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## EL Final Report: Undergraduate Summer Research Internships

Sophie Wu

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Sophie Wu

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Dr. Barbara Bruce

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## EL Final Report

### **Introduction**

There are many ways that my double major in mathematics and the humanities can get pretty abstract at times. I'm incredibly grateful for the WUSRI (Western Undergraduate Research Internship) program, which has given me the opportunity to lead two distinctly meaningful research projects during the last two summers of my undergraduate career. Both of these projects have helped me bridge my two major academic interests into unique and interesting discoveries, both about the world around me and myself. Since these projects were so different—the first, supervised by Prof. Ricardas Zitikis of the Statistics and Actuarial Science department, concerning microinsurance, and the second, supervised by Prof. Lyle Muller of the mathematics department, concerning computational neuroscience—I gained a rich and diverse set of experiences that have informed many of the important choices I have now made about my future as an interdisciplinary researcher.

I will begin this report with an overview of my work with Prof. Zitikis on microinsurance in developing markets and a subsequent overview of my work with Prof. Muller on computational neuroscience. At the end, I'll finish with some conclusions about the nature of interdisciplinary research and some reflections on how my experiential learning has been essential to my personal development. I hope that this can be helpful to any student who may be considering interdisciplinary research in the future. A consistent thread across my experiences

has been that there are a lot more angles to combining two disparate fields than I originally thought were possible—and tons more that I thought of even while writing this report. Reflection and introspection are powerful tools for discovery!

### **WUSRI #1 - Microinsurance with Dr. Ricardas Zitikis**

I was first introduced to the WUSRI program in the summer after second year, and as someone who was keen on getting my feet wet with research, I desperately contacted professors across a variety of departments—from mathematics to sociology to visual arts—asking if they would be willing to take me on as a research intern. In a cold email, I first pitched myself to Prof. Zitikis as a student who was open to “any sort of interdisciplinary research at all.” He was enthusiastic about supervising a student with an unconventional background to take on statistics research, claiming that much of current statistics research had become myopic through generations of insularity. I was all too happy to have a professor who saw my background in the humanities as an asset rather than a handicap, but I wasn’t quite sure what sort of research I really wanted to do. Prof. Zitikis suggested microinsurance: smaller packages of insurance which can be targeted towards lower-income (and often remote) communities. Compared to insurance in developed markets, microinsurance faces a huge problem of lack of data, so the development of novel statistical methods used in microinsurance is a hot and booming field of study. I was intrigued by the idea that this research would combine an understanding of narrative and social structure (*Why* is this microinsurance needed? How can we know that it is improving the lives of communities?) and a technical understanding of the quantitative methods used. With this, I began my first ever independently led research project.

My biggest key learning from this research project: you can never know what to expect from doing something new until you do it, and it's usually the most unexpected surprises that will spark your growth the most. I had always known that I have had an interest in finding interdisciplinary connections between what I study in school. Before this research project, I had only ever known this through taking a variety of classes in the humanities and mathematics and wondering what possible intersections might exist between the two disciplines. This project was my first experience in applying my interests to create something new that I could call my own. When I first started researching microinsurance from different perspectives, I had some experience with academic research, but it had always been in the context of the classroom and, more specifically, usually in the context of essays and assignments. This meant I was used to having very specific expectations for the final product of anything I turned in for a professor. It was tricky for me at first to even imagine what sort of research paper I wanted to create because I had no research model to follow or examples to take inspiration from. Overall, I had many moments where I felt stuck and found myself grappling with a lot of questions to which I didn't immediately know the answers since none of the answers were immediately present in my literature review.

Although there were many times when I felt like I was stumbling through my understanding of microinsurance, I realized this was because there was no pre-existing to bridge the gap between my research interests that were related to this project: the statistical methods used in microinsurance and the qualitative reports on the impact of microinsurance on people's lives. I wondered why this gap even existed in the first place and came up with multiple explanations: perhaps the statistical papers were more interested in selling the idea of microinsurance, while the philanthropic and narrative-based papers were more interested in

exploring the nuances of microinsurance through a critical lens. Through working on this kind of research project, I could more deeply understand the characteristics of the different disciplines that I had studied in school and the parallels and distinctions that existed between them. And I tried to remind myself throughout my practice that it was because I felt so lost sometimes while exploring my research that it was so necessary in the first place. After all, I hoped to be able to bridge that gap (or at least offer *something* new to fill the gap with!).

