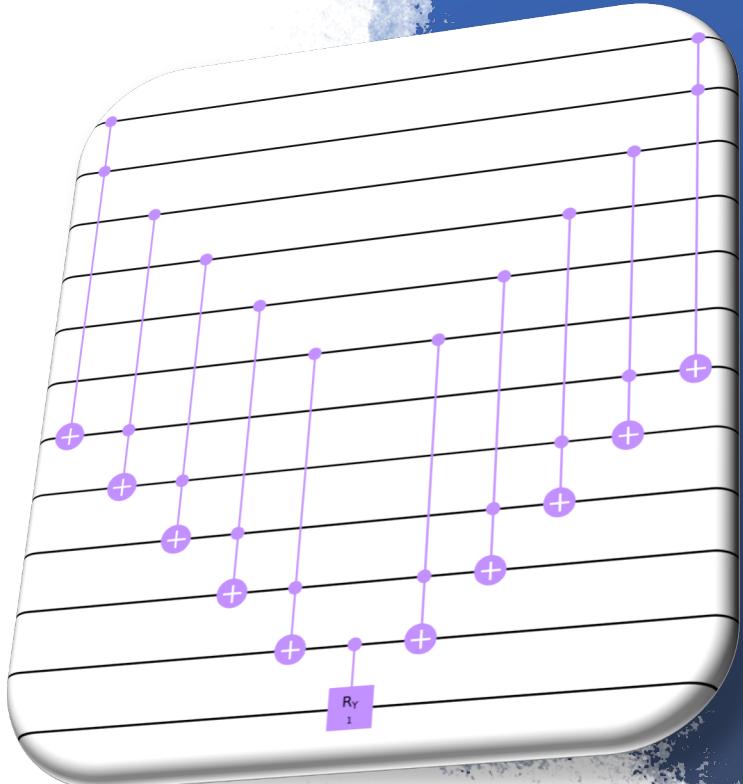


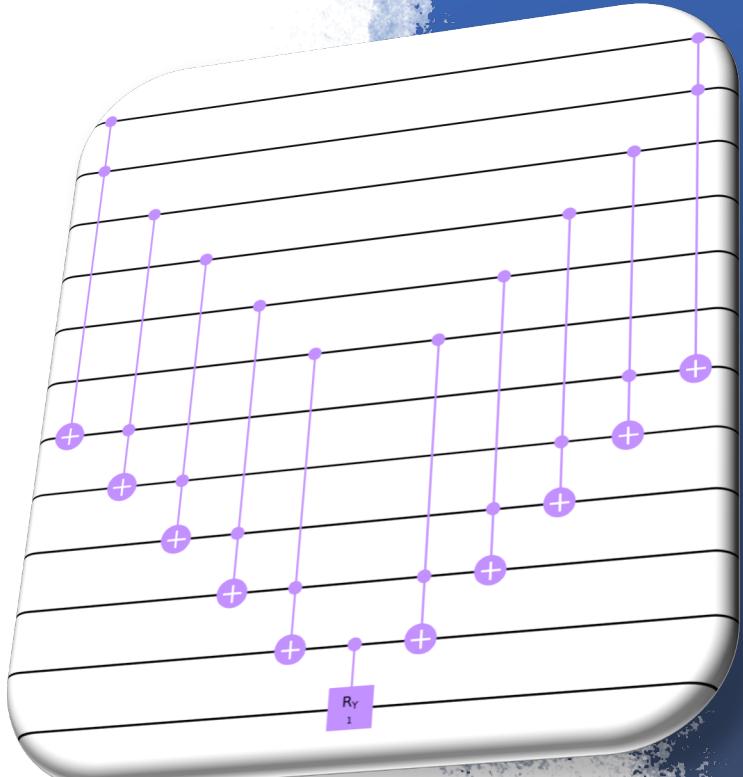
# Byskit

*Bayesian Qiskit*



