7TH
ASTI ROBOTICS CHALLENGE
2022/2023 TOURNAMENT RULES

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7th ASTI ROBOTICS CHALLENGE

2022/2023

ASTI Talent and Technology Foundation

ASTI Foundation was created in 2017 in awareness of the opportunities and major challenges presented by digital transformation, understanding that many jobs would be lost and new ones created, and that the key to managing this sustainable transition is and will be to educate and train young people for the world of work by developing talent and technology.

Its main programmes are **STEM Talent Girl**, which seeks to foster a vocation for science and technology among girls and young women, and the **ASTI Robotics Challenge**, which aims to promote STEM talent in the mobile robotics field. In recent years, new initiatives have been incorporated, such as **RuralBOTic**, aimed at promoting robotics in rural areas, **STEAM Talent Kids**, to promote robotics in primary school from a gender equality perspective, and **VET STEAM**, which encourages women to enrol in science and technology-oriented vocational education and training.

ASTI Robotics Challenge

The ASTI Robotics Challenge led by ASTI Foundation is designed to attract, stimulate and develop the talent that will enable Industry 4.0. Young people at secondary school, vocational education and training centres or university, as well as makers, are invited to apply the knowledge they have acquired in STEM subjects to a real collaborative mobile robotics project. The best projects will subsequently compete in a series of challenges in a robotics tournament with prizes for the top performers.

Challenge eligibility criteria and phases

Anyone meeting the following requirements may participate in this challenge free of charge and on a voluntary basis:

▪ Private individuals

▪ Residents outside Spanish territory

▪ Children under 18 years of age must register with a mentor or tutor over 18 years of age.

▪ Teams may have between 1 and 5 (maximum) participants.

An advisory committee will evaluate the entries received to decide which teams will advance to the final tournament.

Teams must present evidence of having overcome the challenges of the tournament for which they are registered.

ASTI Foundation reserves the right to refuse entry to participants who do not meet the requirements described in these rules.

Registered teams must share and present a research paper in the final challenge.

Entries for this category will be accepted until 11:59 p.m. on 31 March, the deadline for submitting the following information to info@astichallenge.com, indicating "ASTI_CHALLENGE_VII_INT + team name" in the subject:

- Team name, team members and affiliation
- Summary of the research paper (abstract of a maximum of 500 words + keywords + descriptive image)
- Tournament challenges in which you wish to participate
- Evidence of having overcome the tournament challenges in which you wish to participate

Participants in this category may participate in one or more of the following challenges:

- Mini-maze
- Grid
- Programming

All participating teams must submit a research paper on robotics or automation.

The research paper will be presented publicly in a talk lasting no more than 10 minutes. The best research paper will receive a €500 prize.

There will be a €500 prize for each tournament challenge, which will be won by the team with the best score in each challenge.

Prizes

There are four prizes for the winners of each challenge.

- Mini-maze
- Grid
- Programming
- Research paper

Each €500 prize will be won by the team with the best score in each challenge. Participants can win multiple prizes.

By accepting these rules, participants acknowledge their terms and conditions and undertake to comply with them. Consequently, by registering for the tournament participants fully and irrevocably consent to these rules and acknowledge their legality.

Announcement of the winners

The list of winners will be announced to the teams after the final tournament. The participants expressly consent to the publication of their name and image for publicity or communication purposes in relation to this challenge and on any medium without compensation of any kind. To this end, the result of the challenge will be announced with a link to a press release containing the names of the winners of the different challenge prizes.

Geographical scope

The scope of this challenge is international.

Publication of the challenge rules

These rules will be available on the website **www.astichallenge.com** and will therefore be available to anyone who wishes to consult them.

Taxation

The prize winner(s) will be liable for any taxes applicable to the prize.

Data protection

In accordance with Organic Law 3/2018 of 5 December 2018 on the protection of personal data and guarantee of digital rights relating to the protection of natural persons, and in accordance with the provisions of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, we hereby inform you that the personal data provided in this form will be processed by FUNDACIÓN ASTI TALENT AND TECHNOLOGY FOUNDATION for the following purposes:

Processing of the application to register as a team participating in the ASTI Robotics Challenge, as well as tasks deriving from organization of the project.

