Workshop Title:

Asymmetric Interval Numbers (AINs) in Decision Analysis: A New Approach to Modeling Uncertainty

Chair of the workshop: Prof. Wojciech Sałabun

Expected duration: about 60 minutes

Workshop Overview:

This workshop introduces a novel concept for representing uncertainty in decision-making processes: Asymmetric Interval Numbers (AINs). AINs offer a flexible and intuitive way to capture asymmetrical uncertainty, common in real-world problems, while maintaining mathematical rigor and compatibility with multicriteria decision analysis (MCDA) methods.

Unlike traditional interval numbers, AINs allow the expected value to be explicitly represented within the interval, making them better suited to capturing expert judgments and real-world imprecision. They reduce the risk of overestimation and enable finer control over the modeling of uncertainty, particularly where data are skewed or incomplete.

Participants will gain insight into a wide range of uncertainty modeling techniques, explore the theoretical underpinnings of AINs, and learn how to apply them in real decision-making scenarios using open-source tools developed within the AIN project.

Workshop Structure:

1. Overview of Uncertainty Modeling Techniques

A concise review of classical and modern approaches for representing uncertainty in decision-making:

- Probabilistic models,
- Fuzzy sets and fuzzy numbers,
- Classical interval numbers.

We will highlight the limitations of representations and motivate the need for a more expressive, asymmetric model, leading to the development of AINs.

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2. Asymmetric Interval Numbers – Theory and Applications in Multicriteria Decision Analysis

This section presents the core theoretical framework:

- Formal definition and structure of AINs
- Arithmetic operations and their properties
- Mathematical theorems on symmetry and asymmetry
- Comparison with existing uncertainty models

Use cases in MCDA will be discussed, showcasing the practical advantage of AINs in supporting non-compensatory, uncertain, or asymmetrically distributed input.

3. Modeling Uncertainty in MCDA Using Asymmetric Interval Numbers

Participants will be guided through practical examples of how AINs integrate with selected MCDA methods, including: SPOTIS, COMET, or RANCOM

We will present empirical case studies and demonstrate the use of the open-source Python library AsymIntervals, which enables the creation, manipulation, and visualization of AINs. Participants will learn how to apply these tools to real-world problems in risk analysis, strategy selection, and multi-criteria project evaluation under uncertainty.

Information about the Chair:

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Prof. Sałabun specializes in multicriteria decision analysis (MCDA), uncertainty modeling, and intelligent decision support systems. He is the author of several innovative decision-making methods, including the **COMET method** and **RANCOM subjective weighting model**. His current research focuses on extending classical decision frameworks to handle asymmetric and imprecise data using newly developed structures such as **Asymmetric Interval Numbers (AINs)**.

References:

[1] Sałabun, W. (2025). Asymmetric interval numbers: A new approach to modeling uncertainty. Fuzzy Sets and Systems, 499, 109169. https://www.sciencedirect.com/science/article/pii/S0165011424003154

[2] Sałabun, W. (2025). Python library asymintervals 1.1.1, Python Package Index (pypi) https://pypi.org/project/asymintervals/

[3] Sałabun, W. (2025). Documentation of Python library asymintervals 1.1.1, Read the Docs, https://asymintervals.readthedocs.io/en/latest/