

# STEFAN HOSEIN

## Project Report

### Background

Stefan Hosein graduated with first class honors from the University of the West Indies with a Bachelor's Degree in Computer Science. He was awarded numerous awards during his time, most notably his awards for graduating at the top of his class and his faculty. During this time he was heavily involved in the edification of not only himself but of others by assisting in the Code Dojo programme – which sought to help young children learn how to program. Moreover, he was a tutor – while still an undergraduate – for year 1 Computer Science courses.

Apart from Computer Science, Stefan has a passion for helping orphanages and he along with two other University of the West Indies students (Zahra Gomes and Lacey Chunilal), formed a group, Escape Velocity, where they help orphans learn about science. He is also an avid scuba diver with his latest certification being Rescue Scuba Diver.

### Overview of the internship experience

The NASA experience was definitely a rewarding one - there was never an insipid moment. From the sheer magnitude of the size of NASA to the intriguing and minuscule creatures called microbial mats, there was always something going on at NASA. I was lucky enough to: get my first set of work put up on NASA's website; meet the director of the NASA Ames Research Center; attend an open house where NASA was open to the public for a day and every department showed off their research; sit in at Carnegie Mellon's University's (CMU) Machine Learning meetings.

At NASA, one of the most memorable moments that happened was that I gave a presentation of my work to academics from University of California Berkeley and Carnegie Mellon University - these are the top Computer Science universities in the world - at a workshop hosted by NASA. This was something that I did not expect and while it was definitely nerve racking, it was worth it at the end since I was able to make a name for myself in the academic community however small!

After work, there usually was always something going on, whether it be sports — volleyball is quite popular — going to Castro Street (equivalent of Ariapita Avenue) for food and drinks. If you are lazy you can order food and have it delivered to your door; any kind of food: Chinese, Mexican, Japanese, American, Greek and Italian.

During the weekends, I always made an effort to do something new that I never did before. I went hiking up in the Redwood forest with my mentor to witness some breathtaking views. Drove down to Santa Clara beach to absorb the very cold water and fantastic array of foods

selling on the boardwalk. I was fortunate enough to see all the major sights in San Francisco like the Golden Gate Bridge, Union Square (shopping paradise), Fisherman's Wharf, Lombard Street and many others. Further, being in Silicon Valley it was the home of many tech companies like Google, Facebook, Apple and Twitter, and of course I visited all.

## Tasks undertaken during the internship

### Fall 2014:

The first project I was required to create a MATLAB Graphical User Interface (GUI) which visually showed how the Inductive Monitoring System (IMS) behaved when applied to data from a multi-functioning device<sup>1</sup>. IMS is a learning algorithm that seeks to model what are the nominal operations for a particular system and when the system behaves in an anomalous manner this behavior is flagged. Thus, the GUI showed that IMS successfully flagged anomalous behavior within the multi-functioning device, i.e. when energy consumption was too high.

After, I began to implement the RANSAC algorithm into Adverse Condition and Critical Event Prediction Toolbox (ACCEPT)<sup>2</sup>. ACCEPT is a MATLAB toolbox that seeks to predict adverse events in time series data (time series is a sequence of data points, typically consisting of successive measurements made over a time interval). I then wrote the developer's guide so that someone can add new features to the project.

Finally, I employed advanced data mining and machine learning algorithms on data acquired from the Sustainability Base to predict when an alarm would occur in the hot water piping system. ACCEPT used linear, quadratic, bagged neural networks, k-nearest neighbors and extreme learning machine as its regression methods and used redline, optimal and predictive as detection methods. We were able to get a good prediction horizon but encountered a lot of false alarms — this is where our system says that there will be an alarm but in reality there is none. This is due to our low sampling rate (every 5 minutes) and for further research into this problem we would need a much higher sampling rate to get accurate results since water pressure changes rapidly.

### Summer 2015:

I started from where I left off in the fall by continuing to employ ACCEPT to predict anomalous changes, but this time, in the temperature, throughout the Sustainability Base. ACCEPT used linear, quadratic, and extreme learning machines as its regression methods and used redline, optimal and predictive as detection methods. We were able to predict alarms with a very high accuracy using features from a novel feature selection algorithm. (WILL ELUCIDATE WHEN WE ARE FINISHED AND RESULTS ARE OPEN TO PUBLIC).

---

<sup>1</sup> [http://ti.arc.nasa.gov/m/project/sustainabilitybase/IMS\\_Video.mp4](http://ti.arc.nasa.gov/m/project/sustainabilitybase/IMS_Video.mp4) [takes a while to load]

<sup>2</sup> <http://ti.arc.nasa.gov/opensource/projects/accept/>

## **Lessons learnt from the internship experience**

There were a plethora:

- The only color they see is green, not that they are greedy, but in Silicon Valley, once you are efficient at your job you will be rewarded - race and nepotism does not factor much into most companies.
- Trinidad and Tobago needs to spend a lot more time on research and development - this is where innovative ideas and solutions come. A Ph.D. student in America can get a job in academia or industry, and a lot of them go into the industries like Google, Amazon, etc. As a result, these companies are the pioneers because they are always researching to find the next best idea.
- Trinidad and Tobago has the ability to compete at the world stage and it is up to us as a country to foster this way of thinking. We need to be more innovators rather than always the consumers.
- I truly love machine learning/artificial intelligence and will hopefully make a successful career out of it.

## **The way forward - the relevance of the research to society and its impact on the future**

My research extremely relevant to Trinidad and Tobago, since I worked with Artificial Intelligence in a built environment — NASA's energy efficient building called the Sustainability Base.

Firstly, the technology sector in Trinidad is very limited and still in an embryonic stage. By learning new techniques especially in the building of intelligent software I can give back to the country the knowledge I gained. Hopefully this will encourage and spark a growth in proper software development in Trinidad and Tobago so that companies would want to invest the business with these local software companies. Indeed, building quality software would stop companies in Trinidad and Tobago from outsourcing and thus promote the continued growth of our economy.

Moreover, Trinidad and Tobago focuses a lot on oil and in so doing, research on alternative resources and energy efficient buildings are not emphasised. This knowledge can help aid those in Trinidad and Tobago who are trying to push for more energy efficient buildings as the building can be smart. This can be done by the diagnosing and predicting aberrant behavior of its systems like: heating, AC, water pressure and temperature. Moreover, knowing that NASA is putting a lot of work into a sustainable way of living may be an incentive for such an oil rich nation to deeply ponder on what will happen to us when our perpetual oil supply finishes.