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Tasks at Kyrgyzstani Olympiads in Informatics: Experience and Proposals

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Abstract. Many of tasks proposed at Olympiads in Informatics (OI) mean “images” in any sense but in most cases they do not appear evidently. At each OI in Kyrgyzstan, one task is given to present any graphical image, either in text mode or in graphical mode. Such tasks meet the Statute S1.7 of the IOI Regulations “to bring the discipline of Informatics to the attention of young people”, make OIs more attractive for sponsors, can reflect state and national features. Ways to generate and to score such tasks and presentation of some tasks at the Conference is supposed. The history and content of OIs and teaching Informatics in Kyrgyzstan are also described.

Key words: olympiads in Informatics, Kyrgyzstan, history, graphics.

1. Survey of Teaching Informatics in Kyrgyzstan

Informatics (under the traditional name “Foundations of Informatics and Computer Facilities”) is taught in all secondary schools of Kyrgyzstan since autumn 1985. Firstly it was taught “with chalk on a blackboard” and calculators and pupils sometimes visited local computer centers. Further several were put in some schools. Now almost all schools have classes with IBM-compatible computers, some of them linked up with WWW.

By the State standard, now Informatics is taught obligatorily in 7th (1 hour a week), 8th and 9th (2 hours a week) forms. Decision to teach or not Informatics in elder (10th and 11th) forms is given to schools. Many schools, all lyceums and gymnasiums themselves introduce Informatics lessons in elder forms. Now, a new curriculum is elaborated. It provides teaching Informatics in all forms of primary and secondary school, from 1st till 11th ones.

2. Survey of Olympiads in Informatics in Kyrgyzstan

The Olympiads in Bishkek city, the capital of Kyrgyzstan, are conducted since 1985 (annually in January); National ones are conducted from 1987 (annually in March). The contestants on all four levels: I (school); II (district or area); III (city or region); and IV (National) are divided into two groups: the first one includes 10th form schoolchildren (16 years old and younger) and the second one does 11th form schoolchildren (17 years old).

Each of the seven regions, Bishkek city as a capital and Osh city as "a southern capital" send 2 pupils in each group of the IV level. So, 19–20 pupils (including winners of the preceding year) participate in the first group and 17–18 pupils do in the second one.

Because of essential differences between traditional contents of IOI and ones of our Olympiads (see below), Spring camps with final Selective competitions to IOI are conducted for all better contestants (6–8 of the first group and 3–4 of the second one) of the IV level (annually in April).

The IV level is conducted by the Ministry of Education and Science at the Kyrgyz National University or at the Kyrgyz State Technical University with support by sponsors. Spring camps are conducted at the National Computer Gymnasium.

Also, some universities conduct Olympiads and other kinds of competitions in Informatics (irregularly) for their students and for schoolchildren to attract entrants.

Kyrgyzstan participates in IOI since 2000. Our achievements are three bronze medals won by A. Mokhov (IOI 2000), A. Baryshnikov (IOI 2004), I. Goroshko (IOI 2005).

3. Content of Olympiads

The IV level of Olympiad includes two rounds: "theoretical" (by pen and paper; two tasks; 2.5 hours) and "practical" (by computer; three tasks; 2.5 hours).

The theoretical round yields the opportunity to diversify content of Olympiads and to involve items of Informatics which cannot be covered by tasks for computer implementation.

Most of tasks proposed at theoretical rounds may be classified as follows (Pankov *et al.*, 2000).

T1) A goal is described. To write a corresponding algorithm (using operations and conditions which are impossible or too difficult to be implemented at a computer).

T2) To restore (guess) an algorithm and its goal (or possible goals) by examples of results of its work.

T3) To understand (guess) the goal (or possible goals) of a given algorithm (also described with non-formal operations and conditions) and to improve it. The output of the algorithm may be "graphical" also.

We announce that, to obtain a full score, the contestant has to write a (same) algorithm in two languages. There can be a natural language, flow-charts, program in an algorithmic language (possibly, with additional non-formal operations), vast comments to a program, and so on.

REMARK 1. In T3 case, the given algorithm must have a simple goal but could be written very complicatedly, with unnecessary operations and conditions, cycling or infinite (until overflow) branches.

