seeed studio

Hands-On Computer Vision

ICTP-UNU Workshop on TinyML
for Sustainable Development

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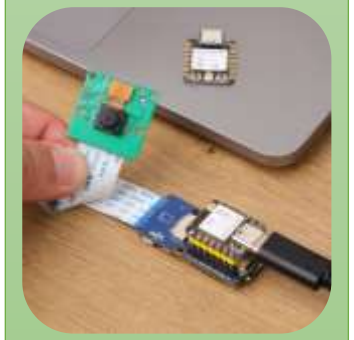

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MCU + AI Sensors = Unlimited Creative Possibilities

Main Content

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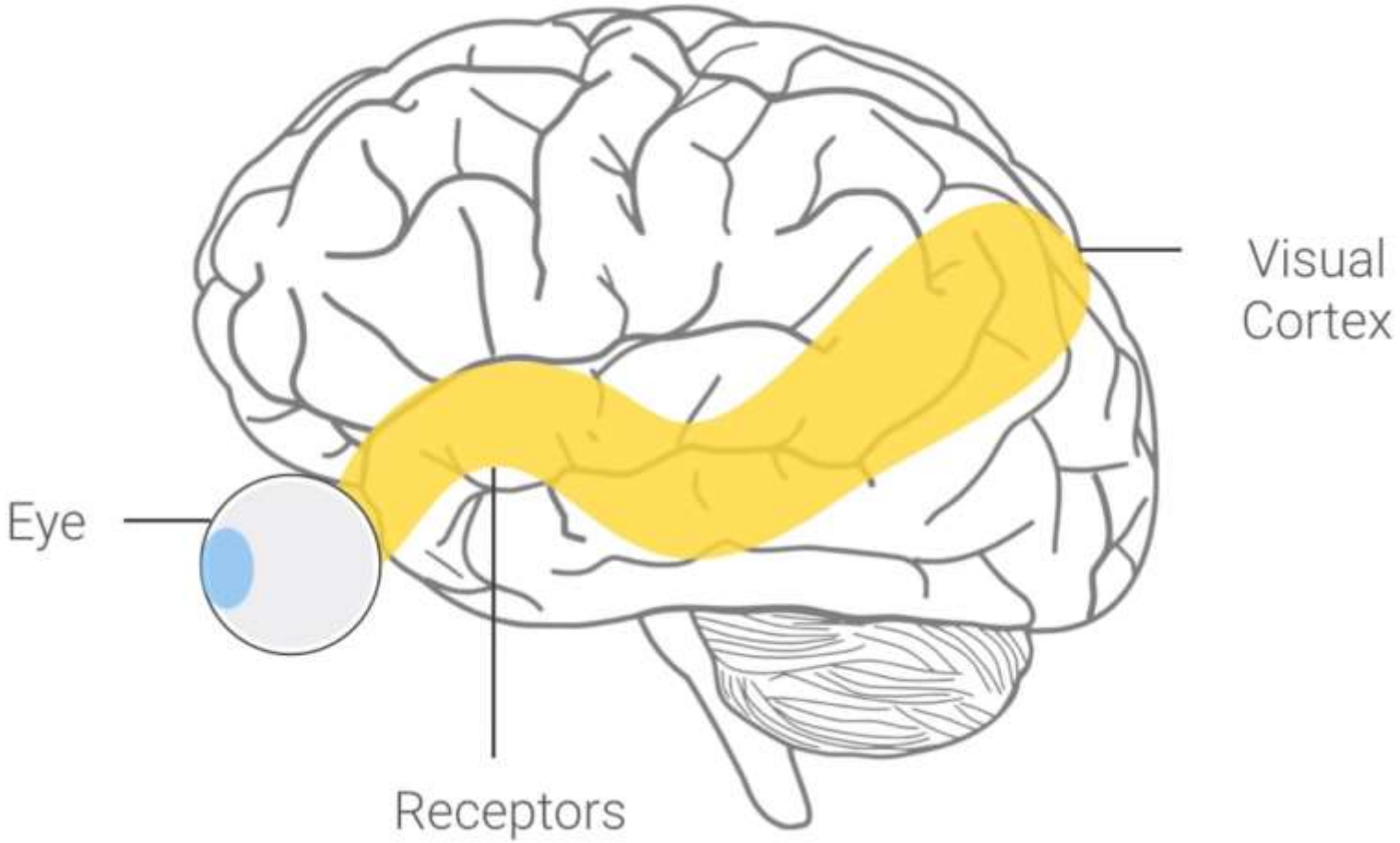
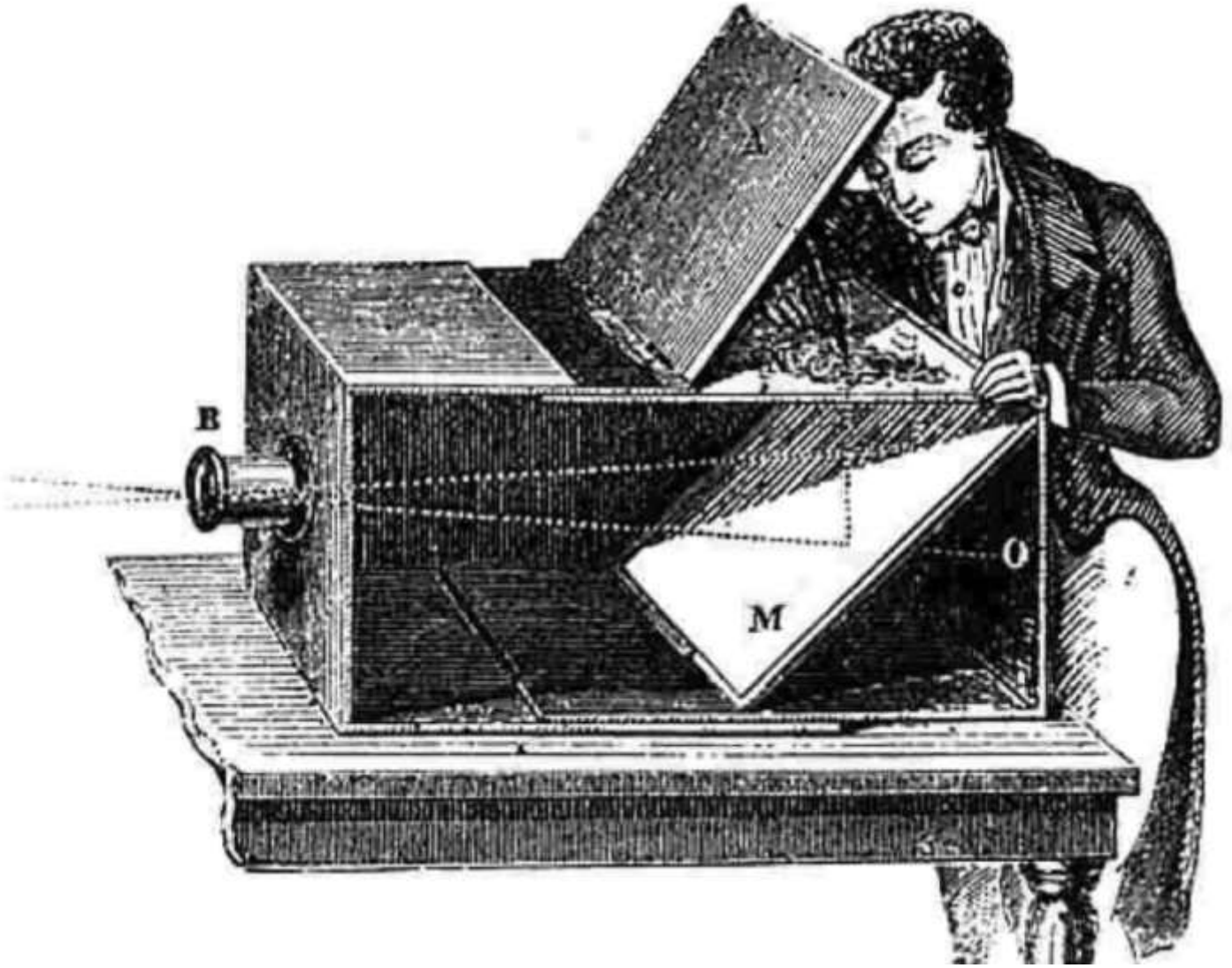
Introduction to
Machine Vision

