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Universität Potsdam

Climate Data Collection and Analysis Workshop

February 27, 2024

Today's Schedule

Day 2: Designing, Building, and Analyzing Data from Open-Source Sensors

09:30 – 10:00 Moving towards High-Frequency Data

10:00 – 10:30 Potential of Low-Cost Hardware to Improve Environmental Monitoring

10:30 – 10:45 Tea/Coffee Break

10:45 – 11:15 Designing and Building a Low-Cost River Monitoring Station

11:15 – 12:30 Practical Example – Collecting, Transmitting, and Processing High-Frequency Data

12:30 – 13:30 Lunch Break

13:30 – 14:00 Construction of a Low-Cost Weather Station

14:00 – 14:45 Practical Example – Combining Sensor and Satellite Data for Further Analysis

14:45 – 15:00 Tea/Coffee Break

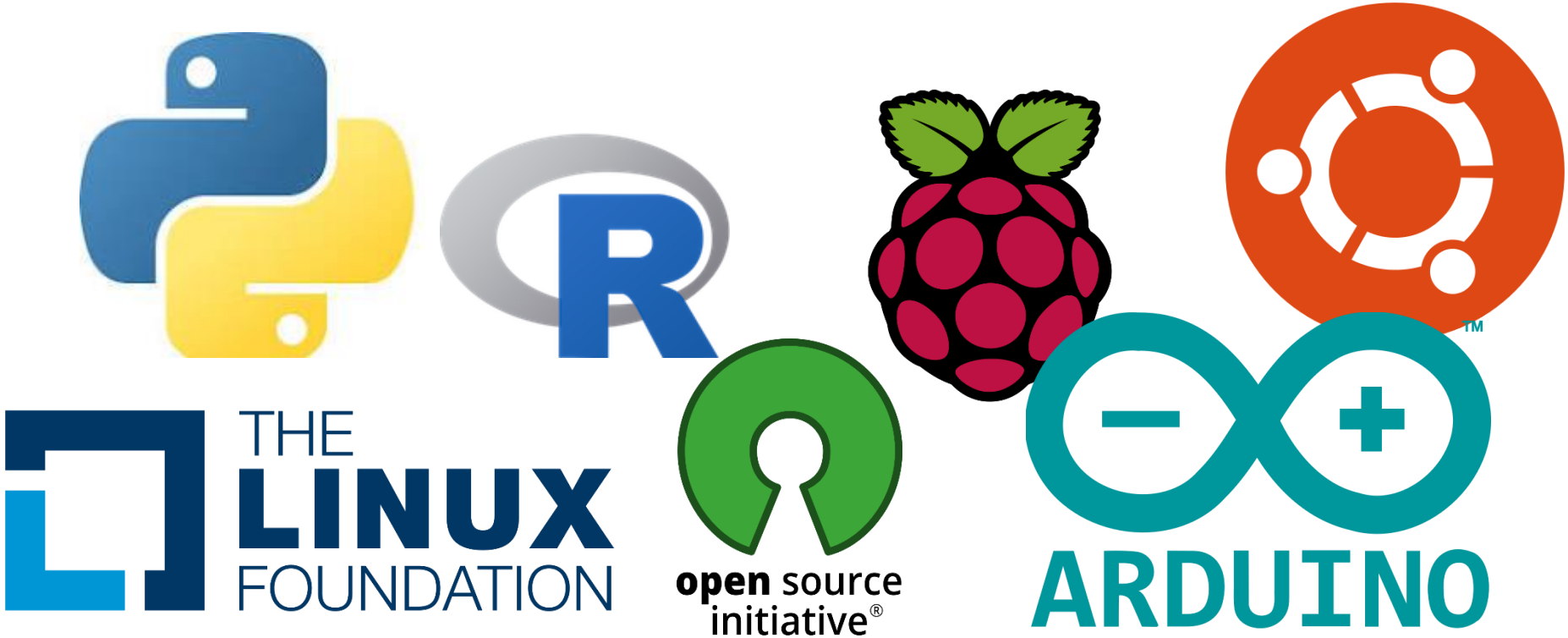
15:00 – 15:45 Research Outlook and Practical Applications in Nepal

