

# SYMBOLA

Artificial Intelligence on Raspberry Pi



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## Disclaimer

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The procedures and software described in this guide are subject to change and may not be up-to-date. Users are advised to exercise caution and consider their specific circumstances when following the instructions.

This guide may contain links to external websites. The author is not responsible for the content or accuracy of any external site.

Please use this guide responsibly and at your own risk.

## Contact the Author

If you've spotted an error or simply wish to make contact, feel free to leave a message at:

[symbola.co.uk/contact](https://symbola.co.uk/contact)

Your feedback and inquiries are always welcome!

## Preface

### Introduction to Artificial Intelligence and Large Language Models

Artificial Intelligence (AI) has evolved remarkably over the past few decades, transitioning from simple automated tasks to complex problem-solving capabilities. At the forefront of this evolution are Large Language Models (LLMs), a type of AI that excels in understanding and generating human-like text. LLMs, powered by advanced algorithms and massive datasets, can perform a variety of language-based tasks such as translation, summarization, and even engaging in interactive dialogues. Their versatility and growing accessibility have sparked a revolution in how we interact with technology.

The remarkable aspect of LLMs is their flexibility in deployment. Traditionally, running such sophisticated AI models required substantial computational resources, often relying on powerful cloud-based servers. However, recent advancements have made it possible to run these models locally on much smaller and more affordable hardware. This breakthrough not only enhances privacy and data security but also opens up a plethora of opportunities for hobbyists, developers, and educators to experiment and innovate.

### Introduction to the Raspberry Pi 5 (8GB model)

Enter the Raspberry Pi 5, an emblem of innovation in the world of single-board computers (SBCs). This compact yet powerful device packs an 8GB RAM punch, making it a suitable candidate for hosting locally-run AI models, including LLMs. The Raspberry Pi 5's enhanced processing capabilities, coupled with its affordability and ease of use, make it an ideal platform for AI enthusiasts and professionals alike to explore the realms of AI without needing expensive infrastructure.

This guide specifically focuses on setting up a Large Language Model to run locally on the Raspberry Pi 5 8GB model. By doing so, we aim to bridge the gap between advanced AI technologies and personal computing, providing a hands-on experience in running and interacting with an AI model right from the comfort of your own home or workspace.

### What to Expect from This Guide

In this guide, we will walk you through the step-by-step process of setting up your Raspberry Pi 5 to host a Large Language Model. We will cover everything from the initial setup of the Raspberry Pi hardware to the installation and configuration of the necessary software. Our goal is to provide a comprehensive yet accessible pathway for you to embark on this exciting journey into the world of local AI.

Whether you are a student, a hobbyist, a developer, or just someone curious about AI and technology, this guide is tailored to help you unlock the potential of your Raspberry Pi and dive into the innovative world of local Large Language Models.

## Hardware Requirements for Setting Up Your Raspberry Pi 5

### 1. Raspberry Pi 5 (8GB RAM Version)

This is the most powerful model currently available, recommended due to the nature of LLMs requiring high levels of computing resources. Example suppliers include [pimoroni.com](https://pimoroni.com) or [thepihut.com](https://thepihut.com). These suppliers offer all the parts required, and you may also find starter kits that are quite convenient.

### 2. Power Supply

An appropriate and reliable power supply for the Raspberry Pi 5 is crucial for stable operation. The official power supply for this model is highly recommended. Make sure to purchase the correct version for your country!

### 3. MicroSD Card

A high-speed MicroSD card with a minimum recommended capacity of 64GB is necessary for the operating system and software.

### 4. Keyboard and Mouse

Essential for the initial setup and configuration.

### 5. Monitor/Display

A monitor with an HDMI interface is required for the Raspberry Pi.

### 6. Micro-HDMI to HDMI Cable

This cable is needed to connect the Raspberry Pi to the display.

### 7. Ethernet Cable or Wi-Fi Connectivity

Internet access is crucial for downloading necessary software and updates.

### 8. Cooling Fan

To ensure the best performance, a cooling fan is essential for this model.

### 9. Case for Raspberry Pi (Optional)

A case is recommended to protect the hardware.

### 10. MicroSD Card Reader

Either a built-in or an external USB reader will suffice.

### 11. Access to Another Computer

This is necessary to install the operating system files onto the MicroSD card. This can be a Windows or Mac computer.