Introduction to Machine Vision

Introduction to Machine Vision

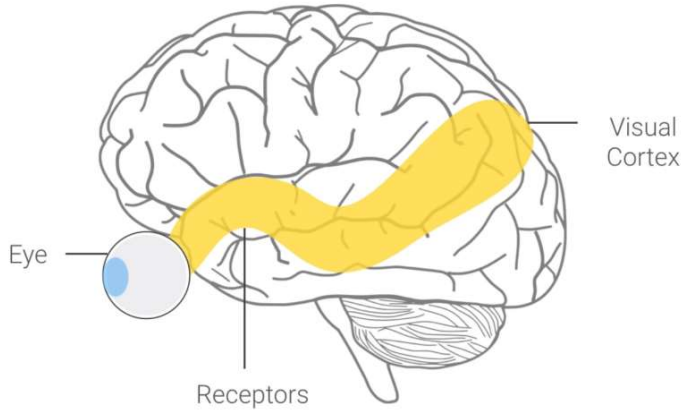


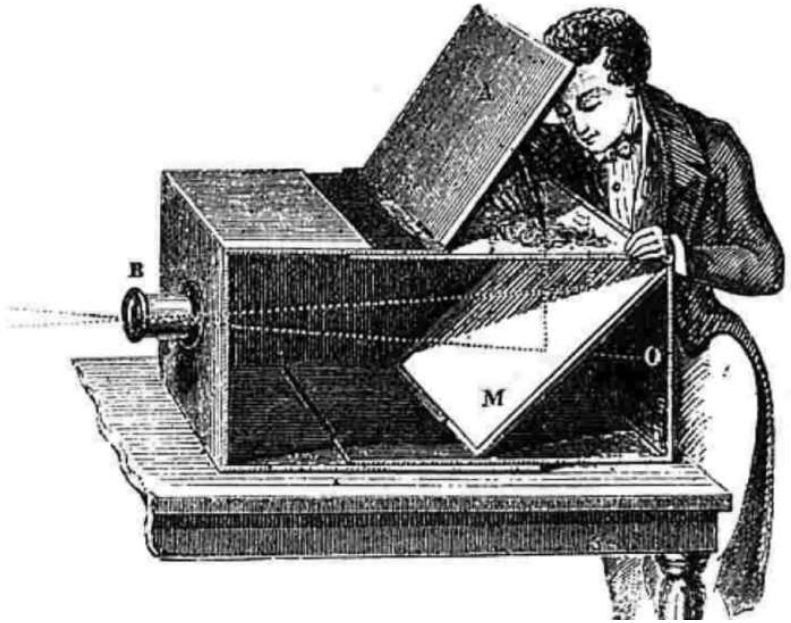
Introduction to Machine Vision



Introduction to Machine Vision

Introduction to Machine Vision





Introduction to Machine Vision

28 x 28
784 pixels

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	34	186	253	217	208	136	136	136	166	232	99	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	61	242	208	111	3	0	0	0	0	0	18	32	107	43	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0	215	97	0	0	0	0	0	118	253	68	0	0	0	0	0	0	0
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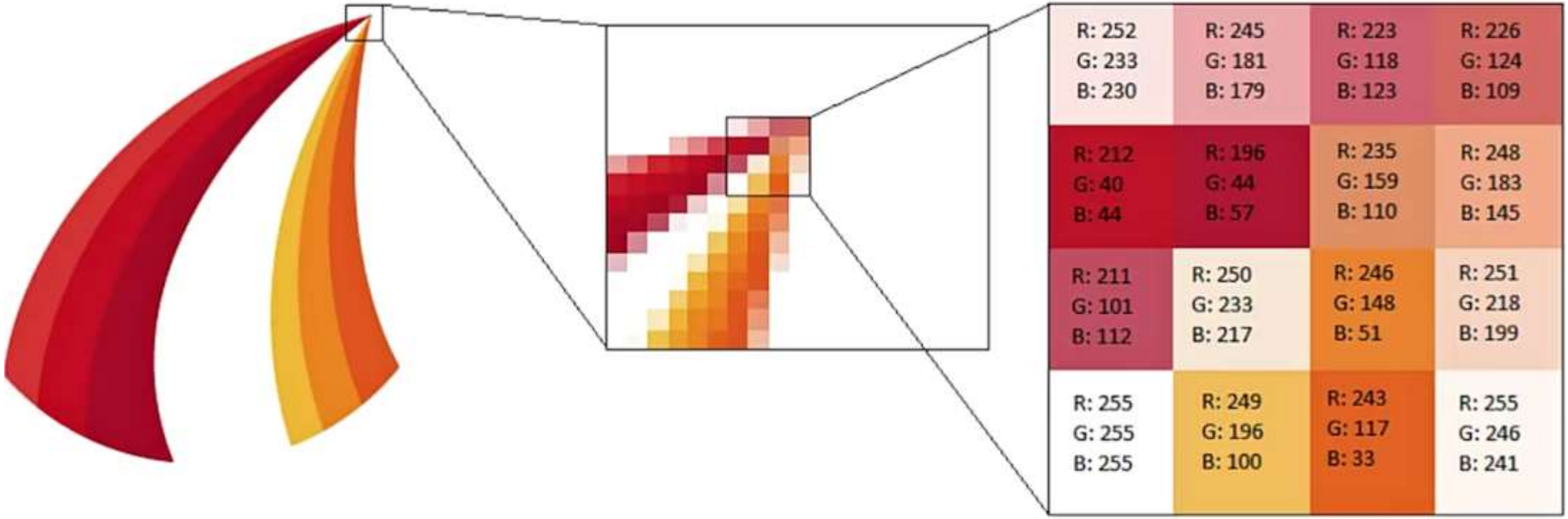
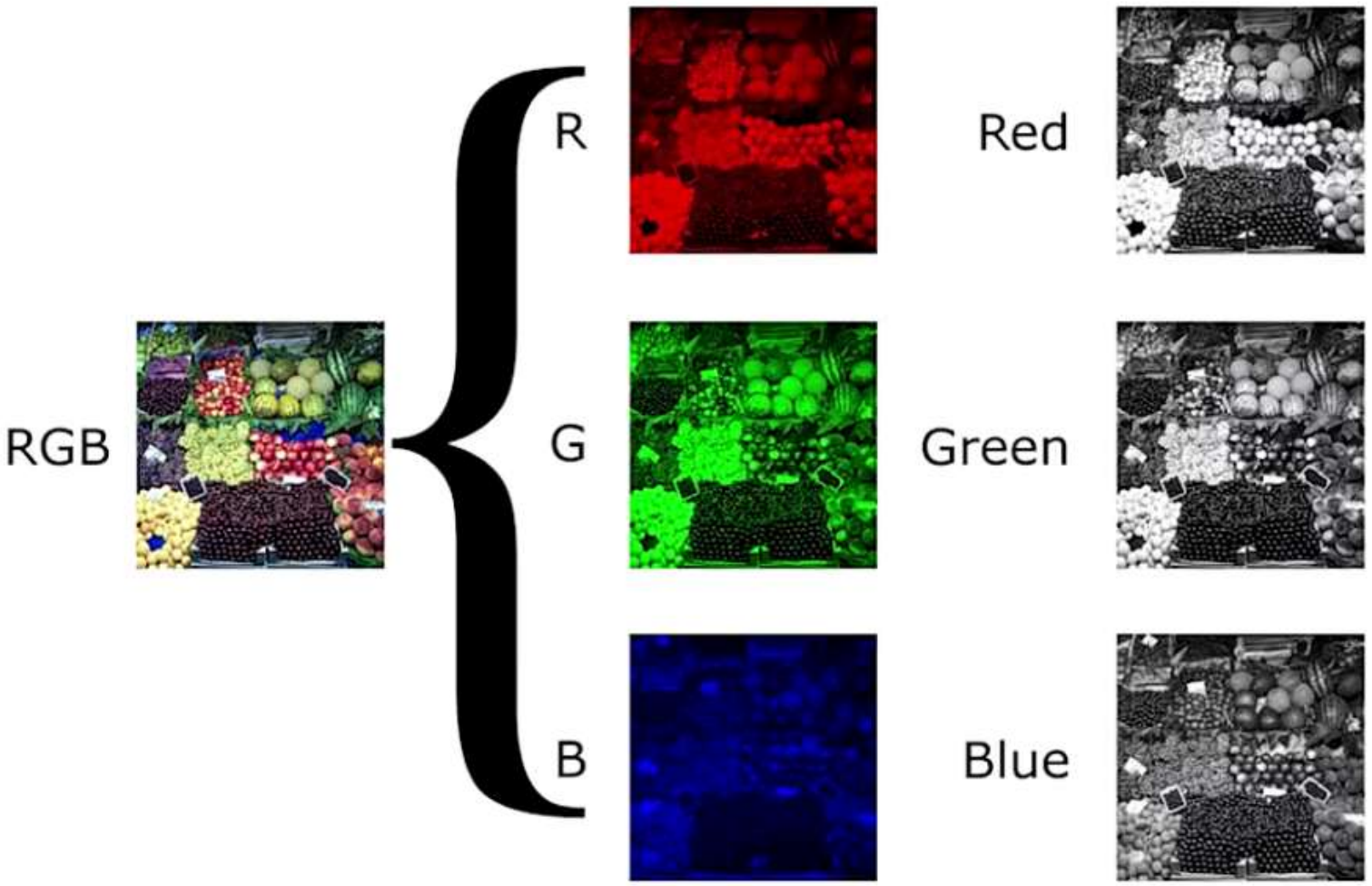
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A greyscale image can be understood as consisting of dark (0) and light (numbers greater than zero), the closer to 255 means the brighter the area is.

Introduction to Machine Vision



Introduction to Machine Vision



Shape 3D Array
(480*540*3)

