Popular science abstract:

Symmetry breaking is one of the leading research directions in the field of modern theoretical physics - understanding the difference between matter and antimatter is necessary to recognize how the Universe has begun. Due to the unusual difficulty of observing such phenomena directly, this issue does not have an undisputed theoretical explanation. The only chance for verifying current predictions is to recreate conditions that prevailed in the Young Universe in particle accelerators and escape to the frontier technological solutions. The European Center for Nuclear Research (CERN) is a leading institution of this field and since 2010 has been running a program dedicated entirely to the research of the processes mentioned above, under the name LHCb (Large Hadron Collider beauty). LHCb experiment has already contributed in a measurable way to the research on symmetry violation, among others through characterization of charm and beauty meson decays. Since December 2018, the LHCb experiment has been undergoing a huge and unprecedented upgrade of its spectrometer. The main goal of modernization is to adjust the spectrometer to increased instantaneous luminosity - this requires an overhaul of the detectors in such a way that they are capable of registering particles with higher resolution. In particular, one of the LHCb tracking detectors, the VELO (Vertex Locator), will be modernized from strip to pixel technology and will be ready for operation in 2021.

The new VELO detector will have to deal with radiation doses significantly exceeding those that have appeared at the LHC so far. This problem is at the same time a crucial part of this project, which aims to develop intelligent and automatic software, which will first evaluate the current radiation state of over 41-millions of analog pixel read-out channels in the detector. Then, using intelligent optimization techniques, deeply evolved in computer science for the past few years, it will optimize the configuration of these channels in such a way, that the initial performance of the detector will remain possibly unchanged. Creation of this radiation preventing software is unconditional and is one of the vital parts of upgraded VELO commissioning. The success of using Artificial Intelligence (AI) techniques to control 41 million channels would be a massive step in improving the quality of data in the LHCb experiment.

The second, accessory part of the project will use-case application of artificial neural networks for the analysis of physical data coming from the LHCb detector before modernization, on the example of the recently explored decay $L_b \rightarrow D_s p$. Such meson decays are very attractive because they provide useful information about symmetry breaking processes. Since neural networks have already shown excellent performance when modelling the complicated distributions, this approach may lead to better results than those obtained only using the statistical methods.