Using Low Cost Sensors to Measure Particulate Air Pollution*

Background:
Poor air quality is a problem that affects the health of many communities, and measuring air quality can be extraordinarily important to people with health problems. In Lewisburg, PA, the high volume of truck traffic on Market Street may be leading to high levels of particulate air pollution, a known human health hazard. The Lewisburg Neighborhoods Corporation, the Mayor of Lewisburg, and a group of faculty are interested in establishing a network of 'low-cost' air pollution sensors throughout the Borough of Lewisburg to monitor air quality. These sensors measure particulate matter that is smaller than 2.5 μm (i.e., PM 2.5).

Although we aren't yet able to properly calibrate the sensors last week, we've done enough testing to determine that eight low-cost sensors can collect data. (I determined this for sensors #5–#8).

Research Questions for this week:
Can low-cost sensors detect changes in indoor air quality around campus?

Materials:

- **Arduino Uno board or equivalent.**
  - An Arduino consists of a circuit board (or microcontroller) that can be used to run sensors and collect data. The board can be programmed by Arduino computer code, and the code must be uploaded from a computer to the Arduino board. The board can be powered through a USB cord to a computer, or through a 9V battery connection.
- **Air quality sensors.** We are using one low cost air quality sensor Plantower (http://www.plantower.com/en/). In addition, we will measure temperature and humidity with a sensor from Grove (http://wiki.seeedstudio.com/Grove-Temperature_and_Humidity_Sensor_Pro/), as temperature and humidity have been shown to affect the ability of low cost sensors to measure particulate air pollution. In addition, today we will use the TSI Optical Particle Sizer as a reference sensor. This sensor collects high quality data, but it costs approximately $15,000.
- **MicroSD Card Reader:** The SD card allows users to record data for long periods of time to be opened later for analysis on a computer. The card should be something smaller than 32 GB.
  https://www.amazon.com/SenMod-Adapter-Reader-Module-Arduino/dp/B01JYNEX56/ref=sr_1_1_sspa?s=electronics&ie=UTF8&qid=1525987957&sr=1-1-spons&keywords=sd+card+reader+arduino&psc=1
  https://www.amazon.com/gp/product/B00MHZ70KO/ref=oh_aui_detailpage_o00_s00?ie=UTF8&psc=1

Wiring and setup: The Arduino, sensor, and SD card (used to collect data) have already been connected for you.

You loaded the Arduino code on to the instrument last week. As soon as the sensor is connected to the electricity, it will collect data.

Data Collection:
Data will be collected for eight Plantower sensors. Each team will be responsible for one sensor, and should collect data for 24–48 hours, in an indoor location with access to an electrical outlet.

Preparation for Data Collection:
Remove the SD card from the board and insert it into the SD port on the computer. Copy the file "DATALOG.txt", and save it with a new relevant name that includes the number of your

sensor and today's date. An example file name: 'Sensor1_2019_12_03.txt'. Then upload the file the Lab 13 Google Folder. I ran an experiment yesterday and would like to look at the data, although the reference sensor did not work again ☹. After you finish copying the data file to the Google Folder, **delete the "DATALOG.txt" file from the SD card**, and reinsert the SD card to the sensor's Arduino shield. ***Choose a place you plan to collect data at, discuss with me, and confirm before you leave.***

Data Collection:
Plug the Arduino board into an electric outlet inside at the location you chose. Come back after 24–48 hours and unplug it. Remove the SD card from the board and insert it into the SD port on the computer. Copy the file "DATALOG.txt", and save it with a new relevant name. When finished copying the data file to the Google Folder, reinsert the SD card to the sensor's Arduino shield. Note that the second column of data is PM2.5 ($\mu g/m^3$). So copy and paste the second column of data to a new sheet. In the new sheet, insert a column to the left of the PM2.5 data for time, beginning with 0. Fill in the rest of this column (time in seconds). The Arduino board collects data every _____ seconds. (You should be able to determine this time interval from the data you analyzed for Lab 12. **Create a scatter plot of the PM2.5 data as a function of time.**

Deliverables:
Presentation File (one per team) with three slides to be posted on the Google Drive Lab 13 folder before lab on Tuesday 12/10

1. Show a picture of the location for which you collected data, and briefly describe why you were interested in this location.
2. Present a scatter plot of the 'Concentration vs. Time' data for the low-cost sensor. Provide an oral analysis of the data—i.e., describe what you think happened and why the data looks like it does.
3. Provide a summary or recommendation about future work needed, and comment whether you think it makes sense to continue this work, with the goal of using low-cost sensors to measure particulate air pollution.

You may do a little research, and report what others say about low-cost sensors used to measure particulate air pollution.

Due Date:
December 10, 3-5 minute presentations in lab.