Height

Width

Colour Channel

Introduction to Machine Vision

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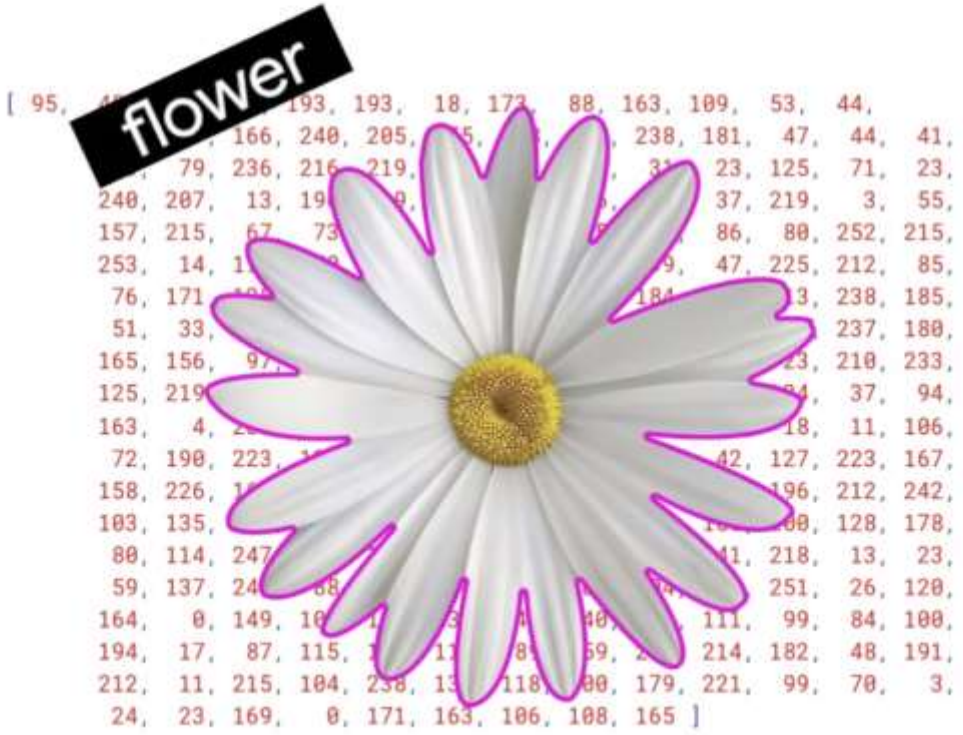
```

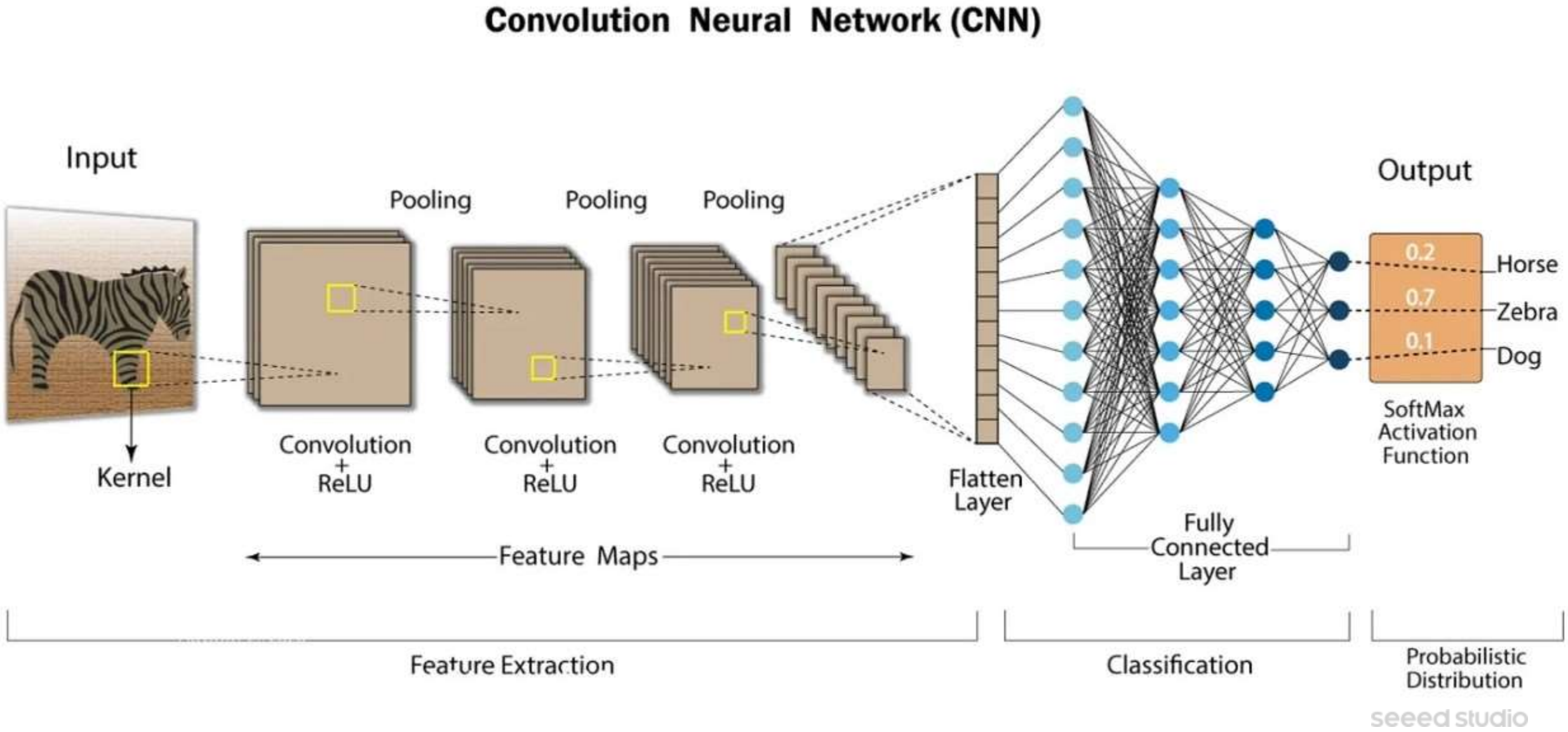
Introduction to Machine Vision

Machine Learning

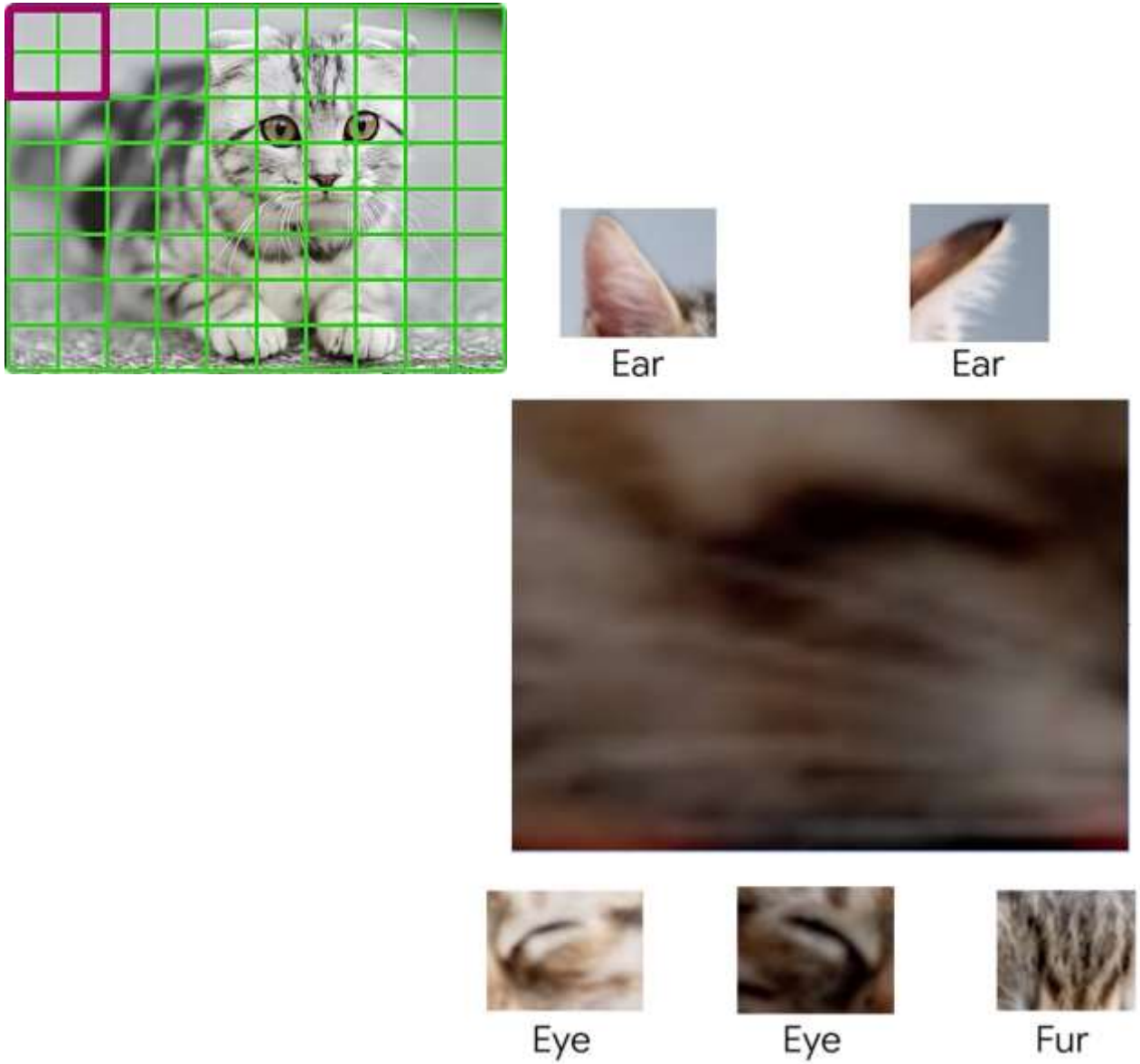


Introduction to Machine Vision

Introduction to Machine Vision



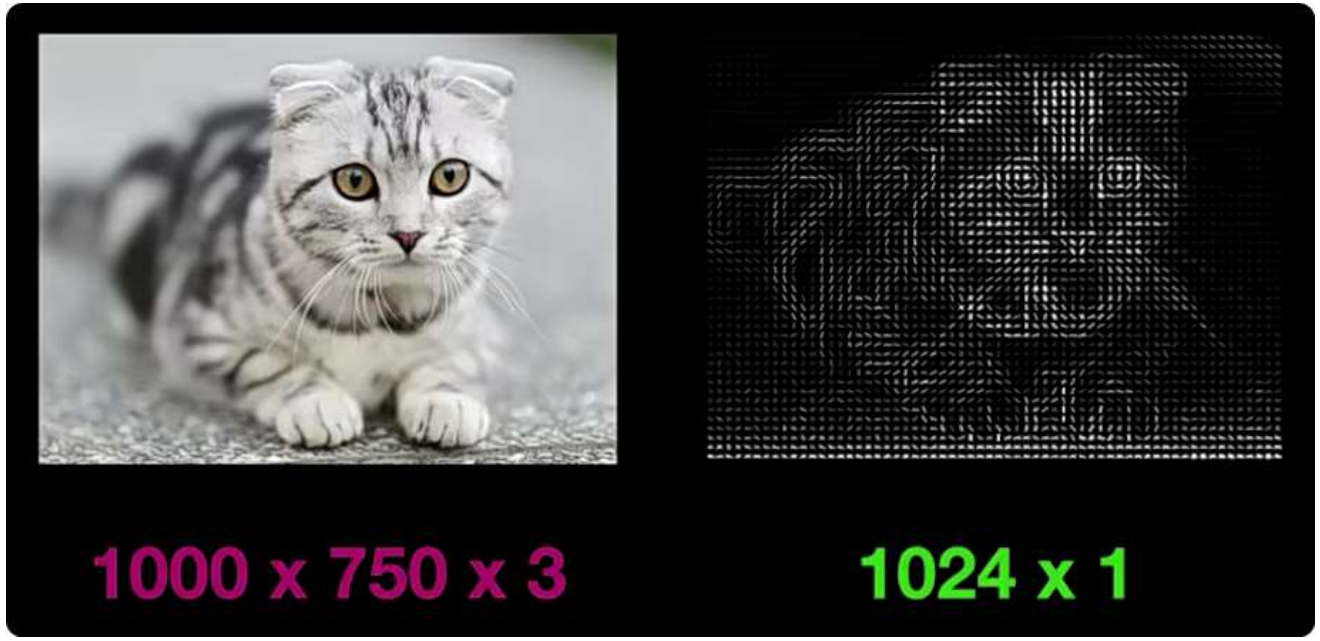
Introduction to Machine Vision



Convolutional Layers

- Convolutional layers use a set of learnable filters (also known as convolutional kernels) that slide over the input image and perform convolution operations.
- Each filter extracts specific features from the image, such as edges, textures, or shapes.
- The result of the convolution operation is a set of feature maps that represent the response of different features at various locations in the image.
- By using multiple filters, convolutional layers can extract a variety of features from the image.

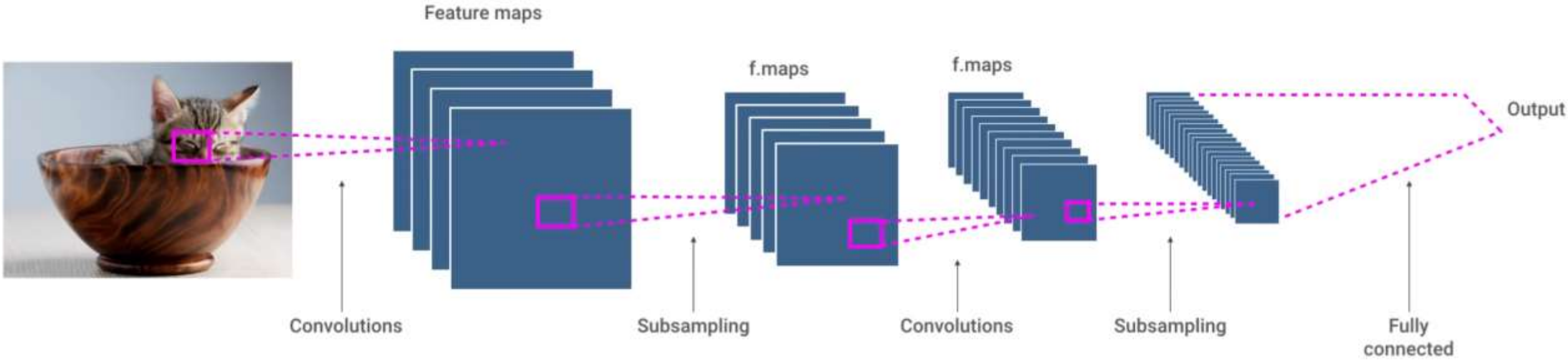
Introduction to Machine Vision



Pooling Layers

- Pooling layers are used to reduce the spatial dimensions of the feature maps while retaining the most important feature information.
- The most common pooling operation is max pooling, which selects the maximum value within each region of the feature map as the representative of that region.
- Pooling operations help to reduce the size of the feature maps, thereby reducing the computational burden of subsequent layers and providing some level of translation invariance.

Introduction to Machine Vision



Fully Connected Layers

- After multiple convolutional and pooling layers, CNNs typically employ one or more fully connected layers for the final classification or prediction task.
- Fully connected layers flatten the features extracted by the previous layers and apply a weight matrix to transform them into the final output.