REMARK 2. In T2 and T3 cases, the jury must have their own version about the goal but contestants' different guesses can obtain full score if they are witty and meet the data.

Most of tasks proposed at practical rounds are standard:

P1) A goal and restrictions on input are described. To write a program transforming input into output in a limited time (5 seconds) due to this goal.

In one of three tasks, the output must either be graphical or imitate graphics in a text mode (see the detailed description below).

To diversify scope of tasks, the following types of tasks are also proposed.

P2) To write a program for P1 with restricted means (for example, comparison only letter-by-letter). Hence, the jury is to verify the listing too.

P3) A very slow (possibly, non-formal) algorithm and restrictions on input are described. To write a program being equivalent to it and working in a limited time.

P4) "Black box". A program is given as an exe-file (a contestant may run it as many times as she wishes). To write a program being equivalent to the given one. (It means that the given program is sufficiently simple, does not contain large numbers and complex algebraic expressions).

REMARK 3. At each Olympiad, some tasks must be devoted to state symbols or other features, algorithms in Kyrgyz language, sponsors (their logos, business, addresses etc.), number of the year, events of the year, geography of Kyrgyzstan (Pankov *et al.*, 2003).

Thus, some tasks of our Olympiads demand erudition, knowledge in other subjects, such as physics, chemistry, geography, philology.

Tasks in Selective competitions correspond to traditional scope of IOIs: long arithmetic, combinatory, graphs, discrete optimization, moving along rectangular grid (points with integer coordinates) and polygons on it, embedding of words, cubes with integer sides (Pankov, 2004).

REMARK 4. Simple in sense and interesting tasks for graphs are generated by involving of "moving" objects differing from a point (two points which are prohibited to meet, "train", "worm" etc.).

4. Graphical Tasks

Many of tasks proposed at Olympiads in Informatics (on graphs, rectangular grid, counting of geometrical figures, coverings, packings) mean "images" in any sense, and examples to them are given in a graphical form but the output is textual. For example, see

(Pankov *et al.*, 2005). (Also, while solving a task, a contestant can program an additional graphical output for their own use, to avoid rough mistakes).

We shall not consider such tasks; we mean “graphical” tasks as ones with graphical output. By our opinion, such tasks meet the Statute S1.7 of the IOI Regulations “to bring the discipline of Informatics to the attention of young people”. By our experience, such tasks make Olympiads more attractive for sponsors and can reflect state and national features.

By our opinion, tasks themselves ought to contain text only; graphical images can be in examples only.

4.1. *Possible Content of Graphical Tasks*

We propose the following standard and non-standard ways to elaborate graphical tasks (including interactive tasks, animated cartoons).

G1) A simple drawing (an element of state symbols, a sponsor’s logo etc.) is described verbally; either its dimensions (numbers) or some characteristic points (on a display) are input.

Such a description of an image is a base for more complex tasks. All motions (transformations) mentioned below must be continuous and slow. “User” means the member of jury verifying the solution.

G1A) Firstly, all display “is covered with snow”. If User “erases snow” with a cursor then the image appears. (More generally, the image changes under a cursor).

G1B) The image moves (transforms) due to demanding of the task. The image can also be “larger” than the display; then its parts appear successfully.

G1C) Additionally, firstly User inputs a (very simple) drawing (one or two segments); after input it transforms into the image.

G2) The image is being built successfully of elements (letters, points, segments) input by User arbitrarily until the image is completed; if the input element does not meet the condition then it is rejected.

G3) The image is to reflect any mathematical object being an input and/or a solution of the task.

G4) The initial image presents a base for the task. User inputs a data for the task; the program adds a presentation of an (optimal, close to optimal or arbitrary) solution of the task to the image.

There is also a kind of mathematical tasks which do not demand graphics explicitly but can be solved effectively by graphical and pixel methods rather than mathematical ones:

GD) A geometrical image is defined in any way. Find a distance between two mentioned points with a low accuracy (2–5%).

GA) . . . Find an area of any mentioned part of the image with a low accuracy (5–10%).

4.2. *Composition and Scoring of Graphical Tasks*

To make a task interesting and accessible for contestants of various levels, it may be subdivided into stages and/or alternative subtasks in increasing order of complexity, with corresponding scoring of each stage. Let the total score be 10 points.

