

Qoffee Maker

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What is the Qoffee Maker?

Qoffee Maker consists of several parts like a RasQberry (including a Raspberry Pi), a coffee machine, and a touch screen. It is based on quantum computing and will produce a coffee, cappuccino, etc. based on the measurement result of a quantum circuit. Getting your favorite type of beverage implies creating a quantum circuit whose measurement result is the appropriate representing binary number. Qoffee Maker can be used for events to give outsiders an insight into the comprehensive field of quantum computing. Moreover, they can collect their first quantum experiences by creating their quantum circuit.

Explanation

You can build your own quantum circuit by dragging & dropping various quantum gates onto the qubits (ordered q2, q1, q0, and each is initialized with 0). As a result, the properties (state) of the qubits are changed and the diagram below shows the resulting measurement probabilities of the binary numbers. Each number is mapped to a certain beverage (see table below) and there are eight beverages in total. To get your favorite drink, you have to first click on "Determine your beverage" and then on "Order drink".

Besides the theoretical mode, you can execute the quantum circuit on real quantum hardware or simulators.

Drag & Drop Quantum Gates onto the Qubits to build your circuit. [Go back.](#)

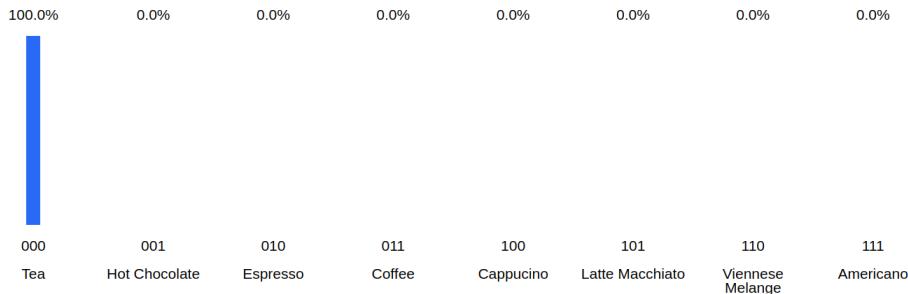

① ⋮ ⌂

q₀ —
 q₁ —
 q₂ —
 + —
 c₃ —

Measurement Probabilities

[Determine your beverage](#)

[Theoretical](#) [Simulator \(error free\)](#) [Simulator \(real quantum device\)](#) [Export to IBM Quantum Composer](#)



[Fullscreen](#) [Refresh Auth](#) [Restart](#)

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Let's practice your skill of building quantum circuits by solving these exercises:

1. I want a cappuccino.
2. No caffeine, please.
3. I want tea or coffee.
4. I want something to drink, it doesn't matter what.
5. I want something with caffeine, but not too strong.
6. I want an Espresso using single-qubit gates only on q0.
7. I want a regular coffee but want to use only one X-gate (plus other gates as needed).
8. I want tea or something strong, but I prefer tea.
9. I want something strong, but preferably an espresso.
10. I want something with caffeine.
11. I want either something without caffeine or something with much caffeine but without milk (CXX gate).
12. I want something to drink, it doesn't matter what, preferably a coffee, but no americano.

To do this, you can use the IBM Quantum Composer which has a quite similar interface compared to the one of the Qoffee Maker: <https://quantum-computing.ibm.com/composer/files/new>

A short introduction can be found here: <https://quantum-computing.ibm.com/composer/docs/iqx>

If you want to learn more about the concepts and circuits in the field of quantum computing, you can follow this link: <https://quantum-computing.ibm.com/composer/docs/iqx/guide>

Setup Guide

List of parts

Devices

- RasQberry (including a Raspberry Pi 4)
- Siemens Coffee Machine
- Touchscreen monitor
- Small keyboard for RasQberry

Cables

- Micro-HDMI HDMI
- USB Type-A USB Type-B
- Power:

- Touch screen: Power cable
- Raspberry Pi 4: Power adapter USB Type-C
- Power outlet strip
- (Extension cable)

All parts are stored in **lockers** in the DCM (**MN09, 2. floor**).

