



Contribution ID: 103

Type: Poster

Fully convolutional 3D neural network decoders for surface codes with syndrome circuit noise

Tuesday 2 December 2025 15:30 (1 hour)

Artificial Neural Networks (ANNs) are a promising approach to the decoding problem of Quantum Error Correction (QEC), but have observed consistent difficulty when generalising performance to larger QEC codes. Recent scalability-focused approaches have split the decoding workload by using local ANNs to perform initial syndrome processing and leaving final processing to a global residual decoder. We investigated ANN surface code decoding under a scheme exploiting the spatiotemporal structure of syndrome data. In particular, we present a vectorised method for surface code data simulation and benchmark decoding performance when such data defines a multi-label classification problem and generative modelling problem for rotated surface codes with circuit noise after each gate and idle timestep. Performance was found to generalise to rotated surface codes of sizes up to $d=97$, with depolarisation parameter thresholds of up to 0.7% achieved, competitive with Minimum Weight Perfect Matching (MWPM). Improved latencies, compared with MWPM alone, were found starting at code distances of $d=33$ and $d=89$ under noise models above and below threshold respectively. These results suggest promising prospects for ANN-based frameworks for surface code decoding with performance sufficient to support the demands expected from fault-tolerant resource estimates.

Author: GICEV, Spiro (The University of Melbourne)

Co-authors: Prof. HOLLENBERG, Lloyd (The University of Melbourne); USMAN, Muhammad (CSIRO/The University of Melbourne)

Presenter: GICEV, Spiro (The University of Melbourne)

Session Classification: Poster Session

Track Classification: Topical Groups: Quantum Science and Technology