Publication of your identification data (name and surname) in the challenge project gallery, on the project website (https://astichallenge.com/) or on the Foundation's social media profiles (Twitter and Instagram), provided you have granted your consent thereto, in order to publicize the project. You may freely object to this data processing without that objection affecting the relationship between the parties. We also inform you that you may withdraw your consent at any time.

Use of photographic and audiovisual images (image and audio), in accordance with the provisions of Organic Law 1/1982 of 5 May 1982 on the protection in civil law of the right to honour, personal and family privacy and personal image, recorded during the ASTI Robotics Challenge in which you participate and in which you may appear individually or as part of a group and which may be published in the challenge project gallery, on the project website (https://astichallenge.com/) or on the Foundation's social media profiles (Twitter and Instagram), provided you have granted your consent thereto, in order to publicize the project.

ASTI Foundation undertakes to ensure that the use of these images is not under any circumstances detrimental to your honour or reputation or contrary to your best interests, respecting at all times the applicable legislation. You may freely object to this data processing without that objection affecting the relationship between the parties. We also inform you that you may withdraw your consent at any time.

Likewise, we may send you advertising or commercial information related to ASTI Foundation's sector and/or activity or related to events held by ASTI Foundation that may be of interest to you, as well as corporate greetings, by any medium, including digital, if you have given us your consent to do so. You are free to opt out of receiving these communications without this affecting any other contractual, commercial or professional relationship you may have with ASTI Foundation. You may withdraw your consent at any time.

Your data will not be disclosed to third parties, unless required by law or by the competent authorities.

International transfers of data will not be made.

Your data and that of the other members of your team will be kept a) while your application to register for the project is being processed; b) for the duration of the project in order to maintain appropriate contact with the participants and for the time necessary to deal with claims arising from processing; and c) for as long as you do not object to this for the purposes for which we have requested your consent.

The basis that legitimizes the processing of your data is your consent to manage the data provided for registration in the project, for the publication of your name and surname, for the recording and publication of your image and voice, and for the sending of commercial communications.

You may exercise your rights of access, rectification, erasure, objection, portability, restriction of processing of personal data and objection to automated individual decision-making by writing to us at FUNDACIÓN ASTI TALENT AND TECHNOLOGY FOUNDATION, Autovía A1, km 213.5, 09390 Madrigalejo del Monte (Burgos), Spain or at info@astifoundation.com. Requests must include proof of identity (copy of ID card, passport, etc.). In all cases, you have the right to lodge a complaint with the Spanish data protection agency (AEPD – Agencia Española de Protección de Datos).

For further information, see our privacy policy. https://astichallenge.com/politica-privacidad/

Modifications

ASTI Foundation reserves the right to make changes to the mechanics and criteria of the challenge, provided they are justified, are not detrimental to the participants and are communicated to them.

1. All robots must be battery-powered and must not require mains power except for recharging.

2. During the contest, teams will be allowed to add or remove robot components to adapt the robot to each of the tournament challenges. The dimensions of the robot and its accessories must not exceed 210 mm x 297 mm. There will be a technical inspection on the day of the event to confirm that the robot's dimensions and construction materials comply with the tournament rules.

3. Each of the challenges and their scoring system will be published on the challenge website.

2022/2023 ASTI ROBOTICS CHALLENGE:

INDIVIDUAL CHALLENGES

1. Grid

- *Capacities assessed*: Ease of installation, configurability, speed, manoeuvrability.
- *Description of the challenge*: The test takes place on a 2.5 m x 2.5 m grid. The grid consists of a set of 15 mm-wide black lines on a white background. The lines may not be equidistant. A set of starting positions and a set of destination positions are defined on the grid. The robot must move from a starting position to a destination position in the shortest time possible.
  Each team will have a time limit, which will be set on the day of the tournament and will not exceed 10 minutes, to complete as many missions as possible.
  In each mission, the judge may place obstacles on the grid and then randomly assign a number corresponding to the starting position and a letter corresponding to the destination position. The number of obstacles will increase with the number of completed missions.
  Once the mission is assigned, the team must program or reconfigure their robot to complete the mission autonomously without touching the obstacles. Upon completing the mission, or if so requested by the team, the judge will assign a new mission. If the robot touches an obstacle, it must start the mission over again.

