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Real time control of quantum devices using machine learning

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Machine learning has been the enabler of well-known breakthroughs in computer science, such as the victory of Alpha Go over a Go world champion and superhuman face recognition. We can direct this potential to the characterisation and tuning of quantum devices in real time. As in Go, where a player must carefully balance short and long-term goals and devise actions accordingly, we have demonstrated a deep reinforcement learning algorithm that devises efficient policies to find desired measurement features. Our algorithm divides the parameter space of a semiconductor quantum device into blocks and finds target measurement features by performing a minimum number of block measurements. In this way, we reduce the long characterisation times required due to device variability. We have also developed an algorithm that measures bias triangles, important features for qubit operation, and gives them a score. The device parameters are then updated to optimise this score in real-time. The algorithm, using a disentangling variational auto-encoder, proves capable of fine-tuning several device parameters at once. I will also show automatic identification of Pauli spin blockade. To conclude, I will demonstrate an algorithm able to tune a double quantum dot device regardless of the semiconductor realisation. These approaches are widely applicable, opening the way to a completely automatic and efficient route to quantum device tuning and characterisation, and thus taking a crucial step towards the scalability of quantum circuits.

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