- Fully connected layers can learn complex relationships between features and generate the desired output based on the task requirements, such as the probability of an image belonging to a specific class.

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Introduction to Machine Vision

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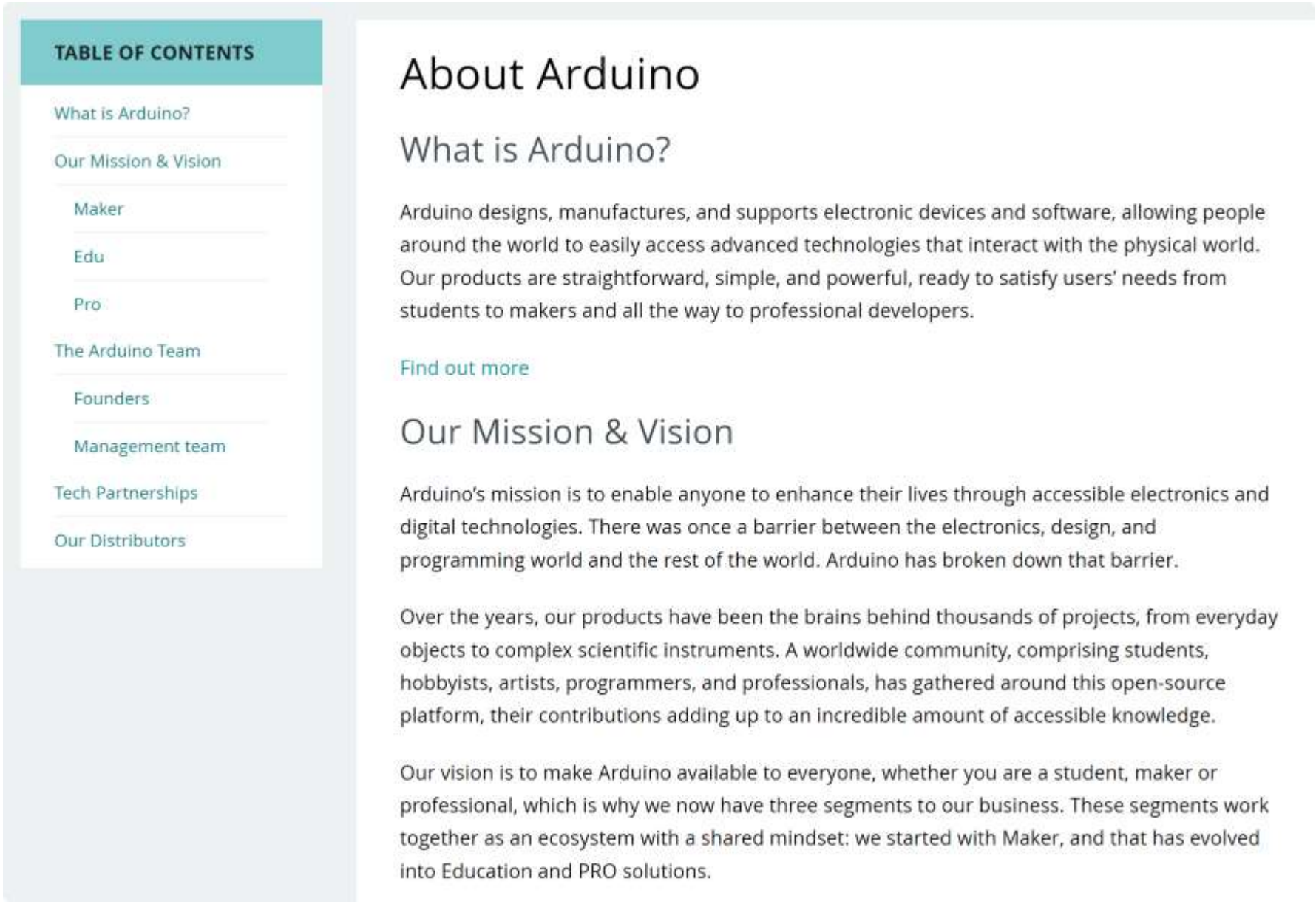
Arduino Environment Preparation

Arduino Environment Preparation



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About Arduino

What is Arduino?

Arduino designs, manufactures, and supports electronic devices and software, allowing people around the world to easily access advanced technologies that interact with the physical world. Our products are straightforward, simple, and powerful, ready to satisfy users' needs from students to makers and all the way to professional developers.

Find out more

Our Mission & Vision

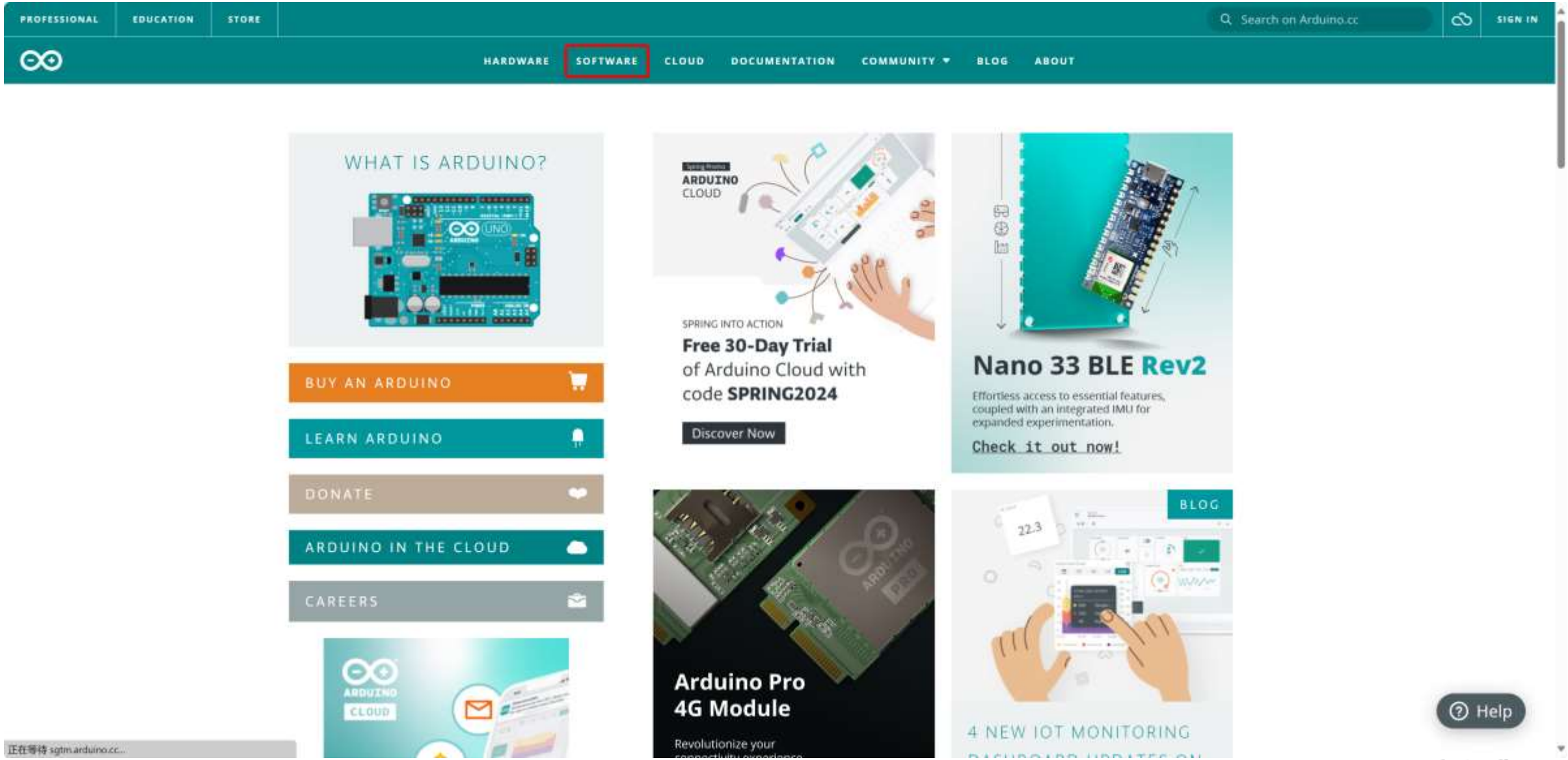
Arduino's mission is to enable anyone to enhance their lives through accessible electronics and digital technologies. There was once a barrier between the electronics, design, and programming world and the rest of the world. Arduino has broken down that barrier.

Over the years, our products have been the brains behind thousands of projects, from everyday objects to complex scientific instruments. A worldwide community, comprising students, hobbyists, artists, programmers, and professionals, has gathered around this open-source platform, their contributions adding up to an incredible amount of accessible knowledge.

Our vision is to make Arduino available to everyone, whether you are a student, maker or professional, which is why we now have three segments to our business. These segments work together as an ecosystem with a shared mindset: we started with Maker, and that has evolved into Education and PRO solutions.

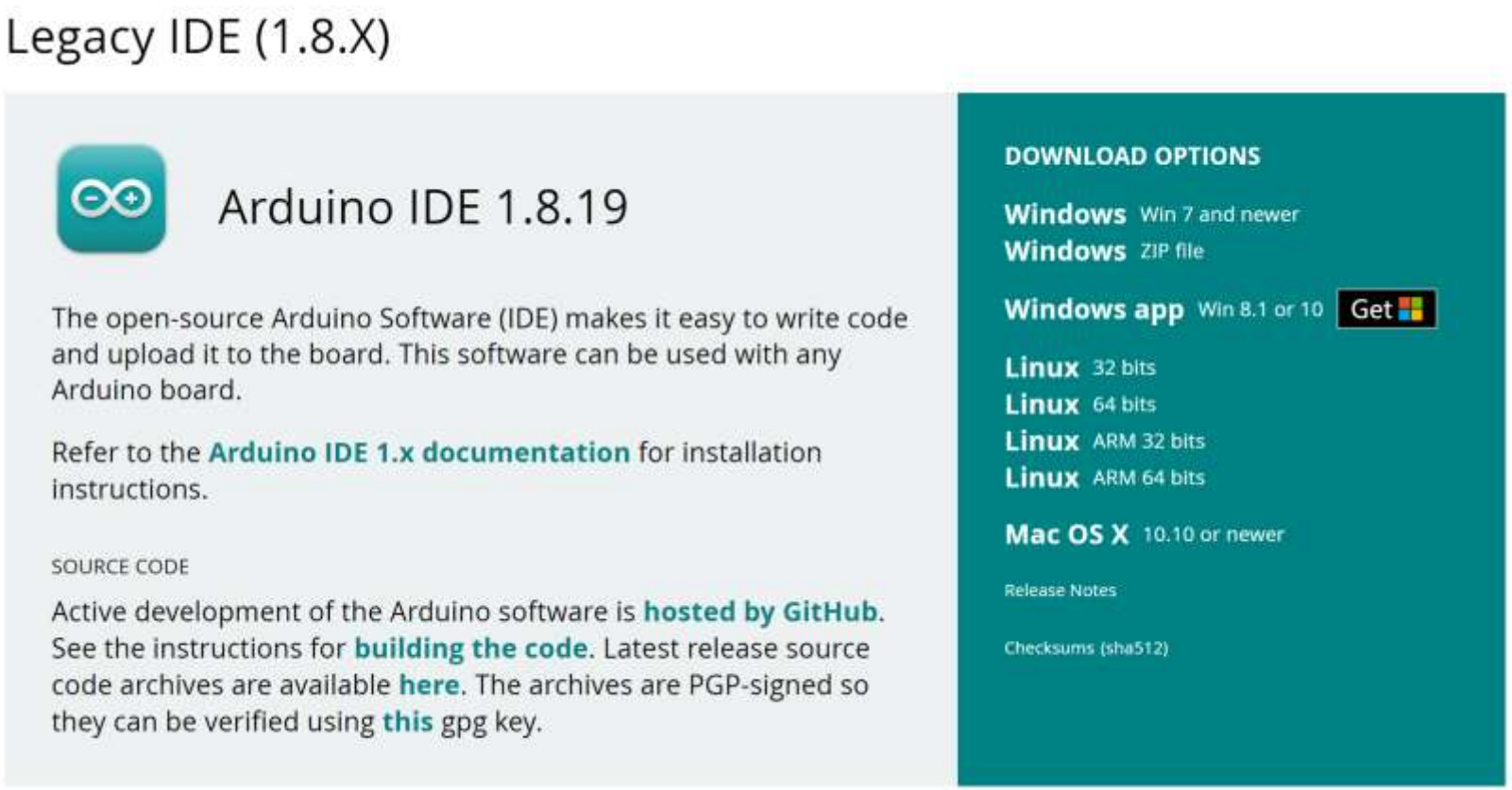
Arduino Environment Preparation

