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OLYMPIADS IN INFORMATICS

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Editorial

Rebirth of Artificial Intelligence

International Olympiad in Informatics, or the IOI as it is called, runs the IOI conference for 11th time. Last year an additional volume of papers established with a focus on experience and ideas on the host country, Iran this year. Tehran is home for the 29th International Olympiad in Informatics in 2017!

Iran participated in the 3rd IOI in Athens in 1991 as an observer, and there we found IOI a great opportunity to promote informatics in Iranian schools. National contests and training sessions in informatics were soon organized, and a team from Iran participated for the first time in the 1992 IOI in Bonn (Germany). Informatics studies attracted many Iranian students, and informatics made a minor appearance in the national curriculum, but most interest materialized in an extra-curricular fashion. It has been almost three decades since IOI has begun in Iran. Since then, the Olympiad has had great impact in envisioning informatics among the youth in the K-12 and college levels.

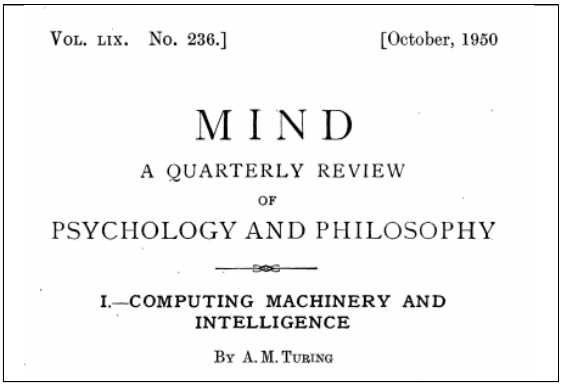
Organizing the 29th IOI in Iran is also a great opportunity to promote more and more informatics studies among today's youth. We have brought in a message from Donald Knuth (a computer science icon) in a special interview about how IOI may affect informatics studies. We have also discussed how we are witnessing a turning point in informatics, as the rebirth of artificial intelligence is requiring more and more informatics skills. We then looked at the rebirth of artificial intelligence through a historical approach, to look for trends and a true underlying message for the future.

Computational mathematics has its roots in ancient Egypt and ancient Greece, and more advancements were made in the 8th century in the land of Persia, where concepts of Algebra and procedural thinking evolved. But, it took a long way, until the 20th century, for modern concepts of computation to be fully articulated.

Alan Turing in 1936 introduced the concept of the Turing Machine to solve the *decision problem*. The Turing Machine also envisioned the idea of the computer and programming, ushering in a new era of information technology and rapid computational advancement.

Turing continued to advance the field of mathematics, and in his paper *Computing Machinery and Intelligence (Mind, October 1950)* he addressed the problem of Artificial Intelligence (AI).

He further proposed an experiment that became known as the Turing test, an attempt to define a standard for a machine to be called "intelligent". Essentially, a computer



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MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

could be said to "think" if a human interrogator could not tell it apart, through conversation, from a human being.

The field of AI research was born at a workshop at Dartmouth College (USA) in 1956. Attendees such as John McCarthy (Stanford), Marvin Minsky (MIT) and others became the founders and leaders of AI research. They and their students produced programs that the press described as "astonishing": computers were winning at checkers, solving word problems in algebra, proving logical theorems, and speaking English. AI's founders were optimistic about the future, and they predicted, "machines will be capable, within twenty years, of doing any work a man can do". They failed to recognize, however, the difficulty of some of the remaining tasks.

Year by year, we witnessed gradual advancements in AI, but 2015 was considered a landmark year for artificial intelligence. The success was due to a combination of increasing computational power and a staggering number of software projects that use AI. Sixty-five years after Turing in 1950, AI witnessed a rebirth!

The Internet of Things (IoT) has connected billions of sensors, appliances, and tools. It comprises of a deluge of data and application integrity. Computing power has increased tremendously: computers are no longer fast calculators with memory, but powerful computational devices that can make rational decisions through artificial intelligence and deep learning.

Deep learning is the heart of artificial intelligence. It is primarily based on the neural network architecture and is in need of more sophisticated algorithms and programming to reach the next level. A movement as "Programming for All" has become a new standard for literacy, as programming is no longer a niche but a skill fundamental to our technological society. So, IOI is a true platform to attract and encourage youth to engage in programing. Programming is an art and a power – a power that can make a better world!

Yahya Tabesh

For the IOI-2017

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Three Decades of International Informatics Competitions : How did IOI Start

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1. Informatics Competitions: Who Wins?

People are used to judge of the degree of development of a country by its gross domestic product, industrial indicators, agricultural output, the level of cultural life, stability of the political system and so on. However, if you ask 'What is the most important factor that drives up all these things?' you would inevitably realize that this is the human factor. Behind any significant achievement there are talent, high professionalism, devotion, perseverance, leadership. Talent, skills and personal characteristics as these are a decisive resource for the development of the society. Surely, natural resources (oil, gas, ores), even if not detected and used today, remain stored for future generations. However, abilities, talent and potentially fruitful personal characteristics of today's young people disappear forever, if not found, developed and used in time. The competitions (of any kind) help identify talent and develop personal characteristics which play an important role in any achievement.

The state of the art in any social sector and its potential for development depend heavily on how many bright young people are attracted to it. A distinguished characteristic of our time is that the digital technologies (DT) penetrate (and even invade) all aspects of social life. This is why the attraction of high quality human resource to DT becomes important for the sustainable development of the whole society. Competitions in informatics contribute significantly in this respect. Very often the participation in a competition predetermines the future professional realization of a young person. The first success (and sometimes even the first failure at a competition) motivates for further efforts which, sooner or later, brings success and this steers the young persons to professional realization in the field of DT.

For many people the competitions are just a tool to identify the best performers. What is often overlooked is the fact that the competitions bring benefits to all participants, not only to winners. In the process of preparing for the competitions and even during the competition all participants increase their skills and knowledge significantly.

Informatics competitions cultivate algorithmic and computational thinking which is increasingly gaining importance in all areas of human activities. Taking into account that hundreds of thousands of young people participate in competitions, the integral effect on the general knowledge in this area becomes apparent. It wouldn't be an exaggeration to claim that informatics competitions today are an integral and essential part of the global educational process which is no longer limited only to the classroom.

Not only the competition itself but also what happens after the competition is important from educational point of view. The participants share their experiences with the solution of the competition problems and this also has serious educational effect. These after competition discussions might be as important as the preparation for and the competition itself. This is why the social program after the competitions should be considered as an extension of the competition and should be given proper attention.

There are many other ways in which the competitions influence, sometimes indirectly, the educational system and educational institutions. Practice shows that the presence of good students (competition participants) in class drives up the level of all the class by giving a "pattern to follow" and by motivating the other students to work harder. Moreover, the presence in class of such students places higher demands on the preparation of the teachers themselves. This two-way-prompt influences positively the entire educational process and improves, directly or indirectly, the reputation of the educational institution. The desire of many universities to attract good students by offering stipends and other privileges has a natural explanation. Enrolling competition winners has a long-term positive effect on the reputation of the institution. After graduation from the university, the competition participants, who already have problem solving skills, are likely to find solutions to difficult and complex real-life problems easier and faster than others. Once their success is noticed, the recognition of the university they come from increases almost automatically.

2. Thirty Years Since the International "Open Competition on Programming" in Bulgaria

To compete means to compare your abilities and skills with the abilities and skills of others. The broader the base of comparison (larger participation in the competition), the better. This is in the base of the frequently observed trend when school competitions outgrow the frames of the school and become town competitions, the latter grow again to national competitions and, finally, students get involved in international competitions. Informatics competitions appeared in some Bulgarian schools already in the late 70's of the last century under the name "Programming competitions". Originally, the solutions to problems given at the contests required mainly "paper work". The contestants were asked to write on a paper a program which, if run on a computer, performed a specific task. Then the papers were checked and assessed by the jury. If "computer time" was available, the programs of the students were executed on computer as well. The number of computers in the country in those years was very limited and the access to them for school students was rather restricted. With the advent of microcomputers the situation changed. More and more school students got access to computers and this made it possible to organize competitions which are similar to the ones practiced today - the execution of the code on a computer became an obligatory part of the assessment. The national competitions in informatics exist in Bulgaria since 1981. The nation-wide Olympiad in Informatics (with this name) was started in May 1985.

The first international informatics competition in Bulgaria took place in Sofia on May 17–19, 1987. It was called “Open Competition on Programming” and was conducted just before (and in connection with) the Second International Conference and Exhibition “Children in the Information Age”, May 19–23, 1987 (Sendov & Stanchev, 1988). Responsible for the organization of the competition were the Ministry of Culture, Science and Education, the Union of Bulgarian Mathematicians and the Institute of Mathematics at the Bulgarian Academy of Sciences. There were 28 contestants (school students) from 6 countries: Bulgaria (BG), Czechoslovakia (CZ), Federal Republic of Germany (FRG), Hungary (H), Romania (R) and Soviet Union (SU). Bulgaria and Romania participated with two teams. The students were divided in three age groups (less than 14, less than 16 and less than 18 years). The problems for all age groups were selected and prepared by the International Jury chaired by Petar S. Kenderov (with Zdravko Vassilev as Deputy) on the base of problems proposed by the team leaders of the participating countries. All problems were hard and related to real-life applications (Kenderov & Maneva, 1989). The competition lasted four hours. The results of the students were excellent. Some of them discovered original approaches to the complete solutions. Others had found the right way to the solution but did not have enough time to solve the problem completely. Even the students who were not quite successful in this competition had shown by their work that they completely deserve to be participants in an international competition on programming. The jury gave two first prizes - to Markus Gutschke (FRG) and to Vulcho Vulchev (BG1). There were three second prizes: Dimitrij Evsjuhin (SU), Andrei Dobos (CZ) and Tomas Mueller (FRG). Vladimir Vesely (CZ), Michael Sperber (FRG) and Svetoslav Nestorov (B2) got third prize. The competition was a success and sparked great interest and enthusiasm both among participants and organizers. Evgenia Sendova who is known for her great appreciation of everything related to informatics and school greeted the participants with the following inspiring words:

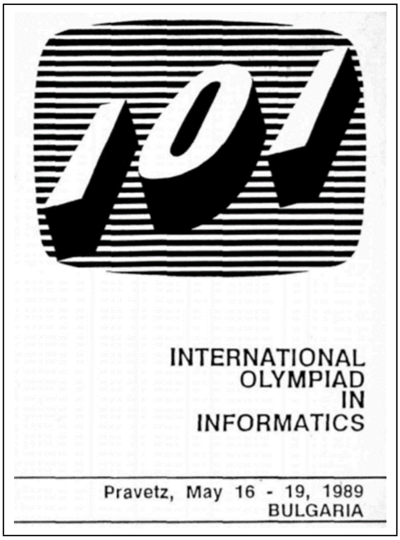
Welcome, welcome dear friends
representing many trends
coming to a competition
we hope it will become tradition.
Is it not a great idea
to gather all of you in here
to show that you are very clever
and you will become friends forever.
Higher, stronger, further wiser –
Friendship is the best adviser

One of the byproducts of this competition was the idea that it is time to organize an international Olympiad in informatics. At the 24th session of the General Conference of UNESCO held six months later in Paris, Professor Blagovest Sendov, a member of the Bulgarian delegation, suggested to include an International Olympiad in Informatics (IOI) in the Fifth Main Program of the UNESCO Plan for 1988-89. The proposal was approved and by a contract with the UNESCO Division of Science, Technical and Environmental Education, Bulgaria took on the obligation to organize the first IOI just before the third Conference and Exhibition "Children in the Information Age" (Sofia, May 20–23, 1989).

Additional experience in conducting international informatics competitions was gained in 1988 when a competition for school students from technical schools was held in Bulgaria (Varna, October 5–8). There were 19 students from six countries: Bulgaria, Cuba (C), German Democratic Republic, Hungary, Poland (P) and the Soviet Union. The International Jury was guided by Pavel Azalov (Chairman) and Evgeni Genchev (Deputy Chairman). There were two first prizes which went to Georghi Rivov (BG) and Marchin Wojas (P). A second prize was given to Alexiel Matos (C) while the third prize went to Pavlin Kostov (BG).

3. The first IOI – International Olympiad in Informatics

The first IOI was conducted in Pravetz, Bulgaria, from 16th to 19th of May, 1989. It was modeled after the International Mathematical Olympiad (IMO) and this was explicitly mentioned in the written Regulations of IOI. For instance, the participating countries were required to send to local organizers sample problems in advance from which the International Jury had to select the problems to be given at the competition. Only participants younger than 19 years old by the beginning of the competition were admitted.



The front page of the book of Kenderov & Manev (1989) with the logo of IOI.

In the first half hour after the start of the competition the participants had the right to put questions to the International Jury (in written form) concerning the formulation of the problems. The student work was preliminary checked and assessed by the respective team-leader and then finally marked by the “Coordinating Commission”. The final marking was with the International Jury which decided also how many first, second and third prizes are to be given to most successful participants. All expenses related to the stay in Bulgaria of the teams and the team-leaders were covered by the organizers. There was an excursion to Sofia and an entertainment program for the participants in the competition. Professor Iltscho Dimitrov, the then Minister of Education, gave a reception for IOI participants.

There were however significant deviations from the established routine of IMO. According to the rules of IOI, a team consisted of not more than three students accompanied by a team-leader. With teams of six students which was the case in IMO, it would have been difficult for organizers to ensure support for local expenses of participants and to provide the necessary number of computers (APPLE II compatibles or IBM PC/ XT/AT/ compatibles) for all contestants. Another deviation from the practice of IMO was that, while doing the preliminary assessment of the papers, the team-leader had the right to talk to a participant and to ask for explanations of his/her work. This helped significantly the process of marking the papers. At the end of the competition each team leader accompanied by a member of the Coordinating Commission collected the problem solutions from the members of the respective team. The work of each student (the final version of the solution) was copied on two floppy disks. One of them remained with the team leader and the other stayed with the Coordinating Commission. The program of each student was run with a set of preliminary prepared (and approved by the Jury) Test Examples.

Thirteen countries have sent teams to IOI. These were (alphabetically): Bulgaria, Cuba, Czechoslovakia, Federal Republic of Germany, German Democratic Republic (GDR), Greece, Hungary (H), Peoples Republic of China (PRC), Poland, the Soviet Union (SU), Vietnam, Yugoslavia and Zimbabwe. The teams from Hungary and from Yugoslavia had two students each. Bulgaria participated with two teams and the Soviet Union with three teams. Thus, altogether, there were 46 students distributed in 16 teams. The International Jury consisting of Chairman (Petar S. Kenderov), Deputy Chairman (Nelly Maneva) and the team leaders gathered on Wednesday morning (May 17, 1989) to select a problem for the competition. A special Scientific Commission has prepared in advance six problems based on suggestions made by team-leaders before the IOI. By a procedure described in (Kenderov & Maneva, 1989) the International Jury selected a problem which was originally proposed by China. Then the problem was refined and formulated in the official languages of the Olympiad: English and Russian. The team-leaders translated the problem into the respective languages understandable to their students.

