Advancing Generative Machine Learning with Quantum Computing

Patrycja Tulewicz[1], Karol Bartkiewicz[1], Jan Roik[2], Karel Lemr[2]

[1] *Institute of Spintronics and Quantum Information, Faculty of Physics, Adam Mickiewicz University, ul. Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland*

[2] *RCPTM, Joint Laboratory of Optics of Palacý University and Institute of Physics of Czech Academy of Sciences, 17. listopadu 12, Olomouc 771 46, Czech Republic*

The main difference between classical programming and machine learning (ML) is the reliance on explicit instructions for the former, as opposed to ML. The implicit operation of ML can be particularly useful for complex problems resistant to conventional methods, such as those in quantum systems. The integration of quantum computing and machine learning appears to offer a promising solution to these challenges, with additional benefits for the advancement of quantum information research. This talk will discuss how a new approach to generative machine learning emerges from quantum state discrimination [1].

A novel approach, the Synergic Generative Adversarial Network (SGAN), significantly reduces the number of hyperparameters required for generative quantum machine learning. This method supports collaboration between generators and discriminator, outperforming traditional quantum generative adversarial learning in some scenarios. Experimental results, both from quantum simulators and real quantum computers of IBMQ [2], show the effectiveness of our approach. A system trained with our algorithm successfully learns to recognize and generate maximally entangled states

Acknowledgments

This work was supported by the Polish National Science Centre from funds awarded through the Maestro Grant No. DEC-2019/34/A/ST2/00081

References

[1] Karol Bartkiewicz, Patrycja Tulewicz, Jan Roik, and Karel Lemr. Synergic quantum generative machine learning. *Scientific Reports*, 13(1):12893, Aug 2023.

[2] IBM Quantum. `https://quantum-computing.ibm.com/`. 2021.