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Variational Quantum Algorithms for Combinatorial Problems at Colliders

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In a process such as $pp \to t\bar{t}$, it is a binary classification problem to determine which of the top quarks the final state particles decayed from. This becomes exponentially more complex as the number of final particles increases. Variational Quantum Algorithms (VQAs) are hybrid quantum algorithms in which a quantum circuit is parameterized and a classical optimizer is used to minimize the energy of the final state of the quantum circuit. Encoding a cost function as an ansatz for the circuit layout allows for the solving of this minimization problem. I explore the use of various proposed VQAs – e.g. QAOA, MA-QAOA, FALQON – applied to the decay of a top and antitop quark pair, in a simplified case, and show how the invariant mass difference as a cost function can be transformed into a Hamiltonian and applied as a circuit and some preliminary results.

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