One qubit as a Universal Approximant

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Abstract

A single-qubit approximant is a quantum circuit with only one qubit capable to mimic the behavior of any complex function, which is useful in the field of Quantum Machine Learning.
We implement the single-qubit universal approximant in a superconducting qubit circuit cooled to the base temperature of a dilution refrigerator (20mK). The qubit is a 3D transmon geometry located inside an aluminum three-dimensional cavity. Coherence times greatly exceed typical gate time, thus allowing to perform several layers of approximation. Final results show an overall agreement with the theoretical predictions and noise in the system seems to set a lower bound on the cost function.

References

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Figures

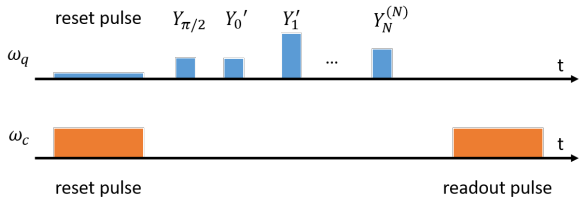

Figure 1: Pulse sequence of the N layers Universal Approximant algorithm. Upper (blue) row corresponds to the qubit pulses and lower (orange) one to the cavity pulses. Prior to the control pulse an active reset is performed to the system. Afterwards, a sequence of Y and Z gates is applied to the qubit. Z gates are virtual and correspond to axis variation in subsequent Y pulses. Finally, a readout tone measures the state of the qubit by probing the cavity.

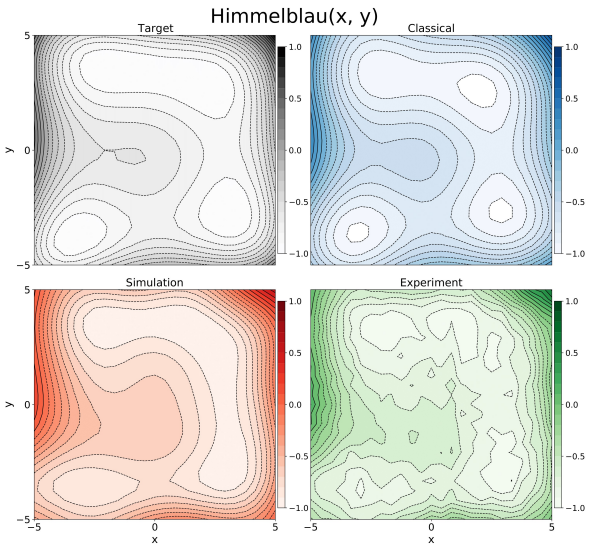

Figure 2: Top left picture shows the target Himmelblau two-dimensional function to be approximated. Classical optimization is seen in the top right corner. Optimization of the system by classically simulating a qubit is shown on the bottom left corner while the experimental realization with the parameters obtained in the classical simulation is located in the bottom right of the figure.