Best practices in running quantum algorithms on NISQ devices

Quantum Business Europe 2023

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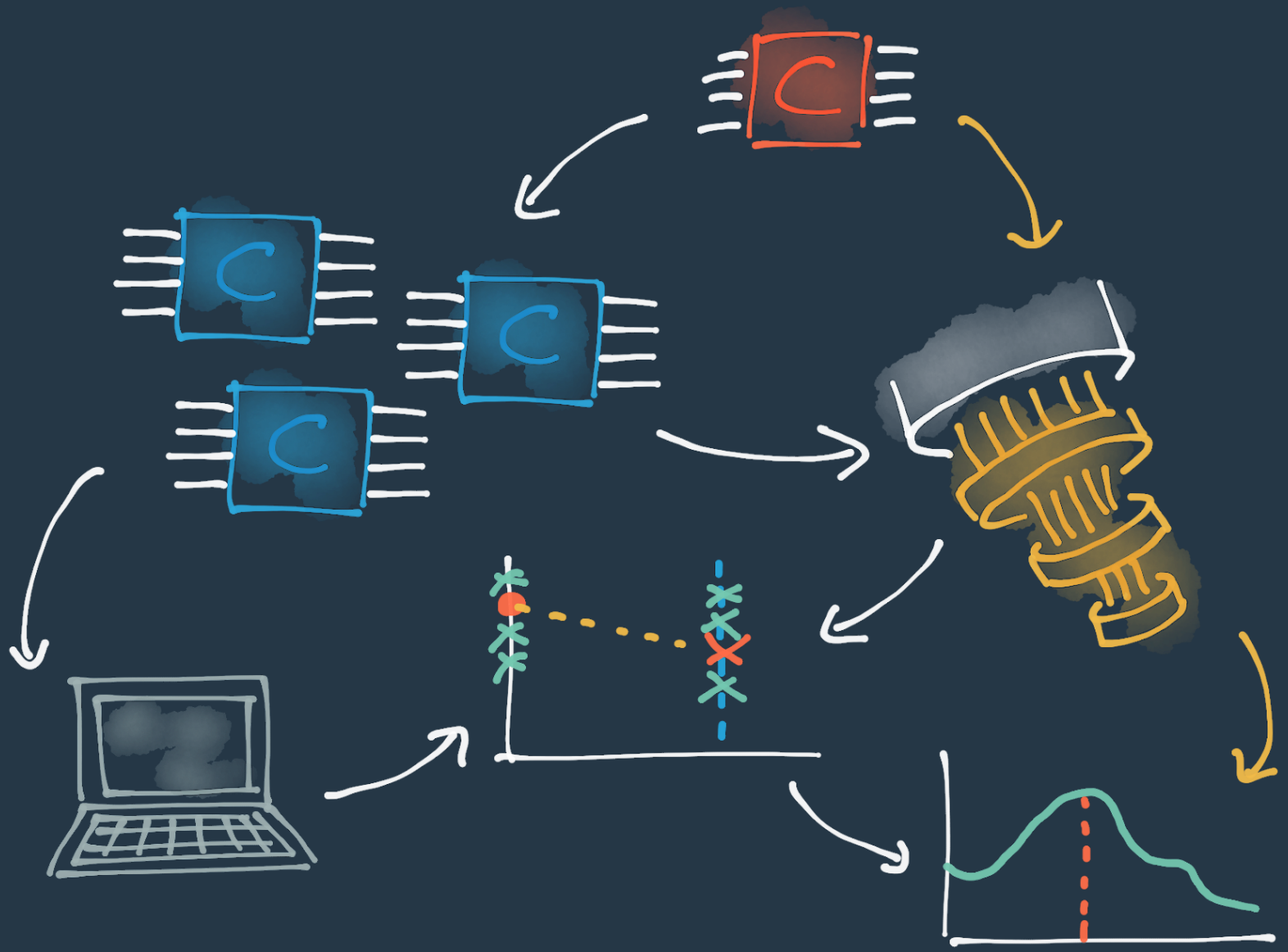
Best practices in running quantum algorithms on NISQ devices

~~Which collection of tools should I use for all your algorithms?~~

What are some ideas and philosophies which I should keep in mind when building and running my algorithm?

The Quantum Computing Stack

- **What can I do before my circuit hits the device?**
- How can I extract more information from the results I have?



PyTKET

- Quantum computing toolkit and optimising compiler.

```
pip install pytket
```

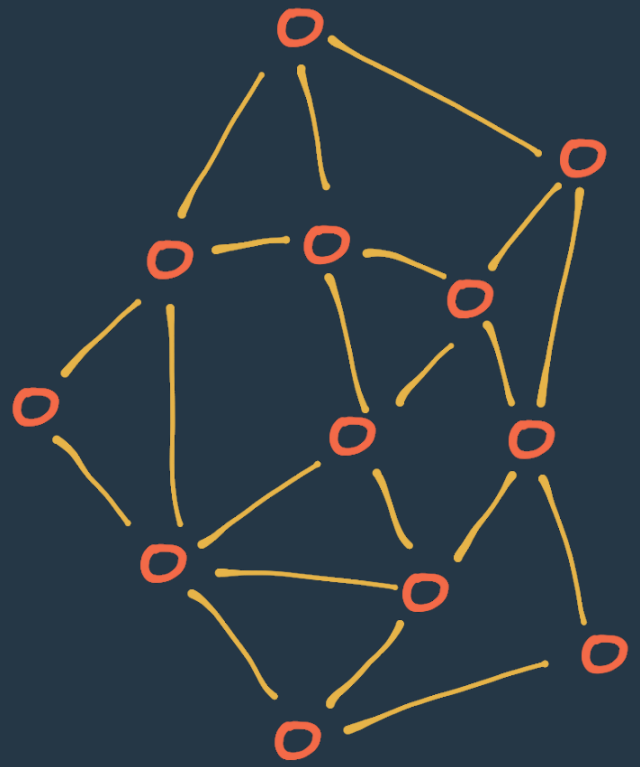
- Support numerous backends: IBMQ, Rigetti, IonQ, AQT and IQM.
- Provides interface with other libraries: braket, cirq, pennylane, qsharp, …