Here is the problem given at the first IOI (by default N stands for an arbitrary positive integer):

Given $2N$ *boxes in line, side by side; two adjacent boxes are empty, and the other boxes contain* $N-1$ *symbols* “A” *and* $N-1$ *symbols* “B”.

Example for N = 5.

A	B	B	A			A	B	A	B

Exchanging rule:
The contents of any two adjacent non-empty boxes can be moved into the two empty ones, preserving their order.

Aim:
Obtain a configuration where all A*'s are placed to the left of all* B*'s, no matter where the empty boxes are.*

Problem:
Write a program that:

1. *Inputs from the keyboard the initial state as a sequence of* A*'s and* B*'s and zeros (for the empty boxes), and models the exchanging.*
2. *For a given initial state finds at least one exchanging plan, which riches the aim or reports that such a plan does not exist. The output should contain the initial state, the intermediate states after each step, and the final state.*
3. *Finds a plan reaching the aim with a minimal number of steps.*

Results:
Present at least one solution for the example mentioned above.

The maximal number of points given for a complete solution to this problem was 100. Those students who scored above 90 points were given the first prize. These were: Teodor Tonchev (BG2), Markus Kuhn (FRG), Emanuil Todorov (BG1), Andrius Cepaitis (SU1), Igor Maly (CZ) and Daniel Szabo (H). Second prize was given to students who got between 80 and 90 points. These were: A. Altanov (BG1), I. Marinov (BG1), H. Schwetlick (GDR), U. Nielaender (GDR) and L. Novick (SU1). The third prize went to students who got points in the range 60-80. Two encouragement prizes were also awarded. One of them went to Alexei Kolybin (SU3) who was the youngest participant and the second was given to Anita Laloo (Zimbabwe) – the only girl among the participants.

The first eight places in the unofficial country (team) ranking is given by the next Table 1:

Table 1
The first eight places in the unofficial country (team) ranking

No	Country/team	Team Leader	Score
1	Bulgaria (first team)	P. Azalov	275
2	Peoples Republic of China	W. Wu and Q. Ling (Deputy)	221
3	Federal Republic of Germany	P. Heyderhoff	215
4	Czechoslovakia	O. Demacek	209
5	German Democratic Republic	M. Fothe	207
6	Soviet Union	V. Kirjuchin	190
7	Bulgaria (second team)	K. Manev	188
8	Hungary (two students only!)	T. Toeroek and L. Zsako (Deputy)	149

Many people contributed to the organization and conduction of IOI. The work of the International Jury was supported by the software system created by P. Azalov and V. Dimitrov. In the hands of I. Nenova and V. Dimitrov this system served perfectly all the information needs of IOI – starting with the registration of participants and ending with the ranking with respect to results obtained in the competition. Alexander Pokrovsky from UNESCO (Division of Science, Technical and Environmental Education) was involved in all stages with the organization and conduction of IOI.

4. Additional Competitions Needed

As mentioned in (Kenderov, 2006) the traditional Olympiad-style competition along with the very positive features have some shortcomings when it comes to the identification of talent and inclination to research work. Most such competitions are limited in time to several hours and this imposes a significant stress on the nervous system of the participants. The students have to solve the problems correctly, quickly and in the presence of their direct competitors. Yet, there are many highly creative students, who do not perform well under pressure. Such “slow thinkers” often come up with new and valuable ideas a mere day (or even just five minutes) after the end of the competition, yet receive no reward or incentive. Traditional competitions disadvantage such students, even though some of them are highly creative and could become good inventors or scientists. Indeed, what matters in science is rarely the speed of solving difficult problems posed by other people. More often, what matters is the ability to formulate questions and pose problems, to generate, evaluate, and reject conjectures, to come up with new and nonstandard ideas. All these activities require ample thinking time, access to information resources in libraries or the Internet, communication with peers and experts working on similar problems, none of which are allowed in traditional competitions.

Obviously, other types of competitions are needed to identify, encourage, and develop such special “slower” minds. The competitions should reflect the true nature of research, containing a research-like phase, along with an opportunity to present results to peers – precisely as it is in real science.

As a matter of fact, such competitions, designed to identify students with an inclination to scientific research in the field of informatics already exist in many countries. It make sense to think about establishing an international competition of this type.

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P.S. Kenderov. One of the masterminds and major driving force behind the establishment of the first International Olympiad in Informatics (IOI) in 1989. Co-founder of the International Olympiad in Linguistics in 2003. Professor of Institute of Mathematics and Informatics of Bulgarian Academy of Science. Winner of the Erdös award in 2014 due to his significant role in the development of mathematical challenges worldwide.

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International Olympiad in Informatics: Roads to Algorithmic Thinking

Interview with Donald KNUTH

The interview with Donald Knuth for the 2017 special issue of the Informatics Olympiad Journal took place in his residence at the Stanford campus on December 20, 2016. Yahya Tabesh, Amir Zarkesh and Mohsen Hejrati were present and Don generously answered all the questions. Mohsen recorded the interview and Jill Knuth (Don's wife) kindly facilitated it.

Donald Knuth a legendary in computer science and professor emeritus at Stanford University, is the author of the multi-volume work *The Art of Computer Programming*. He contributed to the development of the rigorous analysis of the computational complexity of algorithms and systematized formal mathematical techniques for it. In addition to fundamental contributions in several branches of theoretical computer science, Knuth is the creator of the TeX computer typesetting system. Knuth created the WEB and CWEB computer programming systems designed to encourage and facilitate literate programming. In 1971, Knuth was the recipient of the first ACM Grace Murray Hopper Award, he also received the Turing Award in 1974 and he has received various other awards including the National Medal of Science, the John von Neumann Medal, and the Kyoto Prize.

Donald Knuth

Yahya: *It is almost three decades that International Olympiad in Informatics (IOI) had been organized, we would like to have your impression about IOI and these kind of programs.*

Donald: It sounds like a wonderful motivation it is better than trying to get to new levels of the games. It would be good for their creative thinking for the problems they are going to face in their lives every day. While the games, I know a lot of students learn a great deal by playing, like my grandsons, they play a lot of these games that have little bit of programming. I think having the real challenge of where there are working against other students is much more valuable.

Amir: *So do you think this kind of gaming can be a good learning environment?*

Donald: Sure, and there is also other kinds of skills and programming skill. You can have good response, learning how to organize, like the football or best tennis players they program three moves ahead of the ball. Those are similar in mathematical problems as well. I get to play video games not quite often but for example there was a game, it was based on a James Bond movie, I don't want to talk about it too much but it was very interesting. There is a connection with games and programming because a lot of scientists are creating new games. And of course lots of great researchers came to how to play chess and golf but video games and some other games are in a different category.

Yahya: *It is very interesting, the advances of the Artificial Intelligence (AI) which used to be kind of more slowly going forward as far as unsuccessful applications just recently because of the computer power has suddenly opened a lot of possibilities. Even games, you can make it very responsive to what we do and figure out ways.*

Donald: Exactly, a lot of the ideas have a sort of a critical point where until you get to the critical point it looks like you will never be going to get really far and then after those more things happen. I don't know any general move so that I can tell about these critical points, and of course a lot of the most recent things are situations where probably never will be a rule that is not understandable by humans anymore, because there are a lot of things comes up with rules that just works but nobody knows why. Between a neural network that seems what you have got is kind of a hologram of the solution instead of the solution. Little parts that are scattered all over the place. I had a situation couple of years ago where I was working on the satisfiability problem and there are random heuristics that go on in this problem and the idea was to prove that a certain class of graphs could not be colored with three colors and there is mathematical proof of this but a mathematical proof that I knew if you have the graph with size N it took order N^2 in steps and $N log N$ is definitely not in, but my computer got random found refutations proofs of that it looked very much linear and so I thought oh, there is another kind of proof that I didn't know of this graph here and so I thought okay, all I will look at what the computer proof was and I will see where I would understand and I spent so many days on this and I found no idea of how to construct what the computer came up with. A lot of these heuristic methods come up with answers are probably beyond human comprehension. I also went to the famous problem of P verses NP because people say if P is same as NP then there is a polynomial algorithm to solve the satisfiability, then all of these problems will suddenly be easy to solve. But if that, it is quite possible that there exists an algorithm but it is too hard for anybody to know and so asking somebody if there is an algorithm exists or not it is very wage and If somebody tells me yes there is an algorithm, that is not good to me unless they say what the algorithm is but we know for this problem there exist an algorithm to solve this problem but nobody has the idea that how fast the algorithm runs. There is one and you can prove that there is one but it does not tell you anything more than existence.

Yahya: *So did you see because of the fact that every kid has a super computer in hand now, that this can be the start of a change in a type of advances in computer science, kind of you look back 30 years ago and the whole volume that you wrote and the whole subject that you covered, is a change going to happen from existence proof and from more practical kind of searches, opening new doors, do you see any new transitions happening?*

Donald: Certainly there have been huge transitions in the problems that I can solve and that is what I write three problems three program a week because I can't resist and I see a problem now that I couldn't solve before. Just before you came here I thought tonight I am going to write the program. We are varying things that also getting more familiar with subject developers, so we are seeing giant steps instead of baby steps. We could understand little parts of the picture but now we are seeing enough of it that we can go

Yahya, Knuth, Amir

further even if computers are going fast. But a lot of the matters about space and speed and forgetting the space now is another reason that now I can solve. On the other hand, that can make people so lazy. We used to think when there was a problem and now we just have super computers that can solve the problems that I was not able to before and that could make you sloppy and then you can't push the envelope. The Olympiad is a push that people who are in it have to think.

Amir: *what are you programming these days?*

Donald: I use CWEB[1] which is a literate programming which is a combination of C and TeX and I could go on and on to say that this is the best possible thing but essentially the most important thing is I imagine myself not as just trying the computer solve it but I try to imagine telling a class how to solve the problem telling audience and human beings how to solve it, and so I have to explain myself and I have to get my thoughts a little in order as if I am at a blackboard or something, rather than just hacking and that discipline says I define the data structure here and maybe I should write down invariant and I declare variables as this is a number of items in this list and this verifies and gives some explanation of, and the method of the programming says that each program is made of different parts that are put together in simple ways and but you have to see the sculpture and you can start up but at the top to break it down, say at the start I will break it down to groups imagine A and B and C and then I start looking on A. Another way to write a program is to start with some routine items that I want to use some kind of library for the problem and start there and go, but in either case it is corresponds to the way my memo conception of the program and it means that I write more keystrokes and the program working faster because it is a very reliable way to organize and then I can also come back to, a year later and figure out with the other kind of programming.

Amir: *How do you see this progression of languages used to be C now, people learn Java and more recently they learnt Python, how do you see this?*

Donald: It kind of kept going, I think every generation wants to write its own proper language I don't know why this is true but I guess I know what is the truth. Because any complicated thing can be improved and if you can prove it that it is so complicated then you can improve it very simple but there is no optimum program of all of the although there is local optimum. But also one side is that because people have different intuition at things naturally. I have very little experience with Python, I had a deadline and I was giving a lecture about so if I could understand it's program and then I would be prepared for the illustration for my lecture, I have never used Python before but it is easy to understand programming, so I had an hour to look for this program and modified it and I had the other half hour to learn about Python and 5 minutes to go and present, it was pretty intuitive and I had some worse experiences later. but then I started with Java-script and other language but when I write three programs a week but there is 50

[1] CWEB is a computer programming system created by Donald Knuth and Silvio Levy as a follow-up to Knuth's WEB literate programming system.

weeks in a year and I would say 150 programs this year and I would say 140 of them in CWEB.

Yahya: *You have always talked about the art of programming, how the sense of beauty and joy could be reflected in programming?*

Donald: Well, my answer is if they start using literate programming they would be happy but really it gives me special pleasure because I get programs that works, so you get a program that I know why it works and I can see it but as something that makes a nice story, telling a nice story is really important for communication between people and I think of programming as communication between people. Now it is the communication of person to machine (and not person to person), that gives you joy to tell the true story.

Yahya: *We are using the libraries in Python or C and they can help to develop more fast and do better programming but somehow for the beginners I am not sure if they should go through these libraries and how they could be creative and how good will develop their own ability in programming.*

Donald: If programming has only such a situation that let you every week that you write a new, you get another library instead of new start doing that so your job become stranded to applying only parameters and let somebody else make the definition, so you look only on what is on the menu for this package and if that is the fact, then it is hard to sustain creatively. But on the other hand, if you got a powerful library and you're going to reinvent the wheel all the time if not using it, and so the other canned programs that I wrote in Mathematica[2] where I take advantage of the fact that this programs would do integrations for me and lots of over cursing calculations that would have been much harder can go easier. I can see also why it would be also exciting to have a plot full library that could make pretty picture or good music and set things going. And Java has a great graphic designer and certainly I want to have a rich library of tools but for my own. For all the illustrations in my book I do MetaPost[3] which is a language for illustrations but I don't use certain things that other people packaged for me.

Yahya: *In more high level also they put API (Application Programming Interface) for various applications and just when you have the API you can use the application, of course it is good for developing new applications. I remember some guys went to put Craigslist[4] on the Google map before they released the API, it was really a hard job to*

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[2] Mathematica is a mathematical symbolic computation program, used in many scientific, engineering, mathematical, and computing fields. It was conceived by Stephen Wolfram.

[3] MetaPost refers to both a programming language and the interpreter of the MetaPost programming language. Both are derived from Donald Knuth's Metafont language and interpreter. MetaPost produces diagrams in the PostScript programming language from a geometric/algebraic description. The language shares Metafont's declarative syntax for manipulating lines, curves, points and geometric transformations.

[4] Craigslist is a classified advertisements website with sections devoted to jobs, housing, personals, for sale, items wanted, services and discussion forums.

adapt the houses in the Craigslist over the Google map and they made a hard job to make it. now the API is released and they can make it easily. But where is the balance point using APIs and how should we have new creativity and innovative thinking?

Donald: If every week number of API come up, this is a full time job just knowing what they are, and not getting anything done. I started running to this ages when X Windows and different systems of applications came over and I already show the same for books and that was when the open source was coming around and for me it meant that okay, I have all these books that are open source and I could look at each of the programs and see what they did. What open source meant to me was that I can open books all the time and getting a lot of things, and I still have to look up all the time when I am writing and look up the foremost parameters every time and some of the interfaces are intuitive but each works fine for a different person so you have to learn everybody else's intuition if you wish to switch into and sometimes when you talk about a box and screen you have to give the lower left corner first and sometimes the x corners is and y corner is down. But to me, the key thing that makes computer scientist especially good, is the job levels of abstraction and distraction so good programmer would have a lot of low level things and know them in order to solve the problem and you have to have a certain kind of experience and you have to start this particular process and going from high level to low level is the top skill and people who have that are worth.

***Yahya:** So you mean in a modular way?*

Donald: Just in general to understand the instruction but there is another level that this package may have and something could go wrong at this step then you have to understand and when you are a creative programmer to figure out what is the problem.

