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CANADIAN INTERNATIONAL YOUTH LETTER

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My Experience in the International Olympiad in Informatics 2002

"Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain first which carries the further the works of thought and intelligence."

Louis Pasteur (1822 -1895)

This year, I was fortunate enough to be a member of the Canadian team for the 14th International Olympiad in Informatics 2002, held in Yong-In, Korea. I was selected along with three other Canadian high school students at the Canadian Computing Competition, organized by the University of Waterloo in February (Stage 1) and May (Stage 2, between the finalists from Stage 1). Informatics (or Computer Science, as it is called in Canada and the US) is a fast-growing science that deals with the storage, manipulation, and use of information in a computer, as well as the development and analysis of various methods of computation and computerized problem solving. It is essential in the new millennium as more and more applications are discovered for computers. The International Olympiad is a world-wide informatics competition between high school students. Over 300 participants from 77 countries attended the IOI 2002. The week-long stay in Korea consisted of not only competitive problem solving but also tours, presentations, and recreational activities. The Canadian team consisted of four high school students, and we received two silver and one bronze medal in total. Overall, it was an amazing experience.

This logo represents the IOI itself. The big smile of this mouse of "Hahoe T'al", the typical mask of Andong in Korea, shows the festive atmosphere of IOI-2002.

Computers are essentially machines that think. They are the next step up the ladder of evolution of human technology. Our ancestors started out as animals that explored their environment, searching for food and shelter, but did not use any sort of tools at all. These prehistoric hominids soon started picking up objects from their environment and using them, however: for example, a stone hurled at an offensive predator was a lot more effective than a direct fight with that predator. Humans then evolved from picking up objects in their environment to creating their own tools. By scraping rocks against each other, for example, they could create sharper, more useful surfaces. These surfaces could be used to cut and sharpen pieces of wood. They could be attached to handles for better efficiency or used as arrows or building materials. Eventually many useful tools and products were created that facilitated human existence. The next step in technology was to create automatic machines, tools that could perform a task on their own with minimal human supervision and effort. Inventions like water-powered mills and the steam engine made many production processes more efficient, further improving human lifestyles. However, these machines still had to be watched over and operated by people. Therefore, the next step in the process was to make machines that could "think" and work autonomously, fixing problems as they came along - computers. With the invention of electronics, this became feasible, and robots were adopted on many assembly lines. Once the electronics were developed, one could create a program for the computer to follow, and the computer would do whatever the program dictated. This program could include logic, decision making code, iterations, data access from a remote source, communication with other machines, and many other functions. Apart from industrial applications, however, computers could also be used for more general purposes. Today's personal computers can run a wide variety of programs created for many purposes, perform computations at lightning fast speeds, solve problems that teams of humans would not be able to do at all with paper and pen, store billions of bits of information, and access a global network of services through the Internet.

Despite all these amazing feats, however, there are many things that computers still cannot do, many systems that need to be implemented more efficiently, and many problems where the best known algorithms would take millions of years to run. Computer science deals with these issues, as well as the theory of studying and analyzing algorithms. This analysis is mathematical in nature, involving mathematical definitions, proofs and calculations dealing with "computer" concepts, and extends not just to the machines we have today but to the general question of what can and cannot be computed by any machine, and how efficiently such computations can be made. For example, computer scientists have proved that certain tasks - such as finding all the solutions to any Diophantine equation (a polynomial equation where we look for integer solutions, such as x3y + 4zy2 - 3z = 21) - can never be performed by any calculating machine. They have also discovered a large set of problems, termed "NP-complete", that cannot be solved by any known algorithm in less than exponential time. This means that if such a problem's input is N items long, for example, no program known can solve it in less time than aN where a is some number (larger than 1). An example of this is the Traveling Salesman Problem: given N cities and the distances between them, find a path which visits each city only once, returning to the starting city, and is minimal in length. This problem has obvious practical applications: a company might want its delivery trucks to travel the fastest route every day before returning to headquarters, a speaker might want to visit N cities in the shortest time when going on tour, etc. However, it cannot be solved in less than aN operations by a computer (and imagine trying to work out the very best tour of 1000 locations by hand - it's just as impossible). For example, if we take a to be 2, perhaps the problem can be solved in 1 microsecond with one city. But then two cities would take 2 microseconds, 3 cities would take 4 microseconds, 4 cities would take 8 microseconds, 5 cities would take 16 microseconds, etc, with the running time doubling whenever we increase N. These numbers quickly become huge. For example, 10 cities would take 1000 microseconds (1 second), 30 cities would take 1 billion microseconds (18 minutes), 50 cities would take 36 years, and 100 cities would take many times more than the estimated lifespan of the universe.

