URC 2018: Advanced Division Rulebook

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Competition Overview

Title: An Automated Harvest

Competitors will have to build robots used to harvest ripe apples from an orchard. In recent years, automation driven by IoT (Internet of Things) continues to be adopted across diverse fields, with agriculture being no exception. Agricultural automation not only makes effortless mass production of food a very real possibility, but also a viable solution to food shortages caused by a projected world population increase of one billion in the next decade. The mission of these robots is to set off at the Starting Point, follow along the track to visit each tree in order and harvest only the ripe red apples before delivering them to the barn and returning to the Starting Point.

Figure 1. Advanced Division Course
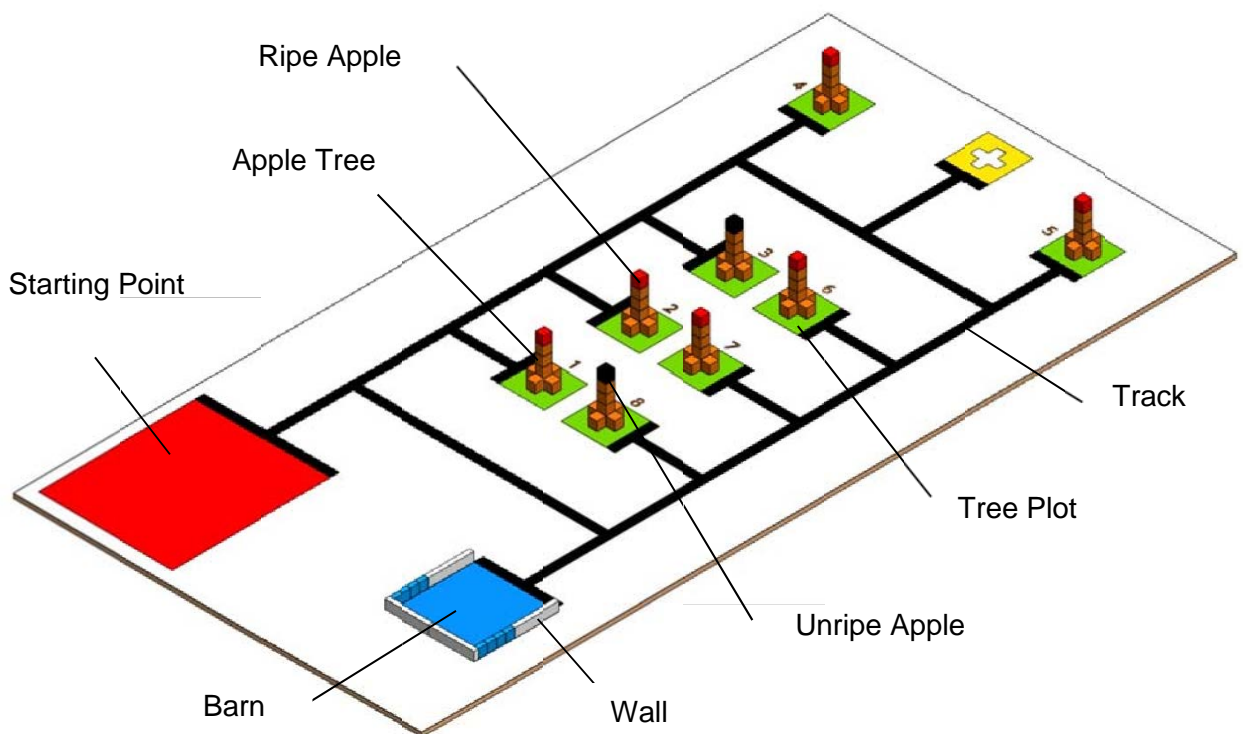
1. The Competition

○ Missions

◇ Basic Mission

Robots will have to set off at the Starting Point, going around the orchard and picking apples to deliver them to the Barn. The mission is complete once the robot finishes the job, returns to the Starting Point, and turns on its finish light (a blue LED).