***Amir:** So they can leverage the abstraction of programming and they can zoom in?*

Donald: Sort of not knowing what even to do. Yeah, this is a difference with mathematics and mathematician, they need to know one or two rules that governs the work on different levels but in computer programming there are several steps and each step is different so in dealing with programming those two skills are somehow the most important.

***Yahya:** So for high school, mathematical learning in high schools, somehow I had the feeling that this kind of step by step whatever you say, problem solving, algorithm thinking is missing, they have just focused on the other kind of mathematics but as you mentioned this other kind of mathematics also is needed.*

Donald: What do you mean the other kind of mathematics?

Yahya: I mean, as you mentioned they just go toward calculation, and not kind of algorithmic thinking.

Donald: Because you know there are a lot of kinds of mathematics so there are some kind of mathematics that are closer to computer programming but people who try to do computer programming with little understanding and idea of proof and that may not get them to deep understanding.

Yahya: *But in learning programming, they may just focus on syntax, not the problem solving abilities and computational thinking and algorithms.*

Donald: Yeah, I saw a quotation couple of years ago that mathematics without proof is like soccer without ball or football you know. Well, and computer programming are also informal proofs all the time and you know explaining why what I am doing is supposed to work and that is not necessary for the very simplest programming and is not necessary for the plugin and libraries you may use. But still on using that I have to know for example what is the purpose of the sorting and what are the consequences, and if I sort a set of data, I can look at them in a certain way and I will know that what I am trying to solve is helpful, so I will look at something that officially requires to follow but I have to look at it in a certain way.

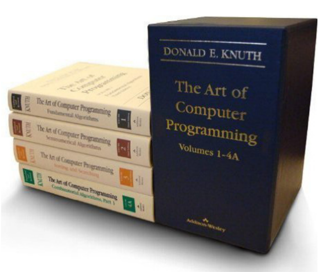
Yahya: *You mentioned about the open source, what do you think about the open source movement, it brought a lot of opportunity but how we can manage it?*

Donald: Well, if open source is opposite of closed source I am in favor because I don't like secrets. In black box, they cannot investigate why something works and if we cannot build on most ideas if everybody kept everything to themselves then everything would advance in a much slower rate and I guess your next question from me is about patents. I don't think that develop the creativity, because after people started having patents on trigger idea that you expected students to do as homework, now I had to pay for permission to use them, so all these things I think are problematic and these become intellectual property. There are also a lot of wonderful ideas in these commercial programs and they have to pay for because they cannot be discovered and so they deserve some credit for doing it. I benefit a little bit form this because my books years ago, I had to write the books once so over the years and I got more rewards for writing the books and so maybe I should feel guilty about that like this organ here that was, I couldn't have that without having written books.

A comprehensive monograph written by Donald Knuth that covers many kinds of programming algorithms and their analysis.

Knuth began the project, originally conceived as a single book with twelve chapters, in 1962. The first three volumes of what was then expected to be a seven-volume set were published in 1968, 1969, and 1973. The first installment of Volume 4 (a paperback fascicle) was published in 2005. The hardback Volume 4A, combining Volume 4, Fascicles 0–4, was published in 2011. Additional fascicle installments are planned for release approximately biannually; Volume 4, Fascicle 6 ("Satisfiability") was released in December 2015.

The collection has been translated to at least ten more languages.



The Art of Computer Programming

Amir: *Wow this is fascinating; do you play a lot?*

Donald: Yeah, I am actually working now a dream for more than 40 years to write a major piece of music for organ and I am in the process of finishing it now.

Amir: *Aare you using math in it more or are you just using it as art form?*

Donald: There is math in it but only if it sounds good. I read a page about it, I am just preparing to leave for Sweden and where else and I am going to give a talk in Stockholm to royal college of music. The Swedish people are interested in crazy new ideas.

Amir: *You mentioned something very interesting, you said that programming to you is more of communication and storytelling. Can you explain it a little more, because I think that for education is important, to get the feeling?*

Donald: I think also Stanford finds that very important, thing is that students learn from each other and instead of having students keeping stuff they learn from each other, one student showing another how to do something as a teacher, it is very viable for the student who is doing the teaching.

Of course there is a tendency now for a student to "ok, show me how to do this" and then this student would never learn, but the teacher at least learns. And that's, you learn much more if you view a program if you just do the program as something that writing it down for the computer to process. The reason is it has to make more sense. I cannot make this as a real strong point because certainly if I as a person to say it is okay so I am going to reformulate my thinking but when I am writing a program, the idea is that I am trying to explain, I get it right much more often than if I just run a program and that's because I force myself to explain it and I guess it would help.

Donald playing organ!

Amir: *Recently there have been mentioned to the point that this, the type of programming and and computational thinking behind syntax is important for everybody to learn and not just those who want to become programmers. What do you think?*

Donald: I think It is better to understands more of the processes with a mental model, because it makes more precision, suppose I am trying to learn music, theatre or some better that other notes. So now let me try to imagine that from the stand point of computational thinking, so how could I write a program and give me a bunch of notes and my program would say that this sound is pleasant or not, well there is no real answer to this because what you want to do, any combination might be the right answer, but if you want to know does it sound like Mozart or Tchaikovsky or does this sound like or some other people this is a good question where you can learn much more music by asking that question and thinking about it as a computational process deciding whether something is good or not. I have examples from chemistry or law or poems or English I mean, but there is a way to think about these things as computation and I think that leads to, it makes it easier for people to understand what they don't know and then they can learn more as they try to answer these questions.

Amir: *How could we make this computational thinking approach more popular for high school kids?*

Donald: It is going to take some generations. You can get, one more becomes part of peoples for doing things and how they do or talk to each other about these things. But until you get to that to level it will be specialized. I think things like Olympiad are a way to reform everybody, it would take a long time even for the teachers to understand but maybe you can automate it and just have enough things but it gets few great teachers to explain it and that be everybody loves and it is not going to also happen unless they have best friends who do it.

Amir: *Maybe instead of classes and teachers put in the games that teaches them.*

Donald: Yeah, if a little bit of more computational thinking every year than the past year, it would go. But I doubt that if we assume that almost everybody on the block does. Right? Instead of not just the ones who are Olympiad champions and stars. I personally don't think we are going have secure system if everybody is going to have everything, I disagree with the fact that everybody can learn anything. Because many things I have tried to do and I finally said to myself that well, this is not going to be easy for me and same I am explaining to people about programming. Some of them were even very motivated but they were good in other things. So I am not, here I am talking about programming at the highest level, not at a useful level. But when we hear, but it certainly would be wonderful if enough people had computational thinking and learn how to use it. Everybody is supposed to know 1/3+1/4, but I don't know how many people really do this. It is what you are learn in the process about the structure of that there is such a thing as fractions and understanding of that helps. If you understand that then you have that what you can do. But everybody needs to learn problem solving, even I may say dogs learn how to solve problems when a dog learns how to climb a fence, so problem solving is like that.

Yahya: *Just go back again to Informatics Olympiad and have some sort of final words more about this IOI and for these kids around the world how we can attract them and when they got attracted how we can keep them go further?*

Donald: It all depends on the quality of problems and that's great for the people to come up with the problems and so to me that is the most critical thing, is to generate experts in creating the problems. Because if we have good problems it would be irresistible for us.

Yahya: *How we can make it more popularize and attract more people?*

Donald: I suppose you have to get into that somebody let people admire and show that they are interested. So it goes with, I am sure each country work, how much they have tennis playing, golf playing and chess playing and programming and flying drones and robots and make paintings, each culture has themes that they are currently hot and I am not a sociologist but the more you can try to something that makes it cool to do this, and sometimes people are good programmers but that doesn't motivate, so whatever solution is, it is one of the beauties that we didn't know about it in the past.

Yahya: *We highly appreciate your time and for this enjoyable talking.*

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Almost Three Decades of IOI in Iran

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Iran started participation in Olympiads in 1987 by sending a team to International Olympiad in Mathematics in Cuba. International Olympiad in Physics was the next and Iran joined in 1987 by sending a team.

In 1991, Dr. Yahya Tabesh was an observer in International Olympiad in Informatics (IOI) in Athens, Greece. In 1992, Iran sent a team of four high-school students to IOI'1992 in Bonn, Germany (Fig. 1). Dr. Tabesh was the team leader and I was the deputy. Our participants got two silvers and two bronze medals which was quite good for our first participation.

Next year in 1993, I was the team leader in IOI'1993 in Mendoza, Argentina (Fig. 2). Our team obtained one gold (full mark), one silver, and two bronze medals. If we unofficially rank the participating teams based on the sum of the scores of the team

Fig. 1. IOI'1992, Bonn, Germany.

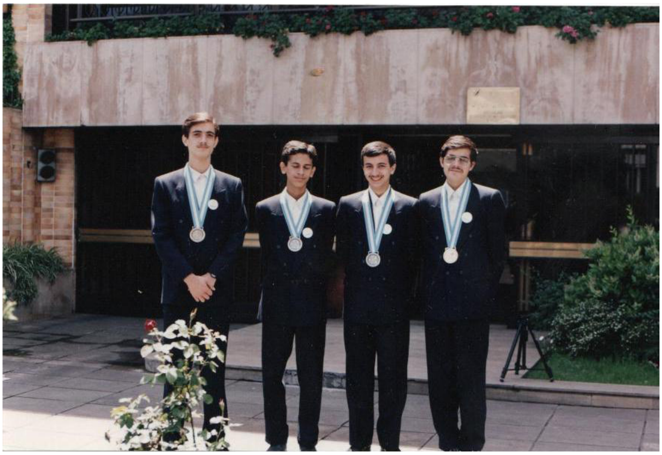

Fig. 2. Team of Iran students in IOI'1993, Mendoza, Argentina.

Fig.3. Team of Iran students in IOI'2000 Beijing, China.

members, our rank in IOI'1993 was 4th, which was our best such ranking until 2016, that we obtained two gold medals and two silvers and ranked 3rd.

Since 1993, we have participated in all IOI's, except in IOI'2004 in the US, and in IOI'2008 for the reasons of visa problems. So far, Iran has participated in 23 IOI's with 93 team members (IOI'95 in the Netherlands invited 5 mixed-gender members). and obtained 21 gold medals, 49 silvers, and 23 bronze medals (sums to 92) medals.

Graphs in the following figure (Fig. 4) depicts the number of participating teams and the unofficial rank of the Iranian team for each year.

IOI has had great impacts both on the high schools that work on sending kids to Olympiad camps and on universities that absorbs the IOI team members.

We have several rounds of competitions and camps each year to select our IOI team members. Usually 10,000 to 15,000 high school students in second and third grades par-

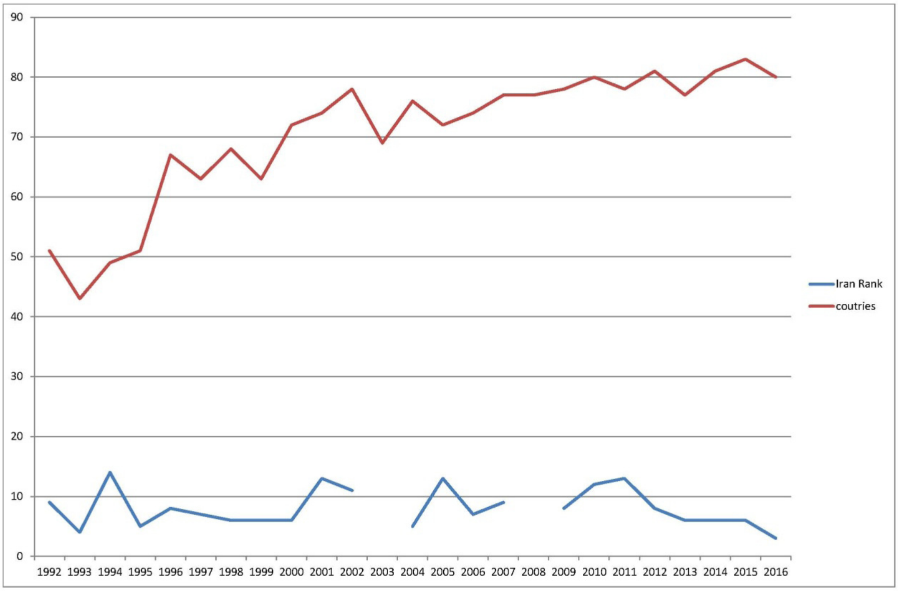

Fig. 4. Number of participating teams and the unofficial rank
of the Iranian team for each year

ticipate in the first round nation-wide exam each year. This exam contains about 50 easy multiple-choice tests. The top 500-1000 of this exam go to a 2nd round harder exams (both multiple-choice and written) from

M. Ghodsi. Distinguished professor of computer science at the Sharif University of Technology. Co-founder of the Iranian National Olympiad in Informatics. Member of the IOI International Committee (1997–1999) and Member of the IOI International Scientific Committee (1999–2000). Founder of the ACM/ICPC in Iran and director of the west Asia region. Recipient of the Dr. Amin's Life-Time Achievements Award in 2016 and ACM/ICPC, Asia Outstanding Contribution Award in 2010.

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Iranian National Olympiad in Informatics

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Introduction

Iranian National Olympiad in Informatics (INOI) is organized by Young Scholars Club (YSC), an entity organizing all scientific Olympiads on behalf of the ministry of Education (see logo of YSC, Fig. 1). YSC holds nation-wide contests to select top students in each field, representing Iran in international Olympiads. This includes Olympiads in mathematics, physics, computer, chemistry, and biology. YSC has appointed a committee for each Olympiad whose responsibility is to select and prepare the students for the national and international contests. One of these committees is the national committee of INOI. The INOI committee consists of different generations of IOI and INOI medalists. Three decades of experience has led the INOI committee to establish a multi-round selection system which we explain next in more details.

Fig. 1. Young Scholars Club is the host for Olympiads.

The First Round

Every February between five to ten thousand students at grades 10 and 11 participate in the 1st round contest nationwide, one thousand of which advance to the 2nd round. In the 1st round, the contestants answer thirty easy multiple-choice problems in three hours.

The goal of the 1st round is to examine the mathematical knowledge and creativity of contestants. Therefore, the problems are designed in a way that the basic mathematical knowledge is sufficient to solve them. Problems are divided into three main categories, namely combinatorics, preliminary graph theory, and puzzles. Most of them are mainly focused on enumerative combinatorics and simple optimizations.

The 1st-round committee starts the preparation process from December. The committee calls all former INOI medalists to submit their problems in order to form a long-list of problems. Afterwards, the committee selects the final problem set for the contest through several meetings, and turns them into multiple-choice problems. Finally, the committee asks three former INOI medalists to take the contest in advance to find any potential issues. To get more insight, we next explain a sample problem of the 1st round exam.