# Byskit

*Bayesian Qiskit*

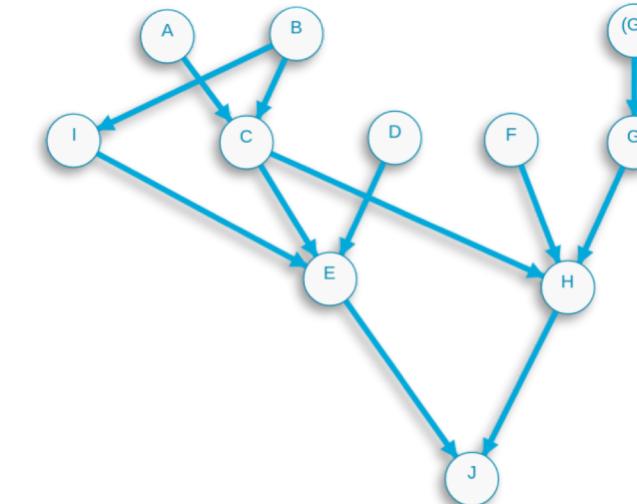
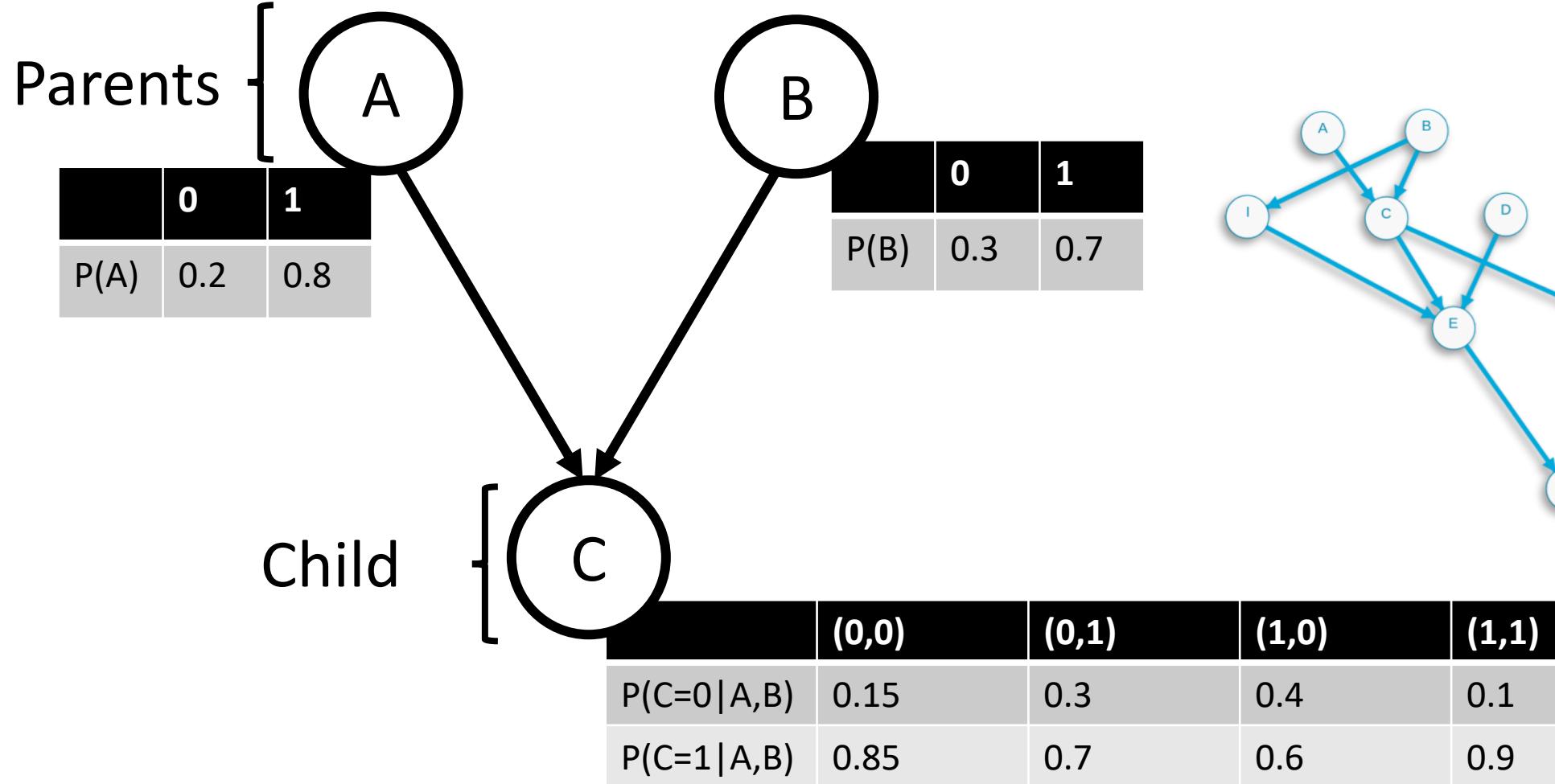