Prerequisites

- Android Phone or iPhone
 - Mobile hotspot (used for the RasQberry and the coffee machine)
- Note:** To avoid any errors your network shouldn't have any proxy.

Setup Instructions

First steps

1. Build up the different parts independently (coffee machine, RasQberry, touch screen) and connect them to a power outlet.
2. Connect the display with the RasQberry by cables (HDMI Micro-HDMI; USB Type-B USB Type-A) and plug in a keyboard in the RasQberry.
3. Power on the coffee machine and the touch screen. The RasQberry is powered on automatically.

Coffee Machine

1. Fill in all consumables: coffee beans (on top of the machine), milk (left), water (right)



- After the startup, you should see a screen like this:



Home Connect

- Install the Home Connect iOS App or Android App.
- In the Home Connect mobile app, you need to sign in with a Home Connect User Account (SingleKey ID).
After starting the app, you need to follow the instructions until you reach the welcome screen which gives you the possibility of logging in.

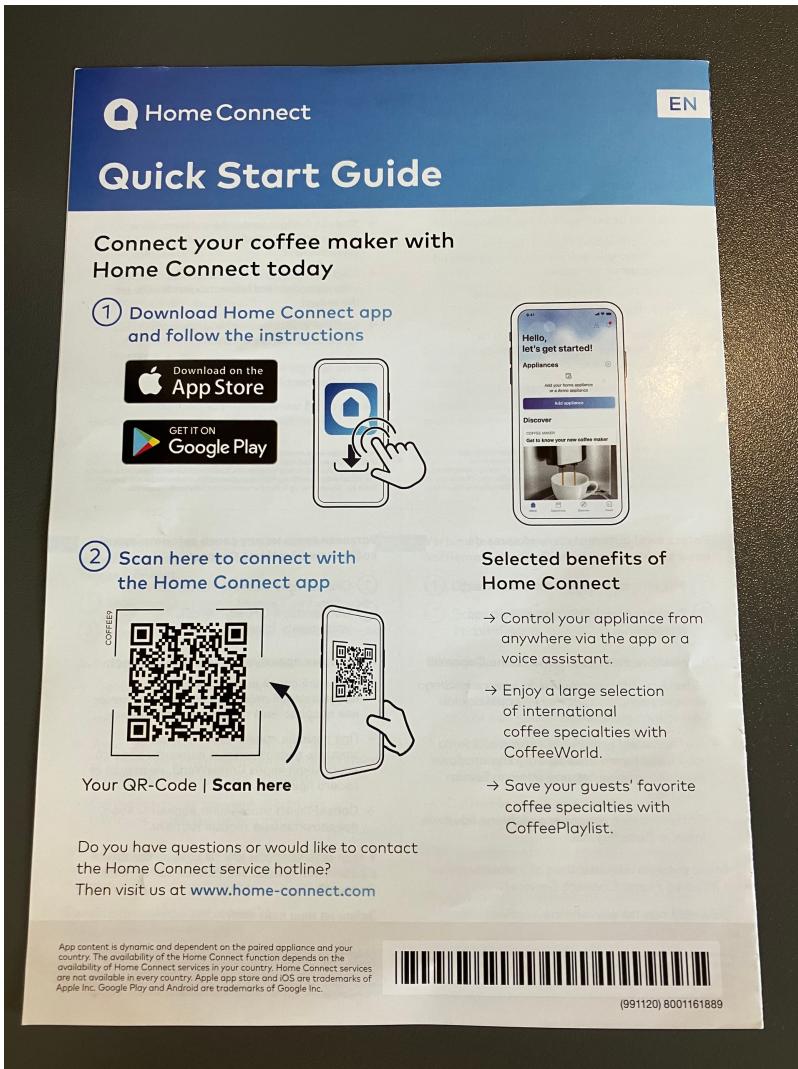
[blocked URL](#)

Use the credentials of the **Emerging Tech Account**:

E-mail: emerginge...@bmwgroup.com

Password: QuantumCoffee2023

- Add your coffee machine to the Home Connect app under "Appliances."
Follow the app instructions (activate GPS and Bluetooth) until all available appliances are shown. If the app doesn't find your coffee machine, you can add your appliance manually by pressing the button.
Now you need to scan the QR code of the coffee machine:



The next step is to connect the coffee machine with Wi-Fi.

