

Part 1.

Stakeholder - an individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, action, or result of a project. Stakeholders are either directly involved in the project or have interests that may be impacted by the outcome of the project. If the project is expanded to a large area such as IOI itself, the project may have a vast number of stakeholders, including communities or the general public.



Fig 1. Hierarchy for internal Stakeholders

Types of Project Stakeholders:

1. Internal Stakeholders – Individuals/groups who are directly related to the project.
 - a. **Sponsor(s)**: a person/group who provides supplies and support for the project and is responsible for assisting success. The company Acer plays a great role as a **supplier** in holding IOI Olympiads, the computers/notebooks are powered by Acer. The sponsors themselves are divided into VIP, platinum, gold, silver and bronze according to their contribution. For example, MICRON VIP, Huawei platinum, PayPal gold, DBS silver and Charles & Keith bronze sponsored the 2020 IOI competition. Furthermore, sponsors include **organizers**, **supporters** and **partners** too and examples of them are as follows:
Organizers of IOI 2019 and 2020 were the Ministry of Education of the Republic of Azerbaijan and National University of Singapore, School of Computing.
Supporters of IOI 2019 and 2020 were Azercell and Pasha bank, and Ministry of Education of Singapore, Infocomm Media development authority and Singapore Exhibition & Convention Bureau respectively.

Partner of IOI 2020 were Singapore Airlines.

- b. Functional Managers:** Key individuals who are controlling the resources that will support a project, such as financial backing, correct conduction of organization and skilled employees. Those include the **President** (Greg Lee) who provides leadership, **Office and Secretary** (Benjamin Burton) who provides services for administration and development, **Treasurer** (Eljakim Schrijvers) who administers the financial needs, **Chairs** who are charged with organizing IOI in their designated year in their respective country and several Committees. Past Chairs of the IOI 2018, 2019 and 2020 are Kazuo Furukawa, Mr. Jeyhun Bayramov and Bernard Tan Cheng Yian respectively. There exist several **committees**, *International Committee* which is charged with overseeing the organization; finding future host countries, evaluating pas IOIs and etc., *Scientific Committee* which is charged with overseeing the competition and *Technical Committee* which is charged to oversee the technical side of the contest; program development tools, evaluation software and etc. Examples of listed committee members are Araz Yusubov, Farid Ahmadov and Jamaladdin Hasanov respectively.
 - c. Program Managers:** Those who work with the team to develop the product and ensure the project is finished according to the deadline. In other words, these individuals ensure that managers are managed, their responsibilities are the management of Team Guides and Leaders and Host Technical Committee members.
 - d. Management:** Here we are talking about the Team Leaders and Guides, and the Host Technical Committee members, who are skilled volunteers. Leaders take care of the management of the Guides, and Guides take care of management of participants. Part of the HTC team oversees the writing of software, the operation of computers, the printing of table names and requests to printers, and the uninterrupted connection to the server, while the other part controlled the requests / fulfillments from participants.
 - e. Participants:** Students who participate in the Olympiad. Those students
2. External Stakeholders – Individuals who are not directly involved but are engaged from outside and are impacted by the project outcome.
- a. The government:** Government might collect taxes from holding such events to invest back in society.
 - b. Media:** Media reports information to the society and public.

RWSSA Stakeholder Classes Table

P.S. I think that categories in this table are analyzed more by the system point, but I still wanted to note them.

	In case of IOI	
Acquires	Functional managers, supporters, partners and suppliers	President, Treasurer, Office and Secretary, Chairs and Sponsors: organizers, and Includes senior managements and business sponsors
Assessors	ITC Team	Testers – focusing on testing
Communicators	Management, ITC Team, Media	Project/Product manager and documenter – they are explaining to other stakeholders and documenting
Developers	ITC Team and Development team	Programmers from the team to solve development issues
Maintainers	ITC Team and Development Team	Programmers from the team to evaluate the system
Production Engineers	ITC and ISC Team	ISC provides content for the system and ITC the whole system
Suppliers	Sponsors, especially suppliers, such as Acer itself, and ITC Team	Sponsors because some supply hardware and ITC because they supply software and maintains it
Support Staff	Team Guides and Leaders, ITC (specifically HTC) Team	Help Desk, HTC team specifically
System Administrators	ITC Team and System admins	Thinking that ITC team is big and there are system administrators.
Testers	ITC Team and participants	Testers and participants can test the system too. If problems occurred, they can report it.
Users	Participants	Participants

Table 1. RWSSA Stakeholder Classes

Part 2.