**Byskit** automatically :

**... compiles a classical discrete Bayesian network into a quantum circuit representation.**

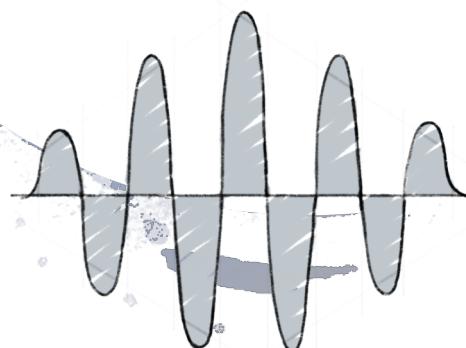
*Previously these circuits have been constructed manually [1]*

# Classical Bayesian Network



# Quantum Advantage to Bayesian Networks

Quantum computing applications which exploit **amplitude amplification** protocols have been shown to yield significant computational benefits compared to their classical analogs. [2, 3]



**Byskit** automatically :

**... compiles a classical discrete Bayesian network into a quantum circuit representation.**

*Previously these circuits have been constructed manually [1]*

[1] **Quantum circuit representation of Bayesian networks**, Sima E. Borujenia, *et al.*, [arXiv:2004.14803](https://arxiv.org/abs/2004.14803) .

[2] **Quantum inference on bayesian networks**. Low, G. H., Yoder, T. J., & Chuang, I. L. (2014). Physical Review A, 89 , 062315.

[3] **Quantum amplitude amplification and estimation**.Brassard, G., Hoyer, P., Mosca, M., & Tapp, A. (2002). Contemporary Mathematics, 305 , 53–74.

# Quantum Implementation

Quantum circuit representation of Bayesian networks, Sima E. Borujenia, et al.

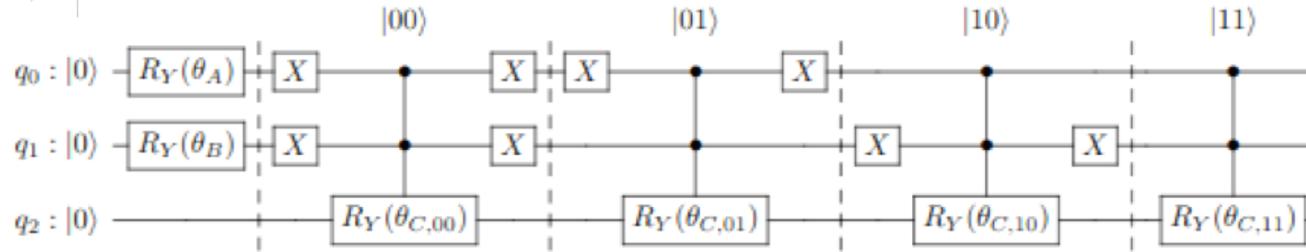
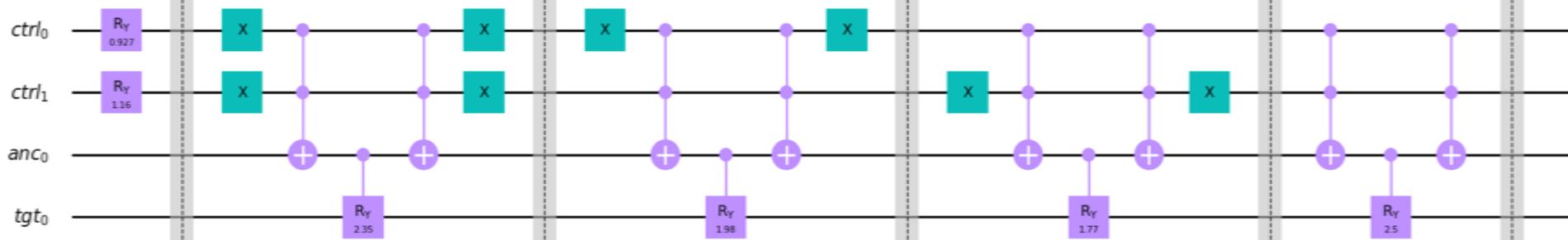
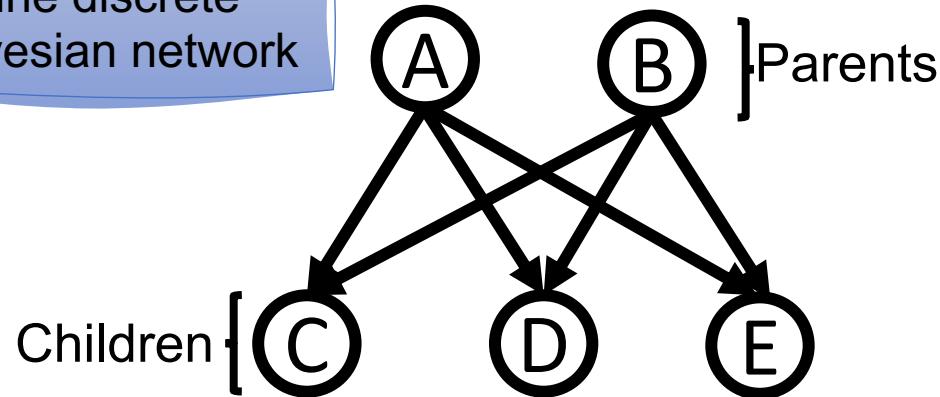


