## Bits and Qubits

- **bit:** unit of information describing a two-dimensional classical system
- many realisations of a bit:
  - voltage level within a circuit
  - switch turned on/off
  - way to denote true/false
- a bit describes a system whose set of states has size 2: $\{0, 1\}, \{\top, \bot\}$
- let's represent each state a bit can taking using a vector:

$$|0\rangle = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, |1\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix},$$

- note these are orthonormal
- **quantum bit/qubit:** unit of information describing a two-dimensional quantum system
- represent a qubit as a vector with complex entries:

$$\begin{bmatrix} c_0 \\ c_1 \end{bmatrix}, |c_0|^2 + |c_1|^2 = 1$$

- a classical bit is a special case of a qubit
- $|c_0|^2$: probability that, after measuring the qubit, it will be found in state $|0\rangle$
- whenever a qubit is measured, it automatically becomes a bit: you never see a general qubit
- qubit collapse

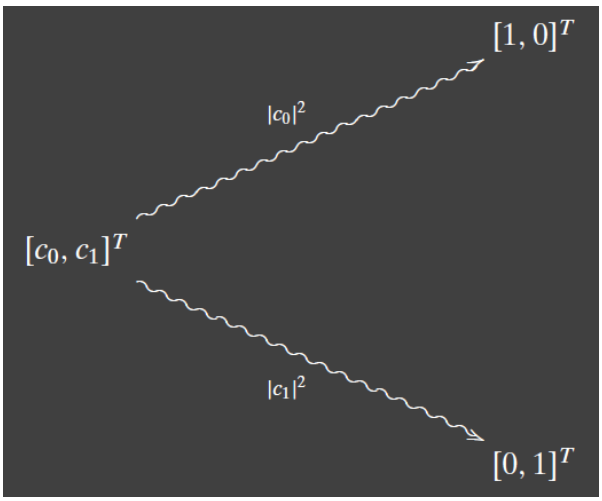


**Figure 1:** Qubit Collapse

- the canonical basis of $\mathbb{C}^2$ is just $\{|0\rangle, |1\rangle\}$ ## Classical Gates

### Reversible Gates

### Quantum Gates