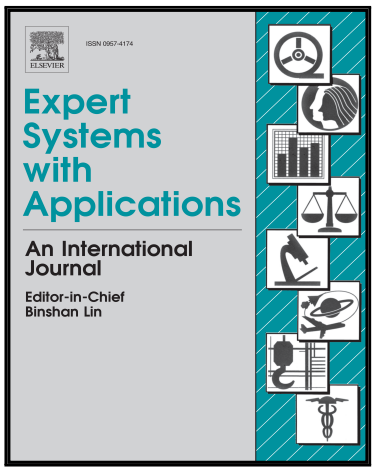


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# An Integrated Inverse Adaptive Neural Fuzzy System with Monte-Carlo Sampling Method for Operational Risk Management

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**Abstract**

Operational risk refers to deficiencies in processes, systems, people or external events, which may generate losses for an organization. The Basel Committee on Banking Supervision has defined different possibilities for the measurement of operational risk, although financial institutions are allowed to develop their own models to quantify operational risk. The advanced measurement approach, which is a risk-sensitive method for measuring operational risk, is the financial institutions preferred approach, among the available ones, in the expectation of having to hold less regulatory capital for covering operational risk with this approach than with alternative approaches. The advanced measurement approach includes the loss distribution approach as one way to assess operational risk. The loss distribution approach models loss distributions for business-line-risk combinations, with the regulatory capital being calculated as the 99,9% operational value at risk, a percentile of the distribution for the next year annual loss. One of the most important issues when estimating operational value at risk is related to the structure (type of distribution) and shape (long tail) of the loss distribution. The estimation of the loss distribution, in many cases, does not allow to integrate risk management and the evolution of risk; consequently, the assessment of the effects of risk impact management on loss distribution can take a long time. For this reason, this paper proposes a flexible integrated inverse adaptive fuzzy inference model, which is characterized by a Monte-Carlo behavior, that integrates the estimation of loss distribution and different *risk profiles*. This new model allows to see how the management of risk of an organization can evolve over time and it effects on the loss distribution used to estimate the operational value at risk. The experimental study results, reported in this paper, show the flexibility of the model in identifying (1) the structure and shape of the fuzzy input sets that represent the frequency and severity of risk; and (2) the risk profile of an organization. Therefore, the proposed model allows organizations or financial entities to assess the evolution of their risk impact management and its effect on loss distribution and operational value at risk in real time.

*Keywords:* Monte-Carlo sampling, Integrated adaptive neural fuzzy system, Loss Distribution Approach, Operational Value at Risk, Risk profile, Basel Committee on Banking Supervision

## 1. Introduction

All organizations face operational risk, since this type of risk refers to the possibility of incurring losses due internal events such as deficiencies, flaws/inadequacies in processes, systems or people or due to external events (Bank for International Settlements, 2016). This means that no operation of an organization is exempt from possible losses. However, for managers and stakeholders, it is important to know when the magnitude of the losses becomes significant for an organization. Only when the magnitude of an operational risk is comprehended, it is possible to prioritize different operational risks.

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