Genetic Network Programming with Actor-Critic and Its Application to Stock Trading Model

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Genetic Network Programming (GNP) has been proposed as an extended method of Genetic Algorithm (GA) and Genetic Programming (GP). GNP represents its solutions using graph structures, which contributes to creating quite compact programs and implicitly memorizing past action sequences, therefore it has been clarified that GNP is an effective method mainly for dynamic problems. Moreover, an extended algorithm of GNP which combines evolution and reinforcement learning (GNP-RL) has been proposed. Original GNP is based on evolution only, therefore the programs are evolved mainly after task execution or enough trial, i.e., offline learning. On the other hand, GNP-RL can change its programs incrementally based on rewards obtained during task execution, i.e., online learning.

Recently, research on stock price prediction and trading model using softcomputing has been done. Generally speaking, methods for predicting stock prices and determining the timing of buying or selling stocks are divided into two groups; fundamental analysis and technical analysis. Generally, the research on stock price prediction and trading model using softcomputing belongs to technical analysis which analyzes numerically the past movement of stock prices. Such methods determine the timing of buying or selling stocks based on the technical indexes such as rate of deviation, Relative Strength Index, Golden cross and so on. The proposed method also belongs to technical analysis.

In this paper, there are two important points. First, we combine GNP and Actor-Critic which is one of the reinforcement learning methods (GNP with Actor-Critic, GNP-AC), and Importance Index (IMX) is introduced for efficient stock trading decision making. Concretely speaking, IMX tells GNP-AC whether or not the buying or selling signals are likely to appear at the current day, and Actor-Critic learns a threshold value which predicts the rise or fall of the stock prices based on IMX. Actor-Critic has a distinguished ability to deal with continuous actions, so we adopt it for the learning of GNP. Second, although there are so many technical indexes in the technical analysis, GNP with Actor-Critic can select appropriate indexes to judge the buying and selling timing of stocks. In other words, GNP with Actor-Critic could optimize the combinations of important technical indexes.

To confirm the effectiveness of GNP-AC, we carried out the trading simulations using 20 brands selected from the companies listed in the first section of Tokyo stock market in Japan, especially large market capitalization companies. The simulations are carried out using three terms; training (January 4, 2001–October 1, 2003), validation (October 2, 2003–December 30, 2003) and testing terms (January 5, 2004–December 30, 2004). The best individual in validation term is used in testing term.

The simulation results show that the mean profit rate of GNP-AC (7.1%) is better than Buy&Hold (1.5%) which is usually regarded as a benchmark index. In detail, GNP-AC can obtain equal or larger profits in the trade of 14 brands out of 20 than Buy&Hold. In addition, the stock prices of seven brands are down trend, so Buy&Hold always makes a loss, however the proposed method can obtain profits in three brands and always decrease the loss in other brands.

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