

## USA Computing Olympiad (USACO)

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**Abstract.** The USA Computing Olympiad (**USACO**) supports pre-college computing around the world through computer programming competitions and training materials. The **USACO** holds six Internet-based contests each year. Unique in the contest community, they

- are open to every pre-college programmer around the world at no charge;
- feature three divisions of escalating difficulty and one beginning level contest;
- are machine-graded, with instant feedback on simple errors found during submission;
- are analyzed with solutions and results provided;
- are translated into foreign languages for the contestants;
- are created by a handful of coaches with the help of assistant coaches who interact through a comprehensive website that collects problems, test data, solutions, data validators, and discussions.

The **USACO** has reached out to the international community by

- inviting international students to challenge our students at the USA International Computing Olympiad (USAICO) here at Colorado College during our summer program;
- providing a discussion form on our website for contests and training pages;
- grading and ranking international students along with our own;
- providing a grading system for IOI 2001, 2003, 2004, 2006 and 2008 (expected).

In April, the **USACO** conducts the US Open, a proctored exam for US students, and, one day later, an Internet exam for international students. Based on the results of these contests, 16 students are invited to an all-expense-paid training camp in the early summer, where 4 students are selected to be the US Team at the International Olympiad in Informatics (IOI).

The **USACO** is sponsored by USENIX, SANS, and IBM. All **USACO** contest administration is staffed by 100% volunteers.

**Key words:**

USACO, USAICO, internet programming competitions, pre-college programming competitions, programming training, IOI, USA team selection.

### Goals

Since 1992, the **USACO** has served the youth of the global pre-college computer programming community with four primary goals:

1. Provide pre-college students with opportunities to sharpen their computer programming skills in order to enable them to compete successfully at the international level.
2. Enhance the quality of pre-college computer education by providing students and teachers with challenging problems, training materials, and competitions that emphasize algorithm development and problem-solving skills.
3. Recognize excellent students with outstanding skills in computer science and encourage them to pursue further opportunities in the profession.
4. Provide educational, motivational, and competitive materials in the form of programming competitions and web-based training via the Internet.

### USACO Scope

The USACO sponsors six Internet-based contests each year. Unique in the contest community, they:

- are open to every pre-college programmer around the world at no charge;
- feature three divisions of escalating difficulty;
- are machine-scored, with instant feedback for simple errors found during submission.

Fig. 2 graph shows the growth in participation. Now anywhere from 900–1,000 enter each competition.

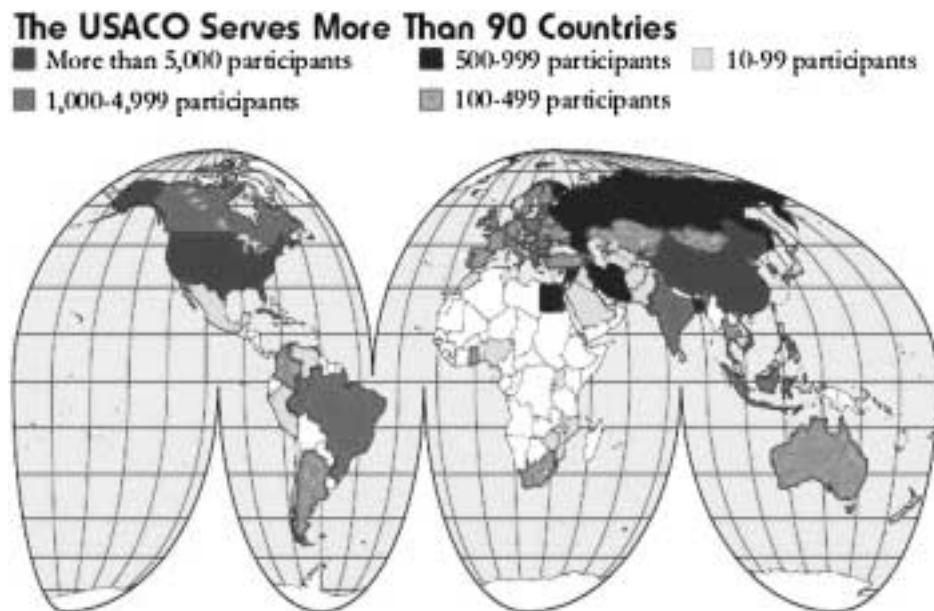


Fig. 1. USACO scope.