The robot can be repositioned manually at the starting position at any time at the expense of the corresponding penalty. Under no circumstances may it be remotely controlled.

The robot must be autonomous. One "start" and "stop" button (on the robot or on the controller) is allowed. Participants are allowed to pick up the robot at the end of the turn to place it back on the assigned starting position.
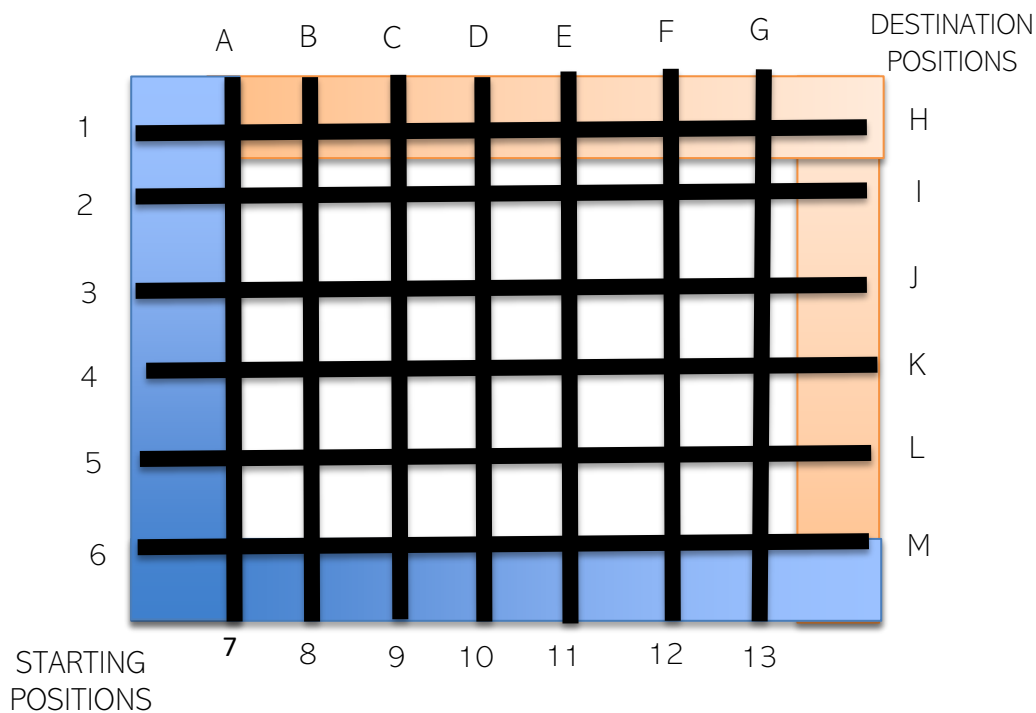
- *Type of control*:
    - Autonomous.
- *Scoring*:
    - 25 points for each completed mission.
- *Penalties*:
    - 10 points for each request for a mission change.
    - 5 points each time the robot is manually returned to the starting position (except after completing a mission).

2. Mini-maze

- *Capacities assessed*: Perception and autonomy.
- *Description of the challenge:* The mini-maze is a small circuit made of wood. The walls are at least 100 mm high and painted in different colours. The floor of the maze is white and the board is divided into four zones: A, B, C and D.

Neither the measurements of the board nor the final layout are provided beforehand. Sensors are therefore required for this challenge. The objective of the challenge is for the robot to autonomously steer itself through the maze without touching the walls until it reaches Zone D. The robot will start from a pre-determined position on the board.

Each robot will have a time limit, which will be set on the day of the tournament and will not exceed 10 minutes, to complete the route from a stationary position in the starting area. The number of attempts permitted will be decided on the day of the tournament. At the end of each attempt, the zone in which the robot is located and the time elapsed will be recorded. Each attempt will end either when the robot reaches Zone D, or when the robot is picked up at the participant's request, or when the time limit expires. Only one attempt will be counted and the team may decide which attempt it wishes to submit to the judges. Between attempts participants will have a restricted amount of time to recalibrate the robot. This time will be defined on the day of the tournament.