EXAMPLE 1. The first stage of a task of type G1B must be a task of type G1 (1–2 points).

EXAMPLE 2. The first stage of a task of type GL or GA may be a task to present the graphical image itself (4–5 points).

EXAMPLE 3. If letters are to be shown then it can be done: in text mode (1 point), with segments (5 points) or with segments and arcs (10 points).

5. Examples of Tasks

Most of tasks given below are very simple. We give them as examples rather than standards.

Task 1 (T2). Any algorithm transforms certain words containing the letters B, M, P. For instance, the algorithm transforms the word PBPBMB into PB, MBMBPBMB into MBMB, MBPBPBMBPB into PB, PBPB into PBPB, MBPBPBPB into PBPB. For certain words, for instance, PPB, MBMP, BBPBPMPB, the algorithm gives “error”. A) What sense may be in this? B) Write such algorithm.

Comments. Contestants gave different “right” answers to A): “algebraic simplifying: +B+B-B+B= +B+B”; “Annihilation of particles in nuclear physics” etc.

From these examples a contestant cannot guess, what does a word of type PBMBMBPB transforms to? Thus, any non-empty respond demonstrating paying attention to it was considered to be right.

Task 2 (T2). While working the algorithm elaborates a sequence of natural numbers; the last number is the output.

Ex.1. 5000, 2000, 1000, 1500, 1700, 1600, 1550, 1520, 1510, 1515, 1516, 1517, 1516.

Ex.2. 5000, 2000, 1000, 500, 700, 900, 950, 970, 990, 995, 997, 998, 999, 998.

A) What sense may be in this? B) Write such algorithm.

Jury’s version: it is a process of weighing with the traditional (decimal) set of weights: 1, 2, 2, 5, 10, 20, 20, 50, . . ., with rounding down.

From these examples a contestant must guess that an input is a positive number. Also, s/he cannot guess, what is the heaviest weight in the set? Thus, any solution demonstrating paying attention to it was considered to be right.

Task 3 (T3) (2003). A) What goal may this algorithm have? (A possible goal must be defined by the initial (instead of simplified) text of algorithm). B) Is it possible to simplify or improve it (with the same input and output)?

Let $X := 90$*;* $Y := 53$*;* $T := -201$*; Output* X, Y, T*.*
M1) Let $T := T + 38$*; Input* B*.*
If $B > 0$ *then let* $X := X - 1/2$ *else* $Y := Y - 1/2$*.*
If $X < 72$ *then let* $X := X + 1/2$ *and* $Y := Y - 1/2$*.*
If $Y < 42$ *then let* $X := X - 1/2$ *and* $Y := Y + 1/2$*.*
If $X > 72$ *or* $Y > 42$ *then go to M1.*
Output X*,* Y*,* T*; End.*

Answer B). A version of simplified algorithm:

Let $X := 90$*;* $Y := 53$*;* $T := -201$*; Output* X, Y, T*.*
M) Input (any) numbers 58 times.
Let $X := 72$*;* $Y := 42$*;* $T := 2003$*; Output* X, Y, T*; End.*

Comments. Analysis demonstrates that values of numbers B do not influence to the final result. But it is stressed in the condition of the task, that the simplified algorithm should have the same input and output, as initial one. Therefore the jury reduced points to those who had missed a statement of type M) in simplified algorithms.

A) As the final value of T is a year (2003 A.D.), we may suppose that the initial value of ' is any historical date (201 B.C.). It is possible to recollect, that it is the date of first known mention of ethnonym "Kyrgyz". Hence, the algorithm shows the movement of Kyrgyzes at time from Altai Mountains up to Tien Shan Mountains, in general south-west direction. Then X, Y are, likely, coordinates (geographical coordinates). One may guess, that X is longitude and Y is latitude [we have chosen the center of Khakassia as the initial point and Talas valley as the final point of wandering]. Inputs of numbers B denote orders or historical circumstances pushing people in various directions (once during each generation).

As much is unknown in the history of Kyrgyzes, this algorithm, irrespective of input numbers (defining coordinates of intermediate points) yields the same output.

