

Augmented fuzzy cognitive maps for modelling LMS critical success factors

Jose L. Salmeron

School of Engineering, University Pablo de Olavide (Spain), Ctra. de Utrera, km. 1, 41013 Seville, Spain

ARTICLE INFO

Article history:
Available online 7 February 2009

Keywords:
e-Learning
Fuzzy Cognitive Maps
Critical Success Factors

ABSTRACT

This paper proposes to build an Augmented Fuzzy Cognitive Map-based for modelling Critical Success Factors in Learning Management Systems. The study of Critical Success Factors helps decision makers to extract from the multidimensional learning process the core activities that are essential for success. Using Fuzzy Cognitive Maps for modelling Critical Success Factors provides major assistance to the e-learning community, by permitting prediction comparisons to be made between numerous tools measured by multiple factors and its relations.

© 2009 Elsevier B.V. All rights reserved.

1. Introduction

Learning Management System (LMS) are software packages, usually web-based, that enables the management and delivery of learning content and resources to students. The main goal is to propose a tool for evaluate LMS in a social computing point of view.

In addition, a Fuzzy Cognitive Map (FCM) is proposed for modelling Critical Success Factors (CSFs). FCM is a knowledge-based methodology suitable to model complex systems and handle information from an abstract point of view [1]. Soft computing techniques, as FCMs, have been successfully applied to model complex systems involving concepts, factors, states, events and trends [2].

2. Theoretical background

2.1. Critical Success Factors

The study of CSF was developed by Rockart [3] as a method to enable Chief Executive Officers to recognize their own information needs so that information systems could be built to meet those needs. Rockart defined CSFs as the needed elements for achieving a goal. This concept has wide acceptance among scholars and practitioners [4].

Some authors [5] analysed some aspects of CSF just by the use of personal interviews. However, a few of them used a formal methodology [6,7].

2.2. Learning Management Systems

e-Learning CSFs within a higher education institution can be grouped [8] into the following categories: (1) instructor; (2)

student; (3) information technology; and (4) university support. This work is focused on the IT one.

A LMS is a software bundle that enables the management and delivery of learning contents and collaborative resources to online students. While most LMS are commercially delivery (e.g.: WebCT, Scholar360, Desire2Learn, CentraOne, ANGEL Learning, and Edumate), open source software models do exist (e.g.: Moodle, .LRN, Atutor, and LON-CAPA).

Numerous scientific publications address the issue of CSFs in the e-learning field [8]. However, little efforts have been done for modelling LMS Critical Success Factors. In addition, none of them used a formal methodology. Therefore, a formal method to this to model CSF of LMSs is a useful endeavour.

3. Research model

3.1. Fuzzy Cognitive Maps

FCMs [9–11] constitute neuro-fuzzy systems, which are able to incorporate experts' knowledge [12]. FCM describes a cognitive map model with two characteristics. Firstly, causal relationships between nodes have different intensities, represented with a number from 0 to 1. As we analyze the cognitive maps, the causal value that they establish is the sign plus or minus. However, a FCM substitutes these signs by a fuzzy value between -1 and $+1$ where the zero value indicates the absence of causality. Secondly, it involves feedback, where the effect of change in a concept node may affect other concept nodes.

From an Artificial Intelligence perspective, FCMs are supervised learning neural systems, whereas more and more data is available to model the problem, the system becomes better at adapting itself and reaching a solution [6].

E-mail address: salmeron@upo.es

With the purpose of model the CSFs, advice was taken from a panel of experts. The expert panel number is quite difficult to establish and no study has been conclusive with respect to it [13]. We select six experts for this study. Literature [14] suggests a range of 5–18 to be an ideal number. Multiple choices were contemplated. In this sense, the main selection criterion considered was recognized knowledge in research topic, absence of conflicts of interest and geographic diversity. All conditions were respected.

3.2. Augmented Fuzzy Cognitive Maps

It is possible to represent the different relationships among factors by means of a matrix (A), called the adjacency matrix:

$$A = \begin{pmatrix} \dots & \dots & \dots \\ \dots & e_{ij} & \dots \\ \dots & \dots & \dots \end{pmatrix}; \quad e_{ij} \in [-1, +1] \forall i, j$$

e_{ij} indicates the relationship between the i and j concepts, enabling us to obtain values between $[-1, 1]$. Three types of relationships can be seen: (1) $e_{ij} > 0$, indicating a positive relationship, (2) $e_{ij} < 0$, indicating a negative one, and (3) $e_{ij} = 0$, where no relationship exists. Therefore, when an expert assigns a value e_{ij} , three issues must be considered. Firstly, the e_{ij} intensity to indicate how strong the i concept is in j . Secondly, the sign (+/−) of e_{ij} must be decided to indicate if the relationship between the i and j concepts is direct or inverse. Lastly, the causality relationship needs to be indicated to establish if the i concept is a cause of j or vice-versa. This process is presented in Fig. 1.