I spent a lot of this summer reading applied mathematics and statistics textbooks, both recommended by my supervisor and found through my Googling, which was my first interaction with applied mathematics. It has been really interesting reading these books from the perspective of a student in pure mathematics and the humanities. Both of these fields (although disparate in many ways) share a common goal in their pursuit of knowledge for knowledge's sake. It is often taboo in humanities or mathematics research to find the "utility" in a research question before exploring it. Both subjects take inspiration from the real world in different ways (mathematics from the universal patterns of our universe and the humanities from artistic expressions of our everyday lived experiences), but each takes a similar pride in being justified in their own right, as if being studied by the objective perspective of someone separate from the world we live in ourselves. But interestingly, I think that it's the combination of these two fields where applied mathematics finds its utility. After all, applied mathematics seeks its relevance to the world through its applications in improving people's lived experiences (although, I think there are many ways these experiences can be difficult to quantify numerically), and it relies fundamentally on the principles and rules discovered through pure mathematics.

From this distant and academic perspective, it did seem a little bit strange to me to be approaching the issue of poverty that is endemic to particular regions which I have never been to

and to have the privilege of understanding these issues from afar (or trying to, at least). I think it's been interesting to also read about how microinsurance programs have typically been limited by a lack of literacy—both financial and linguistic—present in the populations for which its services are offered. Each step I take further in understanding the advanced statistical tools used to build microinsurance models is a step further away from the basic explanation of microinsurance given to its customers: “in exchange for premium payments, you will be at lower levels of risk.” And this is already a promise that already sounds shaky to families who earn little to begin with and have plenty of reason not to trust foreign institutions with their hard-earned income.

I spent the last month of my research internship writing my final paper, and I noticed that the pressure I felt for this paper was very different from the usual pressure of schoolwork. While writing my paper, I wasn't quite stressing over a grade or worrying about what anyone else would think of my work. I just felt a lot of pressure to make something good because I cared about this project, and I wanted to make sure that I was making the most out of it. Afterwards, I realized that a lot of anxiety that I had experienced before with handing in school projects often felt uncontrollable, because sometimes I wouldn't feel a sense of ownership over my work, and I would be worried more about the grade than whether I was happy with what I was producing. Although it was an uphill battle to sort out my project at first, because I felt that it was so unlike any other research paper that I had ever read before, it also helped me manage my stress to remind myself that the cause of my stress was internal and, ultimately, something that I had personal control over.

Although it was challenging, I also really enjoyed combining the different forms of information that I had collected and produced in a singular narrative. I realized that researching

was one thing but presenting your research results effectively was a whole *other* thing. I needed to really think about how I wanted to present the information I had collected and analyzed before I could start to present it as a cohesive unit. But I also didn't want to be so wrapped up in my perfectionism that I would spend hours deliberating before writing a single, complete phrase in long splurges of ideas that I would later have to cut down and refine and connect to each other. I certainly think that this project has improved my writing, because it made me think a lot more about the process of writing itself, in a variety of applications using information from different disciplines. And on a higher level, this project taught me the importance of holding yourself to a high standard of quality with your writing, while not letting high expectations ruin your capacity to complete it. I have carried this with me ever since.

## **WUSRI #2 - Computational Neuroscience with Dr. Lyle Muller**

I learned a *lot* from writing my microinsurance research paper, and I am proud of all that I did that summer. But I felt that the most interesting components of my research leaned into criticizing the statistical methods (What is it that our limited weather *can't* tell us, and what does *that* tell us?) rather than “selling” them. I wanted to dive deeper into this sort of research, which was how I stumbled upon the Muller lab and decided to learn more about computational neuroscience (which I didn't even really know was a field before!) before receiving an offer to complete a USRI with the lab for the subsequent summer. There were a few ways that this research internship offered me a different perspective on research as a whole.

Firstly, I deeply appreciated the novelties of my computational-neuroscience research. Before this research internship, computational neuroscience was an entirely foreign field to me. Unlike my microinsurance project, where I was at least able to vaguely put an image to the

economic jargon used in my literature review, computational neuroscience required a hefty amount of understanding of abstract mathematical and biological concepts. Even just choosing a research topic at the beginning of the summer required reading heaps of unfamiliar words, which then required heaps of Googling, which then required reading even more heaps of unfamiliar words, which then required more Googling—ad infinitum. Aside from familiarizing myself with this entirely new field, I found that there were always new things to be learned in the process of my research. Given the relative newness of computational neuroscience as a field, many old problems are open, and many new theories are contestable. Along with the interdisciplinary nature of my research, this meant that I felt like there were constantly new opportunities for intimidation. There were many moments throughout my summer when it was easy to feel like I was lost in the weeds. But now that I can look back on that summer holistically, I recognize that I did enjoy my research a lot more because of the wide breadth of content I could engage in. There is plenty of room for creativity in applied mathematics research, primarily because the tools that you are developing bridge so many disparate disciplines and ideas. Through this experience, I now know that exposure to completely new ideas is something I enjoy immensely in a daily practice, and I will certainly be keeping this as a priority in mind when making future career choices.

