Contribution ID: **93** Type: **Poster**

Adaptive phase estimation through a genetic algorithm

One of the fundamental motivations for science and technology is measurement of parameters with extreme precision. Quantum metrology is a significant application of quantum information theory for emerging quantum technologies, which exploits the theories of quantum mechanics, like entanglement, to surpass the limits on measurement and estimation of parameters realized using only classical techniques [1]. Phase estimation is a framework of quantum metrology where the challenge is estimation of unknown phase shifts by developing optimal protocols that estimate the phase to maximum possible precision by exploiting minimum number of resources [2,3]. We have designed a robust machine learning algorithm for the process of adaptive feedback based phase estimation using single photons in a Mach-Zehnder interferometer, which is able to deliver high performance using only a few resources [4]. The designed algorithm is a Genetic Algorithm, which is a search based evolutionary algorithm used for an offline optimization of control feedback policies that are used during the phase estimation process. The results of estimation show that the value of the unknown phase can be estimated using a limited number of photons, with an accuracy close to the theoretical limits. We also explored the performance of our algorithm in the presence of usual sources of errors, in order to concoct noise-robust policies that are tailored for both noisy and noiseless cases. Our results illustrate the potential of extending such methodologies to other applications in quantum metrology and for solving more general problems related to quantum information, where an adaptive approach could be used with optimal feedback control.

[1] V. Giovannetti, S. Lloyd, and L. Maccone, "Quantum-enhanced measurements: beating the standard quantum limit,"Science, vol. 306, no. 5700, pp. 1330–1336, 2004.
[2] A. Hentschel and B. C. Sanders, "Efficient algorithm for optimizing adaptive quantum metrology processes,"Physical Review Letters, vol. 107, no. 23, p. 233601, 2011.
[3] A. Lumino, E. Polino, A. S. Rab, G. Milani, N. Spagnolo, N. Wiebe, and F. Sciarrino, "Experimental phase estimation enhanced by machine learning,"Phys. Rev. Applied, vol. 10, p. 044033, Oct 2018.
[4] K. Rambhatla, S. E. D'Aurelio, M. Valeri, E. Polino, N. Spagnolo, and F. Sciarrino, "Adaptive phase estimation through a genetic algorithm,"Phys. Rev. Research, vol. 2, p. 033078, Jul 2020.

Presenter: Mr RAMBHATLA, Kartikeya (Shiv Nadar University)

Session Classification: Beers and Posters