

## New submission from RSAF Final Report

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To: Scholarly Activity <scholarlyactivity@langara.ca>

### **1. Please introduce yourself – include pertinent background information relating to the topic of your research project. Include your project title.**

My name is Jeremy Chiu, and I am an instructor in the Department of Mathematics and Statistics. My background is in mathematical modelling, with a focus on modelling biological phenomena. My Master's thesis studied honeybees mathematically, which was similar to this research project – Mathematically Modelling Rolling Locust Swarms. Rolling locusts swarms are well-documented, but not necessarily well-understood. The research was conducted by Miguel Algorta, a senior Langara math student (who has now successfully transferred to the University of British Columbia). The goal of the project was an attempt to better understand locust behaviour by using mathematical equations to describe their movement. Since the number of equations grew quite large and became quite complicated, efficient algorithms to approximate solutions became the focus of our research.

### **2. Please discuss your educational background and your work experience that led you to taking on this research project. If possible, include a quote that helps define your interest in this project.**

I did my Master of Science in Applied Mathematics at Simon Fraser University. My thesis was Mathematically Modelling Thermoregulation in Honeybee Swarms. I spent about two years attempting to write down equations that describe how honeybees collectively move to survive freezing climates, and developing computer algorithms that could solve these equations. The summer research project can be thought of as a 2-month version of my 2-year Master's thesis, with a focus on locusts rather than honeybees.

J.R. Philip said (1966), "A model is a useful (and often indispensable) framework on which to organize our knowledge about a phenomenon." Our goal was to create a model of rolling locust swarms using mathematical equations. Dr. John Stockie, a math professor at Simon Fraser University and my former supervisor, said (2014), "A mathematical model is the mathematical structure that ties the specific situation back into a more general theory." Miguel and I ultimately described rolling locusts swarms using a system of ordinary differential equations, a topic which is theoretically well-understood.

### **3. Please explain the concept for your project in terms that others not in your field would understand, like an executive summary.**

We sought to create a computer simulation of rolling locust swarms. Rather than having the locusts move ad-hoc, we setup and equations that, when solved, would describe how their movement. Most of our time and energy was devoted to 1) creating sensible equations and 2) designing methods to efficiently solve the equations.

### **4. Identify goals and objectives for the project, and how the results may be used, perhaps to solve a problem, or to inform further research in that field.**

Math research tends to be so theoretical that the implications are quite indirect. In general, math research will not give tangible results until the graduate level. And so, the primary goal of this project was to demonstrate that Langara College can offer its students research opportunities similar to larger schools.

### **5. Briefly explain the steps taken to conduct the project research, and the results found.**

Similar to how most mathematics research begins, we first attempted to reproduce results from a published paper. After rederiving equations and computer algorithms to solve the equations, the goal was to extend the paper either by running simulations the paper hadn't considered yet, or by modifying the equations.

Miguel and I met weekly. I first had him read and summarize the paper, then re-derive all equations and double-check all their work (where we found a few typos in the paper), and then attempt to reproduce the code to simulate the model. After we had working code, we first reproduced the paper's figures (which verified the code was working), and finally ran simulations that the author did not publish.

**6. Who else was involved in this project? How did their involvement help? I.e: other faculty, students, community partners**

The project was originally suggested by Dr. JF Williams, an Associate Professor from SFU's Department of Mathematics. When I encountered difficulties, including in the mathematics and future projection of the project, I consulted with him on how to proceed.

**7. What were/are you hoping to get from conducting this research?**

The main goal of this project was to demonstrate that Langara College could also provide its students with research projects similar to larger universities like UBC or SFU. UBC and SFU regularly offer summer research terms to aspiring undergraduate students, especially those interested in pursuing graduate school. The opportunity for an undergraduate student to conduct research prior to graduate school is invaluable. It bolsters resumes and provides first-hand experience about what research in mathematics is like. I am proud that Langara College will be able to offer similar research experiences to our students.

**8. Can you share any personal stories that made this research experience memorable/valuable?**

In my last year of undergraduate studies at SFU, I was given the opportunity to conduct one semester of math research with two professors. This term was instrumental to my future career as a graduate student. Doing research at an undergraduate level let me understand what "research" really meant – this greatly influenced my decision to become a graduate student rather than go into industry. It also directly led to my acceptance into graduate school because the two supervisors for my summer research became my Master's degree supervisors.

My Langara research term, as the supervisor now rather than as the student, was memorable for me because I could give back to the next generation of undergraduate students, just like my two supervisors did for me when I was an undergraduate student.

**9. Do you have any tips/suggestions/ideas for applying this research in your field? Or for others in their fields? Or for conducting future research of this kind?**

If we had more time, I believe it would have been excellent to work alongside biologists so they can point out which parts of our work would be most useful.

**10. Any final comments? What are the "next steps" for this project? And for you?**

We were originally going to create a poster and join an annual SFU poster competition. Unfortunately, the conference was cancelled in 2019. We were then preparing a poster for Langara's Applied Research Day, which was also unfortunately cancelled. So the immediate next step would be to create a poster which would summarize our research.

If we still had time, I would have Miguel investigate equations different from the original paper.

**Please upload any images that will help to showcase your project.**

- [Gravity-with-line-2.gif](#)
- [Gravity-with-line-fast1.gif](#)