York University
PHYS 2030: Computational Methods (3 credits)
Winter 2017

Key dates:

3/6 – Groups assigned, overview
3/13 – 1-page proposal due
4/3 – Group presentations
4/5 – Reports due

Overview

The goal of the project is to provide a chance for students to work in groups to identify a question, acquire, and "analyze" a set of data. The focus is on developing a testable quantitative hypothesis and the computational machinery to address such. In a nutshell, the project will revolve around using an Arduino (`https://www.arduino.cc/`), with which you will need to design a project/code so to "measure something" (of substance). The basic procedure will go something like this:

- First understand what an Arduino is, what it is capable of, and how to use it
- With your group, develop some sort of testable (hypothesis-driven) question that revolves around using the Arduino to measure something and subsequently analyze the data (so to confirm or refute the question)
- Write a proposal detailing what you aim to do
- Once approved, build your measurement device and acquire the data and then analyze
- As a group, give an oral presentation on your project
- As a group, after the oral presentation (during which you will receive critical feedback/questions), prepare a short written report
- Feel free to be creative!

Specifics

You (as a group) will need to develop a physics-driven testable hypothesis around the context of physically measuring something with the Arduino. You will need to then assess the validity of the hypothesis based upon a quantitative analysis of the collected data. Ideally, all DAQ (incl. both D/A and A/D as needed) is done/controlled via software and hardware you develop using the Arduino. Analysis methods used ideally would be consistent with material covered in class (e.g., nonlinear or nonparametric regression, Monte carlo methods, Fourier analysis, basic statistical analyses, etc...), but may extend in novel directions as needed. There has to be a reasonable degree of sophistication associated with the methodology chosen, but you shouldn't go overboard (as there is only so much time dedicated to this component of the course). Students will be placed in randomized groups of approximately 6 students. All students are expected to contribute significantly, and you will be asked to assess your peer's contribution (such will be factored into the final grade).

Additionally, you will likely need to acquire some additional "hardware" (beyond just the Arduino) to build your measurement device. Some options:

- Ask the 2030 TA (Hugh) or instructor (Chris)
- Contact folks who run the physics or engineering labs (e.g., Alexandre Novikov at sashanov@yorku.ca)
- Digikey (`http://www.digikey.com/`; super fast shipping)
- Go to Sayal (`http://www.sayal.com/zinc/index.asp`; there is an actual store close to York, just to the north via a 5 min. drive, really fun place to go!)

One last item that should be mentioned: *safety*. Dealing with electronics involves some degree of risk, as does creating an experimental condition and collecting data. Use common sense, and always err on the side of caution. The course instructors/TA are more than happy to help provide input if there are any concerns regarding safety. Some basic tips can be found here: `http://www.dummies.com/how-to/content/electronics-safety-rules.html`

Examples

To give a general idea for projects that can be built, here are some websites that will give you some ideas:

- `https://en.wikipedia.org/wiki/Inverse-square_law#Example_2`
- `http://playground.arduino.cc/Projects/Ideas`
- `https://www.hackster.io/arduino/projects`
- `http://www.instructables.com/id/Arduino-Optical-Theremin/`
- `http://www.instructables.com/id/Talking-Arduino-Heart-Rate-Monitor/`; note that here one needs to go beyond simply "monitoring", such as examining rate waveform shape

There can be a variety of project themes, but remember that this is a physics course, so projects should fall within that category (incl. biophysics). For example, the first bullet above suggests an acoustics project where you test the inverse-square law (i.e., does sound pressure fall off at $1/r^2$ with distance away from the source?). Regardless of your project choice, you'll likely find things are much more "complicated" than you might initially envision. So thus not only do you want to think carefully about your proposal, but all try to allow yourself time/energy/strategy to plan for the unexpected (e.g., learning about *diffuse–fields* in acoustics).

Grades

There will be several components to the project grade as follows:

- Proposal (10%) – This should briefly (but clearly!) provide motivation as to the chosen direction and a clear hypothesis-driven question related to what you aim to collect and how such will be analyzed. You will also need to develop a methods section that details what you will need (beyond the Arduino) and a clear vision of how you will get such put together. The overall length should be 1 page. You will receive critical feedback from the course instructors/TAs and ultimately require "approval".

- In-class oral presentation (40%) – Details in a following section.

- Report (30%)
  – You will be expected to prepare a cohesive 4-5 page report. This should provide some background on the nature of the problem/data, and clearly outline the basis for your analysis strategy. Furthermore, the report should clearly summarize your key results. In addition to the report, you will need to include the relevant Arduino/Matlab code used as well as circuit diagrams for the Arduino setup (such that the course instructors could reproduce your DAQ/analysis). Guidelines for the presentation should also be helpful here. There will only be one report per group (i.e., each student need not write their own), so there will be an expectation for high quality of this component.

  a detailed methodology

- Student assessment (20%) – You will be provided with an assessment sheet, which you will fill out for each member of your group (e.g., level and degree of contribution). Your evaluation will then be factored into the determination of their final grade. If you simply give everyone 100%

Presentation Guidelines

Logistics – The presentations will take place in class. You will be allowed 10 minutes total: 8 minutes for your talk and 2 minutes for questions. You will be timed, so it is crucial that you do not exceed your allotted time (otherwise you may be penalized). Since you are working in groups, you will both be expected to contribute significantly to the content and presentation. Ideally, get your presentation to the instructor before class so he can load them onto a flashdrive and bring them to the classroom.