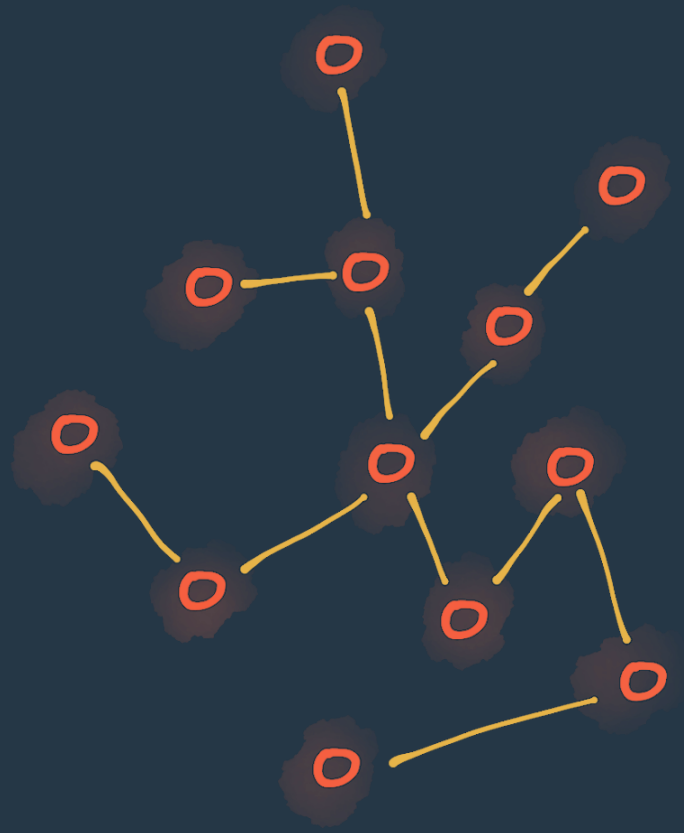
```
pip install pytket-[extension name]
```

- First and foremost a compiler, with a plethora of useful compiler passes.
- I focus on pulling out the last drop of performance after the general-purpose passes.

Non-Uniform Devices

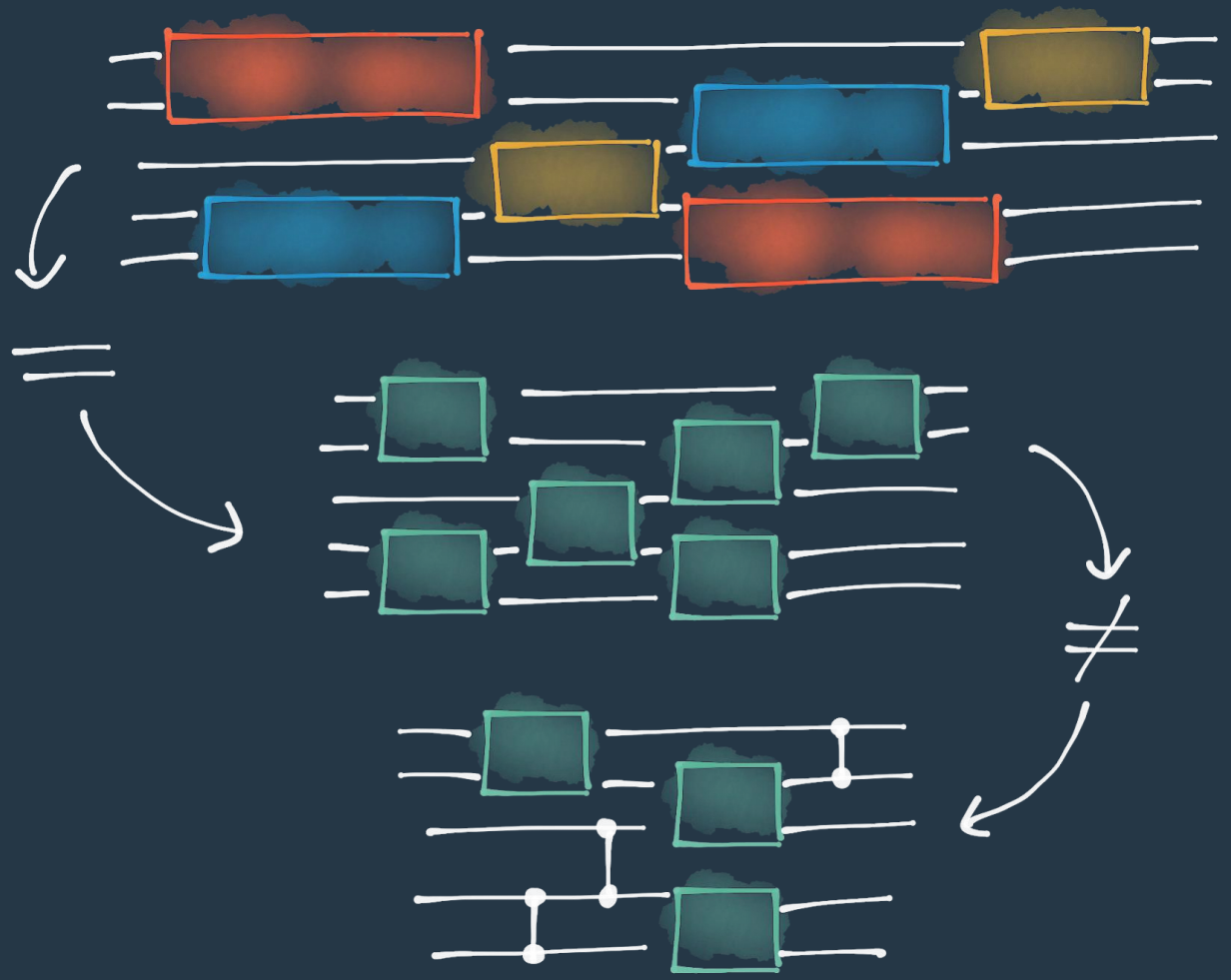
- Not all qubits are connected
- Gates are of different quality





Approximate Resynthesis

- Optimally resynthesis 3 qubit circuits.
- Approximately resynthesis 2 qubit circuits.
- Trade-off between approximation and noise.