Follow the app instructions:

Coffee Machine: Go into your Home Connect settings Put on Wi-Fi "Netzwerk verbinden" (engl.: Connect to network) "Manuell verbinden" (engl. Connect manually)

Mobile Device: Go into your Wi-Fi settings and log in to the temporarily created Wi-Fi network called "HomeConnect" with the password "HomeConnect"

Now go back to the HomeConnect App and enter the SSID and password of your mobile hotspot. If this step was successful, you could select the option "Mit App verbinden" (engl.: Connect to app) in the Home Connect settings of the coffee machine.

4. Check if the coffee machine is connected to the wireless network (Wi-Fi symbol in the top right-hand corner).



5. You also can change the configuration for the different beverages (cup size in ml, amount of coffee vs. milk, etc.) in the settings.

RasQberry

1. Wait until the RasQberry has booted. It is finished if you see multiple desktop icons and an IBM-themed background.
2. Control the RasQberry by using the small keyboard or by using the touch screen.
3. Check for a working network connection. Do this by moving the cursor to the top of the screen. You should see a Wi-Fi symbol otherwise connect the RasQberry to your mobile hotspot.
4. Open the Qoffee Maker application by clicking on the desktop icon called "2 Qoffee Maker (dockerhub)". In the directory `/home/pi/RasQberry/Desktop-Icons` you can find more applications.
5. Wait a few seconds until the Jupyter notebook screen turns up in the browser.
6. Open the `qoffee.ipynb` notebook.
7. Wait a few seconds until a little rocket turns up in the menu bar.

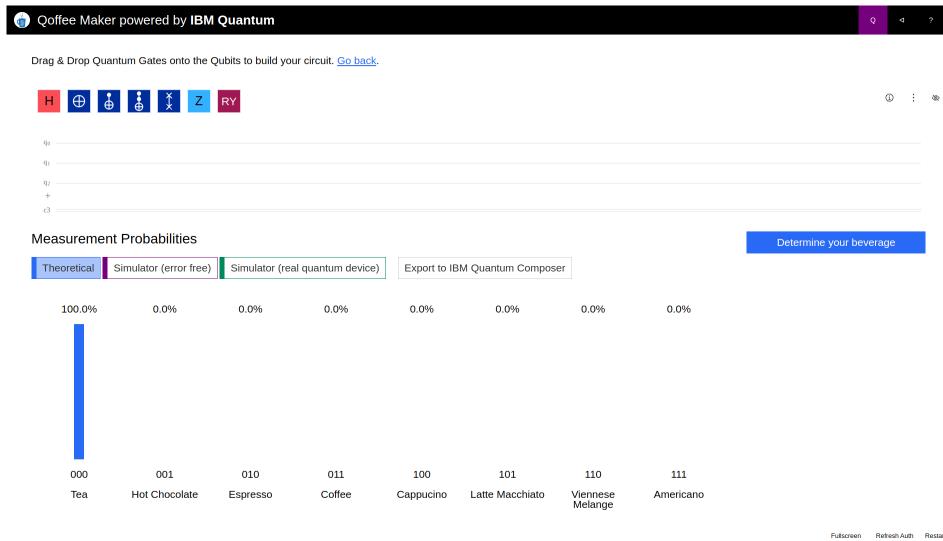
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8. Click on the rocket to open the app mode. The window should now be fullscreen showing the following GUI:

9. Click on the button "Refresh Auth" in the lower right-hand corner. If it turns green, go on with the instructions. Otherwise, you should see a popup saying "127.0.0.1:8887 says Authentication with HomeConnect failed". Click OK and you will be redirected to

a login page in a new tab. Log in with the Emerging Tech Home Connect Account credentials and click on "Approve." You can close the tab now. Try clicking on "Refresh Auth" again, the button should now turn green.

10. Try out the circuit composer, determine your beverage and order it. If everything works fine, there should now be a hot drink in your cup!



