

## Week 14: Interface and Application Programming

6.5.2015

This week we will learn about interface and application programming.

The agenda:

[http://academy.cba.mit.edu/classes/interface\\_application\\_programming/index.html](http://academy.cba.mit.edu/classes/interface_application_programming/index.html)

### languages

C, GCC, C++, GDB, DDD  
.NET, C#, Mono  
Java, OpenJDK, IcedTea, Scala, Android  
Processing: <https://processing.org/> , Wiring, Arduino  
LabVIEW, Simulink, Max: , Pd, Scratch (aimed at kids):  
<https://scratch.mit.edu/>  
Bash: , Tcl  
Python (tutorial): <https://www.python.org/> -  
<https://docs.python.org/2/tutorial/>  
Perl:  
Ruby:  
JavaScript (tutorial): [https://developer.mozilla.org/en-US/Learn/Getting\\_started\\_with\\_the\\_web/JavaScript\\_basics](https://developer.mozilla.org/en-US/Learn/Getting_started_with_the_web/JavaScript_basics)  
Node.js: <https://nodejs.org/>  
V8: <https://nodejs.org/>  
Npm:  
Java script just as compatible to C.

### device interfaces

RS/EIA/TIA 232/422/485, pySerial: <http://pyserial.sourceforge.net/>  
Serialport: <https://www.npmjs.com/package/serialport>  
serial: [https://developer.chrome.com/apps/app\\_serial](https://developer.chrome.com/apps/app_serial)  
FTDI: <http://www.ftdichip.com/>  
libFTDI: <http://www.intra2net.com/en/developer/libftdi/>  
python-ftdi ftdi  
USB: <http://www.usb.org/home>  
, PyUSB usb  
IrDA python-irda  
GPIO, VISA, PyVISA  
Ethernet: [http://docwiki.cisco.com/wiki/Ethernet\\_Technologies](http://docwiki.cisco.com/wiki/Ethernet_Technologies)  
, SLIP, socket: <https://docs.python.org/2/library/socket.html>  
, ws: <https://www.npmjs.com/package/ws>  
hello.mag.45.html hello.mag.45.js video:

### user interfaces

Tk – graphic library: <http://www.tcl.tk/>  
, Tkinter:  
<http://www.pythonware.com/library/tkinter/introduction/index.htm>  
hello.load.45.py:  
wxWidgets: <http://wxwidgets.org/>  
, wxPython: <http://www.wxpython.org/>  
panel\_png\_path.py: <http://kokompe.cba.mit.edu/index.html>  
Qt: <http://www.qt.io/>  
, PyQt  
GTK, PyGTK  
Clutter: <https://blogs.gnome.org/clutter/>  
, PyClutter

forms,  
jQuery: <http://jqueryui.com/widget/>

### graphics

X Windows: <http://www.x.org/wiki/xline.c>, [ximage.c](#)  
AWT, JFC, Swing:  
<http://www.oracle.com/technetwork/java/index.html>  
JavaLine.java, JavaLine.html  
JavaImage.java, JavaImage.html – java plugins (not recommended to rely upon them)  
Canvas: <http://www.w3.org/TR/2dcontext/> (based on pixels)  
[canvas\\_lines.html](#)  
SVG: <http://www.w3.org/TR/SVG/> (everything you put on the screen remains an object that you can interact with and change its properties. Resolution dependent)  
[svg\\_lines.html](#)  
WebGL: <https://www.khronos.org/webgl/>  
, three.js: <http://threejs.org/>  
[webgl\\_lines.html](#):  
[http://academy.cba.mit.edu/classes/interface\\_application\\_programming/webgl\\_lines.html](http://academy.cba.mit.edu/classes/interface_application_programming/webgl_lines.html)  
OpenGL: <https://www.opengl.org/>  
, GLUT: <https://www.opengl.org/resources/libraries/glut/>  
, PyOpenGL: <http://pyopengl.sourceforge.net/>  
[glimage.c](#), [glsurf.c](#), [video](#)  
[glimage.py](#), [glsurf.py](#)  
RenderMan, Pixie, cgkit  
VTK (Volume graphics): <http://www.vtk.org/>  
, pyvtk: [http://www.vtk.org/Wiki/VTK/Writing\\_VTK\\_files\\_using\\_python](http://www.vtk.org/Wiki/VTK/Writing_VTK_files_using_python)  
, Mayavi: <http://docs.enthought.com/mayavi/mayavi/>