S.M.A.R.T – it's used to guide the development of measurable goals.

S – Specific, meaning specific answers to questions such as “what, where, how, when will it be done?”.

Equipment and system must be ready to be used at the location where the contest is held before the contest start. Now let's make it a little more specific.

P.S. The following information is from the 2019 IOI competition. I thought that the closer the year, the more reliable the resources are.

1. Hardware and Software Equipment:

- a. Each contestant must be assigned a laptop with these recommended hardware specifications:

- CPU: Intel Core i3-8130 (2.20Ghz)
- Ram: 4 GB
- Storage: 500 GB HDD
- Built-in display with 1366x764 resolution
- Built-in US-layout keyboard
- Built-in touchpad
- Mouse
- 3 USB ports: contestants are allowed to bring their own keyboard and mouse according to regulations.
- Printer: contestants are allowed to print their solutions and their requirements.

The specifications of these laptops may vary from year to year and improve in the coming years.

b. Each contestant must be assigned a laptop with these recommended software and programs:

- A special operating system must be installed on each laptop such as Ubuntu 18.04.
- Specific Compilers must be installed on each laptop with specific versions such as OpenJDK 8 and GCC 7.4 to compile programming languages such as Java, C++, Objective-C.
- Specific text editors and IDEs must be installed on each laptop with the latest and stable version such as Atom 1.38.2, Code:Blocks 17.12, IntelliJ Idea Community 2019.1.2 and more.
- Specific debuggers must be installed on each laptop such as GDB 8.1, Valgrind 3.13.0 and etc.
- Specific interpreters must be installed on each laptop such as Ruby 2.5, Python 3.6 and 2.7 with matplotlib library.
- Some other applications must be installed on each laptop based on requirements such as Firefox 67.0, GNOME Terminal 3.28.2

2. Network, Servers and Environment

- Virtual Machine must be installed on each laptop for practice, such as Virtual box. An appropriate IOI contest environment called IOI 2019 VM Image has been created and needs to be downloaded to Virtual Machines
- The Internet connection must be stable during the contest, not being lost locally, ie on just one or a few computers, nor on the entire network. One way to solve this is to use ethernet cables, but its arrangement can be physically difficult. As for the whole

network, the reason for the loss of the Internet in the whole network is the company that provides the Internet.

- Network Firewalls: Laptops must have outgoing access to DNS, HTTP, HTTPS and TCP port 655.
- Bandwidth: there should be a reasonably dedicated bandwidth to each laptop, enough for streaming, such as 5 Mbps per laptop
- Specific VPN might be used to connect to the server.
- Equipments such as routers, switches, power sources and servers are required. For holding IOI contest, we need relatively more services with relatively less performance.
- Scalable: Simultaneous submissions should not crash the servers. To not face this issue, server instances should increased.
- Secure: Nobody should see/modify the codes of other people. It neither can be connected and attacked externally.
- Available: The system/contest page should be available and accessible.
- Reliable: Snapshots of data must be backed up when servers are down.
- Efficient: Response time should be minimal. Resonpe time can be affected by network bandwidth, volume of users and request submitted and latency.
- Extensible: new or

M – Measurable, answers to “How many/much and how do we know if we reached the goal?”

1. Hardware and Software Equipment:

It depends on the number of countries to join and how many people will come from each country. Usually, 4 contestants from each country take part in the competition. For example, in 2017, 83 countries joined and a total of 314 contestants participated in the contest. This means that we need 314 working laptops. Suppose that the relative error is 5%, 329 laptops, mice and desks are needed. I’m expecting it to be in one large hall.

2. Network, Servers and Environment

Since everybody will be in the same hall, I believe 4 96-port, 8 48-port or 16 24-port switches could be used. One large switch might cease if the network fails. Therefore, it is advisable to use switches with a relatively small number of ports. Maybe a pair of firewalls configured as high availability are required. In the same way, the number of servers, its CPU and VPN usage can be decided.

A - Achievable, answers to “do we have the resources and capabilities to achieve the goals”.

This, of course, is provided by sponsors and suppliers. For example, computers are supplied by ACER.

