🚀 **CHALLENGE COMPLETED** View successful submissions

Jump to code — Collapse text

A Halfway-Decent Photocopier 400 points

Backstory

Trine is getting bored. "*So, we've finished the usual Laws of Infodynamics. Let's make things more interesting!*" She shows Zenda and Reece to the office photocopier. "*I figured out a way to turn this into a quantum resource! Pretty cool huh?*" Zenda and Reece look at each other, puzzled as ever by Trine's unconventional ideas about office equipment. Trine pats the photocopier. "*Yup, this old thang can photocopy a basis state. You can use it to make Bell pairs! In fact, we can introduce the photocopier into our superdense and teleportation protocols in such a way that it turns infodynamic inequalities into equalities. We'll find that a photocopier is halfway between a qubit and an entangled bit! I always said this was a halfway-decent photocopier.*" Zenda and Reece shrug and start feeding qubits into the machine.

Coherent protocols

Zenda and Reece are having a bit too much fun feeding qubits into the photocopy machine. It's not very good at photocopying qubits, but it can copy basis states into new registers in the following way

$$|j\rangle \mapsto |j\rangle|j\rangle,$$

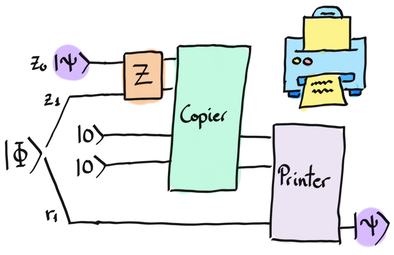
and extending linearly to the whole space. From linearity, you can prove yourself that the operator the photocopy machine is applying does not allow for copying arbitrary states!

Zenda ponders the meaning of Trine's words. She wonders if she can use the photocopy machine as a quantum fax machine instead. *That should be equivalent to quantum teleportation... except that I wouldn't need to do mid-circuit measurements.* She convinces Reece to join on the mischief, sharing with him half of the Bell state

$$|\Phi\rangle = \frac{1}{\sqrt{2}}(|0\rangle_{Z_1}|0\rangle_{R_1} + |1\rangle_{Z_1}|1\rangle_{R_1}).$$

Let's see how Zenda and Reece get away with this. Zenda has a state $|\psi\rangle$ that she wants to transfer to Reece, and half of the Bell pair above. After doing some operations Z on her two qubits, she can perform the `copier` operation that copies basis states into two registers inside the copy machine's server. That information is then transfered to Reece's printer where, after performing the `print` operation with his states, he prints the state $|\psi\rangle$ into his half of the entangled pair.

Zenda shows Reece the schematics for the above:



Your task is to build the operator Z that Zenda must perform on her qubit, as well as the copier and printer operators needed to teleport the state. For the copier operator, the simplest way is to use the basis copying operator introduced at the beginning:

$$|j\rangle|0\rangle \mapsto |j\rangle|j\rangle,$$

Which well-known gate achieves this?

▸ **Laws of Infodyamics Part IV: Coherent versions of the Third and Fourth Laws**

Challenge code

In this challenge, you will be asked to complete the `zenda_operator`, `copier` and `printer` functions. All of them are quantum functions where you will only have to place the necessary gates.

Inputs

The inputs of this challenge correspond to the three coefficients of a $U3$ gate in charge of encoding the state $|\Phi\rangle$ that Zenda wants to send.

Outputs

To check the solution, we will calculate the expected value with respect to a particular observable to see that it coincides with the same one generated by Zenda. If your solution matches the correct one within the given tolerance specified in `check` (in this case it's a `1e-2` absolute error tolerance), the output will be `"Correct!"` Otherwise, you will receive a `"Wrong answer"` prompt.