A sample problem. *Five police officers are seated around a table wearing sunglasses, which are either red, blue, or yellow. Each officer can only see the world through his own sunglasses, therefore rather than seeing the actual color of an object, he sees a combination of the object's color and the color of his sunglasses. For example, an officer wearing a red sunglass sees a blue object in purple. Keep in mind that an officer does not see other sunglasses in their actual color too. The following table shows how the combination of colors is.*

yellow	blue	red	
orange	purple	red	red
green	blue	purple	blue
yellow	green	orange	yellow

Captain Ilich asks each officer to report the set of colors when he sees the other four sunglasses. For example, suppose that the police officers wear red, red, blue, yellow and yellow sunglasses, respectively. The second officer says: "I see red, purple and orange *colors". For how many cases out of all* 3^5 *cases, Capitan Ilich can uniquely determine the color of each officer' sunglasses?*

1) 150 2) 153 3) 183 4) 213 5) 243

Solution to the sample problem. *The answer is* 243. *Let* S *be the set reported by an officer. If a primary color (red, blue or yellow) is in* S*, the color of his sunglasses is that primary color. Moreover, if two different secondary color (purple, orange or green) is in* S*, the color of his sunglasses is determined uniquely. Now suppose that* S *doesn't contain any primary color and contain only a single secondary color. In this case, the four other officers' sunglasses have the same color and Ilich can guess the color of their sunglasses, and so the color of the officer's sunglasses can be determined from this color. Therefore, Ilich can guess the color of sunglasses in all cases, and consequently the answer is* $3^5 = 243$.

The Second Round

The second round of INOI is held on two consecutive days in April. Each exam lasts for almost four hours. The first-day exam consists of twenty-five multiple-choice problems similar to the 1st-round exam, but more challenging. The second-day exam consists of four theory problems, mainly focused on graph theory, and combinatorics, similar to the problems in IMO. Contestants are required to provide a detailed proof, which can span over multiple pages.

Grading is done in two phases. First, all contestants are graded by their multiple-choice exam, and then roughly the top 300 contestants will be graded on their written exam. Each question is graded by two former medalists independently, and if the scores are different, they will grade it again for the third time together. The final score of each student is the sum of the contestant's scores obtained in both exams. Contestants may also object to their grades, should they decide any of their grades is below their expectation. Finally, the top 80 contestants advance to the 3rd round.

The preparation process of both exams is done in parallel by two separate committees. The head of each committee invites former INOI medalists to submit their problems. These problems are verified and categorized by their difficulty and subjects, and the committee selects the exam questions from them. Finally, three former INOI medalists take these exams and give their feedback to both committees to refine the problems.

As already mentioned, the 1st-round and 2nd-round exams mostly concentrated on theoretical computer science. This is mainly due to increasing the creativity of contestants and measuring their skills in computer science under a fair platform. Unfortunately, all students in the entire nation do not get the opportunity to learn the fundamentals of algorithms and programming. Therefore, including algorithmic and programming problems to the 1st and 2nd rounds would be in favor of a few students who have coding experience. We also believe by a solid background in combinatorics, students are more prepared to learn algorithms. Below, we present a sample written problem and a sample multiple-choice problem of the past 2nd-round exam.

A sample written problem. *Let $n > 2$ be an integer. Ilich has $3n - 2$ coins of weight 1 gram and 2 coins of weight 0.5 grams. He needs one of the 0.5-grams coins for shopping. Since all coins are identical in terms of shape, he had trouble finding the proper coin. He only has a magical machine that can help him solve the problem. At each step he can put two coins on the machine, and the machine shows whether or not the sum of the weights of the selected coins is an integer number.*

1. *Prove that Ilich can solve his problem by using the machine in at most $2n - 1$ steps.*
2. *Prove that Ilich can not design an algorithm which guarantees to solve the problem in less than $2n - 1$ steps.*

Solution to the sample written problem.

1. *Partition the coins into n groups $A_1, \ldots, A_n$ such that for every $1 \le i \le n$, $|A_i| = 3$. Also denote the members of $|A_i|$ by a_i, b_i and c_i. For every $i < n$, use the machine for $\{a_i, b_i\}$ and $\{a_i, c_i\}$. Since there are only two 0.5-gr coins, if the result of both sums are integers then a_i, b_i and c_i are 1-gr coins. In this case call A_i a "`perfect" set. Otherwise you can partition A_i into two nonempty subsets $A_{i,1}$ and $A_{i,2}$ such that $|A_{i,1}| = 2$ and the coin in $A_{i,1}$ has different weight from coins in $A_{i,2}$. In this case define A_i as an "imperfect" set.*
   - *If at these $2n - 2$ steps, Illich finds out that he has two imperfect sets, namely A_i and A_j, then he can conclude that $A_{i,1}$ and $A_{i,2}$ contain the 0.5 gram coins.*
   - *If at these $2n - 2$, Illich finds only one imperfect set, namely A_i, then by checking a member of a previously determined perfect set by a member of this imperfect set he can compute the weight of the coins in the imperfect subset, and thus he can find at least one 0.5-gr coins.*
   - *If none of the above cases occur, then A_n has two 0.5-gr coins and a 1-gr coin. So by using a machine one more time for a_n and a member of a perfect set he can find a 0.5-gr coins.*
2. *To obtain a contradiction assume that Ilich has an algorithm which can solve the problem by less that $2n - 1$ steps. Also Assume that the magic machine at all steps shows integer sums. Construct a simple graph G which has $3n$ vertices which represent the coins and two coins are adjacent if and only if at one step Ilich use the coins to check sum of this two coins; Thus G has less than $2n - 1$ edges. Assume G has r connected components with $a_1 \le \cdots \le a_r$ vertices. Denote the set of coins of each component by $S_1, \ldots, S_r$; Note that $|S_i| = a_i$ for every $0 \le i \le r$. Now since every component with t edges has at least $t - 1$ edges so r is at least $3n - (2n - 2) = n + 2$ components. So since $\sum_{i=1}^{r} a_i = 3n$, one of the followings cases occur:*
   - *$a_1 = a_2 = a_3 = 1$. In this case every pair of these three coins may be the two 0.5 gram coins and ilich can not guarantee the correctness of his algorithm.*

- $a_1 = a_2 = 1 < a_3$. *In this case since* $\sum_{i=1}^{r} a_i = 3n$ *and* $r \geq n+2$, a_3 *should be equal to two. So both coins in* $S_1 \cup S_2$ *and both coins in* S_3 *vertices can be the pair of the two 0.5-gr coins.*
- *If* $a_2 > 1$ *then we have* $a_2 = a_3 = 2$. *So there are two scenarios that Ilich can not distinguish between them. First scenario is that coins in* S_2 *are 0.5-gr and all other coins are 1-gr coins. Second scenario is that coins in* S_3 *are 0.5-gr and all other coins are 1-kg coins.*

So Ilich can not guarantee that his algorithm works which of course is a contradiction.

A sample multiple-choice problem. *Suppose that we have a table where* 0 *or* 1 *is written in its each cell. The set of four cells being in in the intersection of any two different rows and two different columns, and containing* 0 *is called a "Jabali" group. Also the set of four cells being in the same row and containing 1 is called a "Soltani" group. What is the maximum positive integer* n, *such that there is an* $n \times n$ *table with no jabali group and no soltani group?*

1) 4 2) 5 3) 6 4) 7 5) 8

Solution to the sample multiple-choice problem. *The answer is* 5. *See below table for* $n = 5$:

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
1	0	0	1	1
1	1	0	0	1

Now we prove that no such table exists for $n > 5$. *For the sake of contradiction suppose that* $n > 5$, *and there is a table not containing any Jabali or Soltani group. In each row there must be at least* $n - 3$ *cells with number* 0. *Thus, there are at least* $n \times \binom{n-3}{2}$ *pairs of* 0 *cells, such that the cells of each pair are in the same row. We have* $\binom{n}{2}$ *pairs of columns in the table. Since* $n > 5$, *we have* $n \times \binom{n-3}{2} \geq \binom{n}{2}$, *and according to the pigeonhole principle there are at least two same pairs of columns that have number 0 in their cells and a Jabali group is found. This contradicts our assumption, and therefore the proof is complete.*

The Third Round

The third round of INOI is an onsite programming contest which aims at evaluating contestants' programming and problem solving abilities, without requiring any background in formal algorithms. By holding this annual contest, the INOI committee tries to encourage students to get more familiar with computer programming before the summer camp, so that this camp can be more focused on principal computer science theory concepts. This contest is designed as a filter to eliminate the students with insufficient experience in computer programming, rather than a contest to identify the best students. Around top 80 students from the 2nd round are eligible to participate in this contest and about 40 of them will be qualified for the INOI summer camp.

The contest is held in two consecutive days and each contest consists of 3 tasks, each divided into 3 subtasks. The tasks are batch problems and do not require any I/O interaction. In addition, there are no time or memory limits for each task. The answer to each subtask is an integer number. To prevent cheating, a unique prime number is assigned to each contestant and the answer to each subtask is a function of this number. An online judging system is provided to the contestants to validate their answers instantly. Each contestant can use the judging system at most 20 times for each subtask. The first subtask of each task is usually solvable using a very simple program or even by hand. The second subtask is solvable without complex algorithms, usually by just brute forcing the problem space, and the third subtask requires finding an optimal solution for the problem. Below we present a sample problem from the past 3rd-round exam.

A sample problem. *Assume that* $\Delta = 19913$. *We call a pair of integers* (a, b) *k-friendly if and only if* a *and* b *have exactly* k *common divisors. For example, pairs* (3, 9), (10, 14) *and* (9, 3) *are three different 2-friendly pairs. We also call a pair* (a, b) *less than* C, *if and and only if* $a < C$ *and* $b < C$.

1. *Define* A *as the number of 1-friendly pairs less than* Δ. *What is the remainder of* A^4 *divided by* Δ?
2. *Define* B *as the number of 48-friendly pairs less than* Δ. *What is the remainder of* B^4 *divided by* Δ?
3. *Define* C *as the number of 48-friendly pairs less than 12299390. What is the remainder of* C^4 *divided by* Δ?

The Summer Camp

The most intense and important program of INOI is the summer camp. Students who advanced to this program, come to the country's capital Tehran from all over the country and live together for almost three months. All students who participate in this program receive a medal at the end of the summer; the top 8 students receive a gold medal and later participate in more training programs. The rest of the students receive silver and bronze medals.

The summer camp is very similar to a school of computer science. Four main courses are always included in this program, namely C++ programming, algorithms, graph theory, and combinatorics. In addition to this, an additional short course is added to the program. The goal of this short course is to make students familiar with a more advanced area of computer science. Each course has its own instructor and grading policy.

During the summer, many classes are held for each course and students are evaluated in the mid-term and final exams. Apart from this, every week there is a theoretical exam to evaluate the overall problem-solving skill of the students. Moreover, as students learn more about programming languages and algorithms, we hold some programming exams most of which have either two or three problems and last for five hours. The problems are relatively easier than IOI, since the students are new to programming, but as we approach the end of the summer, the programming exams intensify and get harder.

At the end, based on some written exams and programing exams students are ranked; the first top 8 students get a gold medal (Fig. 2), the next top 16 students get a silver medal, and the rest get a bronze medal.

Fig. 2. Gold medals!

The Gold Camp and the Team Selection

All 8 gold medalists of the summer camp enter the gold camp; 4 of whom will eventually participate in the IOI. The gold camp starts at the beginning of Fall and usually ends before Spring when the team-selection contests are held. In contrast to the previous training camps, the main focus of this program is on the algorithmic and programming problems. Most of this training program is online, though a few 1-week long camps are usually scheduled for onsite classes and midpoint evaluations.

In the online training camp, several problems are selected from various online programming platforms such as Codeforces, SGU, Topcoder, etc., and given to the student as weekly assignments. The students have a limited amount of time to solve the problems and submit their solutions to an online judge. They're encouraged to have discussion sessions and collaborate to find the solutions, however, students have to write their codes individually.

Students get their grade after the deadline for each assignment. These grades are not incorporated in the final team selection criteria, however, if a student exhibits a poor performance on the assignments, based on the decision of the INOI committee, he might be penalized or even disqualified from participating in the final team selection contests.

Every month, a 1-week onsite training camp is scheduled for the students both for educational and evaluation purposes. These camps are held and accommodated by YSC. The main focus of these camps is on training classes, mostly instructed by former INOI medalists. In addition to this, most onsite camps feature one or two programming exams to monitor the progress of the students. The results of these exams are incorporated in the final team selection process.

Following the training camps come the team selection contests. A few weeks before Nowruz (Iranian festival of spring), students come to Tehran to participate in these contests. The number of contests varies between 3 to 5, based on the decision of the INOI committee. The format of each contest is similar to the IOI contests. Each contest consists of 3 programming problems, designed by the committee and lasts for 5 hours.

The Team Training

The students who advanced to the IOI participate in a spring camp to further practice for the IOI. The main goal of this camp is to ensure that the syllabus of IOI is completely covered. The IOI team also get more familiar with advanced algorithms and data structures, not necessarily included in the IOI syllabus. This camp takes place in YSC and continues until the IOI contests. The format of this camp is based on practice contests. The team take at least 3 practice contests, in the same format as an IOI contest, every week. The contests are selected from the previous IOIs and the most recent CEOI and BOI contests. After each contest, the committee holds discussion sessions for each contest.

Fig. 3. Iran team in the IOI 2015.

Another important part of this camp is inviting former IOI medalists to share their experiences about the contest environments and unexpected things that can happen in the IOI contest, with the new team. Interestingly, these experiences have proven to be useful for the members of the new team and helps them to prevent common mistakes, caused by stress of the contest and the new environment that the students are put in.

M.A. Abam is a faculty member of the computer engineering department at Sharif university of Technology. He has been the chair of the INOI committee and team leader of Iran at IOI since 2011. He is also chair of the IOI 2017.

A. Asadi is a computer engineering student at Sharif and a member of the INOI committee. He is also a coach and problem maker at the INOI summer camps.

A. Jabal Ameli is a Sharif computer engineering graduate and a member of the INOI committee. He is also a coach at INOI summer camps, he used to be the deputy leader of Iran at the IOI 2016.

S. Seddighin is a Sharif graduate and PhD student at the University of Maryland and used to be a member at the INOI committee. He is also a silver medalist at the IOI 2007 and a Sharif team member at the ACM/ICPC in 2009.

F. Shahmohammadi is a software engineer at Google and a Sharif and UCLA graduate. He used to be a member of the INOI committee and a coach in the summer camps. He also used to be the deputy leader of Iran at the IOI 2013.

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Kahu and Olympedia: Ideas for Educating Computer Science to High-School Students

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1. Introduction

There is an unbalanced geographic distribution of IOI medal winners in the world. There are geographic regions and countries with tens of gold, silver, and bronze medals, while some other regions have lower success rates (Fig. 1).

