

Transferable Belief Model in Computer Security

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Abstract: *While Bayesian theory is universally accepted, Dempster-Shafer decision theory still lacks a wider recognition among practitioners. In real life, however, there are many situations involving uncertainty in which the theory of probability is not useful. The presence of uncertainty in a decision problem should not necessarily imply that probability theory must be engaged. Bayesian theory cannot, for example, represent the evidence collected by various sensors installed in the firm's intrusion detection systems (ids). Sensors are only configured to produce signals pertaining to a limited number of subsets of the frame of discernment. There is, hence, no objective way to assign probabilities to those elements of the frame that are not concerned with ids sensors. This article demonstrates the use of Dempster-Shafer theory in computer security, by applying Smets' Transferred Belief Model (TBM) in the design of an intrusion detection system. A detailed numerical example is presented.*

Keywords

belief function, transferable belief model, Dempster-Shafer theory, Dempster's combination rule, Dempster conditioning rule

1.0 Introduction

The theory of belief functions is due to Arthur P. Dempster and Glenn Shafer. It is Dempster who set out the basic ideas of the theory in a series of articles in the 1960s ([2], [3], [4], [9]). Shafer then developed the theory further and established its terminology and notation in 1976, in his book, 'A Mathematical Theory of Evidence.' This theory was then called "Dempster-Shafer theory." giving credit to the contributions of both Dempster and Shafer.

The theory of belief functions offers one way to use mathematical probability in subjective judgment. It is a generalization of the Bayesian theory of subjective probability [16]. In Bayesian theory, the quantification of judgments about a question assigns probabilities to all possible answers to that question. Dempster-Shafer theory is however more flexible as it allows the derivation of degrees of belief for a question from probabilities for a related question. These degrees of belief may not necessarily have the needed mathematical properties in probability theory.

In practice, Fisherian and Neyman-Pearson applications are the most popular, followed by Bayesian applications which have been steadily growing in recent decades [16]. The application of Dempster-Shafer theory is still lagging behind due to the limited number of applications published in the literature. Dempster-Shafer theory is however becoming more and more widely known and accepted in the literature. This paper is intended to help the effort of awareness and acceptance of Dempster-Shafer theory among researchers and practitioners.

Historically, probability theory has been often linked to decision making under uncertainty. But in real life, there are many situations involving uncertainty in which the theory of probability is not useful. It is important to know that the presence of uncertainty in a decision problem should not necessarily imply that probability theory must be engaged [16].

The theory of probability may apply, however, when the relevant frequencies are available. Pearl (1988) discussed the use of subjective judgment in causal