TECHNICAL P-SYSTEMS: OPERATING IN THE STOCK MARKETS WITH TRANSITION P-SYSTEMS

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Abstract: *During last 50 years, the markets have been object of study. Technical and fundamental indicators have been used to try to predict the behaviour of the market and then execute buying or selling orders. This paper use the capabilities and functionalities of the transition P-systems to create an intelligent model which is able to process the information returned by the indicators in a efficient way .Membrane techniques provide a new approach of markets behaviour estimation*

Keywords: *Trading strategies, Technical indicators, Intelligent Transition P-Systems.*

Introduction

Markets indicators are numerous. Markets Operators try to determine the existence of trends. Once a trend is found it is generally a sign of earning profit by selling or buying depending on the trend. One of the most popular are the average (MACD) and the relative strength index (RSI). These 2 indicators can suggest and confirm the existence of a trend [Azzopardi, 2010]. Furthermore these indicators are helpful to establish the trend predictions patterns for the markets operators. This paper provides a new approach to an automatic view of these through the use of transition P-systems properties.

In order to do that this paper is organized as follows:

- Brief introduction of Transition P-systems
- Properties of the two market indicators.
- Theoretical Method to use the transition P-system in the stock markets with these indicators.
- Conclusions and further work.

Introduction to P-systems theory

Natural computing is a new field within computer science which develops new computational models. These computational models can be divided into three major areas:

- Neural networks.
- Genetic Algorithms
- Biomolecular computation.

Membrane computing is included in biomolecular computation. Within the field of membrane computing a new logical computational device appears: The P-system. These P-systems are able to simulate the behavior of the membranes on living cells. This behavior refers to the way membranes process information. (Absorbing nutrients, chemical reactions, dissolving, etc)

I. A P-system is a computational model inspired by the way the living cells interact with each other through their membranes. The elements of the membranes are called objects. A region within a membrane can contain objects or other membranes. A p-system has an external membrane (also called skin membrane) and it also contains a hierarchical relation defined by the composition of the membranes. A multiset of objects is defined within a region (enclosed by a membrane). These multisets of objects show the number of objects existing within a region. Any object 'x' will be associated to a multiplicity which tells the number of times that 'x' is repeated in a region.

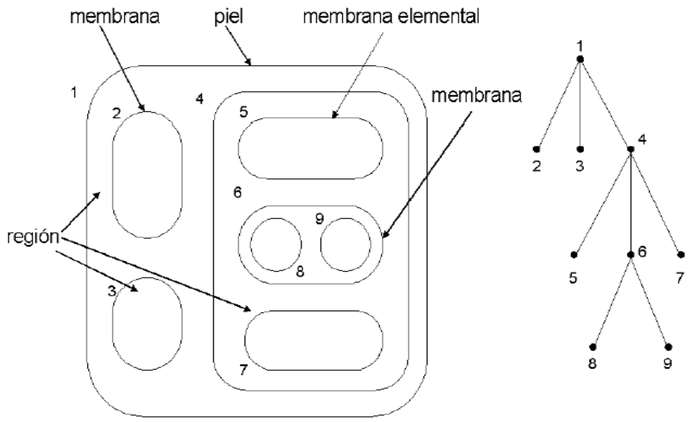


Figure 1. The membrane's structure (left) represented in tree shape (right)

According to Păun 's definition, a transition P System of degree n, n > 1 is a construct: [Păun, 1998]

$$\Pi = \left(V, \mu, \omega_1, .., \omega_n, (R_1, \rho_1), ..(R_n, \rho_n), i_0\right)$$

Where:

1. *V* is an alphabet; its elements are called objects;
2. μ is a membrane structure of degree n, with the membranes and the regions labeled in a one-to-one manner with elements in a given set ; in this section we always use the labels 1, 2, .., n;
3. $\omega_i \ 1 \le i \le n$, are strings from V^* representing multisets over V associated with the regions 1, 2, .., n of μ
4. $R_i \ 1 \le i \le n$, are finite set of evolution rules over V associated with the regions 1, 2, .., n of μ; ρ_i is a partial order over $R_i \ 1 \le i \le n$, specifying a priority relation among rules of R_i . An evolution rule is a pair (u,v) which we will usually write in the form $u \to v$ where u is a string over V and v=v' or v=v' δ where v' is a string over $\left(V \times \{here, out\}\right) \cup \left(V \times \{in_j \ 1 \le j \le n\}\right)$, and δ is a special symbol not in. The length of u is called the radius of the rule $u \to v$
5. i_o is a number between 1 and n which specifies the output membrane of Π .