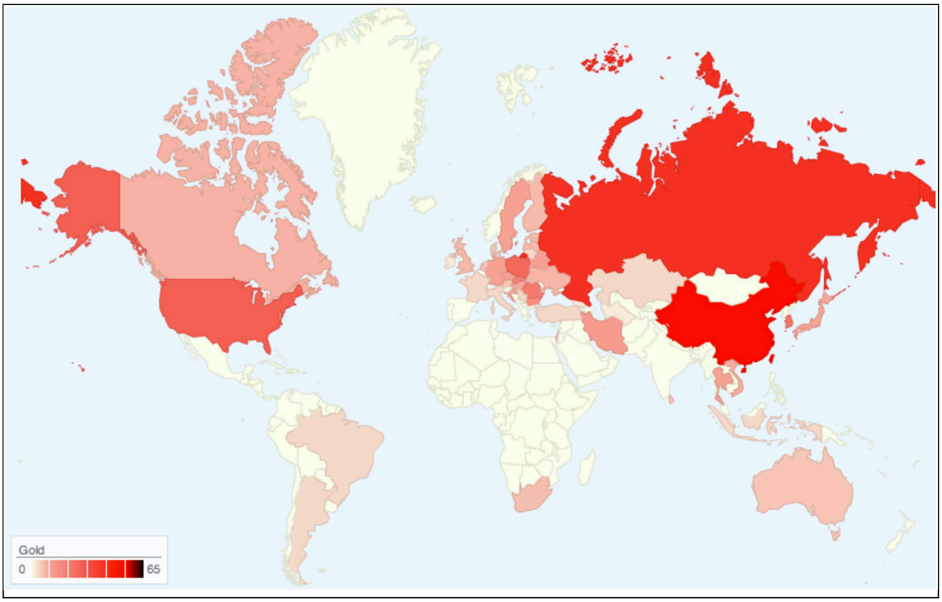

Fig. 1. Geographic distribution of IOI gold medals by 2014.
Statistics are provided by Mārtiņš Opmanis.

Even in a single country, there might be some cities – such as capitals – in which a majority of medal winners of that country are raised, whereas some other cities have not achieved good ranks in the national computer science competitions (Fig. 2). Similarly, the development of computer science in research, education, industry and its effects in human life is biased towards certain geographic regions in the world or perhaps certain cities in a country. Many parameters are involved, namely unequal distribution of human population, different economic states and industrial levels. But a very important parameter is the quality of computer science education among high school and university students. There are cities with many experienced teachers, training camps, computer sites, libraries with related books, etc., while other cities might have lower access to these resources.

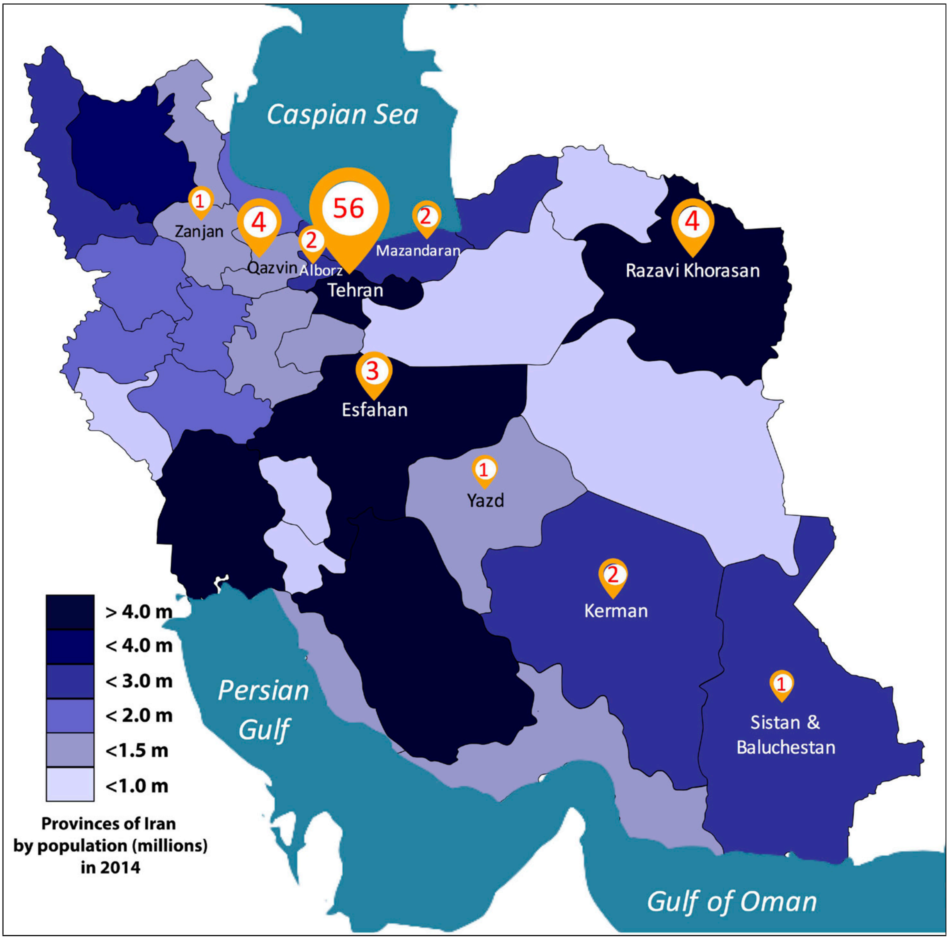

Fig. 2. Geographic distribution of Iranian students who passed Round 2 selection exam of National Informatics Olympiad.

In the scientific committee of the National Iranian Olympiad in Informatics (INOI) we aimed since several years ago to reduce the gap between students of different Iranian cities in their access to the useful material. There were several programs including publishing paper magazines for scientific Olympiads and sending teachers, mainly previous IOI or INOI medal winners, to the cities far from the capital. But these programs were effective for limited audience.

In the recent years we started several programs to provide useful material online. We found these programs effective for the broader range of audience, at any time, in any city.

2. Kahu

Kahu is the first social network of computer science, INOI and IOI-style problems in Persian language. The word "Kahu" – Persian translation of "lettuce" – was selected after a famous sheep character in the children TV series who loved to eat lettuce. It was developed voluntarily by two students, Ali Babaei – an IOI double gold medalist – and Javad Abedi – an INOI medalist. The central idea of Kahu is very similar to StackOverflow.com or other StackExchange-style websites: each user can ask or answer questions. The related topics of each question are tagged by the user who post the question. The question tags can be also edited by Kahu admins.

Both questions and answers can receive up- and down-votes, which will change the "credit score" of the user who has posted it. Based on outstanding activity, such as asking a popular question (that is visited many times) or posting an answer that is up voted many times, users can receive multiple bronze, silver or gold medals. Our experience shows the badges and credit score can boost the activity of a group of users.

Kahu used StackOverflow.com style platform, because it enables students to answer themselves questions, which eliminates need of active teachers to respond questions. It was launched in 2014 and since then about 1000 users registered on the platform and posted 1900 questions, 2500 answers and 17000 comments. Traffic spikes around First-Round and Second-Round INOI exams. These rounds of exams are mostly theoretical and students usually ask for the answers of questions in previous and current year exams.

Based on our experience there are different groups of users that visit Kahu website. Some users are high-school students who are actively learning informatics Olympiad and want to take part in INOI. There are a few professional teachers of informatics Olympiad who also actively post questions and answer the questions of other users. These two groups of users are active on Kahu for different motivations. There are also other users who visit Kahu without posting new questions or answers on it.

While learning new questions and the way to solve them is the main motivation for the contestants, the teachers are mostly active because they think it is a constructive way to spend time online, to help others or perhaps to advertise themselves. But we think the credit scores, medals and other badges that are presented to active users are also a very important motivation for many users. Although badges and credit scores have been very effective, there have been also some side-effects, such as serial voting or register-

Fig. 3. The main page of Kahu.

Fig. 4. A posted question and its answers on Kahu.

ing multiple users by the same person who vote the same posts, in order to influence the credit of the same or other people.

Another challenge was to train users select good titles for questions they post. Titles are very helpful for users to visit interesting questions or while looking for a particular question. Many users preferred to select a short title for their questions. Even setting a minimum length for the title was not a perfect solution, since some users padded titles with some characters such as "!" or "?". More effective strategies were to advertise selecting good question title as a culture of using Kahu, actively editing titles by admins, and posting constructive comments by senior users to ask better title for the questions posted by new users. Hence active administration of websites like Kahu by senior users or teachers is very important.

3. Olympedia

Olympedia is the first online encyclopedia of computer science topics in Persian language (Fig. 5). The name is selected by combining Olympiad with Encyclopedia. It is mainly developed by Hamid Zarrabi-Zadeh, a member of the INOI scientific committee and the chair of the host technical committee of IOI 2017. It works on a wiki platform,

Fig. 5. Snapshot of Olympedia website (www.opedia.ir).

and is targeted for educating high-school students. The contents of Olympeida are freely accessible to read, but editing them and adding new pages are restricted for the members of INOI scientific committee and the teachers of Olympiad.

This website contains a brief introduction to the essential concepts of discrete mathematics and computer science, including graph theory, combinatorics, mathematical reasoning techniques, data structures, and algorithms. It also provides access to a unique resource of theory and practical tasks that have been used during 26 years of the INOI. Table 1 shows the contents of Olympedia.

Olympedia is based on the dokuwiki open-source platform, equipped with several new features essential for the educational nature of the project. A key feature of Olympedia is its enhanced markup language that facilitates embedding special contents such as solutions to the samples and problems presented in the text. There is also an option for

Table 1

Contents of Olympedia website (`opedia.ir`) and the structure of the national Olympiad in informatics in Iran

Topics	Sections	Subsections and additional information
Learning Informatics Olympiad	Combinatorics	Counting, Permutations, Inclusion-exclusion principle, Proof techniques, etc.
	Graph theory	Graphs, Trees, Connectivity, Directed graphs, Eulerian tours, etc.
	Algorithms	Sorting, Simple data structures, Recursive algorithms, Divide & Conquer, Dynamic programming, etc.
	Programming	Variables, Control statements, Loops, Arrays, Functions, STL, etc.
	Advanced algorithms	Fenwick tree, Interval tree, Segment tree, Big numbers, Maximum flow, etc.
	Getting ready for the Olympiad in informatics	Good strategies for solving tasks of each round, writing correct proofs, etc.
About Informatics Olympiad	Different rounds of the contest	General info about the structure of each round of the INOI
	Results of Iran team in the IOI	Medal winners and leaders of Iran team in previous IOI's
	Members of the National committee	List of 17 current and 38 past members of INOI National Committee
	Assistants of the National committee	List of students who assisted the INOI National Committee over past 15 years
	Contestants	List of INOI medal winners during past 25 years
	Useful websites	Links to Persian and international programming contests
Tasks of former Olympiads	Round 1	Multiple-choice exam with ~ 30 combinatorial questions
	Round 2	2 days: ~ 25 multiple-choice questions + 4 theoretical (algorithms, theorem proof) tasks
	Round 3 (Programming)	2 days IOI-style simple programming contest
	Summer camp	Almost 8 weeks of courses & exams in combinatorics, graph, algorithms and programming
	Team selection camp	Winter course to select four IOI team members among eight INOI gold medalists
	Contests archive	The archive of tasks from past 27 years of INOI

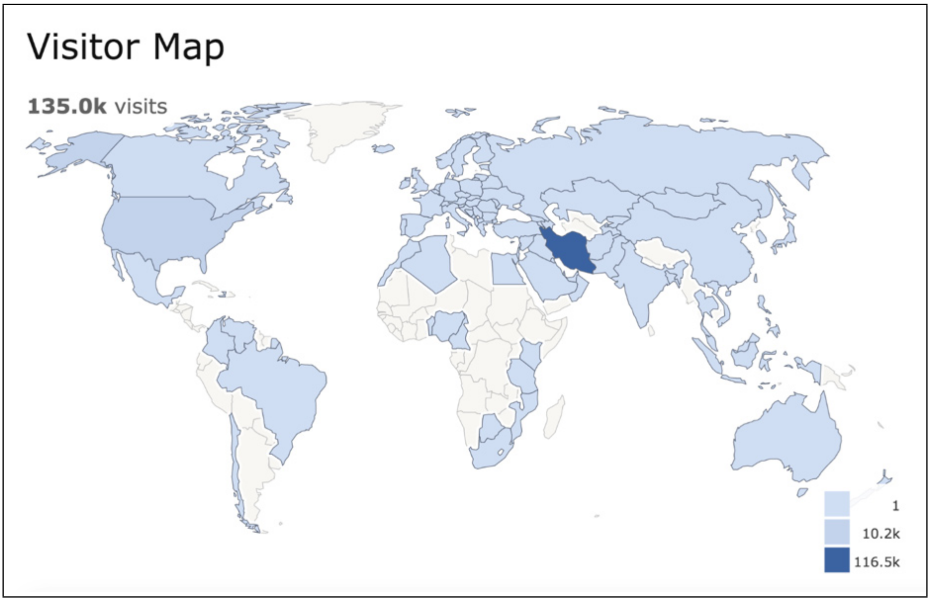

Fig. 6. Geographic distribution of the Olympedia visits over the past year (June 2016 – June 2017).

providing “hints” to the students, before displaying the complete solution. There is also a judging system embedded into the system, which provides a handy tool for presenting programming tasks in Olympedia. In particular, students can send their programs to be judged against the stored data sets, or simply send the result of their programs in the output-only model.

Since its launch in 2014, Olympedia has served a large group of students. Just over the past year, Olympedia has been visited more than 130,000 times. The distribution of the visits is illustrated in Fig. 6.

4. Conclusions and Future Work

Here we presented two platforms of online, free and public education of computer science and informatics Olympiad topics and problems to Persian-speaking students: Kahu and Olympedia. Kahu is open for all students to post new questions and answer the questions of other users. But the pages of Olympedia, as a reference, are created by trusted teachers, medal winners and members of INOI scientific committee. We also aim to use novel ways to educate highschool students. An effective way is to teach simple topics of computer science, capture videos and publish them online and free. For this purpose, the INOI scientific committee has asked some websites who offer vide captured online courses to prepare proposal for contents. We hope these resources, along with public contests such as Bebras, will help to educate more students.

A. Babaei is an IOI double gold medalist. He is a Sharif graduate and co-founder and CEO of Torob, biggest shopping search engine for Iranian online stores in terms of data and user. Together with Javad Abedi he launched Kahu as his capstone project.

H. Zarrabi-Zadeh is a faculty of computer engineering at Sharif University of Technology. He has been a member of the International Scientific Committee (ISC) from 2014 to 2015, and a member of the International Technical Committee (ITC) since 2015. He is the chair of the IOI 2017 Host Technical Committee (HTC). He is also director of the ACM/ICPC in the west Asia region (Tehran site).

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Informatics Contests in Iran

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A series of informatics contests is held in Iran annually for students in various age groups. The main object of these informatics contests is to motivate and attract students to problem solving, algorithmic thinking and programming in an extra curriculum fashion.

Contests are being held both in school and college levels mainly in a teamwork but in some of them individuals also can compete.

We briefly describe and introduce some of these contests.

1. Iranian National Olympiad in Informatics

Started in 1991, the Iranian National Olympiad in Informatics (INOI) is simply the oldest nationwide informatics contest in Iran. Besides promoting informatics and computational thinking among school students, the contest serves as the main process for selecting Iranian teams to participate in the IOI. The contest has several rounds, all organized by the Young Scholars Club, a national entity responsible for organizing scientific Olympiads in Iran. More than 4,000 students from grades 10 and 11 participated in the first round of INOI in 2016.