◇ Special Missions

The special mission will be held during finals. The content of this mission will be announced the day of the competition.

◇ Robot Requirements

> Act autonomously from the point they leave the Starting Zone until they finish the job.

> Harvest as many ripe apples as possible and deliver them to the Barn.

> Complete the mission in the shortest possible time.

○ Course Guide

◇ Apples

All apples will be built from Artec Blocks as shown in Figure 2, using red blocks for ripe apples and black blocks for unripe apples. All apples on the course have the same shape.
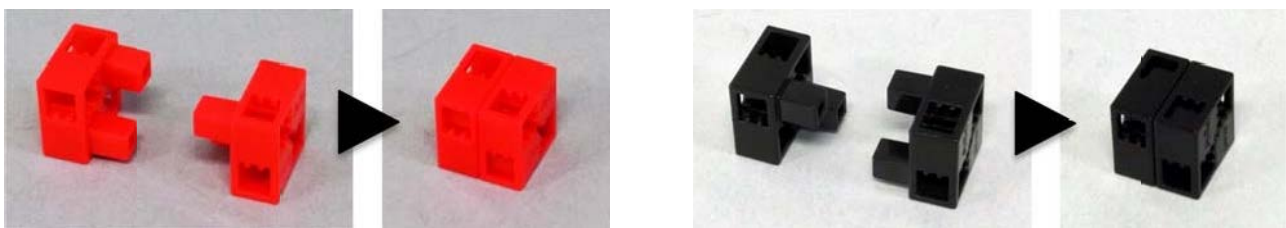

Figure 2. Assembling the Apples

◇ Apple Trees

Apples are placed on top of apple trees as shown in Figure 3. Apple trees will also be built from Artec
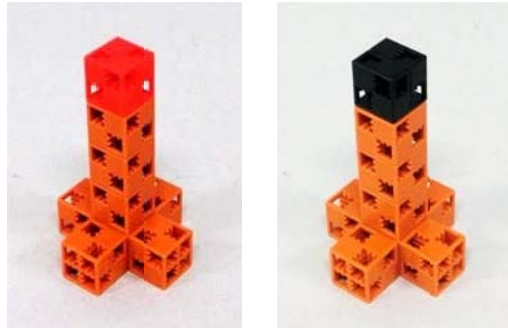
Blocks as shown in Figure 4.
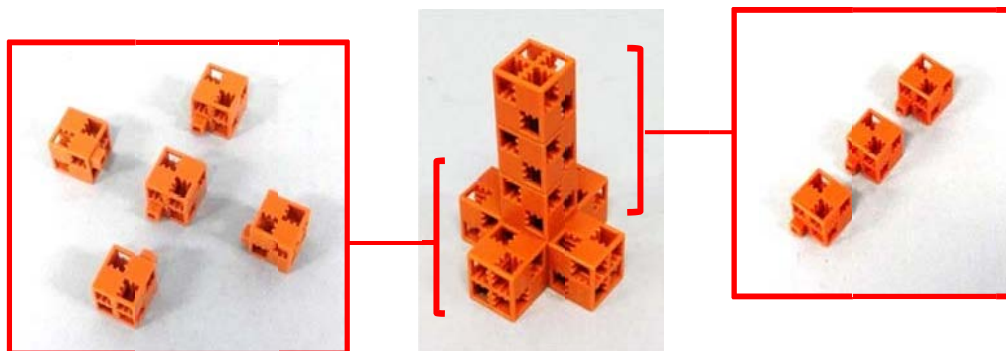

Figure 3. Placement of Apples

Figure 4. Building an Apple Tree

There will be a total of eight apple trees placed around the orchard on green plots indicated by the

numbers one to eight.