Figure 5: Conceptual quantum circuit for the 3-node Bayesian network

Successful reproduction



Define discrete Bayesian network

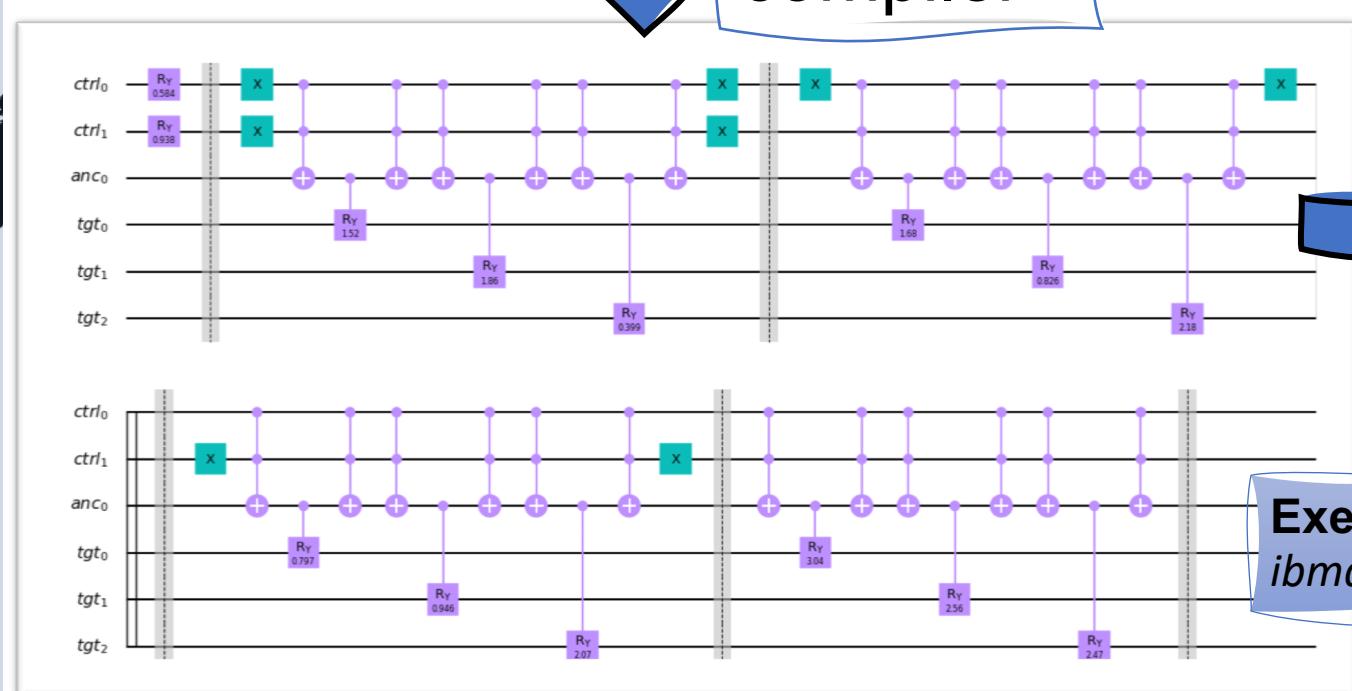


Compute probability of each state  $P(|q_n \dots q_0\rangle) = \frac{n_{|q_n \dots q_0\rangle}}{N}$