Let *U* be a finite and not an empty set of objects and N the set of natural numbers. A *multiset of objects* is defined as a mapping:

$$M : V \to \mathrm{N}$$

$$a_i \to u_1$$

Where a_i is an object and u_i its multiplicity.

As it is well known, there are several representations for multisets of objects.

$$M = \{(a_1, u_1), (a_2, u_2), (a_3, u_3)...\} = a_1^{u_1} \cdot a_2^{u_2} \cdot a_n^{u_n} ......$$

Evolution rule with objects in *U* and targets in *T* is defined by $r = (m, c, \delta)$ where $m \in M(V), c \in M(VxT)\ and\ \delta \in \{to\ dissolve, not\ to\ dissolve\}$

From now on *'c'* will be referred to as the consequent of the evolution rule *'r'*

The *set of evolution rules* with *objects* in *V* and targets in *T* is represented by R *(U, T).*

We represent a rule as:

$$x \rightarrow y \quad or \quad x \rightarrow y\delta$$

where x is a multiset of objects in M((*V*)xTar) where Tar ={here, in, out} and y is the consequent of the rule. When δ is equal to "dissolve", then the membrane will be dissolved. This means that objects from a region will be placed within the region which contains the dissolved region. Also, the set of evolution rules included on the dissolved region will disappear.

P-systems evolve, which makes it change upon time; therefore it is a dynamic system. Every time that there is a change on the p-system we will say that the P-system is in a new transition. The step from one transition to another one will be referred to as an evolutionary step, and the set of all evolutionary steps will be named computation. Processes within the p-system will be acting in a massively parallel and non-deterministic manner. (Similar to the way the living cells process and combine information).

We will say that the computation has been successful if:

1. The halt status is reached.
2. No more evolution rules can be applied.
3. Skin membrane still exists after the computation finishes.

Properties of the markets indicators (MACD, RSI)

1. MACD

Developed by Gerald Appel in the late seventies, the Moving Average Convergence-Divergence (MACD) indicator is one of the simplest and most effective momentum indicators available. The MACD turns two trend-following indicators, moving averages, into a momentum oscillator by subtracting the longer moving average from the shorter moving average. As a result, the MACD offers the best of both worlds: trend following and momentum. The MACD fluctuates above and below the zero line as the moving averages converge, cross and diverge. Traders can look for signal line crossovers, centerline crossovers and divergences to generate signals. Because the MACD is unbounded, it is not particularly useful for identifying overbought and oversold levels.

The MACD indicator is special because it brings together momentum and trend in one indicator. This unique blend of trend and momentum can be applied to daily, weekly or monthly charts. The standard setting for MACD is the difference between the 12 and 26-period EMAs. Chartists looking for more sensitivity may try a shorter short-term moving average and a longer long-term moving average. MACD(5,35,5) is more sensitive than MACD(12,26,9) and might be better suited for weekly charts. Chartists looking for less sensitivity may consider lengthening the moving averages. A less sensitive MACD will still oscillate above/below zero, but the centerline crossovers and signal line crossovers will be less frequent.

