RESEARCH SKILLS WITH ARDUINO AND R

PCB4917/ZOO6927

Class Periods:

- Monday, Period 3 – 4 (9:35 AM – 11:30 AM)
- Tuesday, Period 3 – 5 (9:35 AM – 12:35 PM)
- Thursday, Period 3 – 5 (9:35 AM – 12:35 PM)
- Friday, Period 3 – 4 (9:35 AM – 11:30 AM)

Location: Rolfs Hall, Room 105
Academic Term: Spring 2020, First Immersion Session

Instructor: Christopher Dutton
Research Areas: Low-cost open source technologies, environmental monitoring, aquatic ecosystem ecology, biogeochemistry, microbial community dynamics, conservation
Email: duttonc@ufl.edu (please contact me through Canvas for course related emails)
Office Hours: Anytime, by appointment (typically within a few hours of notice)
Office: Bartram Hall, Room 617
Course Website: Canvas (https://elearning.uf.edu/)

Course Description

We will learn about low-cost open-source options for conducting lab- or field-based research and then how to share the data and analyses in a fully reproducible manner. The focus of this course will be on using Arduino based microcontrollers and low-cost sensors to build data loggers to collect information from our environment. This course will also include a primer on basic electronics, sensor technologies, communication options, and a short introduction to the use of the R statistical computing language, Rstudio and Rmarkdown files to aid in research reproducibility. Skills learned in this course are applicable to any field of study. **The overarching goal of this course is to inspire you and to have fun exploring low cost open source technologies.** 4 Credit Hours.

Course Objectives

At the conclusion of this course, students will be able to:

- Troubleshoot hardware and software and resolve errors within the Arduino IDE
- Understand electronic terminology
- Effectively communicate any errors so that others can reproduce those errors and assist you
- List important design considerations of unattended data loggers
- Describe all the components of an Arduino and basic electronic microcontrollers
- List and describe the common communication protocols for different types of sensors
- Troubleshoot basic Arduino and R code
- List the important elements of research reproducibility
- Identify an unknown sensor, hook it up to an Arduino and get data
- Construct a basic data logger and describe the components
- Collect data using low-cost open source methods

Format

- Approximately ¼ of the course time will be in lectures, and ¾ will be in focused group work and problem-solving exercises.
- For exercises in class, groups can be comprised of 2 to 3 students.
- There will be two quizzes that are open note, open book, open laptop, and googleable.
- There will be a final project and class presentation for each group. This will involve
    1. designing a data logger using any sensor(s) that you choose,
    2. use it to collect data,
    3. write a short paper to describe how you designed the data logger and the data you collected,
    4. give a short presentation to the class on your project.

Course Pre-Requisites / Co-Requisites

None. No prior knowledge necessary.

Materials and Supply Fees

<u>There are no material or supply fees for this course. No purchases are required!</u> We will be working in small groups of 2 to 3 with each group sharing the following equipment:

- Adafruit MetroX Classic Kit - Experimentation Kit for Metro
    - https://www.adafruit.com/product/3588
- Adafruit Assembled Data Logging Shield for Arduino
    - https://www.adafruit.com/product/1141
- Grove – Starter Kit for Arduino
    - https://www.seeedstudio.com/Grove-Starter-Kit-for-Arduino-p-1855.html
- Partiocle.io IOT Starter Kit
    - https://store.particle.io/products/iot-starter-kit

<u>You may purchase these items for yourself if you desire but it is not required.</u>

Required Textbooks and Software

<u>There are no required textbooks for this course.</u> It is recommended that each person in this course brings a laptop computer with them during each class. At a minimum, each group will need a laptop computer during class. We will be using the following FREE software packages during this class:

- Arduino Integrated Development Environment (IDE)
    - https://www.arduino.cc/en/Main/Software
- R Programming Language
    - https://cran.r-project.org/
- R Studio
    - https://rstudio.com/

Recommended Materials

There are a number of very good books on Arduino and R. However, I strongly recommend these two "learning systems", which are free and provide a great resource for learning Arduino.

- https://learn.adafruit.com/
- https://learn.sparkfun.com/

How to do well in this course?

Show up and actively participate in your group. Ask questions when you don't understand something. There are no dumb questions! Reach out to me early for any problems, issues, or questions.

Course Schedule

This is a preliminary outline of the course schedule. We may move some topics around depending on the specific interests of the students in this class.

Week 1: Arduinos
- Day 1 – Introductions and distribution of Metro Kits
- Day 2 – Installation of Arduino Software and Arduino Coding Exercises
- Day 3 – Arduino Coding Exercises
- Day 4 – LEDs and Buttons

Week 2: Sensors and Data Logging
- Day 5 – Sensor Types and Communication Protocols
- Day 6 – Code Challenge! Sensor Challenge! **Quiz 1**
- Day 7 – Principles of Data Collection
- Day 8 – Code Challenge! Sensor Challenge!

Week 3: Sensors, Data Logging and Communication
- Day 9 – Sensor Housings, Power Issues, Communication Options
- Day 10 – Introduction to Particle.io and distribution of IOT Kits
- Day 11 – Particle.io Coding Exercises
- Day 12 – Particle.io Coding Exercises. **Quiz 2**

Week 4: Projects
- Day 13 – Introduction to Projects
- Day 14 – Introduction to R and R Markdown
- Day 15 – Project Group Work
- Day 16 – Finalize Project and begin data collection

Week 5: Presentations and Wrap-up
- Day 17 – Collect, compile and analyze data.
- Day 18 – Project Group Work. Finalize Project and Presentations
- Day 19 – Group Presentations!
- Day 20 – Next Steps with Arduinos, Course Feedback, Etc…

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance and participation are mandatory and will be a large part of your final grade. Due to the fast-paced nature of this course, it is very important to attend all classes. Of course, I understand that things come up and that's OK too. You will need to meet with me as soon as possible after a missed class so that I can bring you up to speed with what you missed. If you know that you will miss a class, please notify me ahead of time so that we can plan to make it up. Excused absences must be consistent with university policies and require appropriate documentation. Additional information can be found here: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Attendance	40	40%
Quiz 1 (open note, open book, googleable)	15	15%
Quiz 2 (open note, open book, googleable)	15	15%
Final Project	20	20%

Presentation	10	10%
	TOTAL:	100%

Grading Policy

Percent	**Grade**	**Grade Points**
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://gatorevals.aa.ufl.edu/. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://gatorevals.aa.ufl.edu/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see:
http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:
Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or
http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.