

The New Zealand Experience of Finding Informatics Talent

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Abstract. If Informatics, or indeed Computer Science, doesn't exist as a recognised, valued and suitably assessed senior high school subject, there is a challenge in finding students and training them to Olympiad standard. In New Zealand there are now 4 events which provide students with the opportunity to be selected for the New Zealand Olympiad in Informatics (NZOI) training camp. This has allowed the numbers of students able to be considered to expand from 5 in 2007 to 19 in 2010. In the other scientific disciplines, the olympiads all benefit from the presence of a sanctioned academic subject in high school. With the advent of a new "Body of Knowledge" (curriculum) and suitable assessment instruments to attract the more academically oriented students to Computing, it is hoped that the school system will become actively engaged in the NZOI program by encouraging students into contests.

Key words: informatics, olympiad, contest, training.

1. New Zealand and Its Education System

New Zealand is physically isolated, a long thin country spread over 2 major islands. The total population is just over 4 million with a concentration of 1.3 million living around Auckland city. The education system is free (public schools) with children typically starting on their 5th birthday. The school system consists of Primary (years 1 to 6), Intermediate (years 7 to 8) and Secondary (years 9 to 13). Until year 10, the curriculum is compulsory, but from year 11 onwards students choose 5 or 6 subjects per year. The main public assessment system for secondary school students is called NCEA, which is loosely modeled on the concept of mastery. The 3 levels correspond for the majority of students to years 11, 12 and 13.

Informatics does not yet figure in the curriculum. Senior courses in Computing are different in every school, as they are dependent on the skills and motivations of the teacher. The mechanisms for assessing it Computer Science an academic subject have been remarkable by their absence. For this reason, finding students in high school who may excel in Informatics has been an arduous task.

2. Identifying Informaticians – The Standard Route

In the 5 years of New Zealand's participation in the Informatics Olympiad, we have relied on the smallness of the country and personal connections to help identify potential students. There are 3 contests which are used to help our organization find interested students.

There is a tradition of New Zealand students sitting annual tests set in Australia such as those of Educational Assessment Australia (EAA), a testing organisation which specialises in annual large-scale testing of primary and secondary school students in the core curriculum subjects. The Australian Maths Trust holds a written informatics test, the Australian Informatics Competition or AIC (<http://www.amt.canberra.edu.au/aicsample.html>), and it has recently been introduced as an option for New Zealand students. The popularity of the EAA tests means students and their parents are used to the concept of paying a small fee for the student to sit an international test, and receiving comprehensive results, identifying the percentile the student is placed in. Names of schools with students from New Zealand who have performed exceptionally well in the AIC are communicated to the NZOI and their schools are then contacted. These students have been identified as exceptional problem solvers, and possibly algorithmic thinkers, and are invited to the training camp in summer for the Olympiad. Most will have no coding experience. Some online help is offered through a google group prior to camp. The value of such pen and paper competitions in Informatics is re-enforced by Burton (2008).

The second major competition through which students are identified is the New Zealand Programming Contest (NZPC www.nzprogcontest.org.nz). This contest has a 22 year history and is a team contest, initially designed for tertiary students. It is held over five hours on a Saturday in August and the contest is held at approximately 5 to 6 sites around New Zealand. The students can use any language the site will support. It is used by some students as a training ground for the ACM ICPC contest. In the last 5 years it has been opened to secondary students, and the problem set includes problems approachable by all secondary students with some knowledge of programming. Again the organiser of this contest, Phil Robbins, notifies NZOI of all school contestant's leaders and the students are then contacted and invited to the NZOI summer camp in December.

Such students are often self taught although there are small numbers of teams from schools where programming is taught. But to enter this contest the students have actually programmed, albeit typically in a non IOI language. They will almost certainly have had no formal algorithm training. Although the teams contain 3 students, it is very common for only one student to be interested in attending summer camp. Because the IOI is predominantly C++ (or C) and this is not often the language of first choice to begin learning programming with, this creates the necessity for some pre-camp training.

The third major competition is the Australian Computer Programming Contest run from the University of Southern Queensland by Michael de Raadt (<http://www.sci.usq.edu.au/staff/deraadt/acc/index.html>). This is also a team (of 3 students) event but it is held purely for junior (up to age 15) and senior high school students. It is typically held over a 10 day period in August and the school can nominate which

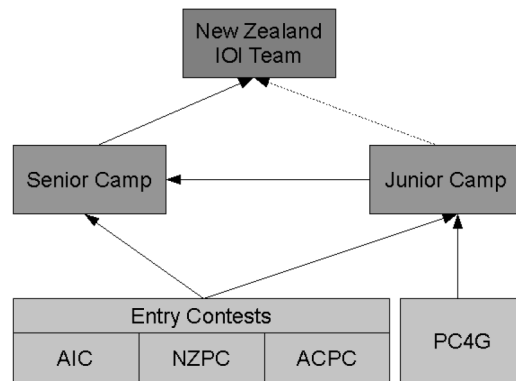


Fig. 1. Pathways to the New Zealand Olympiad in Informatics team.