SVG – niceest to use, WebGL – much faster, good performance

**Multimedia** (video programming, sound programming)

SDL: <http://www.libsdl.org/>  
, Pygame: <http://www.pygame.org/news.html> (fund and easy to use)  
openFrameworks: <http://www.openframeworks.cc/>  
, ofpython: <https://code.google.com/p/openframeworks-python-bindings/downloads/list>  
HTML5: <http://www.html5rocks.com/en/features/multimedia>  
, WebRTC: <http://www.webrtc.org/>

### math

SciPy: <http://www.scipy.org/>  
, NumPy: <http://www.numpy.org/>  
, Ipython: <http://ipython.org/> (ibooks in a browser)  
Netlib, BLAS, LINPACK, LAPACK  
MATLAB: <http://se.mathworks.com/>  
, Octave, matplotlib:  
[matline.py](#), [matimage.py](#)  
R: <http://www.r-project.org/>  
, Rpy:  
Mathematica: <http://www.wolfram.com/>  
, SymPy, Sage  
typed arrays, web workers, file reader  
fab modules:  
Math.js: <http://mathjs.org/>  
, Science.js: <https://www.npmjs.com/package/science>  
, numbers.js:  
jqPlot:  
, D3: <http://d3js.org/> (interesting for visualising your project, the data coming in)

, Highcharts:

signal processing: [http://www.rle.mit.edu/dspg/pub\\_books.html](http://www.rle.mit.edu/dspg/pub_books.html) (a book)

, modeling:

<http://www.cambridge.org/us/academic/subjects/physics/computational-science-and-modelling/nature-mathematical-modeling>

Lots of projects need to do maths.

Lot of technical computing will be leading into javascript in the future.

### **assignment**

Write an application that interfaces with an input &/or output device.

Class:

Svg – standard for web graphics

Take an input and output device and build an interface to your device

FTPI serial

Pick a language

Processing, Python

Java Script

Then you need widgets – buttons, slicer

Put graphics on the screen

Do SGV, GL

Media frameworks

To put up more complex graphics

There is no right answers

People use some of these things

Try them

Mobile application

Raspberry Pi application

Native Android or iOS application

Talk to something that you made

Bluetooth application

Make an embedded something... and an application that talks to it

Do Hello World examples – but find the one that best fits you

My project: on my input board I have code ready that reads the light – the task can be to make a program that shows what the actual value is.

Assignment work:

