

## Lab 2 Basics of quantum computer simulation.

- we will be using [a quantum simulator](#) by Joanna Patrzyk and Bartłomiej Patrzyk
- NOTE: Please install simulator directly from zip
- [Issue tracker](#)

### Exercise 1 : Playing with the QUIDE - simple example

1. Open the [example1.cs](#) file showing how to create a single register and how to use the Hadamard (H) gate in the simulator. The code of the algorithm should appear in the top left part of the window
2. Generate visual quantum circuit from the code using "Build Circuit" button. The circuit should appear in the bottom left part of the window
3. Execute circuit step by step by pushing right arrow button "step forward".
4. The output will be shown in the output window in the top right part of the window .
5. Run the file by pushing "Run in a console" button. Instead of the quantum circuit you'll get console output.
6. Check the simulator results with mathematical calculations.

### Exercise 2:

Add a second q-bit to a circuit and apply the H gate to it. Observe the changes in the probability panel. Check the simulator results with mathematical calculations.

### Exercise 3

Check in the simulator the operations of the X, Y, Z, SQRT(X). Check the simulator results with mathematical calculations.

### Exercise 4

Check in the simulator that  $\text{SQRT}(X) * \text{SQRT}(X) = X$

### Exercise 5

CNOT(i,j) gate is the 2-qbit controlled-NOT gate that has a control bit (i) and a target bit (j). CNOT gate is defined to act as the identity if a control bit is 0 and as NOT on a target bit if a control bit is 1.

Check in the simulator the operation of CNOT. Observe the behaviour of the control and target bits. How to find the matrix representation for CNOT ?

### Exercise 6

Construct the SWAP gate from the CNOT gates  $S(i,j)=\text{CNOT}(i,j)\text{C}(j,i)\text{C}(i,j)$

### Exercise 7

Tofoli gate is the 3-qbit controlled-controlled-NOT gate T(i,j,k) that has two control bits (i and j) and a target bit (k). Toffoli gate is defined to act as the identity for control bits in states 00,01 or 10 and as NOT on a target bit if a control bits are in a state 11.

Build and test Toffoli's gate in the simulator. How to find the matrix representation for Toffoli?

**Exercise 8**

Register and login to IBM quantum experience

<https://quantumexperience.ng.bluemix.net/gx/editor>

Try gates you already know.