Upon a Tridimensional Perspective of the Stock Market

Claudiu Vinţe, Bucharest, Romania
claudiu.vinte@opteamsys.com

Abstract
A class of recursive algorithms employed to generate a tridimensional map of the stock market.

Keywords
stock market map, recursive algorithms, *divide-and-conquer* strategy

Having to face the current complexity of the financial markets in general, and the capital market in particular, the general public, the investors and the specialists alike are continuously requesting various tools designed to assist them in assessing the evolution of the market, as whole, as quickly and as accurately as possible.

There is a large spectrum of instruments, graphical and non-graphical, conceived to capture the evolution of a given stock on the market, over a certain time window, most of them generically falling in one of the following category **[1]**:

- bidimensional charts (evolution of the stock price over the time), in a variety of representation – line chart, bar chart, Japanese candlesticks etc;
- tridimentional charts (evolution of the stock price in time, connected to the traded volume of the stock);
- statistical indicators, to be interpreted as numbers.

Our intention is to propose a visual way of capturing the evolution of the entire market, over a given period. The concept relies chiefly on three principles:

1. concentrate on an unique board all, or most of the companies listed on the stock exchange, on designated section of the exchange, or grouped into an industrial sector etc.;
2. the size of each company represented on the board is given by its market capitalization and connected, relatively, to the whole market capitalization;
3. the evolution of stock prices is to be designated based on a color scheme.

Each of the above principles generates a certain perspective over the stock market. Considered together, they lay out the fundamentals for designing a map of the market that has the ability to provide, at single glance, the position in the market (sector) of each listed company, the size of the company relative to the size of the other companies, and to

the market as a whole, along with the price variation of the company stock on the market. To illustrate the concept that we are proposing, **Figure 1** depicts a sample that contains a handful of companies put together in the stock map, and revealing the above mentioned perspectives.

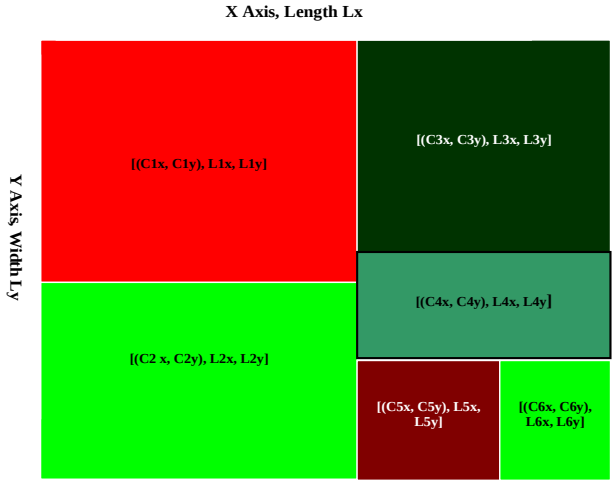

Figure 1. The intended graphical distribution of the capital on the market map.

On the market map, there will be a rectangle associated to each listed company. The size of the rectangle is proportionally determined, based on the relative weight (ratio) of the individual market cap of a considered company, in the overall market capitalization. In ***Figure 1***, each rectangular is identified based on the coordinates of its topmost left corner C_x, C_y, and the side lengths on the X (abscise) and Y (ordinate) axis, L_x and L_y, respectively.

The purpose of this paper is to introduce the algorithm designed to generate such a map of the stock market, based on the following input data:

- number of the companies to be included in the map;
- size of the map, in number of pixels for the length and the width of the board;
- market capitalization of each company - computed by multiplying the number of the shares issued by the company on the market, with the closing price of the stock from the previous trading day, or from the reference date that we may want to take as base;
- price variation of each stock during the day, or during the considered period.

In order to fill the map, the algorithm has to determine the dimensions of each rectangle,

in connection with the market capitalization of the company. There may be great discrepancies among the listed companies, when it comes to market capitalization. The gap between the bigger companies and the smaller ones may end up in the range of thousands of times **[2]**. That introduces the impossibility of preserving the real weight (ratio) of an individual company on the market, when its size has to be translated into the dimensions of a rectangle to be drawn on a computer screen. We addressed this issue by normalizing the market capitalization of each company and, consequently, of the stock market as a whole **[3]**.

The normalization process is conducted by computing a logarithmic factor that is designed to bring the market cap of the companies into a narrower interval of values, preserving, at the same time, the original proportions among the companies. Formalizing, the normalization process is described below.

$$mc_i = q_i * p_i, \quad i = \overline{1,n} \tag{1}$$

$$MC = \sum_{i=1}^{n} mc_i \tag{2}$$

$$\overline{mc} = \frac{MC}{n} \tag{3}$$

$$\left\{ \begin{array}{c} f_i = \ln(\frac{MC}{mc_i}) + \ln(1 + \frac{\overline{mc}}{mc_i}) \\ mc'_i = mc_i * f_i \end{array} \right\}, \quad i = \overline{1,n} \tag{4}$$

$$MC' = \sum_{i=1}^{n} mc'_i \tag{5}$$

Where:

n	number of the listed companies on the market
q_i	number of shares issued on the market by company *i*
p_i	last closed price of the stock of company *i*
mc_i	market capitalization of company *i*
$\overline{mc}$	the average market capitalization of a company on the considered market
MC	overall market capitalization
f_i	normalizing factor
mc'_i	normalized market capitalization, corresponding to company *i*
MC'	normalized overall market capitalization

The logarithmic factor takes into account the weight of a company in the overall market capitalization and distance of the individual market cap from the average market capitalization. Once the input data is adjusted to the needs of the graphical representation on a computer screen, the algorithm can begin to determine the position and the size of each rectangle on the map, associated to the company considered.