https://www.arduino.cc/



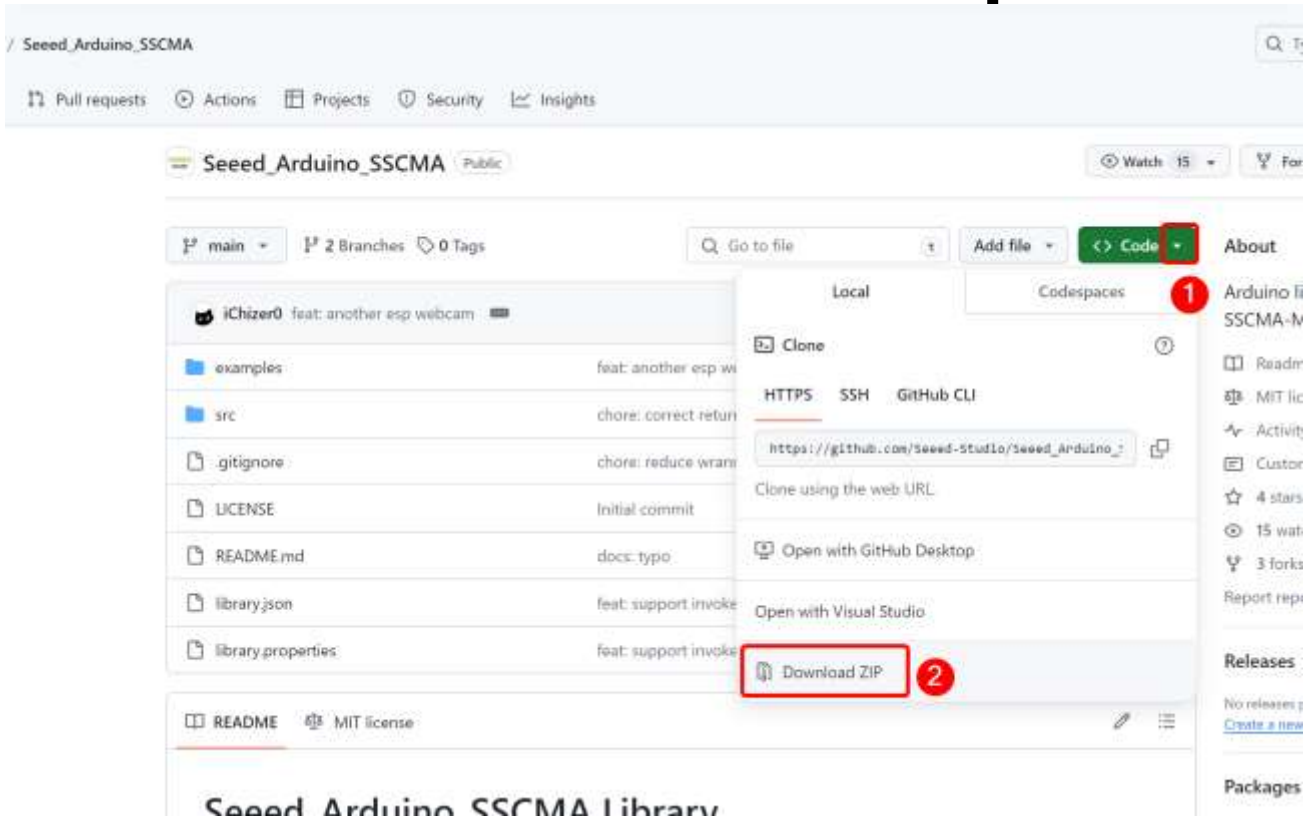
seeed studio

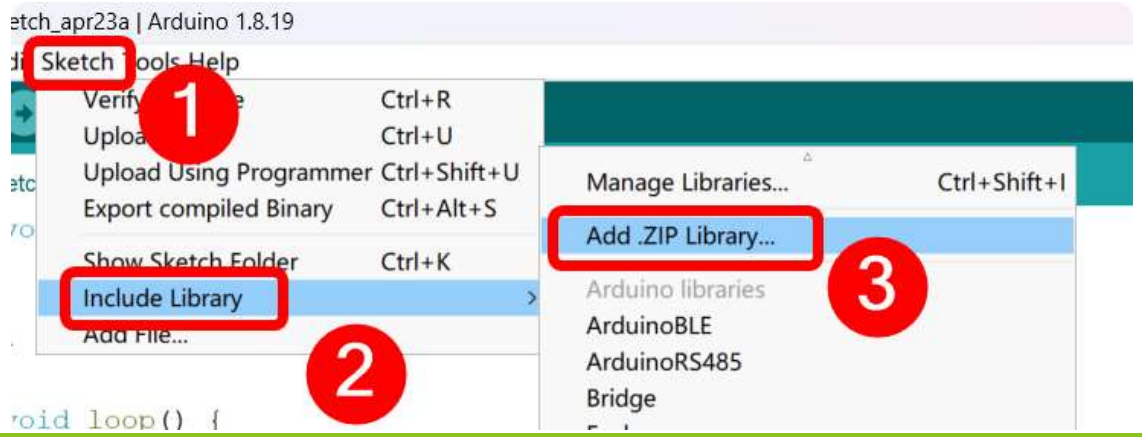
Arduino Environment Preparation



1. Visit the official Arduino website: https://www.arduino.cc/en/software
2. Click on the "Windows" or "Mac" button based on your operating system.
3. Download the Arduino IDE 1.8.19 installer.
4. Once the download is complete, run the installer.
5. Follow the installation wizard, accepting the license agreement and choosing the installation directory.
6. If prompted, allow the installer to install device drivers.
7. Once the installation is finished, click "Close" to exit the installer.
8. Open the Arduino IDE from the desktop shortcut or the start menu.
9. You're now ready to start using Arduino IDE 1.8.19!

Arduino Environment Preparation





1. Open your web browser and navigate to the GitHub repository: https://github.com/Seeed-Studio/Seeed_Arduino_SSCMA

2. Click on the green "Code" button and select "Download ZIP" to download the library as a ZIP file.

3. Save the ZIP file to a location on your computer where you can easily find it.

4. Open the Arduino IDE.

5. Go to Sketch > Include Library > Add .ZIP Library.

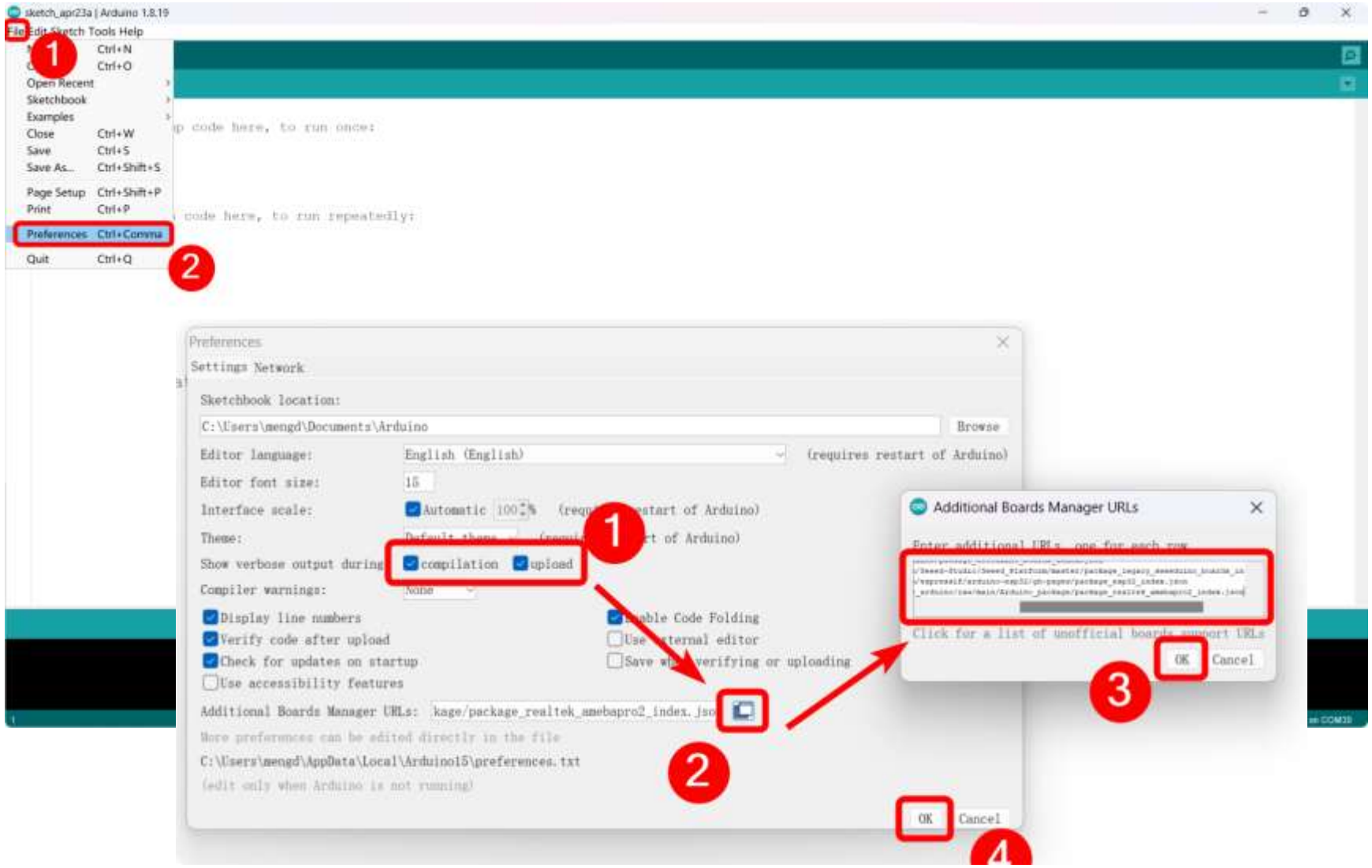
6. In the file browser window that appears, navigate to the location where you saved the downloaded ZIP file.

7. Select the ZIP file and click "Open" to add the library to your Arduino IDE.

8. The Seeed_Arduino_SSCMA library should now be installed and ready to use.

9. To verify the installation, go to Sketch > Include Library and check if "Seeed_Arduino_SSCMA" appears in the list of installed libraries.

Arduino Environment Preparation



1. Open the Arduino IDE.

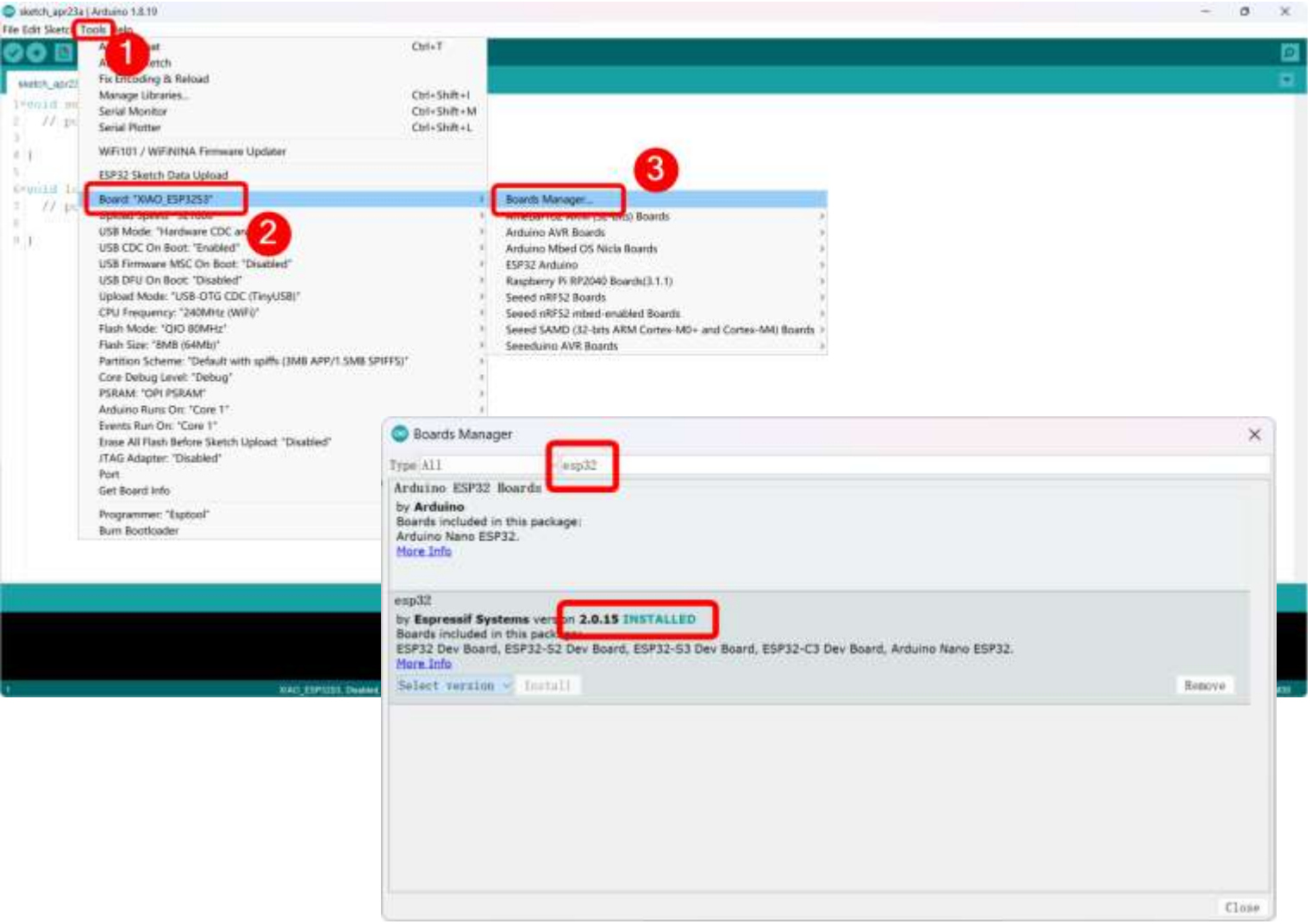
2. Go to File > Preferences.

3. In the "Additional Boards Manager URLs" field, enter the following URL:

https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json