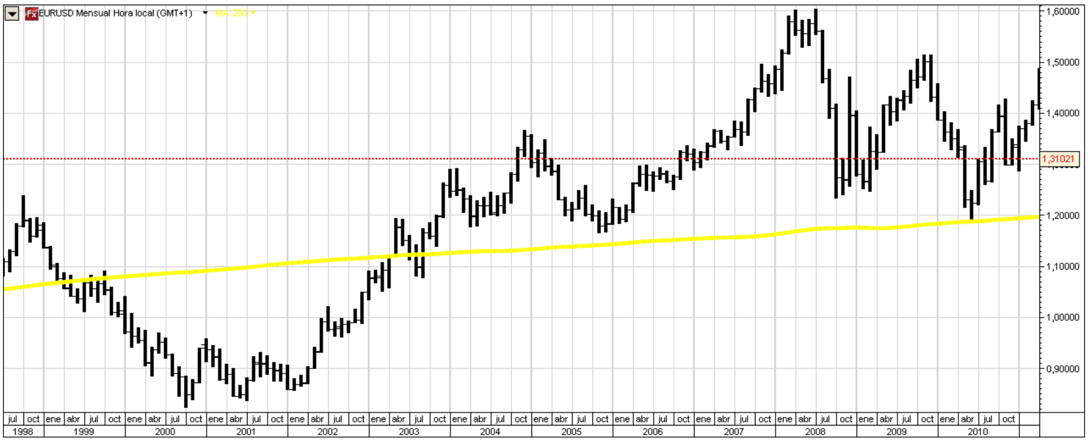


Figure 1. MACD 200 periods of instrument EURUSD

2. RSI

The relative strength index (RSI) is a technical indicator used in the analysis of financial markets. It is intended to chart the current and historical strength or weakness of a stock or market based on the closing prices of a recent trading period. The indicator should not be confused with relative strength.

The RSI is classified as a momentum oscillator, measuring the velocity and magnitude of directional price movements. Momentum is the rate of the rise or fall in price. The RSI computes momentum as the ratio of higher closes to lower closes: stocks which have had more or stronger positive changes have a higher RSI than stocks which have had more or stronger negative changes.

The RSI is most typically used on a 14 day timeframe, measured on a scale from 0 to 100, with high and low levels marked at 70 and 30, respectively. Shorter or longer timeframes are used for alternately shorter or longer outlooks. More extreme high and low levels—80 and 20, or 90 and 10—occur less frequently but indicate stronger momentum.

The relative strength index was developed by J. Welles Wilder and published in a 1978 book, New Concepts in Technical Trading Systems, and in Commodities magazine (now Futures magazine) in the June 1978 issue.[1] It has become one of the most popular oscillator indices.[2]

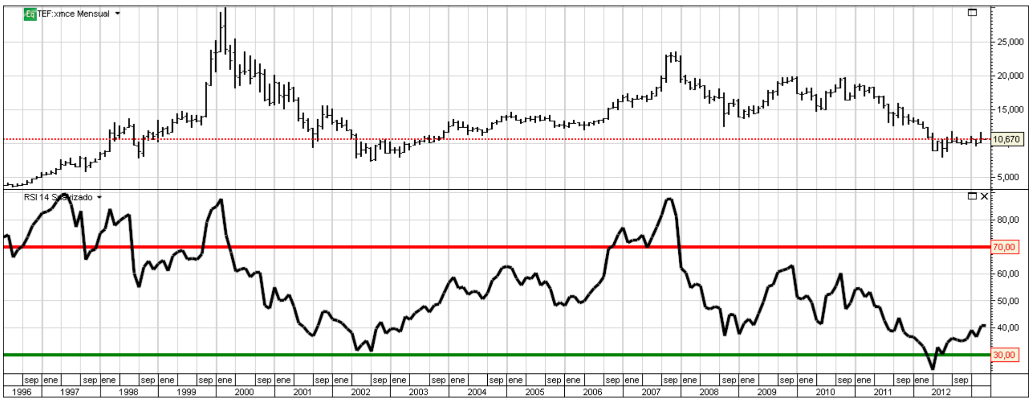


Figure 2. Index Relative (RSI) of strength for the instrument EURUSD

Transition P-systems working with indicators

Once the characteristics of P-systems and the indicators are explained separately, a proposal for building a community P-system working with the indicators is made. In particular, it is possible to define a P-system able to learn through the use of the technical indicators

As there are regions in the living cells a master membrane will synchronize the rest, which contains the info from the indicators