The maze walls can be moved to allow the layout of the maze to be changed between turns. To overcome the challenge, participants will need to ensure that the robot's sensors are functioning to their best capacity.

The images on the following pages show the robot to scale at its maximum size.
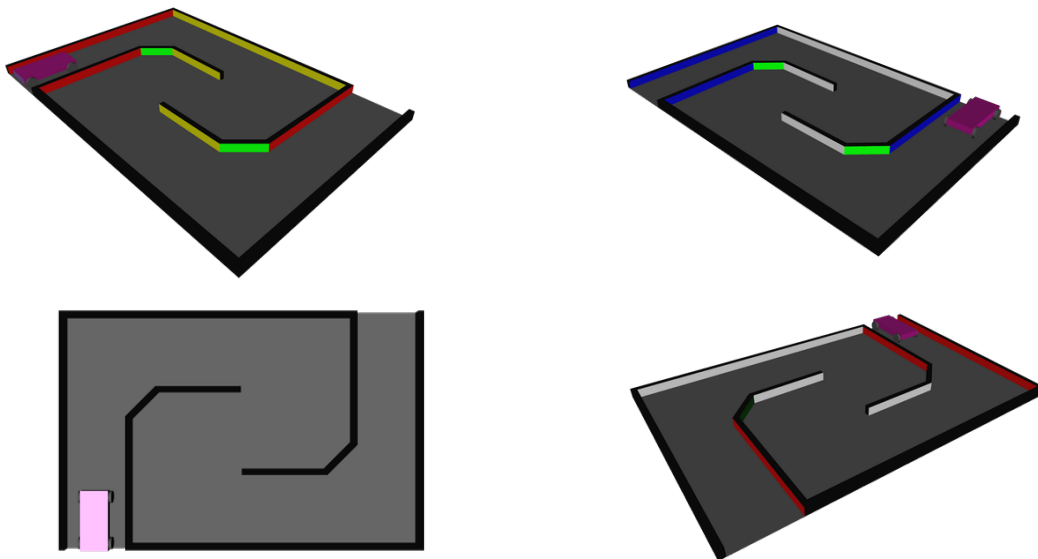
These images are for illustrative purposes only.

- *Type of control*: Autonomous.
- *Scoring:* Participants will be ranked according to the zone the robot reaches and the time elapsed, with the robot that takes least time receiving the highest score. Each turn will be scored independently. The final challenge score will be

the sum of the scores of each turn. The following table shows the distribution of scores per zone:

A	B	C	D
1st: 5 points	1st: 10 points	1st: 15 points	1st: 20 points
2nd: 4 points	2nd: 8 points	2nd: 12 points	2nd: 16 points
3rd: 3 points	3rd: 6 points	3rd: 9 points	3rd: 13 points
4th: 2 points	4th: 4 points	4th: 6 points	4th: 9 points
5th: 2 points	5th: 4 points	5th: 6 points	5th: 8 points
6th: 1 point	6th: 2 points	6th: 3 points	6th: 6 points
7th: 1 point	7th: 2 points	7th: 3 points	7th: 5 points
	8th: 1 point	8th: 2 points	8th: 4 points
	9th: 1 point	9th: 2 points	9th: 3 points
		10th: 1 point	10th: 2 points
			11th: 1 point

- *Penalties*:
    - Each time the robot touches the wall it will receive a 10-second penalty.

3. Presentation of the paper to the jury

- *Capacities assessed*: Innovation, research, synthesis and effective communication.
- *Description of the challenge:* Teams must publicly present a research paper. They will have a maximum of 10 minutes. After the presentation, the jury, which will be made up of experts from the technology sector, will have 5 minutes for a round of questions. The presentation will be judged on content and quality of communication. Aspects such as communication skills and degree of innovation will be assessed, as will the ability to answer the jury's questions.

