SuperCon2009 for High School Students

Cybermedia Center Osaka University

Cybermedia Center, Osaka University, Japan

Outline

Supercomputing Contest (SuperCon) is a team-based programming competition for high-school students. It is hosted by the Global Scientific Information and Computing Center (GSIC), Tokyo Institute of Technology (Tokyo Tech), and Cybermedia Center (CMC), Osaka University (OU). SuperCon was initiated in 1995, and the newly introduced Clay C916 Supercomputer was used in this contest. The contests held every year from 1995 to 2005 were hosted solely by GSIC, Tokyo Tech, and, the recent four contests from 2006 to 2009 were co-hosted by CMC, OU. In 2004, 4 international teams from China, Korea, Singapore, and Thailand participated in the 10th anniversary of SuperCon in 2004. In 2009, 23 high schools and 36 teams from all over Japan participated in a preliminary contest, and 20 teams advanced to the SuperCon 2009 Finals.

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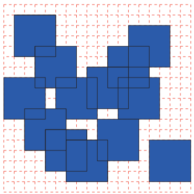
SuperCon uniquely provides high-school students with the opportunity to use supercomputers like TSUBAME Grid Cluster of GSIC, Tokyo Tech, and NEC SX-9 of CMC, OU. The long duration of the competition is another feature of SuperCon. It starts with seminars on supercomputing with vectorization and parallel processing. Students would be staying at Tokyo or Osaka for 5 days (August 3-7, 2009). They would be asked to develop a program that solves high-level problems. SuperCon provides participants with an opportunity to interact with students from all over the country. The contest fosters creativity, teamwork, and innovation in developing new software programs. Some participants are winners of the International Mathematical Olympiad and International Olympiad in Informatics. After the Contest, some students actively participated in other programming contests for university students like the ACM International Collegiate Programming Contest.

Visit the booth #1155 of GSIC, Tokyo Tech shows the SuperCon2008 poster.

SuperCon2009 preliminaries problem:

Area Counting

Write a program that computes the area of the union of the given axis-parallel unit squares in the plane. For the figure on the right, the answer is 172.



Problem for SuperCon 2009 finals:

Rescue in Space

Story:

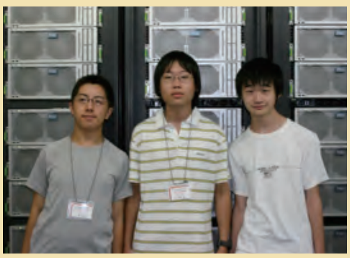
On clear nights, we can see many stars. Ancient people looked up at the stars and imagined fictitious objects by connecting stars; these objects are called constellations. A constellation consist of stars which appear near to each other when we see them from the earth, but in real space, they are not necessarily near each other. For example, although Aldebaran and the Pleiades belong to Taurus, the former is 60 light years from the earth, while the latter is 410 light years from the earth. In the distant future, when the human race find its way outside the solar system, they would be able to see stars from an outer planet far from the earth. Many stars would still be visible from this outer planet, but their arrangements would be different from the ones observed from the earth. Therefore, the constellations also would be quite different. That is, given a photograph of stars, we should be able to determine the star from where the photograph was taken if the coordinates of every star in the universe are given. The Problem of the the SuperCon 2009 finals is to determine the star to rescue a crash-landed spaceship which sent us the photograph of the stars taken from another star.

Problem:

Given an arbitrary number (N) of a fixed star in space, and 1000 pieces of the "all-sky photographs" (defined below Fig 3-1) taken from an arbitrary star among N stars, write a program that determines the stars from where the all-sky photographs were taken. The team that gives the most number of correct answers in the shortest period wins.

The winner: team "zatoriku"

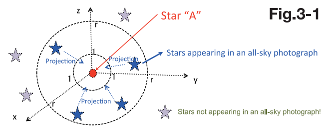
Masaki Hara Riku Yoshizato Shinichiro Kawai



Glossary:

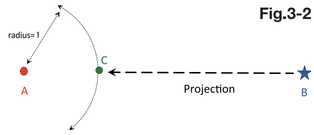
1. All-sky photograph: An all-sky photograph consists of three-dimensional "projection coordinates" (defined below) of n stars within a distance r from a star (called star "A") where the photograph is taken (Fig. 3-1). Stars farther than r that are away from the star "A" do not appear on the all-sky photograph.

Fig.3-1



2. Projection: Let "A" be the star from where the all-sky photograph is taken, and B1,..., Bn denote the n stars that are located within a distance r from the star "A." Then, "projection" is defined as an intersection point "Ci" of a line segment "A" to "Bi" (or its extension in some cases) and a spherical surface whose center is "A" and radius is unity (Fig.3-2).

Fig.3-2



3. Projection coordinate: Projection coordinates C1',..., Cn' are the rotation of C1, ... ,Cn so that the coordinates Bi (any of the n stars) are mapped onto Ci'(0,0,1) on the coordinates where "A" is the origin. The star Ci' is called "standard" (Fig.3-3).

Fig.3-3

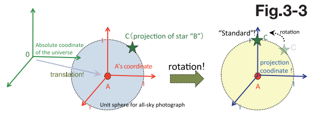


Fig.3-4

Input:

1. Coordinates of stars in the universe:

1-1. Coordinates of stars in the universe are given as 3-dimensional real-valued coordinates (x, y, z) and -3000 <= x, y, z <= 3000 (Fig.3-4).

1-2. N: the number of stars in the universe. For the semifinals, N = 100,000 and for the finals, N = 500,000 or 1,000,000.

2. All-sky photograph data:

2-1. All-sky photograph data consists of n sets of projection coordinates C'i (x'i, y'i, z'i) (i=1,2,...,n). In definition, x'i^2 + y'i^2 + z'i^2 = 1 because every C' is on a unity spherical surface.

2-2. Shooting range: Stars within a distance r from the center star "A" appear on the all-sky photograph. Note that the value r varies from photograph to photograph. The value of r is a real number and 50 <= r <= 51.

2-3. The number of stars, n, appearing on an all-sky photograph is limited in the range 50 <= n <= 10,000. Stars containing less than 50 or more than 10,000 stars in its shooting range r may be eliminated, but the number of such stars are not many.

2-4. The first coordinate C'1(x'1,y'1,z'1) of the n sets of the projection coordinates C1',...,Cn' is called “standard" and is therefore (0, 0, 1).

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