Q&A

Usage tips

1. What do I need to consider before and during the usage of the Qoffee Maker?

Before using the Qoffee Maker you need to insert the following line in the Jupyter Notebook to implement tea: ConsumerProducts.CoffeeMaker.Program.Beverage.HotWater

```

In [1]: # gather drink metadata
DRINKS = {
    "000": {
        "id": "000",
        "name": "Tea",
        "key": "ConsumerProducts.CoffeeMaker.Program.Beverage.HotWater",
        "options": 0
    },
    "001": {
        "id": "001",
        "name": "Hot Chocolate",
        "key": "ConsumerProducts.CoffeeMaker.Program.Beverage.MilkFroth",
        "options": 0
    },
    "010": {
        "id": "010",
        "name": "Espresso",
        "key": "ConsumerProducts.CoffeeMaker.Program.Beverage.Espresso",
        "options": {
            "ConsumerProducts.CoffeeMaker.Option.FillQuantity": 50
        }
    },
    "011": {
        "id": "011",
        "name": "Coffee",
        "key": "ConsumerProducts.CoffeeMaker.Program.Beverage.Coffee",
        "options": 0
    },
    "100": {
        "id": "100",
        "name": "Cappuccino",
        "key": "ConsumerProducts.CoffeeMaker.Program.Beverage.Cappuccino",
        "options": 0
    }
}

```

If you want to produce a tee or americano, you need to remove the milk tank otherwise the coffee machine won't produce these beverages. During the usage of the Qoffee Maker you have to refill the milk, water and coffee beans tank and empty the drip pan.

2. Does the RasQberry have built-in LEDs and how do I use them?

Yes, of course. You can start the LEDs by clicking on the desktop icon "RasQ-LED". By using the desktop icon "Clear LED Lights" you can turn them off.

For more information on the LEDs, please have a look at the RasQberry GitHub repository <https://github.com/JanLahmann/RasQberry>.

3. Can I export the quantum circuit to a real quantum computer and how does it work?

Sure, you can export your quantum circuit to a real quantum computer by clicking on the button "Export to quantum computer" in the Qoffee Maker GUI. If you scan the shown QR-Code, you will be redirected to the IBM Quantum Composer. Now you have to log in with an **IBMid** for which you can use the following **credentials**:

E-mail: emergingtech-dev@bmwgroup.com

Password: QuantumCoffee2023

After selecting an IBM quantum computer, you can run your quantum circuit which may take some time.

To make the export to a real quantum computer possible, the IBM Quantum API Key from the IBMId account is stored in an environment file on the RasQberry. It can be accessed here: `/home/pi/Qoffee-Maker/.env`

4. Can I calculate my quantum circuit with a simulator?

Yes, by clicking on "Simulator (error free)" and "Simulator (real quantum device)" you can calculate these models too. Wait a few seconds for them to show up in the graphs below. The colors indicate which model is which.

5. Is the quantum circuit always run-in with an error-free simulator?

Yes, by default the circuit is always run with an error-free simulator. Change this by clicking on the "Q" in the top right-hand corner. It should change its colors between purple (error-free) and green (simulating a real device).

6. Can I use only seven quantum gates to build my own quantum circuit?

No, there are many more. You can show them in the composer by clicking on the crossed-out eye on the right side of the screen.

7. How does the RasQberry communicate with the coffee machine?

The RasQberry communicates with the coffee machine by using the **Home Connect API**. Therefore a **Home Connect Developer account** is needed which can be accessed with the following **credentials**:

Username: QoffeeMaker

E-mail: emergingtech-dev@bmwgroup.com

Password: QuantumCoffee2023

The Qoffee Maker application is registered with the following data in the **Home Connect Developer** account:

QoffeeMaker

Created 2023-05-15 | Last Modified 2023-05-15

Access	Private <small>Private access is limited to a single Home Connect user account as defined.</small>
Home Connect user account for testing	emergingtech-dev@bmwgroup.com Add more > <small>This Home Connect user account has been configured in your profile. You can override it for this application.</small>
OAuth Flow	Authorization Code Grant Flow
Client ID	D4F06523EE55F33C6563E55A73F0EF5335FD5E19AA4D243CD3BDDF4AF768BBB0
Client Secret (required)	9ECF6BA1B186710665A453C3408022BC68920BAF55A709FB3904427050755FD0
Redirect URIs	• http://localhost:8887/auth/callback
One Time Token Mode	Disabled
Proof Key for Code Exchange	Disabled

This information is stored in an environment file on the RasQberry which can be found here: `/home/pi/Qoffee-Maker/.env`

8. How do I turn the RasQberry off and on again?

There is a shutdown symbol in the menu bar at the top of the screen. Moreover, you can also plug the power adapter off and in again.