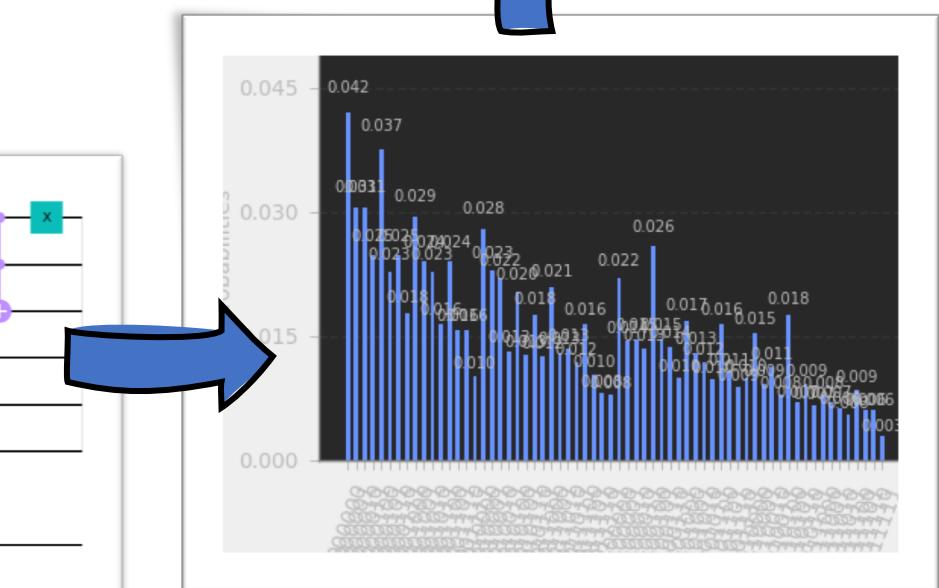
Compute marginal probabilities

$$P(|q_i\rangle) = \sum_{q_j, j=n, \dots, 0, j \neq i} P(|q_n \dots, q_{i+1}, q_{i-1}, \dots, q_0\rangle)$$

