

Introduction of “Honorable Mention” Award at the International Olympiad in Informatics

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Abstract. In 2020, there are 14 International Science Olympiads for secondary school students, which aim to gather teams from all the countries around the world, with the brightest young eligible students from each country. These Olympiads are not just a science competition but a means to care for talent in the particular scientific field. International Olympiad in Informatics (IOI) is one of the first five Olympiads that arose, after Mathematics, Physics and Chemistry, and before Biology Olympiad. Being the “summit” of the brightest students, they generously award recognitions to contestants in the form of gold, silver and bronze medals, and additionally – the so called “honorable mention” award. IOI is the only Olympiad that up until 2019 has not introduced the fourth-degree award – “honorable mention”. In this paper we explore the rules of the other four scientific Olympiads in order to compare their methods of awarding contestants to the current one used by IOI, and to use that analysis for proposing a rule change that will introduce “honorable mention” category at IOI. Furthermore, a set of possible approaches are considered, and for each one, the “retroactive” impact of the rule to the results of the last five IOI issues is presented. At the end, as a conclusion, the most appropriate approach is proposed.

Keywords: science competitions, programming, International Olympiad in Informatics, medals, awards, honorable mention.

1. Introduction

The **International Science Olympiads** are a group of worldwide annual competitions in various areas of science. In 2020, there are 14 International Science Olympiads for secondary school students, which aim to gather teams from all the countries around the world, with the brightest young eligible students from each country. These Olympiads are not just a science competition but means to care for talent in the particular scientific field. The competitions are designed for the 4–6 best high school students from each participating country selected through internal National Science Olympiads. Further in this section we present more information on the first five of these Olympiads, in chronological order of their appearance.

1.1. *International Mathematical Olympiad*

The **International Mathematical Olympiad (IMO)** is an annual mathematics competition for high school students. The first IMO was held in Romania in 1959. The problems come from various areas of mathematics, which are included in math curricula in secondary schools. Finding the solutions of these problems, however, requires exceptional mathematical ability and excellent mathematical knowledge on the part of the contestants.

The country delegation to an IMO consists of up to six student competitors and (a maximum of) two leaders. Awards are determined as follows (IMO regulations, clause 5):

- Gold medal: the top 1/12 of scores receive gold medals.
- Silver medal: the next 2/12 of scores receive silver medals.
- Bronze medal: the next 3/12 of scores receive bronze medals.
- Honorable mention: any competitor who receives a perfect score of 7 on any one question, but who does not receive a medal, is awarded an honorable mention.

1.2. *International Physics Olympiad*

The **International Physics Olympiad (IPhO)** is an annual physics competition for high school students. The first IPhO was held in Warsaw, Poland, in 1967.

Each national delegation is made up of at most five student competitors plus two leaders, selected on a national level. The students compete as individuals and are put to hard theoretical and laboratory examinations. According to the results, the students can be awarded gold, silver or bronze medals, or an honorable mention. The minimal scores required for Olympiad medals and honorable mentions are chosen by the organizers, according to the following rules (IPhO statutes, clause 6):

- A gold medal should be awarded to 8% of the contestants (rounded to a nearest integer).
- A silver medal or better should be awarded to 25% of the contestants (rounded to a nearest integer).
- A bronze medal or better should be awarded to 50% of the contestants (rounded to a nearest integer).
- An honorable mention or better should be awarded to 67% of the contestants (rounded to a nearest integer).
- All other participants receive certificates of participation. The participant with the highest score (absolute winner) receives a special prize, in addition to a gold medal.

1.3. *International Chemistry Olympiad*

The **International Chemistry Olympiad (IChO)** is an annual academic competition for high school students. It is also one of the International Science Olympiads. The first IChO was held in Prague, Czechoslovakia, in 1968.

Each delegation consists of up to four students and two mentors (one of them is designated as the head of the delegation or “head mentor”). A delegation may also include a handful of guests and scientific observers. Students must be under the age of 20 and must not be enrolled as regular students in any post-secondary education institution. All participants are ranked based on their individual scores and no official team scores are given.