15:45 – 16:00 Wrap Up and Further Resources

Overview of Open-Source Hardware

In the last ~20 years, there has been a massive decrease in the cost of computers

There has also been a huge expansion in the amount of free and open-source software



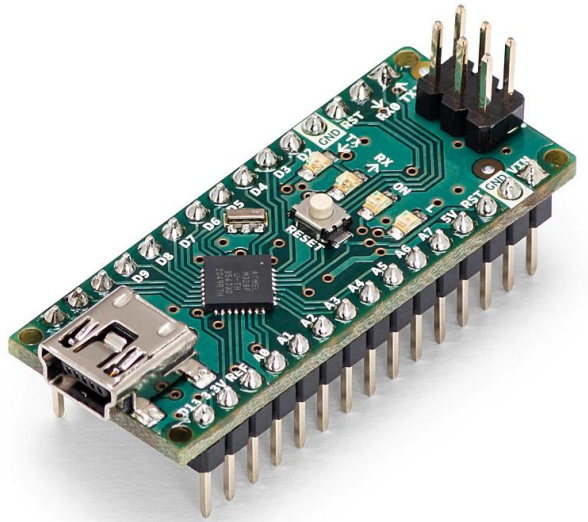
Via: Wikimedia.org

Focus on Open Hardware

There are several platforms that can be used to build open-source environmental monitoring platforms

The two most common, and the ones we will focus on, are the **Raspberry Pi** and **Arduino** platforms

Via: https://www.deviceplus.com/raspberry-pi/the-history-of-raspberry-pi/



Via: https://store.arduino.cc/products/arduino-nano

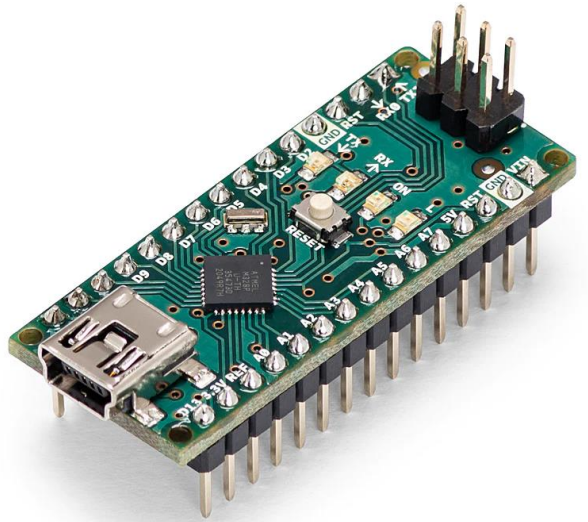
Focus on Open Hardware

These cover two main tasks:

Processing Data

Via: https://www.deviceplus.com/raspberry-pi/the-history-of-raspberry-pi/

Connecting to Sensors



Via: https://store.arduino.cc/products/arduino-nano

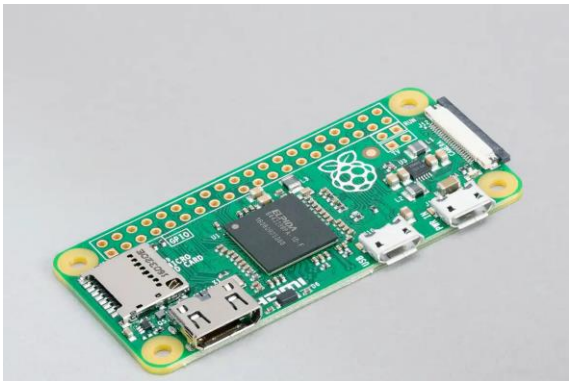
Raspberry Pi

Raspberry Pi was founded in 2005 with the goal of making computers available for low-cost for educational purposes