R – Realistic, answers to “is the goal realistic and within reach”. The fact that the IOI was held in 2007 confirms the fact that the IOI competition can be held taking into account the

requirements. This is not the first experience. IOI has been held for 13 years. If started at the right time, it is possible to held.

T – Time-oriented, answers to “when will all these be done?”

Because this process is long, there must be checkpoints in addition to the endpoint. The preparation process can take months, and shipping laptops, purchasing equipment, and downloading software are all time-consuming processes.

Part 3.

Context view and viewpoint is often used in the architectural design. Other than system clarity, it also demonstrates relations to the external entities. This model has a wide audience, being significant interest to all stakeholders. There is 1 actor mentioned here, but it covers all stakeholders. Then let's talk about how the system works and why I see this system this way. Contestants, first of all, need to log in, that is, authenticate themselves by entering the username and password. It will also retrieve from the User Database. After that, when the time comes in the system, the questions will be retrieved from the Question database and students will start the contest. Contestants will begin to submit their solutions, which will move to the evaluation section when they first arrive at the system. In Evaluation, if a teacher's assessment is needed, it will be helpful and will then appear in the system after being written to the Result database.

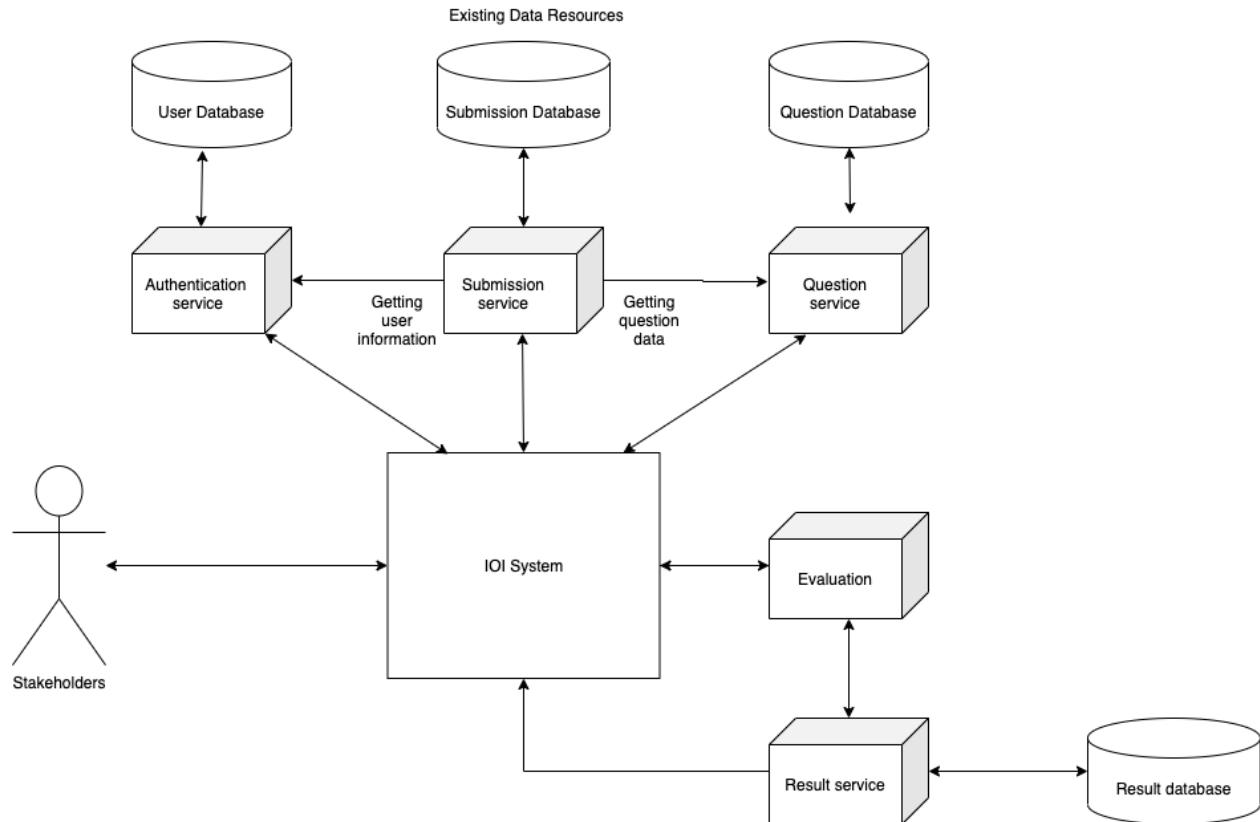


Fig 2. Informal Context Diagram

As for the seats of the contestant, I expect them to sit in the form of 4 desks. In fact, if the number of people was small, we could fill the middle part of them with routers. The space in the middle is a service room that the HTC team can enter and is off contests' interest. There are also printers in this room, and 24 switches are installed on the walls of the outer part of the room. Star topology was used. All nodes are connected individually, and any cable failure only affects the network of that laptop. That is, one malfunctioning node does not affect the rest of the network.

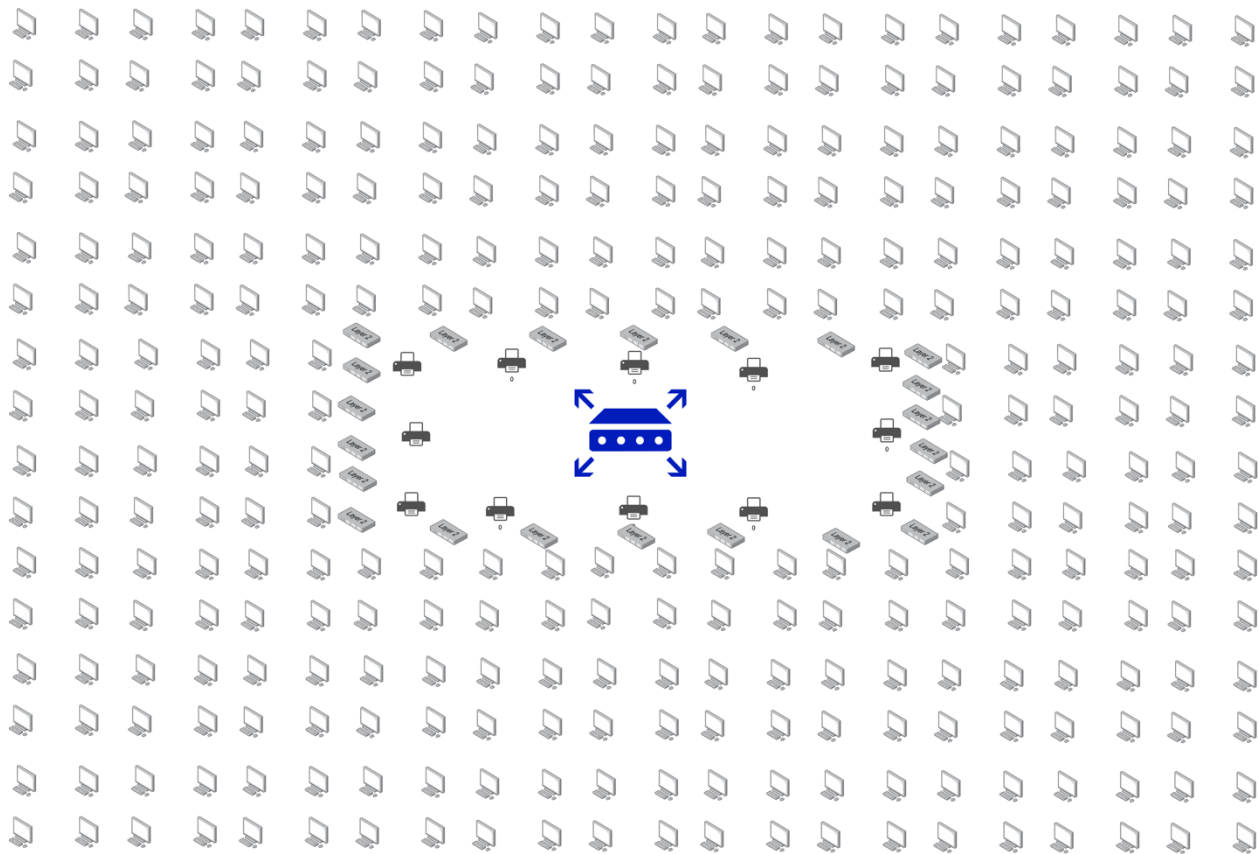


Fig 3. Structure with Service Room.