Rules for awarding medals at IChO (IChO regulations, clause 15):

- The best 10% to 12% of all competitors receive gold medal.
- The next 20% to 22% receive silver medal.
- The following 30% to 32% receive bronze medals.
- An honorable mention is received by non-medalists who are in the best 70 to 71% of all competitors.
- The exact number of recipients for each award is determined automatically to yield the largest possible difference in the marks of students receiving different honors. In the case of identical differences, the one resulting in more medals will be selected.
- Each medalist must receive the medal and a corresponding certificate from the organizer.
- Other prizes may be awarded in addition to the medals.
- Each competitor receives a certificate of participation.
- In the awarding ceremony, the non-medalists are called alphabetically.

1.4. *International Olympiad in Informatics*

The **International Olympiad in Informatics (IOI)** is an annual competitive programming competition for high school students. It is the second largest science Olympiad, after the International Mathematical Olympiad, in terms of number of participating countries (87 at IOI 2019). The first IOI was held in 1989, in Pravez, Bulgaria.

Students at the IOI compete on an individual basis, with up to four students competing from each participating country. Students in the national teams are selected through national computing contests, and they are led by one or two team leaders from the country. The contest consists of two days of computer programming/coding and problem-solving of algorithmic nature. The knowledge and skills necessary to solve the tasks are on very high level, often compared to the content of the most competitive algorithmic courses at the universities.

The scores from the two competition days and all problems are summed up separately for each contestant. At the awarding ceremony, contestants are awarded medals depending on their relative total score (IOI regulations, clause S6.11). No more than half of the contestants are to receive medals on the basis that:

- About one twelfth of all contestants receive a gold medal.
- About one sixth of all contestants receive a silver medal.
- About one quarter of all contestants receive a bronze medal.

More exact algorithm is given in the E6.11 of the IOI regulations, which states: Medal boundaries are allocated by the following rules:

- The score necessary to achieve a gold medal is the largest score such that at least one twelfth of all contestants receive a gold medal.
- The score necessary to achieve a silver medal is the largest score such that at least one quarter of all contestants receive a gold or silver medal.
- The score necessary to achieve a bronze medal is the smallest score such that at most one half of all contestants receive a medal.

1.5. *International Biology Olympiad*

The **International Biology Olympiad (IBO)** is an annual science Olympiad for high school students under the age of 20. All participating countries send the four winners of their National Biology Olympiad to the IBO, usually accompanied by two adults who are members of the international jury for the duration of the competition. The first IBO was held in Czechoslovakia in 1990, with 6 participating countries. Nowadays, there are up to 78 participating countries (at IBO 2019).

The awards are determined according to the cutoffs below, where n is the number of competitors, and $[n]$ is the ceiling function (e.g. $[4.1] = 5$, $[4.9] = 5$). The maximum number of awards equals $0.7 [n] + 2$ (IBO guidelines).

Gold medal	$w = [0.1 n]$	The last gold medal winner is the one preceding the largest gap out of the three following the top w competitors
Silver medal	$x = [0.3 n]$	The last silver medal winner is the one preceding the largest gap out of the three following the top x competitors
Bronze medal	$y = [0.6 n]$	The last bronze medal winner is the one preceding the largest gap out of the three following the top y competitors
Certificate of merit	$z = [0.7 n]$	The last certificate of merit winner is the one preceding the largest gap out of the three following the top z competitors

In the following section we will provide statistics regarding the number of medals awarded at the year 2019's issues of the Physics, Chemistry and Biology Olympiads, since they all have "steady" principles for awarding medals and Honorable mentions/

Certificates of merit. We will look into the results from IMO more deeply, considering more of the last issues, since there is a specific condition for awarding the Honorable mention awards. Further in the paper we will list several different proposals/approaches for introducing the Honorable mention at IOI, and for each one, the “retroactive” impact of the approach to the results of the last five IOI issues will be analyzed. At the end, as a conclusion, based on the conducted analysis, the most appropriate approach will be proposed.