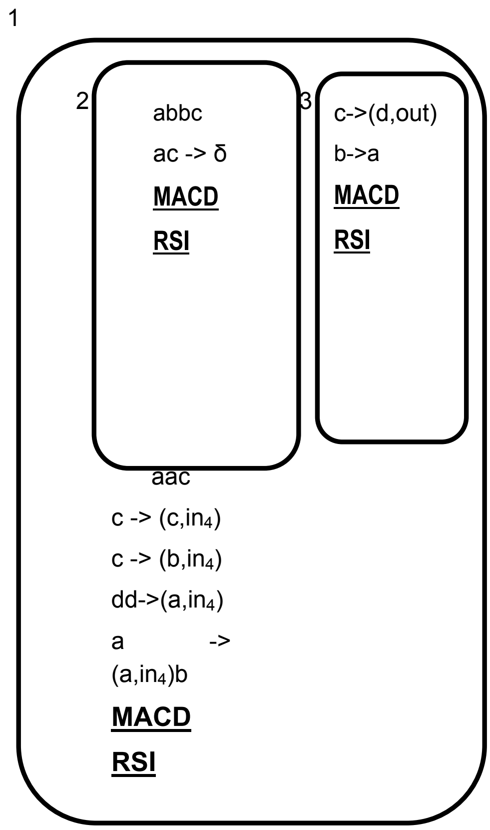
The way to do this is:

In the regions, given a set of membranes $M = \{m_i \mid i \in \mathrm{N}, 1 \le i \le n\}$ where m_i is a membrane, MACD and RSI are placed in it. In the end every membrane sends a signal to the master membrane, which determine one the following signals = {buy,sell,null)

If the info sent by the membranes does not return any buying or selling signal, the P.system returns null which means that buying or selling is not recommended.

The P-system considers three major stages:

- Static structure of the P-system;
- Dynamic behavior of the P-system;
- Synchronization between membranes.



Master membrane

Figure 3. P-system with technical indicators, Technical P-system

The result will be placed outside of the membrane after the P-system finishes its execution.

Every membrane gets control the info and sends the signal to the master membrane. Every membrane is storing the information about the information (MACD and RSI) processing for every region in a given moment. The P-system evolves following the master membrane patterns. Moreover the master membrane outside the P-system controls the execution steps of the P-system.

Membranes learn from the times that evolution rules are applied and the results obtained based on the technical indicators. The aim of this P-system supervised by the master membrane is not just to returning buying or selling signals but also to improve the time the signals are returned so the operations can be placed in the market immediately.

According to Paun's model all the rules application processes occur in every region in a parallel manner. Moreover the process is non-deterministic.

- The evolution rules that are applied in every membrane m_i . The number of times that every rule r_i is applied to obtain an extinguished multiset are referred as ki.

For every membrane records are stored as: ($(r_1,1),(r_2,2),..,(r_i,7),..,(r_m,3)$ +the technical indicators and the success or failure of placing an operation. In that way the P-system can learn.

The more time the P-system works the better results are obtained. At the end tof the computation he master membrane will return the final signal (buying, selling, null) based on the info and hits. The optimal number of times the rules are applied determines the execution time to be reduced. This will reduce the execution time.

In order to implement this system it is important to take into account:

- The need of auxiliary space to store information about the rules' election, hits and failures of every membrane output.
- The need of extra time to calculate the times that the evolution rules have to be applied
- In the beginning the results might take shorter. This might occur because as there are not enough information from the P-system computation, the decisions made by the robot about the rules could be worse. As the P-system learns, outputs can be more accurate. When changing non-determinism by intelligent elections, Paun's biological model is not useful anymore to implement the living cells behavior which means that these technical P-systems cannot be used to implement the living cells model.

Conclusions

The idea of implementing this biological model is taking advantages of the parallelism and synchronization to perform markets operations. This theoretical model proposed here shows that it'd be possible to obtain and to place accurate orders in the markets in a fast way with a small margin of error. As a first approach it shows it might be a good starting point to introduce the membrane models into the markets so they can theoretically provide a large source of signals to operate successfully.

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