4. Programming challenge

1. Description of the challenge

The objective of the challenge is to help a robot reach its destination by controlling its wheel speeds. The robot is a differential unit measuring 10 cm x 10 cm.
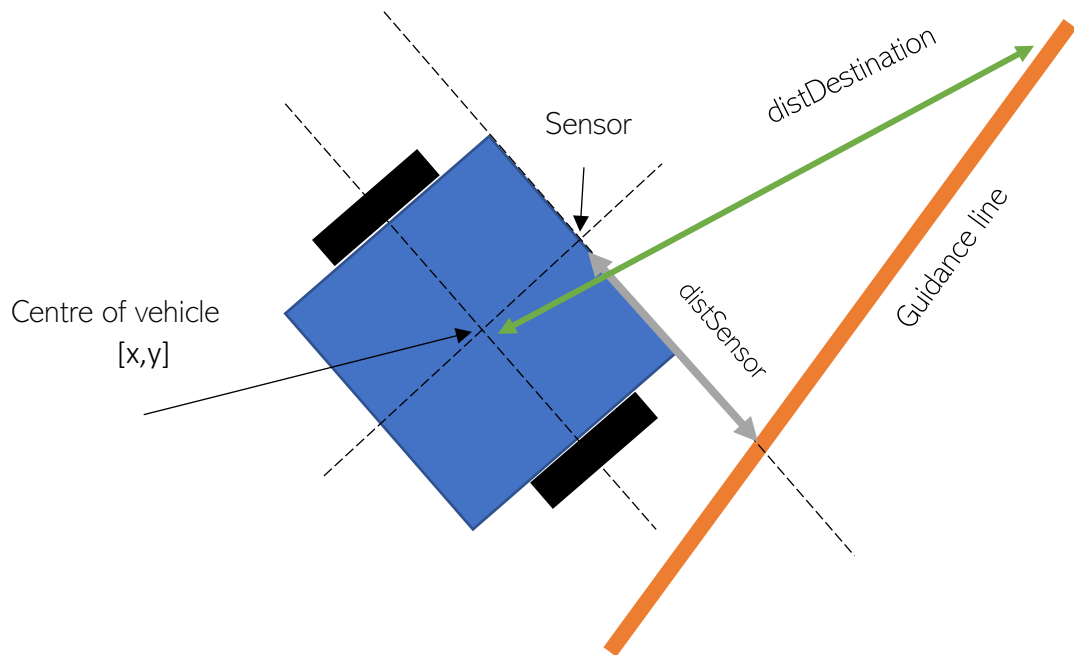
Figure 1. View from above

In a differential robot, if the two wheels rotate at the same speed the robot moves in a straight line. If the rotation speed of the right wheel is greater than that of the left wheel, the robot will tend to turn to the left. If the rotation speed of the left wheel is greater than that of the right wheel, the robot will tend to turn to the right.

To help the robot reach its destination a guidance line and 2 sensors are provided. The line is only an aid and following it is not mandatory. The destination point will always be on the guidance line. The *distDestination* sensor sends the distance in a straight line between the centre of the robot and the destination point. The *distSensor* sensor indicates the distance between the centre of the front of the vehicle (location of the sensor) and the intersection between the line extending from the front of the vehicle and the guidance line (see Figure 1). When the sensor is positioned to the left of the guidance line the result is positive, when the sensor is positioned to the right of the line the result is negative. When the sensor is directly over the line the *distSensor* distance is 0. If the robot moves perpendicular to the guidance line, the line extending from the front never intersects with the guidance line and the value returned by the sensor is NaN (Not a Number).