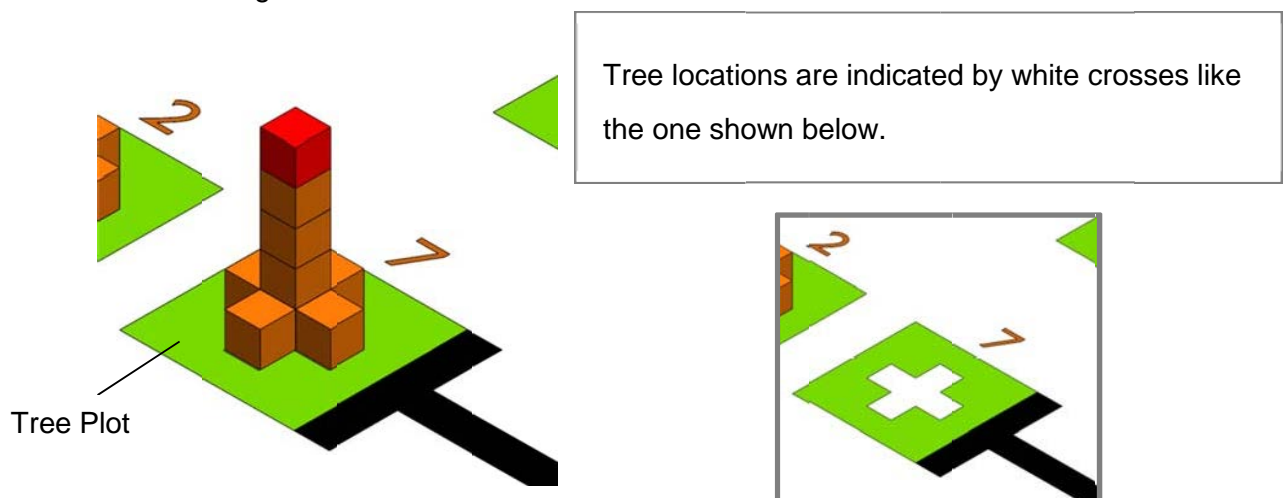Tree locations are indicated by white crosses like the one shown below.

Tree Plot

Figure 5. "Planting" an Apple Tree for the Competition

◇ Walls

The blue Barn area the apples are delivered to will be enclosed by three walls made from Artec
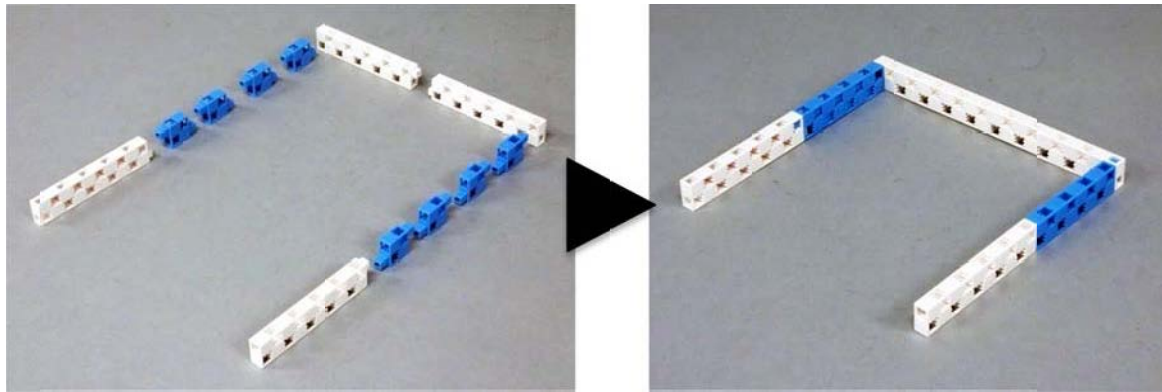
Blocks. The walls are <u>not fixed on the course</u>.


<u>Figure 6</u>. Building the Walls

2. Competition Rules

1) Each round of the competition is 360 seconds (six minutes).