Functional View and Viewpoint defines elements that deliver the system's functionality. This viewpoint helps to demonstrate how the system will perform the functions required of it. In addition, I found a system that was used in the old IOI competitions, in 2012 and 2017. Contest Management System is the free and open-source grading system that has been used in IOI contests. It has aims of providing a grading system that naturally adapts to the needs of an IOI-life competitions. The administrations recorded in *Table 2* are Python programs based on the top point of AsyncLibrary, a specially crafted RPC library utilizing the asyncore system. A portion of the administrations, called workers, give likewise a subsequent interface because of the web system Tornado. We can say, they can speak with different administrations and serve website pages to directors. Replicable classification implies if different occasions of the administration can collaborate. Associations among the administrations are appeared below

Name	Replicable	Duties
<i>LogService</i>	No	Receiving, aggregating and displaying all the logs of the system.
<i>Worker</i>	Yes	Running compilations and evaluations of submissions in a safe environment.
<i>EvaluationService</i>	No	Maintaining the queue of the jobs to be assigned to the <i>Workers</i> .
<i>ScoringService</i>	No	Transforming the evaluation results into scores, and communicating them to the live rankings.
<i>Checker</i>	No	Calling the heartbeat function of all the services.
<i>ResourceService</i>	Yes	Collecting resource usage information about the machine in which it is running, and starting all the services on a machine.
<i>ContestWebServer</i>	Yes	Serving web pages to the contestants, accepting submissions and providing feedback.
<i>AdminWebServer</i>	No	Serving web pages to the administrators, configuring and managing the contests.

Table 2. RWSSA Stakeholder Classes

Grading systems designed for coding, of course, one person can submit another person's code. To prevent such cheating, all evaluations and compilations from students run in a complete sandbox. For this system, they developed a sandbox version of Martin Mares. This system also provides live ranking. The name of this service is listed in Figure 4.

RankingWebServer and it is replicable. It's built on top of the Tornado and is not a core part of the CMS. CMS pushes information to RankingWebServer utilizing HTTP protocol, so supposition that ContestWebServer is the lone purpose of agreement between CMS's network and the outside is saved, since RanginkWebServer doesn't inquiry CMS. An arrow illustrates a request of any kind, and multiple arrow heads mean that services can be replicated. Checker and ResourceService communicate with all services, therefore, no arrows were