Secondly, I really enjoyed being part of a lab working on a group project. I'm not sure how often I will ever get to experience such a supportive and communal cold dive into an entirely new field, but I know that I am lucky to have been exposed to this sort of environment even once in my undergraduate degree. Right from the start of the summer, my supervisor, Prof. Lyle Muller, was exceptionally supportive about seeing my WUSRI as a learning experience. I know from talking to other summer research students that not all supervisors have offered the



same kind of flexibility. Many of my friends were given a problem to work on right from the start and then spent the whole summer working on that singular problem. Prof. Muller told me it was most important that I look for a project which I find personally interesting, while also offering me many solid suggestions for starting points and letting me know that it was okay to experiment with ideas along the way. Without these suggestions for first ideas, I probably would have been swimming around in the dark for much, much longer, and without having someone who could validate my ideas and offer guidance on future steps, I would have made much slower and more hesitant progress in my work. Around a month into my research internship, I settled into a project on analyzing chaotic dynamics using reservoir computing with another undergraduate student doing research in the lab. Aside from having the support of my supervisor and other more experienced researchers in the lab, I found that being able to work with another student on the same project made the process of research feel significantly less daunting. Most importantly, it was immeasurably helpful to have someone to talk and relate to about the project, whether it be to celebrate new findings or to support each other in times of frustration. I am interested in continuing to do research in the future, and I now know to prioritize research opportunities which offer collaborative and supportive environments.

Lastly, I was grateful that this experience pushed me to find my own accomplishments and capabilities notable. As with the previous WUSRI, a requirement for this internship was to produce a final research output, and I worked with the other undergraduate student in the lab on my project to produce a paper which we submitted to Western Scholarship. Going into the writing process, we already knew that we didn't have any extraordinary findings or publishable results and that many of our leading questions would remain unanswered by the end of the summer. We both had enjoyed our research internships, but we did also feel a little

underwhelmed by our end results since we had initially expressed to each other that we had hopes of producing something we could submit to a journal at the end of our internship programs. As we wrote our final paper, we started to piece together all the little bits and pieces that we had experimented with over the summer to organize our ideas. And in the end, we wrote something that I realized neither of us would have been able to produce at the beginning of the summer. Regardless of our results, I found that it was fun to turn our work into something cohesive and presentable. And I realized that many of the other ways that we had presented our work over the summer, such as through giving updates to the other lab members at the weekly lab meetings, had also felt meaningful in their own right. Overall, that summer was an immensely liberating and validating process to oversee my own learning and to affirm my own capabilities as a learner. I know that, regardless of how long it might take me to reach my future goals in my research, I must recognize my learning along the way. For that reason, I am very glad that this project finished in a real and shareable output.

My biggest lesson in my second WUSRI was that working with others is an invaluable resource when accessed properly. Thankfully, this project forced me to get more used to asking the “wrong” questions (or at least believing that there aren’t any!). Since the process of following research leads has been so mercurial for me, I have often felt guilty for bringing up so many disparate topics to my supervisor and the other people in the lab. But after being thrown into such unfamiliar academic territory through the course of this internship, I definitely realized (by force of necessity) the importance of accepting that you might not always sound like you know exactly what you’re doing. After all, very few people do—that’s why all research fields are so filled with open questions and leading discoveries. And my friends at the lab have been more

than welcoming and willing to tackle the questions I have thrown at them along the way, even when they haven't known the answers themselves right off the bat.

### **Where to next (and why)?**

Altogether, these research experiences really influenced my decision to go into the Digital Humanities after I graduate. I'm really grateful that I learned a lot of computational and technical tools that I was able to use in my application to my future M.A. program. I know it will prove very helpful to have a good computational toolkit to approach the wide variety of problems in the Digital Humanities that I might see in the future. A big part of my choice to enter this field, rather than strictly computational or quantitative research, was my reflections on comparing my two experiential-learning experiences. I found work that was critical of technology, and that was able to recognize its own limitations, significantly more appealing than work that just touted the importance and power of technology. It seems especially important now that stronger technologies should be used with a lot of questioning the *what* and *how* and *why* of that technology being used. In the digital humanities, I hope to find some novel computational approaches to studying the humanities but, alongside these discoveries, to remember the hesitations that I have had throughout my research of applying quantitative methods to complex and subjective questions.

