USENIX notes

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USACO REPORT

Rob Kolstad, USACO Head Coach

USENIX is one of the principal sponsors of the USA Computing Olympiad, the USACO. USACO fosters computing for students before they enter universities, a function of ever-growing importance as the percentage of college students choosing computer science as a major hovers at its 20-year low of 2.2%.

Through a series of six contests, 14 USA students and a single international representative earned berths at the 2008 USAICO, the USA Invitational Computing Olympiad, a grueling seven-day on-site set of six competitions that culminates in the announcement of the traveling team that will represent the United States at the International Olympiad on Informatics (IOI). This year's USAICO took place on the grounds of the University of Wisconsin–Parkside south of Kenosha, Wisconsin, near the home of director Dr. Don Piele.

While the name USACO may suggest that the competitions are strictly for USA students, this is by no means true. USA students generally compose a quarter or fewer of the competitors. In this season's largest Internet-based competition (March 2008), 984 students vied for a gold medal. Of those, 304 (30.9%) were from China, and 134 (13.6%) were from the USA. Students from Belarus (58), Bulgaria (46), Romania (44), the country of Georgia (35), Indonesia (33), Poland (25), Iran (25), and India (25) rounded out the top 10 of the 61 countries represented at the contest. Contests are translated into a number of languages, including Chinese, German, Farsi, Georgian, Indonesian, Polish, Russian, Spanish, and Turkish.

The three-hour USACO competitions feature three divisions (Gold, Silver, and Bronze), which ask competitors to write algorithmic programs in C, C++, Pascal, and/or Java. The Bronze contests set simple tasks that involve sorting, array manipulation, string manipulation, and the like. Once a

student has mastered "flood fill" (e.g., given a map of elevations, how big is a lake that includes square [33, 25]?), he or she moves to the Silver division. Solutions for Silver division tasks require algorithmic thinking and programming: Dijkstra's algorithm, graph manipulation, graphic algorithms, and challenging ad hoc problems that each have a unique algorithm for solution.

Silver problems often have time constraints that become quite challenging unless the proper programming technique or algorithm is chosen. Consider a task involving a triangle of numbers with five (later, N) levels:

```
        7
      3   8
    8   1   0
  2   7   4   4
4   5   2   6   5
```

The challenge is to maximize the sum of numbers chosen by starting at the top of the triangle and traveling down the triangle to the bottom row, moving slightly right or left each time you descend one row. In the sample above, the route from 7 to 3 to 8 (on the third row) to 7 to 5 produces the highest sum: 30. Almost any first-year computer programmer will sneer at such a problem and quickly—and correctly—aver that a recursive solution will be but a few lines long.

Of course, there's always a twist. In this case, the triangle has as many as 100 rows and the time limit is 1.0 seconds in a 2.4 GHz Pentium-based computer. The simple recursive solution requires 2^{100} iterations—that's 1.27×10^{30}. Even a superfast computer that can perform 10^9 iterations per second would require 10^{21} seconds—40 quadrillion years—a number that dramatically exceeds the one-second time limit. The trick is to solve the problem backwards, starting at the bottom row, enumerating the best set of N – 1 solutions, and working your way back up to the top. This easily implementable solution requires $O(N^2)$ time and way fewer than 10,000 operations for the 100-row triangle.

Silver programmers who demonstrate the "dynamic programming" algorithm (named for a math technique, not for programming) move to the extremely challenging Gold level. Only 276 folks entered the Gold competition in the huge March contest. Only 25 (less than 10%) achieved 800 or more points out of 1000. Here's the easiest task from the March Gold division:

At Bessie's recent birthday party, she received N ($2 <= N <= 100,000$; $N\%2 == 0$) pearls, each painted one of C different colors ($1 <= C <= N$).

Upon observing that the number of pearls N is always even, her creative juices flowed, and she decided to pair the pearls so that each pair of pearls has two different colors.

Knowing that such a set of pairings is always possible for the supplied testcases, help Bessie perform such a pairing. If there are multiple ways of creating a pairing, any solution suffices.

Doesn't that seem easy? Give it a try!

The June USAICO camp this year assembled our best finishers in the half-dozen Internet contests held since November (an additional qualifying exam is held in October).

Camp attendees were partitioned into two sets: those vying to make the IOI team for the August trip to Egypt and those training for next year's team. Attendees hailed from states across the continent (along with our international representative, imported specially to keep our top competitors challenged). Thomas Jefferson High School for Science and Technology in Virginia supplied a large number of students, as did their rival, Montgomery Blair High School in Maryland. Attendees included: seniors David Benjamin from Indiana, Artur Dmowski from New York, Kevin Lee from New Jersey, Spencer Liang from California, Haitao Mao from Virginia, and Jacob Steinhardt from Virginia; juniors Shravas Rao from Ohio and Goran Zuzic from Croatia; sophomores Michael Cohen from Maryland, Brian Hamrick from Virginia, Jacob Hurwitz from Maryland, Neal Wu from Louisiana, and Scott Zimmermann from Maryland; and two younger students, freshman Wenyu Cao from New Jersey and talented seventh-grader Daniel Ziegler from California, who gave the high schoolers a run for their money. All the seniors are attending Harvard or MIT this fall.

Coaches included former IOI champions Brian Dean from Clemson University, Alex Schwendner from MIT, and Percy Liang from UC Berkeley, along with perennial administrators Don Piele and Rob Kolstad. Coaches supervised, taught, deconstructed problems and solutions, and created the three problems for each of the ten contests (different contests for different divisions) of the camp.