2. Awards Presented at Other Science Olympiads

Science Olympiads are not just a science competition but a means to care for talent in the particular scientific field. International Olympiad in Informatics (IOI) is one of the first five Olympiads that arose, after Mathematics, Physics and Chemistry, and before Biology Olympiad. Being the “summit” of the brightest students, at all Olympiads contestants are generously awarded with recognitions in the form of gold, silver and bronze medals, and additionally, the so called “Honorable mention“ award.

Here we provide statistics regarding the number of medals gained at the year 2019’s issues of the Physics, Chemistry and Biology Olympiads, since they all have “steady” principles for awarding medals and Honorable mentions/Certificates of merit.

According to their official statistics sites / official published documents, in Table 1, Table 2 and Table 3 we may see the number of awards presented at each Olympiad.

Table 1
Awards presented at IPHO 2019

Total # of contestants 363 from 78 countries	#	%	Cumulative %
Gold medal	34	9.37%	
Silver medal	66	18.18%	
Bronze medal	101	27.82%	55.37%
Honorable mention	50	13.77%	69.15%

Table 2
Awards presented at IChO 2019

Total # of contestants 309 from 80 countries	#	%	Cumulative %
Gold medal	37	12.33%	
Silver medal	64	21.33%	
Bronze medal	95	31.67%	63.43%
Honorable mention	23	7.67%	71.10%

Table 3
Awards presented at IBO 2019

Total # of contestants 285	#	%	Cumulative %
Gold medal	31	10.88%	
Silver medal	55	19.30%	
Bronze medal	87	30.53%	60.70%
Honorable mention	27	9.47%	70.18%

As a general conclusion, all three Olympiads award more than 50% medals (55.4% – 63.4%) which is more generous than the IOI rule of awarding no more than 50% of the contestants with medal. Even more, if we include the contestants awarded with Honorable mention (or Certificate of Merit at IBO), we may see that the total number of awards is around 70% of all participants (69.2% – 71.1%). Since IOI did not award Honorable mention award until IOI 2019, obviously the percentage of awards given at IOI is 20 percent points smaller than other Olympiads, or in percentages, 29% less awards.

2.1. Awards at IMO in the Last 4 Years

We will look into the results from IMO more deeply, considering more of the last issues, since there is a specific condition for awarding the Honorable mention awards.

Table 4 shows the number of awarded contestants from IMO in the years 2016 to 2019, according to IMO statistics (IMO 2017). At IMO, any competitor who receives a perfect score of 7 on any one question, but who does not receive a medal, is awarded

Table 4
Awarded contestants at IMO in the years 2016–2019

	2016 year		2017 year		2018 year		2019 year	
	Number of awarded contestants	Awarded contestants (%)	Number of awarded contestants	Awarded contestants (%)	Number of awarded contestants	Awarded contestants (%)	Number of awarded contestants	Awarded contestants (%)
Gold medal	44	7.31	48	7.80	48	8.08	52	8.37
Silver medal	101	16.78	90	14.63	98	16.50	94	15.14
Bronze medal	135	22.43	153	24.88	143	24.07	156	25.12
Honorable mention	162	26.91	222	36.10	138	23.23	144	23.19
Total awards	442	73.43	513	83.41	427	71.88	446	71.82
Total participants	602		615		594		621	

an honorable mention. From the table we can see that the number of students who are awarded with honorable mention is approximately 23% – 37%. In total, IMO awards almost same percentage of medals as IOI, but more total awards (71.8% – 83.4%) compared to 50% at IOI.

As a conclusion, it is obvious that IOI should introduce an additional, fourth level award, in order to equalize the possibility of winning an award for its contestants, compared to other Olympiads.

3. Different Approaches for Introduction of Honorable Mention at IOI

During the IOI 2019, on the initiative of the authors of this paper, a discussion on the introduction of Honorable mention (HM) award was held for the interested team leaders. Different approaches for awarding this fourth level award were proposed and discussed. In this paper we are analyzing five different approaches/scenarios that are based mainly on the experiences from the other science Olympiads, as well as ideas from the leaders based on the experiences of regional Olympiads like the Balkan Olympiad in Informatics, for example.