2) Robots are placed on the red Starting Point and start at the sound of the referee's whistle.

3) Robots are not allowed to cross the Starting Point, including the air above the orchard, until the round starts.

The black line is not part of the Starting Point.
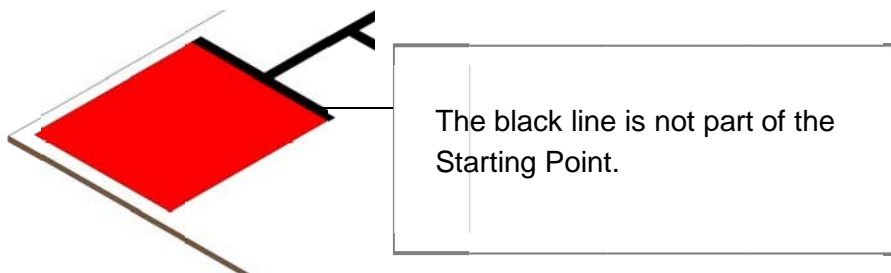
4) Once the robot starts moving, competitors are not allowed to touch it until the end of the round.

5) No retries are allowed during the round.

6) Ripe apples are set on six of the eight trees (see page 11, Figure 8 for the location of each tree), with unripe apples placed on the remaining two. The numbers of these trees will not be revealed until the day of competition and are decided fairly by a referee's lottery at each venue.

7) Each ripe apple harvested by the end of the round is worth 20 points (this includes simply knocking a ripe apple down from the tree). Be aware that no points will be awarded if the robot moves the apple tree out of the plot and only half points will be awarded if the tree is moved partially out.

Partially Moved	Moved Completely Out	Knocked Over
Half Points	No Points	
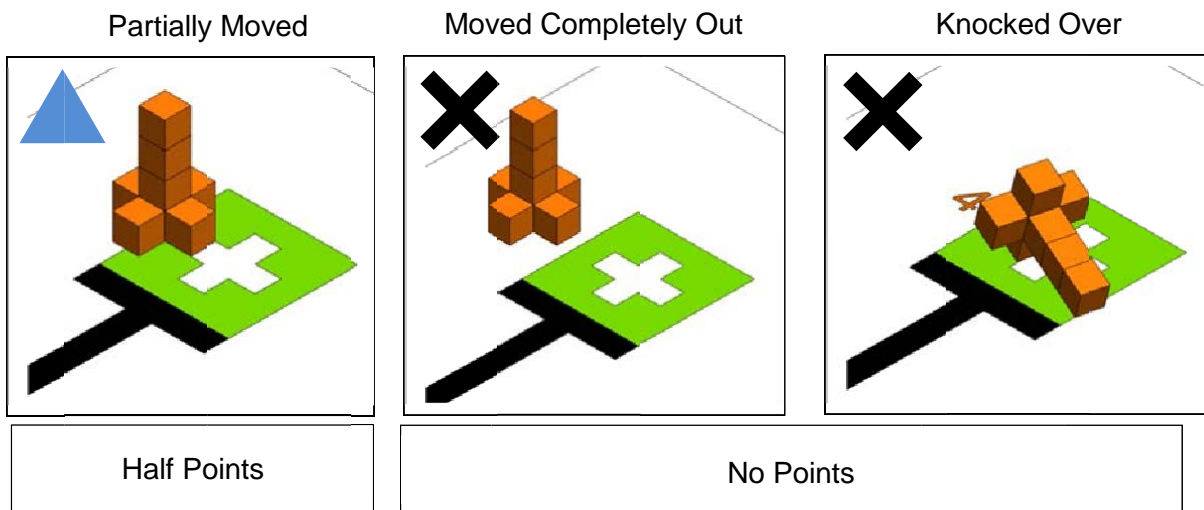
8) Each unripe apple harvested by the end of the round results in a 20-point deduction (this includes simply knocking an unripe apple down from the tree). The amount of points deducted will not change even when the robot moves the apple tree from its plot. Be aware that points will not be deducted in the event the robot moves a tree with an unripe apple without harvesting it (meaning the unripe apple still remains on top of the tree).

