2019 ASABE Student Robotics Challenge

The ASABE Student Robotics Challenge provides a stimulating and fun hands-on learning experience for undergraduate and graduate students to learn and demonstrate their knowledge and skills in agricultural robotics. For 2019, the challenge, to be held during the ASABE Annual International Meeting in Boston, Massachusetts, July 7 to 10, 2019, will simulate autonomous management in a plant nursery.

The Robotics Challenge event in 2019 will be held on a new playing field setting. This year, two robots from two teams will compete against each other. The competition will be held in a tournament format, and it will be divided into two divisions: a “beginner” division and an “advanced” division. The tournament will be held on Tuesday July 9th, 2019, but teams can practice on the competition boards on Monday July 8th, 2019, the day before the tournament.

The details about the rules of the competition are below. You can submit all of your questions about the event and challenge rules here: https://goo.gl/forms/g0XJDt9AgYKqLIMB2

Updates to the rules are in red.

Objective: To correctly identify, arrange, and fertilize (advanced only) the most nursery plants in the shortest possible time in a match against another team.

Environment: A plant nursery environment will be simulated on a symmetrical 16ft x 4ft playing field.

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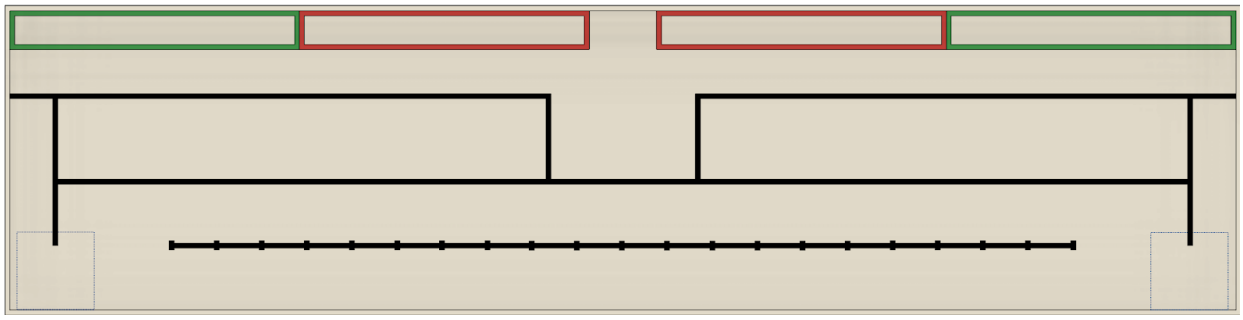
Competition Rules

