Computation of Rotation Radii and Angles using Accelerometer Data and Optimization Algorithms

Jérôme Chabbert
Department of Physics, John Abbott College, 21275 Rue Lakeshore, Ste.-Anne-de-Bellevue, QC, H9X 3L9
chabbert.jerome@gmail.com

Introduction

Embedded or IoT (Internet of Things) devices all have one goal: cost efficiency. A small device needs to be as energy and space efficient, and affordable as possible. The industry is always seeking alternatives to expensive, older technology through the creation of new data analysis software suites that use cheaper devices. In line with this train of thought, the goal of this research project is to verify the possibility of providing the functions of a gyroscope using a lower cost alternative accelerometer, while still providing sufficient accuracy.

Methods

We developed a data-analysis library using the following:

- Python 3.7 with modules:
  - Tensorflow : A machine learning/optimization library
  - Numpy : A advanced math library (Matrices, Vectors, …)
  - Matplotlib : A graphing library

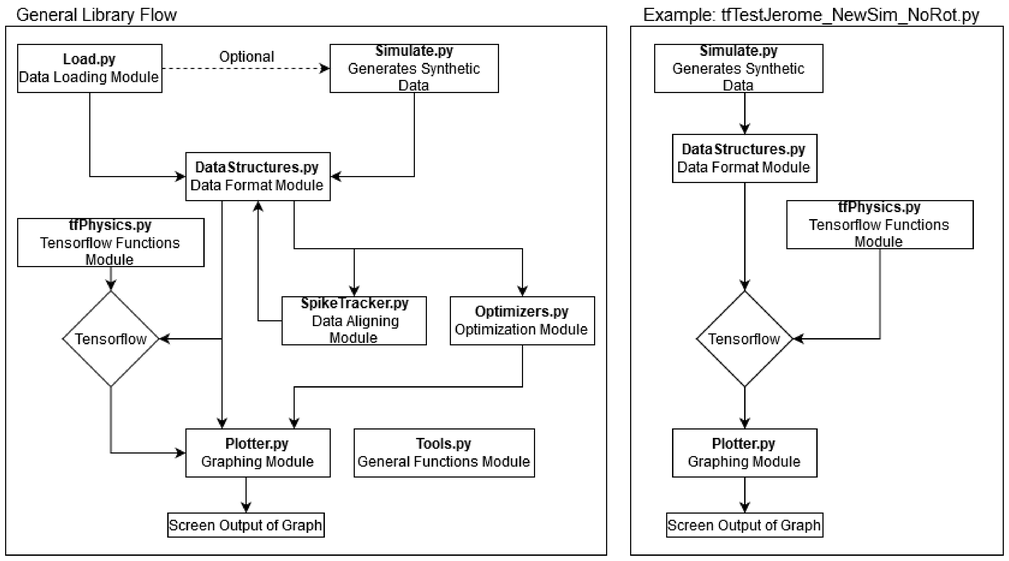
We also developed our own optimization module using

- Stochastic Gradient Descent (SGD)
- Adam[1]

Both of which are easy-to-use optimization algorithms.

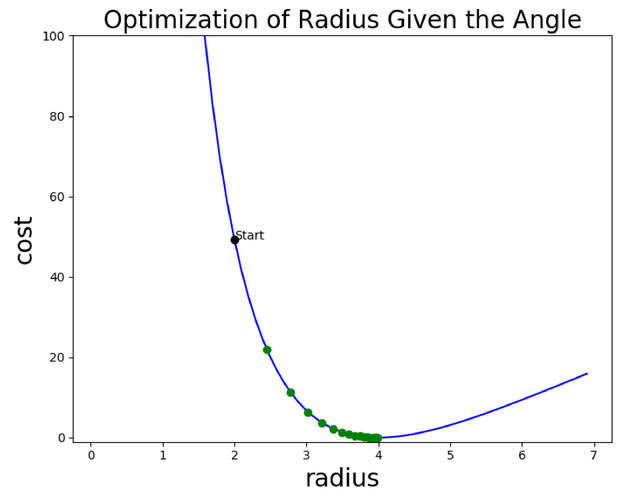
```
import tensorflow
import numpy as np
import matplotlib
```

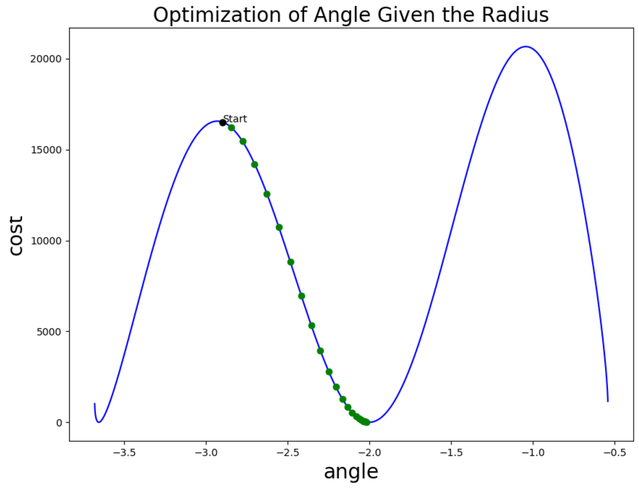
Implementation



Results

Our library currently supports both 1 variable and 2 variable optimization but it cannot optimize the cost function that we are using when presented with a 2 variable scenario.





In the first graph, we give our Adam implementation the correct angle and ask it for the best possible radius.

In the second graph, we do the opposite: give it the radius and ask it for the angle

Discussion

We are very close to our goal of verifying the possibility of replacing a gyroscope by an accelerometer. The only thing that we are missing, as mentioned before, is to either fix the cost function or the optimization module.

Lessons Learned:

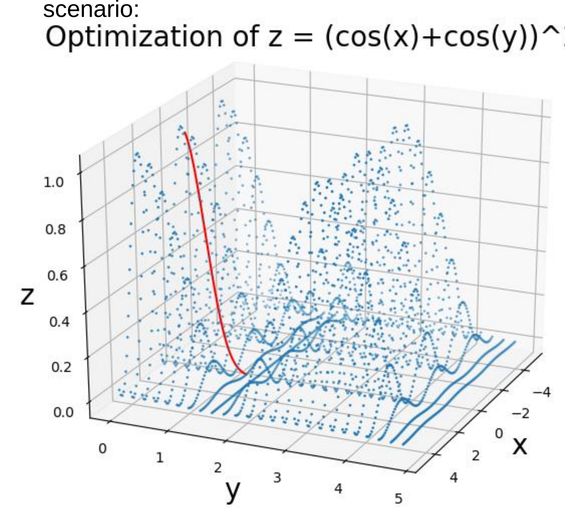
- Documentation should be done during the development and not after
- Build a project plan
- Make sure that the whole team has the same version of whatever module we are using

Conclusions

The results that we obtained seem to show that it would indeed be possible to achieve a good balance between cost and accuracy using an accelerometer and free open-source modules.

Future Work

The next step in the development is to find a cost function which is both useful to our project and is compatible with our optimization module. Here is an example of our module working in a 2 variable scenario:



Acknowledgements

This project was made possible under the supervision of Prof. Larnder (research supervisor) and Prof. Silerova (course coordinator), and with the collaboration of Hoang Anh, Justin and Adamo. I would like to express my gratitude to everyone who worked on this project with me.

Literature Cited

1. Diederik P. Kingma, et al."Adam: A Method for Stochastic Optimization." (2014).