Self-Organized Maps and Quantum States Classification

Ludmila Botelho[1], Jarosław Miszczak[1], and Thiago Maciel[2]

[1]Institute of Theoretical and Applied Informatics, Polish Academy of Sciences

[2]Universidade Federal de Santa Catarina

In order to fully understand the power of quantum computers it is necessary to understand the the space of quantum states structure, especially regarding the configuration and dynamics of entangled state. One can be interested in scrutinize how those structures behave in the context of higher-dimensional quantum systems, once such systems are difficult to visualize, leading us to a field of research methods for projecting it on low-dimensional space, which is useful for tracing the execution of quantum algorithm. Moreover those methods could constitute an valuable addition to system supporting quantum programming development.

On this study, we investigated the application of the unsupervised machine learning in the form of self-organizing maps, also known as Kohonen map, for the purpose of analysing the structure of the space of quantum states. The Kohonen map is a type of Artificial Neural Network which is also inspired by biological models of neural systems. A feature of such map is to preserve the topological structure of higher dimensional data.

We demonstrate that it is possible to provide a definition of self-organizing maps based on the dynamics of quantum states expressed in terms of completely positive trace-preserving (CPTP) maps. Alongside, we also utilize the standard version the self-organizing maps for analysing state partial transposition values trough informational complete measurement statistics and quantum state tomography.

Keynotes: Self-Organized Maps, Kohonen Map, Quantum State Tomography, Entanglement