Machine learning workshop on accelerator and beam physics 2023

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The Machine Learning Workshop on Accelerator and Beam Physics 2023[1] was held in a hybrid on-site and online from November 27–29, 2023. This is a second workshop of Accelerator Machine Learning Forum.[2] This workshop was aimed at discussing the applications of machine learning in the accelerator field and promoting its application in Japan. A total of 101 participants attended this workshop: 28 on-site and 73 remote. In this workshop, 17 presentations were presented, including 12 general presentations, 2 invited talks, and 3 student presentations.

On November 27, the workshop began with a talk by Dr. Nishi from RIKEN, "Study for Bayesian optimization of heavy ion beam transport using simulation" followed by 6 talks on the use of Bayesian optimization[3] and neural networks. Dr. Yasutome from SPring-8 reported Bayesian optimization has already been introduced in the routine operations, complementing tuning by operators. Dr. Kamakura from Center for Nuclear Study, University of Tokyo reported about the possibility of predicting the beam intensity of ECR ion sources using convolutional neural networks[3] and plasma light images. Dr. Nomura from JPARC presented "Generation of Mountain Plot Image by Neural Network." A mountain plot is an image wherein the vertical oscillation of a beam can be visualized. He discussed the practicality and challenges of using PredNet[4] to learn time-series data and predict future changes. After all talks, a facility tour of the RIKEN Nishina Center was conducted, and a group photograph was captured (Fig. 1).

Fig. 1. Group photograph of on-site participants of the Machine Learning Workshop on Accelerator and Beam Physics 2023.

On November 28, 11 presentations were presented, including 2 invited talks and 3 student presentations. As the first invited talk, Dr. Yonehara from Fermilab introduced the machine learning project being conducted at Fermilab. In particular, he reported that they have been able to predict parameters very accurately in target experiments, which could be applied to experiments at the RIKEN Nishina Center. In the second invited talk, Dr. Yoshida from Tohoku University reported on the application of machine learning to the analysis of nuclear emulsion images. He reported that the trajectory of particles was traced from the images, resulting in the discovery of rare events. Mr. Maruyama from Sumitomo Heavy Industries, Ltd. presented "Creation and Evaluation of Ion Source Failure Prediction Model Using LOF[6] Method." In this presentation, he reported that their failure prediction algorithm considered the influence of judgment errors and determined the likelihood of failure based on the frequency of abnormal judgments. Mr. Kato from the University of Tokyo proposed a "one-stroke" approach to safely utilize Bayesian optimization. This method will be very important, particularly downstream in high energy.

On November 29, a tutorial on Bayesian optimization was conducted. In the tutorial, Dr. Nishi explained how to code a Python program with ChatGPT. Therefore, Dr. Morita explained the fundamental theory of Bayesian optimization and provided a practical exercise using the tutorial code to optimize beam optics with given beam emittance. The tutorial had approximately 15 participants on site and an on-line participation of 40–60 at any time. On-site participants attempted to rewrite the tutorial code to render it more practical for real operation, sparking extensive discussion. In a survey conducted after the workshop, 70% of respondents said they would like to use the tutorial's content in their work, indicating that the tutorial was very useful.

This workshop was supported by the Young Scientists Support Program of the Particle Accelerator Society of Japan, which provided travel expenses for students and young researchers who prepared presentations. This support facilitated lively discussions among students and young researchers. This was a very meaningful workshop from the perspective of the "dissemination of machine learning in the accelerator field," which is among the main objectives of the Accelerator Machine Learning Forum,[6] the co-sponsor of this workshop.

References

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