Consideration to keep in mind –

- Your time is valuable, so use it wisely!

- Before getting your presentation together, you have one key task: **Complete your project!** First, organize your data. Then locate trends in your data and isolate specific results. Finally, distill information to key points.

- Preparing an effective presentation is much more difficult and time-consuming than you would think. Not only do you need to probe deeply into the model to gain a deep understanding as to what is going on, you also need to determine (*and practice*!) how to best convey your findings to others in a digestible way.

- Primary goal is to explain a technical finding.
- If there is no content, there is no presentation.
- Presentation style/delivery enhances and clarifies your content. Slides provide visual reinforcement of the spoken message, as the focus should be on you the speaker (not a screen!)*. Bad slides can distract the audience by being irrelevant, confusing, or inconsistent†.
- Length: 5-6 slides for 8 minute presentation. Budget under time!
- Introduction: Explains the goals and purpose of the project. Ideally, these goals and purpose relate to the Discussion points.
- Methods: Distill Methods to key procedures. Numbered list is fine. Ideally, do not show equations (unless they are extremely simple and friendly).
- Results: For your results, develop 2-3 relevant figures. Include key words in figures to remind yourself (and audience) of each bullet point. Figure should allow listener to fill in gaps due to lapses in attention. An example of an effective result slide is shown in Fig.1.
- Discussion: should be limited to most important details (related to Results). Succinct is ideal.
- Drafting Your Presentation (sequential tips for success): Complete your project & organize ideas. Plan the presentation. Sketch candidate slides. Combine slides to create story-board. Develop 2-3 bullet points for each slide. Draft the presentation ('slide sorter view' in Powerpoint is very useful here!). Edit & revise. Prepare for Q&A. Practice.
- Tips for slides: Fonts matter (Title 44 pt; Subtitles 28 pt; Other text 20 pt; sans serif). Understandable at a glance. Use animation sparingly (if at all). Color-wise, use a light background with dark text dim and keep colors consistent. Add slides to fill in gaps, remove slides to eliminate redundancy.
- Format-wise, Powerpoint and/or PDF work best. Preferably both: PDF works as a good backup in case there are issues with a .ppt file (e.g., incompatible versions, fonts all messed up, etc...).
- PowerPoint Tips: Easy to create irrelevant slides with little content. Easy to waste 'real estate' with nifty borders. Avoid.
- Your title slide is important! Typically, it is the one slide that is up on the screen the longest (and before you even start!), so it can really help set a tone. Make sure that your title is informative, specific, and understandable at a glance. It should contain your name(s) and the date.

*One need not use Powerpoint or any other type of ''slide' (e.g., Keynote, overhead transperancies, etc.) in order to give a 'good' talk. In fact, some of the best talks have speakers not using any sort of electronic visual aid (e.g., a 'chalk talk'). However for technical talks such as this, visual reinforcement of the points helps significantly to convey your message. Thus, it is good to get in the practice of effective slide preparation/delivery.

†A very useful reference you may want to examine at some point is *The Visual Display of Quantitative Information* by Edward Tufte. Well worth the effort of tracking down, at least to get exposed to the idea that there is actually some deep thought already in place as to how to best visually convey complex sets of data.