2 hour time slot they wish to enter the contest in. The language can be of the students' choice but few students choose C++ (or Pascal). The organiser notifies NZOI of the schools which entered, and again the students who entered are invited to consider summer camp.

Fig. 1 shows these 3 competitions (the AIC, the NZPC and the ACPC) as “feeding” the summer training camps of the New Zealand Olympiad in Informatics organisation. Sample problems of these 3 contests are included in Appendix 1.

3. Identifying Informaticians – A New Proposition

It is relatively obvious that there is a gender disparity in much of the western world where informatics is concerned. There are many small inroads being made into addressing equity issues and one of these is a spin off from a Young Women's Programming Contest which ran from 1988 to 1999 in Auckland, New Zealand. Its primary aim was to attract young women to consider IT/Programming as a tertiary study choice and the top prize included a scholarship for each of the 2 members of the top team (Costain, 1999).

Although this contest became defunct, a number of the women originally involved in its organisation agreed it was worthy of resurrection, but in a different format. In 2008, a Programming Challenge 4 Girls (PC4G) was held for teams of 2 year 10 girls – (approximately 14 years old). The model is consistent with the ideas of Fisher and Cox (2006). It was held on one day late in the school year at a tertiary institution which hosted the catering, labs, staff and some of the prizes.

In 2009, it was held at 4 sites around the country and the aim is for many more in 2010. Marked work was graded into gold, silver, bronze and participation, and specially designed gold, silver and bronze medals were awarded.

The day consists of a morning's instruction and practice, followed by a challenge in the afternoon. Alice was chosen as the language as it is extremely easily learned, there is a lot of resource already developed and its colour and imagery is appealing to younger high school students. While the judging takes place, the girls are shown highlights of the host

institution or given something interesting IT-related to do or watch. A small presentation ceremony is then held where prizes and the medals are awarded.

The model of teaching and practice in the morning was chosen partly because many schools have no teachers competent in any form of programming. So the teacher sits with their teams and learns alongside the girls. While the girls sit the challenge the teachers are offered some professional development workshops related to Computer Science. This has proven very popular, with the teachers maybe recognising for the first time the power of their subject to intellectually challenge their students.

Fig. 1 shows this challenge feeding the Junior summer training camp.

4. Junior Summer Camp

With many students effectively being totally self-identified for the summer training camp, it became obvious that not all of those who attended camp coped with learning algorithms, and/or implementing them in C or C++.

So in January 2010, a Junior stream was added. Unlike the Australian Junior camp, which is a “baby algorithms camp”, the Junior camp was to get students used to C and some basic searching and sorting algorithms (including a Bubble sort, despite Barack Obama’s advice!). The intention is that the students will return to Senior camp the following year.

To find junior students we invited those from the (older) identifying contests to self-select. As a guide they were asked if they could solve one of the questions worth 10 points from the NZPC *on their own* (The NZPC has 3, 10, 30 and 100 point problems). Typically they would have worked in a team to solve one of these, so they were asked to honestly assess if they could do this individually.

In addition the girls who were in the top team from one site of the PC4G were approached and one of the girls decided to come to camp. For future years, the top teams from all sites for the PC4G will be invited.

The PC4G is not only a way of finding new programming talent, but it is also a new way for encouraging girls into programming.

Initially there were 6 students in the Junior camp, including 2 girls, although it became evident that one student had sufficient C to move to the Seniors camp. The remaining 5 learned about binary, how integers, characters and real numbers are stored, and enough C to implement simple sorts and searches. There were lectures and problems each day, with 3 tutors (one of whom was a girl) on hand to assist.

Two Junior camp student’s reports are included in Appendix 2, illustrating that the inclusion of a Junior stream was worthwhile.

5. Senior Summer Camp

New Zealand first entered the IOI in 2006, with 4 students picked out of 5 who both entered the NZPC and were interested in being trained further. There was no camp that year but some ad-hoc training took place for 3 of the students.

A January Summer camp was established in 2007, with the help of the New Zealand Maths Olympiad. Only 4 students attended and staff who volunteered were naturally disappointed. However the volunteers have been remarkable in their loyalty and have continued to come to an increasing number and quality of student at camp. With our first success (a silver medal) in 2008 and with 2 bronze medals in 2009, the general perception of the lecturing staff is that we are attracting the right type of student and in (just) sufficient numbers.