2. HelliNet

HelliNet is a nationwide programming contest aimed at promoting and enhancing problem solving and programming skills among school students in Iran (Fig. 1). Initiated in 2005 by Allameh Helli high school (Tehran, Iran), the contest is now one of the biggest on-site programming contests in Iran.

There are two tracks in the contest, one for students in grades 7 to 9, and the other for grades 10 to 12. The contest is team-based, with each team consisting of two students.

Fig. 1. HelliNet has attracted many students.

More than 160 teams participated in the 10th HelliNet contest in 2016. HelliNet is very popular among high school students.

3. Bebras

Bebras is an international initiative for promoting computer science (informatics) and computational thinking among school students at all ages (www.bebras.org). Initiated in 2004 in Lithuania, the community now includes over 50 countries. Iran joined the Bebras community in 2014, and organized the first official Bebras challenge in 2015 via Fatemi Cultural Institute. Almost 3,000 school students participated the first challenge in five groups, ranged from grade 3 to grade 12.

Fig. 2. Logo of Bebras in Iran.

4. Bayan Programming Contest

Initiated in 2012, Bayan is an international programming contest held by Bayan software company in Iran. More than 10,000 contestants from 103 countries participated in the third Bayan Programming Contest in 2014–2015. Bayan Programming Contest is a three rounds contest such that two first rounds are online and final round is hosted by Bayan Company. The contest has been an attractive target for students from all age groups, with a ranking page particularly devoted to school students.

Fig. 3–4. Moments from the Bayan, a worldwide contest.

5. ICPC Tehran Site

The ACM-ICPC is one of the oldest programming contests in the world for the college students. Since 1998, Tehran has served as one of the official sites for the ACM-ICPC in the west Asia region, hosted and organized by Sharif University of Technology. Over

Fig. 5. ACM-ICPC has attracted many college students

the past 18 years, 36 Iranian teams have been qualified to the ICPC World Finals from the Tehran site, with their best result being the world finals silver medalist in 2001. Besides being a main target for IOI medalists in Iran, the Tehran Site also organizes several satellite Internet programming contests, in which school students actively participate and compete.

6. Community of Problem-Solvers

Informatics contests have developed a community of problem solvers and algorithmic thinkers' nationwide. Some of them have been attracted to computer science, mathematics and engineering which have joined as sophisticated programmers and developers in software companies and some of them have gone for graduate studies and are prominent faculty and researcher.
That is the way it is…

H. Zarrabi-Zadeh is a faculty of computer engineering at Sharif University of Technology. He has been a member of the International Scientific Committee (ISC) from 2014 to 2015, and a member of the International Technical Committee (ITC) since 2015. He is the chair of the IOI 2017 Host Technical Committee (HTC). He is also director of the ACM/ICPC in the west Asia region (Tehran site).

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Iranian Market for Computer Programmers

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1. Introduction

Iran growing knowledge economy is in demand of computer programmers and provides various opportunities for them. Internet penetration in Iran has already reached over 82%, while mobile penetration is above 100% with almost 50% smartphone users (see References). These figures indicate a growing market for software developers and computer programmers.

Advanced software technologies, both for web and mobile applications, and also technologies for back-end developments are vastly employed. Infrastructures in the form of data centers and cloud computing are also provided. More tools are available for application development, such as Farsi add-ons for localization and payment systems with debit cards through banking platforms. Web or mobile applications mostly address the needs of local market, but there are also global interests in some of the software products and applications.

We will look at the ecosystem for high tech startups which are the main marketplace for computer programmers. We will also look at the programmers' lives, and the conclusion will show more facts about the programming market in Iran.

2. Ecosystem

With the advancement of computer technologies and Internet, computer programming is no longer limited to any particular circumstances. Compared with other scientific skills, it does not require high-tech laboratories, nor long years of education, but professional training for programmers and software developers which mainly takes place in colleges and universities. College graduates have the opportunity to join enterprises or they can develop some preliminary idea and join an accelerator program in a team. There are many running accelerator programs around the country, and as soon as a group of developers are admitted to a program, they will receive some pocket money, but most

importantly, they will receive technical or business mentorship. Within the period of three to six months, they should be able to develop a prototype or MVP (minimum viable product) which they then should test the market and convince investors for investments. Successful groups will establish a startup company and can join an incubator to develop the product and also the market and business model and can move forward.
Among many successful startups in Iran, here are few examples:

- TAP30, a ridesharing company.
- Mamanpaz, a shared food providing platform.
- Netbarg, a marketplace for local merchants by offering goods and services.
- ESTD, provides a Three-Phase, Black Oil Reservoir Simulator.
- Cafebazaar, leading Android app marketplace.

Startup movement is growing in Iran: some logos

3. Programmers' Life

There are many examples of contribution by young programmers, in developing life changing software products. As we're witnessing in Iran, the average age of software companies' developers has dropped significantly during the last decade. Our experience shows that top-notch programmers start their journey into the world of programming from high school years. Their self-trainings at high school years make them highly qualified developers at their early 20s and eligible to take significant responsibilities in the industry.

For Iranian students, there are different paths to develop programming skills, such as participating in Informatics Olympiads or robotics contests. In the case of Informatics Olympiads, for example, students go through tough trainings that improve their systematic problem solving skills. They are trained to firstly define problems well, break them down into simplest forms, and prioritize and implement solutions.

Those early trainings, alongside some incentives provided by the government to foster programming skills among youth, have resulted in advancements of software and internet industries in Iran. The participants of Informatics Olympiads are now playing crucial roles in the market in a variety of fields ranging from artificial intelligence and machine learning, image processing, natural language processing, computer networking, data security, to management and finance.

Iranian companies are competing over attracting these talents by providing dynamic work environments. Due to their outstanding abilities, most startups and enterprises' strategies have been to provide an environment to flourish their creativity for innovations. They construct innovative teams, learn from each other, complement each other, rise ambitious spirits in the teams and make decisions collaboratively toward their self-envisioned goals. The regulators have been supportive to young programmers who plan to follow their careers in knowledge-based companies by providing facilities through Iran's National Elites Foundation.

4. Conclusion

Iran is among the top 20 countries by population with a dominant young generation, and provides attractive market for software and internet products. Special situation of Iran's economy has led to opportunities to build domestic solutions in ecommerce and other Internet based services. This sector has grown relatively faster than other sectors of economy due to lower barriers to entry and infrastructure requirements. International companies have been reluctant to compete in this market for years and that made an opportunity for local players to win in the long run. A wide variety of untouched areas are available to look into. Due to this fact, a growing number of students plan to study related sciences in technical universities and management schools. A highly qualified talent pool is expected in the future of internet industry in Iran and needs further considerations by regulators.

For the participants of Informatics Olympiads, professional future is bright. To complement what they've learnt so far, they need to utilize their skills to solve real world problems. Types of problems that are too big for any of us to encompass all its aspects individually. Team working is crucial and communication and leadership skills make distinguished engineers. In Iran, there has been less emphasis on developing such skills in universities and schools. That makes it the role of companies and individuals to fill the gap between formal education and skill needs of the market. Despite the conventional idea that most of educational and training courses are not applicable in real world, our experience shows the contrary. Informatics Olympiad has been and will remain constructive toward building future of Iran's development in this specific industry.

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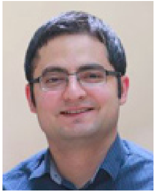

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Robotics in the Iranian Schools

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Introduction

It is almost two decades that robotics has attracted many students in the Iranian schools to envision creativity and innovation. Science, Technology, Engineering and Mathematics (STEM) are essential to empower youth with innovative and critical thinking. Extra-curricular and project-based learning can attract more students to STEM beyond formal education and prepare them to be deep thinkers and problem solvers. It brings also an opportunity for youth to develop their own knowledge and have chance to become innovators and researchers.

Robotics are phenomenal for this target, we will present a brief survey about robotics in the Iranian schools, how it started and its most important advancements.

Robotics e-Club at Schoolnet

Schoolnet established under the supervision of Sharif University of Technology in early 2000s as a school portal to empower youth in the information era. Schoolnet was a pioneer to support development of information technology in the Iranian schools and provided e-contents and a teamwork platform for students and teachers. Schoolnet mainly was focused on STEM education through e-Clubs as sub-sections on the portal, to support project-based and collaborative learning. e-Clubs covered various subjects but robotics was essential since attracted many students to the new concept.

A pathfinder robot designed by the schoolnet partners, and kits provided for more than 100 schools. Robotics team of each school included 3, 4 students assembled robots and the challenge was how to tune them for better performance. In an independent robotic fest at the Sharif University, all students gathered and a contest between pathfinders motivated them more.

Schoolnet served as a pioneer and attracted many students to information technology and robotics.

Khwarizmi Youth Science Fair

After success of schoolnet in bringing robotics to schools, Tehran Education Department (Ministry of Education) considered robotics as an extra-curricular activity for the school kids and provided training sessions either in programming and simulation or physical robots. Training for simulation included programming in C++ and graphics libraries. Also training in mechatronics for physical robots.

Later on, many other schools nationwide considered robotics as a mean of hands-on learning to support STEM and advancements of information technology.

More development happened and some Robotics team of high school students participated in the international RoboCup leagues in football and rescue. They participated either with physical robots or in simulation, successes motivated schools and students more and more.

Fig. 1. Football Simulation 2D.

Fig. 2. Football Simulation 3D.

In later years, Khwarizmi Youth Science Fair, considered robotics as a major field and attracted more students. Khwarizmi Youth Science Fair is an annual event focused on STEM and students across the country participate in a two round contest. Students submit their own projects to the local fairs across the country and selected projects can compete in the final round. In robotics they considered different branches such as:

- Rescue Simulation.
- Football Simulation (2D and 3D).
- Junior Football (1-on-1, 2-on-2).
- Mine detection robot.
- Rescue robots.

For few year robotics were the heart of the Khwarizmi Science Fair and many students nation-wide in team-works motivated to work on robotics and attracted to STEM as well.

The wheels were on the road! Many robotics club and contests organized throughout the country and many students attracted to robotics.

Fig. 3. Repairing the program for the contest.

Fig. 4. Preparation for the contest.

Fig. 5. Robotics is attractive for all ages.

Fig. 6. Pathfinder contest.

Sharif NAD Cup

Robotics and technology clubs and competitions have been organized and are very active across the country but one of the most successful one is the Sharif NAD Cup which is under support of Sharif University of Technology. Sharif NAD Cup is a science and technology competition which has been organized by the NAD Company.

A group of young talented scientists and educators are founders of NAD Co. The company is focused on STEM education for K12 through training workshops and contests.

Various subjects such as microelectronic, robotics, physics, chemistry, biotechnology, nanotechnology and etc. are under coverage. The approach is beyond curriculum in subjects such as physics and chemistry but being pioneer in new concepts as nanotechnology, robotics and etc. The company organizes workshops by requests from schools but organizing science fair and contests are essential, almost 2,000 students participate in the science fair annually.

Robotics still is the point of attraction for the Iranian students in the science fair. The participants are in different age groups and through various rounds they compete and can reach to the final round.

Robotics has been considered in various forms such as football leagues or robot fighters. Robotics team through different levels as elementary to higher levels compete in rounds and winners are recognized nationwide by receiving the Sharif NAD Cup.

Fig. 7. Sharif NAD Cup, Science Fair.

RoboCup IranOpen

RoboCup is an international research and education initiative[1]. It is an attempt to foster artificial intelligence and intelligent robotics research by providing a standard problem where wide range of technologies can be integrated and examined, as well as being used for integrated project-based learning. For this purpose, RoboCup chose to use football game as a primary domain, and organizes RoboCup.

Iranian teams have been an active participant of RoboCup events since 1998. College and school teams can apply for participation by submitting a research paper to RobCup and qualified teams will receive admission for participation. The number of

Fig. 8. IranOpen Football League.

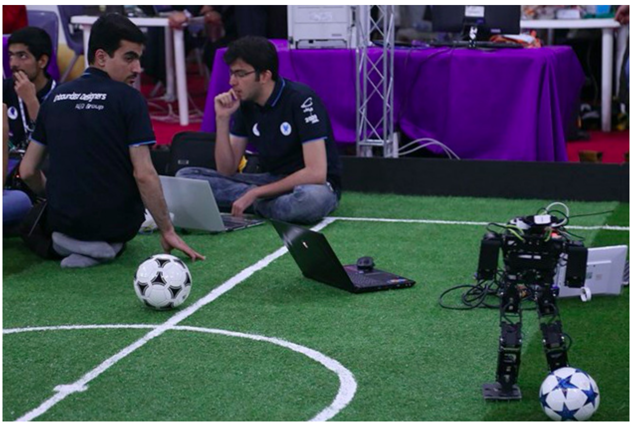

Fig. 9. IranOpen 2017, repairing programs.

[1] http://www.robocup.org/

Fig. 10. IranOpen 2017, more advancements.

Iranian teams has been largely increasing over the past years. Thereby, the need to have a regional event seemed rather necessary. Furthermore, since the overall number of world interested teams in RoboCup has increased; regional events may and can be a proper field for RoboCup leagues. Technical committees to observe team's qualities for RoboCup world competitions qualifications.

IranOpen is a place for teams willing to take part in RoboCup world competitions in order to show their qualities and standards. It is also a place for fresh teams to gain experience and become ready to join the world class teams. RobCup mostly has attracted college students but high school students also have had chances to participate.

Robotics and Artificial Intelligence in Schools

Artificial Intelligence (AI) considered by what so called "Turing Test" and the idea was that a computer could be said to "think" if a human could not recognize it through conversation. It started with some game development such as chess playing by computer but more advancements have enriched AI in the last decades. Increasing the computing power and more developments in Virtual Reality (VR), Augmented Reality (AR), Chatbots and etc. are break through for artificial intelligence.

Artificial Intelligence is essential for new advancements in science and technology and must be reflected in K12 education properly. Robotics is a true mean of AI for school kids and can attract youth to STEM and computer programming and can open new doors in education.

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Isfahan Mathematics House

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The first mathematics house established in Isfahan (Iran) through the cooperation of some Iranian school teachers and university faculties since 1999 (Barbeau *et. al.*, 2009). Currently, there are more than 30 mathematics houses across the country and also more mathematics houses have established in France, Belgium and etc. Recently an international network of Mathematics Houses has been organized at the 13th International Congress of Mathematics Education in Germany in 2016 to foster more international collaboration.

Here, we briefly introduce the mission and activities of Mathematics Houses in Iran but mainly we are focused on the Isfahan Mathematics House as a case study.

Fig. 1. Beauty of mathematics!

A Learning Environment

Mathematics House is an innovative learning center focused on mathematics and informatics education but in a non-curricular way. It is a place for experimental learning through workshops and projects, and subsequent reflection in showcases and mathematics festivals. One prominent example is Isfahan Mathematics House, a center of excellence as a learning environment (Barbeau *et. al.,* 2009, Challenging Mathematics-UNESCO, 2012).