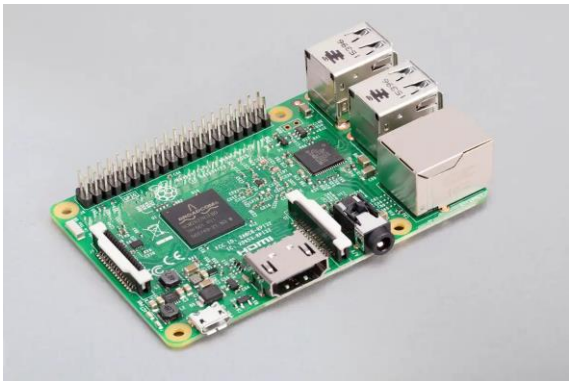
The prices range between ~4 Eur and ~30 Eur

They have been used in a huge range of projects, and are ideal for many applications

They are based on the Linux programming language, and are the equivalent of a very small computer



Via: https://www.raspberrypi.com/products/raspberry-pi-zero/



Via: https://www.raspberrypi.com/products/raspberry-pi-3-model-b/

Raspberry Pi

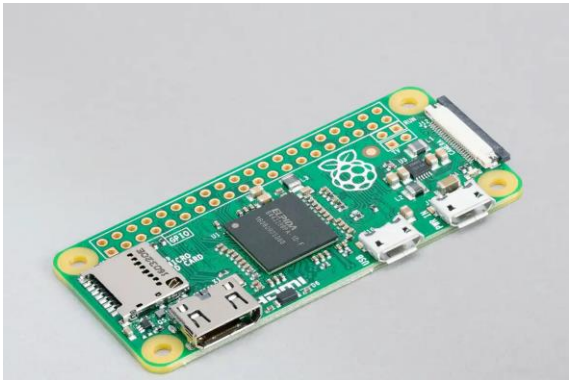
They require very little power

They can access wifi or Bluetooth

They are idea for processing, storing, and transmitting data from environmental sensors

They can be used in a wide variety of settings, with many different pieces of hardware

The software is fully customizable!



Via: https://www.raspberrypi.com/products/raspberry-pi-zero/

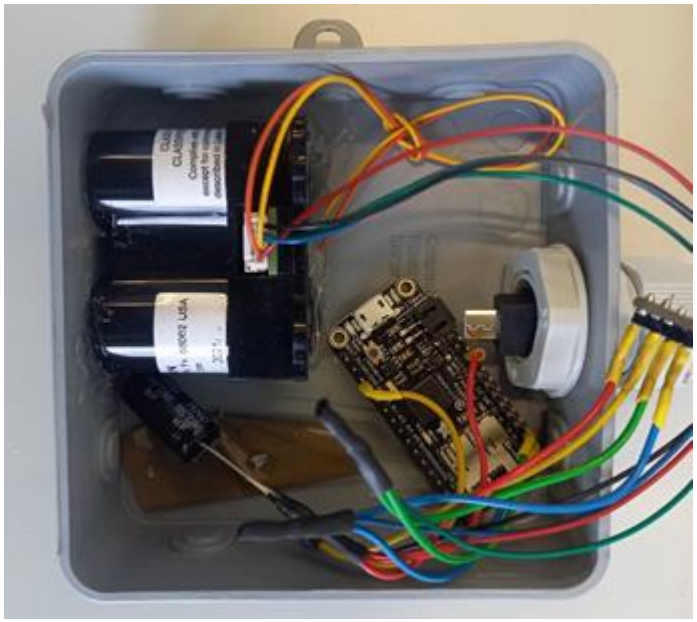
Via: https://www.raspberrypi.com/products/raspberry-pi-3-model-b/

Arduino

The Arduino project was started with a similar goal – create low-cost and open source hardware for educational purposes

Arduino boards are **not** small computers – you cannot attach a keyboard, screen, or treat them like a normal computer