4. Click "OK" to close the Preferences window.

Arduino Environment Preparation



5. Navigate to Tools > Board > Boards Manager.

6. In the Boards Manager window, search for "ESP32".

7. Locate the "ESP32 by Espressif Systems" entry and click on it.

8. Select the latest version from the dropdown menu and click "Install".

9. Wait for the installation process to complete. This may take a few minutes.

10. Once the installation is finished, close the Boards Manager window.

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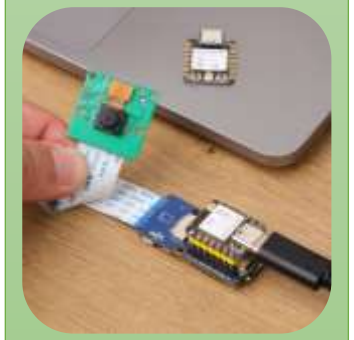
Arduino Environment Preparation



3

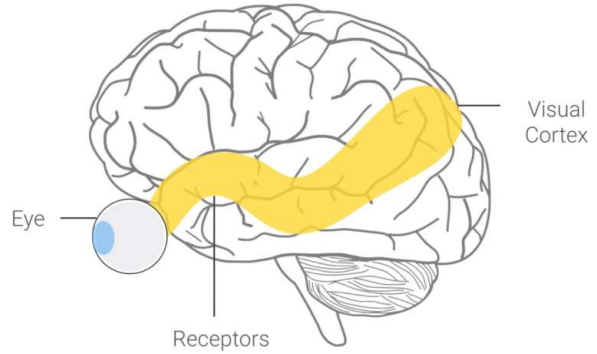
Equipment Introduction & Demonstration

Equipment Introduction & Demonstration

1. Grove Vision AI V2

2. XIAO ESP32C3

Equipment Introduction & Demonstration



Lighting: Lighting illuminates the object or scene to make its features visible.

Lens: This captures the image and delivers it to the sensor in the camera as light.

Capture board, frame grabber or sensor: These devices work together to process the image from the camera and convert it to a digital format as pixels.

Processor: The processor runs software and related algorithms that process the digital image and extract the required information.

Communication: These systems enable the machine vision cameras and processing system to communicate with other elements of the bigger system.

Equipment Introduction & Demonstration

Popular & Powerful SoCs Integrated

ESP32, RP2040, nRF52840, SAMD21, and more to come

Extra Tiny Size With SMD

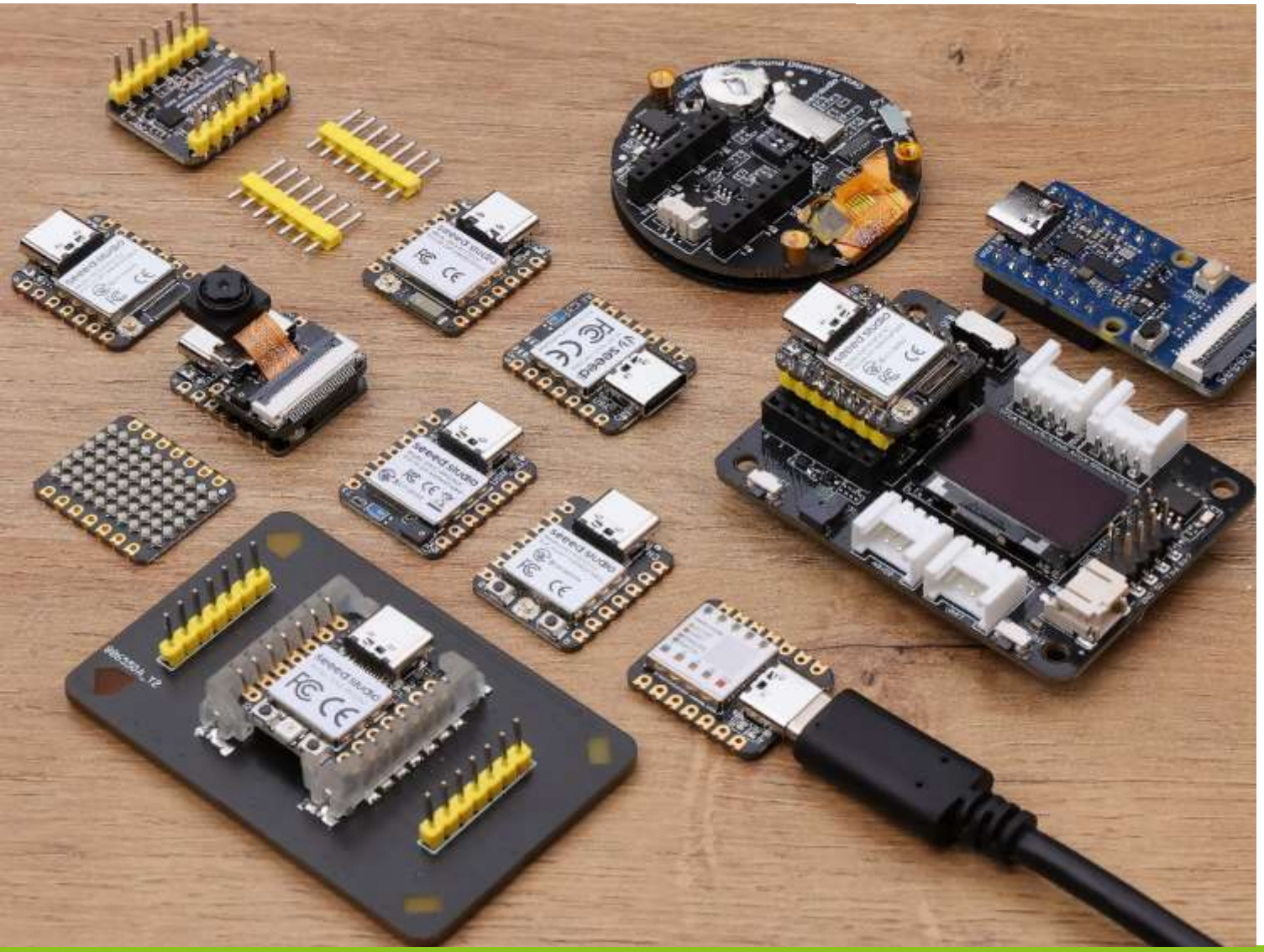
Sized at 21x17.5mm with single-sided surface mount design, ready to blend in space-constrained designs

Developer-Friendly

Natively compatible with Arduino, supporting MicroPython, and CircuitPython

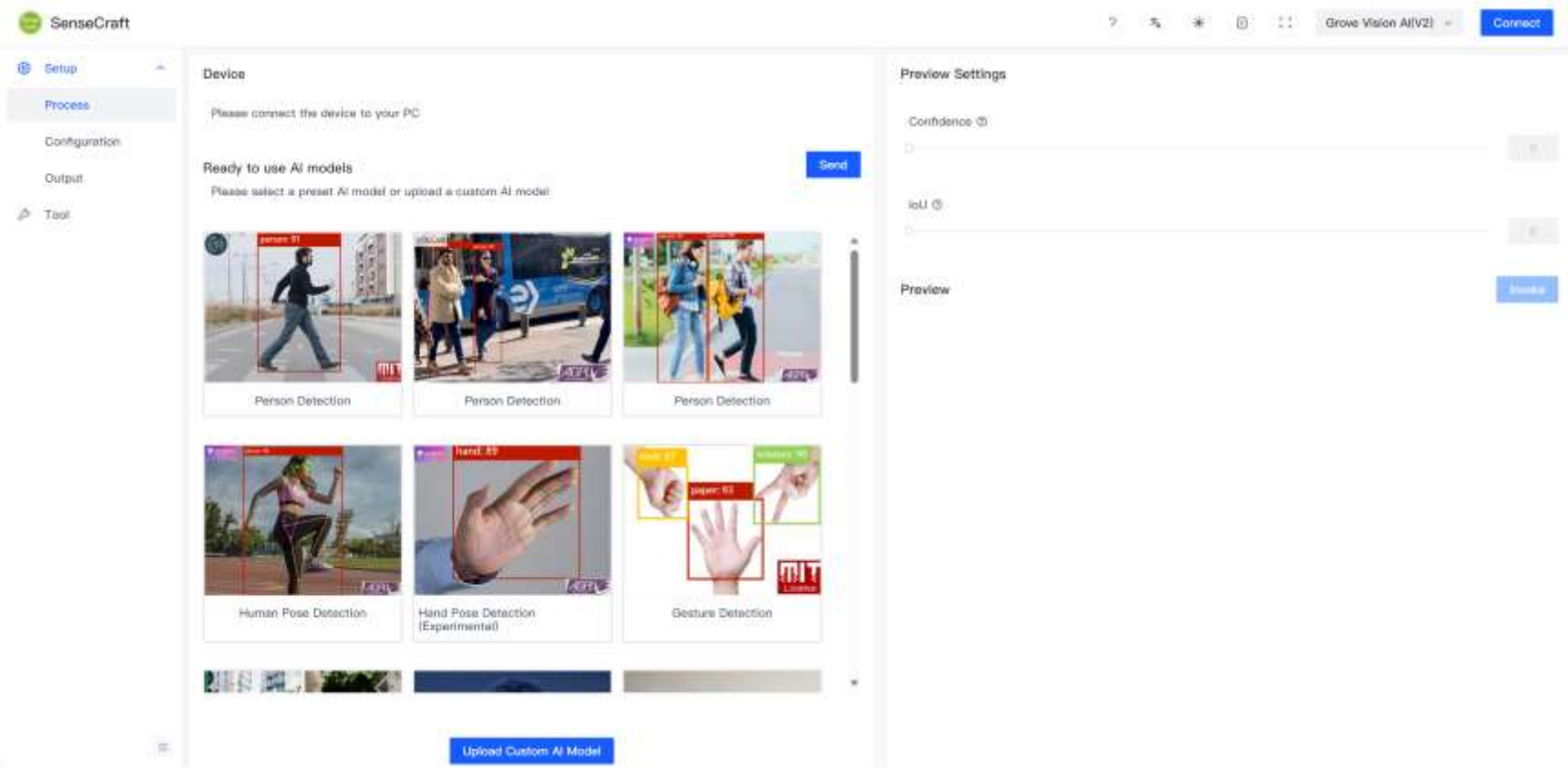
IoT Cloud Integration

A Seamless integration with AWS, Microsoft Azure, Google Cloud and more