Various methodologies could be used in order to reach a consensus among the experts [15]. Finally, the Augmented FCM approach has been adopted, because it doesn't need that experts change slightly their judgement for consensus as Delphi methodology [16]. The augmented adjacency matrix is built adding the adjacency matrix of each expert [1].

Let two FCMs with no common nodes. FCM_A with c_i^A as nodes $FCM_A = \{c_i^A\}$, and FCM_B with c_j^B as nodes $FCM_B = \{c_j^B\}$. The

adjacency matrix of FCM_A is $A_A = (w_{ij}^A)$; and the adjacency matrix of FCM_B is $A_B = (w_{ij}^B)$. The augmented adjacency matrix is

$$A = \begin{pmatrix} w_{ij}^A & 0 \\ 0 & w_{ij}^B \end{pmatrix}$$

If there are common nodes, then the element w_{ij}^{Aug} in the augmented matrix is

$$w_{ij}^{Aug} = \frac{\sum_{k=1}^n w_{ij}^k}{n},$$

n being the number of FCMs added, one by expert, k the identifier of each expert, and i and j the identifier of the relationships (Fig. 2).

Let two FCMs with common nodes. Starting from each adjacency matrix

$$A^{Expert_1} = \begin{matrix} & A & B & C \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{pmatrix} 0 & 0.5 & -0.2 \\ 0 & 0 & 0.1 \\ 0 & 0 & 0 \end{pmatrix} \end{matrix}$$

$$A^{Expert_2} = \begin{matrix} & A & C & D \\ \begin{matrix} A \\ C \\ D \end{matrix} & \begin{pmatrix} 0 & 0.4 & 0 \\ 0 & 0 & 0 \\ 0.7 & 0.1 & 0 \end{pmatrix} \end{matrix}$$

The augmented adjacency matrix will be built as follows.

$$A^{Aug} = \begin{matrix} & A & B & C & D \\ \begin{matrix} A \\ B \\ C \\ D \end{matrix} & \begin{pmatrix} 0 & 0.25 & 0.1 & 0 \\ 0 & 0 & 0.05 & 0 \\ 0 & 0 & 0 & 0 \\ 0.35 & 0 & 0.05 & 0 \end{pmatrix} \end{matrix}$$

The resulting Augmented FCM graph is shown in the Fig. 3.

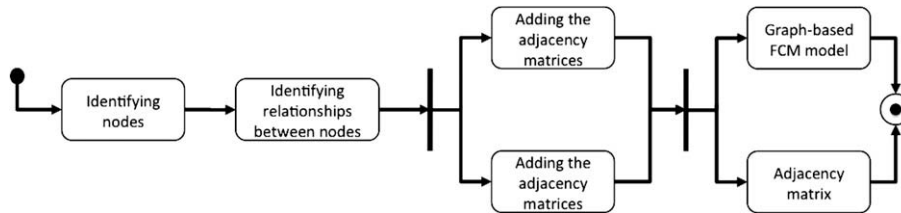


Fig. 1. Basic stages for building a Fuzzy Cognitive Map.

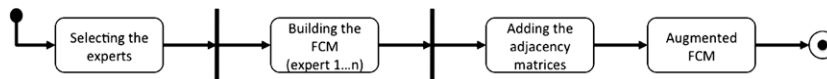


Fig. 2. Building an Augmented Fuzzy Cognitive Map.

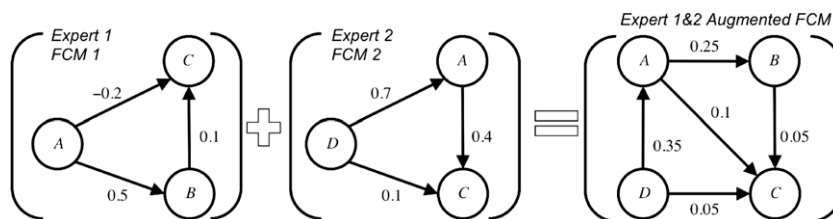


Fig. 3. Adding Fuzzy Cognitive Maps.

Download English Version:

<https://daneshyari.com/en/article/404034>

Download Persian Version:

<https://daneshyari.com/article/404034>

[Daneshyari.com](https://daneshyari.com)