These small boards are meant to ***interface with other hardware***

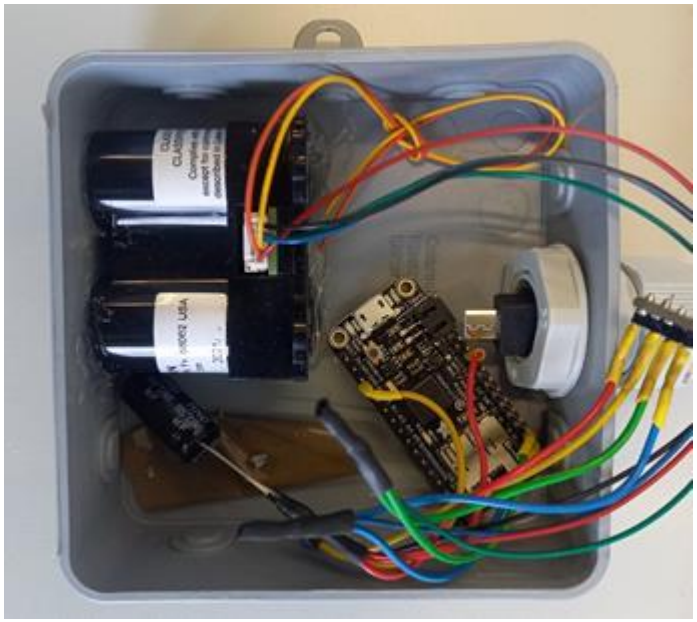


Arduino

Each board does **one task only** – it is perfect for taking data from any environmental sensor and **translating it into an easy to read format**

Since it is open source, there are **many different sensors** that can be used with the platform

Power consumption is very low, so they can even be used with a **battery**



Low-Cost Environmental Monitoring

Many environmental monitoring stations are very expensive

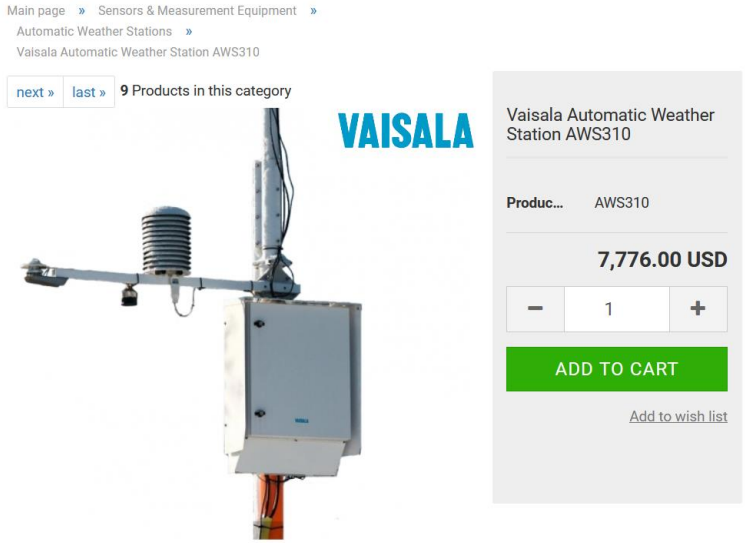
You are limited to which variables come with the commercial product

Prices for Automated Weather Stations (AWS)

Automated Weather Stations (AWS) pricing varies by vendor, configuration, and features. Different AWS vendors may offer a variety of different options and customisations. In general, AWS prices usually include the cost of hardware equipment, sensors, data loggers, communications equipment, software, and installation and maintenance.

For a basic AWS system, prices can range from a few thousand dollars to $10,000 USD. This price range depends largely on the type and number of sensors selected, the frequency of data collection, the data storage capacity, the communication method (e.g., wired or wireless), and the vendor's brand and services.

