Australian Students at the Graduate Industrial Maths Modelling Camp, Edmonton

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The 10th Graduate Industrial Mathematics Modelling Camp (GIMMC) and 11th Industrial Problem Solving Workshop (IPSW) were held by the Pacific Institute for the Mathematical Sciences (PIMS) at the University of Alberta, Edmonton, Canada, in June 2007. As a member of PRIMA, the Australian Mathematical Science Institute (AMSI) assisted one student from Macquarie University and one from the University of New South Wales (UNSW), to attend. PIMS provided free accommodation, meals and registration.

At GIMMC, experienced researchers work with groups of students on a number of industrial mathematics problems that have previously been advanced at other meetings. The aim is to give students some experience and confidence before the following week's IPSW, which is similar to the Australian Mathematics In Industry Study Group.

The following are personal accounts from the students.

Kaiser Lock (Macquarie University)

GIMMC and IPSW held by PIMS took place at the University of Alberta, Edmonton, Alberta. Canada is one of the furthest places from Australia but with the generous funding from both AMSI and Macquarie University, I was fortunate enough to be able to participate in this workshop and I have benefited greatly from it.

On the first day, all the camp participants (who I later found out came from educational backgrounds ranging from mathematics and biology through to computing and engineering) were gathered together. We were addressed by the faculty mentors who are experts in a wide range of mathematical theory and applications. They presented us with several industry problems, which aimed to give us the opportunity to learn mathematical modelling techniques under their supervision and to prepare for the following IPSW. The following problems were posed.

- 1. Natural frequency of a fluid-carrying plate (Robert Piche, Tampere University of Technology)
- 2. The early stages of atherosclerosis and the 'oxidative modification hypothesis' (Christina Cobbold, University of Glasgow)
- 3. Modelling health service usage for Canada's aging population (Warren L. Hare, Simon Fraser University)

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- 4. Epidemiology (Abba Gumel, University of Manitoba)
- 5. Coagulation Fragmentation Equations (Henry van Roessel, University of Alberta)
- 6. The Chemo tactic Paradox (Thomas Hillen, University of Alberta)

I was lucky enough to get my first preference, 'the early stages of atherosclerosis and the oxidative modification hypothesis'. Christina guided three other students and myself through the resolution and provided relevant knowledge (and the most organic chemistry I have seen since high school). This knowledge helped us to model the rate of lipoprotein oxidation at different concentration levels of anti-oxidants as under the 'Oxidative Modification Hypothesis', this is believed to be the main cause of deposition of cholesterol within the arterial wall. On the fourth day, our group delivered a presentation, which was the culmination of three full days of reading about low-density lipoprotein, disagreements and eventual agreements on modelling approach, computational debugging and analysis.

During the second week, the industry experts posed the following six problems.

- 1. Optimisation of drug structure for protein targets using molecular morphology characterisation (Cross Cancer Institute, Edmonton)
- 2. Optimisation of multi-drug composition for the most efficacious action (SinoVeda, Edmonton)
- 3. 3-D Analytical solution of air/water two-phase bubbly flows (Syncrude, Edmonton)
- 4. The two core statistical/mathematical challenges in epidemiology (US Smokeless Tobacco Company and Alberta Smokeless Tobacco Education, Edmonton)
- 5. Probabilistic assessment of television viewer demographics (Invidi, Edmonton)
- 6. How does landscape management affect the infection risk to zoonotic diseases? (Canadian Parks and Wilderness Society)

On the first day of IPSW, the industrial mentors Dr Carl Phillips and Dr Karyn Heavner explained the problems arising in epidemiology to our group, which comprised our mentor, Warren L. Hare, five other students and myself. The problem lies in the fact that epidemiological studies are characterised by study errors, including measurement errors, confounding, non-comparability of compared groups, and non-generalisability of results to the whole population. The nine of us spent the rest of the week aiming to develop methods to quantify the uncertainty resulting from the unknown levels of these various errors. Due to time constraints, we were only able to propose a possible approach to be used in epidemiological studies to fully demonstrate the uncertainty. On the fifth day, we presented and published a report on the proposed method, demonstrated numerically the effects of the uncertainty on the published result, and how the proposed method would be able to quantify the uncertainty.

Although the workload at the camp was quite heavy, we did manage to find some time for non-mathematical pursuits and to enjoy the peaceful University of Alberta campus and surrounding greens. When all of my GIMMC group

GIMMC June 2007

mates and I decided to take full advantage of the summer weather in Edmonton by doing our group discussion and brainstorming in the nearby park by the water, we were introduced to the nice breeze, comforting summer sun and pesky mosquitoes (needless to say, we stayed in the computer lab for the rest of the camp). Over the weekend, we also managed a pleasant trip to the world's largest shopping centre, West Edmonton Mall, as well as an exciting one-day road trip to Drumheller. Here, our breath was taken away by the amazing view of the Canadian badlands, the dinosaurs and all the fossils. I really enjoyed myself despite the fact that the excursion ended with a disastrous canoe trip down the Red Deer River, which caused us to arrive back at University of Alberta at three in the morning.

This interactive, intensive two-week event has offered me such an excellent opportunity to gain experiences in learning some inventive and rigorous problemsolving techniques. I was able to tackle real-world problems using mathematical and statistical tools, and saw the application of mathematical knowledge to various industrial problems in the fields of medicine, government, etc. I have also built on my team skills considerably by working together with international students and researchers coming from very different educational and cultural backgrounds. Moreover, two coffee breaks each day not only provided us with the refreshing and much needed coffee and finger foods, but also the opportunity to socialise and network with industrial partners, experts and other researchers. Needless to say, it was also a great opportunity for me to see and explore Canada and to learn that 'entrée' does not always mean 'appetiser'.