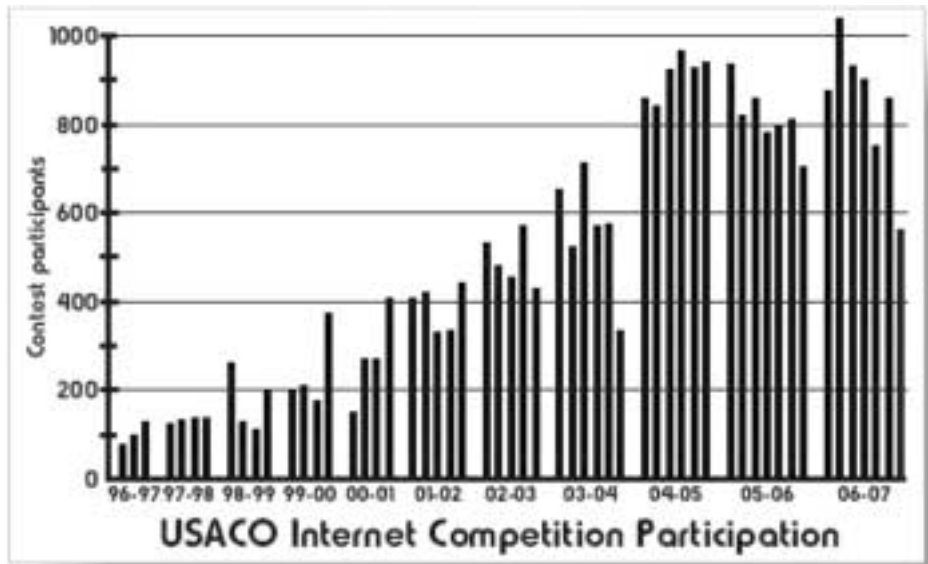


Fig. 2. Internet participation.

### USACO Training

The USACO offers 200 hours of Internet-based training in the form of instructional texts and challenging programming tasks. Over 62,000 participants have registered for the training pages; over 321,000 tasks have been successfully solved. IOI world championship competitors from many countries extol USACO's training. Fig. 3 shows the growth of monthly training system logins.

The hs-computing mailing list was created to distribute Internet competition problems and exchange information about advanced pre-college computing education and training. Its subscribers include high school teachers, coaches, and students. The list currently includes over 28,000 correspondents from more than 90 countries.

### USACO Invitational

Each year, the USACO invites 16 USA students and (sometimes) the best of the international competitors for a week of competition at the USA Invitational Computing Olympiad.

Challenging contests (the equivalent of three complete IOI world championship competitions) are complemented by an academic, recreational, and cultural program to stimulate competitors both intellectually and athletically.

The intense week culminates in an awards ceremony that includes the week-long winner and names the four members of the USA international traveling team. Travel to competitions is the biggest reward and incentive for USACO contestants. The June USAICO contest challenges the top 16 USA programmers to compete for the traveling team.

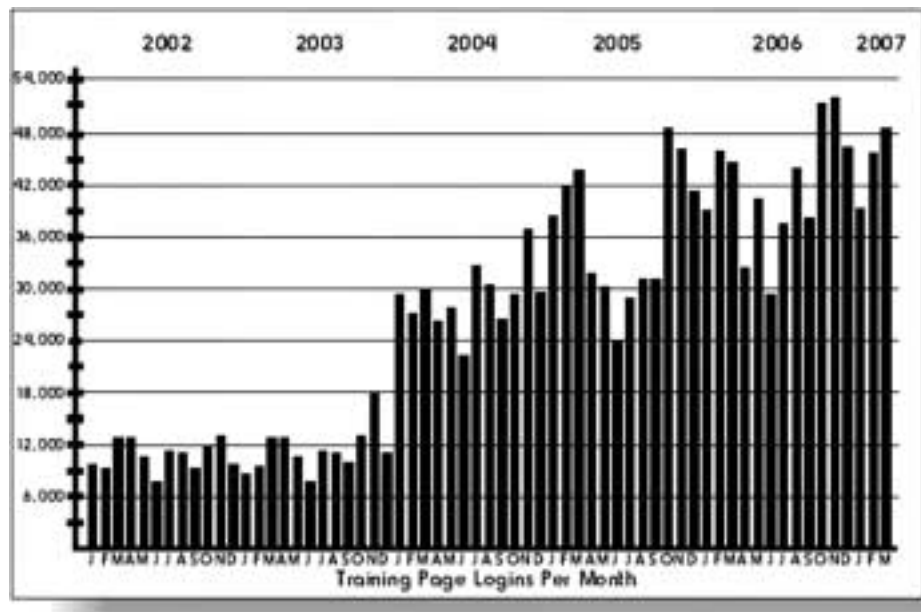


Fig. 3. Training page logins.

The top four USACO programmers compete against programmers from 75 other countries at the annual IOI (the world championships) in addition to occasional trips to the Central European Olympiad in Informatics and other international competitions.