These hesitations manifested primarily in my microinsurance research. I saw a lot of papers that were explicitly about the quantitative side of microinsurance and how you were supposed to apply this specific statistical technique to this or that problem but very few papers that would then cite that paper to ask, how helpful is this actually? How important is this discovery in genuinely improving people's lives? It seemed like the economic literature behind

the efficiency of microinsurance was jarringly disjointed from the research on the statistical and quantitative methods that you could use in microinsurance. And there's a pretty believable reason for this. There are a lot of people who stand to benefit from having this idea be sold so fervently, that just by researching this topic better and having a better technological solution to fixing this we can fix it without actually interrogating the systems around them.

Afterwards, when I did my computational neuroscience research at the Muller lab, I realized was that it was possible to do quantitative research that recognizes its own limitations. Computational neuroscience is a really great example of this, partially because it's such a new field. When modeling the human brain with a computer, researchers have to list very clearly what sorts of assumptions they are making about the brain's behavior, structure, and function (all things that we know so little about already!). Knowing that you can have hesitations about your work's proximity to reality but still gather insights from your models is incredibly appealing to me. But what's really appealing to me is how the hesitations can become a part of what is meaningful about your work. Going into graduate school, where I'm likely going to be researching language models and the neural networks behind these language models, I'm really grateful to have the programming toolkit to tackle this problem technically but to also have had the opportunity to think critically about the relationship between methods in the humanities and the quantitative sciences.

Aside from helping me narrow down my research interests, my experiential learning has been pivotal to determining what I find genuinely meaningful in the day-to-day of the work that I do. I have realized that I really prefer collaborative work and that part of what I really liked about working in a lab environment was holding yourself to a very clear shared goal among other people with similar interests. Having a clear technical standard to your work that you're sharing

with these other people and that you're seeing every day, and having these conversations with them, that are both formally about the research and informally just about things, like how their day is going and what they may or may not find interesting/frustrating about their work, is an environment that I really enjoyed. This sort of being-on-a-team feeling was really good for motivating myself to go above and beyond and to view my work less like a stack of vague future to-do list items and more like I was a part of something real in the present.

Through writing this reflection and thinking about the ways that I have grown through my WUSRI experiences, I am glad to say that I have learned a lot about what kinds of things appeal to me in work, learning, and teamwork. I know that I would not be able to make these kinds of statements if I had just relied on my assumptions about research instead of personally experiencing research itself; there are, after all, many things that you can only learn about yourself in practice. There are lots of other things I would still like to learn. While listening to my classmate's EL presentations, I realized that most of my peers had outputs with their work that were a lot more immediate. Their work seemed to be driven by much more short-term deadlines, and they often described interacting with the people upon whom their work has impacted directly. I believe there is a lot of personal growth that can be facilitated in the non-applicability of research: for example, you get to do a lot of exploratory work, you get to have a lot of direction over what sorts of things you're doing, and you can choose that direction based on what interests and motivates you the most. As stated before, I think this was very helpful for reflecting on what sorts of skills I had learned in the classroom that were applicable to research and what skills I still needed to pick up on especially when it came to being accountable to my own tasks, deciding my own learning materials, and knowing how to work on a long-term project rather than something that would be due in the next couple of weeks. I am also curious to

know what skills I could have developed if my experiential learning had been outside of academic research. I believe that there are some skills that I could still actively work on outside of my research—possibly through volunteering or other work experiences—such as collaborating in more fast-paced environments, which would be beneficial to me, whether I continue in academia or not.

Reflecting on my own experiences constantly has really helped me affirm that research is something I enjoy doing, while also helping me identify and understand the significance of the challenges I have faced along the way. In the long-term, my goal is to continue my research and work towards directing my own research group/organization in the digital humanities/computational arts. I would love to share my love for interdisciplinary research, and I already have a lot of ideas on what a successful working group would look like just from noticing what worked well in my own research experiences. I would like to extend a special thank you to everyone on the SASAH team—especially Dr. Barbara Bruce for reading all my reflections up till now!—for making my unique undergraduate experience possible.