By 2010, 13 students self selected for Senior summer camp, plus one moved from Junior camp (several of the Juniors competed for a place on the team and in fact scored better in several contests than some Seniors students).

6. The Future

The Ministry of Education has accepted the need for reform, although has retained Computing under one of the existing eight learning areas, namely Technology. The ministry is now overseeing the process of translating a “Body of Knowledge” for Computing into Achievement Standards. These are the accepted assessment tool for senior high school students within the NZ Education system (Many private schools and an increasing number of public schools offer alternative assessment regimes, in particular, Cambridge and the International Baccalaureate).

There are 5 strands to the Digital technologies Body of Knowledge, one of which is Programming and Computer Science. It is yet to be seen if this strand will develop into a fully-fledged course with sufficient Achievement Standards by year 13, but many of those working and advocating in this space are hopeful. The time frame is currently being negotiated, but many are now hopeful that the new level 3 (for year13) standards will be functional in 2012.

One of the battles has been to have the discipline accepted as an academic subject in schools, rather than the “Computing as Dumping Ground” model which has operated in many schools until now. With the hoped for recognition that should accompany the educational reform, NZOI can only benefit from having a greater talent pool to train and select from.

Appendix 1. Samples of Problems from the Entry Level Contests

1.1. *Sample Problem from the Australian Informatics Competition*

Packing

David wants to pack an aeroplane with bags. He has several large bags, medium bags and small bags. Each large bag weighs 7kg, each medium bag weighs 5kg and each small bag weighs 1kg. The aeroplane has a fixed weight limit w . David must meet this weight limit exactly, and would like to use as few bags as possible to do it.

David has devised the following set of rules for packing the plane.

Start by placing large bags into the aeroplane one at a time, until he is less than 7kg beneath the weight limit.

Continue by placing medium bags into the aeroplane until he is less than 5kg beneath the weight limit.

Finish by placing small bags into the aeroplane until he reaches the weight limit precisely.

For example, if the weight limit were $w = 20\text{kg}$, then David would proceed as follows. He would place two large bags into the aeroplane, giving a total weight of 14kg and leaving him 6kg beneath the limit. He would then place a single medium bag into the aeroplane, giving a total weight of 19kg and leaving him 1kg beneath the limit. Finally he would add a single small bag, bringing him to 20kg precisely.

Unfortunately David's method does not always use as few bags as possible. Consider a weight limit of $w = 25\text{kg}$. Here David would use three large bags (weighing 21kg) followed by four small bags (coming to 25kg total). Overall David has used seven bags, but he could have made 25kg using just five medium bags and nothing else.

Your task is to work out the smallest weight limit w for which David's method does not use as few bags as possible. What is the rightmost digit of your answer? (For example, if you think the answer is 48 then you should answer 8.)

- (a) 0 (b) 2 (c) 4 (d) 6 (e) 8

1.2. Sample problems from the New Zealand Programming Contest

Problem B Palindrome Numbers 3 points

A word is a palindrome if it reads the same backwards as it does forwards. For example, words such as 'radar' and 'sees' are palindromes.

Mrs Jones, a primary school teacher, thought it would be good for her pupils if they could tell her whether a number had the same property, i.e., it read the same backwards as it did forwards. Numbers like 121 or 12421 would qualify, numbers like 123 or 1231 would not. Numbers like 10 would also not qualify – even though 10 can be written palindromically as 010, Mrs Jones is restricting this to numbers written in the normal decimal way, with no leading zeros.

This problem asks you to perform this task on each of a series of numbers.

Input to this problem is a series of integers (all between 1 and 99999) each on a separate line. The number 0 will be the last line of input and should not be processed. Output will be one line for each line of input, containing just the word 'yes' if the number qualifies as a palindrome number, 'no' if it does not.

Sample Input	Sample Output
121	yes
1231	no
12421	yes
0	

Problem E Earrings 10 points

At Pascal High School, lots of young girls insist on trying to get away with wearing non-regulation earrings. Mr Sneddon, the Associate Principal, sees red every time he spots a pair of long dangly earrings and confiscates them.

He keeps a numbered list of the girls from whom he has confiscated earrings. As he takes them, he uses a permanent marker to record the number of the owner on the back of each earring. Being a bit of a control freak, he also adds a letter to each one – A or B.

At the end of each term and after completing after-school detentions, the girls are to come and collect their earrings. Unfortunately one day Mr Sneddon dropped the envelope he keeps the earrings in and at the end of the term there is one earring that he cannot find.