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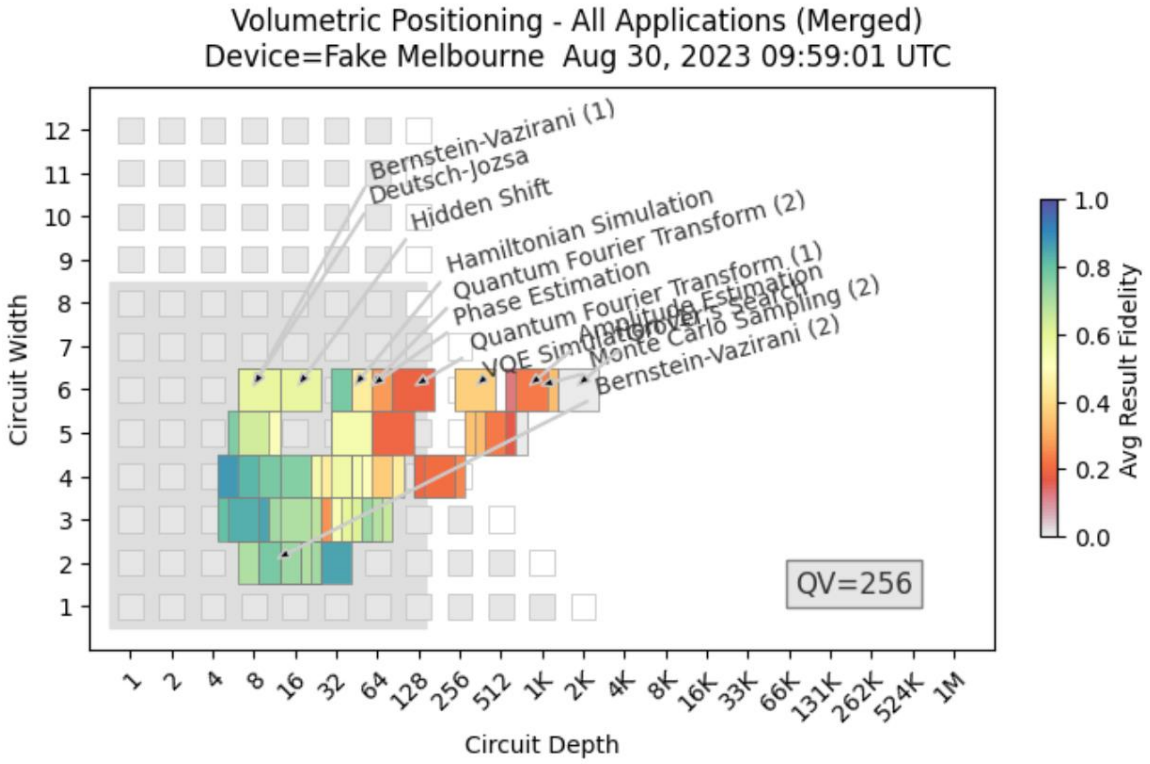
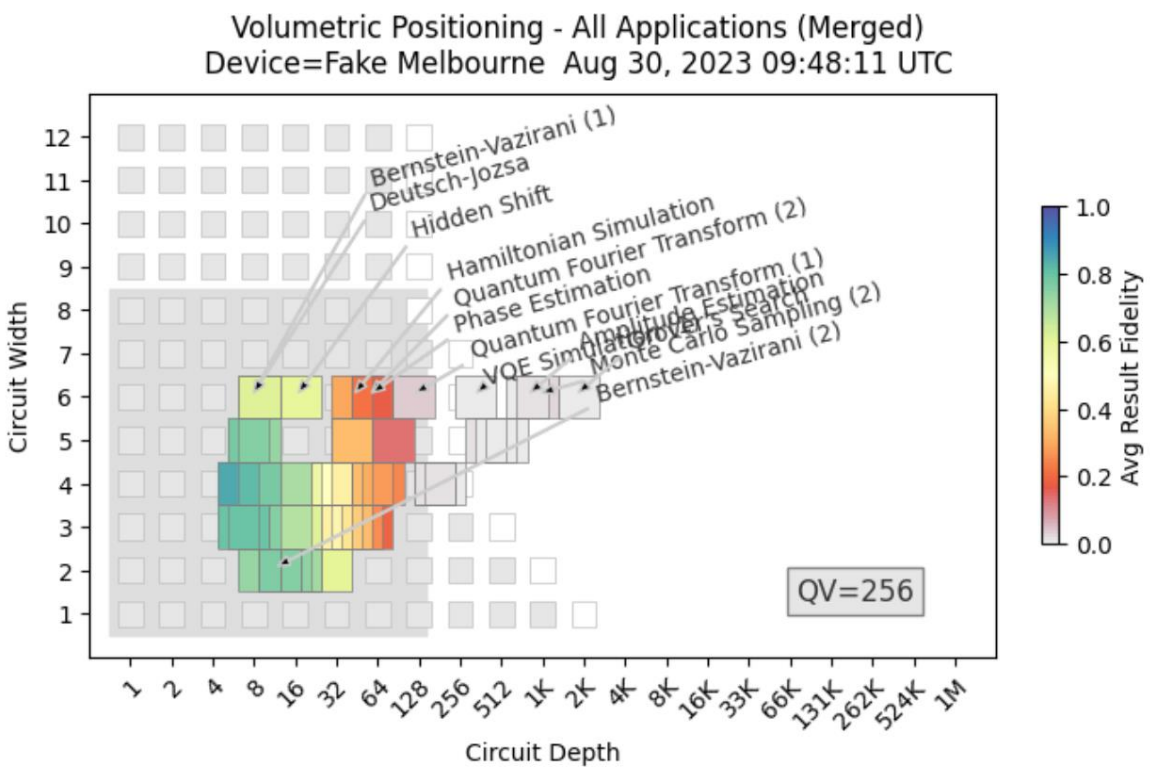