Via: https://www.niubol.com/All-products/Automated-Weather-Stations-AWS.html



https://shop.profec-ventus.com/product_info.php?language=en&info=p550_vaisala-automatic-weather-station-aws310.html

Low-Cost Environmental Monitoring

Alongside the development of low-cost computing, the price of monitoring the environment has also dropped significantly

https://www.seeedstudio.com/Grove-Temperature-Humidity-Sensor-DHT11.html

Low-Cost Environmental Monitoring

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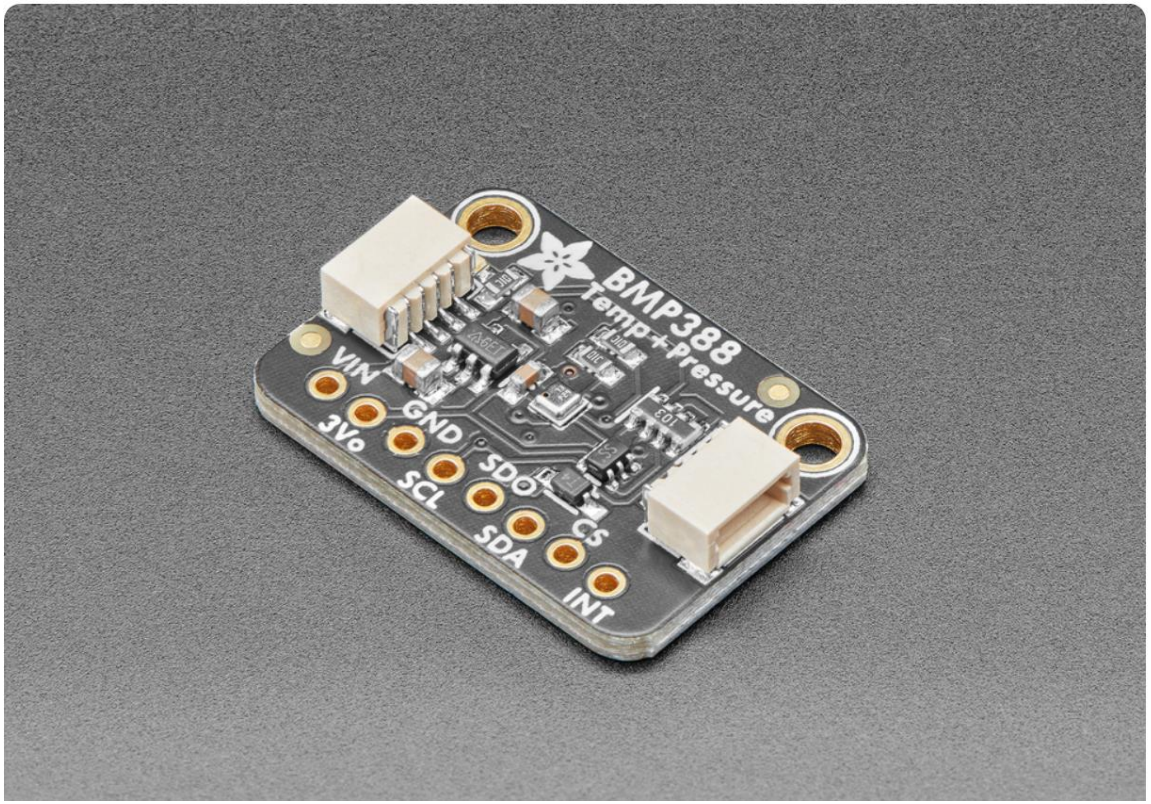

Adafruit BMP388 - Precision Barometric Pressure and Altimeter - STEMMA QT

Product ID: 3966

$9.95

In stock

1 Add to Cart

Also include 1 x STEMMA QT / Qwiic JST SH 4-pin to Premium Male Headers Cable ($0.95)