Figure 2 shows an example of robot performance during the challenge. The blue line is the guidance line. The robot starts from the green dot and the destination point is the red dot. The path described by the robot is shown in black.
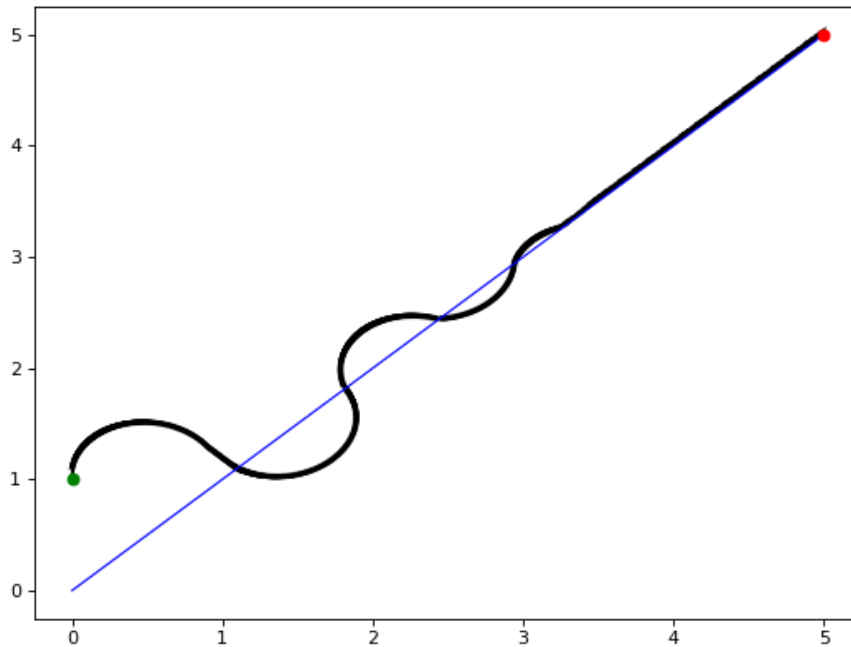
Figure 2. View from above

For this year's challenge we have added obstacles, placing one or more in the robot's path to provide an even greater test. The robot is equipped with a safety laser with a 10 m range covering a 180° arc. The laser provides information on the location of the obstacles in polar coordinates relative to the position of the robot. The *readSensorObs()* function returns a list of pairs (relative angle in radians, distance to the centre of the obstacle) for each obstacle encountered. All obstacles will be circular and have a radius of 1 m.

Figure 3 shows an example of the robot operating in an environment with two obstacles. In this case, the information provided by the obstacle sensor, assuming the obstacles are placed at 1 m and 30°, and at 1.5 m and -20°, would be as follows: **((1, 0.5236),(1.5, -0.3491))**
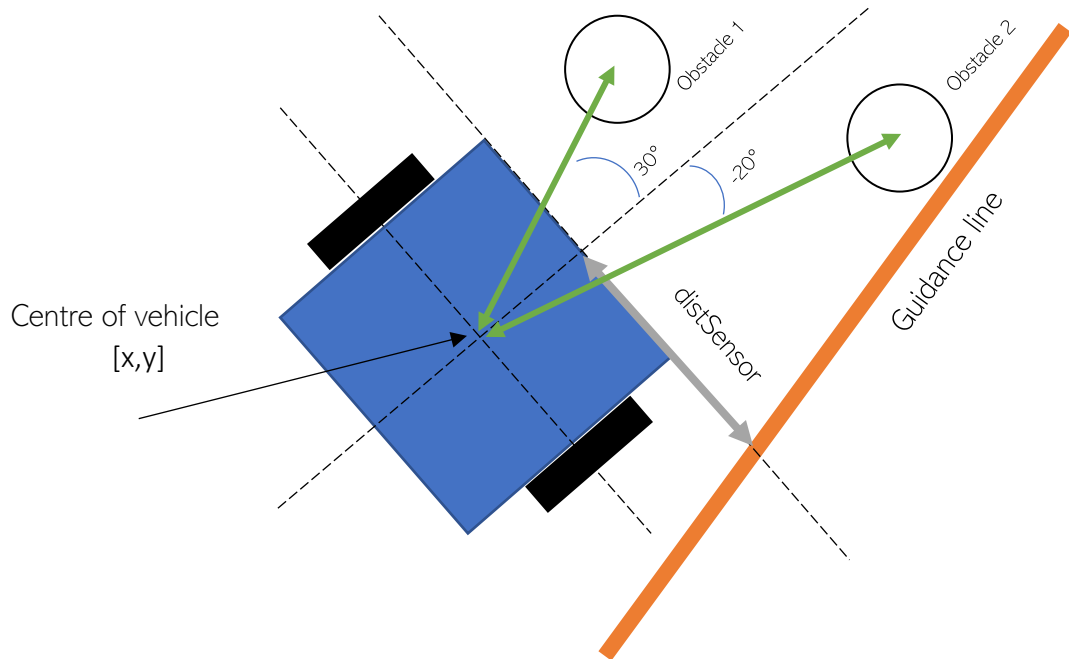
Figure 3. View from above with obstacles

Python will be the programming language used to implement the algorithm. The language has been chosen for its simplicity of programming and execution, abstraction capacity and interoperability. These characteristics make it one of the languages most widely used by the scientific and academic community in algorithm development and validation.