9) Each ripe apple delivered to the blue Barn by the end of the round is worth 50 points. Be aware that these points will not be awarded if the apple is not inside of the Barn. Half points are awarded if the apples are only partially outside of the barn. No points are awarded for unripe apples delivered to the barn, and no points are deducted for shifting or knocking over Barn walls.

Partially outside of the Barn	On top of or outside of the walls
Half Points	No Points
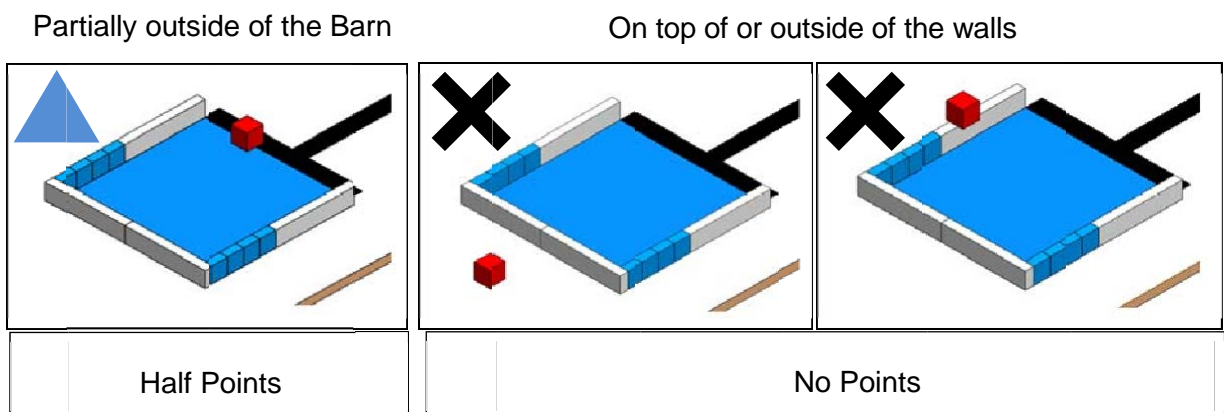
10) Once the apples have been harvested, the robot needs to return to the Starting Point and stop. Stopping completely within the Starting Point is worth 50 points, and these points will be halved if the robot stops while only partially inside of the Starting Point. No points will be awarded if any part of the robot is outside of the course.

Within the Starting Point	Partially Inside	Completely Outside
50 Points	Half Points	No Points
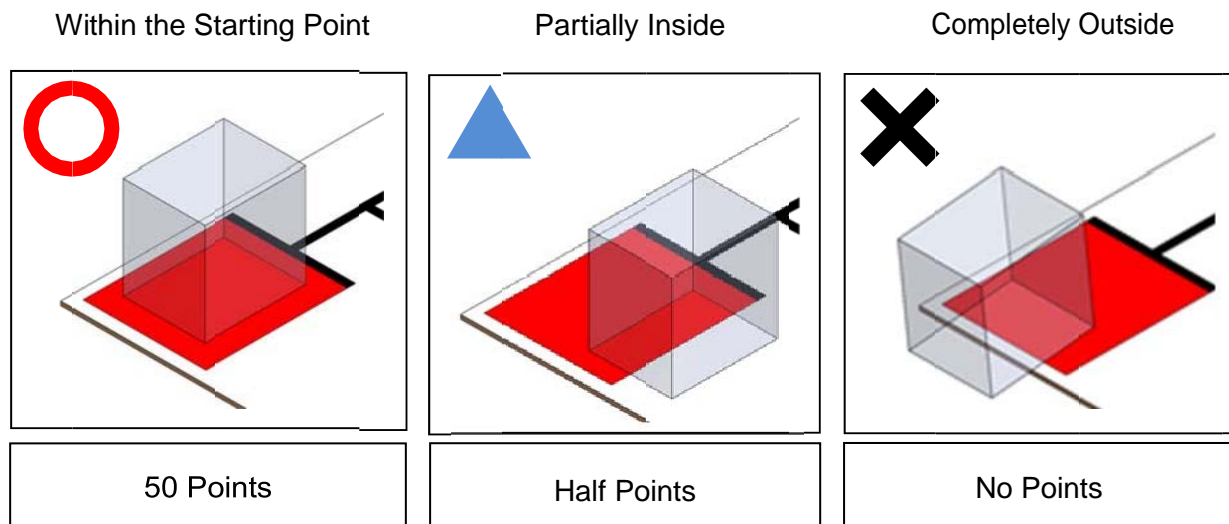
11) The robot must turn on its finish light after it stops. This finish light (LED) must be **blue** and placed in a location readily visible to the referee. The time recorded at the point the light turns on will be the completion time for the round. In the event the light does not turn on or turns on before the robot stops, the completion time will be recorded as the full 360 seconds.

