

Accepted Manuscript

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PII: S0020-0255(17)30370-5
DOI: <https://doi.org/10.1016/j.ins.2018.08.045>
Reference: INS 13889



To appear in: *Information Sciences*

Received date: 30 January 2017
Revised date: 19 August 2018
Accepted date: 20 August 2018

Please cite this article as: Piotr Prokopowicz, The use of Ordered Fuzzy Numbers for modelling changes in dynamic processes, *Information Sciences* (2018), doi: <https://doi.org/10.1016/j.ins.2018.08.045>

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The use of Ordered Fuzzy Numbers for modelling changes in dynamic processes

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Abstract

This paper presents an efficient use of the Ordered Fuzzy Numbers model in the description of processes undergoing dynamic changes. The purpose of this model is to provide a representation of inaccurate quantitative data, and is an alternative to the standard fuzzy numbers model proposed by Zadeh. Ordered Fuzzy Numbers have an additional feature—a direction. Giving them a new potential in applications to represent trends in imprecise values. This new feature is presented and explained via a simplified model of the volume of liquid in a reservoir. The environment is changing dynamically and is described by the changes of inflow and outflow. The proposed example explains how to interpret the direction of Ordered Fuzzy Numbers and how to understand the results of calculations and its influence. Additionally, this paper presents a comparison of the results for Ordered Fuzzy Numbers with the results of Zadeh's classical fuzzy numbers applied to the same exemplary process.

Keywords: Fuzzy Numbers, Ordered Fuzzy Numbers, Kosinski's Fuzzy Numbers, direction of imprecision, modelling trends in data, interpretation of fuzziness

1. Introduction

The idea of classic fuzzy sets and numbers [43, 44, 7] forms the basis of widely known methodologies for modeling the imprecision of the real world.

Unfortunately, the computational properties of classical fuzzy numbers (also known as convex fuzzy numbers) have drawbacks due to rapidly growing imprecision after a sequence of operations [22]. To improve their arithmetic properties, several additional solutions were introduced. Usually, additional operations or constraints are needed (see [38][13][42]) to get around these drawbacks.

An alternative solution is to use Ordered Fuzzy Numbers (OFNs), formulated by Kosiński, Prokopowicz, and Ślęzak [18, 20]. This model takes into account the order of the characteristic parts of a fuzzy number. It creates an additional feature of the data—a direction. By incorporating the direction in

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