## CS 251: [Presentation]: LaTeX and gnuplot

- Handed out: 8/28 Due: 8/31 11pm.

- Please write (only if true) the honor code. If you used any source (person or thing) explicitly state it. You can find the honor code on the web page.

## Overview

The goal of this lab is to move ahead in the "presentation" aspects of this course. Specifically we will look at two invaluable packages, LaTeX (and friends), and `gnuplot`.

## Tasks

1. **Gnuplot** In this exercise you will learn how to visualize raw data. *Gradient Descent* is one of the basic algorithms in many fields including **machine learning**. (Read more about gradient descent here). We want to visualize how gradient descent works. We will use the trimmed down concept of gradient descent to trace the shortest path to a local minima in a 3-dimensional plot $z = f(x, y)$. The shortest path to the local minima from a chosen point $(x_1, y_1)$ can be attempted by

$$x_1 = x_1 - \frac{\partial f(x, y)}{\partial x}$$

$$y_1 = y_1 - \frac{\partial f(x, y)}{\partial y}$$

   (a) Read the description of a surface (e.g. we have chosen $z = x^2 + y^2$) in gnuplot's `splot` syntax (`x**2+y**2`) from the standard input.

   (b) Choose a point intelligently (e.g. we have chosen $x = -80$ and $y = 90$).

   (c) Write an octave script `gradient_descent.m` and use the iterative formula to produce $x_1, y_1$ values and corresponding $z$ values. Send output to `output.dat`. [10 marks]

   (d) Write a program `plot.gnu` using gnuplot to plot the path found as well as the surface on the image `plot.png`. [20 marks]

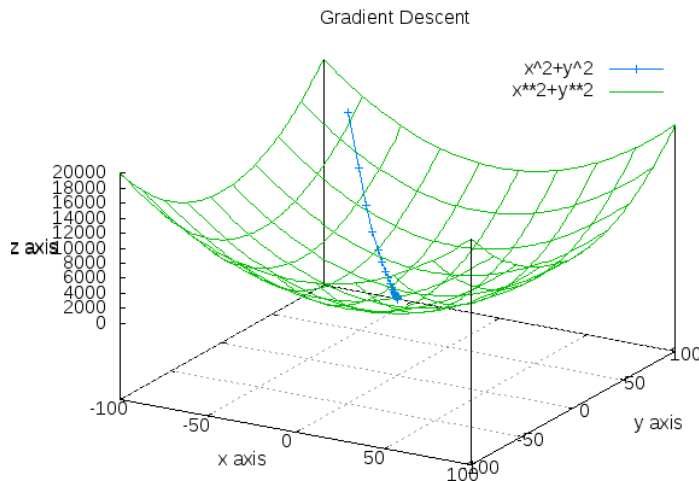   (e) Write a `makefile` which on executing `make plot` generates `plot.png`. [2 marks]

Figure 1: Path traced by the shortest path.

2. **LATEX** : The goal here is to make sure you can make a simple LATEX document. Write a LATEX document `ProjectProposal.tex` to perform the following: (You can include other files in this file, but `ProjectProposal.tex` should be the main document.)

   (a) **Tables**. Create a three column table. The headings for the table are "group name" roll number, and name (The name is the name you liked to be called out in class by the instructor). [5 marks]

   Note: Notice that the first column – group name is the same for all members of your group. It should not be repeated.

   (b) **Images**. Introduce your Box2D design course project pictorially. This is going to be some sort of mechanical Rube Goldberg like machine simulation. For inspiration, look at this Box2D Mountain Bike example for inspiration. There are several others on the Internet. You can also see examples of what your seniors did. You can discuss your proposed design with anyone you like, there are no restrictions. However, designs must be sufficiently different and once frozen, no discussions are permitted.

   You must make the diagram in Inkscape and save it as a image file. Your design must contain at least 10 different moving elements. The base code has 7-8 elements. Note that your final design for the project can be different in details from this preliminary design. Again, do not forget to add a list of all the sources that you referred to for learning about the machine and Box2D. [25 marks]

   (c) **Floating Figure**. Also put a diagram of the actual machine internals that you are emulating. This figure must "float" with the text (similar to what you see in magazines) as opposed to having a figure or a table standing out by itself. In this document, Fig. 1 is not a floating figure. (Floating figures are not common in LATEX but should be.)

   (Content of actual machine: In order to do this, you will need to read about the machine that you want to design. Do not forget to put links to your sources.) [10 marks]

   (d) **Cross Referencing**. Have sections to explain why, when and what you are doing. Make sure you have no less than one page of text. Figure out who is going to do what part of your project (within a group). Remember, for your final grade on Box2D, we will need all intermediate versions of your work. Make cross references, and be sure to have some relevant mathematical equations that you will refer to in the text.

   You will probably need the following sections

- Title,
- Motivation
- Introduction
- Body Part 1
- Body Part 2
- Conclusion
- References

Learn about BibTeX to make references. [25 marks] Learn about various referencing styles, and particularly figure out how to refer to web sites that might disappear by the time we refer to it.

(e) Update the `makefile` written in Problem 1 such that on executing `make ProjectProposal`, It should generate pdf file of your Project Proposal. [2 marks]

Note: In this assignment, we are looking at the quality of the LaTeX document. We are not going to give marks based on the quality of the Box2D design (that we will do later, i.e., count towards your project marks later).

3. **LaTeX and Indian Languages**. The goal of this task is to make you familiar with writing Hindi in printed documents. You may need to look at following document:

pravin.paratey.com/files/devanagari.pdf

Check if you have `dev.sty` package in your system. If not, install the following package (in Debian flavors).

sudo apt-get install texlive-lang-indic

(a) Look at Section 3 of above mentioned document to learn how to use `devnag` tool. [0 marks]

(b) Now refer to the table given in Section 2 to write the script `GayatriMantra.dn` which should display the (somewhat) famous Gayatri Mantra (given below) in the format shown:

ॐ

भूर्भुवः स्वः
तत्सवितुर्वरेण्यं
भर्गो देवस्य धीमहि
धियो यो नः प्रचोदयात् ॥

[20 marks]

(c) Modify the makefile to do the following:
- `make GayatriMantra` should generate the pdf
- `make clean` should remove all unnecessary files (everything that can be recreated by the TA).

[2 marks]

4. **Challenge Question** Find the minimum in the Batman Curve. See here and here

(a) Write an octave script `batmanDescent.m`, which takes in initial values.

(b) Use the iterative formula to produce $x_1, y_1$ values. Save the output to `bat_output.dat`

(c) Write a script `batplot.gnu` using gnuplot to plot the path found as well as the bat-curve.

(d) Modify `makefile` such that on executing `make batplot`, it generates `batplot.png`. [1 mark]

Note: user does not know what initial values to give so she might give some random values.

## Submission Guidelines:

Submit the following documents:

1. **Task 1:** `gradient_descent.m` and `plot.gnu`

2. **Task 2:** `ProjectProposal.tex` and all included files.

3. **Task 3:** `GayatriMantra.dn`

4. **Challenge Question:** `batmanDescent.m` and `batplot.gnu`

5. combined `makefile`

Do not forget to put readme.txt file in a folder. The folder and its compressed version should both be named `lab06_groupXY_final`. Hence, you submit a tar.gz named `lab06_group07_final.tar.gz` if your group number is 7.

## How We will Grade You

- Honor Code and package complete in all respects +2. **Incorrect or incomplete -2**.

- Marks corresponding to all the question is given along with the question itself.