

# UC Physics Hackathon 2021

UC Berkeley Society of Physics Students

## Instructions

Pick one of the three problems to explore with your partner. You have until 2pm PDT on Sunday March 28 to create a presentation. Please read and answer all parts of your problem. You may not consult with anyone outside your team (participating or non-participating). Any other resource is allowed, so long as you cite it in your work and presentation. This includes textbooks, Google, and StackExchange. Some starting resources are provided under [Resources](#).

For clarifications and questions, please use the Slack channel. Siddhant & Shantanu will also hold optional check-ins both mornings, which teams can sign up for via [signup genius](#).

## Friend from Mars

You are on the phone with a person from Mars, who has no concept of any Earthly language. How might you establish a communication scheme with this Martian in a well-defined manner? How much can you communicate? Try to maximize clarity and range of concepts communicable. Complete the following three tasks:

1. Communicate the instructions to bake vegan chocolate chip cookies to this Martian?
2. Communicate the idea of weight lifting to get “buff”?
3. Communicate any interesting and exotic sentence. You may choose what it is.

Since we don't quite have communication with Martians yet, create a computer program that is a simplified model of a Martian trying to learn our language from the phrases we tell it. It should be able to receive sentences and understand the new words appearing in those sentences from the words it already knows in the sentences. It should:

1. “Understand” (i.e. take as input) a base set of words, like numbers and the elements
2. Interpret “meanings” of new words from seeing patterns in messages you feed in
3. Demonstrate that it “understands” the new words it learns

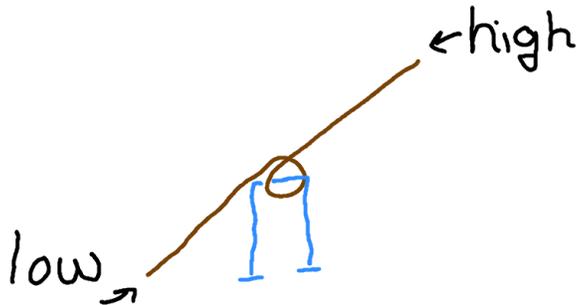
Fill in the details for the coding tasks as you see fit. Clearly state the standard by which you measure the program's “understanding.”

As a starting example, to communicate the names of numbers you could start out “tick one, tick tick two, tick tick tick three,…” Then, to communicate elements, you could give the ratios of the masses of each atom relative to a proton.

## Sticks & Stones

Computers are universal. Collect sticks from the great outdoors or use a manufactured equivalent (ice cream sticks, paper clips, bobby pins). Using any of the materials listed above as see-saws with “high” and “low” representing 1s and 0s (as shown in the image), build mechanical realizations of the common logic gates (AND, OR, NOT, XOR), a 4-bit binary adder,

and make at least one additional logical device that is interesting. Your final device must be built on a 40 cm X 40 cm board. One example is a 3-bit decoder--which you are now not allowed to build! You may use additional materials in your devices, but only “sticks” as see-saws may represent the 0s and 1s. *Hint: Notice that a single see-saw is automatically a NOT gate.*



Along the way, use any programming language to create a framework for modelling the binary behaviour of each component that you physically build. Show that your code works for the logic gates and the binary adder. Then use this framework to prototype your final design.

#### Phone a Friend

A common childhood toy is a rope phone. Two cups connected by a rope make it possible to talk over some distance.

1. Define a “quality” of communication for a rope phone based on the following setup: you feed a single standard tone (441 Hz) into one end and analyze what comes out in a program you code which decides the quality based on your standards.
2. Build a rope phone and analyze how the ‘quality’ depends on various parameters (theoretically and/or experimentally) such as tension, diameter, cup geometry etc.

Modified from Problem 11, 2004 International Young Physicists’ Tournament

#### Resources

You are not required to use these resources. They are not exhaustive.

- Friend from Mars
  - [https://en.wikipedia.org/wiki/Communication\\_with\\_extraterrestrial\\_intelligence](https://en.wikipedia.org/wiki/Communication_with_extraterrestrial_intelligence)
  - [Branching in Linguistics](#)
  - [Programming in Python for Linguists: A Gentle Introduction](#)
  - [Natural Language Processing \(NLP\) in Python](#)
  - [Writing Linguistic Rules for NLP](#)
- Phone a Friend
  - [pyAudioAnalysis](#)
  - [Fourier Transform in Python](#)
- General Coding (Python)

- If you become bogged down in the code, remember that functionality is more important than complexity!
- [Using Jupyter Notebooks](#)
- Packages: [numpy](#), [matplotlib](#), [numpy & scipy](#)