Mathematics house is not in a one-path trail; the environment is designed to foster richer and deeper interactions than the ones commonly seen in schools (Karmzadeh, 2012). It is a learning environment utilizing teamwork and collaboration, where learners create ideas in the form of collaborative projects and interacting genuinely, since their mathematical works belong to them and are related to real life. Part of the fun is sharing projects, allowing modification and experimentation across projects and teams. Mathematics house is instances of some new and successful form of organization for learning that might emerge out of a new culture. It can be considered as an infrastructure that reduce teaching-learning weaknesses in mathematical sciences, for both teachers and students (Rejali, 2007).

Some of the main goals of mathematics house are: popularizing and developing awareness of mathematical sciences including informatics, expanding mathematical sciences among youth, encouraging team work, supporting interdisciplinary research, studies in history of mathematics, developing skills of problem solving and algorithmic thinking (Rejali, 2009).

These goals are achieved through procuring facilities for non-conventional education, introducing new instructional techniques, encouraging joint and collaborative researches, and welcoming relevant novel ideas.

As an instance, the Isfahan Mathematics House is equipped with some game rooms, mathematics laboratory, a studio for producing audio books for the blinds, a rich library, impressive number of activities such as general expository lectures and workshops, summer camps and annual festivals, teamwork competitions, e-competitions, and developing digital contents.

Information and Communication Technology is an effective tool for developing an attractive environment for mathematical learning. Using this tool, one can develop a platform that many complex concepts can be visualized by diagrams and figures, attractive animations, and most importantly, making games and parametric applications to provide mutual interactions between learners and teaching media, such that they can change the parameters and see the results in figures or in the process of the programs and much easier understand the concepts. Isfahan Mathematics House has organized teams of mathematics educators, mathematicians, scenarists and storytellers, artists, programmers and multimedia experts to collaborate and generate innovative educational contents (Behrooz, 2006).

Also Informatics also is a major domain of activities in the Isfahan Mathematics House which explores in the form of training sessions and workshops, teamwork proj-

Fig.2. Children at Workshop.

Fig. 3. Mathematics Workshop.

ects, contests and festivals and a very special one is informatics to empower visually impaired people. In next section, we will present briefly some of these activities.

Roads to Innovative Learning

Isfahan Mathematics House is focused more on experimental aspect of mathematics rather than theoretical ones. So, computing features of mathematics including data sciences, statistics, discrete mathematics, algorithmic thinking, practical techniques of mathematical modeling, and exposing mathematical concepts are more brilliant. Isfahan Mathematics House learning environment develop opportunities for training in problem solving and critical thinking beyond formal school curriculum. Enhancement of creativity and innovation bring joy of learning and develop beauty of mathematics for the youth.

Here are some insightful details of Isfahan Mathematics House programs and activities.

1. **Competitions.** There are diverse models of competitions with different goals. A-lympiad, Tournament of Towns, Mathematics problem solving day, virtual competition of ideation, statistics competition are relevant competitions (Kindt 2009). In most of these competitions, students should make a model and simulate real life problems. Students should be able to inference and analyze data and provide proper ideas. So they should have dynamic, analytical and creative growth mindset.
2. **Workshops.** Many workshops on introduction to mathematical sciences have been running at the house. These workshops goal is to make students familiar with team work and basic concepts of mathematics such as combinatorics, geometry, number theory, statistics and probability, problem solving, mathematical software and computer applications.
3. **Seminars and Lectures.** There are 6 public expository lectures annually and many special talks for special groups of students, teachers and members of the house, as well as the general audiences. In additions, one of the activities of university students section at Isfahan Mathematics House is that students make independent research on different topics and present the results of their findings in seminars.

Fig. 4. Mathematics Workshop.

Fig. 5. Informatics Workshop.

4. **Publications.** IMH has published several books for enhancing mathematical sciences which can motivate the youth for research and doing scientific activities. Educational CDs also has published such as CABRI along covering geometry in the national curriculum and also the *Mathematics City* CD including audio-visual exposition of mathematical concepts.
5. **Visually Impaired Persons.** At the Isfahan Mathematics House, a group of researchers are developing specific materials for teaching mathematics and computer sciences to the blinds. Isfahan Mathematics House has also supported promotion use of ordinary computer among visually impaired persons through audio systems. Isfahan Mathematics House has an important role in manufacturing hardware and software named GOODFEEL, for conversion musical notes in Braille. Isfahan Mathematics House is also publishing audio books for blind people.

Fig. 6. Mathematics for Blinds.

6. **Project-Based Learning.** Learning by doing is an important strategy at Isfahan Mathematics House which is reflected in project-based learning. High school students, college students as well as teachers working on projects in various fields of mathematics and informatics in teamwork and present the outcomes in seminars and festivals also they may publish results as research papers or books.
7. **Summer Schools.** Summers are great time to bring more attraction to mathematical sciences through summer schools which are organized for high school and college students and teachers too. Various subjects in mathematics and computer science are covered in hands-on and project based fashion. Some supporters such as UNESCO has supported teachers summer schools.
8. **Robotics and Artificial Intelligence.** Robotics is an important activity for high school students at IMH including training and hands-on experiences. Trained groups participating in the national and international robotic contests.

Modern Secret

Isfahan Mathematics House established in the year 1999 as a non-governmental organization and gradually developed in more than 30 cities around the country. The Union of Mathematics Houses coordinate relation and cooperation between math houses nationwide. There is also collaboration between math houses and many other associations such as Iranian Mathematical Society, Iranian Statistical Society and Mathematics Teachers Associations.

Isfahan Mathematics House has been recognized internationally by UNESCO, ICMI and some other entities. Cooperation with sister institution also has been established and are emerging such as Fontys Research Institute and Freudenthal Institute in the Netherlands, or in France with the Association Animath that coordinates the diversity of existing non-formal educational activities in mathematics and the Instituts de Recherche sur l'Enseignement des Mathématiques.

Isfahan Mathematics House is of great interest of many mathematicians and scientists who has visited IMH. Jan Hogendijk, professor of history of mathematics at the Utrecht University in the Netherland, in an article (Hogendijk, 2008) has mentioned: Isfahan Mathematics House is a modern secret in ancient Isfahan which encourages mathematics awareness among high school teachers and university students who work together with high school projects.

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Computational Thinking: A 21st Century Skill

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In memory of ***Seymour Papert*** *(1928-2016)*

1. Prologue

Computational thinking is a 21st century skill that is becoming ever-more important in today's increasingly technological world. It should appear formally in the K-12 curriculum, but the inherent vagueness of computational thinking necessitates a long journey to the classroom: contents must be developed under a new pedagogical means and be tested before gradually being incorporated into the curriculum. Training of teachers to adopt the new pedagogical means is also a prerequisite to incorporation. Thus, a faster route to help students could be considering computational thinking as an extracurricular activity, gradually developing and elaborating it, and finally imposing it in the curriculum once a solid framework has been achieved.

In this paper, we introduce the pillars of computational thinking and present practical suggestions, namely computational mathematics and artificial intelligence labs, as platforms for developing computational thinking in K-12. The outlined approach is conceptual and high level – it should not be considered an action plan for the education system, but rather an ideological proposal in need of more elaboration for execution.

2. Computational Thinking Playground

Computational Thinking can be defined as the thought processes involved in formulating a problem and expressing its solution in such a way that a computer can effectively carry out. It is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science. To flourish in today's world, computational thinking has to be a fundamental part of the way people think and understand the world. (Kamvar, 2015). It is essential for school children and should be part of the K-12 curriculum, but we should first consider its roots and the pedagogical model that can be a basis for content development.

The essence of computational thinking is what we can do while interacting with computers, as extensions of our mind, to create and discover (Knuth, 1980). Such a concept was envisioned by Seymour Papert in his book Mindstorms (Papert, 1980) as follows (Fig. 1).

S. Papert focused on two aspects of computation: first, how to use computation to create new knowledge, and second, how to use computers to enhance thinking and change patterns of access to knowledge. More recently, J. M. Wing brought a modified approach and new attention to computational thinking (Wing, 2006) (Fig. 2).

J. M. Wing considers computational thinking as a fundamental skill for everyone's analytical ability along with reading, writing and arithmetic. Wing's paper was welcomed by the community in all levels, especially in K-12, which was highly responsive and began development of applications addressing teenagers, many of which are on the way. We will visit the fundamental ideas of S. Papert but will go to problem solving as a means of instilling CT.

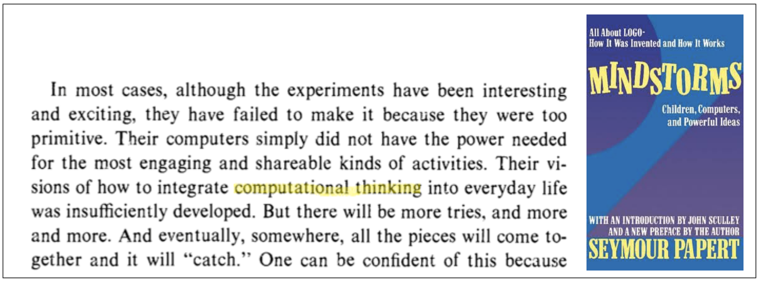
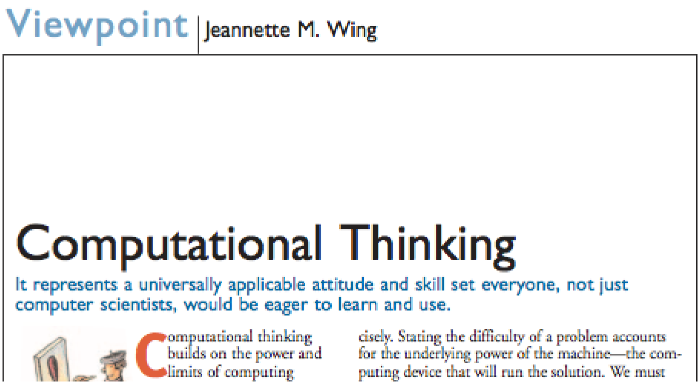

In most cases, although the experiments have been interesting and exciting, they have failed to make it because they were too primitive. Their computers simply did not have the power needed for the most engaging and shareable kinds of activities. Their visions of how to integrate computational thinking into everyday life was insufficiently developed. But there will be more tries, and more and more. And eventually, somewhere, all the pieces will come together and it will "catch." One can be confident of this because

Fig. 1. Computational thinking is a legacy of Seymour Papert reflected in Mindstorms (1984).


Viewpoint | Jeannette M. Wing

Computational Thinking

It represents a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use.

Computational thinking builds on the power and limits of computing

cisely. Stating the difficulty of a problem accounts for the underlying power of the machine—the computing device that will run the solution. We must

Fig. 2. J.M. Wing's paper appeared in the Communication of the ACM in 2006.

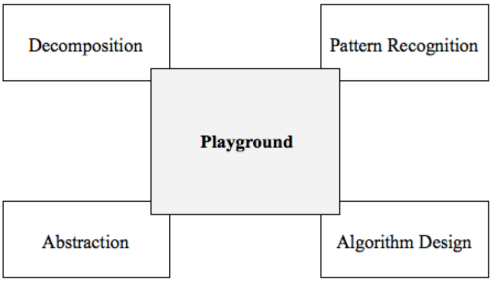


Fig. 3. "Playground" enriches the 4-stages.

S. Papert connected computational thinking and digital pedagogy to the modern approach in education initiated by Jean Piaget. J. Piaget was a developmental psychologist best known for pioneering the learning theory known as constructivism; in brief, he says that learners construct new knowledge in their minds, from the interaction of their experiences with previous knowledge. S. Papert developed the theory of constructivism, adding the notion that the learning is enhanced when the learner is engaged in "constructing a meaningful product."

We consider computational thinking based on S. Papert's enhancement of thinking, specifically with a problem solving approach. Put simply, computational thinking combines critical thinking with computing power as the foundation for innovating solutions to real-life problems.

Computational thinking involves a four-stage problem-solving process as follows:

- **Decomposition**: Analyzing the problem to break it up into smaller parts.
- **Pattern Recognition**: Observing patterns, trends, and regularities in data.
- **Abstraction**: Identifying the underlying principles that generate perceived patterns.
- **Algorithm Design**: Developing step-by-step instructions for solving the problem.

We have enriched and connected the stages with a "playground" as a place for experimental problem solving (Fig. 3). In this model, the playground is an easily accessible place where learners can experiment numerically, geometrically and procedurally by modeling or backtracking in simple or similar cases, all while looking for flows, patterns, symmetry, parity, invariants, recursion, etc. The playground fosters an environment that promotes cognitive learning over force-feeding.

3. Computational Thinking in School

Now that we have established the sense and significance of computational thinking, we must look at how to help these ways of thinking take shape for teenagers in middle and high school. We should consider opportunities to help students after-school as an extra-curricular activity, but we will see how computational thinking may go to the classroom as well (Lee, 2011).

We present some brief ideas to apply as hands-on labs in an extracurricular approach for middle and high school students. Labs are drawn in two domains: computational mathematics and artificial intelligence. Across these subjects we will consider computational thinking as the backbone of problem solving.

3.1. *Computational Mathematics Lab*

Computational mathematics lab is a learning environment focused on skilled mathematics such as discrete math, data science and algorithm design, using computational thinking processes for problem solving. It is a place for experimental learning through workshops and projects, and subsequent reflection in showcases and mathematics festivals. In computational mathematics lab, learners are not in a one-path trail; the environment is designed to foster richer and deeper interactions than the ones commonly seen in schools. It is a learning environment utilizing teamwork and collaboration, where learners create ideas in the form of collaborative projects and interact genuinely, since their mathematical work belongs to them and to real life. Much of the fun lies in sharing projects, allowing for modification and experimentation across projects and teams.

Workshops are the main pathway for empowerment in the lab; they are organized by computational mathematics skills, and learners are partners and active agents in the learning process in a teamwork approach. Contents are presented in a hands-on and step by step problem solving fashion through the four-step computational thinking process.

Projects bring opportunity for creativity enhancement. Learners should formulate a problem as a project in a team and use computational thinking methodologies to tackle it thoroughly. Results of projects will be presented in festivals and showcases, which not only foster further interaction between teens but also attract new teens to join the lab.

3.2. *Artificial Intelligence Lab*

With immense computing power available, artificial intelligence (AI) has become a hot field and is now reflected in different domains such as robotics, Internet of Things (IoT) etc. In the new approach, gathering data through smart sensors, analyzing the data to make meaningful inferences, and applying these inferences to control systems in a decision-making process are essential. Robotics and IoT are means of applying computational thinking processes to formulate problems and find solutions. AI lab is an empowering, high-tech environment for teenagers, where they can be trained in new skills in a heuristic and hands-on fashion, and, through projects, develop their own creativity.

Basic components of robotics and sensors of IoT applications should be provided in the lab. Materials for constructing new objects are also necessary, and a 3D printer is essential. Furthermore, a cloud system to gather data and software tools to analyze said data also should be provided. Upon arrival to the lab, teens should have access to robotics and IoT components and in a heuristic approach should learn about their functionality and applications. Teens should also be trained in teams with the cloud system and data analysis tools. Teamwork in the training process will also bring the opportunity for them to learn from one another. In the second phase, also in teams, they should formulate a problem, and by applying computational thinking process, they should look for a solution, which they can construct and test by gathering data on the cloud and applying data analysis tools.

