Full-stack Quantum Machine Learning for HEP

MCM23

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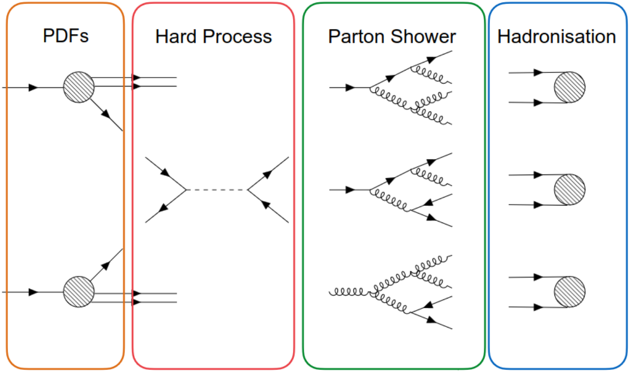
20 December 2023

Aim and motivation



Introductory concepts

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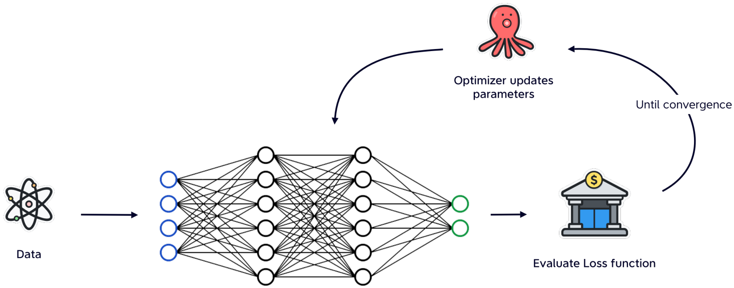
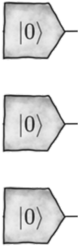


Parametric Quantum Circuits

- Classical bits are replaced by **qubits**: $|q\rangle = \alpha_0 |0\rangle + \alpha_1 |1\rangle$;



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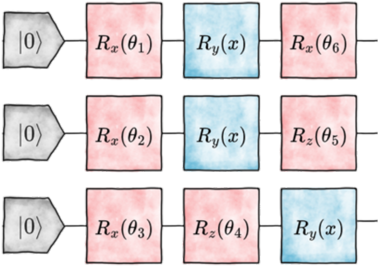

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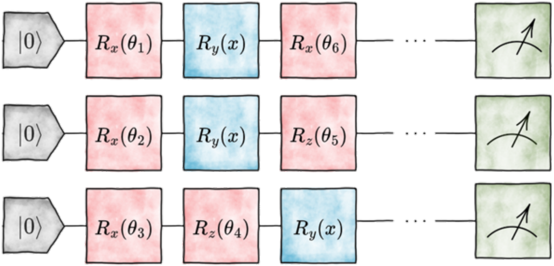
- information is accessed calculating expected values $\mathrm{E}[\hat{O}]$ of target observables $\hat{O}$ on the state obtained executing $\mathcal{C}$.



Machine Learning
$\mathcal{M}$: model;
$\mathcal{O}$: optimizer;
$\mathcal{J}$: loss function.
(x, y): data

Quantum Computation
$\mathcal{Q}$: qubits;
$\mathcal{S}$: superposition;
$\mathcal{E}$: entanglement.

Quantum Machine Learning - operating on qubits

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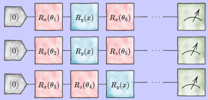
Circuit execution



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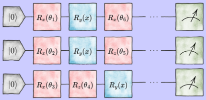

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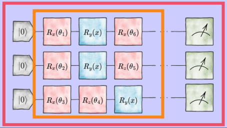

Quantum Machine Learning!

Optimizer $\mathcal{O}$
Hybrid-strategy

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loss function $\mathcal{J}$
$\mathcal{J}(y_{meas}, y_{est})$

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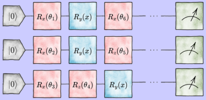
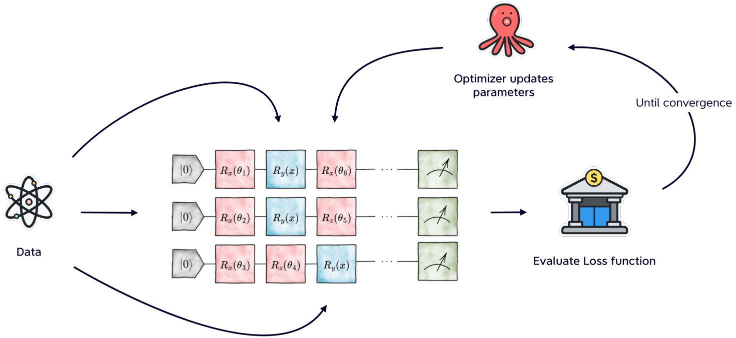


From ML to QML



Thank you for your attention!