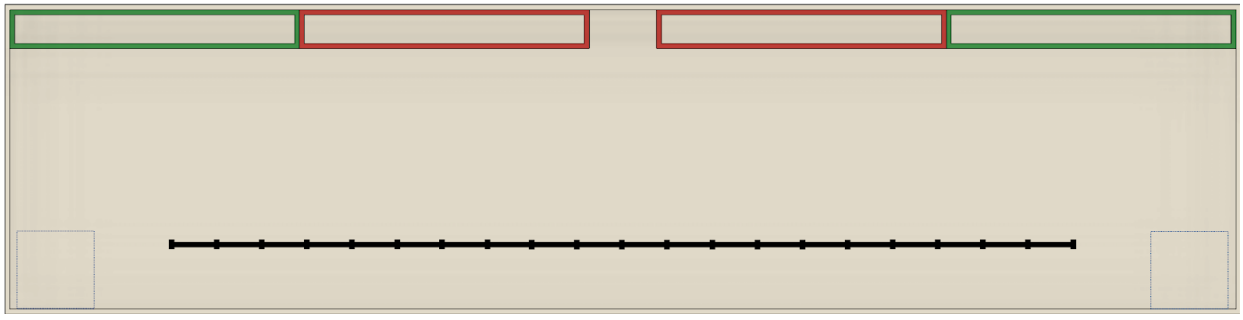
Playing Field

Both the advanced and beginner divisions will have a playing field that is 16ft x 4ft and are only allowed to use one robot to compete in the challenge. Below are the layouts for the two divisions. There are 21 simulated pot-plants on the board and robots need to identify them and transport them to the storage area. One pot, called the “Golden Pot,” will be placed in the center of the board and will have extra points for the robot that collects and places it correctly. The competition will be divided into a “Beginner” and an “Advanced” division. The beginner division is mainly geared towards undergraduate students with limited coursework in programing or microprocessors, while the advanced division is targeted towards upperclassmen and graduate students majoring in engineering. There will be black tape (as indicated below) on the board to aid the beginner teams with navigation.

Top view of the playing board for beginners division

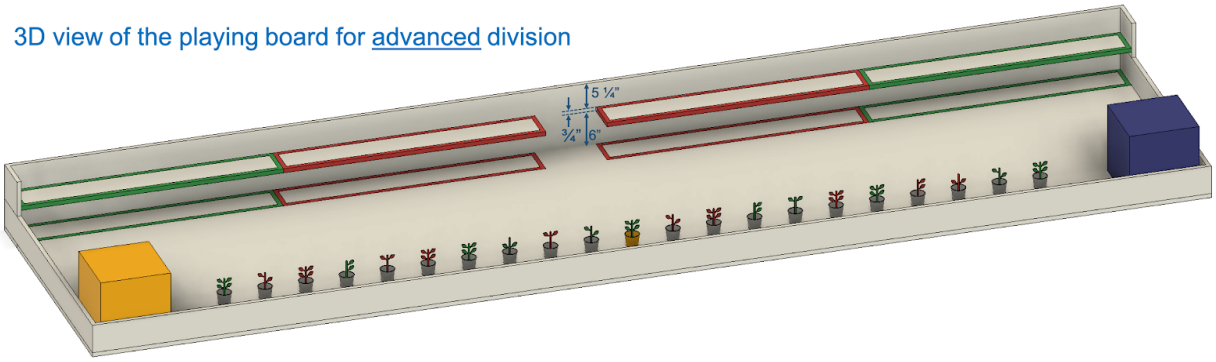


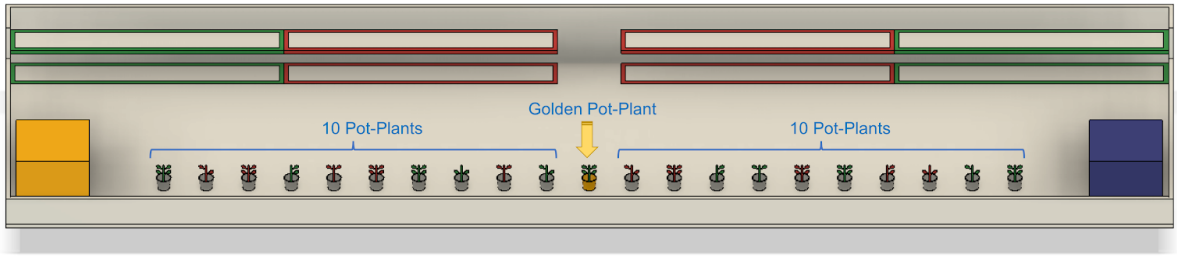
Top view of the playing board for advanced division



The board for the advanced division has the storage area arranged in two shelves. The advanced robot needs to place the healthy plants on the top shelf and the stressed plants on the lower shelf. No black tape will be placed on the board for the advanced robots.