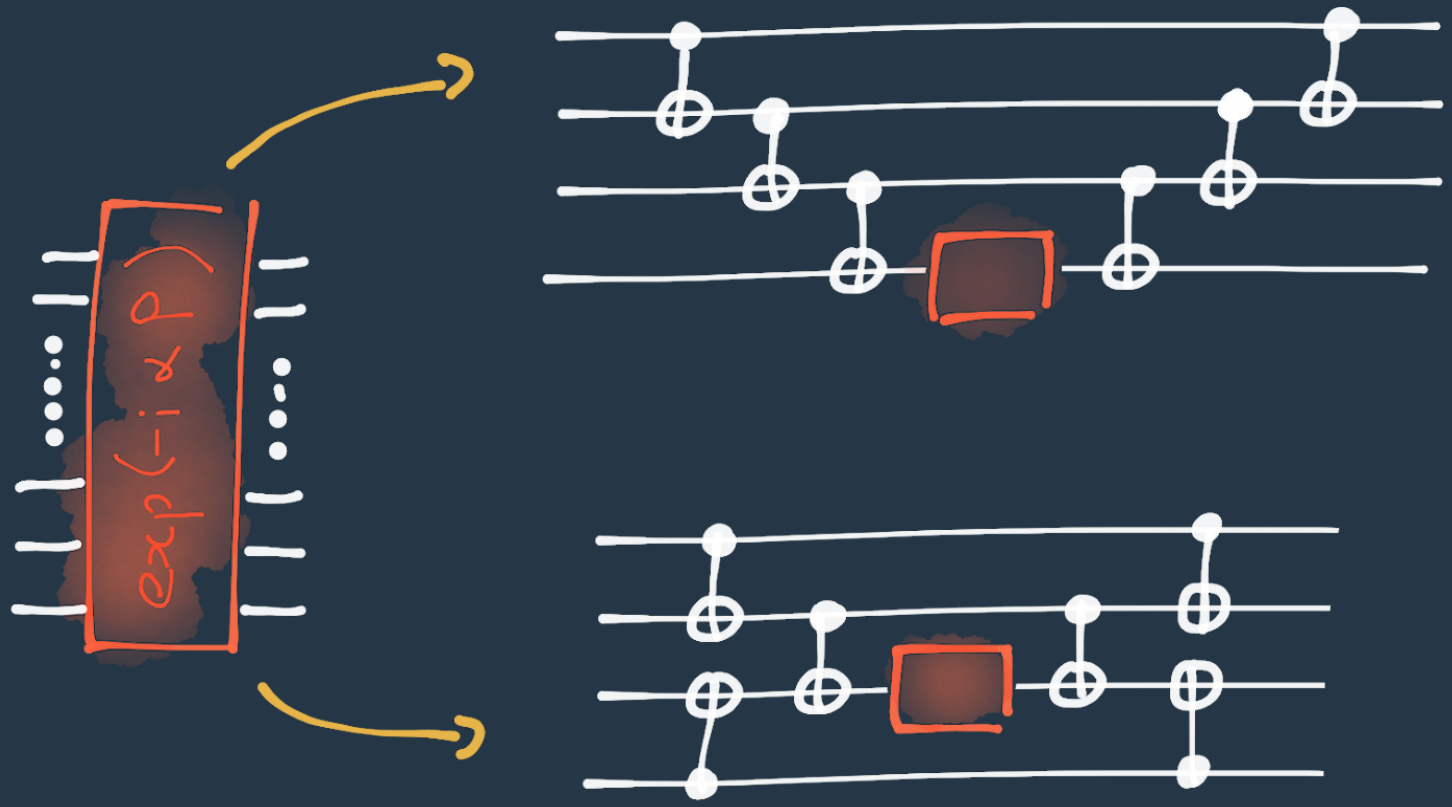
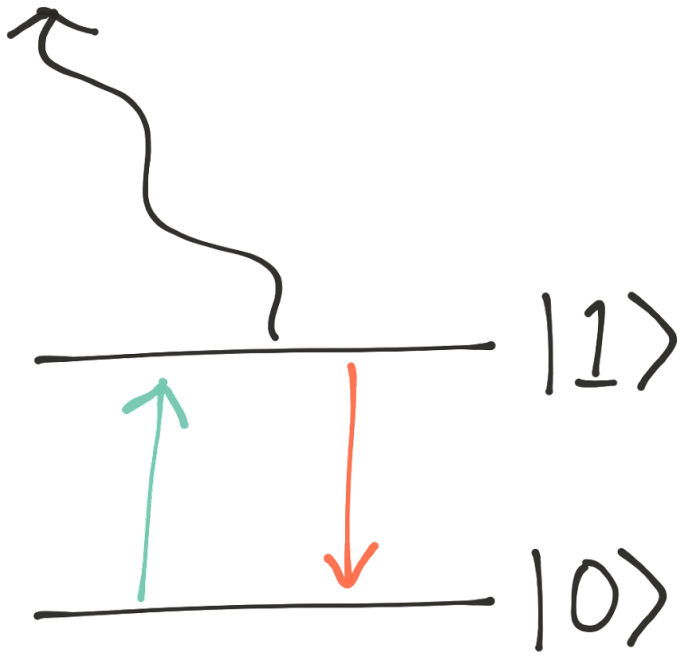
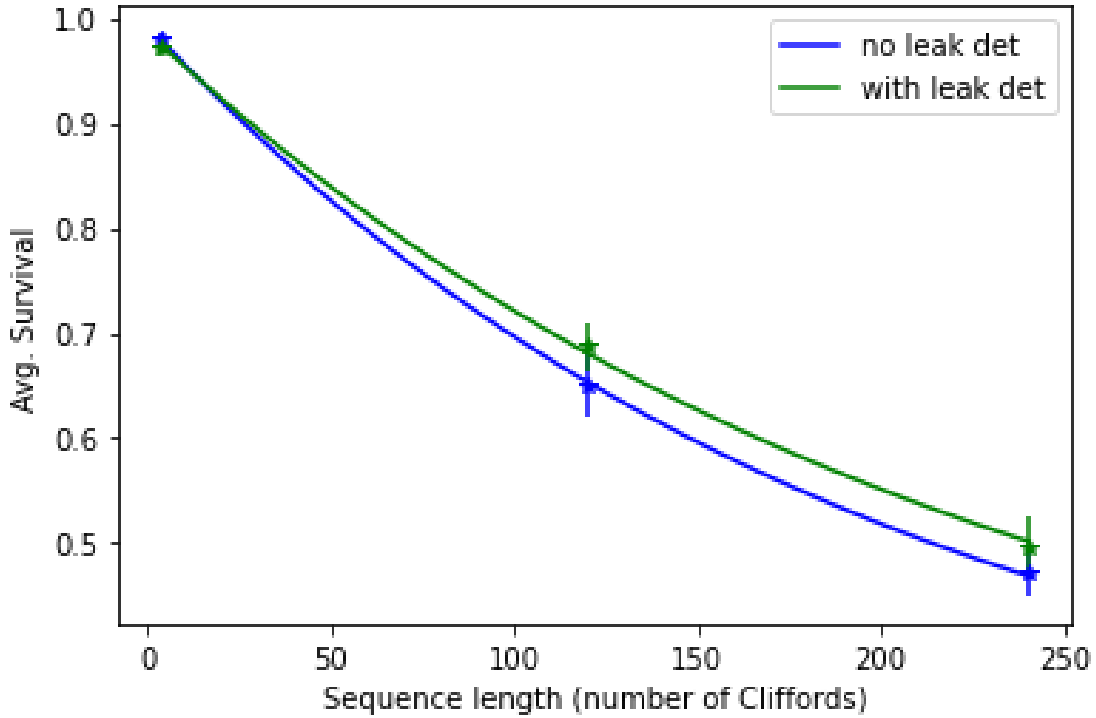