The algorithm allocates the rectangles on the market board based on a *divide-and-conquer* strategy, implemented in a recursive manner. At each step, the algorithm distributes the companies in two groups: the companies that are to be allocated on the board at the current stage, and the companies that are to be allocated on the remaining area of the board in the subsequent steps. The procedure continues recursively for latter group of companies, until the companies are exhausted, along with the available drawing area on the board **[4] [5]**. The companies are allocated beginning with the biggest company from the topmost left corner of the map, and continuing toward the smallest company listed on the market, which will end up in the bottommost right corner of the map, see **Figure 2**.

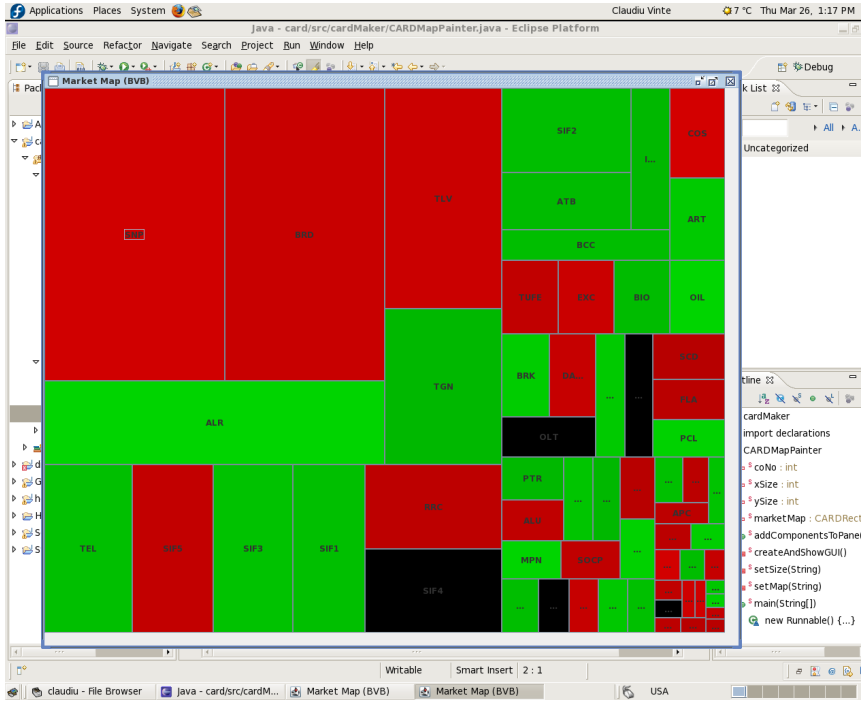

Figure 2. The resulted market map, containing all the companies listed on the first section of BVB.

Depending of the desired form factor we want to obtain, there are multiple ways of distributing the rectangles on the map.
The rectangles are colored based on the price variation of the stock within the considered interval of time:

- nuances of red for loses;
- black for stagnation of stock price;
- nuances of green for price gains on the market.

The CARD engine (Capital Allocation through Rectangular Distribution) that we have developed, is able to construct various distributions for a group of companies considered to be represented graphically: the entire market, per market sectors, clusters of interconnected sectors or industries etc. We implemented the CARD engine in Java, and developed, on the top of it, a collection of Java applets for Opteamsys Solutions, applets responsible for the graphical representation of CARD.

The sample showed in **Figure 2**, contains the market map that CARD algorithm generated, based on the companies listed on the first section of Bucharest Stock Exchange[1]. The market data regarding the issued number of shares of the listed companies, and the stock price variations are supplied to the CARD engine, through a collection of data feeds, connected over SOAP, to the BVB's delayed price data web services **[6]**.
The Java applet is able to provide even more information regarding each individual company, by selecting its corresponding rectangle on the map with the mouse:

- current market price of the stock;
- current market capitalization of the company;
- company fundamental data;
- link to news related to the selected company etc.

The CARD engine provides algorithms for constructing, along with tridimensional maps of the market, graphical bars that can be used for capturing the weight and the evolution of each market sector within an exchange section, or on the stock market as a whole.

In conclusion, the tridimensional perspective on stock market, offered by the map constructed with CARD engine, in connection with a real time data feed from the Stock Exchange, can provide a quick and accurate view upon the changes occurred in the capital market, over a desired time frame, to all the interested parties: market analysts, brokers, investors etc. Our undergoing research is focused on two directions:

- defining a master algorithm to drive, in a flexible manner, the distribution of companies within an industry sector, and the allocation of the sectors on the

1 On December 3rd 2008, there were 61 companies listed on the first section of Bucharest Stock Exchange **[6]**

overall market map;

- mechanisms for embodying the stock market map with enriched company specific financial data, comments and analyses from the market specialists.

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[6] Bucharest Stock Exchange - *http://www.bvb.ro/* - the are links to information regarding the listed companies, and web services for delayed price data, and traded volume