organs**, **cells** and **chemical molecules**.

Evolutionary approaches draw inspiration from the processes of biological evolution which breed solutions to problems: include **genetic algorithms**, **genetic programming**, **evolutionary strategies** and **evolutionary programming**.

A significant recent addition to these methodologies is **grammatical evolution**, an evolutionary automatic programming methodology.

Grammatical Evolution



Grammatical Evolution is an evolutionary algorithm that can evolve computer programs, rule sets or more generally sentences in any language.

The result of the expression of the genetic material as proteins in conjunction with environmental factors is the phenotype. In GE, the phenotype is a sentence(s) in some language (a program in the C programming language) that is generated from the genetic material.

Comparison between biological genetic system and the grammatical evolution system

Basic Trading System Using GE

An application of GE to construct a simple trading system based on technical indicators. The challenge is to select indicators, their associated parameters, and to combine indicators to produce a trading signal.

The rules are used to generate one of three signals for each day: *Buy*, *Sell* or *Do Nothing*.

If a *Buy* signal is indicated, a fix investment of €1,000 is made. If a *Sell* signal is indicated, an investment of €1,000 is sold. These positions are closed at the end of a fixed ten-day period. This gives rise to a maximum potential investment of €10,000 at any point in time.

Basic Trading System Using GE (2)

The daily signals generated by the trading system are using following rules:

Buy ← *Value* < 0.33

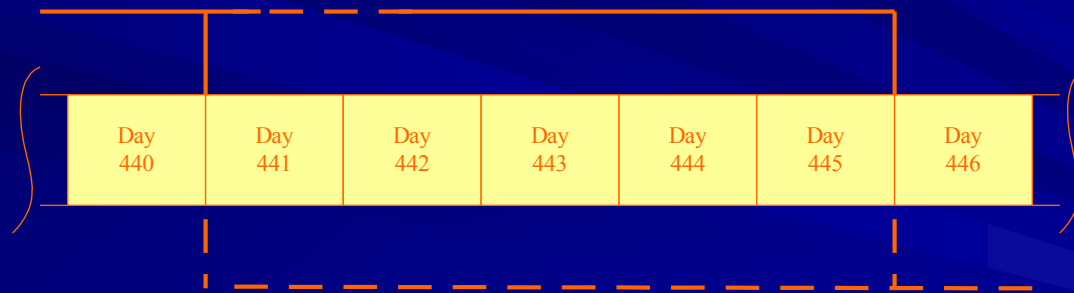
Do Nothing ← 0.33 >= *Value* < 0.66

Sell ← 0.66 >= *Value*

Rather than employing a single fixed training period, the trading system continues to retrain as new data becomes available using a variant on the *moving window* approach.

Adaptive Trading System

The first 440 days data is used to create the initial population ($G=100$) of trading rules. After x days have elapsed, the *training window* moves forward in the time-series by x days, and the current population of trading rules is retrained over the new data window for the number of generations g (2 or 10), $g < G$.



A small value of g means that memory is emphasised over adaptation, as new data have relatively less chance to influence the trading rules.

Adaptive Trading System (2)

The hybrid trading system adopts more complex *entry strategy*, and a variable size investment, depending on the strength of the trading signal. The amount invested for each signal is:

$$\text{Amount invested} = \frac{\text{Size of trading signal}}{\text{Maximum trading signal}} * 1000$$

The stronger the signal the greater to amount invested, the maximum of investment amount of €1,000. Signal received oscillate around a zero. Signals greater than zero constitute a *Buy* signal, those less than zero constitute a *Sell* signal.

If the sum to be invested is greater than the cash available, the model will invest the cash available reduced by costs of the transactions.

Conclusion

A model of bio-inspired hybrid adaptive trading system based on technical indicators usage by **grammatical evolution** and *moving window*. This permits the system to adapt to dynamic market conditions that worked well in past market environments.

Improve - is to implement a **multi-stage model**. Using GE or an alternative methodology is to create a series of '*families*' of trading rules and predictions and from the best rule from each '*family*' could then be used as input to a second-stage model, which produces the final trading signal.

Presented model can be applied to other business activities: financial forecasting, corporate failure prediction or bond rating company.

THANK YOU !