3D view of the playing board for advanced division

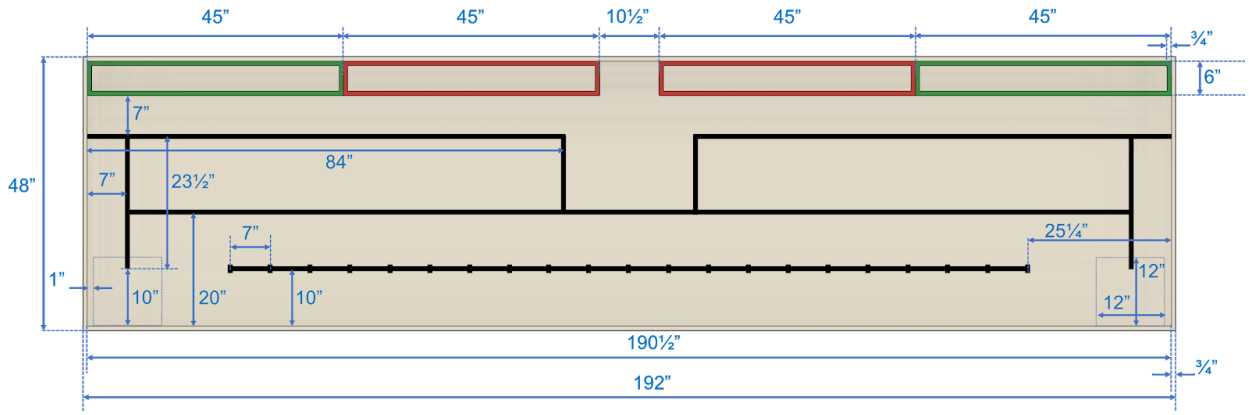




- The storage areas on the board for advanced division are arranged in two shelves.
- The top shelf is for healthy plants and the lower shelf is for stressed plants.
- The top shelf will be placed at a height of 6”.
- The height of the wall in the back of the storage area is 12”.
- The yellow and dark blue cubes on the board represent the robots.

In this tournament, each team will have ONE robot which will start from one corner and the robot from the opposing team will start on the same wall, but on the opposite side (as shown in the images above). The robots should be able to work on either side of the board, since each team’s starting position will be unknown before each match. The maximum size for a robot is 12” by 12” by 12” at the beginning, although robots will be allowed to expand after the preliminary measurement and after the match has begun. A 12” by 12” by 12” box cover will be placed over the robots until the timer begins. Robots are allowed to take pots from the opponent side after they collect all the 10 pots on their own side plus the golden pot. The distance between plants (the centers of the pots) and the south edge of the playing field is 10”. The height of the walls around the board are 5”. For the advanced division, the north wall is taller (12”) to accommodate the two shelves of the storage area.

Top view with dimensions



- The board is completely symmetric.
- The black tape on the board may be used for navigation (for beginners division) and for locating the pots (for both divisions).
- The width of the black tape on the board is ¾”.
- The 12x12” areas in the lower left and right corners of the board (shown by dotted lines) are the starting location for robots. Robots must start within 1” of the side walls.
- The green and red tape on the board delimit the storage areas for the two types of plants.
- The width of the green and red tape on the board is ¾”.