12) Bonus points are awarded for completing the special mission. No points are deducted for failing the special mission or not attempting it at all.

13) The referee will declare the round finished in the event of the following:

・The robot turns on its finish light (LED). In the event the light does not turn on or turns on before the robot stops, the completion time will be recorded as the full 360 seconds.

・The round has reached 360 seconds.

・The robot falls while on the course and can't return to the Starting Point by itself.

・The robot falls apart or is otherwise rendered unable to continue the round.

・Competitors declare, "Stop!"

・Competitors violate any rules.

3. Competition Flow

1) Each team gets two rounds. Only the round with the highest score of the two will count towards the team's rank.

2) Teams are given time for a trial run on the actual course before each round. Each team can use this time to adjust their robots and programs. The order of these trial runs is decided by a lottery held by the hosts of the competition.

3) Competitors can also freely adjust their robots and programs on the practice course while other teams are doing their trial runs.

4) Teams will also use their time in 2) and 3) to prepare for special missions.

5) Robots will be checked by inspectors once all teams have finished their trial runs. All robots which have passed inspection will be placed in a designated location and can't be touched until the round starts. Programs should be transferred prior to inspection, as no changes can be made to any robot after it's been inspected (this includes during the round).

6) The first round will be held in the order decided by the lottery held by the hosts of the competition. After being called, competitors will retrieve their robot and wait in the designated location until the round starts. Robots and programs can't be adjusted during this waiting period.

7) Once the first round ends, competitors will immediately move their robot to the designated location and wait until they're allowed to adjust it. Robots and programs can't be adjusted during this waiting period.

8) There will be an adjustment period between the first and second rounds. Teams will be allowed to use this period to adjust their robots and programs on the practice course.

9) Once the adjustment period is over, robots will be inspected again as they were in 5).

10) The second round will be held in an identical way to the first round in 6). Once the round ends, competitors will immediately move their robot to the designated location and wait until the results are announced.

11) Ranks are calculated using the results of each team's rounds.