Qty	Discount
1-9	$9.95
10-99	$8.96
100+	$7.96

Add to Wishlist

Description

Technical Details

https://www.adafruit.com/product/3966

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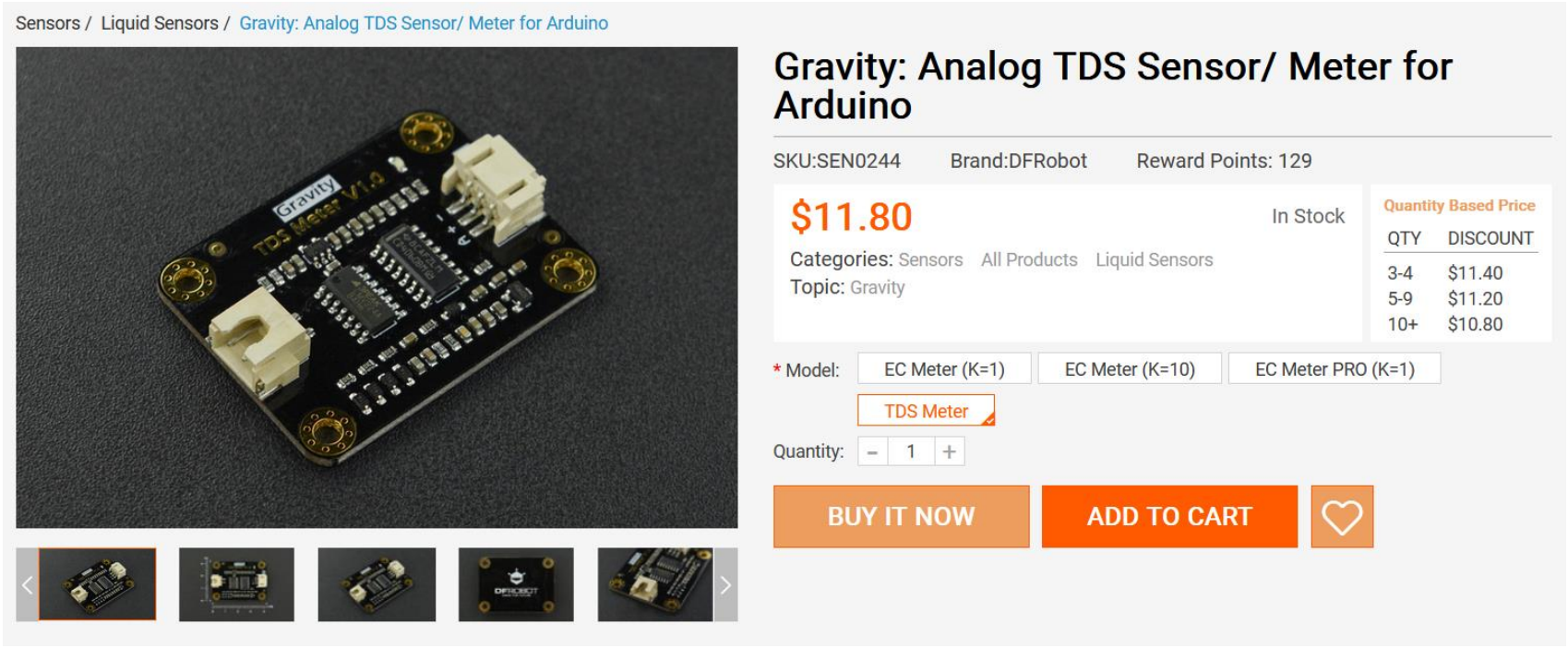


https://www.dfrobot.com/product-1662.html

Low-Cost Environmental Monitoring

The availability of Arduino-based sensors is also massive!