Participants are provided with the code that models the behaviour of the robot, the line and the sensors, as well as the necessary functions to visualize the robot's trajectory. **This code cannot be modified.** Participants will only be able to edit the sections of the program enabled for this purpose (Section A and Section B, see Figure 4 below). Section A is for the user to initialize all the variables required before each phase is executed. The code in Section B is executed every 100 ms and provides the instructions that control the robot.

Participants only need to submit the code for Sections A and B, which will be automatically validated. Code that does not meet this requirement will not be taken into account (see Figure 4).

Wheel rotation speed is modified with the following function:

```python
def fijarVel(self,vIzq,vDer):
    if vIzq > 2:
        self.__vizq=2
    elif vIzq <-2:
        self.__vizq=-2
    else:
        self.__vizq=vIzq
    if vDer > 2:
        self.__vder=2
    elif vDer < -2:
        self.__vder=-2
    else:
        self.__vder=vDer
```

This function receives the speed of the left wheel as the first input parameter and the speed of the right wheel as the second input parameter. The maximum permitted speed is 2 m/s in both directions.

2. Additional rules

- Plagiarism will result in the disqualification of the participating team and the prohibition from participating in the rest of the tournament challenges.

- Participants will be able to implement functions and call them.

- Please contact the organizers should Python libraries not currently included in the code be needed.

```
#PROGRAMA PRINCIPAL
#----------------------
Tfin=200
r=Robot(Tfin)

while r.leerT() < Tfin and not r.leerFinFases()
      and not r.leerColision():
    r.actTiempo()
    Tfin=200
    #----------------------------------
    # Tocar a partir de aqui {
    #----------------------------------


    #----------------------------------
    # } No tocar desde aqui
    #----------------------------------

    while r.leerT() < Tfin  and not r.leerFinal()
          and not r.leerColision():

        r.actTiempo()

        #----------------------------------
        # Tocar a partir de aqui {
        #----------------------------------


        #----------------------------------
        # } No tocar desde aqui
        #----------------------------------

#------------------
if  r.leerFasesSuperadas()==9:
    print ("--------------------")
    print (" :) Ha llegado al final")
    print ("--------------------")
    print ("Fases superadas:")
    print (r.leerFasesSuperadas() )
    print ("Tiempo total: ")
    print (r.leerTiempoTotal() )
else:
    print ("--------------------")
    print (" :(  Intentelo de nuevo")
    print ("--------------------")
    print ("Fases superadas:")
    print (r.leerFasesSuperadas()    )
    print ("Tiempo total: " )
    print (r.leerTiempoTotal() )

#DIBUJO
r.pintar()
```

SECTION A

Participant code

SECTION B

Participant code

Figure 4. Main program

3. Description of the challenge

This year we are adding obstacles to our challenge. The new challenge will be published on **4 November 2022**. The teams folder containing all the information on this challenge also has all the details about the last edition.

4. Submission procedure

Email the algorithm to desafio@astichallenge.com, indicating "Programming phase + team name" in the subject. More than one algorithm can be submitted, though only the last entry will be taken into account for scoring.

5. Submission deadline

Entries must be submitted by 11:59 p.m. on 31 March.

6. Sample routine and program

Below is the link to last year's routine, which can be used for testing:

https://drive.google.com/drive/folders/1WDczKZwdPX-xN5CC0EmaA4CFpNFi2soI?usp=share_link

This folder contains an Excel file that will be updated with the scores obtained by the code submitted. Scores will be updated on Fridays at 12:00 p.m.

Full details at:

www.astichallenge.com/