For every approach, we provide different tables and accompanying graphic that show the important characteristics of the approach, such as:

1. Number and percentage of awarded contestants, that will show how many contestants gain additionally award, on top of the ones awarded with medals.
2. Range of points that qualify the contestant to score a medal or HM, in order to see if some approach awards HM for some students with rather small number of points, for example, or average points for the contestants that gain a particular award.
3. Number of countries that haven't won a medal for the particular year, but would have won one or more HM awards, etc.

The data in the tables that follow originate from the last five International Olympiads in Informatics (years 2015–2019), according to the IOI statistics pages (IOI 2015, IOI 2016, IOI 2017, IOI 2018, IOI 2019). We consider a hypothetical situation in which we apply the proposed approach for HM over the already scored points of the contestants. Analyzed scenarios are:

- Honorable mention for the following 15% of contestants who did not win a medal.
- Honorable mention for contestants who have correctly solved at least one task (received 100 points), but did not win a medal.
- Honorable mention for contestants who have won at least 50% of the points won by the last bronze medalist.
- Honorable mention for the following 20% of contestants who did not win a medal.
- Honorable mention for the following 20% of contestants who did not win a medal but have also won at least 50% of the points won by the last bronze medalist.

3.1. Honorable Mention for the Following 15% of Contestants Who did not Win a Medal

The data in Table 5, Table 6 and Fig. 1 show that if this approach is used, then all contestants awarded with HM will have rather close scores among each other, i.e. the contestant who will receive the last HM will still have a significant number of points, compared to the one with HM who is the first non-medalist.

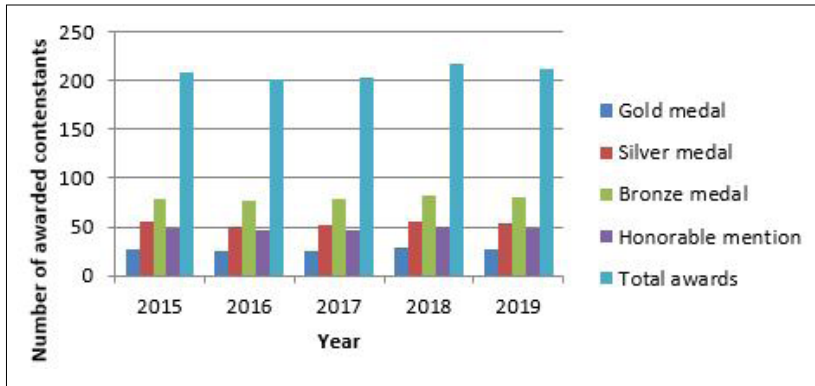


Fig. 1. Awarded contestants at IOI (HM 15%).

Table 5

Honorable mention for the following 15% of contestants who did not win a medal (GM = Gold medal, SM = Silver m., BM = Bronze m., HM = Honorable mention, TA = Total awards, TP = Total partic.)

	2015 year			2016 year			2017 year			2018 year			2019 year		
	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)
GM	27	8.4	73.4 - 100	26	8.4	69.3 - 99.5	26	8.4	58.8 - 98.2	29	8.7	56.0 - 83.2	28	8.6	69.1 - 91.2
SM	55	17.1	54.3 - 72.9	51	16.6	54.7 - 68.8	52	16.9	41.6 - 58.5	55	16.4	45.3 - 55.7	54	16.6	54.9 - 68.6
BM	79	24.5	30.9 - 53.9	77	25.0	40.0 - 53.3	78	25.3	22.9 - 41.5	83	24.8	31.2 - 45.2	81	24.8	41.7 - 54.8
HM	48	14.9	20.7 - 30.8	47	15.3	30.2 - 39.8	46	14.9	16.5 - 22.6	50	14.9	24.3 - 30.8	49	15.0	34.2 - 41.6
TA	209	64.9		201	65.3		202	65.6		217	64.8		212	65.0	
TP	322			308			308			335			326		

Table 6
Honorable mention for the following 15% of contestants who did not win a medal – average points