## Writing the Operating System to the MicroSD card

### 1. Install Raspberry Pi Imager on Your Computer

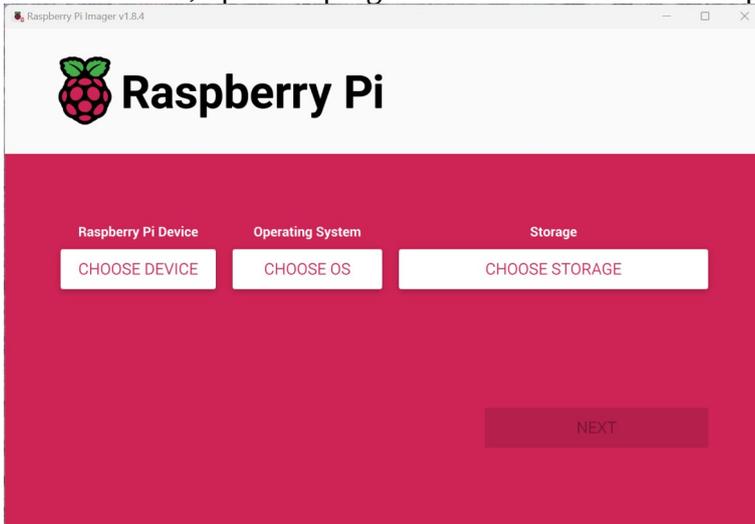
Download it from: [raspberrypi.com/software](https://raspberrypi.com/software).

### 2. Insert the MicroSD Card into the Reader

Place your MicroSD card into the card reader, then connect it to your computer.

### 3. Install and Run the Raspberry Pi Imager

Once installed, open the program. You should see the Raspberry Pi Imager interface.



### 4. Choose Raspberry Pi Device

Select "Raspberry Pi 5."

### 5. Choose Operating System

Select "Raspberry Pi OS (64-BIT)."

### 6. Choose Storage (The MicroSD Card to Write To)

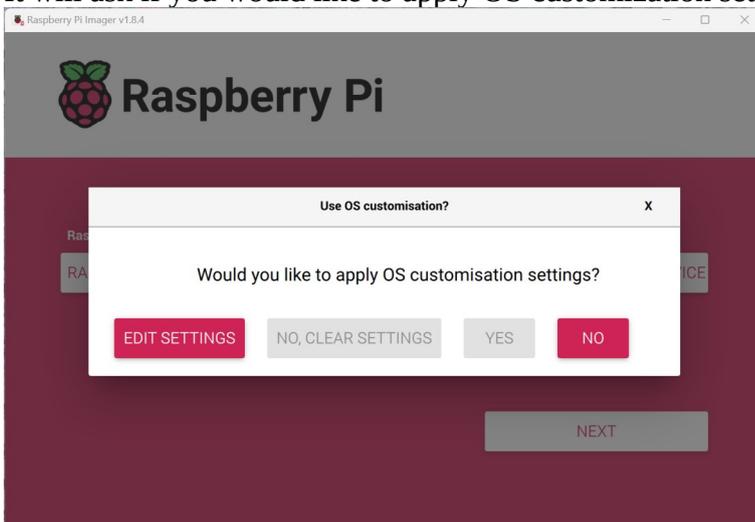
**Note: All data on the MicroSD card will be deleted!**

Choose your MicroSD card from the list.

### 7. Click "Next"

### 8. A Pop-Up Message Box Will Appear

It will ask if you would like to apply OS customization settings.



### 9. Select "Edit Settings"

## 10. Set Hostname

Enter "rasp-ai" as the hostname.

## 11. Set Username and Password

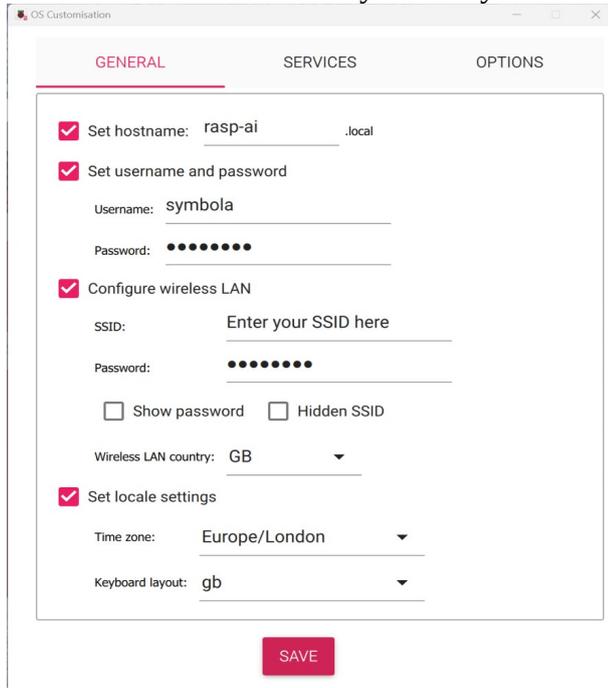
Don't forget these credentials!