### USACO International Service

USACO staff contributes significantly to the international competition community. In 2003, USACO director Don Piele hosted the IOI world championships at his home campus at the University of Wisconsin-Parkside. USACO staff supervised all online grading for the IOI world championships in 2001, 2003, 2004, 2006, and is on deck for Egypt's 2008 International Olympiad. Coach Greg Galperin served on the International Scientific Committee; Don Piele retired in 2006 from the 15 member IOI governing committee after 12 years of service.

USACO Internet training and contests also serve the international community.

### USACO Problems

USACO contest problems focus on the signature mascot of cows. The tasks require extensive knowledge of computer algorithms and are very challenging.

One recent contest's tasks were translated into 14 languages, including Chinese, German, English, French, German, Indonesian, Polish, Russian, Serbian, Spanish, Turkish,



**USACO competitor Ben Joeris blackboards graphical algorithms with coach Brian Dean**

Fig. 4. Teaching.

Turkmen, Ukrainian, and Vietnamese. The problem below was suggested by Canada's Maria Plachta.

*Problem 2. The Wedding Juicer*

Farmer John's cows have taken a side job designing interesting punch-bowl designs. The designs are created as follows:

A flat board of size  $W$  cm  $\times$   $H$  cm is procured.

On every 1 cm  $\times$  1 cm square of the board, a 1 cm  $\times$  1 cm block is placed. This block has some integer height  $B$ .

The blocks are all glued together carefully so that punch will not drain through them. They are glued so well, in fact, that the corner blocks really don't matter!

FJ's cows can never figure out, however, just how much punch their bowl designs will hold. Presuming the bowl is freestanding (i.e., no special walls around the bowl), calculate how much juice the bowl can hold. Some juice bowls, of course, leak out all the juice on the edges and will hold 0.

### USACO Faculty

The coaching ranks also include several associate coaches. Many of these associates use the USA's training and contest resources for their own country's competitions. The list includes gold medal winners, other country's coaches, and both foreign and domestic graduates of the USACO invitational competitions.

Guest coaches at the 2006 competition included repeat IOI Gold Medal winner Bruce Merry from South Africa and Canada's Troy Vasiga from the University of Waterloo.

Canada's wunderkind Richard Peng has been invited to coach at the 2007 USAICO. The regular faculty include:

- Director Dr. Don Piele is a Professor of Mathematics at the University of Wisconsin-Parkside. Founder of the International Computer Problem Solving Competition and USACO, Don has been organizing programming competitions since 1977 and took the first United States Team to IOI in 1992.
- Leader and Head Coach Dr. Rob Kolstad conducts the Internet competitions. A veteran of supercomputer startup companies and technical associations, he has organized programming competitions since 1973. Rob manages the Internet competitions, the online training, the automated grading system, and USAICO.
- Leader/Deputy Leader Dr. Brian Dean has coached since 1996 and recently completed his doctorate at MIT. He has interned at Akamai, Alta Vista, and Microsoft. Brian earned multiple awards for teaching at MIT. He is now an Assistant professor at Clemson University.
- Deputy Leader Liang joined the coaching staff in 2002 and is currently a Ph.D. student at Stanford, studying machine learning and natural language processing. His industrial experience includes IBM, Intel, ITA software, Microsoft Research, and Google.

The USACO is privileged to have a number of veteran organizers, contest champions, and performers in both the academic and industrial world on its staff. They have decades of experience and include both organizational veterans and enthusiastic former competitors.

- MIT student Alex Schwendner first attended USACO camp in 8th grade. He has won the US Open, the inaugural USAICO, and the USACO National Championship. Four trips to the IOI yielded two silver medals and two gold medals.
- MIT student Eric Price attended four USAICO Olympiads. A Silver and Gold Medalist at the IOI, he achieved the rare perfect score in 2005 (in addition to a Gold Medal at the International Mathematics Olympiad). Eric also organizes the Harvard/MIT Math Tournament.

### **USACO Sponsors**

The USACO currently has three sponsors:

- USENIX: The Advanced Systems Computing Association;
- IBM;
- SANS: Security Training.

### **References**

The USACO genera web site: <http://www.usaco.org>  
 The USACO Discussion Board: <http://ace.delos.com/bb/>  
 The USACO registration: <http://ace.delos.com/usacoregister>  
 The USACO training pages: <http://train.usaco.org>  
 The USACO Internet Contests: <http://ace.delos.com/contestgate>



**R. Kolstad** is the head coach of the USA Computing Olympiad and a consulting in the computer industry. Previous employment includes a startup supercomputer company, a large workstation manufacturer, a startup internet server corporation, and non-profit technical organizations. His current consulting revolves around the world of software support for patent litigation.



**D. Piele** recently retired from his long-time position as professor of mathematics at the University of Wisconsin-Parkside. Active not only in computer olympiads as the USACO director (and founder of other contests including the popular and long-running International Computer Problem Solving Competition), D. Piele also works extensively with mathematica.