Byskit compiler

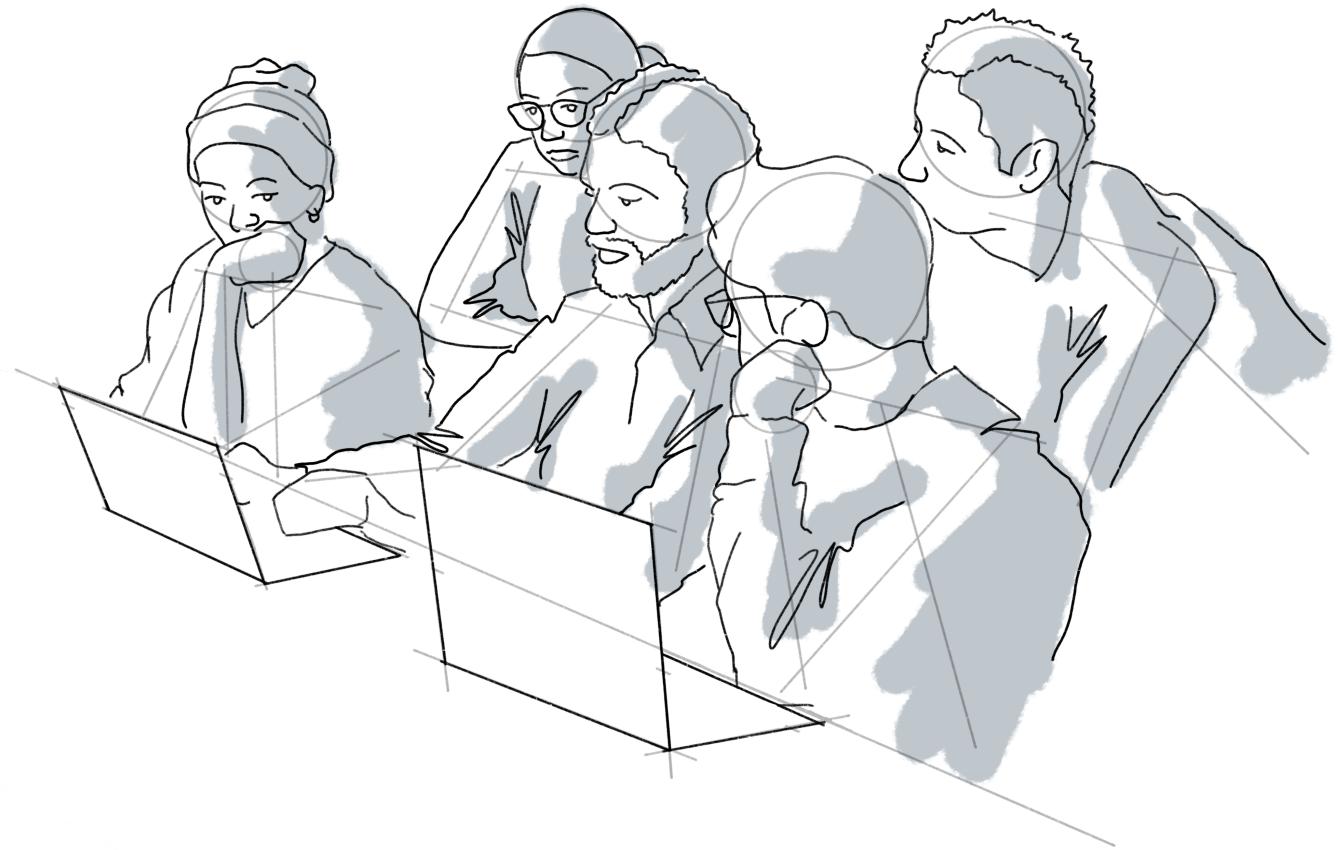


Execute on  
ibmq\_16\_melbourne



Drug design  
Diagnostics  
Decision automation

**Use cases ...**



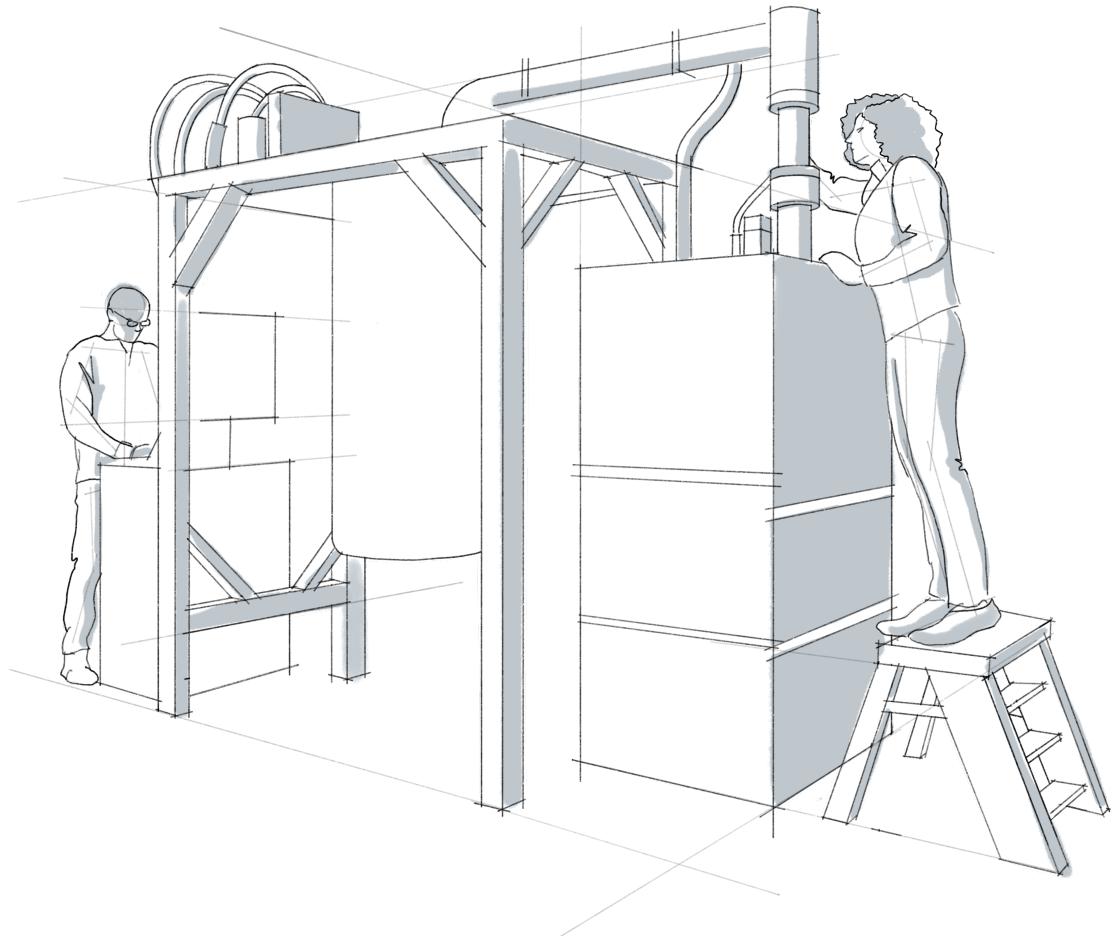
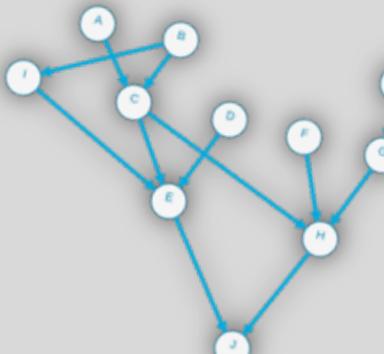
# Looking Forward ...