12) In the event different teams have the same score, the team with the shorter completion time gets the higher rank.
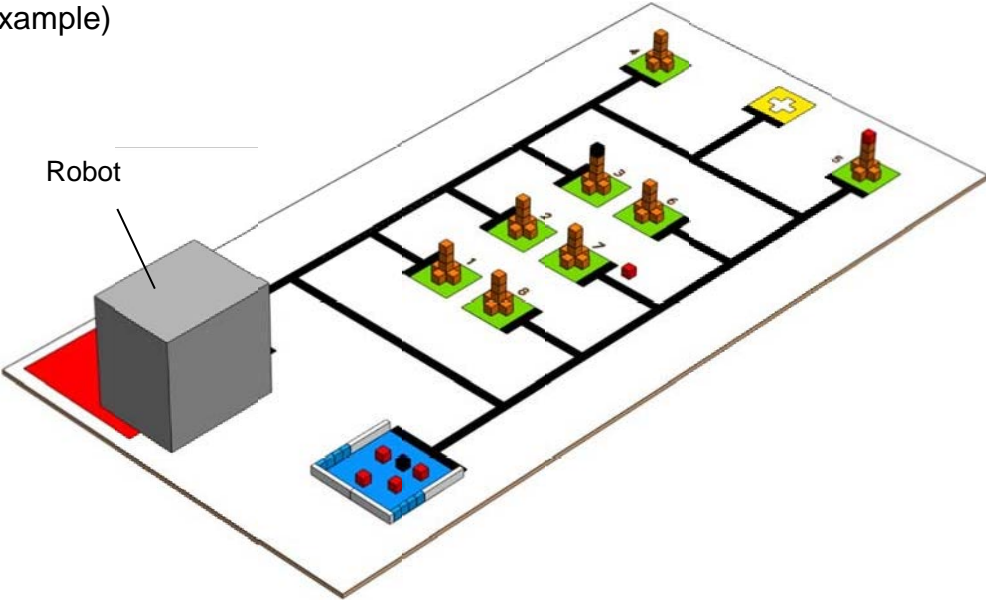
4. Robot Specifications

1) Only one robot is allowed per team.

2) See **Appendix 1** on page 12 and **Appendix 2** on page 13 for the ArtecRobo parts and Artec Blocks competitors can use to build their robots.

3) Each robot can only use one Studuino. There are no restrictions on the number of other parts.

4) Any parts from 2) can't be modified.

5) Competitors are not allowed to reinforce their robots using parts (such as screws, adhesive tape, etc.) other than those listed in 2).

6) Robots must not exceed 30 cm in width, 35 cm in length, and 45 cm in height at the start of the round.

7) There are no weight restrictions on robots.

8) While robots are allowed to transform at the start of the round, they must stay in one piece.

9) Any programs for the robots must be made using one of the following pieces of software.

・Studuino Icon Programming Environment

・Studuino Block Programming Environment

・Arduino IDE

・Dolittle

・Atmel Studio

10) Robots should act autonomously once the round has started.

11) Competitors aren't allowed to handle the robot once the round has started.

12) Robots must use three AA batteries.

13) Competitors may only use parts and PCs that they've brought themselves to adjust their robots and programs during the trial run before the start of the round.

14) Robots and programs can only be built by teams actively participating in the competition.

Any competitors who violate the rules of the competition will be banned from competing for three years (starting with this year's competition).

5. Scoring

① Each harvested ripe apple is worth 20 points. Only 10 points will be awarded if the apple tree is moved from its plot.

② Each harvested unripe apple will result in a 20-point deduction.

③ Each ripe apple delivered to the Barn is worth 50 points. Only 25 points will be awarded for apples only partially inside of the Barn.

④ A robot stopping completely within the Starting Point will be awarded 50 points. Only 25 points will be awarded to robots only partially stopped within the Starting Point.

⑤ Completing the special mission during finals is worth a maximum of 70 points.

⑥ The final score is the sum of items ① to ⑤.

(Scoring Example)

Robot

○ Harvesting Apples
- ・ Ripe Apples x 5 → 20 points x 5 = 100points
- ・ Unripe Apples x 1 → -20 points x 1 = -20points