Almost every day of the USAICO competition and training camp opened
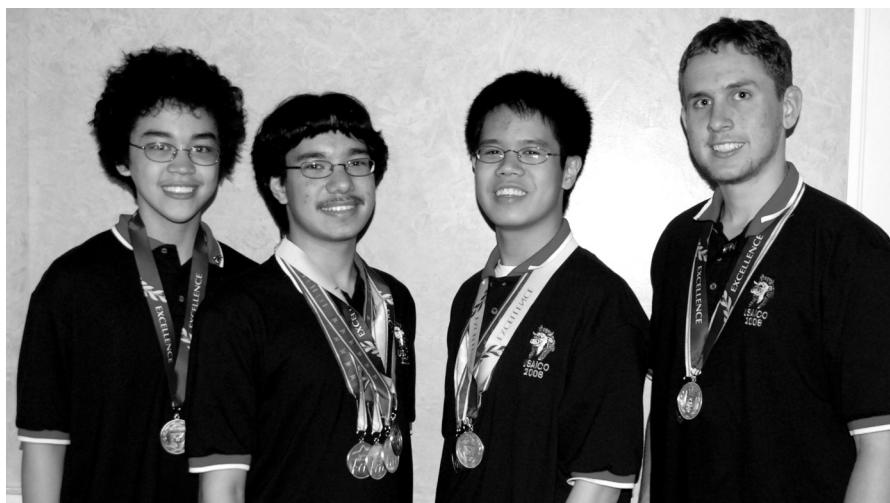
IOI representatives Brian Hamrick, David Benjamin, Neal Wu, and Jacob Steinhardt

with a three- or five-hour contest for the high-level combatants. After lunch, contest review commenced, during which unsolved tasks were vanquished. Afternoon activities included ultimate Frisbee, Frisbee golf, miniature golf, game programming (two different games this year, including one from IBM used at the international ACM contest), movie night, and swimming. Attendees are busy from breakfast at 8 a.m. until about 10 p.m.

When the dust settled, four IOI representatives were announced, two sophomores and two seniors: Brian Hamrick, David Benjamin, Neal Wu, and Jacob Steinhardt. The level of competition was so high that team membership was up for grabs until the final five-hour contest. These four elite students represented the USA at the 20th IOI in Mubarrak City, Egypt, August 16–23, 2008. Look for the report in the December issue of *;login:*.

You don't have to look far to hear moaning about the lack of performance by today's high school students (a complaint documented since the dawn of history). The students at the USAICO include math champions, physics aficionados, musicians (coach Percy Liang also continues to perform in the world of competitive piano), and science fair winners (Jacob Steinhardt was a Silver Medal winner at the prestigious 2007–08 Siemens Competition in Math, Science & Technology for his project entitled "Cayley graphs formed by conjugate generating sets of S_n"). Croatian competitor Goran Zuzic not only achieved the highest scores at our USAICO competition (of course he can't represent the USA at the IOI) but also won his country's math and physics competitions as a high school junior.

USACO competitors grow into technical community citizens of fine repute: for example, former competitor and coach Russ Cox just won his second Best Paper award at a USENIX conference. USACO appreciates the support of USENIX and continues to strive to build strong students and future technical leaders and contributors.

UPDATE ON SAGE

Jane-Ellen Long,
SAGE Programs Director

LISA '08, Nov. 9–14

It's LISA time again. Join us in San Diego, CA, November 9–14, 2008, at the 22nd Large Installation System Administration Conference. You'll find all the information and activities you've come to expect, and more. This year we're offering six days of focused training at a special rate. Choose either virtualization—and who doesn't need to know more about that, these days?—or Solaris training from the experts. Find out more at www.usenix. org/lisa08/.

SAGE Short Topics Booklets Get Longer

Two new titles, each of nearly 100 pages, have joined the ever-expanding collection of SAGE Short Topics in System Administration, carrying on the tradition of Information from the Source. The first, *LCFG: A Practical Tool for System Configuration,* was written by—who better?—Paul Anderson, author of the LCFG tool and also author of the SAGE booklet on *System Configuration. LCFG* tells you everything you need to know to determine whether this is the right tool for your site and, if so, how best to deploy it there.

Don't forget to compare Cfengine, laid out for you by Cfengine tool author Mark Burgess in the SAGE title *A System Engineer's Guide to Host Configuration and Maintenance Using Cfengine,* and the upcoming SAGE booklet on BCFG, written by, you guessed it, BCFG tool authors Narayan Desai and Cory Lueninghoener.

The second of the recent titles, *Deploying the VMware Infrastructure,* is a collaborative effort by John Arrasjid, Karthik Balachandran, and Daniel Conde of VMware and Gary Lamb and Steve Kaplan of INX. (What were we saying about the importance of understanding virtualization?)

Everyone can preview and order the booklets online at www.sage.org/pubs/ short_topics.html. SAGE members can also read and download the full booklet PDFs.

SAGE Talk

Have you joined *;login:* columnist Peter Baer Galvin's Wiki on Solaris System Analysis 101 at wiki.sage.org/bin/view/ Main/AllThingsSun? (What were we saying about Solaris training?)

Not into Solaris? The SAGE blog is back, with a series on open source enterprise monitoring by *;login:* author Matthew Sacks. Comments welcome!

Speaking of joining, visit us on the SAGE Facebook group: www.sage.org/ facebook. For a more formal group, join the LinkedIn SAGE group at www.sage.org/linkedin.

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Don't forget to troll around the SAGE Web site from time to time. Check out the Recommended Reading and the Toolbox, and see what else is new online and what SAGE groups meet near you. (And please let us know if your group's not listed.)

Jobs, Jobs, Jobs

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