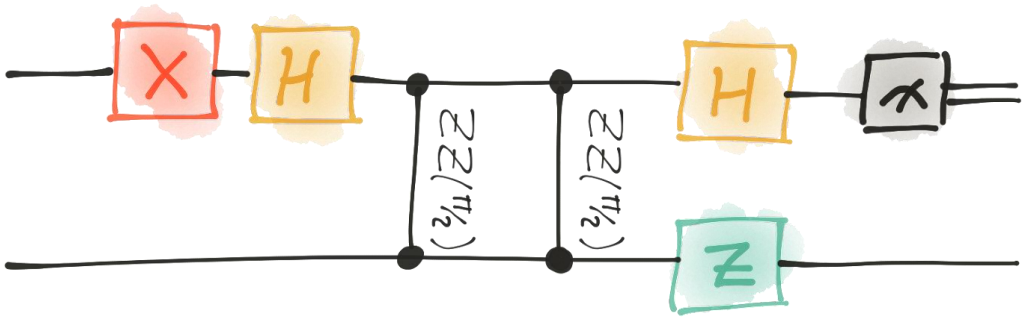


Application Specific Compilation









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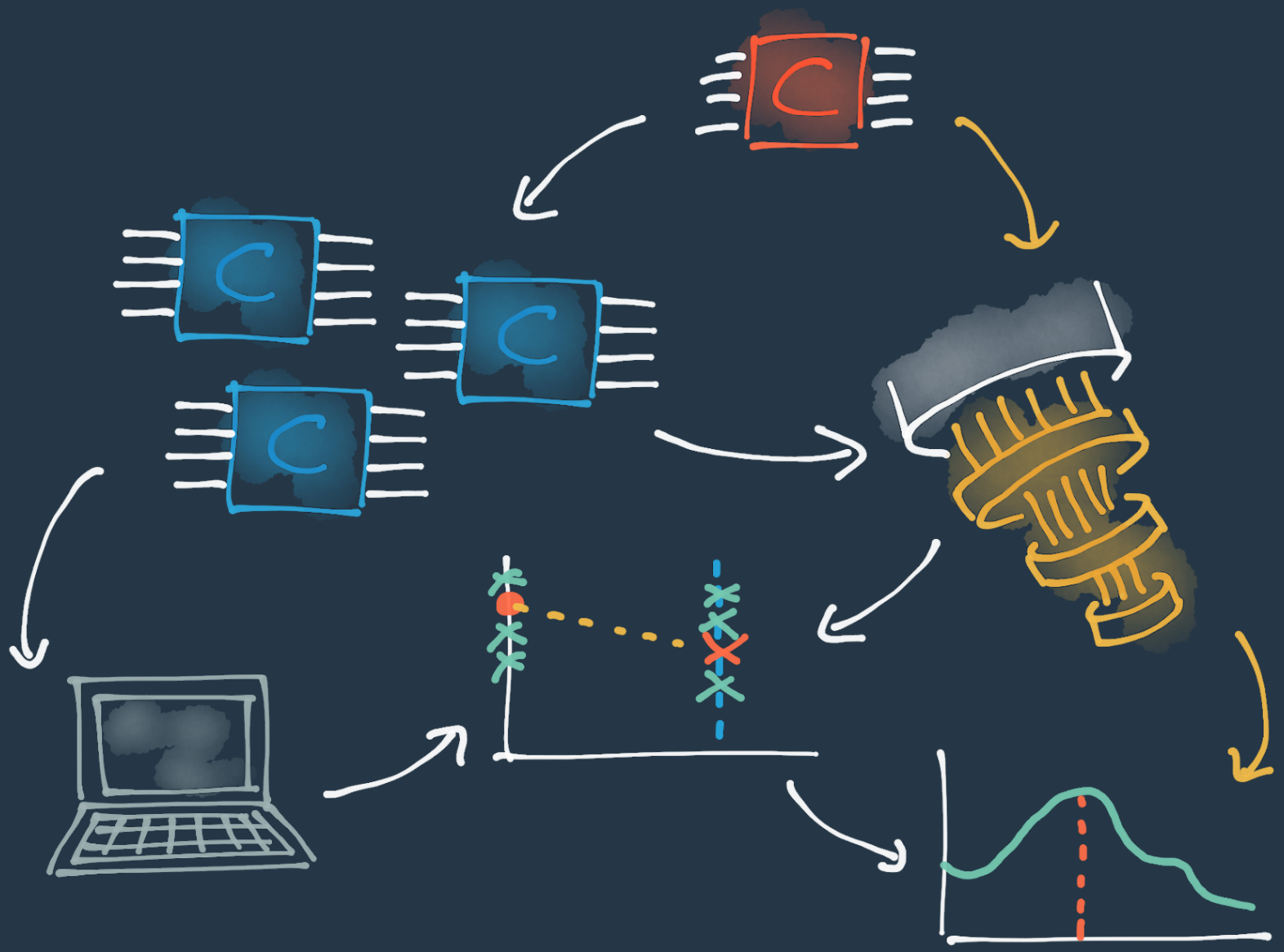
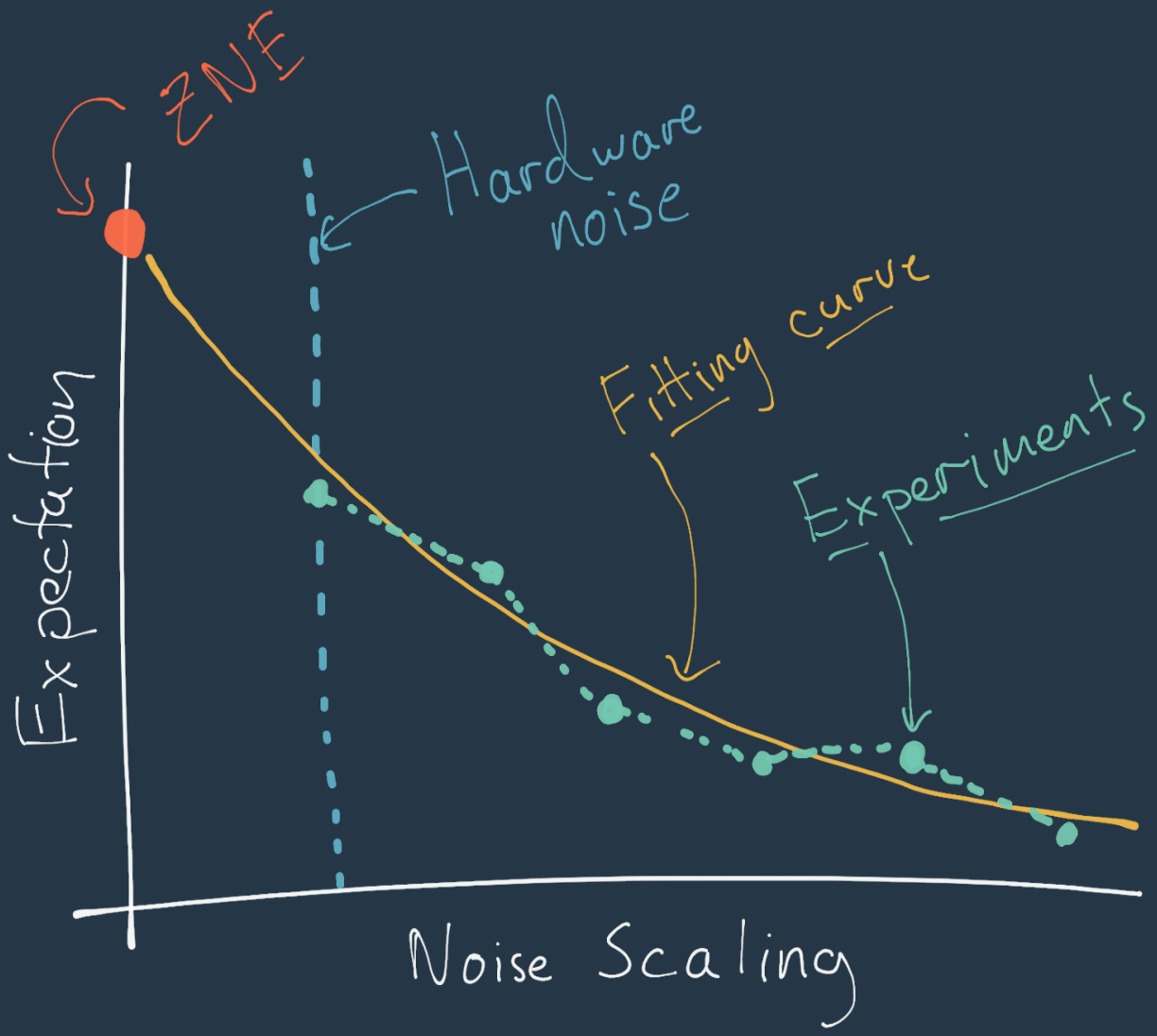
