Bayesian optimization of photonic quantum circuits with crosstalk noise

Fulvio Flamini[*1]
1. Institute for Theoretical Physics, University of Innsbruck, Technikerstraße 21, 6020 Innsbruck, Austria

Photonic integrated circuits are a promising platform for applications in the quantum domain [1]. However, the unavoidable effect of imperfections can severely hinder their performance for large-scale, high-density circuits [2] [3]. In this context, one relevant issue is the effect of thermal crosstalk between tunable phase shifters [4]. Despite recent solutions involving hardware modifications, a complete noise cancellation appears to be out of reach. Hence, a careful characterization of crosstalk is a first, essential step to counteract it.

In our analyses, we first consider two universal architectures for photonic circuits [5] [6] and numerically study the impact of crosstalk in arbitrary operations (Fig. 1). We then present a strategy to (i) improve prior knowledge on crosstalk in a given circuit and, similarly, to (ii) optimize the voltage-to-phase map required to achieve a target transformation. Both objectives involve a simple and efficient Bayesian optimization, which attempts to keep the number of measurements as low as possible.

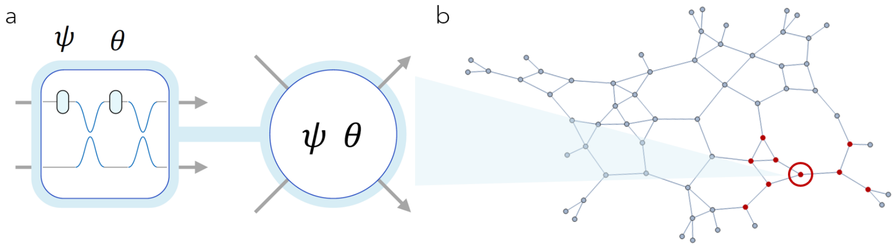

Fig. 1: (a) Photonic circuits consist of unit cells (Mach-Zehnder interferometers) with two tunable phase shifters. Any circuit can be described as a directed graph, where each node represents a unit cell. (b) Crosstalk affects phase shifters that are spatially close, which often correlates with a graph proximity neighborhood.

References

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*Corresponding author: fulvio.flamini@uibk.ac.at