	2015 year		2016 year		2017 year		2018 year		2019 year	
	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)
Gold medal	73.40 - 100.00	86.7	69.33 - 99.50	84.42	58.84 - 98.25	78.55	56.00 - 83.17	69.59	69.12 - 91.18	80.15
Silver medal	54.26 - 72.92	63.59	54.67 - 68.83	61.75	41.57 - 58.50	50.34	45.33 - 55.67	50.5	54.86 - 68.58	61.72
Bronze medal	30.91 - 53.92	42.42	40.00 - 53.33	46.67	22.86 - 41.50	32.18	31.17 - 45.17	38.17	41.70 - 54.77	48.24
Honorable mention	20.67 - 30.85	25.76	30.17 - 39.83	35.00	16.48 - 22.63	19.56	24.33 - 30.83	27.58	34.18 - 41.60	37.89
Mean		54.62		56.96		45.16		46.46		57.00
Deviation		22.87		18.47		22.17		15.62		15.81

In Table 7, we analyze the number of countries that would have been included in the “awarded” countries, i.e., countries that don’t have a contestant who has won a medal, but would have had contestant with HM.

With this approach additional 11 countries in each year would have entered in the group of “awarded” countries. Table 8 further shows that using this approach we decrease the number of “non-awarded” countries from approx. 26 to approx. 15.

Table 7
Analysis of the number of gained honorable mentions and medals with honorable mentions by countries, if honorable mention is given to the following 15% of contestants who did not win a medal (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won only HM	7	11	9	4	6
Number of countries that won more than one HM	4	/	2	7	5
Number of countries that won a medal and one or more HM	6	12	12	9	8
Number of countries that won more than one medal and one or more HM	15	18	11	16	12
Total	32	41	34	36	31

Table 8

Analysis of the number of countries that did not receive a medal but would receive an honorable mention if an honorable mention is given to the following 15% of contestants who did not win a medal (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won one HM	7	11	9	4	6
Number of countries that won more than one HM	4	/	2	7	5
Number of countries that did not win a HM	15	16	12	15	17
Total	25	27	23	26	28

3.2. Honorable Mention for Contestants Who Have Correctly Solved at Least One Task (Received 100 Points), but did not Win a Medal

The data in Table 9 show that if this approach is used, there would be great discrepancies among the number of participants that would win HM in each year. We furthermore explore additional characteristics in Table 10.

Table 10 shows the number of contestants who would win an honorable mention, their average points in %, lowest points of contestant who would win an honorable mention, the percentile of that contestant, and the number of contestants that would have a higher score than the lowest ranked contestant with honorable mention, but would not win an honorable mention.

Table 9

Honorable mention for contestants who have correctly solved at least one task (received 100 points), but did not win a medal (GM = Gold medal, SM = Silver medal, BM = Bronze medal, HM = Honorable mention, TA = Total awards, TP = Total participants)

	2015 year			2016 year			2017 year			2018 year			2019 year		
	Number of awarded contestants	Awarded contestants (%)	Average points (%)	Number of awarded contestants	Awarded contestants (%)	Average points (%)	Number of awarded contestants	Awarded contestants (%)	Average points (%)	Number of awarded contestants	Awarded contestants (%)	Average points (%)	Number of awarded contestants	Awarded contestants (%)	Average points (%)
GM	27	8.4	86.7	26	8.4	84.4	26	8.4	78.6	29	8.7	69.6	28	8.6	80.1
SM	55	17.1	63.6	51	16.6	61.7	52	16.9	50.0	55	16.4	50.5	54	16.6	61.7
BM	79	24.5	42.4	77	25.0	46.7	78	25.3	32.2	83	24.8	38.2	81	24.8	48.2
HM	5	1.6	23.2	31	10.1	32.6	3	1.0	20.4	47	14.0	24.5	37	11.3	35.4
TA	166	51.6		185	60.1		159	51.6		214	63.9		200	61.3	
TP	322			308			308			335			326		

Table 10
 Honorable mention for contestants who have correctly solved at least one task
 (received 100 points), but did not win a medal – additional characteristics
 (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of awarded contestants with HM	5	31	3	47	37
Average Points (%)	23.17	32.57	20.42	24.54	35.38
Lowest points	117	115	113	102	130.39
Percentile	19.50	19.17	18.83	17.00	21.73
Number of contestants who scored higher than the lowest ranked HM and did not win HM	55	52	25	34	75