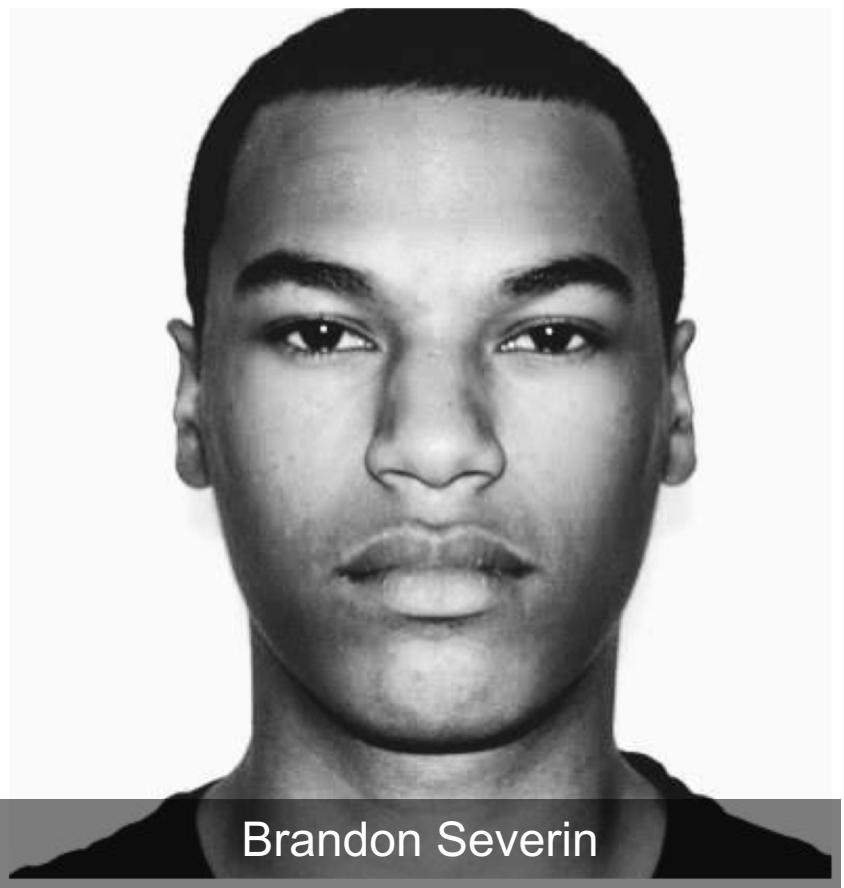
Include the ability to handle

... more generations.