## 12. Configure Wireless LAN

If you're unsure of your Wi-Fi network's SSID, check on your phone, laptop, or Wi-Fi router.

## 13. Set Locale Settings

Select the time zone and keyboard layout that suits your setup.

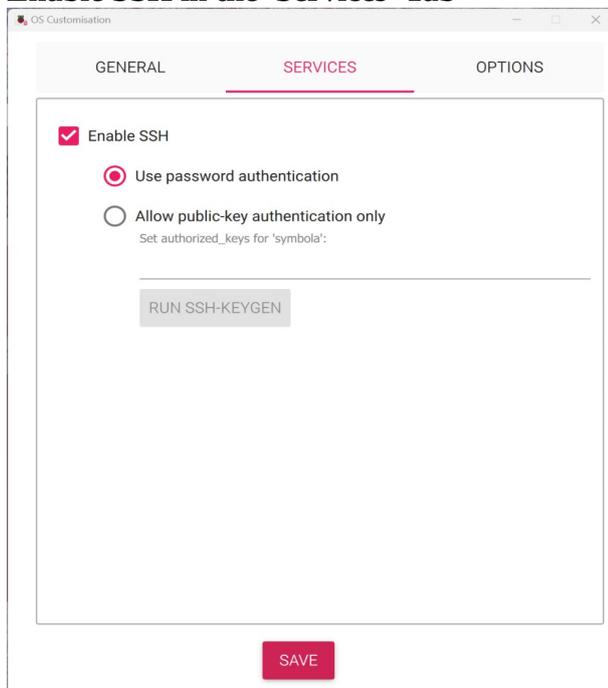


The screenshot shows the 'OS Customisation' window with the 'GENERAL' tab selected. The following options are checked and configured:

- Set hostname: rasp-ai .local
- Set username and password
  - Username: symbola
  - Password: [masked]
- Configure wireless LAN
  - SSID: Enter your SSID here
  - Password: [masked]
  - Show password  Hidden SSID
  - Wireless LAN country: GB
- Set locale settings
  - Time zone: Europe/London
  - Keyboard layout: gb

A red 'SAVE' button is located at the bottom center of the window.

## 14. Enable SSH in the 'Services' Tab



The screenshot shows the 'OS Customisation' window with the 'SERVICES' tab selected. The following options are checked and configured:

- Enable SSH
  - Use password authentication
  - Allow public-key authentication only
    - Set authorized\_keys for 'symbola':

A 'RUN SSH-KEYGEN' button is visible below the authentication options. A red 'SAVE' button is located at the bottom center of the window.

## 15. Leave Options in the 'Options' Tab As Is

## 16. Click on "Save"

**17. Back to the Pop-Up Message Box**

When asked again about applying OS customization settings, select "YES".

**18. Read the Notice About Data Erasure**

Select "YES" (only if you are okay with all data being erased on the MicroSD card).

**19. Wait for the Operating System to be Written to the MicroSD Card**

## Setting up the hardware

**1. Insert the Prepared MicroSD Card into Your Raspberry Pi****2. Fit the Cooling Fan** (if purchased)

Before powering up your Raspberry Pi, attach the cooling fan. This step is crucial to maintain optimal operating temperatures, especially important when running demanding applications. Follow the instructions provided with your cooling fan for proper installation.

**3. Place the Raspberry Pi in a Case** (if purchased)

If you have a case for your Raspberry Pi, now is the time to secure the board inside it. A case helps protect the Raspberry Pi from physical damage and dust. Make sure that the case is compatible with the cooling fan setup and allows proper ventilation.

**4. Connect to a Display**

Use the Micro-HDMI to HDMI cable to connect your Raspberry Pi to the monitor or display.

**5. Attach Keyboard and Mouse**

Connect these peripherals to the USB ports on the Raspberry Pi.

**6. Ethernet Connection (Optional)**

If you are not using Wi-Fi, connect your Raspberry Pi to the network using an Ethernet cable. This will provide a more stable internet connection, which is crucial for downloading updates and software.

**7. Connect to Power Supply**

Plug in the power supply to your Raspberry Pi. Ensure you are using the recommended power adapter to prevent any power issues.

**8. Ensure Secure Connections**

Before powering up, double-check that all connections (display, keyboard, mouse, Ethernet, and power supply) are secure. A loose connection could lead to problems during the setup process.

