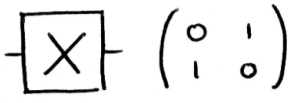
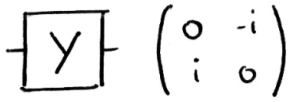
Quantum Gates

Single Qubit Gates

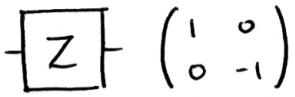
X-gate



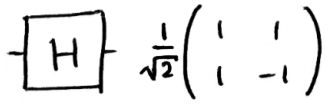
Y-gate



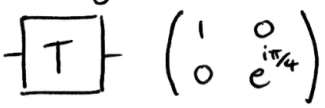
Z-gate



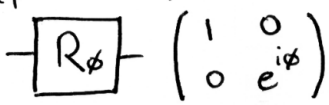
H-gate
(AKA Hadamard Gate)



T-gate
($\sqrt[4]{Z}$-gate)



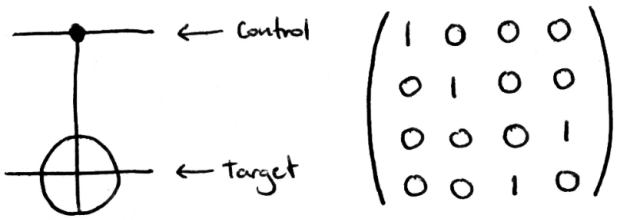
R_ϕ-gate
(phase shift)



Two Qubit Gates

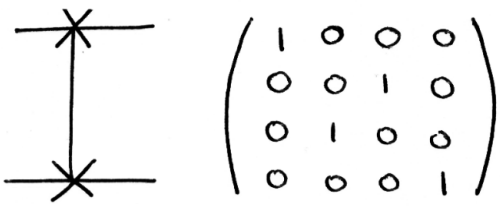
CNOT-gate

Flips the target bit if the control bit is |1>

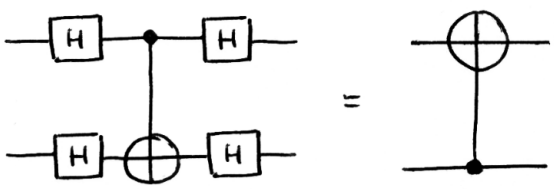


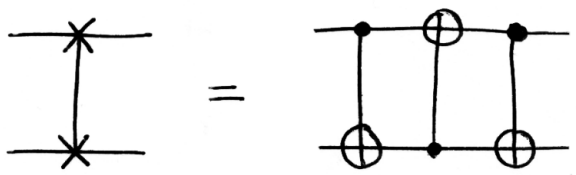
SWAP-gate

Swaps the states of the two qubits
(useful in actual machines)

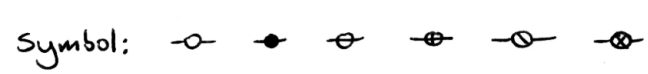


Circuit Identities





Controls

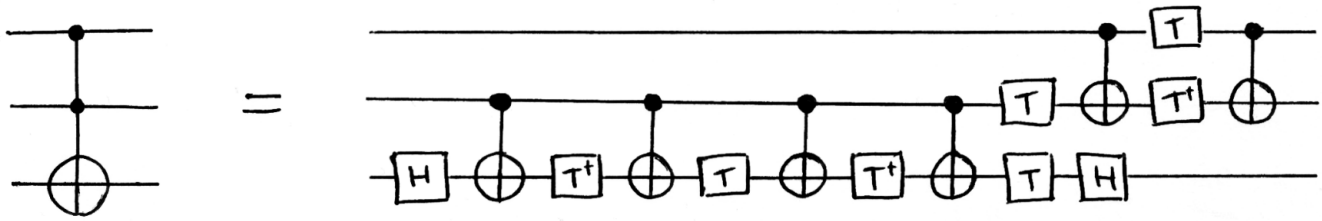


Frank Harkins https://cnot.io

Quantum Gates

Larger Gates

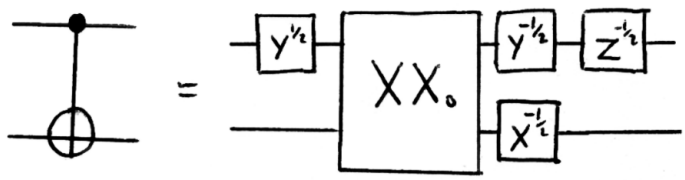
Toffoli Gate



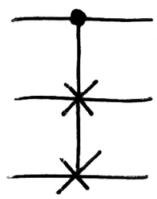
(Toffoli composed from H, T, T† & CNOT gates - [Shende & Markov 2008])

Ising Gate

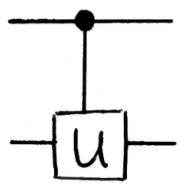
$$XX_\phi = \begin{pmatrix} 1 & 0 & 0 & -ie^{i\phi} \\ 0 & 1 & -i & 0 \\ 0 & -i & 1 & 0 \\ -ie^{i\phi} & 0 & 0 & 1 \end{pmatrix}$$



Fredkin Gate (CSWAP)



Controlled - U



$$= \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & u_{00} & u_{01} \\ 0 & 0 & u_{10} & u_{11} \end{pmatrix}$$

References / Good Resources

A. Barenco, C. H. Bennett, R. Cleve, D. P. DiVincenzo, N. Margolus, P. Shor

T. Sleator, J. Smolin, H. Weinfurter - Elementary Gates for Quantum Computation (1995)

V. V. Shende, I. L. Markov - On the CNOT cost of the Toffoli Gate (2008)