Again, presenting the outcomes of projects in tech festivals and showcases and being recognized for their explorations are good incentives for teens to join the AI lab.

4. Epilogue

Integrating computational thinking into K-12 settings has been attracting greater attention lately, despite the lack of a formal description of what "learning to think computationally" actually looks like among today's youth. The youth can engage in key aspects of computational thinking within a rich learning environment, using computational mathematics and artificial intelligent labs as means to solve problems and create original products.

Certain frameworks and procedures should be developed to introduce CT in K-12, and systematic assessment procedures are still needed to describe the developmental progression of computational thinking through computational mathematics and AI labs. However, the two labs outlined should provide a solid base for further teen exploration in computation.

As a foundation moving forward, the "use-modify-create" framework offers a helpful progression for developing CT over time. It illustrates the benefits arising from engaging youth with progressively more complex tasks and giving them increasing ownership of their learning.

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From Al-Khwarizmi to Algorithm

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Mohammad ibn Musa al-Khwarizmi (780–850), Latinized as *Algoritmi*, was a Persian mathematician, astronomer, and geographer during the Abbasid Caliphate, a scholar in the House of Wisdom in Baghdad.

In the 12th century, Latin translations of his work on the Indian numerals introduced the decimal number system to the Western world. Al-Khwarizmi's *The Compendious Book on Calculation by Completion and Balancing* resented the first systematic solution of linear and quadratic equations in Arabic. He is often considered one of the fathers of algebra.

Some words reflect the importance of al-Khwarizmi's contributions to mathematics. "Algebra" (Fig. 1) is derived from *al-jabr*, one of the two operations he used to solve quadratic equations. *Algorism* and *algorithm* stem from *Algoritmi*, the Latin form of his name.

Fig. 1. A page from al-Khwarizmi "Algebra".

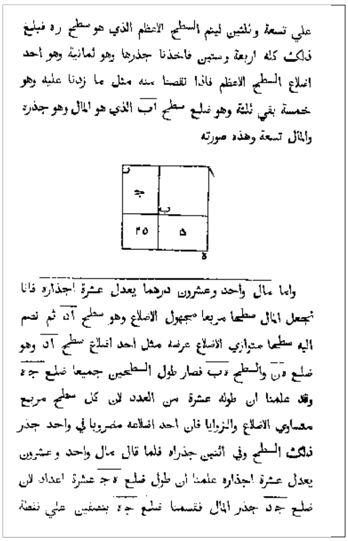
Few details of al-Khwarizmi's life are known with certainty. He was born in a Persian family and Ibn al-Nadim gives his birthplace as Khwarazm in Greater Khorasan. Ibn al-Nadim's *Kitāb al-Fihrist* includes a short biography on al-Khwarizmi together with a list of the books he wrote. Al-Khwārizmī accomplished most of his work in the period between 813 and 833 at the House of Wisdom in Baghdad.

Al-Khwarizmi contributions to mathematics, geography, astronomy, and cartography established the basis for innovation in algebra and trigonometry. His systematic approach to solving linear and quadratic equation led to *algebra*, a word derived from the title of his 830 book on the subject: "The Compendious Book on Calculation by Completion and Balancing".

On the Calculation with Hindu Numerals written about 825, was principally responsible for spreading the Hindu-Arabic numeral system throughout the Middle East and Europe. It was translated into Latin as *Algoritmi de numero Indorum*. Al-Khwarizmi, rendered as (Latin) *Algoritmi*, led to the term "algorithm".

Some of his work was based on Persian and Babylonian astronomy, Indian numbers, and Greek mathematics. When, in the 12th century, his works spread to Europe through Latin translations, it had a profound impact on the advance of mathematics in Europe.

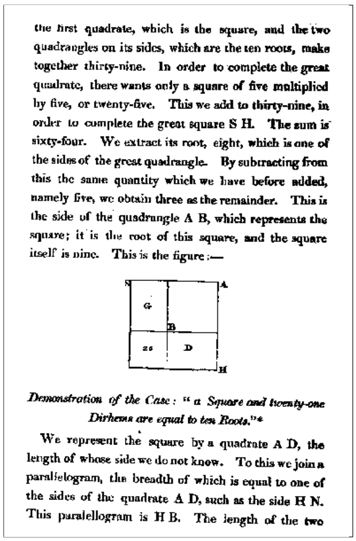
The Compendious Book on Calculation by Completion and Balancing (*al-Kitab al-mukhtaṣar fi ḥisab al-jabr wal-muqabala*) is a mathematical book written approximately 830 CE (Fig. 2 a). The book was written with the encouragement of Caliph al-Ma'mun as a popular work on calculation and is replete with examples and applications to a wide range of problems in trade, surveying and legal inheritance. The term "algebra" is derived from the name of one of the basic operations with equations (al-jabr, meaning



علي تسعة وثلثين ليتم السطح الاعظم الذي هو سطح ره فبلغ
ذلك كله اربعة وستين فاخذنا جذرها وهو ثمانية وهو احد
اضلاع السطح الاعظم فاذا نقصنا منه مثل ما زدنا عليه وهو
خمسة بقي ثلثة وهو ضلع سطح اب الذي هو المال وهو جذره
والمال تسعة وهذه صورته

واما مال واحد وعشرون درهما يعدل عشرة اجذاره فانا
نجعل المال سطحا مربعا مجهول الاضلاع وهو سطح اد ثم نضم
اليه سطحا متوازي الاضلاع عرضه مثل احد اضلاع سطح اد وهو
ضلع دن والسطح دب فصار طول السطحين جميعا ضلع جه
وقد علمنا ان طوله عشرة من العدد لان كل سطح مربع
متساوي الاضلاع والزوايا فان احد اضلاعه مضروبا في واحد جذر
ذلك السطح وفي اثنين جذراه فلما قال مال واحد وعشرون
يعدل عشرة اجذاره علمنا ان طول ضلع هج عشرة اعداد لان
ضلع جد جذر المال فقسمنا ضلع جه بنصفين علي نقطة

a)



the first quadrate, which is the square, and the two quadrangles on its sides, which are the ten roots, make together thirty-nine. In order to complete the great quadrate, there wants only a square of five multiplied by five, or twenty-five. This we add to thirty-nine, in order to complete the great square S H. The sum is sixty-four. We extract its root, eight, which is one of the sides of the great quadrangle. By subtracting from this the same quantity which we have before added, namely five, we obtain three as the remainder. This is the side of the quadrangle A B, which represents the square; it is the root of this square, and the square itself is nine. This is the figure :—

*Demonstration of the Case: "a Square and twenty-one Dirhems are equal to ten Roots."**

We represent the square by a quadrate A D, the length of whose side we do not know. To this we join a parallelogram, the breadth of which is equal to one of the sides of the quadrate A D, such as the side H N. This parallelogram is H B. The length of the two

b)

Fig. 2. The *Book of Algebra* by Al-Khwarizmi.
a) The original Arabic print manuscript of the *Book of Algebra* by Al-Khwarizmi.
b) A page from *The Algebra of Al-Khwarizmi* by Fredrick Rosen, in English.

"restoration", referring to adding a number to both sides of the equation to consolidate or cancel terms) described in this book. The book was translated in Latin as *Liber algebrae et almucabala* by Robert of Chester in 1145. A unique Arabic copy is kept at Oxford and was translated in 1831 by F. Rosen (Fig. 2 b). A Latin translation is kept in Cambridge It provided an exhaustive account of solving polynomial equations up to the second degree, and discussed the fundamental methods of "reduction" and "balancing", referring to the transposition of terms to the other side of an equation, that is, the cancellation of like terms on opposite sides of the equation.

Al-Khwarizmi's method of solving linear and quadratic equations worked by first reducing the equation to one of six standard forms (where b and c are positive integers):

- Squares equal roots ($ax^2 = bx$).
- Squares equal number ($ax^2 = c$).
- Roots equal number ($bx = c$).
- Squares and roots equal number ($ax^2 + bx = c$).
- Squares and number equal roots ($ax^2 + c = bx$).
- Roots and number equal squares ($bx + c = ax^2$).

By dividing out the coefficient of the square and using the two operations *al-jabr* ("restoring" or "completion") and *al-muqabala* ("balancing"). Al-jabr is the process of removing negative units, roots and squares from the equation by adding the same quantity to each side. For example, $x^2 = 40x - 4x^2$ is reduced to $5x^2 = 40x$. Al-muqabala is the process of bringing quantities of the same type to the same side of the equation. For example, $x^2 + 14 = x + 5$ is reduced to $x^2 + 9 = x$.

The above discussion uses modern mathematical notation for the types of problems which the book discusses. However, in al-Khwarizmi's day, most of this notation had not yet been invented, so he had to use ordinary text to present problems and their solutions.

For example, for one problem he writes, (from an 1831 translation):

> *If someone say: "You divide ten into two parts: multiply the one by itself; it will be equal to the other taken eighty-one times." Computation: You say, ten less thing, multiplied by itself, is a hundred plus a square less twenty things, and this is equal to eighty-one things. Separate the twenty things from a hundred and a square, and add them to eighty-one. It will then be a hundred plus a square, which is equal to a hundred and one roots. Halve the roots; the moiety is fifty and a half. Multiply this by itself, it is two thousand five hundred and fifty and a quarter. Subtract from this one hundred; the remainder is two thousand four hundred and fifty and a quarter. Extract the root from this; it is forty-nine and a half. Subtract this from the moiety of the roots, which is fifty and a half. There remains one, and this is one of the two parts.*

Etymologically, the word algorithm is a combination of the Latin word *algorismus*, named after Al-Khwarizmi, and the Greek word *arithmos*, meaning "number". In English, it was first used in about 1230 and then by Chaucer in 1391. English adopted the French term, but it wasn't until the late 19th century that "algorithm" took on the meaning that it has in the modern mathematics and finally in the 20th century it became a common word in computer science.

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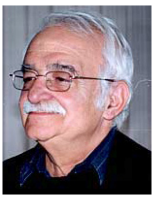

B. Mehri. Distinguished professor of mathematical sciences at the Sharif University of Technology. Member of the Iranian Hall of Fame as an Inspired Figure due to his significant works in research and teaching in mathematics.

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Notes

I participated for the first time in the 3rd IOI in 1991 as an observer, and ever since it has been my dream for IOI to be organized in Iran. My dream is finally realized in IOI-2017, thanks to Dr. Ghodsi and Dr. Abam who made it happen.

Last year, while I was visiting Stanford University, the organizing committee of IOI-2017 asked me to be in charge of the special issue of the Informatics Olympiad Journal for the IOI-2017. It was a true pleasure for me to join the team. Dr. Abam introduced me to Professor Valentina Dagienė, it was great getting to know Valentina and all the great work she has done for the Informatics community. Under their support I drafted a plan and set out to organize an informative, interesting issue. In the following kindly find a brief description of all the contents of the special issue.

- The first item that came to my mind was conducting an interview with Donald Knuth while I was at Stanford. We met Don in his residence at the Stanford campus, and he generously answered all of our questions. I was accompanied by Dr. Amir Zarkesh and Dr. Mohsen Hejrati, both Iranian high tech entrepreneurs in the Silicon Valley. Thanks also goes to Dr. Amin Saberi, a medalist at the IOI and a faculty at Stanford, for his kind support for this endeavor.
- How did IOI start? It has always been somewhat of a mystery, but Professor Petar Kenderov, academician at the Bulgarian Academy of Science and founder of the IOI, generously accepted my request and wrote about the three decades of IOI and how it started.
- Iran joined the IOI in 1992. Dr. Ghodsi, professor of computer science at Sharif University of Technology and co-founder of the Iranian National Olympiad in Informatics, has written a brief introduction about the participation of Iran in the IOI.
- Professor Bahman Mehri, a pioneer and distinguished faculty member at Sharif, has written about al-Khwarizmi, a Persian mathematician who gave his name to the algorithm.
- Dr. Mohammad Ali Abam, a medalist at the International Mathematical Olympiad, faculty at the Sharif Computer Engineering department, and chair of the IOI-2017, has written about the details of the Iranian National Olympiad in Informatics, including national contests and training sessions.
- Informatics training is always an issue such that to bring opportunity for all youth and attract them to programming and problem solving. Dr. Ali Sharifi-Zarchi, Dr. Hamid Zarrabi-Zadeh and Ali Babei, all three very well experienced in IOI,

have written an article and have presented the achievements of the online platforms Kahu and Olympedia.

- In the nearly three decades since IOI began, other programming challenges have been organized in Iran. Dr. Hamid Zarrabi-Zadeh, faculty at the Sharif Computer Engineering Department and director of the ACM/ICPC in Iran, has written about the plethora of programming challenges and contests in Iran.
- Isfahan Mathematics House (IMH) is a unique learning environment for both mathematics or informatics and is focused on extra-curricular experimental and project-based learning. Maryam Ghaemi and Emran Behrooz, research fellows at the IMH, have written about the Isfahan Mathematics House.
- Robotics has long attracted many students in Iranian schools. Gohar Pirayesh and Jafar Ziari, experts in the information technology in education, have written a brief introduction about Robotics in Iranian schools.
- The high-tech startup movement in Iran has attracted many computer science and engineering graduates and is a growing market for computer programmers. Hessam Mirarmandehi and Reza Mohammadi, pioneering high-tech entrepreneurs in Iran, have written about the programming market.
- I myself have been studying new aspects of education in problem solving and algorithmic thinking. I have written an article about computational thinking and present it as a 21st-century skill.

I have to say also, many thanks to the Editorial Board of the IOI journal "Olympiads in Informatics" and all who had assisted with the special issue. Particular thanks are due to the organization committee for the IOI 2017 in Iran, without their assistance we would be unable to hold this special issue of the IOI journal.

Finally, all of these works have common goals: to share the joy of computing, to develop imperative knowledge, and to produce objects of beauty.

Yahya Tabesh

For the IOI-2017

About Journal and Instructions to Authors

OLYMPIADS IN INFORMATICS is a peer-reviewed scholarly journal that provides an international forum for presenting research and developments in the specific scope of teaching and learning informatics through olympiads and other competitions. The journal is focused on the research and practice of professionals who are working in the field of teaching informatics to talented student. OLYMPIADS IN INFORMATICS is published annually (in the summer).

The journal consists of two sections: the main part is devoted to research papers and only original high-quality scientific papers are accepted; the second section is for countries reports on national olympiads or contests, book reviews, comments on tasks solutions and other initiatives in connection with teaching informatics in schools.

The journal is closely connected to the scientific conference annually organized during the International Olympiad in Informatics (IOI).

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The journal language is English. No formal limit is placed on the length of a paper, but the editors may recommend the shortening of a long paper.

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- for three or more authors – (Johnson *et al.*, 2002)
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For books:

Hubwieser, P. (2001). *Didaktik der Informatik*. Springer-Verlag, Berlin.

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