

Contribution for the RIS competition: Obzornik za matematiko in fiziko

In March and April, the first national competition in the development of new analytical methods in medicine - called RIS - was organised by the Society of mathematicians, physicists and astronomers of Slovenia (DMFA) and the Medical Physics Research Group, which consists of researchers from the University of Ljubljana, the Faculty of Mathematics and Physics, the Jožef Stefan Institute, the University Clinical Centre Ljubljana and the Oncology Institute. The competition was open to all students with an interest in advanced computational methods at the interface of medicine, physics and computer science.

The contestants faced a challenge on the topic of Alzheimer's disease diagnosis. More accurate and faster diagnosis is important for the development of successful therapies, proper inclusion in clinical trials and, on the patient's side, for better future planning according to the predicted disease progression. The contestants had to build an automated solution that would allow to distinguish AD patients from normal controls as reliably as possible from 2-[¹⁸F]FDG PET brain images.

The aim of the competition was to promote modern methods of data analysis in medicine, so it was also designed as a learning opportunity. The competition started with an introductory lecture, where the medical background of the problem, 2-[¹⁸F]FDG PET imaging and the statistical and computational methods currently used in science for data classification were presented. The main focus was on state-of-the-art machine learning methods - artificial intelligence.

The competition was held in two rounds. In the first round, the contestants had to create a computer algorithm that could automatically discriminate between the brains of AD patients and healthy subjects from 2-[¹⁸F]FDG PET images (binary classification). In the second round, their model had to predict the outcome of the subjects' cognitive testing using the Montreal Cognitive Assessment Scale (MoCA) (multiclass classification).

26 teams with a total of 68 competitors from 14 different Slovenian faculties and secondary schools entered the competition. The largest representation was from the Faculty of Mathematics and Physics (FMF), the Faculty of Computer Science (FRI) and the Faculty of Medicine (MF) of the University of Ljubljana (UL). The top 11 teams from the first round qualified for the second round. The prize pool of € 1,500 was distributed among the top three teams from the second round based on the performance of the classification algorithm. The winning team consisted of Karel Križnar, Blaž Dobravec and Anton Križnar, the runner-up of Sebastjan Kramar, Matjaž Bostič and Krištof Špenko, and the third-placed team of Luka Salvatore Pecoraro, Žiga Rot and Bernard Sovdat.

In both rounds of the competition, competitors used mainly machine learning methods to solve the problems. The best performing teams used convolutional neural networks to classify 2-[¹⁸F]FDG PET images. The winning team, which achieved a convincing victory in the last round of the competition, put a lot of emphasis on the careful selection of the hyperparameters for neural network learning and on the augmentation of the already available data. The winners' solution used a 3D convolutional neural network whose architecture they designed themselves. The good solutions of the contestants will directly benefit wider research in the field of medical image analysis, especially in the context of medical-physical research, as researchers face classification challenges in their daily research work.

The RIS competition thus brought participants closer to current challenges, faced by medicine, particularly those related to the development and application of advanced analytical methods based on artificial intelligence. The second national competition in the development of new analytical methods in medicine was overall a great success, with excellent participation and interest from the

competitors. Members of the three winning teams were invited to further participate in the Medical Physics programme group.