The Seeed Studio XIAO Series is a collection of thumb-sized, powerful microcontroller units (MCUs) tailor-made for space-conscious projects requiring high performance and wireless con-connectivity. Embodying the essence of popular hardware platforms such as ESP32, RP2040, nRF52840, and SAMD21, the Arduino-compatible XIAO series is the perfect toolset for you to embrace tiny machine learning (TinyML) on the Edge.

Equipment Introduction & Demonstration

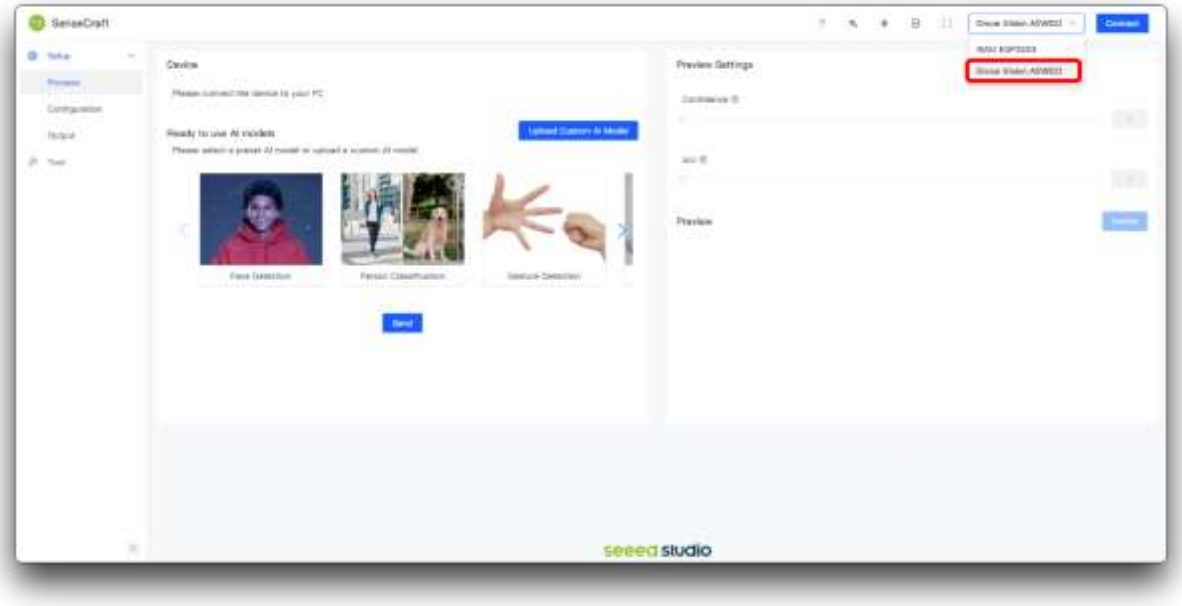


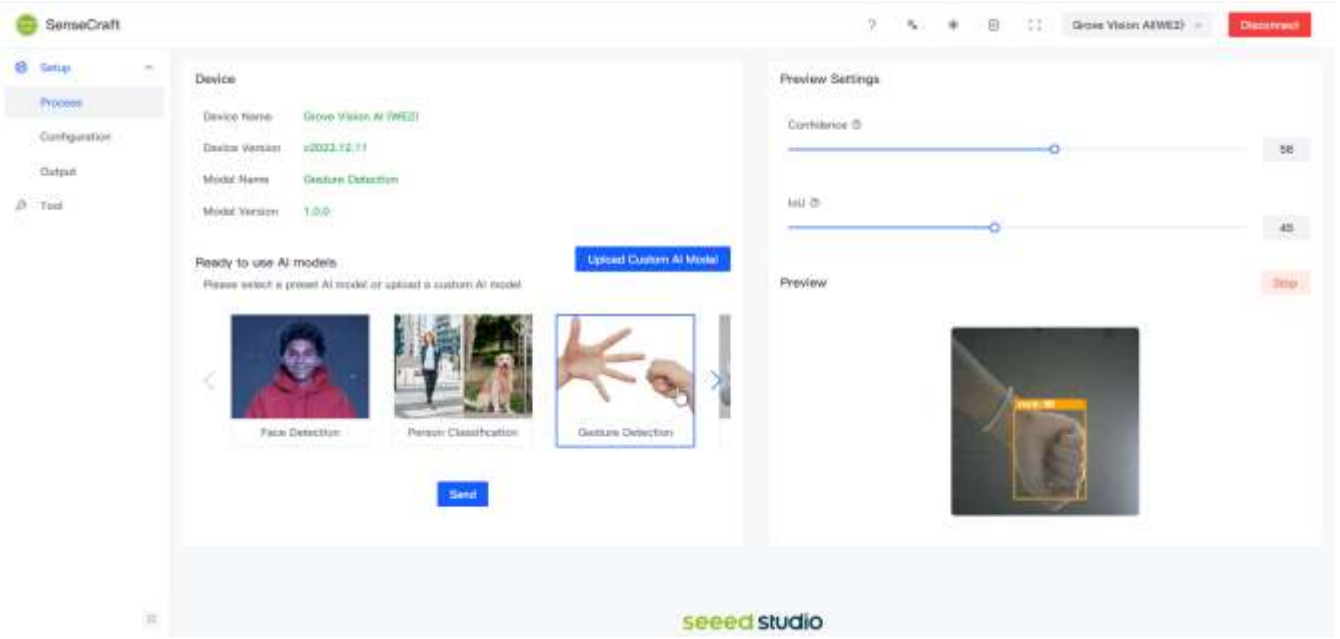
SenseCraft Model Assistant

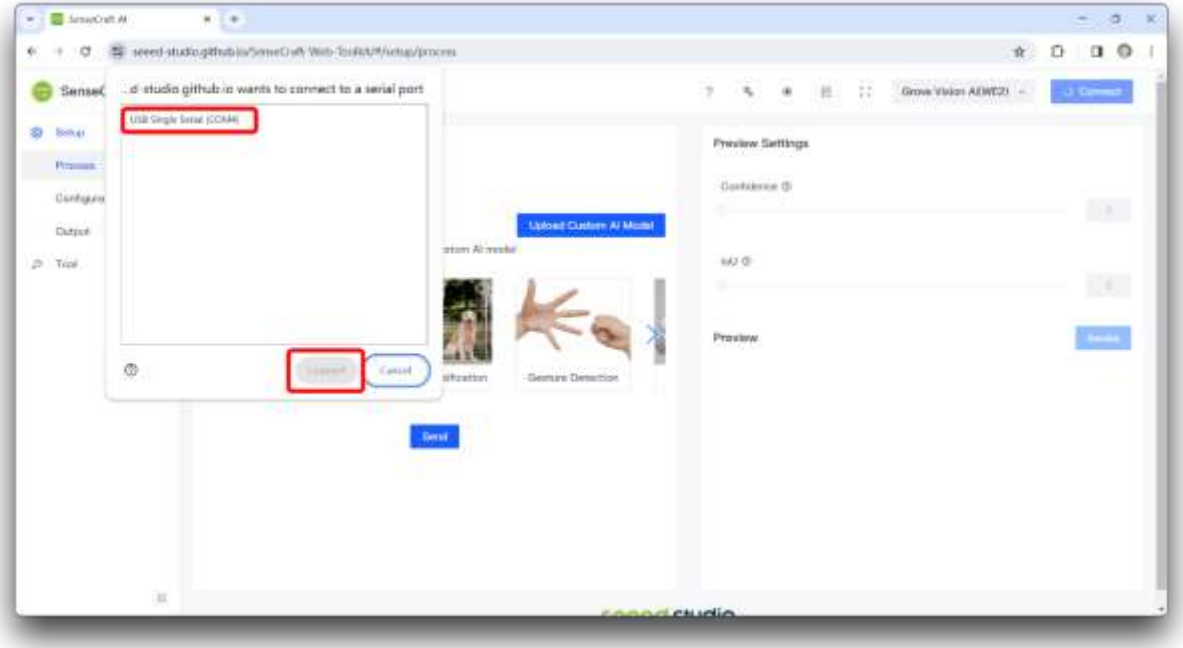
SenseCraft AI empowers users to effortlessly deploy a vast library of publicly available AI models onto their edge devices such as Recomputer (Jetson), XIAO S3, and more, and provides a seamless and user-friendly experience, allowing you to deploy public AI models directly onto your edge devices with just a few clicks. Say goodbye to complex configurations and coding – with SenseCraft AI, you can effortlessly unlock the power of AI on your devices. SenseCraft AI also allows you to upload and share your own trained AI models with the community. By publishing your models, you contribute to a growing library of shared knowledge, fostering collaboration and innovation among AI enthusiasts.

https://seeed-studio.github.io/SenseCraft-Web-Toolkit/#/setup/process

Equipment Introduction & Demonstration







First, we need to open the main SenseCraft AI Model Assistant page.

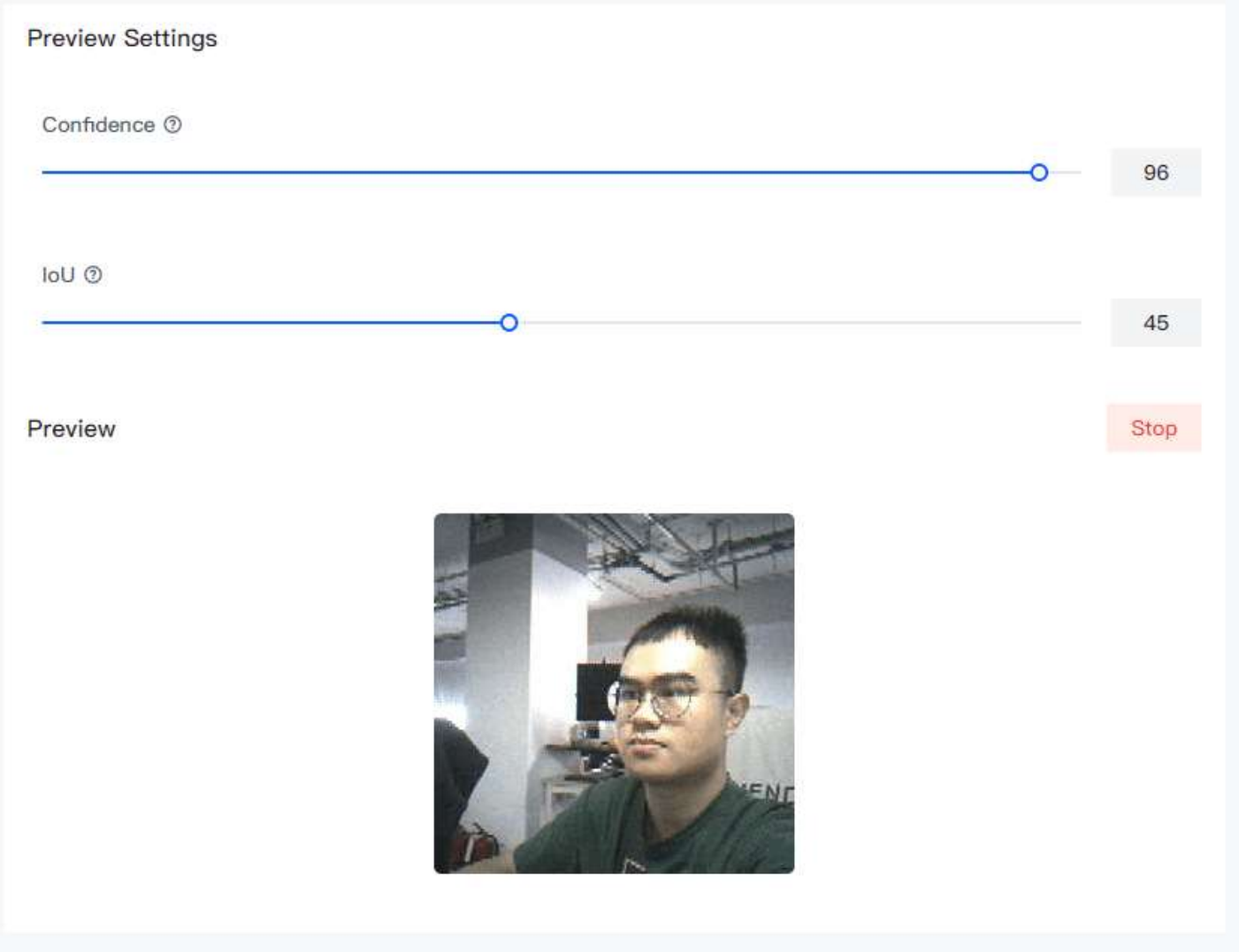
Please use a Type-C type cable to connect Grove Vision AI V2 to your computer.

In the upper right corner of the SenseCraft AI Model Assistant page, you can select **Grove Vision AI (WE2)**. Then click the **Connect** button on the far right.

In the new window that pops up, select the correct COM port for the device and click the Connect button.