It is very likely that you can find a sensor that measures what you want, and that it is affordable

It is possible to duplicate the main functions of a weather station (or other monitoring station) for a fraction of the cost

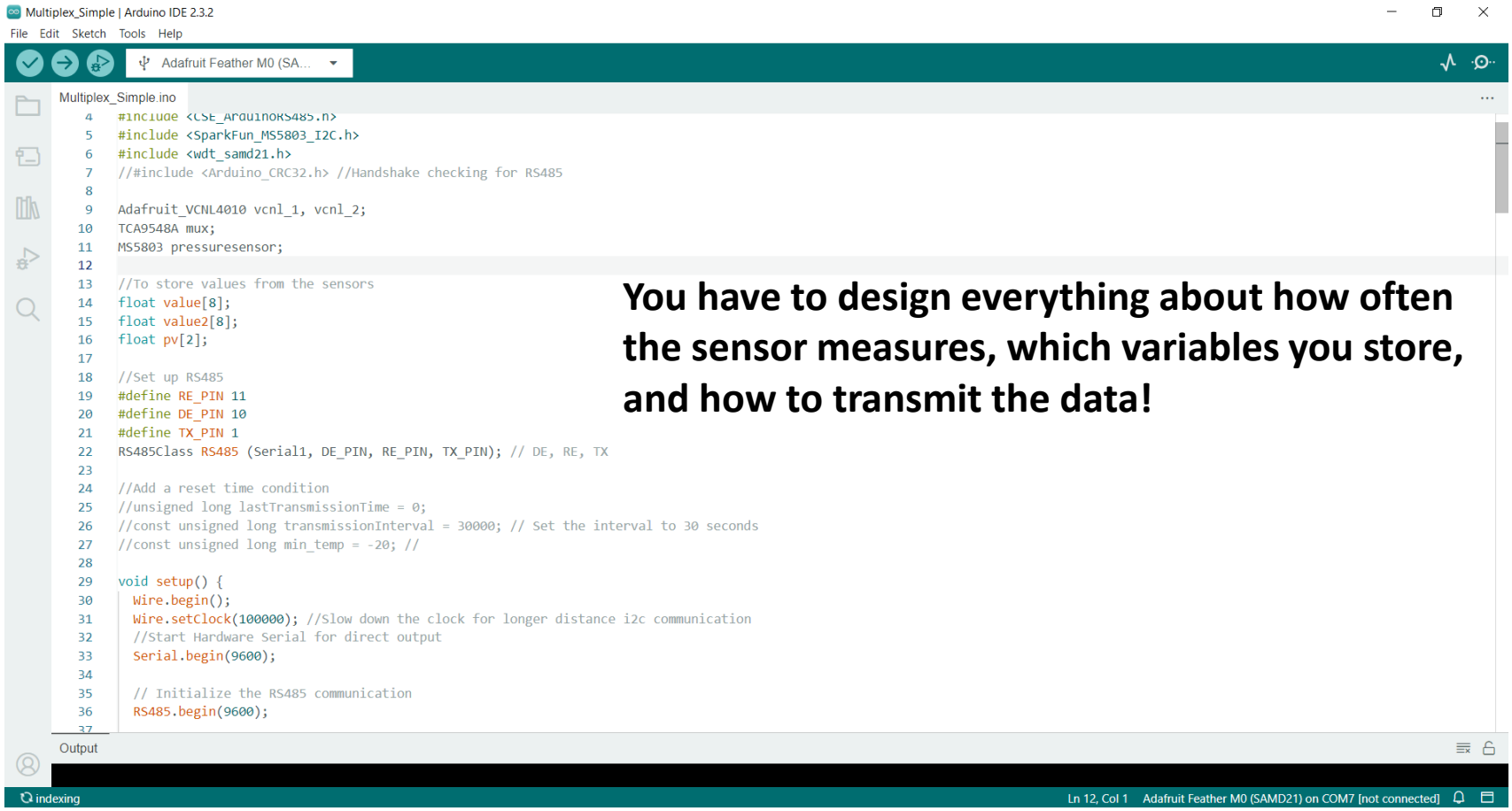
The main difference is that you need to build it yourself – it does not come in a simple package

This requires some knowledge and willingness to try things out

https://www.adafruit.com/category/42

Example Arduino Code

Example Arduino Code



You have to design everything about how often the sensor measures, which variables you store, and how to transmit the data!