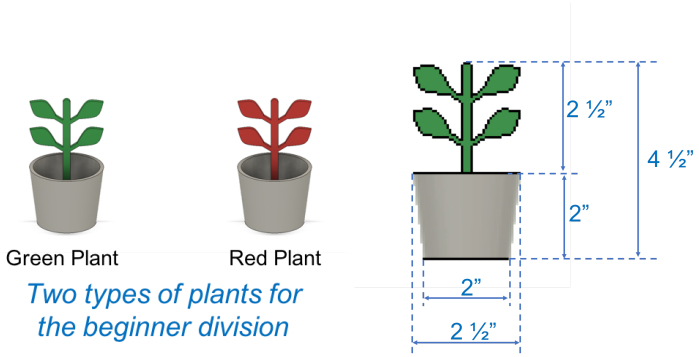
Pot-Plants

The blueprints (3D models) of pots and plants are provided in .stl format so that teams can 3D print them for practice. Pots should be printed with black filament. The golden pot should be printed with yellow filament. Plants should be printed with green or red filament.
On the board there will be 21 total pots, 20 green/red plants (and also healthy/stressed plants for advanced division) and 1 golden pot. All the plants will be randomly placed with exception of the golden pot that will always be placed in the middle. All plants will face the same direction with the leaves parallel to the south edge of the playing field. The golden pot does not have a specified storage area and depending on the color of its plants (red or green) it should be transported to the right storage area. The first team to get the golden plant and correctly place it in the storage area will receive extra points (see Scoring). Teams are required to move all 10 of their assigned plants to the storage area before attempting to move the golden plant.

Beginner Division

The beginner division is designed for undergraduate students who are interested in robotics and may not have a strong background in programming, robotics, or microcontrollers. The membership for the beginner division is only for undergraduate students.

For the beginner division there are two types of plants, red and green plants, all with four leaves.



Two types of plants for the beginner division

There is an additional golden pot that is in play, which both teams can move but are not required to. The board for the beginner division has black lines available for guidance and navigation, if the teams choose to use them. The overall goal is to find the plant, distinguish if it's red or green, and place it in the correct storage location. The match will last for five minutes or until all pots have been moved, whichever comes first. Robots must stop moving at exactly five minutes from the beginning of the round.

Scoring for beginner division

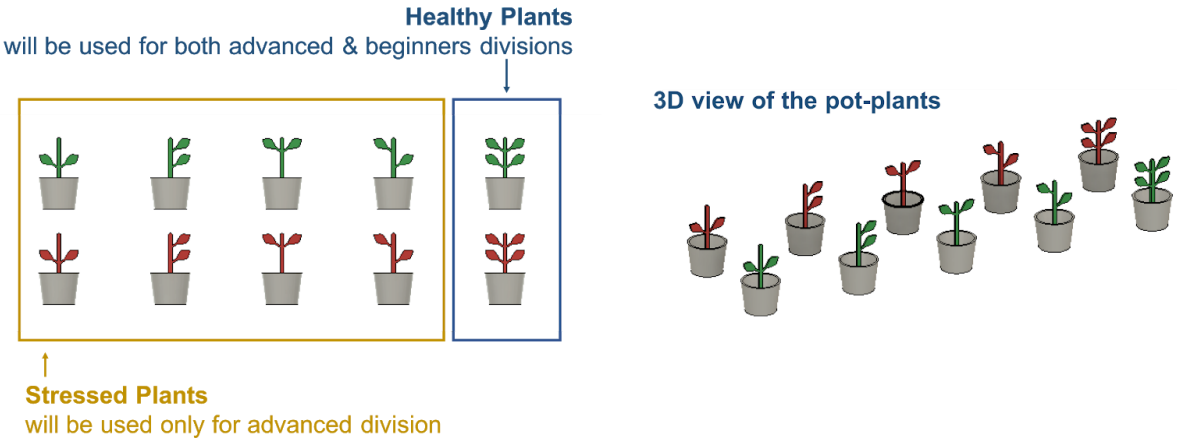
Matches will be won based on the number of points each team scores in that match. Equal match scores will be treated as ties in the match. Points will be earned as follows:

- 1 point per plant that is placed anywhere within the storage area
- 1 additional point per plant that is placed in the *correct location* in the storage area
- 3 points for the golden plant that is placed anywhere within the storage area
- 2 additional points for the golden plant that is placed in the correct location in the storage area
- Note: Only pots that are carried and remain upright until the end of the round will be eligible for points. Any pot that is knocked over will not be counted for any points.

