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Multi-stage cognitive map for failures assessment of production processes: An extension in structure and algorithm

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Abstract

In recent decade, fuzzy cognitive map has had significant applications in the systems analysis. But in majority of recent studies, a process perspective to different issues has not been considered in cognitive maps and the whole processes have been modeled separately or integratedly regardless of the relationships between processes. However, in complex systems that include the various sub systems, considering the process approach to modeling is necessary. In this study, to solve this problem, a multi-stage cognitive map has been introduced in which concepts are in various stages and any stage is associated to other stages with a series of causal relationships, and presenting a new learning algorithm based on the extended Delta rule to train cognitive map to reach the minimum of squares of errors. Furthermore, a new approach using multi-stage cognitive map and process failure mode and effects analysis are used to validate the new cognitive map. In this approach, calculating the score for prioritizing of failures is done based on severity, occurrence, and detection factors and causal relationships of each failure with other failures is carried out by using multi-stage cognitive map instead of conventional score of risk priority number. Also, for the presented approach, three learning algorithms including non-linear Hebbian, extended Delta rule algorithm and its combination with the differential evolutionary algorithm have been compared. The case study on automotive parts manufacturing unit, provides the ability of the proposed approach in prioritizing failures using integration of multi-stage cognitive map and new proposed learning algorithm for this purpose and the analysis of failure modes and the proposed algorithm.

Keywords: Multi-stage Cognitive Map, Extended Delta Rule Algorithm, Process Failure Mode and Effects Analysis, Risk Assessment and Prioritization, Automotive Parts

1. Introduction

In the real world, the analysis of the effective factors on a phenomenon is very complex; so that, these factors can be influenced by many factors and can affect on many others. Cognitive mapping is among the many ways that exist to show this relationship. Cognitive mapping (CM) is a way of design to express one's view of cause and effect or expert about a particular domain and then it is used to analyze the effects of policies or decisions pertaining to the realization of certain objectives (Asher, 1983). This method by linking facts, values and processes to goals and policies allows researchers to predict and analyze mutual influences

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