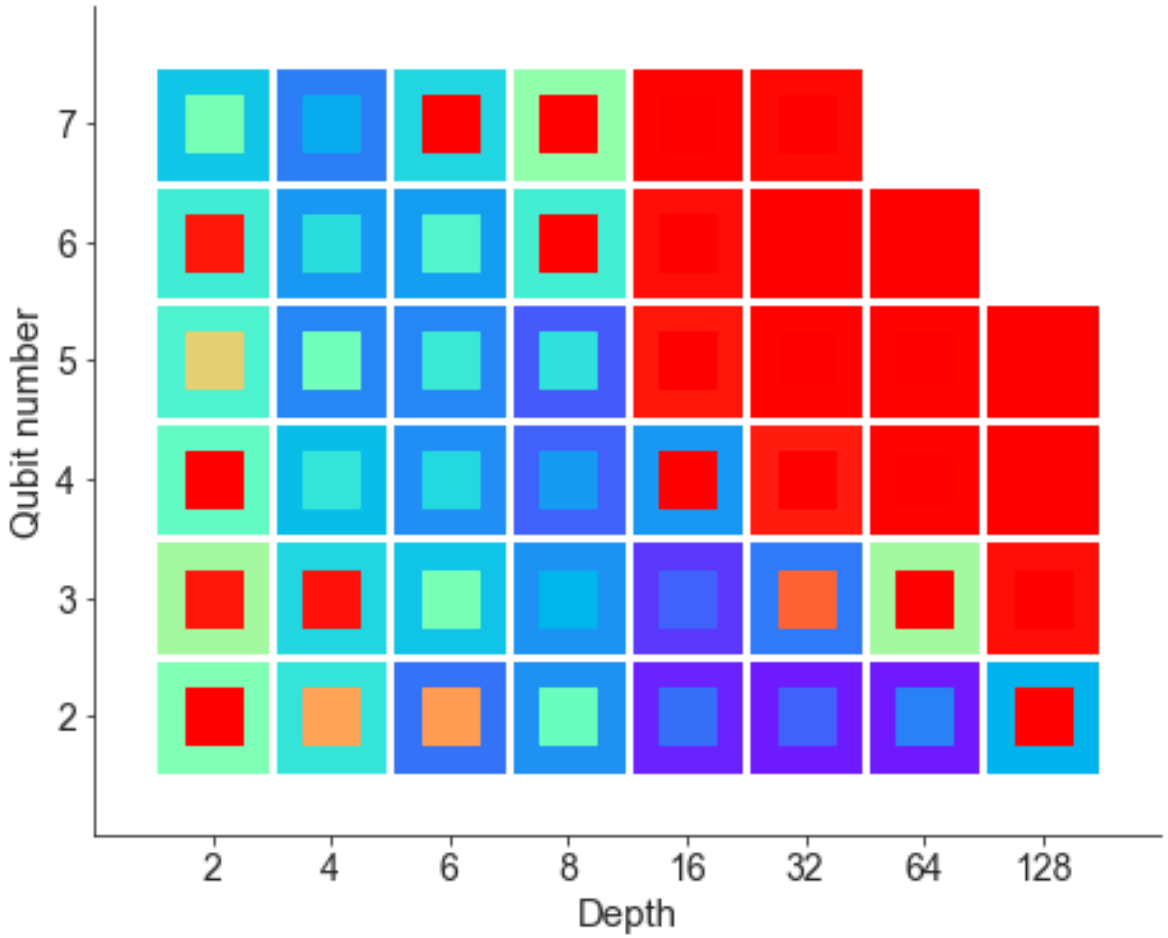
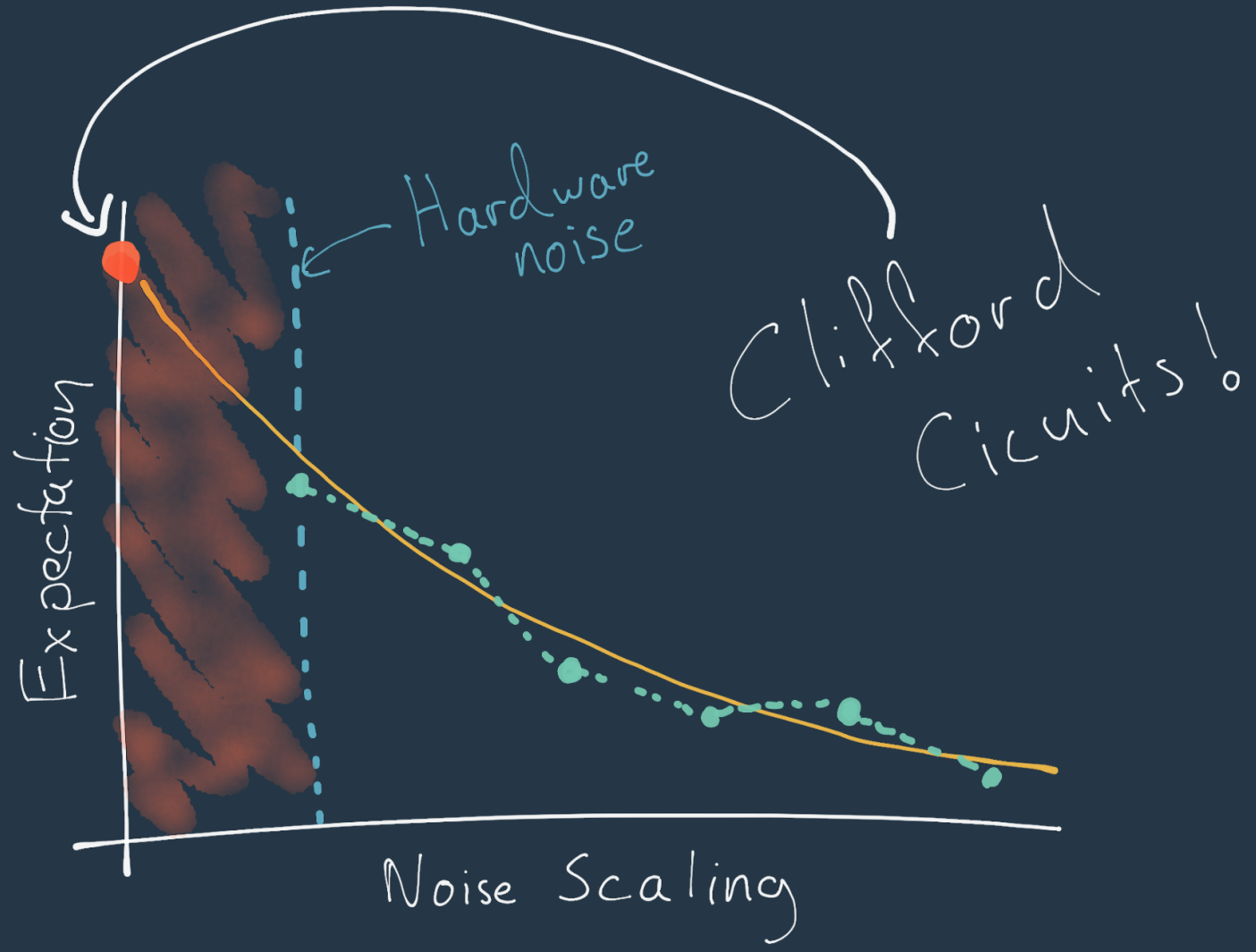
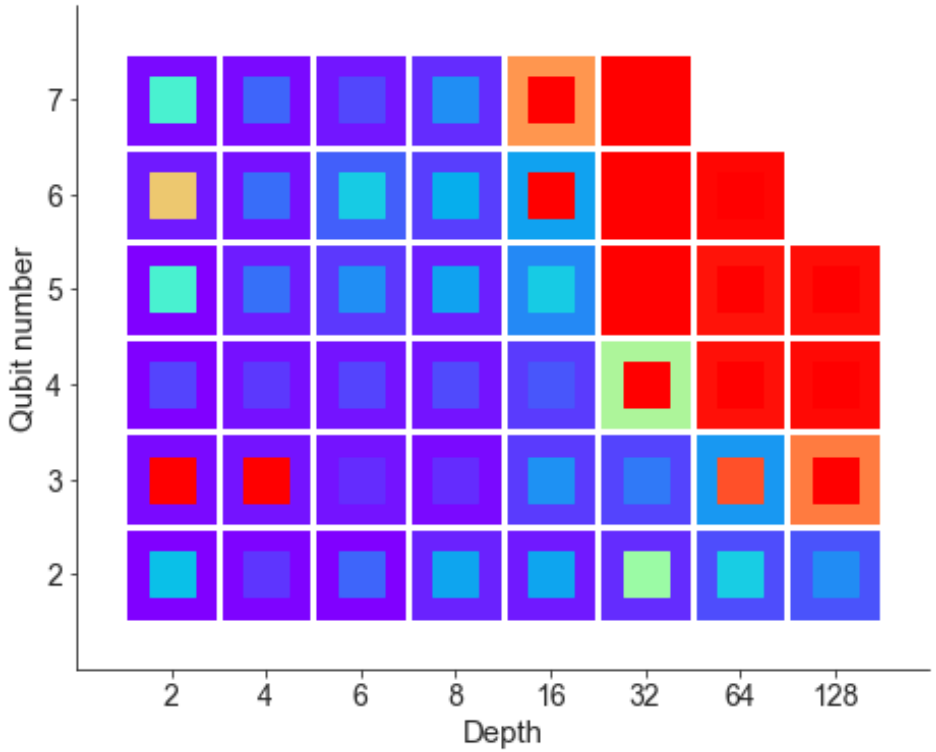