Advanced Division

This division is designed for upperclassmen and graduate students majoring in robotics or remote sensing or who are experienced in programming. For the advanced division, there are two types of plants, red and green, as in the beginner division. However, the number of leaves per plant will vary: plants with four leaves will be identified as healthy plants while plants with two leaves will be identified as stressed plants. Moreover, the arrangement of the leaves in stressed plants will vary. Examples of the possible arrangements are shown below. The advanced robots need to identify the type of plant (color) and monitor them for stress (number of leaves). If stress is detected in a plant, the robot will need to apply fertilizer before, while, or immediately after, placing it in the storage area. Stressed plants should be placed on the lower shelf (same plane as the board floor) while non-stressed plants should be placed on the top shelf.

Different types (colors) a health statuses (healthy or stressed) of plants



The target for the robot is the black pot (or golden pot) with a red or green plant. The robot should be able to detect the plant type based on its color, and check whether it is a stressed plant or a healthy plant based on the number of leaves. If it is a healthy one, it should be stored on the healthy shelf which is the top shelf. If it is a stressed one, the fertilizer should be applied to the stressed plant and it should be stored on the lower shelf. There is no aid line for robots in the advanced division and robots should be able to navigate without any guideline, except for the black line where the pots are initially placed. Each team should bring their own materials to represent fertilizer. The materials used as fertilizer should be in spherical shape with diameters limited to the range of 5-8 millimeters, in any color excluding black. One example of such a material is airsoft pellets. The committee will provide white, 6mm airsoft pellets for any teams that want to use them during the competition. These pellets can be ordered from this link: https://www.amazon.com/Bulldog-Airsoft-Pellets-Biodegradable-Polished/dp/B07DHTWQTP/

Picture showing airsoft pellets, an option for teams to use to represent fertilizer

The match will last for five minutes or until all pots have been moved, whichever comes first. Robots must stop moving at exactly five minutes from the beginning of the round.

Scoring for advanced division

Robots will be scored based on their performance correctly moving and fertilizing plants based on plant type and plant health. Matches will be won based on the number of points each team scores in that match. Equal match scores will be treated as ties in the tournament. Points will be earned as follows:

- 1 point per plant that is placed anywhere within the storage area
- 1 additional point per plant that is placed on the *correct side* of the storage area (based on color)
- 1 additional point for each plant placed on the correct shelf.
- 2 additional points per plant that is correctly fertilized
- -2 points per plant that is incorrectly fertilized
- **3** points for the golden plant that is carried to the correct location in the storage area
- Notes:
    - Correct fertilizer application is defined as applying fertilizer to a stressed plant OR not applying fertilizer to a non-stressed plant.
    - Incorrect fertilizer application is defined as either applying fertilizer to a non-stressed plant OR not applying fertilizer to a stressed plant.
    - Only pots that are carried and remain upright until the end of the round will be eligible for positive points. Any pot that is knocked over will not be counted for any positive points.
    - No fertilizing points (positive or negative) will be awarded to the golden pot plant.

Tournament Regulation

The type of tournament will be decided based on the number of teams registered for each division of the competition. If an adequate number of teams register, the tournament will be held in a two-stage tournament: the group stage followed by the knockout stage. In the group stage, teams compete within groups of four teams each, so all teams will play at least three games in the group stage. Two teams from each group will advance to the knockout stage which is a single-elimination tournament. The final and third-place matches will determine the champion, runner-up, and third-place teams. Other types of tournaments will be considered if the number of registered teams in either divisions is not adequate for a two-stage tournament.

Processor Restrictions

Devices such as consumer-grade computers, laptops, NUC-like devices, smartphones, tablets, or gaming devices may not be integrated into robots for the 2019 competition. Wireless

communication with the robots is completely outlawed. Following are the metrics that will be utilized per processor and RAM restrictions:

Processor Restriction: In an effort to level the playing field and reduce costs for teams, processor restrictions will be implemented for the 2019 competition. The processor restrictions are as follows:

- Processors may not be embedded in consumer- or enterprise-grade electronics, such as laptop computer, NUC-like devices, tablets, mobile phones, or gaming devices.
- Processors and RAM will be limited based on a credit allocation system.
    - Teams have a total of
        - 6 credits to utilize per robot for beginner teams
        - 8 credits to utilize per robot for advanced teams
    - Teams may utilize the credits in any manner they wish for either the processor or RAM. Credits will be allocated in the following way:
        - 1 credit for each 1.0 GHz CPU core, rounded to the nearest 0.10 GHz of manufacturer stated clock speed.
        - 1 credit for each 1.0 GB of RAM, rounded to the nearest 0.10 GB of manufacturer stated RAM.
- Teams must present **detailed manufacturer-supplied spec sheets** of any RAM or processors at the time of the competition. Any team that fails to specify these details will not be allowed to participate in the competition. Processors and RAM cards must be positioned on the robot to allow visual inspection by the judges during the competition.
- Random and spot inspection at any time during the competition may take place.

Fouls and Misconduct

This year we will have 2 robots from 2 different teams compete simultaneously on the same board. We expect teams to play fairly and uphold sportsmanlike conduct. If a team is found to deliberately interfere with the other team's robot or target during a time trial and the judges and committee decides there was foul play, there will be immediate disqualification from the tournament.

In order to prevent this from happening, please use your best judgement to identify what is or is not sportsmanlike. Below, we have outlined some examples of fouls and misconduct. This is not necessarily a comprehensive list and it is at the discretion of the judges and committee to assess what is or is not a foul or misconduct during the competition. If you have any questions about what is or is not a foul, please submit your questions to the committee, as directed at the beginning of the document.

- All sensors or electronics on the robot must have a justification for being on the robot
    - Example - Infrared LEDs
        - Having infrared LEDs on your robot paired with an infrared receiver for wall or object detection is a fine justification

        - Having infrared LEDs on your robot with no justification will be treated as an attempt to interfere with another team's infrared sensors and will result in immediate dismissal from the competition
- If a robot runs over the pots on the other side of the board (including the golden pot) will result in ending that match and the other robot will be considered as the winner of that specific match. Running over the 10 pot-plants on the same side as the robot is not considered as a foul.
- Robots are not allowed to take pots from the opponent side, before they collect all the 10 pots on their own side plus the golden pot.
- Sweeping the pots is considered foul. Robots must lift and carry the pots.
- No wireless communication is allowed after the time trial has begun and no team or team member shall interfere or attempt to interfere with any other team's or the competition venue's wireless communication. Violations of this rule may lead to dismissal from the competition.
- Any operation that may not be acceptable in real world application will cause a team to be disqualified. The judges and committee will decide about any fouls or misconducts that are not mentioned here.

Poster

All teams must participate in the poster session to be eligible to compete. Teams must display a poster which details the function, design and specification of their robot. Posters must be 24-inches wide and 36-inches tall and include the following information:

- Team Name
- University
- Team member names
- Team advisor's name
- Pictures of the completed robot
- A narrative describing how the robot accomplishes the task

You may include additional information if you like, but the above items must be present. A poster session (max two hours) will be held prior to the competition on Monday July 8th, 2019. At least two team members must be present during the poster session. Once the session is over, teams will hang their posters at their assigned workstation.

The poster session will be a time for competitors to use technical and communication skills to interact with the various companies and universities attending the ASABE AIM. Please use this opportunity to showcase your skills and talents to potential future employers.

Prizes

Prizes will be awarded for the top three teams in each division. A prize will also be awarded to the best poster, as determined by the judges. Prize details and amounts will be forthcoming.

Required Components

- Use ¾ inch plywood for constructing the playing field
- Paint the playing field white
- The blueprint for pots and plants are provided (in .stl format) in the zip file
- Storage zones will be identified by red and green colored tape (width: ¾“)
- Black tape will be used for as a navigation guide in the beginner division
- Fertilizer (for advanced division): Each team should bring their own materials resembling fertilizer. The materials used as fertilizer should be in spherical shape with diameters limited to the range of 5-8 millimeters in any color but black.