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A framework for evaluating a software bidding model

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Abstract

This paper discusses the issues involved in evaluating a software bidding model. We found it difficult to assess the appropriateness of any model evaluation activities without a baseline or standard against which to assess them. This paper describes our attempt to construct such a baseline. We reviewed evaluation criteria used to assess cost models and an evaluation framework that was intended to assess the quality of requirements models. We developed an extended evaluation framework and an associated evaluation process that will be used to evaluate our bidding model. Furthermore, we suggest the evaluation framework might be suitable for evaluating other models derived from expert-opinion based influence diagrams.

Keywords: Evaluation framework; Evaluation criteria; Software bidding model; Influence diagrams; Evaluation process

1. Introduction

Recently, we have constructed a risk-based software bidding model [8,9]. The model was developed using Koller's method of risk assessment and decision making [10]. It was presented as a simplified influence diagram (referred to as a contributory factor diagram) and animated using Monte Carlo simulation. The elements in the contributory factor diagram are linked by simple mathematical equations, but the input values to the equations are assumed to be variables each with a (different) defined distribution, not fixed values. The Monte Carlo simulation selects values from the distributions in order to generate the model output. The model is described briefly in Section 2.

In our previous report [8], we noted that our model was difficult to validate. It does not have a single value output as a cost model would. The output from the model is a *distribution* of output values obtained from the Monte Carlo simulation. Furthermore, its inputs are expert opinion-based estimates of the distribution of a variety of input variables (e.g. estimated cost, delivery date, etc.).

This paper considers the problem of evaluating our bidding model. However, we are interested not only in evaluating the specific model we developed, but in the general problem of evaluating expert-opinion based models used to assess risk and to aid decision-making. With the increasing use of expert-opinion based models such as Bayesian Belief Networks [6] and System Dynamic Models [1] to address software engineering problems, we believe there is an urgent need to address the problem of model evaluation, particularly in the case where there is little or no past data. This problem has existed for many years, but there are as yet no generally agreed solutions.

In Section 3, we discuss our initial thoughts about validation and why we now believe them to be inadequate. In Section 4, we consider two evaluation exercises that address some of the issues we face when evaluating our model. We found that it was difficult to judge the appropriateness of any evaluation activities without a baseline or standard against which to assess them. For this reason, we believe it is necessary to determine an evaluation framework. In Section 5, we discuss two evaluation frameworks, one based on criteria for evaluating software cost models and the other aimed at evaluating the quality of conceptual models with particular reference to requirements. By integrating and extending these frameworks, we develop a framework we believe may be suitable for evaluating our bidding model. The framework identifies a set of five quality dimensions that can be used to assess

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the quality of a model: Syntactic quality, Semantic quality, Pragmatic quality, Test quality and Value. Associated with each dimension are goals of quality evaluation, model properties that support the goals and methods that are used to achieve the goals. We equate the methods for achieving quality goals with evaluation actions. Section 6 describes an evaluation process we have developed to help us apply the ideas in the evaluation framework. Section 7 describes the evaluation plan we have developed based on the evaluation framework and evaluation process. Section 8 discusses the evaluation framework and identifies areas for future work.

2. The bidding model

The bidding model is described fully in [8,9] and is only described briefly in this section. The influence diagram for the model is shown in Fig. 1. The bidding model is based on a simple central formula:

$$\text{Price} = \text{Cost} + \text{Contingency} + \text{ProfitLevel} \quad (1)$$

Cost is the cost to build the required software application. It assumed to be represented as a skewed distribution (based on a minimum, most likely and maximum cost estimate triple). Senior managers must determine value from the cost distribution as the basis for constructing a price based on their preferred risk level.

Contingency is assumed to be equivalent to an insurance premium added to a project to cater for the occurrence of unplanned rare events. It is based on assessment of the cost to cater for the contingency event weighted by the probability that the event occurs. Contingency may be adjusted depending on the status of a centrally managed contingency fund.

Profit level is modelled as a percentage of costs and is usually set by senior managers. It may be adjusted based on the strategic importance of the project and the extent of competition.

The model also considers estimated duration and estimated delivery date. These are represented as distributions based on minimum, most likely and maximum estimates. The estimated duration is adjusted according to the anticipated workload. Delivery date and price are model outputs, but are also inputs to the process that determines probability of success, as are estimates of the client's preferred price and delivery date.

All the model inputs are subject to uncertainty. The uncertainty is quantified by representing the inputs as a distribution. Monte Carlo simulation is used to select values from the input distributions. Repeated sampling of the input distributions permits the output distributions to be constructed.

3. Initial considerations

When discussing his modelling method, Koller [10] pointed out that risk models to support decision making are difficult to validate since "You rarely, if ever, have the opportunity to know the results of the road not taken".

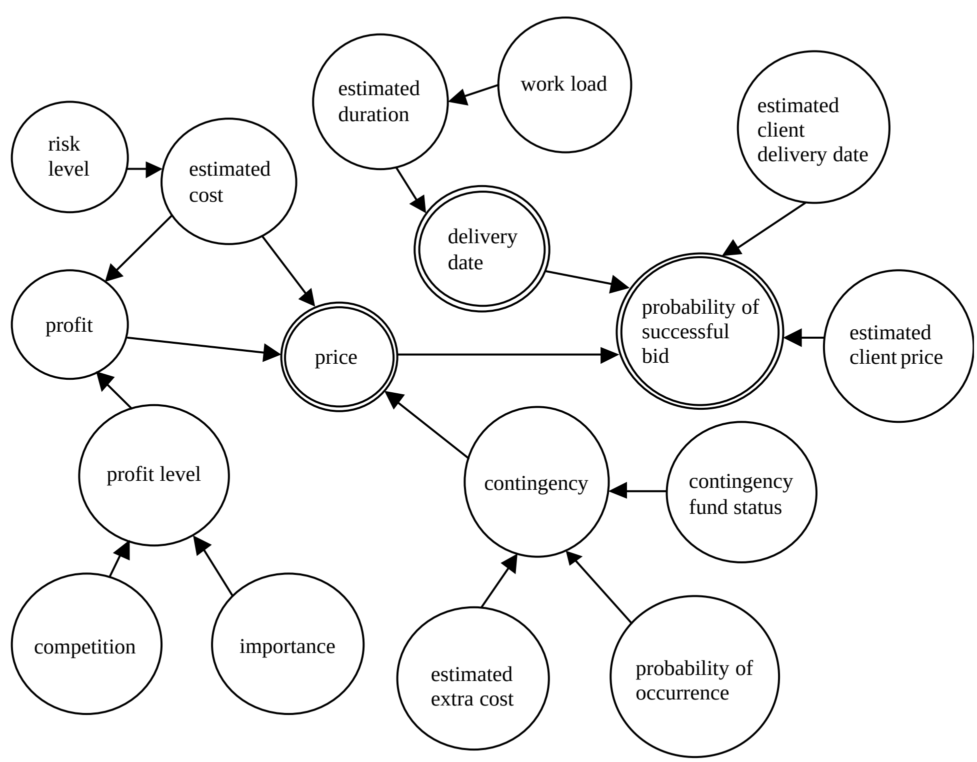

Fig. 1. Software bidding model (Outputs are show as double-circles. Arrows indicate the direction of influence).