9. Where can I see the number of beverages the coffee machine has produced?

Go into the coffee machine settings "Getränke-Info" (engl.: Beverage info)

Bug fixing

1. What should I do if I have problems regarding the RasQberry?

The first thing to try is a restart of the RasQberry. To do this, click on the restart symbol in the menu bar at the top of the screen. If the bar is not visible, move your mouse to the top of the screen. The restart will help if you have issues regarding the Jupyter Notebook (e.g. not starting, multiple instances open). If there are any errors in the terminal while starting the Qoffee Maker, check the environment file (`/home/pi/Qoffee-Maker/.env`) and google the error.

2. The coffee machine doesn't make the ordered coffee. How can I fix it?

The machine has to be in selection mode (you can choose beverages etc.) to be ready for remote control. Check if the option "Fernstart" (engl.: Turn on remote control) is activated in the settings of the coffee machine. Moreover, the coffee machine has to be connected to WiFi.

3. The coffee machine has problems with the WiFi (e.g. WiFi symbol is crossed or has an "x" written in the corner). What do I have to do?

First, try to restart the coffee machine. If this didn't help, go into the settings and turn off the WiFi and activate it again. If all of this didn't help, reset, and reconnect the WiFi network. For this, choose option "Netzwerk entfernen" (engl.: remove network). This will delete the network from the machine. To reconnect it again, install the Home Connect app on your smartphone. Open the app, log in (**Emerging Tech Home Connect Account**) and add a new appliance by clicking on the "+" or click "Add a new appliance". Follow the steps on the screen. When you are prompted to scan the QR code, choose to configure it manually. Enter the E-number of the coffee machine which can be found behind the water tank. Enter

the SSID and the Wi-Fi password of your mobile hotspot. After finishing this a reauthentication on the RasQberry may be necessary.

4. I have problems and I don't know what to do.
A restart of the whole setup (RasQberry and coffee machine) may help.

Consumables

Required

- Drinking cups
- Swizzle sticks
- Tea
- Hot chocolate
- Coffee beans
- Milk
- Coffee machine - Cleaning and decalcification tablets

In stock

Due to Innovation Summit there are plenty of consumables left. They are stored in the **lockers** in **MN09, 2. floor**.

Consumable	Original Quantity	Stock left 15.4.24	Expiration date
Drinking cup (0.2 l)	350	~300	--
Swizzle sticks	1000	~900	--
Sugar (4g sugar bags)	1000	~900	--
Tea (tea bags)	310	~300	--
Hot chocolate (900 g)	1	~800g	31.08.2024
Coffee beans (1 kg)	0.5	-	27.04.2024
Coffee machine - Cleaning tablets	1		--

Open points

1. The electrical equipment testing of the RasQberry (Blue sticker!) isn't done yet.
2. RasQberry LEDs: After some time the RasQberry LEDs shut down. Is there a possibility to control the duration of the lightning?
3. Permanent network connection of the RasQberry and the coffee machine: You can't connect the components to a BMW network because of the proxy.

Further information and files

Please follow the **links** below for further information:

- Qoffee Maker website: <https://qoffee-maker.org/>
- Qoffee Maker GitHub: <https://github.com/JanLahmann/Qoffee-Maker>
- RasQberry GitHub: <https://github.com/JanLahmann/RasQberry>

Qoffee Maker **PowerPoint Presentation**:



Qoffee-Maker.pptx

Presentation as **slide show**:



Qoffee-Maker_Slide-Show.pptx

[Qoffee Maker Video](#)

Qoffee Maker **Background image**:



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