**9. Power On the Raspberry Pi**

Once everything is connected and secured, power on your Raspberry Pi. Proceed with the initial setup of the Raspberry Pi OS.

## First Boot

Upon the first boot, after the desktop screen loads, a pop-up window titled “**Wi-Fi Network Authentication Required**” may appear. If it does, select “Connect” to establish an internet connection.

If all has gone well, your Raspberry Pi should boot up to the desktop and be connected to the internet. At the top left of the screen, from left to right, you will see several icons:

- 1. The Raspberry Pi Logo**

This is the operating system's main "Start" menu, where you can access programs, settings, etc.

- 2. The Globe Icon**

This represents the Chromium web browser by default.

- 3. Two Yellow Folders**

These are icons for the file explorer, where you can manage and access your files.

- 4. The Dark Box with “>\_”**

This is the terminal application, a powerful tool for running various commands and scripts.

On the right side at the top, you'll find icons for Bluetooth, Wi-Fi, volume control, and the time display. These are quick access buttons that allow you to manage your device's connectivity and settings easily.

## Open a Terminal Window

Much of the installation process will be conducted using the terminal. Here's how to open it:

- 1. Navigate to the Terminal**

Look at the top left of the screen and find the icon that looks like a dark box with “>\_” symbol. This is the terminal application.

- 2. Open the Terminal**

Click on the “>\_” icon. A terminal window will open, displaying a command prompt, which is where you can enter your commands.

- 3. Using the Terminal**

Once the terminal window is open, you will see a command prompt waiting for commands to be entered.

**Tip:** If you are viewing this guide as a PDF document on your Raspberry Pi, you can conveniently copy and paste the commands directly into the terminal. This can save time and reduce the chance of typing errors.

## Installing the Local LLM

To install the local LLM on your Raspberry Pi, follow these steps. All these commands need to be typed (or copied and pasted) into an open Terminal window.

### 1. Update the System

1. Update package list
  1. **sudo apt update**
2. Upgrade installed packages
  1. **sudo apt full-upgrade**
3. Install Required Developer Tools
  1. **sudo apt install git g++ wget build-essential**

### 2. Download llama.cpp and compile

1. Clone the repository
  1. **git clone https://github.com/ggerganov/llama.cpp.git**
2. Change directory
  1. **cd llama.cpp**
3. Compile the code
  1. **make -j**
4. **Note: This step may take some time.**

### 3. Download the Required LLM

1. Change to models directory
  1. **cd models**
2. Download the model
  1. **wget https://huggingface.co/TheBloke/Llama-2-7b-Chat-GGUF/resolve/main/llama-2-7b-chat.Q5\_K\_S.gguf**
3. **Note: This step may take some time.**

### 4. Return to the Previous Directory

1. **cd ..**

### 5. Start the Interactive Chat in the Terminal

Run the following command: -

```
./main -m models/llama-2-7b-chat.Q5_K_S.gguf --color --ctx_size 2048 -n -1 -ins -b 256 --top_k 10000 --temp 0.2 --repeat_penalty 1.1
```

**Note:** Type as one line or copy and paste the above in one process.

## Restarting the chat

If you need to restart the chat after rebooting your Raspberry Pi or closing the terminal, follow these steps when opening a new terminal window

### 1. Change Directory

1. Navigate to the llama.cpp directory by entering
  1. **cd llama.cpp**

### 2. Start the Interactive Chat in the Terminal

Run the following command: -

```
./main -m models/llama-2-7b-chat.Q5_K_S.gguf --color --ctx_size 2048 -n -1 -ins -b 256 --top_k 10000 --temp 0.2 --repeat_penalty 1.1
```

**Note:** Type as one line or copy and paste the above in one process.

## Chat Away

You are now ready to chat with the LLM, just like the fantastic ChatGPT from OpenAI. Enjoy exploring the capabilities of your locally-run Large Language Model and discover all the interesting and insightful conversations you can have!

## Changing LLM models

It's possible to change the model you use with your Raspberry Pi. However, be sure to choose a model that fits within the memory constraints of your device.

You can find a list of all models from the family used in this guide at the following link:

<https://huggingface.co/TheBloke/Llama-2-7B-Chat-GGUF/tree/main>

To use a different model, adjust the commands for downloading and running the models based on the file name you find on the site above. Keep in mind that generally, the larger the LLM file size, the more accurate and precise the answers will be, but the response time might be slower. Conversely, smaller LLM files may provide less accurate and precise answers but will respond faster.