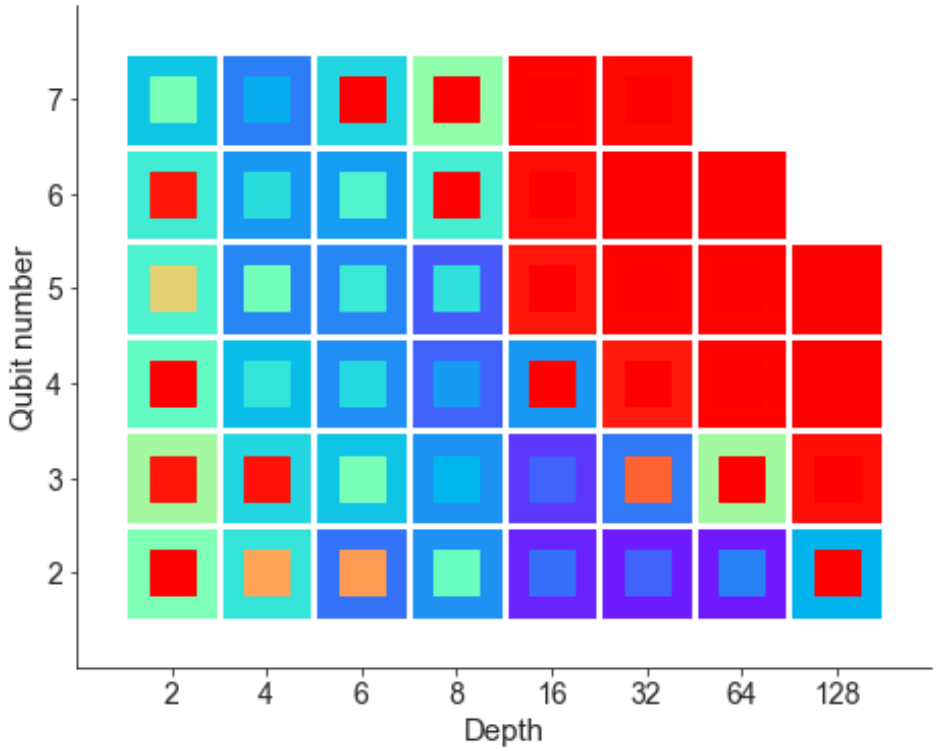


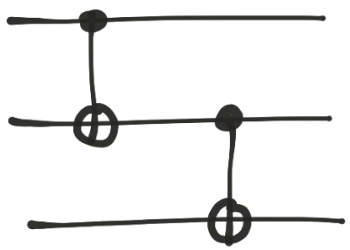
Error Mitigation

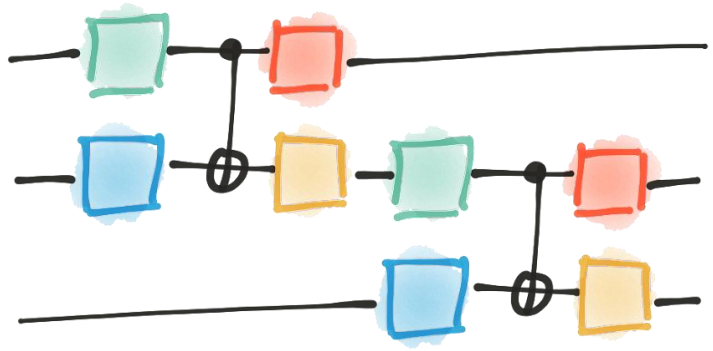


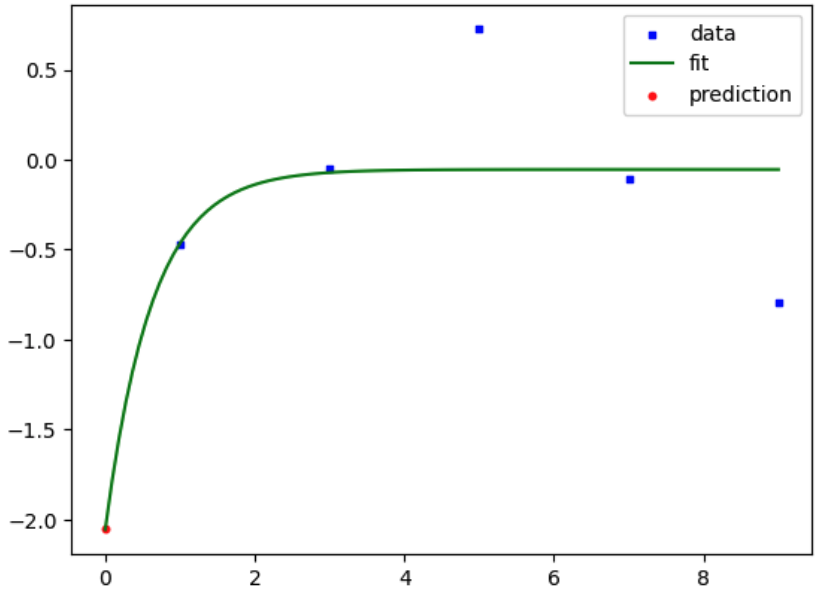


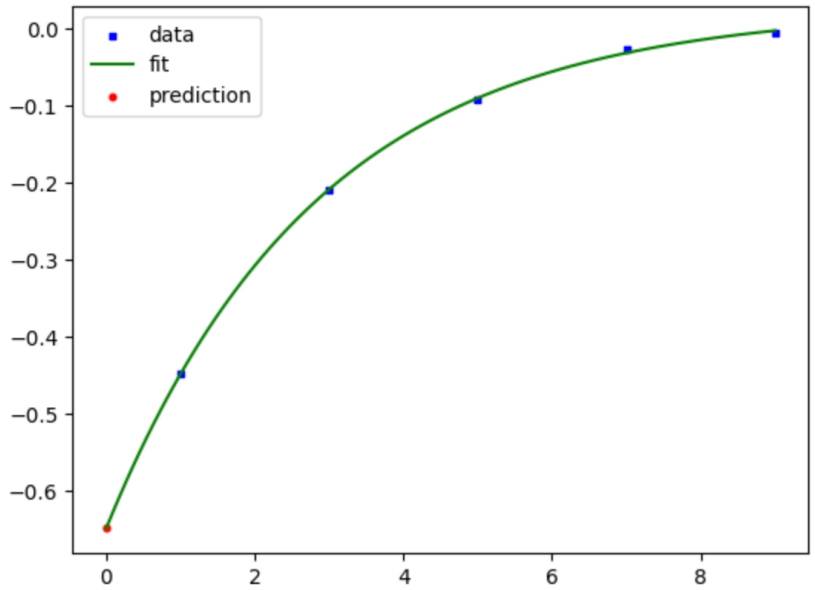




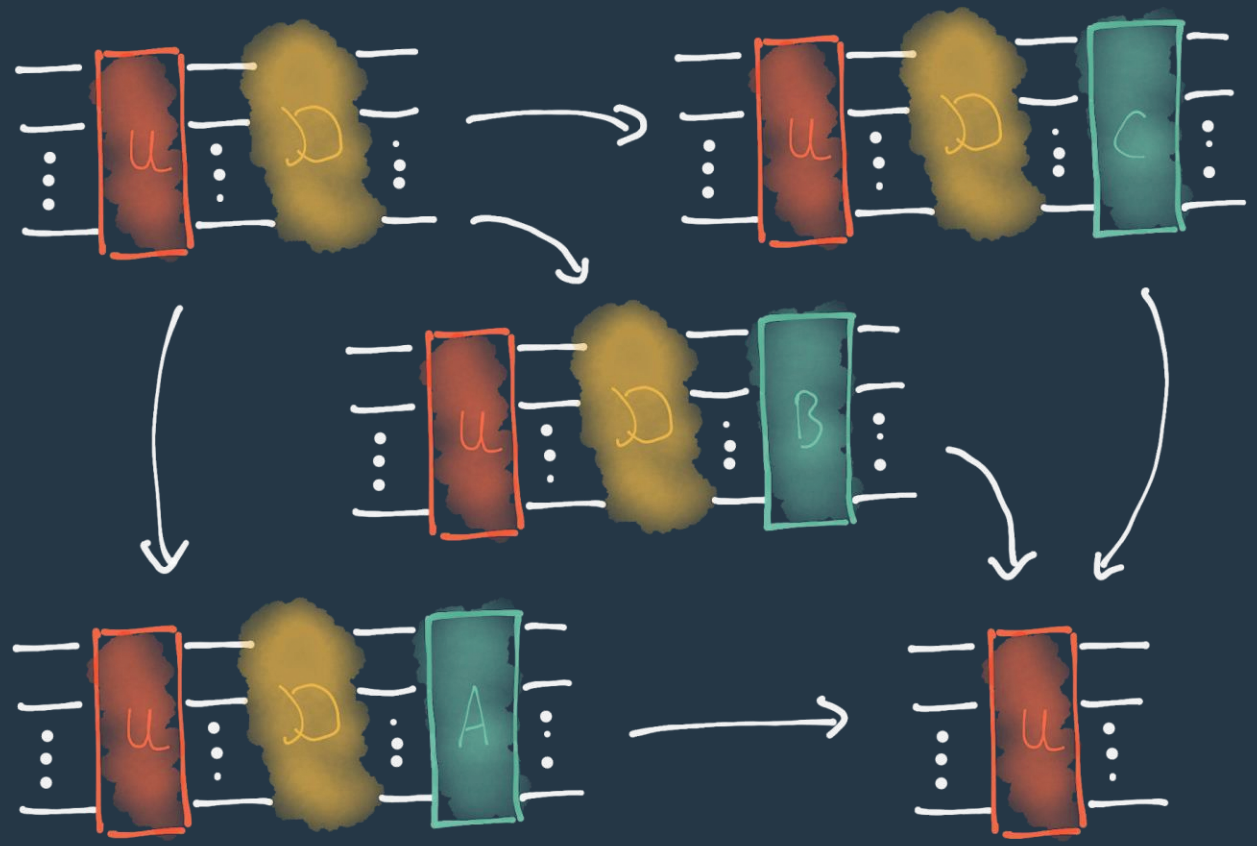








Probabilistic Error Cancelation



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