

HYBRID AUTOMATA FOR INVESTMENT STRATEGIES MODELLING

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In this paper techniques are proposed for investment portfolio modeling. We assume that money time value and market prices are continuously changing values while investment portfolio structure is a discretely evolving object. With these assumptions an investment portfolio can be modeled with a hybrid system (hybrid automaton).

A hybrid automaton is a dynamic system which combines both continuous and discrete dynamics. Its state can be presented as a vector having both continuously and discretely evolving components. A transition function for continuous components belongs to a pre-defined set of continuous curves from a given class (e.g. defined by differential equations), and jumps from one curve to another are allowed. Discrete component dynamics is defined by a finite automaton. The main point is that discrete and continuous transition functions interact.

Hybrid system specific techniques can be used for further analysis of the model. Portfolio performance scenarios, such as tiny portfolio market value movements against a pre-defined desirable scenario (stability) which is important for hedgers or portfolio high profitability which is important for speculators, can be defined using hybrid temporal formulas. Using the proposed model portfolio performance can be analyzed for risk management purposes with respect to different market behavior scenarios. Hybrid controllers can be constructed to achieve a desirable portfolio behavior.

We present a detailed mathematical model for an investment portfolio of equity options, non-dividend equities and cash. We make the following assumptions for the model:

1. Options in the portfolio are OTC plain vanilla European options.
2. There is a finite number of different equities which can be included in the portfolio or can be chosen as an option underlying in the portfolio.
3. Equity market prices are continuous functions of time.
4. Cash is invested with a continuously compounded rate; the risk-free interest rate curve is flat.

References

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