Get Neil's code: into a folder

Copy it onto the microcontroller on the input board

Install PySerial

Neil's code copied onto input board

Look at the code – .py and change the code to make it do something else

In Terminal:

```
Skulinas-MBP:~ skulina$ /Documents
-bash: /Documents: No such file or directory
Skulinas-MBP:~ skulina$ //Documents
-bash: //Documents: No such file or directory
Skulinas-MBP:~ skulina$ cd Documents
Skulinas-MBP:Documents skulina$ cd
Verkefni/2015_FabLab/Week14_Interface_Programming/NeilsCode/
Skulinas-MBP:NeilsCode skulina$ make -f hello.light.45.make
avr-gcc -mmcu=attiny45 -Wall -Os -DF_CPU=8000000 -I./ -o
hello.light.45.out hello.light.45.c
avr-objcopy -O ihex hello.light.45.out hello.light.45.c.hex;\
avr-size --mcu=attiny45 --format=avr hello.light.45.out
AVR Memory Usage
```

```
-----
Device: attiny45
```

```
Program:      502 bytes (12.3% Full)
(.text + .data + .bootloader)
```

```
Data:         1 bytes (0.4% Full)
(.data + .bss + .noinit)
```

```
Skulinas-MBP:NeilsCode skulina$ make -f hello.light.45.make
program-usbtiny
avr-objcopy -O ihex hello.light.45.out hello.light.45.c.hex;\
avr-size --mcu=attiny45 --format=avr hello.light.45.out
AVR Memory Usage
```

```
-----
Device: attiny45
```

```
Program:      502 bytes (12.3% Full)
(.text + .data + .bootloader)
```

```
Data:         1 bytes (0.4% Full)
(.data + .bss + .noinit)
```

```
avrdude -p t45 -P usb -c usbtiny -U
flash:w:hello.light.45.c.hex
```

```
avrdude: AVR device initialized and ready to accept
instructions
```

```
Reading | ##### |
100% 0.00s
```

```
avrdude: Device signature = 0x1e9206
avrdude: NOTE: "flash" memory has been specified, an erase
cycle will be performed
        To disable this feature, specify the -D option.
avrdude: erasing chip
```

```
avrdude: reading input file "hello.light.45.c.hex"
avrdude: input file hello.light.45.c.hex auto detected as
Intel Hex
avrdude: writing flash (502 bytes):

Writing | ##### |
100% 0.52s

avrdude: 502 bytes of flash written
avrdude: verifying flash memory against hello.light.45.c.hex:
avrdude: load data flash data from input file
hello.light.45.c.hex:
avrdude: input file hello.light.45.c.hex auto detected as
Intel Hex
avrdude: input file hello.light.45.c.hex contains 502 bytes
avrdude: reading on-chip flash data:

Reading | ##### |
100% 0.70s

avrdude: verifying ...
avrdude: 502 bytes of flash verified

avrdude: safemode: Fuses OK (H:FF, E:DF, L:E2)

avrdude done. Thank you.
```

```
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
Traceback (most recent call last):
  File "hello.light.45.py", line 16, in <module>
    import serial
ImportError: No module named serial
Skulinas-MBP:NeilsCode skulina$ tar -xzf pyserial-2.6.tar.gz
tar: Error opening archive: Failed to open 'pyserial-
2.6.tar.gz'
Skulinas-MBP:NeilsCode skulina$ tar -xzf pyserial-2.7.tar.gz
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
Password:
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ cd pyserial-2.7
Skulinas-MBP:pyserial-2.7 skulina$ sudo python setup.py
install
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/distutils/dist.py:267: UserWarning: Unknown distribution
```

```
option: 'use_2to3'
  warnings.warn(msg)
running install
running build
running build_py
creating build
creating build/lib
creating build/lib/serial
copying serial/__init__.py -> build/lib/serial
copying serial/rfc2217.py -> build/lib/serial
copying serial/serialcli.py -> build/lib/serial
copying serial/serialjava.py -> build/lib/serial
copying serial/serialposix.py -> build/lib/serial
copying serial/serialutil.py -> build/lib/serial
copying serial/serialwin32.py -> build/lib/serial
copying serial/sermsdos.py -> build/lib/serial
copying serial/win32.py -> build/lib/serial
creating build/lib/serial/tools
copying serial/tools/__init__.py -> build/lib/serial/tools
copying serial/tools/list_ports.py -> build/lib/serial/tools
copying serial/tools/list_ports_linux.py ->
build/lib/serial/tools
copying serial/tools/list_ports_osx.py ->
build/lib/serial/tools
copying serial/tools/list_ports_posix.py ->
build/lib/serial/tools
copying serial/tools/list_ports_windows.py ->
build/lib/serial/tools
copying serial/tools/miniterm.py -> build/lib/serial/tools
creating build/lib/serial/urlhandler
copying serial/urlhandler/__init__.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_hwgrep.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_loop.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_rfc2217.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_socket.py ->
build/lib/serial/urlhandler
running build_scripts
creating build/scripts-2.7
copying and adjusting serial/tools/miniterm.py ->
build/scripts-2.7
changing mode of build/scripts-2.7/miniterm.py from 644 to 755
running install_lib
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/rfc2217.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
```

```
7/site-packages/serial
copying build/lib/serial/serialcli.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/serialjava.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/serialposix.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/serialutil.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/serialwin32.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
copying build/lib/serial/sermsdos.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_linux.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_osx.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_posix.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_windows.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/miniterm.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_hwgrep.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_loop.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
```

```
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_rfc2217.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_socket.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/win32.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/rfc2217.py to rfc2217.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialcli.py to serialcli.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialjava.py to serialjava.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialposix.py to serialposix.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialutil.py to serialutil.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialwin32.py to serialwin32.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/sermsdos.py to sermsdos.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports.py to list_ports.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_linux.py to
list_ports_linux.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_osx.py to
list_ports_osx.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_posix.py to
list_ports_posix.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
```

```
7/site-packages/serial/tools/list_ports_windows.py to
list_ports_windows.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/miniterm.py to miniterm.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_hwgrep.py to
protocol_hwgrep.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_loop.py to
protocol_loop.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_rfc2217.py to
protocol_rfc2217.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_socket.py to
protocol_socket.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/win32.py to win32.pyc
running install_scripts
copying build/scripts-2.7/miniterm.py ->
/Library/Frameworks/Python.framework/Versions/2.7/bin
changing mode of
/Library/Frameworks/Python.framework/Versions/2.7/bin/miniterm
.py to 755
running install_egg_info
Writing
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/pyserial-2.7-py2.7.egg-info
Skulinas-MBP:pyserial-2.7 skulina$ python hello.light.45.py
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file
'hello.light.45.py': [Errno 2] No such file or directory
Skulinas-MBP:pyserial-2.7 skulina$ cd ..
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
command line: hello.light.45.py serial_port
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$
```

---

11.5.2015

Reconnecting and testing wheather Neil's code was working – on two boards. It did.

The values of the reading from the input board are ranging from 740-1022 are .

Slush – gate. Dimmer...

Resister prevents overflow – photoresistor works the same. Measures the voltage. A function of how much light the photoresistor lets through and the action of the resistor.

I opened hello.light.45.py

The intension is to catch a reading of the light through the input board every minute and write a CSV file that could be imported into excel to give a chart of a light reading of a 24 hours period.

Inserted code (at the end) - from:  
<https://docs.python.org/2/library/csv.html>

```
class UnicodeWriter:
    """
    A CSV writer which will write rows to CSV file "f",
    which is encoded in the given encoding.
    """

    def __init__(self, f, dialect=csv.excel, encoding="utf-8",
**kwsds):
        # Redirect output to a queue
        self.queue = cStringIO.StringIO()
        self.writer = csv.writer(self.queue, dialect=dialect,
**kwsds)
        self.stream = f
        self.encoder = codecs.getincrementalencoder(encoding)()

    def writerow(self, row):
        self.writer.writerow([s.encode("utf-8") for s in row])
        # Fetch UTF-8 output from the queue ...
        data = self.queue.getvalue()
        data = data.decode("utf-8")
        # ... and reencode it into the target encoding
        data = self.encoder.encode(data)
        # write to the target stream
        self.stream.write(data)
        # empty queue
        self.queue.truncate(0)

    def writerows(self, rows):
        for row in rows:
            self.writerow(row)
```

Wrote the following code and inserted at front:

```
import csv
csvfile=open('light-reading.csv', 'wb')
lightwriter = csv.writer(csvfile, delimiter=' ',
                        quotechar='|',
quoting=csv.QUOTE_MINIMAL)
```

Inserted:     lightwriter.writerow(filter)

after 'filter'

Tested and csv-file that was created in the folder where the code resides.

---

Analysing:

Get value (filter)

Update display

This needs to stay...

nexttime = 0

```
if nexttime < time.gmtime([secs]):
    lightwriter.writerow([filter])
    nexttime = time.gmtime([secs])+300
```

---

The terminal:

```
Skulinas-MBP:~ skulina$ /Documents
-bash: /Documents: No such file or directory
Skulinas-MBP:~ skulina$ //Documents
-bash: //Documents: No such file or directory
Skulinas-MBP:~ skulina$ cd Documents
Skulinas-MBP:Documents skulina$ cd
Verkefni/2015_FabLab/Week14_Interface_Programming/NeilsCode/
Skulinas-MBP:NeilsCode skulina$ make -f hello.light.45.make
avr-gcc -mmcu=attiny45 -Wall -Os -DF_CPU=8000000 -I./ -o
hello.light.45.out hello.light.45.c
avr-objcopy -O ihex hello.light.45.out hello.light.45.c.hex;\
avr-size --mcu=attiny45 --format=avr hello.light.45.out
AVR Memory Usage
```

```
-----
Device: attiny45
```

```
Program:       502 bytes (12.3% Full)
(.text + .data + .bootloader)
```

```
Data:           1 bytes (0.4% Full)
(.data + .bss + .noinit)
```

```
Skulinas-MBP:NeilsCode skulina$ make -f hello.light.45.make
program-usbtiny
avr-objcopy -O ihex hello.light.45.out hello.light.45.c.hex;\
avr-size --mcu=attiny45 --format=avr hello.light.45.out
AVR Memory Usage
```

---

Device: attiny45

Program: 502 bytes (12.3% Full)  
(.text + .data + .bootloader)

Data: 1 bytes (0.4% Full)  
(.data + .bss + .noinit)

```
avrdude -p t45 -P usb -c usbtiny -U  
flash:w:hello.light.45.c.hex
```

avrdude: AVR device initialized and ready to accept  
instructions

```
Reading | ##### |  
100% 0.00s
```

avrdude: Device signature = 0x1e9206  
avrdude: NOTE: "flash" memory has been specified, an erase  
cycle will be performed  
To disable this feature, specify the -D option.  
avrdude: erasing chip  
avrdude: reading input file "hello.light.45.c.hex"  
avrdude: input file hello.light.45.c.hex auto detected as  
Intel Hex  
avrdude: writing flash (502 bytes):

```
Writing | ##### |  
100% 0.52s
```

avrdude: 502 bytes of flash written  
avrdude: verifying flash memory against hello.light.45.c.hex:  
avrdude: load data flash data from input file  
hello.light.45.c.hex:  
avrdude: input file hello.light.45.c.hex auto detected as  
Intel Hex  
avrdude: input file hello.light.45.c.hex contains 502 bytes  
avrdude: reading on-chip flash data:

```
Reading | ##### |  
100% 0.70s
```

avrdude: verifying ...  
avrdude: 502 bytes of flash verified

avrdude: safemode: Fuses OK (H:FF, E:DF, L:E2)

avrdude done. Thank you.

```
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py  
Traceback (most recent call last):  
  File "hello.light.45.py", line 16, in <module>  
    import serial
```

```
ImportError: No module named serial
Skulinas-MBP:NeilsCode skulina$ tar -xzf pyserial-2.6.tar.gz
tar: Error opening archive: Failed to open 'pyserial-
2.6.tar.gz'
Skulinas-MBP:NeilsCode skulina$ tar -xzf pyserial-2.7.tar.gz
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
Password:
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ sudo python setup.py install
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file 'setup.py':
[Errno 2] No such file or directory
Skulinas-MBP:NeilsCode skulina$ cd pyserial-2.7
Skulinas-MBP:pyserial-2.7 skulina$ sudo python setup.py
install
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/distutils/dist.py:267: UserWarning: Unknown distribution
option: 'use_2to3'
  warnings.warn(msg)
running install
running build
running build_py
creating build
creating build/lib
creating build/lib/serial
copying serial/__init__.py -> build/lib/serial
copying serial/rfc2217.py -> build/lib/serial
copying serial/serialcli.py -> build/lib/serial
copying serial/serialjava.py -> build/lib/serial
copying serial/serialposix.py -> build/lib/serial
copying serial/serialutil.py -> build/lib/serial
copying serial/serialwin32.py -> build/lib/serial
copying serial/sermsdos.py -> build/lib/serial
copying serial/win32.py -> build/lib/serial
creating build/lib/serial/tools
copying serial/tools/__init__.py -> build/lib/serial/tools
copying serial/tools/list_ports.py -> build/lib/serial/tools
copying serial/tools/list_ports_linux.py ->
build/lib/serial/tools
copying serial/tools/list_ports_osx.py ->
build/lib/serial/tools
copying serial/tools/list_ports_posix.py ->
build/lib/serial/tools
copying serial/tools/list_ports_windows.py ->
build/lib/serial/tools
copying serial/tools/miniterm.py -> build/lib/serial/tools
creating build/lib/serial/urlhandler
copying serial/urlhandler/__init__.py ->
```

```
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_hwgrep.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_loop.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_rfc2217.py ->
build/lib/serial/urlhandler
copying serial/urlhandler/protocol_socket.py ->
build/lib/serial/urlhandler
running build_scripts
creating build/scripts-2.7
copying and adjusting serial/tools/miniterm.py ->
build/scripts-2.7
changing mode of build/scripts-2.7/miniterm.py from 644 to 755
running install_lib
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/rfc2217.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/serialcli.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/serialjava.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/serialposix.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/serialutil.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/serialwin32.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
copying build/lib/serial/sermsdos.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial/tools
copying build/lib/serial/tools/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_linux.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.7/site-packages/serial/tools
```

```
copying build/lib/serial/tools/list_ports_osx.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_posix.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/list_ports_windows.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
copying build/lib/serial/tools/miniterm.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools
creating
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/__init__.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_hwgrep.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_loop.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_rfc2217.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/urlhandler/protocol_socket.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler
copying build/lib/serial/win32.py ->
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/rfc2217.py to rfc2217.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialcli.py to serialcli.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialjava.py to serialjava.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialposix.py to serialposix.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialutil.py to serialutil.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/serialwin32.py to serialwin32.pyc
```

```
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/sermsdos.py to sermsdos.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports.py to list_ports.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_linux.py to
list_ports_linux.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_osx.py to
list_ports_osx.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_posix.py to
list_ports_posix.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/list_ports_windows.py to
list_ports_windows.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/tools/miniterm.py to miniterm.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/__init__.py to __init__.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_hwgrep.py to
protocol_hwgrep.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_loop.py to
protocol_loop.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_rfc2217.py to
protocol_rfc2217.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/urlhandler/protocol_socket.py to
protocol_socket.pyc
byte-compiling
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/serial/win32.py to win32.pyc
running install_scripts
copying build/scripts-2.7/miniterm.py ->
/Library/Frameworks/Python.framework/Versions/2.7/bin
changing mode of
```

```

/Library/Frameworks/Python.framework/Versions/2.7/bin/miniterm
.py to 755
running install_egg_info
Writing
/Library/Frameworks/Python.framework/Versions/2.7/lib/python2.
7/site-packages/pyserial-2.7-py2.7.egg-info
Skulinas-MBP:pyserial-2.7 skulina$ python hello.light.45.py
/Library/Frameworks/Python.framework/Versions/2.7/Resources/Py
thon.app/Contents/MacOS/Python: can't open file
'hello.light.45.py': [Errno 2] No such file or directory
Skulinas-MBP:pyserial-2.7 skulina$ cd ..
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
command line: hello.light.45.py serial_port
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
File "hello.light.45.py", line 83
    self.writer = csv.writer(self.queue, dialect=dialect,
**kws)
    ^
IndentationError: unexpected indent
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
python hello.light.45.py /dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
File "hello.light.45.py", line 108
    csvwriter = csv.writer(codecs.open("some.csv", "w", "utf-
8"))
    ^
IndentationError: unexpected indent
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Exception in Tkinter callback
Traceback (most recent call last):

```

```

File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
File "hello.light.45.py", line 50, in idle
    lightwriter.writerow(Filter)
NameError: global name 'Filter' is not defined
^[A^CTraceback (most recent call last):
  File "hello.light.45.py", line 85, in <module>
    root.mainloop()
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1121, in mainloop
    self.tk.mainloop(n)
KeyboardInterrupt
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
^CException in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 43, in idle
    byte4 = ord(ser.read())
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/site-packages/serial/serialposix.py", line 461, in read
    ready,_,_ = select.select([self.fd],[],[], self._timeout)
KeyboardInterrupt

python hello.light.45.py /dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
python hello.light.45.py /dev/tty.usbserial-FTGA2IBF

cd

python hello.light.45.py /dev/tty.usbserial-FTGA2IBF
^CException in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)

```

```

File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
File "hello.light.45.py", line 43, in idle
    byte4 = ord(ser.read())
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/site-packages/serial/serialposix.py", line 461, in read
    ready,_,_ = select.select([self.fd],[],[], self._timeout)
KeyboardInterrupt
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Exception in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 50, in idle
    lightwriter.writerow(filter)
Error: sequence expected
^[A^C
Traceback (most recent call last):
  File "hello.light.45.py", line 85, in <module>
    root.mainloop()
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1121, in mainloop
    self.tk.mainloop(n)
KeyboardInterrupt
Skulinas-MBP:NeilsCode skulina$
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Exception in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 43, in idle
    byte4 = ord(ser.read())
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2

```

```

../site-packages/serial/serialposix.py", line 485, in read
    raise SerialException('read failed: %s' % (e,))
SerialException: read failed: [Errno 6] Device not configured
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Exception in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 52, in idle
    if nexttime < time.gmtime([secs]):
UnboundLocalError: local variable 'nexttime' referenced before
assignment
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
^CException in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 45, in idle
    byte4 = ord(ser.read())
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/site-packages/serial/serialposix.py", line 461, in read
    ready,_,_ = select.select([self.fd],[],[], self._timeout)
KeyboardInterrupt
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
^CException in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 45, in idle
    byte4 = ord(ser.read())

```

```
File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/site-packages/serial/serialposix.py", line 461, in read
    ready,_,_ = select.select([self.fd],[],[], self._timeout)
KeyboardInterrupt
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Exception in Tkinter callback
Traceback (most recent call last):
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 1532, in __call__
    return self.func(*args)
  File
"/Library/Frameworks/Python.framework/Versions/2.7/lib/python2
.7/lib-tk/Tkinter.py", line 583, in callit
    func(*args)
  File "hello.light.45.py", line 52, in idle
    if nexttime < time.gmtime([secs]):
NameError: global name 'secs' is not defined
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$ python hello.light.45.py
/dev/tty.usbserial-FTGA2IBF
Skulinas-MBP:NeilsCode skulina$
```

---

The final version of the code:

```
#
# hello.light.45.py
#
# receive and display light level
# hello.light.45.py serial_port
#
# Neil Gershenfeld
# CBA MIT 10/24/09
#
# (c) Massachusetts Institute of Technology 2009
# Permission granted for experimental and personal use;
# license for commercial sale available from MIT
#

from Tkinter import *
import serial
import csv
import time
csvfile=open('light-reading.csv', 'wb')
lightwriter = csv.writer(csvfile, delimiter=' ',
                        quoting=csv.QUOTE_MINIMAL,
                        quotechar='|')
```

```

WINDOW = 600 # window size
eps = 0.5 # filter time constant
filter = 0.0 # filtered value
nexttime = 0

def idle(parent,canvas):
    global filter, eps, nexttime
    #
    # idle routine
    #
    byte2 = 0
    byte3 = 0
    byte4 = 0
    ser.flush()
    while 1:
        #
        # find framing
        #
        byte1 = byte2
        byte2 = byte3
        byte3 = byte4
        byte4 = ord(ser.read())
        if ((byte1 == 1) & (byte2 == 2) & (byte3 == 3) & (byte4
== 4)):
            break
        low = ord(ser.read())
        high = ord(ser.read())
        value = 256*high + low
        filter = (1-eps)*filter + eps*value
        if nexttime < time.time():
            lightwriter.writerow([filter])
            nexttime = time.time()+300
    x = int(.2*WINDOW + (.9-.2)*WINDOW*filter/1024.0)
    canvas.itemconfigure("text",text="%.1f"%filter)
    canvas.coords('rect1',.2*WINDOW,.05*WINDOW,x,.2*WINDOW)
    canvas.coords('rect2',x,.05*WINDOW,.9*WINDOW,.2*WINDOW)
    canvas.update()
    parent.after_idle(idle,parent,canvas)

#
# check command line arguments
#
if (len(sys.argv) != 2):
    print "command line: hello.light.45.py serial_port"
    sys.exit()
port = sys.argv[1]
#
# open serial port
#
ser = serial.Serial(port,9600)
ser.setDTR()
#

```

```

# set up GUI
#
root = Tk()
root.title('hello.light.45.py (q to exit)')
root.bind('q','exit')
canvas = Canvas(root, width=WINDOW, height=.25*WINDOW,
background='white')
canvas.create_text(.1*WINDOW,.125*WINDOW,text=".33",font=("Hel
vetica", 24),tags="text",fill="#0000b0")
canvas.create_rectangle(.2*WINDOW,.05*WINDOW,.3*WINDOW,.2*WIND
OW, tags='rect1', fill='#b00000')
canvas.create_rectangle(.3*WINDOW,.05*WINDOW,.9*WINDOW,.2*WIND
OW, tags='rect2', fill='#0000b0')
canvas.pack()
#
# start idle loop
#
root.after(100,idle,root,canvas)
root.mainloop()

```

The .csv file can be imported to excel.  
Go file import – as .csv file – import, chose file – Get Data  
–

This file can then be made into a graph to view the changes  
occurring over time of the natural light.