The provided data present many negative characteristics of this approach. For example: unpredictable number of contestants that gain HM, usually rather small number of them; rather low total points for some contestants that will gain a HM award; rather big number of participants that will have more points than someone with HM, but won't get an award. Thus, this approach, based on the IMO approach for HM awarding, is not suitable for the Informatics Olympiad. We may further analyze the results of the Olympiad from year 2019. There are 37 students who have correctly solved at least one task (received 100 points) and haven't gained any medal. However, there is a big difference in the points and places in the scoreboard. For example, the best of these participants has a total of 249.58 points or 41.60%, while the last participant with at least one correctly solved task has 130.39 points or 21.73%, which represents a big difference in the points and places of the awarded participants.

3.3. Honorable Mention for Contestants Who Have Won at Least 50% of the Points Won by the Last Bronze Medalist

Another interesting approach is to award with HM the contestants who have won at least 50% of the points won by the last bronze medalist. This approach guaranties that every contestant that will win HM, will still have a significant number of points – not less than half of the points scored by the last bronze medalist. With this approach, the number of HM winners fluctuates, but, as seen in Table 11 and Fig. 2, is rather stabilized around 25% of the total number of participants, with the exception in 2019. Table 12 presents some additional characteristics for the approach.

In Table 13 and Table 14, we analyze the number of countries that would have been included in the “awarded” countries, that is, countries that don't have a contestant that has won a medal, but would have had contestant with HM. In Table 14 we may see that with this approach we decrease the number of “non-awarded” countries to only 8 in years 2015 and 2019, and up to only 11 in 2016.

Table 11

Honorable mention for contestants who have won at least 50% of the points won by the last bronze medalist (GM = Gold medal, SM = Silver medal, BM = Bronze medal, HM = Honorable mention, TA = Total awards, TP = Total participants)

	2015 year			2016 year			2017 year			2018 year			2019 year		
	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)
GM	27	8.4	73.4 - 100	26	8.4	69.3 - 99.5	26	8.4	58.8 - 98.2	29	8.7	56.0 - 83.2	28	8.6	69.1 - 91.2
SM	55	17.1	54.3 - 72.9	51	16.6	54.7 - 68.8	52	16.9	41.6 - 58.5	55	16.4	45.3 - 55.7	54	16.6	54.9 - 68.6
BM	79	24.5	30.9 - 53.9	77	25.0	40.0 - 53.3	78	25.3	22.9 - 41.5	83	24.8	31.2 - 45.2	81	24.8	41.7 - 54.8
HM	80	24.8	15.5 - 30.8	79	25.6	21.2 - 39.8	80	26.0	11.5 - 22.6	84	25.1	16.2 - 30.8	115	35.3	20.9 - 41.6
TA	241	74.8		233	75.6		236	76.6		251	74.9		278	85.3	
TP	322			308			308			335			326		

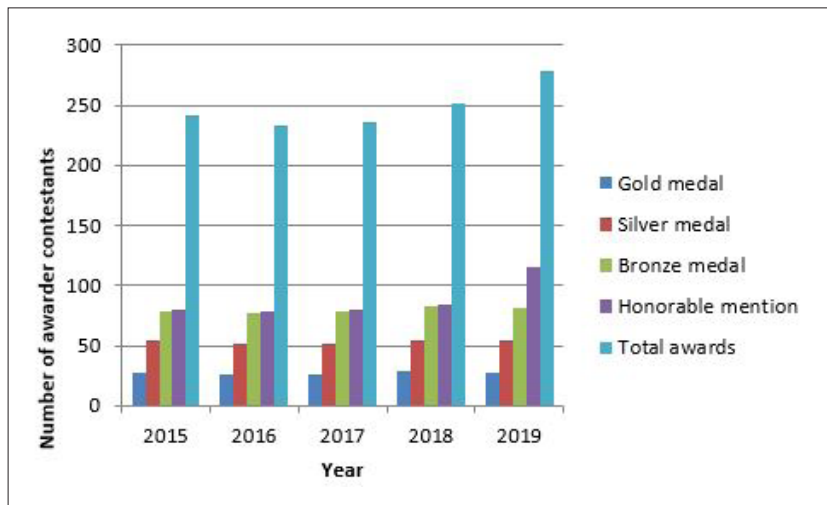


Fig. 2. Awarded contestants at IOI (HM for at least 50% of the points won by the last bronze medalist).