Low-Cost Environmental Monitoring

Since the hardware and the software are both open source, there are **many learning resources online**

https://www.arduino.cc/education/courses

https://docs.arduino.cc/learn/starting-guide/getting-started-arduino/

https://www.arduino.cc/en/Tutorial/HomePage

https://www.instructables.com/Intro-to-Arduino/

https://www.raspberrypi.org/courses/learn-python

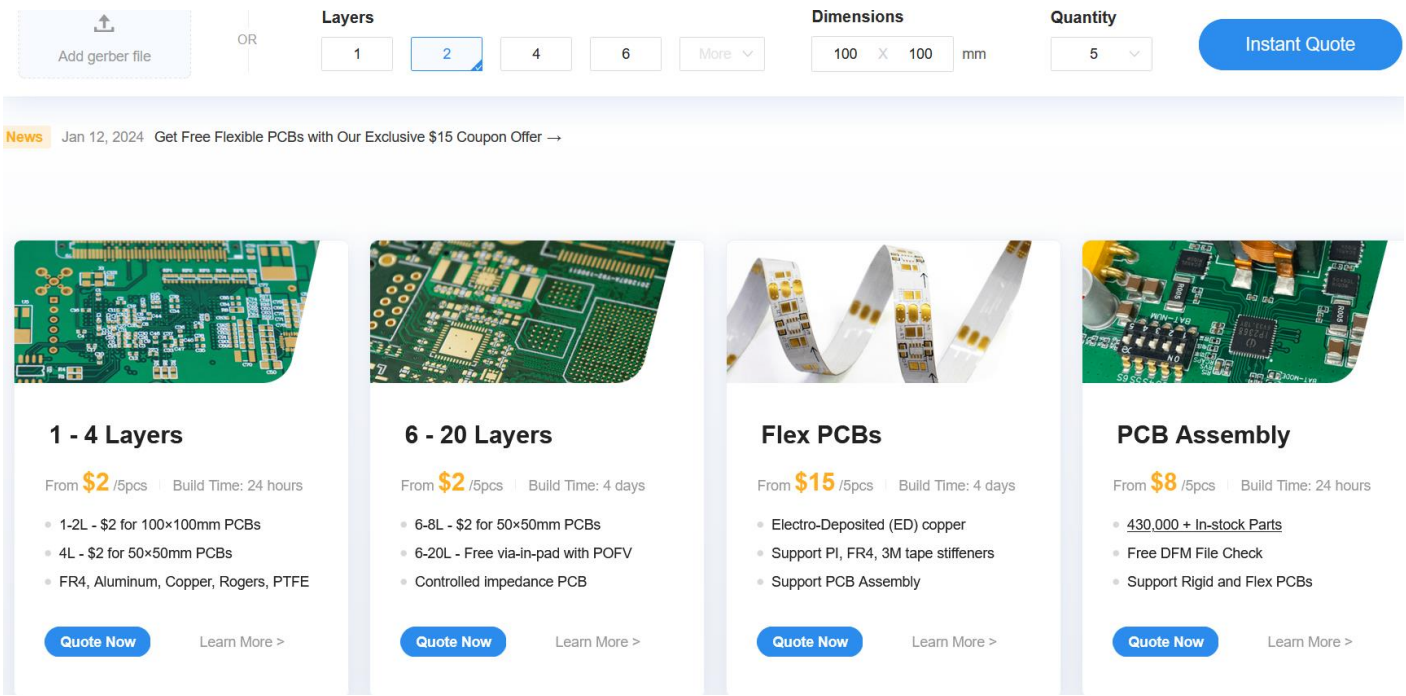
https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started

Creating Custom Hardware

The last step that has changed in the past few years is the availability of custom hardware

Services like https://jlcpcb.com/ allow you to design small hardware and have it quickly built and shipped

This means the availability of different environmental sensors is even larger!



Questions?