Please tell him the name of the angry girl who only gets one earring back.

Input will consist of a number of scenarios. Each scenario will contain:

- A number n ($1 \leq n \leq 100$) on a line on its own, which is the number of girls he has confiscated earrings from.
- n lines each containing a girl's full name (at most 60 characters in length).
- $2n - 1$ lines of data with a girl's number followed by a space then either an 'A' or a 'B'. These lines represent the earrings in the envelope: the number represents the position of the girl in Mr Sneddon's list, with 1 being the first girl. A girl's number will occur twice at most, with a different letter (A or B) for each number.

The last line of input will be a '0' on a line by itself. This line should not be processed.

Output should consist of the scenario number followed by the girl's name whose earring is missing, separated from the scenario number by a single space.

Sample Input	Sample Output
3	1 Alison Addaway
Betty Boolean	2 Helen Clark
Alison Addaway	
Carrie Carryon	
1 B	
2 A	
3 B	
3 A	
1 A	
2	
Helen Clark	
Margaret Thatcher	
1 B	
2 B	
2 A	
0	

1.3. Sample Problems from the Australian Computer Programming Contest

What are Well Ordered Numbers?

An integer is considered well ordered if each digit value increases from left to right.

For example, 123 is well-ordered because $1 < 2 < 3$, but 285 is not well-ordered because $8 > 5$.

Instructions

Write a program that will find and display all possible three digit well-ordered numbers.

Your output should contain eight numbers per line, with a tab character between each number.

Output should be in ascending order.

No other output should be produced by your program other than the numbers.

Example Output

```
123 124 125 126 127 128 129 134
135 136 137 ??? ??? ??? ??? ???
...
```

2. Appendix 2: Summer Camp Reports

Summer Camp Report (1)

The NZOI Junior Training camp was a great learning experience for me. I stayed in Auckland for 5 days, learning to code some basic C/C++. I found that it was all explained very well, at a level that we all understood. Each day, we learnt something new, and then put that new knowledge to good use in a series of problems we had to solve. Some of these were easy, while some provided quite a challenge. I still have one or two codes that don't work quite right!

We ended the camp with a test, which took into account all the skills we had learnt over the course of the camp. It was much more difficult than the practice problems had been as we couldn't get much help from the tutors. Still, it was good to be able to measure my skills against those of the other juniors.

Camp wasn't all hard work, though. We had a lot of free time outside of training hours, which we spent either with fellow attendees, or "hard at work" on our computers "finishing the problems from the day", better known as surfing the internet. We even had an outing to a pool one afternoon, which was a great chance to better get to know our peers.

This camp was an awesome opportunity to learn more about coding, and computers in general. It helped me decide that I want to continue working in the computer world as a career, and I really hope I get to return next year as a senior.

Summer Camp Report (2)

On the 7th of January I flew up to Auckland where I was met at the airport by Margot Phillipps and a few members of the NZOI camp. Being my first time flying alone it was a relief to see them just outside the gate exit! Shortly afterwards we were taken to the Grafton Hall's of Residence, where we dropped off our bags.

Then we walked to the University of Auckland's computer labs, which was to be our main workplace for the duration of the camp. After learning all about binary, hexadecimal and decimal numbers and various other things, we went back to the Halls of Residence to have dinner. The next morning we began to learn about C++.

It was quite cool, as I couldn't make any sense out of it before the camp, having learnt to program with BASIC.

Over the next few days I learnt a lot about the basics of C++, including variables, strings and arrays. Towards the end of the camp we began to do a few Informatics problems of our own. It was good after numerous tries to finally get 100% in the problem! On the last day in the Junior Camp we had a little contest of our own. It was quite interesting competing in an Informatics contest, albeit a small one.

Overall, the Informatics camp was a great experience and I hope to participate in more programming competitions this year, and hopefully I will be able to go to the senior camp next year.

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M. Phillipps was educated in mathematics and philosophy and received a BSc from the University of Otago and a BA from the University of Victoria. After 8 years working as an analyst-programmer, she undertook a year's teacher training diploma before joining the Auckland Institute of Technology (now AUT) to teach introductory programming and databases for 15 years. She taught similar courses at Unitec (Auckland) for 3 years before beginning as a high school teacher in mathematics and programming. In 2006, attendance at the IOI workshop began a voluntary career in adding New Zealand as a participant to the IOI, becoming the international director on the Board of the Computer Science Teachers Association (CSTA) and becoming the executive director of the Programming Challenge 4 Girls. She is currently the qualifications administrator for ACE training, a private computer training company.