

# IBMQ App

## A testing framework for real quantum computing usage

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### Abstract

**G**enerally the learning process follow some specific and pedagogic steps. Sometimes we need to be caputered by a new technology to gather its power and if we are able to give the reader a visual and intuitive explanation of difficult concept we can make the difference. The growing importance of quantum computing can be exploited where the backend engine is not working with bits but with their quantum version. In this paper we describe a three Tier web application deployed on IBM Cloud. We propose visual representation for explaining single qubit gate effect and the quantum version of the so called Hello World code. This web APP is thought as an alternative to jupyter notebooks approach and can be easily shared (public URL and login).

### I. ALGORITHM DESCRIPTION

#### i. Generalized quantum emoticon

Anything that can be done with bits can be done with qubits. Simply leave a qubit in its initialized value for the state 0, or use an operation with the effect of a NOT gate (such as X or Y) to rotate it to a 1. Each qubit then becomes a bit, allowing us to implement Hello, World! directly on a quantum computer.

In practice, it is not so straightforward. ASCII encoding of Hello, World! requires over 100 bits, and therefore over 100 qubits. Current quantum devices are not yet large enough for the job.

In this application we propose a generalization of what is presented on IBMQ Experience tutorial (Quantum Emoticon where the reader can test how the two main principles of quantum computing are exploited: the superposition and the entanglement. Here the reader can use every combination of ASCII character and visualize their realization with qubits,

either simulated or real according to what is available on IBMQ Experience.

For more information about how to use the IBM Q ExperienceQX, consult the tutorials, or check out the community.

#### ii. Bloch Sphere's representation

This APP feature make use of well known math representation of vector in 3 dimension which is widely used in this quantum computing dissemination as it is a clear and usefull tool: the Bloch Sphere. The user can visualize the effect of quatum gate application on its qubit (versor). Since we are working with orthonormal basis we give the user the freedom to star from different basis: X-basis, Y-basis or Z-basis. Current version of the application does not allow subsequent gate application so the user must reset its result before applying a new transformation. The user can perform measurement of the quantum state on all the three basis (x,y,z) in order to reconstruct

the quantum state on the Bloch Sphere. In order to make this algorithm fully visual we utilized the python library qutip that allows to perform analytical calculation and build the block sphere.

The interesting feature is that the result of gate application is showed on two separate Bloch Spheres. In the left one the user is presented the result coming from IBMQ Experience while on the right one we present the analytic result. This comparison can help to understand some typical quantum defects coming from real hardware noise or approximation.

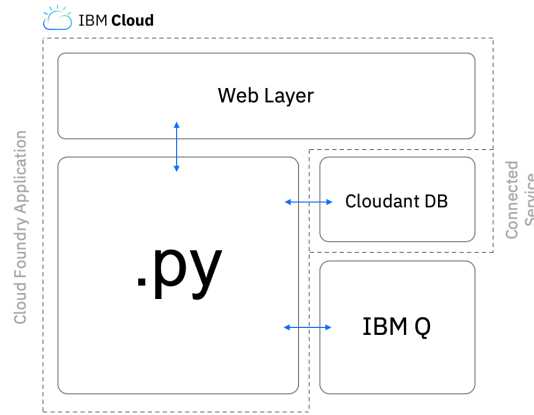
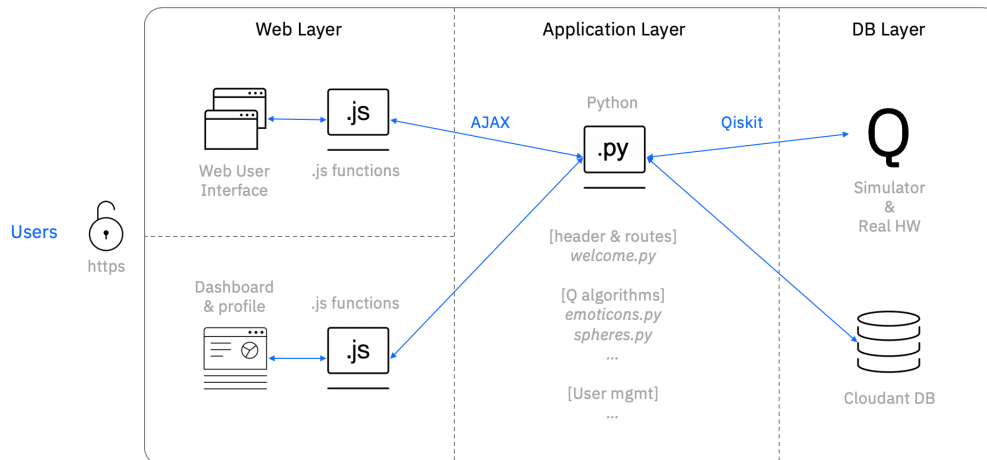
This algorithm it's defined inside the ibmq quantum experience User guide, it consist to We decided to offer two different perspectives giving two bloch-spheres, one to show the QST performance and another one to show the analytical calculation, in order to give evidence of the errors coming from decoherence/noise generated from the real device or from the configured noise-simulator.

Spheres

Quantum Tomography

## II. ARCHITECTURE REPRESENTATION

In this section we describe the overall application architecture.



## III. CONCLUSIONS

We are happy.

## REFERENCES

- [1] Hand, D. J. (n.d.), *Measuring classifier performance: A coherent alternative to the area under the ROC curve.*