Task 4 (GL). Solar disk S with forty uniformly radiating beams is placed in the center of the Kyrgyzstan national flag, on the red background. An image of red "tyundyuk" T is placed inside S. The ratio of length L of a flag to its width W is equal to $5 : 3$. The diameter D of forty-beams circle is equal to $3/5 * W$, the diameter E of S is equal to $3/5 * D$. The diameter F of T is equal to $1/2 * D$.

REMARK. An image of "tyundyuk" (top window of transportable felt house – "yurta") consists of thin ring and six bent lines crossing the ring.

Let us to mark and renumber some points at the flag:

The middle of a left edge of a flag is #1; the end of the left beam is #2, the left edge of Sun is #3, the right edge of "tyundyuk" is #4, the end of the right beam is #5; the bottom edge of Sun is #6, the top right corner of a flag is #7.

To write a program to find the area of a flag with an error less than 1% if A) given the number K ($K \leqslant 5$) and the distance H between the center of a flag and the point

#K (positive number), or B) given two numbers $K \neq J$ ($K, J \leqslant 7$) and the distance H between the point #K and the point #J (positive number).

Comment. Although the goal is to find an area, this task is of type (GL) because the length of the flag defines its area evidently.

The simplest solution by means of computer. Choose size and arrangement of the flag on the coordinate plane arbitrarily; find its area G_1; calculate coordinates of the listed points (denote them as $P[K]$, $K = 1..7$). To solve A) and B) uniformly, denote the center of the flag as $P[0]$. Given two integers $K \neq J$ in [0..7] and $H > 0$, calculate H_1 :=(distance between $P[K]$ and $P[J]$), and the answer $G := G_1 * (H/H_1)^2$.

For example, let $P[0] := (0, 0)$; $L := 2$. Then $W = 2 * 3/5$, $D = 3/5 * W$, $E := 3/5 * D$, $F := 1/2 * D$; $G_1 := L * W$; $P[1] := (-1, 0)$; $P[2] := (-D/2, 0)$; $P[3] := (-E/2, 0)$; $P[4] := (F/2, 0)$; $P[5] := (D/2, 0)$; $P[6] := (0, -E/2)$; $P[7] := (1, W/2)$.

Task 5 (G1B) Suppose that we are above the Earth and we can see Bishkek and Istanbul only through clouds (as two little figures on a homogeneous background). What shall we see (how will the view change) if we move (at our will):

A) downwards (up to clouds);

B) either to East or to West and as in item A);

C) either to North or to South and as in items A) and B)?

REMARK. "Istanbul" is mentioned because there are some Kyrgyz-Turkish lyceums in Kyrgyzstan and their directorate "Sebat" supports Olympiads in Informatics.

Task 6 (G4) (2002). Let Lake looks like an isosceles triangle, the basis of the triangle (northern coast) is 190 km and height (width of Lake) is 60 km. Village is located on northern coast of Lake at 20 km from the western corner. Horse runs with speed of 20 km/hour and swims with speed of 10 km/hour. Write a program: A) to show Lake and Village; B) to enable User to show any point on the coast of Lake; C) to draw the fastest way for Horse or D) to show the motion (in scale of 1 hour =1 sec.) of Horse from this point up to Village along such way.

Scoring: 1 point for A); 2 points for B); 3 points for C); 7 points for D).

Comments. 2002 was the year of Horse. The task reflects a historic fact. This village was named after Horse which had crossed the Issyk-Kul lake in XVIII century.

Task 7 (G1–GA). On midday, near the Ataturk-Alatoo University [a sponsor], a photographer realized that one of mountain peaks will be soon seen exactly on the center of the Sun [element of the insignia of Kyrgyzstan]. He wishes to choose a colored photo for the newspaper "Vecherniy (Evening) Bishkek" [a sponsor]. The seen diameter of the Sun is half degree.

Given the number of seconds passed after "touching" the mountainside by the Sun. Write a program A) performing the sight of the Sun and the mountain; B) calculating the percent of the seen part of the Sun's disk (with the accuracy 10%).

Present the mountain as a symmetrical right angle. The seen diameter of the Sun disc is half degree.

Comments. Beginning of solution of A). The Sun passes its diameter during $24 * 0.5/360$hours $= 120$ seconds. It moves horizontally (on midday) and from left to right (in Kyrgyzstan). When the Sun's disk "touches" the mountainside the "distance" between the center of the Sun and the peak is $60\sqrt{2} = 85$ seconds.