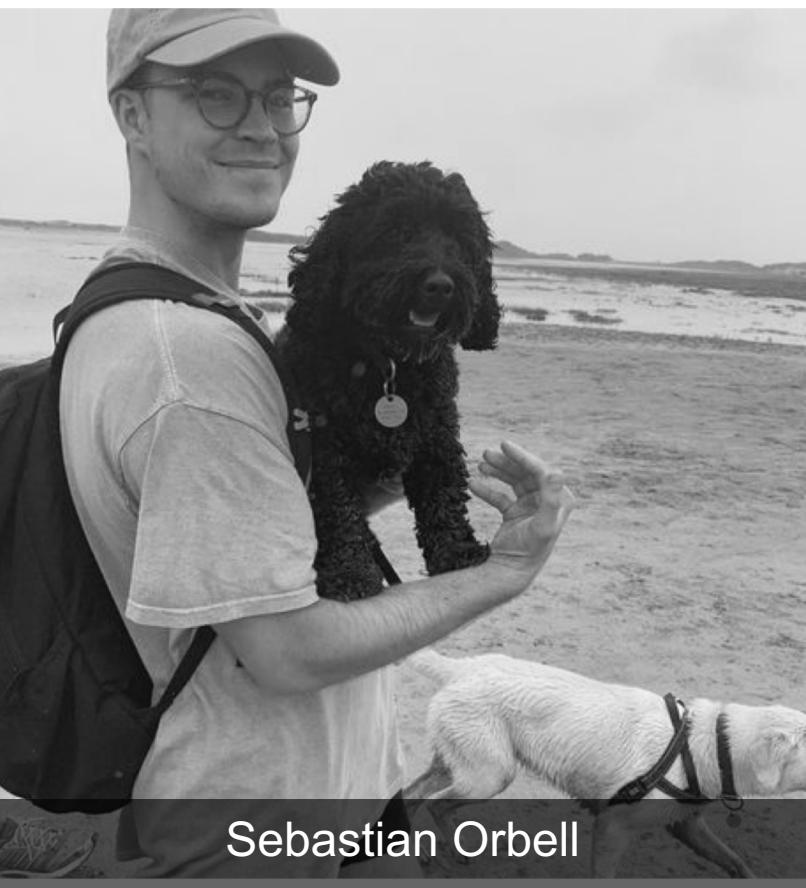
... arbitrary connectivity.

... more than two discrete states by  
mapping each node to multiple qubit.

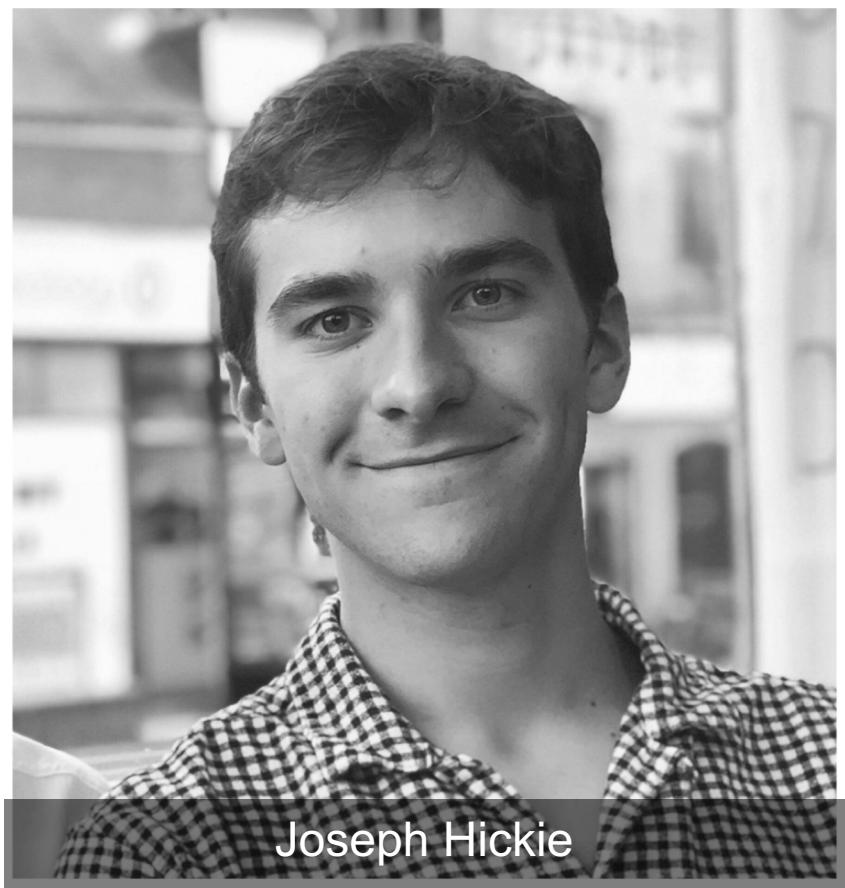




Brandon Severin



Sebastian Orbell



Joseph Hickie

## The Team



OxfordMaterials

[SOURCE CODE](#)