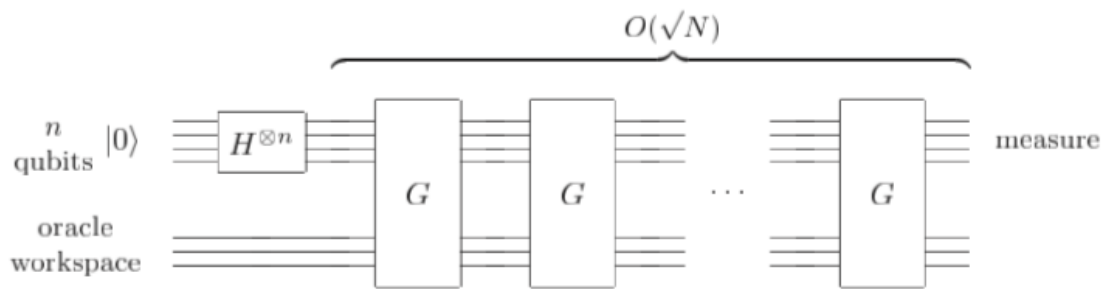


## Grover's Search Algorithm

One of the quantum algorithms that takes advantage of the probabilistic nature of quantum mechanics is Grover's Search Algorithm. This algorithm implements the searching of an unordered database in  $O(\sqrt{N})$  operations, where  $N$  is the number of elements in the database. The classical algorithm that implements searching of this



nature requires  $O(N/2)$  attempts.

### Example:

In an unstructured database, with  $N = 4$  elements, we can consider each element to be a state of an  $n=2$  qubit system. Suppose we are searching for  $|x_0\rangle = |11\rangle = |3\rangle$ .

**Step 1:** First we calculate the number of iterations needed:

$$\text{number of iterations} = \frac{\pi\sqrt{N}}{2} = \frac{\pi}{2} \approx 1.57 \approx 1 \text{ iteration}$$

**Step 2:** initialise the state of the 2 qubit system

**Step 3:** Apply a Hadamard transformation to both the qubits:

**Step 4:** Apply the oracle  $O$  to the state of the system

**Step 5:** Now we can apply the diffusion transform: