KKIO COMPETITION: STUDENT ENGINEERING PROJECTS

RESULTS

1st place: Wojciech Kania: “Intuitive Sound Processing Application”, Politechnika Wrocławska**,** Supervisor: dr inż. Bogumiła Hnatkowska

2nd place: Mikołaj Sikora, Wiktor Pawłowski and Jakub Sroka: “Rule-based system for solving functional harmony exercises”, Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie, Supervisor: dr hab. inż. Maciej Smołka, prof. nadzw. AGH

3rd place: Filip Ślazyk and Przemysław Jabłecki: “A tool for comparison and integration of feature selection algorithms for modeling of response to targeted therapy for patients with hairy cell leukemia”, Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie**,** Supervisor: dr hab. inż. Maciej Malawski, prof. nadzw. AGH

Distinction: Emilia Majerz and Aleksandra Pasternak: "System for analyzing damage to the surface of aircraft structures using convolutional neural networks", Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie**,** Supervisor: prof. dr hab. inż. Witold Dzwinel

Competition committee: Jacek Dajda (AGH), Joanna Świebocka-Więk (UJ), Wojciech Thomas (PWr), Andrzej Paszkiewicz (PRz), Michał Idzik (AGH)

ABSTRACTS

1st place: Wojciech Kania: “Intuitive Sound Processing Application”, Politechnika Wrocławska

Raising popularity of mobile devices has created the need for software capable of processing creative content. This engineering thesis, titled ”Intuitive sound processing application”, focuses on the design and implementation of a user-friendly tool for editing mentioned type of multimedia.

The functionalities scope appropriate for software of this category was established as a part of the performed analysis of existing solutions. Buffering, a technique involving dividing available information into smaller fragments, was used in signal processing, in order to use the available memory efficiently. Applying operations was implemented in a way that allowed for their simple reversion, to improve the comfort of edition. A couple of chosen effects was realised using field literature, mentioned in the thesis text. Appointed goals concerning ease of use were achieved by following the design principles, additionally, in user-application interaction, the support for touch gestures was added.

As parts of the thesis, project documentation and mobile application were created, allowing for import and export of audio in six formats, recording voice memos, signal manipulation, including cutting and moving fragments in the audio track and also application of chosen audio filters and effects. For conveying information about the signal waveform to the user, an interactive, generated view of sound amplitude was used, the solution also included the functionality of playing selected audio fragments.

During the thesis’ realisation, the author drew conclusions about the importance of coherent software design, that included separation of concerns and clearly stated architectural dependencies. The author also appreciated the input given by external testers and prototyping in the software development process.

2nd place: Mikołaj Sikora, Wiktor Pawłowski and Jakub Sroka: “Rule-based system for solving functional harmony exercises”

The main objective of this project was to create a system which will solve functional harmony (music field) exercises. Its result is a plugin for one of the most popular score editors - MuseScore. It solves three basic types of exercises: creating a four-part harmonization of a given sequence of harmonic functions, figured bass realization and four-part harmonization of soprano voice. It satisfies most of the harmonic function rules related to chords building and also leading a melody of each voice. Project is deeply related to music theory. The problem of solving functional harmony exercises was transformed to solving a discrete optimization problem with constraints. It was achieved by a rule-based score system and graph representation of possible solutions. We managed to find accurate algorithms for the given problems that work in a satisfactory time despite the performance problems of the above-mentioned score editor.

3rd place: Filip Ślazyk and Przemysław Jabłecki: “A tool for comparison and integration of feature selection algorithms for modeling of response to targeted therapy for patients with hairy cell leukemia”

The focus of this bachelor thesis is the comparison and integration of feature selection algorithms in the context of processing data of patients suffering from hairy cell leukemia (HCL). The major challenge, in that case, is the fact that data is highly dimensional, moreover, features are non-linearly correlated. As a result, the classification task becomes non-trivial and requires additional steps before the generation of the prediction model.

Multiple approaches of feature selection were researched and compared, such as algorithms utilizing random partitions, penalized regression, correlation coefficients and information-theoretical approach. Another part of the project was the implementation of the tool for comparison and integration of the feature selection methods, as well as classification in the context of the HCL data.

In this project, the dataset was related to the immune response of HCL patients to the targeted therapy. Obtained results are presented and discussed. Selected algorithms were implemented with the use of Python and R language. Their performance was assessed. The research was conducted with the help of High-Performance Computing resources.

The outcome of the project is a containerized web application intended to support research on this kind of leukemia, however, it can be applied to a wide range of similar problems.

Distinction: Emilia Majerz and Aleksandra Pasternak: "System for analyzing damage to the surface of aircraft structures using convolutional neural networks"

The aim of the study was creating a system for classifying photographs of the surface of aircraft structures according to the occurrence of corrosion. The system should consist of a convolutional neural network trained to effectively identify corrosion on the skin. Interaction with the classifier should be carried out with web application. Fundamental subject for the created Thesis was Machine Learning.

The study was created owing to obtaining the DAIS System database containing photographs of fragments of aircraft structures by the Department of Computer Science of AGH University of Science and Technology. The Thesis was created in the framework of the real project on analyzing damage to the surface of aircraft structures and deals with a real need of improving the analysis process.

The Engineer's Thesis contains documentation of the planning process, including technologies' comparative analysis and functional and non-functional requirements specification, and also some of the implementation aspects, and the results. The created system was built using Flask (web application), Tensorflow and Keras (finding neural network) frameworks. During the experiments which led to choosing the efficient neural network for the system, the state of the art architectures and various machine learning methods and preprocessing techniques (data standardization and data normalization, ensemble learning, classification of the features returned by convolutional layers of neural networks by SVM, thresholding) were tested.

The final product utilizes a neural network based on the EfficientNetB0 architecture, trained on standardized data. The network achieved 75% accuracy on the test set, correctly classifying 90% of photos showing corroded surfaces.