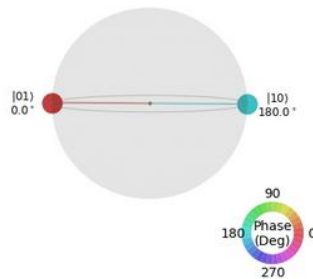# On problem II.ii) of the Qiskit Primer of the Fall Fest

Problem

II.ii) Construct the Bell state $|\Psi^-\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle)$.

Solution

If I read the literature, I see that the Bell state under consideration is written as

$$|\psi^-\rangle = \frac{1}{\sqrt{2}}\left(|0\rangle_A |1\rangle_B - |1\rangle_A |0\rangle_B\right)$$

You see this for instance on page:
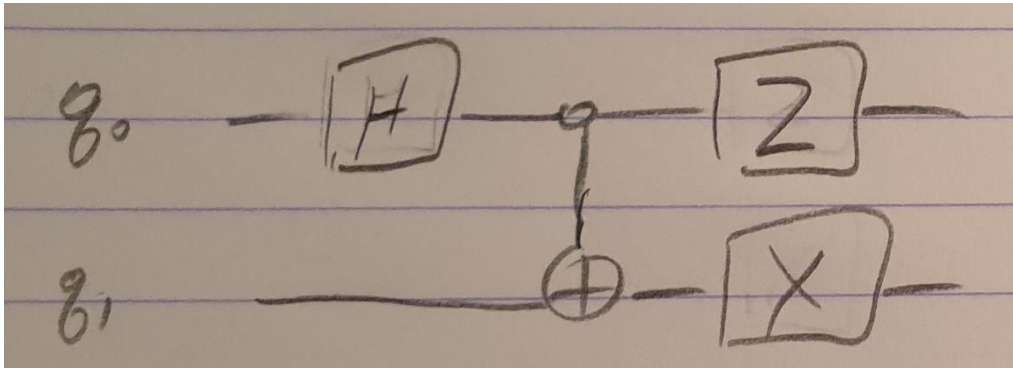
https://www.quantiki.org/wiki/bell-state

and on page

https://quantumcomputing.stackexchange.com/questions/2258/how-to-implement-the-4-bell-states-on-the-ibm-q-composer

This gives me the idea that qubit A corresponds to qubit 0 and qubit B corresponds to qubit 1. Thus the qubits are written from left to right.

In the Qiskit formalism, where you write the qubits from right to left, this would correspond to state:

$$|\psi^-\rangle = \frac{1}{\sqrt{2}}\left(|10\rangle - |01\rangle\right)$$

There are several circuits which lead to this state, one of them being:

This is also the circuit proposed by user1271772 to construct the Bell state on page
https://quantumcomputing.stackexchange.com/questions/2258/how-to-implement-the-4-bell-states-on-the-ibm-q-composer

The Qiskit code corresponding to this circuit is:

```python
def create_circuit():
    qc = QuantumCircuit(2)
    qc.h(0)
    qc.cx(0,1)
    qc.x(1)
    qc.z(0)
    return qc
qc = create_circuit()
sv = Statevector.from_label('00')
sv = sv.evolve(qc)
print(sv)
plot_state_qsphere(sv.data, show_state_labels=True, show_state_phases=True)
```

The state vector is

```
Statevector([ 0.        +0.j, -0.70710678+0.j,  0.70710678+0.j,
              0.        +0.j],
            dims=(2, 2))
```

The plot of the state vector is:
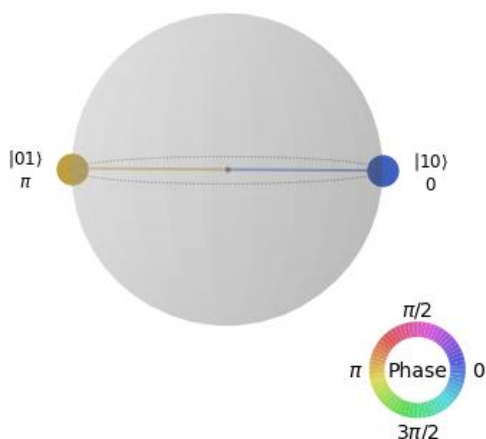
I get the same results if I code the circuit on the IBM Composer.

One of the arguments for my solution being correct is that it is the same solution as the one presented on page
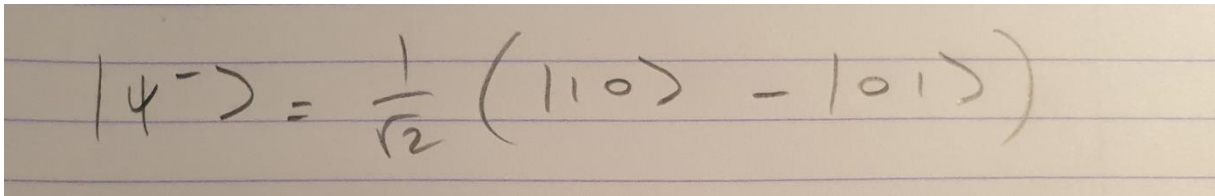
Conclusion

If my solution is correct, then the description of the problem in the Qiskit Primer Fall fest is misleading, and the plot shown is incorrect.

Fix of the description of the problem

The order of the qubits should be changed in the problem. The Bell state should be presented as:

$$|\psi^-\rangle = \frac{1}{\sqrt{2}}\left(|10\rangle - |01\rangle\right)$$

The plot shown in the problem should be modified to be: