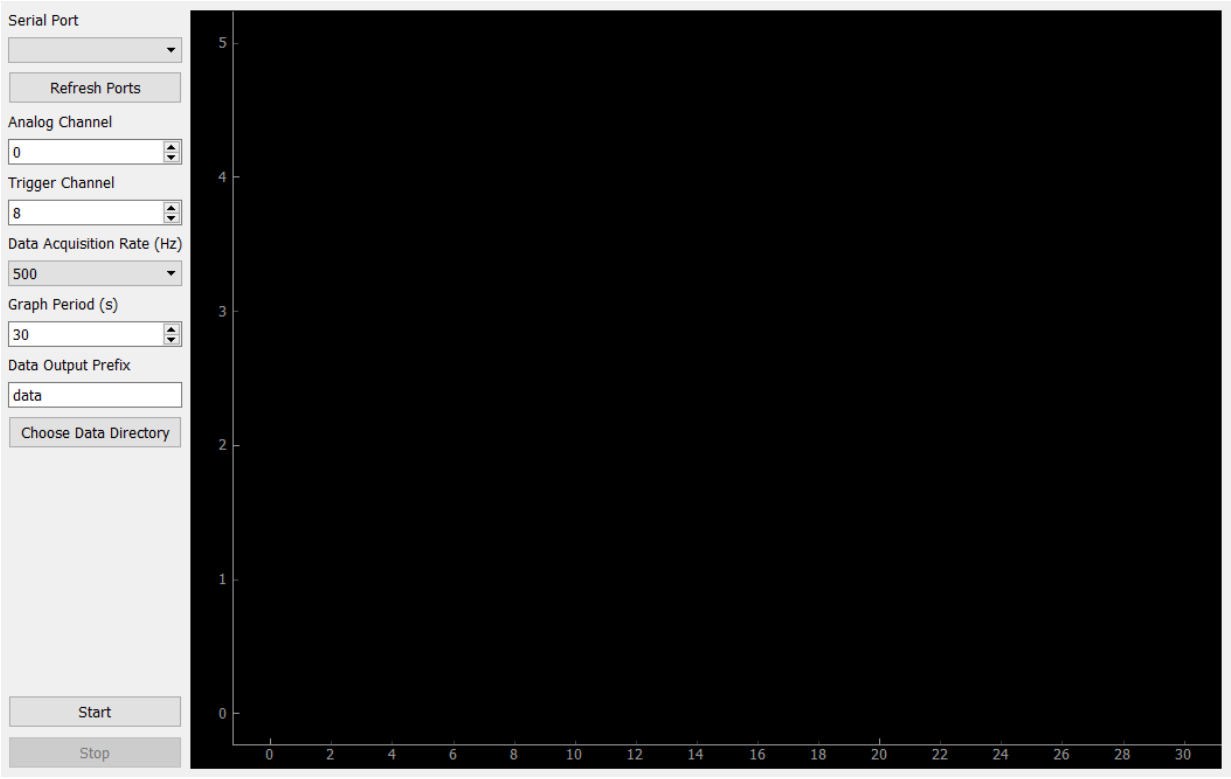
Supporting Information

SOFTWARE INSTALLATION

1. Install the latest version of Python 2.7.
   https://www.python.org/downloads/
2. Install the following python libraries (all are available with open-source licenses):
   a. PyQt4 for Python 2.7
      https://riverbankcomputing.com/software/pyqt/download
   b. pyqtgraph
      http://www.pyqtgraph.org/
   c. pyserial
      https://github.com/pyserial/pyserial
3. Install the Arduino IDE.
   https://www.arduino.cc/en/Main/Software
4. Connect the Arduino to the computer.
5. Open the Arduino sketch located at /ArduinoDataLogger/ArduinoSketch/**ArduinoSketch.ino**
6. Go to Tools->Port and select the port that is connected to the Arduino.
7. Upload the sketch to the Arduino by clicking the "Upload" button in the top left corner of the Arduino IDE.
8. Run **ArduinoDataLogger.pyw** to start the data acquisition program. It can be started through the command line / terminal using the python command.

OPERATION



Serial Port

This section displays a list of the usable ports on the computer. Select the port that is connected to the Arduino. This will be the same port as the one chosen in the Arduino IDE. When pressed, the "Refresh Ports" button will update the list of usable ports.

Analog Channel

The number in this box corresponds to the channel that the Arduino should read data from.

Trigger Channel

The number in this box corresponds to the digital channel that will start data acquisition when it receives a 'High' (5 V) signal.

Data Acquisition Rate

This box gives a list of the rates that the Arduino can acquire data.

Graph Period

This box controls the period of each sweep of the graph. At each new sweep, a new data file is created in the data directory.

Note: There is a maximum period associated with each data acquisition rate in order to avoid memory problems with the device based on the current software design. For longer collection times, multiple files that are created (see above) can be concatenated together.

Refresh Rate (Hz)	Max Collection Time (sec)
10	2,000
20	1,000
50	400
100	200
200	100
250	80
500	40

Data Output Prefix

Prefix of name of data files for current run. Also name of folder where the current run's data is stored. For example, prefix "Data" results in data being saved under /Data/ as "Data_001", "Data_002", etc.

Choose Data Directory

Choose where the folders of data are stored. By default, data is stored under /ArduinoDataLogger/data/.

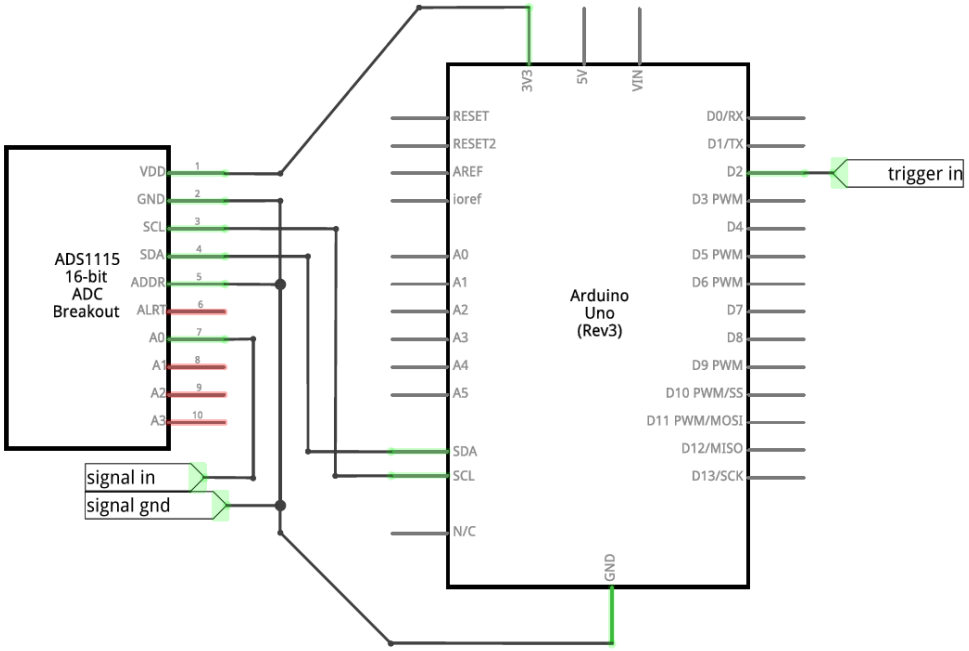
Start

This button begins data acquisition.

Stop

This button ends data acquisition. The program will automatically stop if closed while running.

WIRING DIAGRAM



This circuit diagram was created using the online Arduino circuit program, Fritzing (http://fritzing.org/home/). Wires are connected only in points with the large, dark circles and are simply overlaid at other cross-sections. The 'trigger in' diagram is only needed if trigger functionality is desired (see 'Operation' section for more details) and should be wired to ground if no trigger is used.

Note 1: The ADS1115 breakout board requires soldering of header pins (for breadboard use) or wires (to directly connect to the Arduino) prior to use.

Note 2: The input voltage range when using the Arduino Uno is 0 V to 5 V, so the input signal may need additional components (voltage dividers, voltage inverters, etc.) to ensure that it falls within this range.

PARTS LIST

Component	Vendor	Part Number	Cost[1]
Arduino Uno Rev3[2]	Adafruit	50	$24.95
ADS 1115 Breakout Board	Adafruit	1085	$14.95
USB Type A-to-Type B Cable	Newark	96K1696	$1.12
Jumper Wire Assortment[3]	Newark	99W1758	$3.29
Solderless Breadboard	Newark	99W1759	$2.51
		Total:	$46.82

[1] Costs are based on website access at Adafruit (www.adafruit.com) and Newark (www.newark.com) in March 2016.

[2] Price list built from official components. Arduino Uno clones with cables can typically be found on eBay for approximately $5, bringing the total cost closer to $20.

[3] Wire assortment has 65 pieces, but only 8 are required for this design, so actual cost is closer to $0.41.

COMPARISON TO COMMERCIALLY AVAILABLE USB-DATA ACQUISITION DEVICES

Feature	This Report	LabJack U12[a]	NI USB-6000[b]	NI USB-6003[c]	PicoLog 1012[d]	Omega OM-USB-1208FS[e]
Analog Inputs	4 high resolution and 6 low resolution	8	8	8	12	8
Analog Input Resolution	16-bit (high) and 10-bit (low)	12-bit	12-bit	16-bit	10-bit	12-bit
Analog Input Range (V)	0 to 5	-10 to 10	-10 to 10	-10 to 10	0 to 2.5	-10 to 10
Maximum Analog Input Sampling Rate (kS/s)	0.86 (high) and 15 (low)	8	10	100	100	50
Analog Outputs	0	2	0	2	0	2
Analog Output Resolution	N/A	10-bit	N/A	16-bit	N/A	12-bit
Digital I/O Lines	14	4 (16 more by DB-25 cable)	4	13	2	16
Counters	3	1	1	1	N/A	1
Counter Size	16-bit (1) and 8-bit (2)	32-bit	32-bit	32-bit	N/A	32-bit
Hardware Cost[1]	$47	$139	$170	$520	$159	$229
Software Cost[2]	N/A	$999[3]	$999	$999	N/A	$220

[a] https://labjack.com/products/u12

[b] http://sine.ni.com/nips/cds/view/p/lang/en/nid/211872

[c] http://sine.ni.com/nips/cds/view/p/lang/en/nid/212385

[d] https://www.picotech.com/data-logger/picolog-1000-series/multi-channel-daq

[e] http://www.omega.com/pptst/OM-USB-1208FS-1408FS.html

[1] Cost for National Instruments (NI) devices includes USB-DAQ and NI Hi-Speed USB cable. Cost for reported device tabulated in Table 2.

[2] Software cost could be lower based on the availability of site licenses and educational discounts. Price listed is for recommended base development system listed on NI website.

[3] The current software used for the LabJack data acquisition set-up in teaching labs is LabView-based, so the same list price as the NI website was used.

INSTRUMENT SEPARATION CONDITIONS FOR DATA ACQUISITION COMPARISON

GC Separation (*Figure 2A*):

Instrument:	Shimadzu GC-8A
Components:	9 µL air (dead-time marker)
	1 µL of 1:1:1 mix of 1-propanol, 1-butanol, and 1-pentanol
Stationary Phase:	Carbowax 20M on Chromosorb W HP
Mobile Phase:	Helium (30 mL/min)
Injector: 200 °C	Column: 130 °C
Detection:	Thermal Conductivity
Data Acquisition:	LabJack U12 with Home-built LabView Software (10 Hz Acquisition Rate)

CE Separation (*Figure 2B*):

Instrument:	Agilent 7100 CE
Components:	1 mg/mL each
	Thiourea, Dopamine, Serine
Capillary Dimensions:	50 µm i.d., 360 µm o.d.
	59 cm total length, 50 cm to detection window
Separation Voltage:	30 kV
Buffer:	10 mM borate buffer (sodium tetraborate decahydrate), pH 10
Injection:	Hydrodynamic, 25 mbar for 2.5 s
Detection:	UV, 193 nm
Data Acquisition:	Mass Hunter Instrument Software (20 Hz Acquisition Rate)