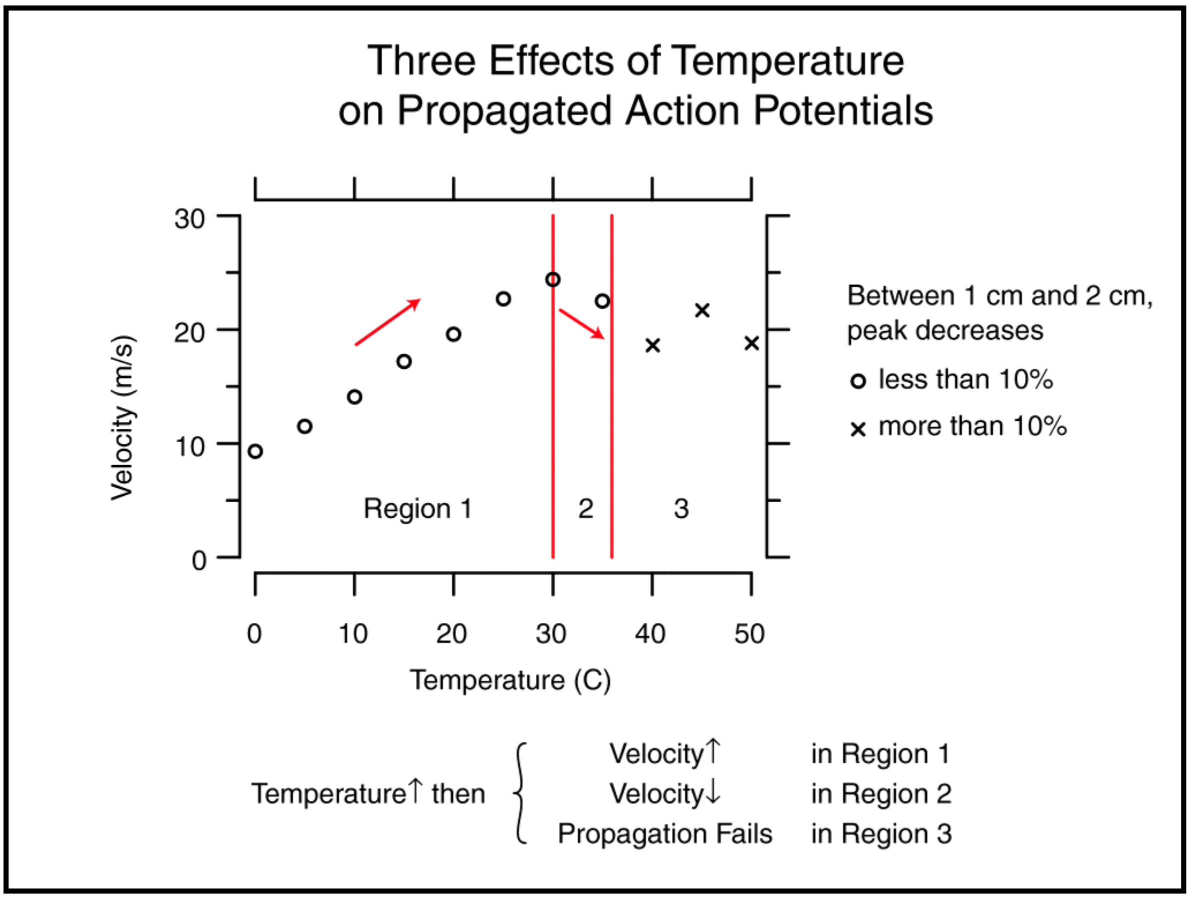
Three Effects of Temperature
on Propagated Action Potentials
Velocity (m/s)
30
20
10
0
Region 1
2
3
0
10
20
30
40
50
Temperature (C)
Between 1 cm and 2 cm,
peak decreases
less than 10%
more than 10%
Temperature↑ then
Velocity↑ in Region 1
Velocity↓ in Region 2
Propagation Fails in Region 3

Figure 1:

Presentation Structure (25%).
A: all information is well organized in proper sections with smooth transitions between sections. Visual elements were effective.
B: overall organization is understandable but could be improved in one section of the presentation or in minor instances throughout the presentation.
C: repeated organizational problems that interfere with presentation coherence. Poor presentation of visual information.

Delivery of Presentation (15%).
A: delivery was clear with appropriate use of non-verbal gestures. Verbal articulation and timing were appropriate.
B: several awkward moments or slips in verbal clarity.
C: repeated awkwardness in presentation, and/or repeated problems with verbal clarity. Presentation too long.

Clarity and Conciseness of Technical Information (15%)
A: technical flow is clear: introduction motivates a topic, results focus on that topic, conclusions follow from results, relevant methods are described.
B: no more than 1 major lapse in tech. clarity.
C: more than one major lapse in technical clarity.

Conceptual Correctness (20%).
A: interpretations of results are tech. correct.
B: interpretations are not well supported.
C: major errors.

Insightfulness (25%).
A: Recognized an interesting issue and developed at least one way to understand it.
B: Thorough description of WHAT happened without a clear understanding of WHY it happened.
C: Confusion about what happened.

Figure 2: Guidleines for presentation. These are also helpful regarding the report.

- Edit the Slides: Edit slides for coherence. Check for irrelevant bullets, plots. Check for balance and coherency in storyboard. Spell-check and proofread.
- Presentation Tips: Arrive early. Check equipment. Check voice projection. Have a printed copy of your presentation in hand as a backup. If you use the pointer, do not block the screen. If you get lost, stop and regroup. Your audience wants you to succeed.
- **Practice!!**: Make sure that you meet the time limit. Practice speaking slowly. Breathe. Know your quirks. Work around your nervous habits. Use visuals as cues, not note cards.
- Prepare for Q&A: Anticipate questions not covered in the presentation. Typically, questions ask you to extend (or refute) an idea. Brainstorm, considering audience & scope. OK to acknowledge gaps in knowledge. OK to prepare extra slides.