My IOI 2002 Experience

There are reasons to believe that problems such as the Traveling Salesman Problem cannot ever be solved in less than exponential time, because of mathematical implications. Studying these issues and coming up with fast algorithms or approximate answers to problems is what computer scientists do.

Of course, many problems have indeed been successfully solved by computer scientists and implemented as programs. Today, computers can quickly search for data in billion-entry databases, transmit information securely over an open communications channel, schedule aircraft flights around the world, route messages from one side of the planet to another, guide robots in dangerous environments, simulate physical and chemical processes, analyze DNA sequences, display constantly-updating, realistic 3D environments in real-time, evaluate complex mathematical functions, and recognize and translate images and speech. That a reasonably inexpensive machine made of metal, plastic, and silicon and running on about as much electricity as a desk lamp could perform such tasks would have been thought impossible fifty or sixty years ago.

Unlike the Olympics in sports, the International Olympiad in Informatics has no separate "events" - contestants are given medals based on their scores, so that in the end there are a number of gold medals, a number of silver medals, and a number of bronze medals. The competition does consist of distinct tasks however; each task involves writing a program to solve a specific problem within some given time and memory limits. The program is marked by its performance on several input data sets, with points awarded for each set solved properly. There are two competition days, with three problems to solve in five hours on each day. Some of the problems are theoretical in nature, but some also have clear practical applications, and all of them require in-depth knowledge, quick logical thinking, and creativity. The problems this year were very varied and interesting, and of course very difficult. There was a lot of strategy involved in choosing which problems to start with, what algorithms and techniques to use for each problem, and how to best manage the time provided. While five hours might sound like a lot of time, they flew by very quickly in the midst of the competition, and each problem required one or two hours of thinking and programming to obtain a good solution. The competition was very challenging but fun and rewarding in the end.

Our stay in Korea also included many presentations, tours, visits, and Korean culture experiences. The event was held on the campus of Kyung Hee University in Yong-In, Korea, near Seoul. Our residences and the buildings where the competition took place were on-campus, but we visited many places around Seoul during our stay. We saw a rebuilt Choson-dynasty village (the Korean Folk Village) where we learned about traditions, customs, technologies, architecture and art work from this time period, a technology museum (the Information Superhighway Centre) where we saw the leading edge in computer systems and electronics technology, an amusement park (Everland) where we spent an unforgettable day of exhilarating activity, a war memorial from the Korean War, and other locations. The leaders and observers on the Canadian delegation toured Seoul and visited museums and palaces, as well as a World Cup stadium, while the competition was taking place.

We also had many opportunities to meet with and talk to contestants from other countries, and have fun. Every evening, the organizers set up Korean culture experiences and presentations in various parts of the campus, and we saw Tae-kwon-do demonstrations, Korean folk dances, modern Korean music, and a presentation Robot Soccer games given by a Soccer World Cup announcer. In some events, such as the Tae-kwon-do presentations, the contestants could participate themselves, making for a very memorable experience. We met contestants from almost every country in the world - Brazil, Israel, the Netherlands, and South Africa, among others - and in our spare time we often found ourselves chatting or playing soccer, basketball or video games with people from the other side of the planet.

I enjoyed the presentations and tours at the International Olympiad in Informatics, as well as the general festive atmosphere and the challenging competition itself. It was a mind-opening experience, not only because I had a chance to experience the Korean culture but also because it was an international event that brought together representatives from around the world for a common purpose and showed how interconnected our world is today and how quickly we are moving into the future. The IOI 2002 was a very well-planned and well-organized event, and the memory of this one-week experience in Korea will be with me for a long time.

© Matei Zaharia
Silver Medal Winner of the International Olympiad in Informatics 2002

At the time of the International Olympiad in Informatics 2002, Matei was in Grade 11 at Jarvis C.I. in Toronto. He is a member of the Youth Association for the Advancement of Science, Innovation and Technology (YAASIT), as well as a website developer for www.yaasit.ca. Matei began as a volunteer after attending ScienceSphere 2001 and hearing about the YAASIT/SciberLink project. He is helping advance the project's Canada-wide youth initiatives and objectives.

Authors are contributors to the career development Canadian International Youth Forums, also known as ScienceSpheres, and Members of the Advisory Council of the Public Awareness Education Programs.

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