Required Math Concepts

Before we begin to study quantum computing, an understanding of the following math concepts will be needed:

- From linear algebra
  1. What is a vector?
  2. Column vectors and row vectors
  3. Vector multiplication, the Inner Product
  4. The absolute value, norm, or modulus. If $v = (a \;\; b)$ then $|v| = \sqrt{v \cdot v} = \sqrt{a^2 + b^2}$
  5. Normalization
  6. What is a Basis? Basis vectors. Orthonormality.
  7. What is a matrix?
  8. Matrix multiplication
  9. Multiplying a vector by a matrix. The Operator concept.
  10. The transpose of a matrix, M^T
  11. The inverse of a matrix, M^{-1}
  12. Eigenvalues and Eigenvectors.
- From complex arithmetic
  1. What is a complex number? $z = a + bi$
  2. How to add and multiply
  3. The conjugate, $z^* = a - bi$
  4. The absolute value, norm, or modulus. If $z = a+bi$ then $|z| = \sqrt{(z^*)(z)} = \sqrt{a^2 + b^2}$
  5. Argand diagrams (plotting numbers on the complex plane)
- Complex Vector Spaces (vectors and matrices with complex numbers)
  1. The adjoint of a matrix, $M^\dagger$
  2. What is a "unitary" matrix? $U^\dagger = U^{-1}$
  3. What is a "Hermitian" matrix? $H = H^\dagger$
- Dirac (bra and ket) notation
  1. For example: $\alpha|0\rangle + \beta|1\rangle$ is just the vector: $\begin{pmatrix} \alpha \\ \beta \end{pmatrix}$