Mathematical solution for B) is complicated but the contestant can do as follows. Choose an acceptable diameter D of the Sun's disk (50–70 pixels); count the number N of pixels in it and include N into the program; after performing the image on a display count the number N_1 of pixels in the seen part of the Sun's disk (the number of yellow pixels in the square with the side D circumscribing the Sun's disk); output the number $N_1/N * 100$ (percents).

Task 8 (G4). Given a natural number N ($13 \leqslant N \leqslant 200$), and two natural numbers L, M ($1 \leqslant L < M \leqslant 10$). Arrange N points with integer coordinates on a plane in such a way that the number of distances between pairs of them that are in the interval $[L, M]$ to be as large as possible. The program must give the following output:

A) a file with:

1) N lines with the list of numbers and coordinates of N points. Each line contains number of point (from 1 to N), its X-coordinate and Y-coordinate. All points must be different. The coordinates must be natural numbers less than 800.

2) One line with number (denote it as K) of pairs of points having distance in the interval $[L, M]$.

3) Corresponding K lines with the list of these pairs of points. Each line contains the number of the pair and the numbers of points in pair (the second must be greater than the first). All pairs must be different.

B) Arrangement of these points replaced by little stars on a display.

Scoring: $1 + 9*$(NumPairsInYourAnswer/NumPairsInBestAnswer)^2 rounded down.

(Such a task was submitted to IOI'2003 but was not accepted).

Comment. This task looks like a continuous one but is discrete.

6. Proposals and Conclusion

At IOI'2006, in Merida Zide Du, President of the IOI, proposed the idea of involving graphics into IOI. Certainly, most of types of graphical tasks mentioned above do not suit responsible international competitions. We propose tasks of type G3 (only task each day). If it is possible, images would be related to any reality: reminiscences of the host country or sponsors. Also, knowledge and skills necessary to fulfill the task must be obvious for contestants.

The following items are to diminish subjectivity and non-automation in scoring.

i) The score for a graphical presentation is fixed: about 30% points; other 70% points are distributed in a common way.

ii) These 30% points are given alternatively: 30 or 0.

iii) The quantity and content of graphical images are fixed: the first image presents the initial data and the second one presents the result.

iv) The only test (G-test below) in the task for graphical presentation is to be as simple as possible.
v) The initial data for the G-test have to be announced as fully as possible.
vi) The size and other parameters of a graphical image in the G-test are to be described in details, for instance "600×400 pixels etc."
vii) If the goal of task is an optimization then the contestant's program for the G-test must give a result not less than 50% of the best result if it is known or of the best result of all contestants (i.e., the score for the test itself may be zero, but the score for the graphical presentation may be 30% points).
viii) The following scoring procedure is proposed:
   – while submitting the task the contestant announces whether the program has the option to generate graphical images (only within the range announced in v));
   – if the G-test is passed (may be, not with the full score) then the Scoring Program shows the graphical images to two or three members of jury. If they (independently) confirm that these graphical images are proper or not proper then the Scoring Program adds or does not add 30% points; if their opinions are different then after this procedure they gather together and discuss all (only few) ambiguous programs (still they do not know contestants-authors of these programs).

We hope that graduated implementation of graphical tasks into Olympiads of top levels will make them more interesting for young people and attractive for prospective sponsors. Also, demonstration of best works can decorate closing ceremonies and publications on Olympiads.

References

Pankov, P.S., T.R. Oruskulov, G.G. Miroshnichenko (2000). *School Olympiads in Informatics* (*1985–2000 years*). Bishkek (in Kyrgyz & Russian).

Pankov, P.S., T.R. Oruskulov, G.G. Miroshnichenko (2003). *Olympiad tasks in Informatics, devoted to Kirghiz statehood, history of Kyrgyzstan and Great Silk road*. Bishkek [in Kyrgyz & Russian].

Pankov, P.S. (2004). Preparing for international Olympiads in Informatics. *Bulletin of the Kyrgyz National University*, **6**(4), 52–54.

Pankov, P., S. Acedanski, J. Pawlewicz (2005). Polish flag. In *The 17th International Olympiad in Informatics* (*IOI'2005*). *Tasks and Solutions*. Nowy Sacz, pp. 19–23.

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