Chapter 16
AI-Driven Decision Support System for Intuitionistic Fuzzy Assignment Problems

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ABSTRACT

The assignment problem (AP) is a well-known optimization problem that deals with the allocation of 'n' jobs to 'n' machines on a 1-to-1 basis. It minimizes the cost/time or maximizes the profit/production of the problem. Generally, the profit, sale, cost, and time are all called the parameters of the AP (in a traditional AP, out of these parameters, exactly one parameter will be considered a parameter of the problem). These are not at all crisp numbers due to several uncontrollable factors, which are in the form of uncertainty and hesitation. So, to solve the AP in this environment, the author proposes the software and ranking method-based PSK (P. Senthil Kumar) method. Here, plenty of theorems related to intuitionistic fuzzy assignment problems (IFAPs) are proposed and proved by the PSK. To show the superiority of his method, he presents 4 IFAPs. The computer programs for the proposed problems are presented precisely, and the results are verified with Matlab, RGui, etc. In addition, comparative results, discussion, merits and demerits of his method, and future studies are given.

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INTRODUCTION AND LITERATURE SURVEY

There are several methods available to solve real-world problems. Mainly, assignment problems (AP) and its solving methods are used to solve real-life problems. An AP plays an important role in assigning the following effectively:

- drivers ↔ trucks
- trucks ↔ routes
- persons ↔ jobs
- operators ↔ machines
- problems ↔ research teams, etc.

The AP is a special case of the linear programming problem (LPP). In LPP, the plan of the decision maker (DM) is to assign '*n*' no. of jobs to '*n*' no. of machines at a minimum cost or time. In the management science literature, to find out the solutions to assignment problems (APs), many researchers presented different methods. Some of the methods are listed in Table 1.

To solve real-world problems by using uncertain parameters, Zadeh (1965) introduced the fuzzy set (FS) theory which is the extension of the crisp set. The crisp sets consider the values 0 and 1 whereas the fuzzy sets consider the values in [0, 1]. The values in [0, 1] are called membership values in FSs. So, there is no FS without the membership values. Due to the important feature of FS theory, it is widely used in many fields.

Therefore, the fuzzy set theory has helped many authors to solve the issues of assignment, transportation, and LPP under uncertainty. Some of the current publications related to these issues are presented in Table 2.

The FS theory deals only with the membership value, but it does not consider the non membership and hesitation index. To counter this issue, Atanassov (1983) introduced the intuitionistic fuzzy set (IFS) theory, which is the extension of both crisp and FSs. Due to this important feature of IFS theory, it is widely used in many fields, for example, transportation, assignment, decision-making, etc.

Due to the existence of uncertainty in the FAPs and FTPs, many authors studied APs and TPs with IFSs. Some of the current studies related to these studies are given in Table 3.

A ranking formula or ranking technique will be helpful to compare two IFNs, which is also used to solve real-world problems. Some of the current research publications related to ranking techniques are shown in Table 4.

The IFAP is one of the optimization problems. Recently, several authors have presented new techniques for optimization problems. To know more, the authors name and published years of some of the academic publications that related to optimization problems are mentioned here (Utami et al., 2019; Lebedeva and Poltavskaya, 2020; Beaula and Seetha, 2020; Khalifa, 2020; Hirata et al., 2020; Prifti et al., 2020; González et al., 2020; Lyapin et al., 2020; Ekanayake et al., 2020; Marelli et al., 2021; Tanneau et al., 2021; Zhang et al., 2021; Rizk-Allah et al., 2021; Chang et al., 2021; Kalhoro et al., 2021; Mohan et al., 2021; Khalifa et al., 2021; Herzel et al., 2021; Wang et al., 2021; Sangeetha et al., 2022; Kanagajothi and Kumar, 2022; Taillard, 2023; Kumar, 2024).

In this book chapter, we are examining the IFAP. Let $[\tilde{C}_{ij}^{I}]_{n\times n}$ be the squared intuitionistic fuzzy cost/time matrix and let $\tilde{c}_{ij}^{I}$ be the intuitionistic fuzzy cost/time of assigning the jth job to the ith machine.