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Confidence limits for data mining models of options prices

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Abstract

Non-parametric methods such as artificial neural nets can successfully model prices of financial options, out-performing the Black–Scholes analytic model (Eur. Phys. J. B 27 (2002) 219). However, the accuracy of such approaches is usually expressed only by a global fitting/error measure. This paper describes a robust method for determining prediction intervals for models derived by non-linear regression. We have demonstrated it by application to a standard synthetic example (29th Annual Conference of the IEEE Industrial Electronics Society, Special Session on Intelligent Systems, pp. 1926–1931). The method is used here to obtain prediction intervals for option prices using market data for LIFFE "ESX" FTSE 100 index options (http://www.liffe.com/liffedata/contracts/month_onmonth.xls). We avoid special neural net architectures and use standard regression procedures to determine local error bars. The method is appropriate for target data with non constant variance (or volatility).

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1. Introduction

Data mining and computational methods such as artificial neural nets are increasingly used in finance. They provide an alternative non-parametric model of option prices, out-performing the Black–Scholes (BS) model [1–4]. These data mining methods are often generalisations of better known non-linear regression techniques. Confidence in the reliability of models and predictions is a key issue in finance. However, while techniques of statistical inference are well defined for the parametric regression methods traditionally employed in financial modelling, this is not the case for the non-parametric data mining techniques. Consequently, there is an absence from the literature of statistical hypothesis testing [5], and models are evaluated on summary criteria such as mean squared error and R^2. Also, prediction and confidence intervals are rarely constructed for option pricing models estimated using these techniques. In our work on option pricing, we have found that when input data is partitioned by moneyness/maturity, model price predictions may be unbiased for some partitions yet biased for others. Examination of pointwise prediction intervals is thus a necessity to obtain a fuller picture of model performance than is given by single summary statistics or hypothesis tests. We seek a method which is generally applicable, and can be used with any regression technique of sufficient flexibility. In this paper we describe a robust method for determining prediction intervals for neural nets and related techniques. We have tested the method empirically using a standard synthetic data set, and compared it with a method restricted to neural nets [6]. Here, our method is applied to obtain prediction intervals for pricing options, using a data set of 14,257 LIFFE European style FTSE 100 index 'ESX' options [7]. Our method uses standard regression procedures to determine local error bars. It is appropriate for target data with non-constant variance (or volatility).

2. Background

Neural nets are a generalisation of multivariate non-linear regression. Standard methods of computing confidence intervals such as the 'delta', and 'sandwich' methods as well as the 'naive' bootstrap apply in principle but have practical problems as discussed in Refs. [6,3]. Nix and Weigend [8] describe a method of using a neural net to estimate the variance of its own predictions of the target variable, thereby allowing prediction intervals to be constructed. They proposed a neural network, with two outputs, that simultaneously estimates the conditional mean of the specific target and its conditional variance. The architecture and cost functions used differed from a standard NN with fully connected hidden layers. The outcome is a model for both $y(x)$, the underlying true regression, and $\sigma^2(x)$ the true noise variance function. Nix and Weigend demonstrated good recovery of the target function and variance function, using the normalised mean squared error, and the mean cost, as performance criteria. The specific characteristics of the method [8] mean that it is restricted to NNs and is not generally applicable.