Table 12
Honorable mention for contestants who have won at least 50% of the points won by the last bronze medalist – additional characteristics

	2015 year		2016 year		2017 year		2018 year		2019 year	
	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)	Points (%)	Average points (%)
Gold medal	73.40 - 100.00	86.7	69.33 - 99.50	84.42	58.84 - 98.25	78.55	56.00 - 83.17	69.59	69.12 - 91.18	80.15
Silver medal	54.26 - 72.92	63.59	54.67 - 68.83	61.75	41.57 - 58.50	50.34	45.33 - 55.67	50.5	54.86 - 68.58	61.72
Bronze medal	30.91 - 53.92	42.42	40.00 - 53.33	46.67	22.86 - 41.50	32.18	31.17 - 45.17	38.17	41.70 - 54.77	48.24
Honorable mention	15.46 - 30.85	23.16	21.17 - 39.83	30.50	11.46 - 22.63	17.05	16.17 - 30.83	28.08	20.91 - 41.60	31.26
Mean		53.97		55.84		44.53		46.59		55.34
Deviation		23.70		19.86		22.91		15.47		17.93

Table 13
Analysis of the number of gained honorable mentions and medals with honorable mentions by countries, if HM is given to contestants who have won at least 50% of the points won by the last bronze medalist (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won only HM	10	11	6	6	5
Number of countries that won more than one HM	7	5	8	10	17
Number of countries that won a medal and one or more HM	9	13	14	13	11
Number of countries that won more than one medal and one or more HM	17	24	17	22	25
Total	43	53	45	51	58

Table 14
Analysis of the number of countries that did not receive a medal but would receive an honorable mention, if HM is given to contestants who have won at least 50% of the points won by the last bronze medalist (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won one HM	10	11	6	6	5
Number of countries that won more than one HM	7	5	8	10	15
Number of countries that did not win a HM	8	11	9	10	8
Total	25	27	23	26	28

3.4. Honorable Mention for the Following 20% of Contestants Who did not Win a Medal

This approach is in the same spirit as the one analyzed in section 3.1 (HM for following 15% of the contestants), but with a different percentage. The corresponding data are given in Table 15, Table 16 and Table 17.

This percentage leads to rather similar number of awards, compared to other Scientific Olympiads (analyzed in Section 2), and as seen in Table 17, it manages to decrease the number of “non-awarded” countries from approx. 26 to only 12 to 14 countries.

Table 15
Honorable mention for the following 20% of contestants who did not win a medal
(GM = Gold medal, SM = Silver medal, BM = Bronze medal, HM = Honorable mention,
TA = Total awards, TP = Total participants)

	2015 year			2016 year			2017 year			2018 year			2019 year		
	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)	Number of awarded contestants	Awarded contestants (%)	Points (%)
GM	27	8.4	73.4 - 100	26	8.4	69.3 - 99.5	26	8.4	58.8 - 98.2	29	8.7	56.0 - 83.2	28	8.6	69.1 - 91.2
SM	55	17.1	54.3 - 72.9	51	16.6	54.7 - 68.8	52	16.9	41.6 - 58.5	55	16.4	45.3 - 55.7	54	16.6	54.9 - 68.6
BM	79	24.5	30.9 - 53.9	77	25.0	40.0 - 53.3	78	25.3	22.9 - 41.5	83	24.8	31.2 - 45.2	81	24.8	41.7 - 54.8
HM	64	19.9	18.6 - 30.8	64	20.8	25.7 - 39.8	62	20.1	13.7 - 22.6	67	20.0	19.0 - 30.8	66	20.2	32.0 - 41.6
TA	225	69.9		216	70.8		218	70.8		234	69.9		229	70.2	
TP	322			308			308			335			326		

