TOP : Tuning An Option Pricing Model Using A Knowledge-Based Approach

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Abstract

Asset valuation models attempt to determine accurately the intrinsic value of a particular asset in order to provide investors with some yardstick for their decisions. However, since these models are simplified representations of the actual financial processes, they only approximate asset prices, often deviating in consistent patterns from the marketplace. Modification of these mathematical models in an effort to improve their performance has proven to be analytically complicated, and according to results of empirical studies more sophisticated models do not produce consistently better predictions of actual prices than the simple model. Rather than modifying the model specification, we believe that the intrinsic value of asset can be determined more accurately by fine-tuning the original model's behavior. An underlying assumption is that past performance results of the asset valuation model reveal its structural behavior, and the revealed structural behavior suggests how to tune the model to achieve better performance in the future.

In particular, this dissertation proposes a new framework for asset valuation consisting of the original financial model plus a model of the financial model's performance. This meta-model is constructed from an analysis of the financial model's performance for some initial set of historical data, along with a collection of domain-specific knowledge about the financial marketplace and the assumptions inherent in the original financial model. Our thesis is that this hybrid model – representing a cooperative effort between the financial model and the knowledge-based model –

predicts the market value of the financial asset more accurately. Among many different types of assets, this study will focus on option pricing. The result is TOP, a knowledge-based system for **T**uning an **O**ption **P**ricing model. TOP breaks down into three distinguishable components – a specific financial model (the Black-Scholes option pricing model), a general problem-solving component which consists of structural pattern construction and explanation generation mechanisms, and a domain-specific component which includes a specific model's performance results and domain knowledge.

A major contribution of this research is that it presents a new methodology for asset pricing. In particular, it provides a framework for induction systems for improving prediction in financial markets. The presented framework employs a hierarchical problem-solving scheme in which more abstract or aggregate descriptors are derived from elementary or primitive ones, and an incremental learning approach in which deviation patterns learned at one point are modified to accommodate more data supplied subsequently. This incremental learning capability, which is essential in the finance domain characterized by the existence of noisy data andy by the lack of completeness in domain expertise, allows our meta-model to evolve over time on top of the original financial model which is deterministically specified over a fixed number of variables.

Our evaluation shows that TOP outperforms the original financial model except for cases where the financial model manifests an exceptionally high degree of variation from the marketplace in an incongruous manner. It further supports the requirement of the incremental learning capability in TOP.