I would like to thank my supervisor Professor Paul Smith for recommending this workshop to me. I am grateful to AMSI and Macquarie University for their travel grants, which made this trip to the other side of the world possible. Thanks also to Thomas Hillen from the University of Alberta, who did an excellent job of organising the workshop, PIMS for this educational and stimulating event and their support for the accommodation and meals during the camp. Finally, thank you to all the participants for the enjoyable times and valuable knowledge I have gained from every single one of them.

Ognjen Stancevic (UNSW)

As an undergraduate, I spent June of every year mostly alone, studying before the upcoming exams. June 2007 was different. Yes, I still studied, but it was some 13 000 kilometres from home, and for quite a different purpose — you could even say that it was for fun. And I surely wasn't alone — another 35 maths/science students studied with me. This June we attended the 10th GIMMC and 11th IPSW in the Canadian city of Edmonton.

I heard about the camp from my supervisor, Dr Gary Froyland, and he thought that it would be a valuable experience for me. As I had never been on a mathematics camp before, I wasn't sure what to expect. Well, the first thing I learned on the arrival to Canada is that their definition of the word 'warm' is very different from ours. Summer in Edmonton is almost comparable to Sydney's winter.

274

The first half of the event was the Graduate Industrial Mathematics Modelling Camp (GIMMC, pronounced 'gimmick'). On day one, six mentors presented and advertised their industrial problems. The students chose which problem they would prefer to work on, and so we formed six groups of four or five, plus the mentor who gave some guidance in modelling, analysis and computer simulations. Generally, the mentors already had a sufficient and working model, and the main purpose of GIMMC was to give us, the students, an opportunity for some real-world mathematical modelling. Most students were doing Masters or PhD degrees in mathematics, physics or computer science. Later I learned that because everyone's background was so different, we could all contribute something useful to the team.

My group modelled the mechanisms behind early stages of atherosclerosis; in particular, our job was to investigate the effects of Vitamins C and E on the disease. The task was to model all the chemical reactions occurring in the artery wall, together with the diffusion of chemicals in and out. A number of different approaches in modelling were possible, but the group opted for a dynamical systems version, mostly because we were all familiar with it. Straight away, after trying to write down some differential equations involving reaction rates, we ran into problems, because we wrongly assumed that the chemicals were homogeneously distributed throughout the wall. For example, several Vitamin E molecules group around an LDL (low density lipoprotein) particle, forming a barrier and making the chemicals inside the particle effectively less reactive. Aside from this, there were many other modelling problems along the way, as well as problems in the analysis and simulations. With some help from our mentor, Dr Christina Cobbold, we tackled each one very well, and considering the two-and-a-half-day time period, we made a lot of progress. There was a lot of hard work (one day we stayed up until 1 am working on the task), but we also had so much fun. Our 'brainstorming session' we spent in a park next to the river enjoying the sunny day, albeit only until mosquito bites became too much and we had to run back to our room at the university. Day four was the presentation day. We presented our methods and findings and we also saw the challenges that the other five groups had to face.

Day five was a much-needed break. For most of us this was a rare chance to get to see Edmonton, and some of Alberta's many national parks.

The second half of the camp was the Industrial Problem Solving Workshop (IPSW), where mentors and students work together on a real-world, unsolved industry problem. Again, we were presented the option of six new problems. These problems were yet unsolved (for a change), and the IPSW seemed much more serious, as if the GIMMC was only a practice run before the main event. My new group had the task of investigating the effects of fragmentation of the environment on biological populations, with particular reference to the spread of Lyme disease through tick populations. Other topics were just as interesting and important. Mathematical optimisation of drug structure, requested by the Edmonton Cross Cancer Institute, seemed like a very promising way of finding new drugs for cancer patients. Another interesting topic was the behaviour of bubbles in two-phase air/water turbulent flow through a pipe. This time the students didn't have to work alone. Our group was helped by two mentors and two members of the faculty who were experts in population modelling.

GIMMC June 2007

Even though my role in the group was less active than before, I learned just as much as I did in the first half of the camp.

This camp was a great experience for me and I would surely recommend it to any Australian student of applied mathematics. It shows you what your job could be like one day, and it is the best place if you want to hear so many (bad) maths jokes. Every single one of my days spent there was filled with excitement, either because of learning new things or meeting new friends, or seeing new places. If I ever get a chance to do something similar again, I will definitely not hesitate to take it.

I would like to thank my supervisor Dr Gary Froyland for encouraging me to attend the camp, and for helping me with the application. Many thanks to AMSI, PIMS and UNSW for financially supporting the visit, and to PIMS for great organisation.

The annual PIMS (Canada) Graduate Industrial Mathematical Modelling Camp and Industry Problem Solving Workshop will be held at University of Regina, June 9–20, 2008. AMSI will pay half return economy air fares for up to three Australian students to attend. Departments are expected to provide the other half but this may be from AMSI institutional travel accounts. The PIMS organisers have kindly agreed to reserve three places with free accommodation and registration. It is expected that these students will be active participants of the Australian Mathematics In Industry Study Group.

Mathematics and Statistics Heads of Discipline are invited to nominate up to two students, with CV and one-page statement on how the student and Australian mathematics might expect to benefit.

Submissions are required before 31 January 2008, as organisers must know numbers in advance.

276