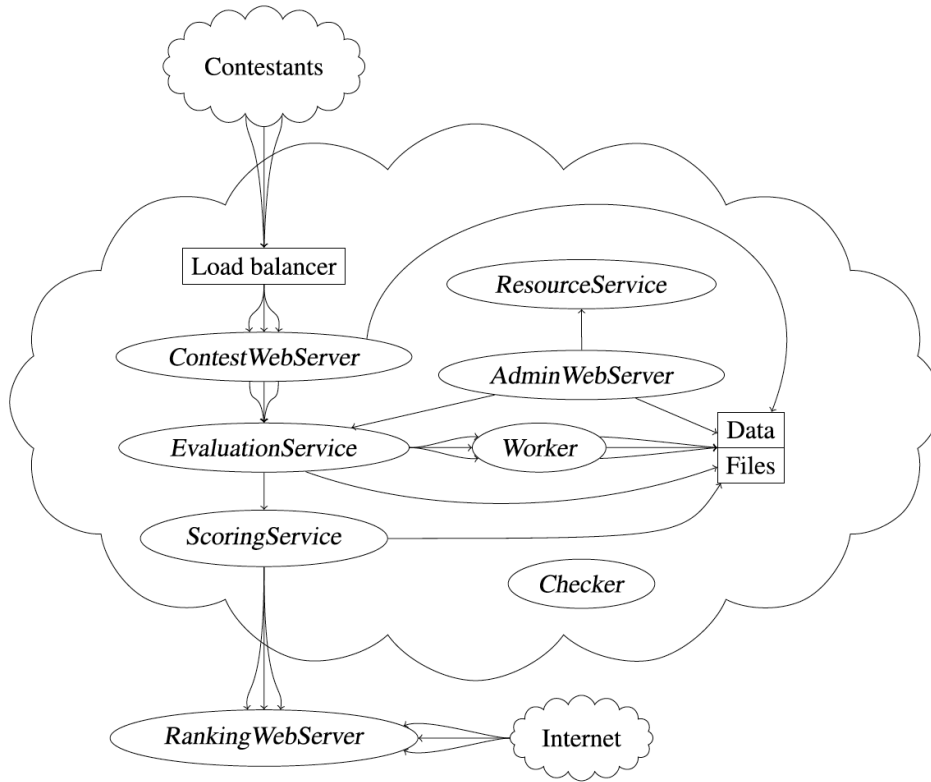


Figure 4. Services and their interactions

Now let's see how the contestant submits their solutions. First, this server makes sure that the submitted file is in the correct and required format. After that, submission files are stored in the ContestDatabase if they do not exceed the designated size. It is also used for recovery in case of failure. After that, it notifies EvaluationService there exists a new submission which is ready to be compiled. EvaluationService Finds compilation via ContestWebServer and pushes it to the job queue. Worker has a simple job. it evaluates all the test cases. EvaluationService also ensures that there is no other job in the queue. ScoringService then receives a request from EvaluationService and receives an evaluated submission, which does not have a score. After updating the score, it is stored in the database. Another function of this service is to transfer information to RankingWebServer. Information consists of user and tasks. Users are pre-registered manually. As a result, throughout the competition, the ranks are ready.

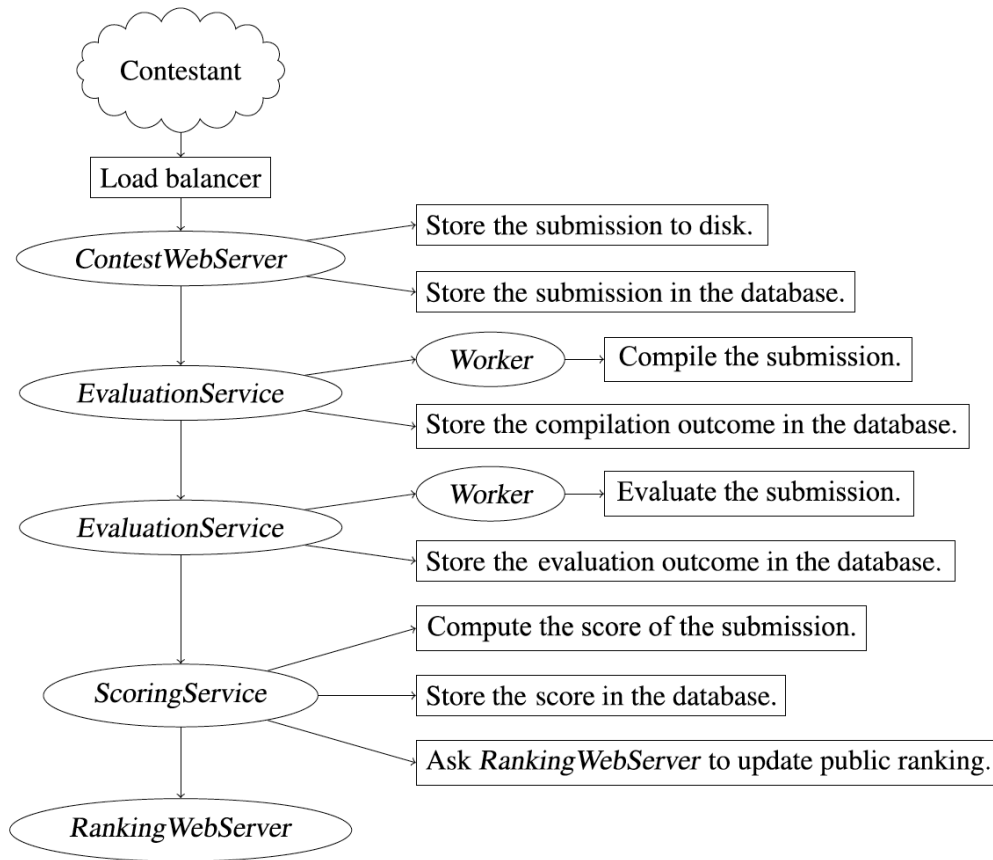


Figure 5. Submission through CMS

References:

P.S. All the parts that I did not mention as a reference are written from my own thoughts, architecture book and from the IOI web sites provided.

1. Maggiolo, S., & Mascellani, G. (2012). Introducing CMS: A Contest Management System. *Olympiads in Informatics*, 6, 86-99. Retrieved December 27, 2020, from <https://ioinformatics.org/journal/INFOL107.pdf>.