Computer science – workshops

Workshops in research teams. Each candidate will declare their willingness to cooperate with a given research team at the recruitment stage, selecting the appropriate topic. These will be stationary classes carried out in modern research laboratories. Each student has to obligatorily complete one topic from presented below:

Contents

1. Knowledge exploration using clustering and outlier detection algorithms

Agnieszka Nowak-Brzezińska, PhdD, DSc, Assoc. Prof.

As part of the workshop, participants will be familiarized with the field of artificial intelligence and machine learning, unsupervised learning. In practical applications, using this learning method is much more often necessary. We do not know how to classify data (texts, images, sounds), and we analyze data in terms of, among others, similarities by creating structures that allow you to identify the group to which the recognized object belongs quickly. The topics discussed during the workshop will include methods such as cluster analysis and outlier mining. An essential part of the workshop will be a comparative analysis of various cluster analysis algorithms regarding the type of data analyzed and input parameters affecting the final result, i.e., the created group structure. The student will learn the methods of data similarity

analysis and the methods of creating representatives of the created groups. Then he will learn about the methods of searching the structures of clusters of objects. The result of the work will be a cluster analysis using different algorithms and different datasets to show which algorithms are suitable for analyzing a particular data type.

2. AI essentials: from decision tress to evolutionary algorithms and neural networks

Małgorzata Przybyła-Kasperek, PhD, DSc, Assoc. Prof.,
Kornel Chromiński, PhD, Rafał Skinderowicz, PhD,

The workshops cover three key artificial intelligence techniques: decision trees, genetic algorithms, and neural networks. Each topic is delivered in a 10-hour module combining theory with practice. Participants will learn to build interpretable decision tree models and apply algorithms such as CART and ID3 for classification and regression. They will explore the principles of genetic algorithms, including selection, crossover, and mutation, and their applications in optimization. The neural network module focuses on neuron structure, activation functions, and backpropagation, with participants creating their own models. By the end of the workshops, attendees will gain practical skills to solve complex problems using these methods.

3. Visual data analysis

Kornel Chromiński, PhD, Magdalena Tkacz, PhD

As part of the workshop, participants will be introduced to the modern approach to data analysis, which is visual analysis. Visual analysis combines a standard approach to data processing using statistical methods and data mining techniques with modern data visualization. Due to the fact that data visualization is better received by recipients than standard compilations and tables with results, visual analysis is becoming an increasingly popular form of data analysis. As part of visual analysis, the results of data analyzes are presented in the form of various types of charts, very often also interactive ones. As part of the workshop, students will learn how to prepare data, analyze them and then prepare a visualization of the obtained results in the most accessible way for potential recipients.

4. Biometric methods for person identification and verification

Rafał Doroz, PhD. Eng., Prof. Piotr Porwik, Tomasz Orczyk, PhD, Eng., Krzysztof Wróbel, PhD, Przemysław Kudłacik, PhD, Eng.

Biometrics is currently a rapidly growing scientific area, exploring various ways to identify individuals through their unique biological characteristics.

The aim of the workshop is to present the modern methods of biometric verification and identification of persons. During the workshop, many issues closely related to biometrics will be discussed, such as the classification of biometric data based on selected machine learning methods.

The problem of occurrence of incomplete and unbalanced data will also be discussed as well as an ensemble classifier architecture that enables direct (without any data modification) classification of such data.

Theoretical background and selected practical applications of fuzzy sets and systems such as cooperation of fuzzy systems with artificial neural networks will be presented. An important part of biometric methods are methods based on Fourier and Haar transforms. The mathematical basis of both methods will be discussed, as well as practical software solutions.

Since the skilful extraction of biometric features and their analysis is an important element of person recognition, the workshop will cover the above aspects on examples of biometric features such as lip prints or voice analysis. Tools and techniques for the extraction and analysis of biometric features will be presented.

5. Discovering Patterns and Selecting Features for AI Models

Beata Zielosko, PhD, DSc, Assoc. Prof. Łukasz Wawrowski, PhD

The aim of the course is to introduce methods for discovering patterns in data using simple and complex AI models. These models will be applied to the analysis of a real dataset and evaluated both in terms of classification quality and in terms of the interpretability and explain ability of the discovered knowledge. The course will also cover selected topics related to feature selection and its impact on the quality of the obtained results.