Then, just select a model you want to use and click the **Send** button below. Here is an example of Gesture Detection.

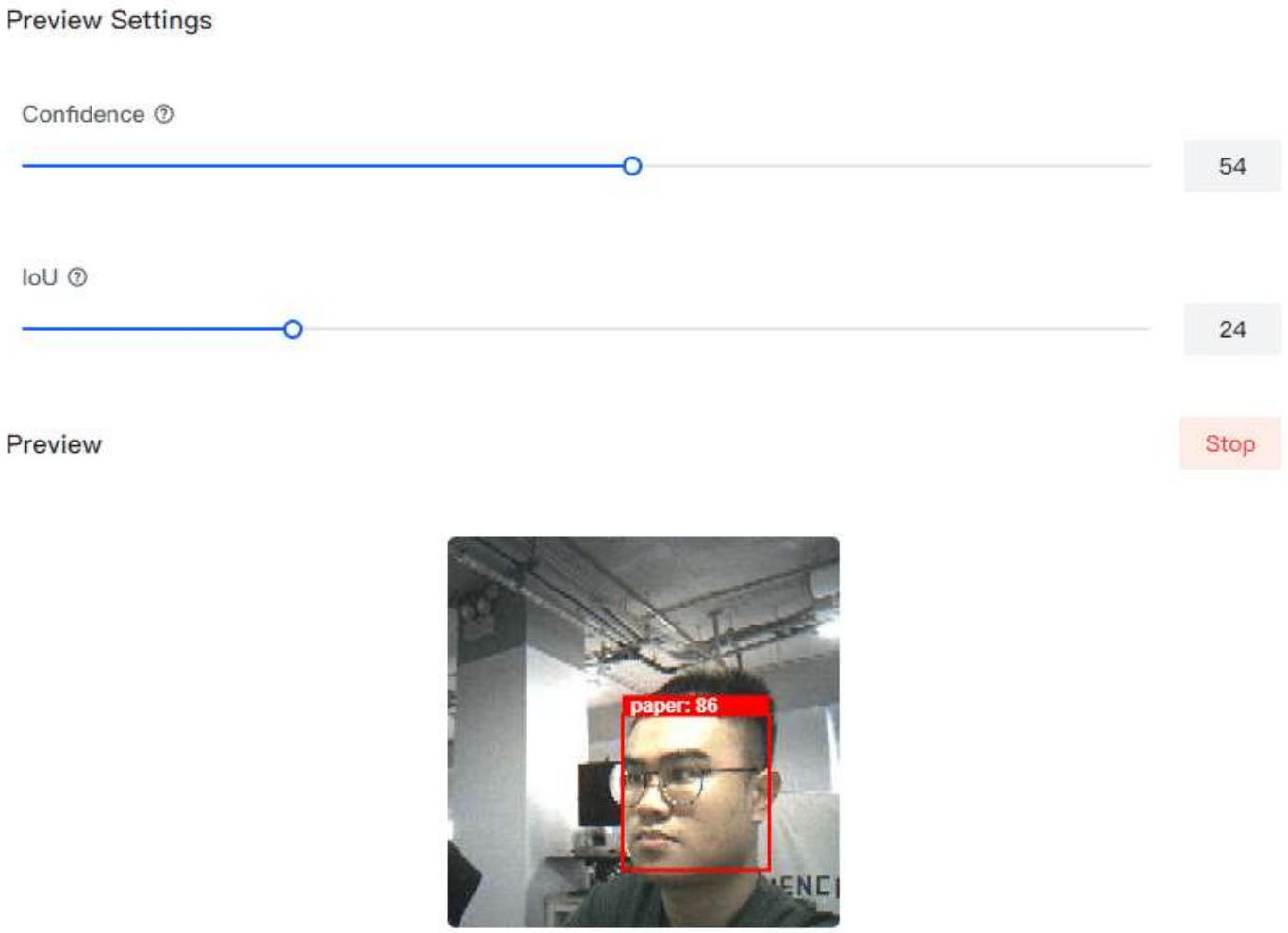
Equipment Introduction & Demonstration



Confidence

Confidence refers to the level of certainty or probability assigned by a model to its predictions.

Equipment Introduction & Demonstration



IoU

IoU is used to assess the accuracy of predicted bounding boxes compared to truth bounding boxes.

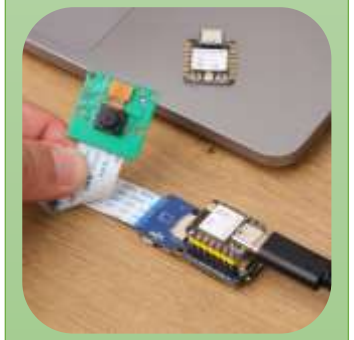
Main Content

1

Introduction to Machine Vision

2

Arduino Environment Preparation



3

Equipment Introduction & Demonstration

4

MCU + AI Sensors = Unlimited Creative Possibilities

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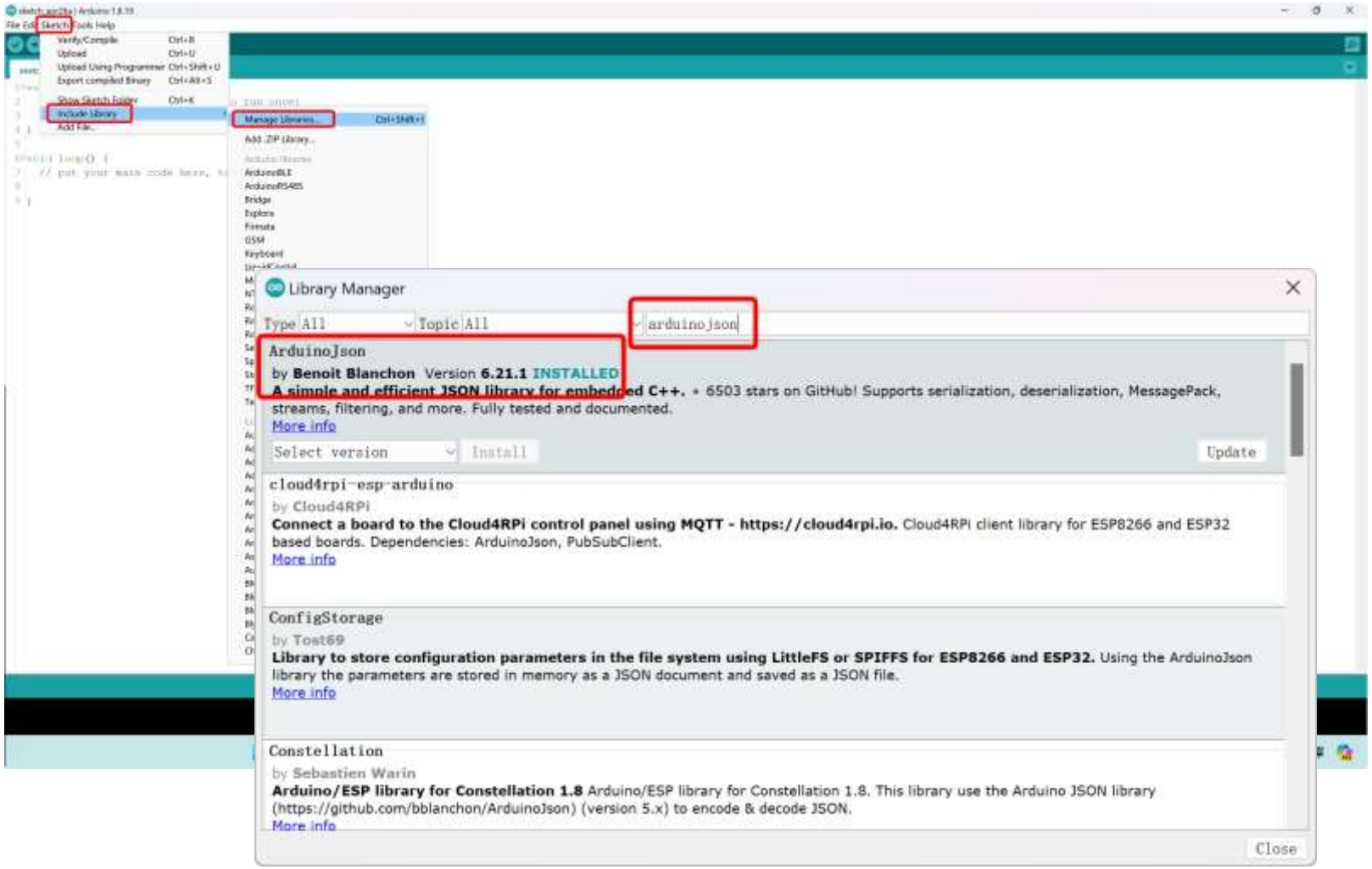

Go to the Sketch menu, then select **Include Library > Manage Libraries...**. This will open the Library Manager. In the search bar at the top of the Library Manager, type in **ArduinoJSON**. The search results will list the ArduinoJSON library. There will be an Install button next to the library. Click the Install button. The Arduino IDE will automatically download and install the library into your Arduino development environment.

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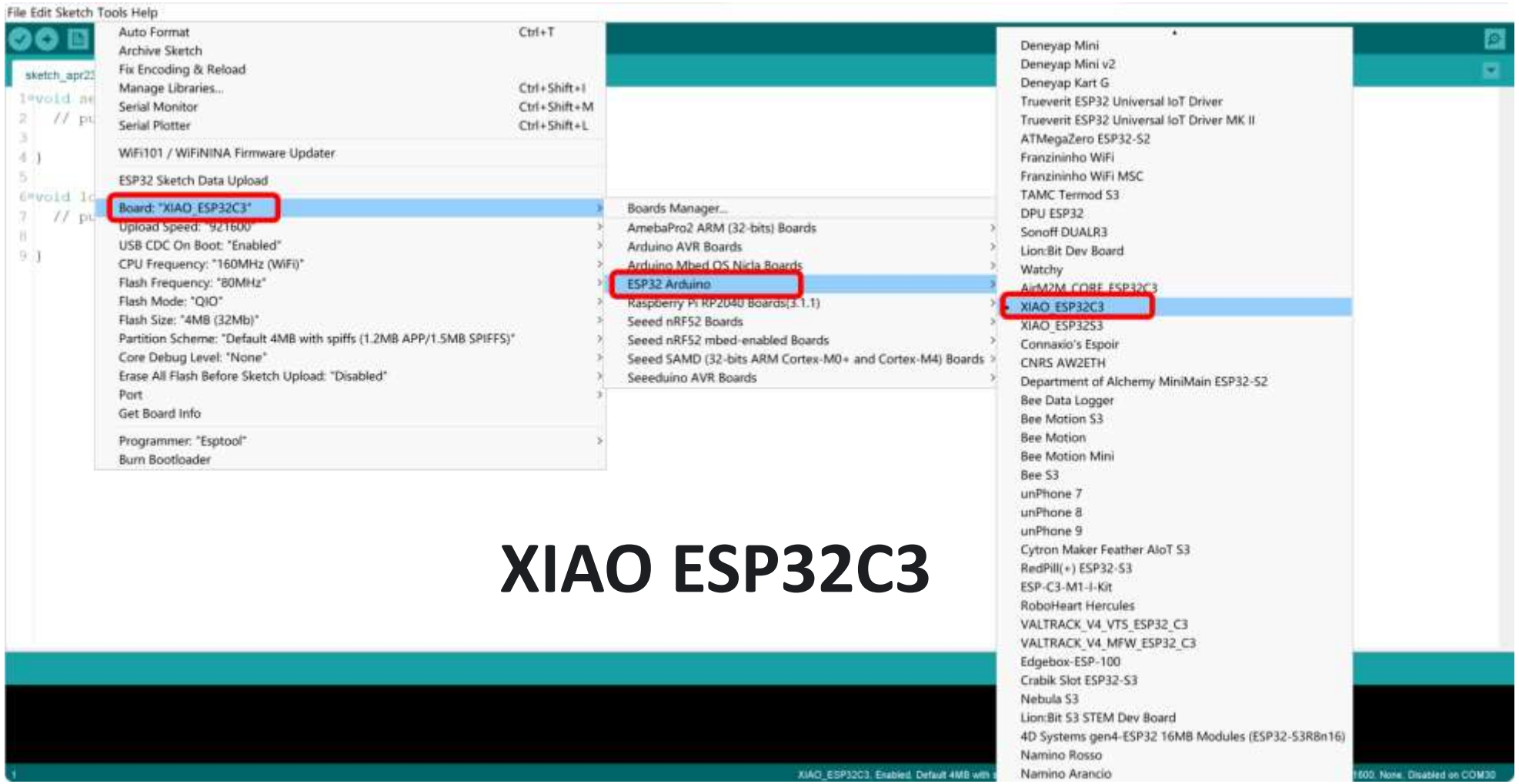

XIAO ESP32C3

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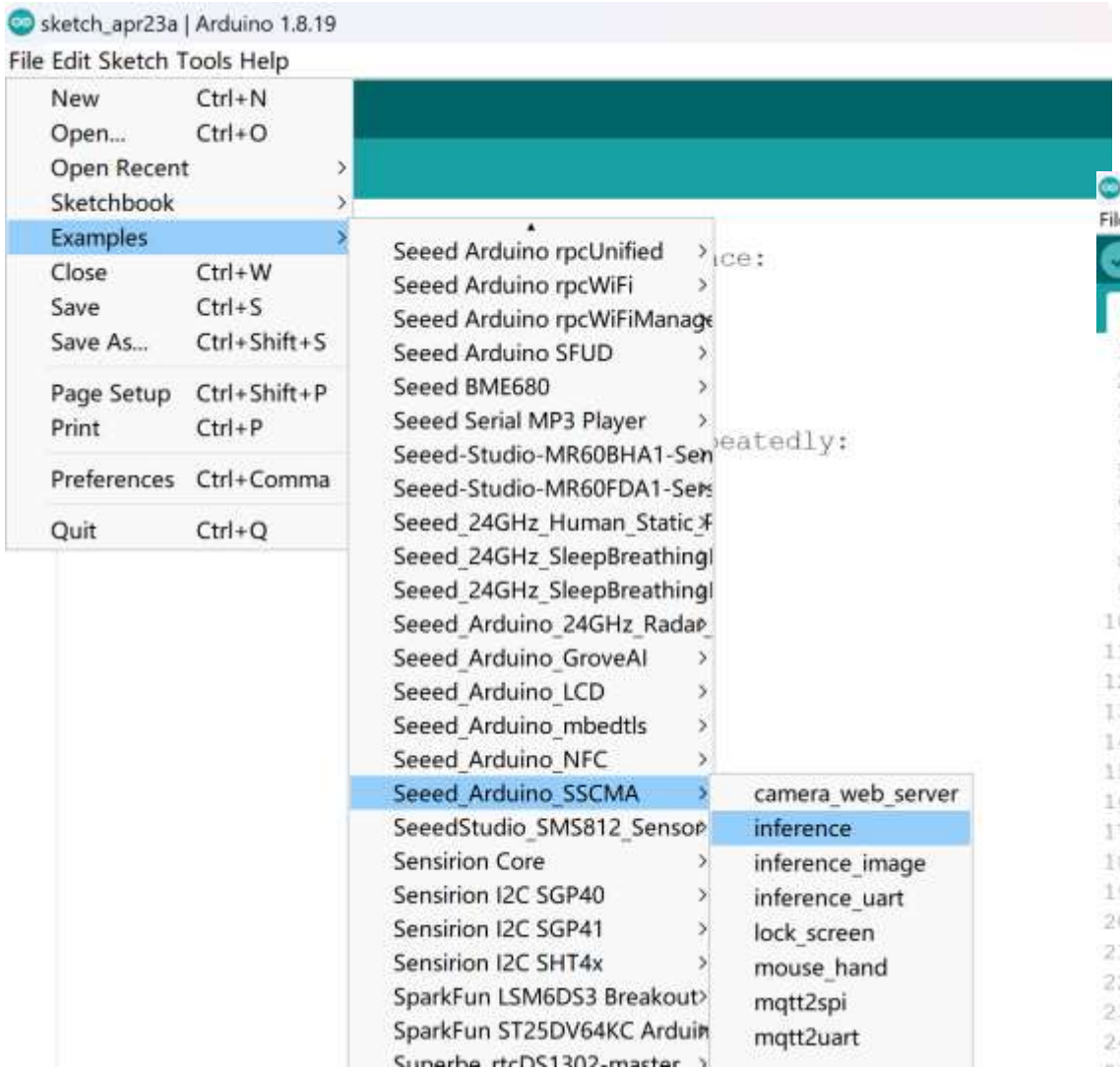
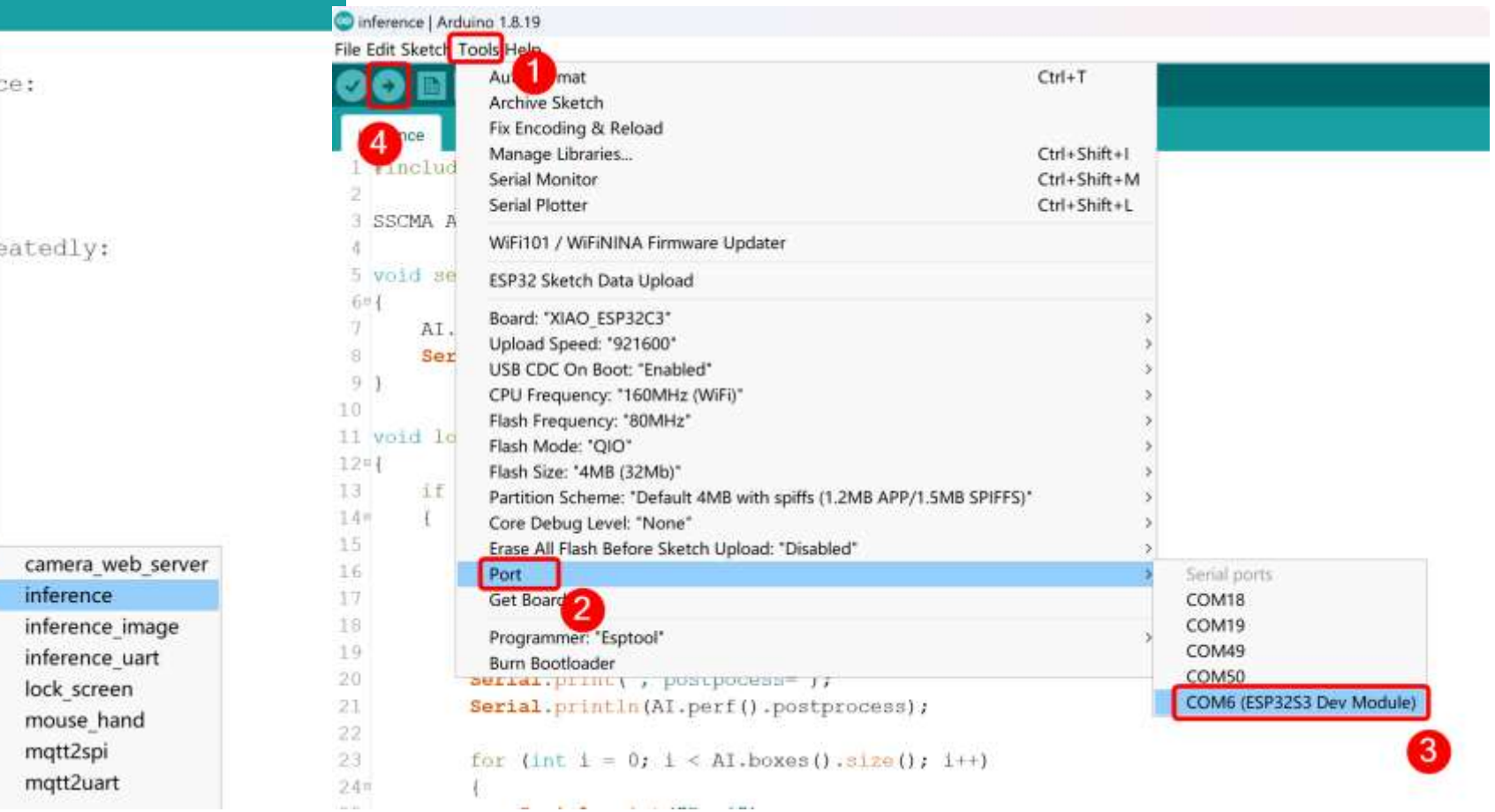
https://wiki.seeedstudio.com/grove_vision_ai_v2_software_support/#demo-1-use-xiao-to-get-recognition-results





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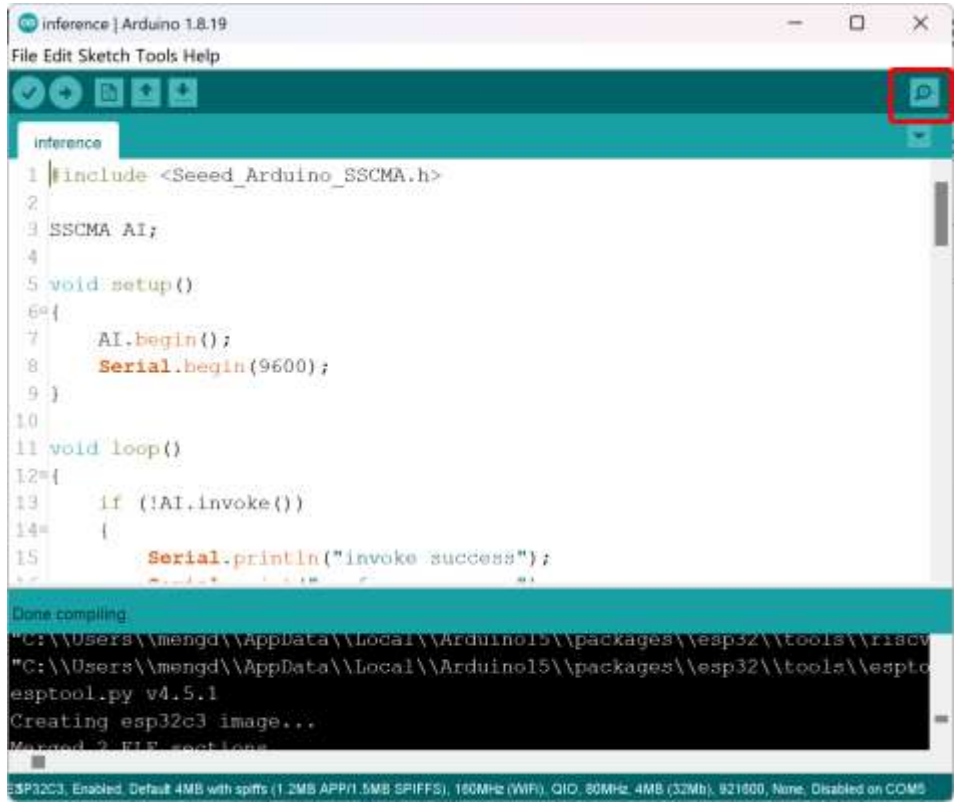

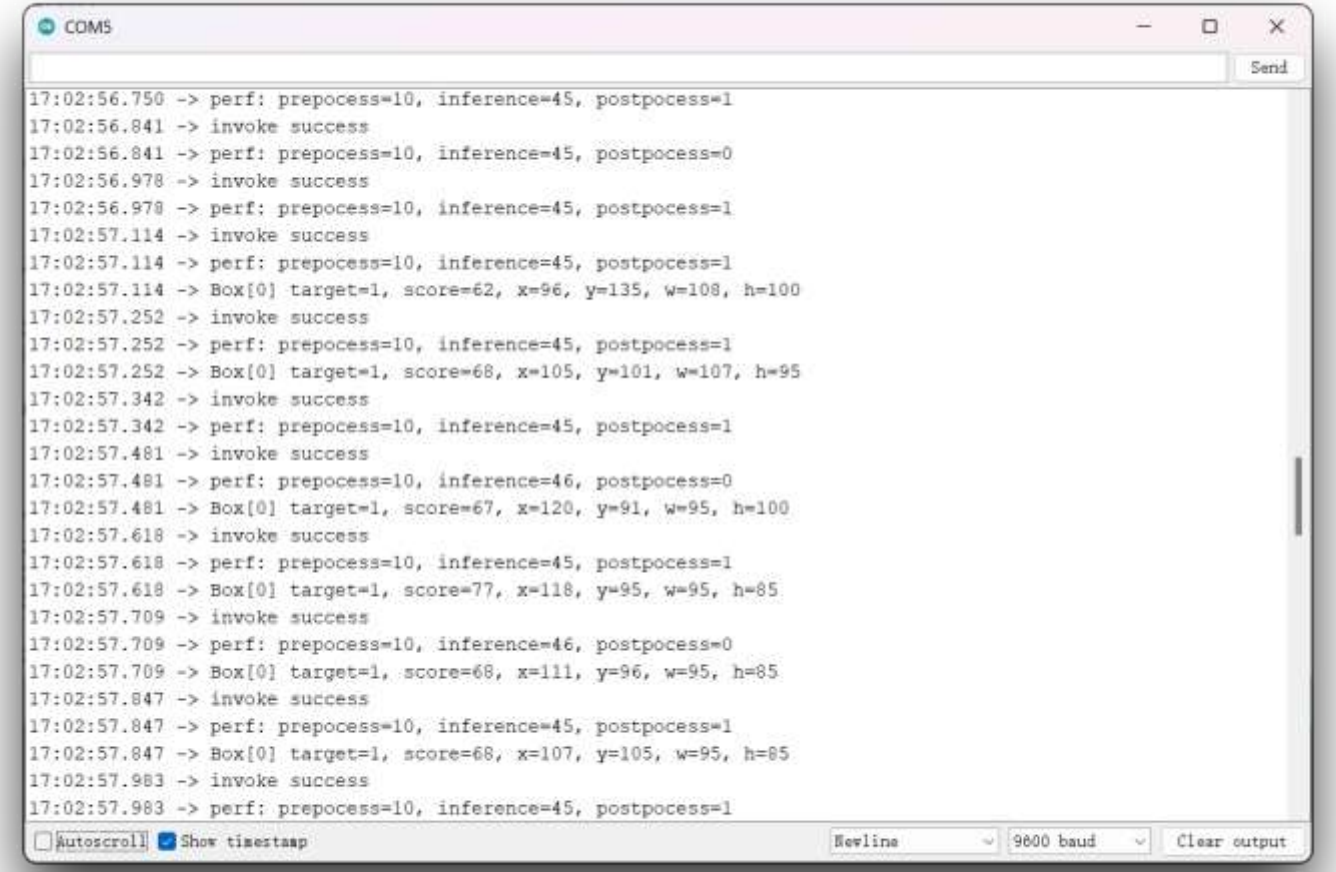

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https://wiki.seeedstudio.com/grove_vision_ai_v2_demo/#step-2-xiao-connects-to-the-computer-and-uploads-the-programme-for-xiao-1

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Thanks you!