Table 16
Analysis of the number of gained honorable mentions and medals with honorable mentions by countries, if HM is given to the following 20% of contestants who did not win a medal (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won only HM	7	12	7	3	7
Number of countries that won more than one HM	6	1	4	9	7
Number of countries that won a medal and one or more HM	7	14	12	10	10
Number of countries that won more than one medal and one or more HM	17	19	15	18	19
Total	37	46	38	40	43

Table 17

Analysis of the number of countries that did not receive a medal but would receive an honorable mention if an honorable mention is given to the following 20% of contestants who did not win a medal (HM = Honorable mention)

	2015 year	2016 year	2017 year	2018 year	2019 year
Number of countries that won one HM	7	12	7	3	7
Number of countries that won more than one HM	6	1	4	9	7
Number of countries that did not win a HM	12	14	12	14	14
Total	25	27	23	26	28

3.5. Honorable Mention for the Following 20% of Contestants Who did not Win a Medal but also Have Won at Least 50% of the Points Won by the Last Bronze Medalist

This approach builds on the idea to award Honorable mention for the following 20% of contestants who will not win a medal, but with a second condition that the contestants must win at least 50% of the points won by the last bronze medalist. The approach guaranties that every contestant that will win HM, will still have a significant number of points – not less than half of the points scored by the last bronze medalist, and that only up to 70% (50+20) of the total contestants will win an award. In theory, this is a better approach than the clear one with only 20% additional contestants, but if we look at Table 15, we will see that in each of the last 5 years, every contestant in the range satisfies this additional condition. This is not a guarantee that it will hold always in the future, but an irregularity is highly unexpected.

4. Conclusion

In this paper we explored the possibility of introducing a fourth level award for the IOI contestants called Honorable mention. Firstly, we presented the rules for awarding recognitions of other four scientific Olympiads (in Mathematics, Physics, Chemistry and Biology) as the oldest five Olympiads including the IOI. Then, we presented data from the last issues of IMO, IPhO, IChO and IBO, in order to show how they implement their rules in practice. After that, we analyzed five different approaches for introducing Honorable Mention at IOI. The results of the analysis were given in series of Tables, as well as Figures. Main results are summarized in Table 18. According to the analysis, the best approach, most similar to other Olympiads, with most clear wording is the one analyzed in the subsection 3.4., i.e., Honorable mention to be awarded to the following 20% of contestants who did not win a medal, getting to the cumulative 70% of awarded contestants.

Based on the data in this paper IC decided to propose to GA introduction of HM at IOI according to the above rule. We believe that this paper will give the rationale behind that decision of the IOI community.

Table 18
 Number of awarded contestants with honorable mention from all analyzed scenarios (HM 15% = Honorable mention for 15%, HM 1 = Honorable mention for correctly solved at least one task, HM 50% = Honorable mention for at least 50% of the points won by the last bronze medalist, HM 20% = Honorable mention for 20%, BM = Bronze medalist, TP = Total participants)

	2015 year			2016 year			2017 year			2018 year			2019 year					
HM	48	14,90	20,67 - 30,85	47	15,26	30,17 - 39,83	46	14,94	16,48 - 22,63	50	14,93	24,33 - 30,83	49	15,03	34,18 - 41,60	49	15,03	34,18 - 41,60
15%																		
HM	80	24,84	15,46 - 30,85	79	25,65	21,17 - 39,83	80	25,97	11,46 - 22,63	84	25,07	16,17 - 30,83	115	35,28	20,91 - 41,60	115	35,28	20,91 - 41,60
50%																		
HM 1	5	1,55	23,17 - 30,91	31	10,06	32,57 - 40,00	3	0,97	20,42 - 22,86	47	14,03	24,54 - 31,17	37	11,35	35,38 - 41,70	37	11,35	35,38 - 41,70
HM	64	19,86	18,58 - 30,85	64	20,78	25,67 - 39,83	62	20,13	13,70 - 22,63	67	20	19,00 - 30,83	66	20,25	32,00 - 41,60	66	20,25	32,00 - 41,60
20%																		
TP	322			308			308			335			336					

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