○ Delivery to Barn
- ・Ripe Apples x 4 → 50 points x 4 = 200 points

○ Returning to the Starting Point
- ・Robot partially outside Barn = 25 points

<u>Final Score:</u>
305 points

6. The Competition Course

A set including the Competition Course and blocks (for apples, apple trees, and walls) will be distributed to each team once their participation has been confirmed.
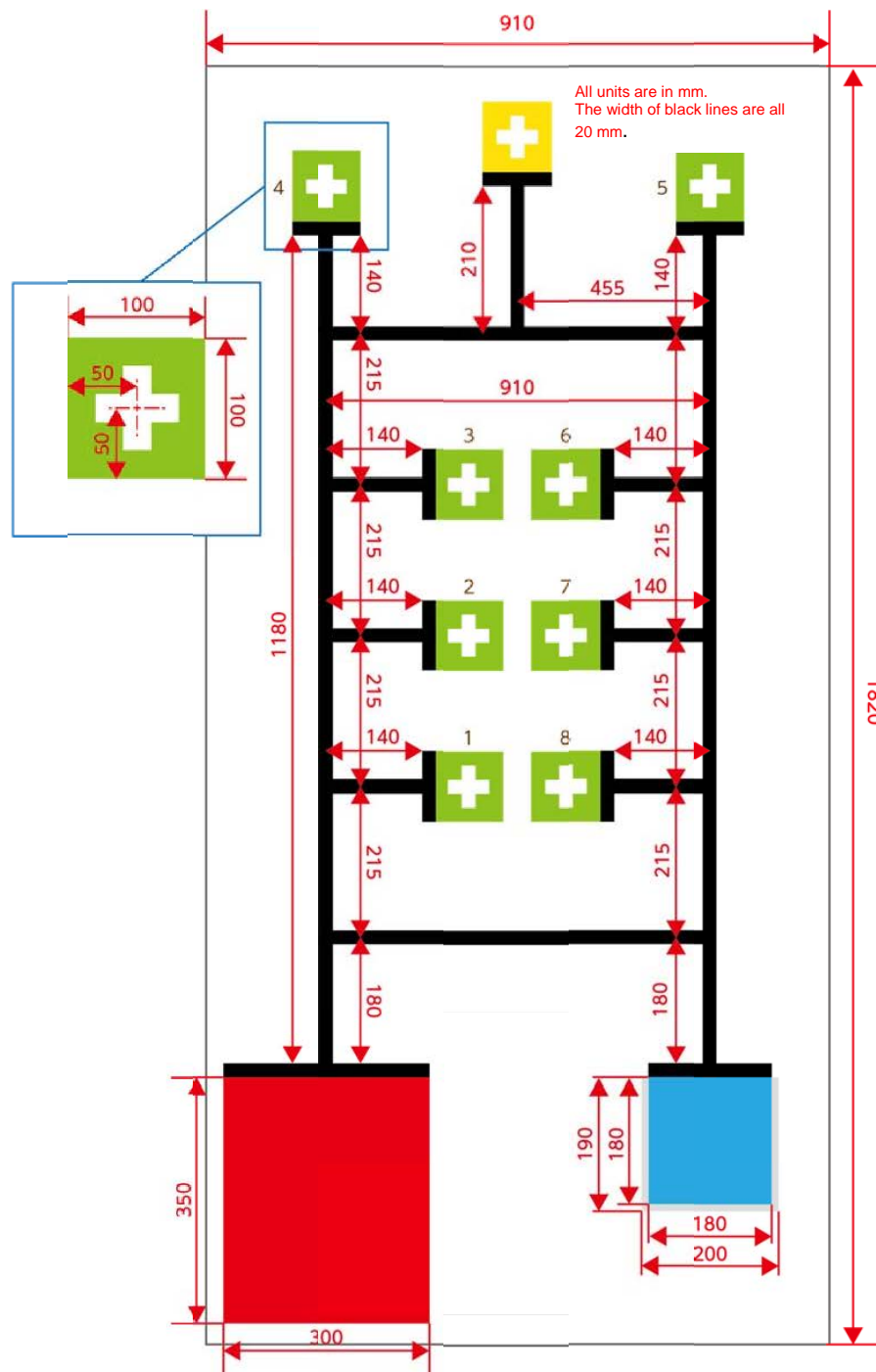
Figure 7. Course Dimensions
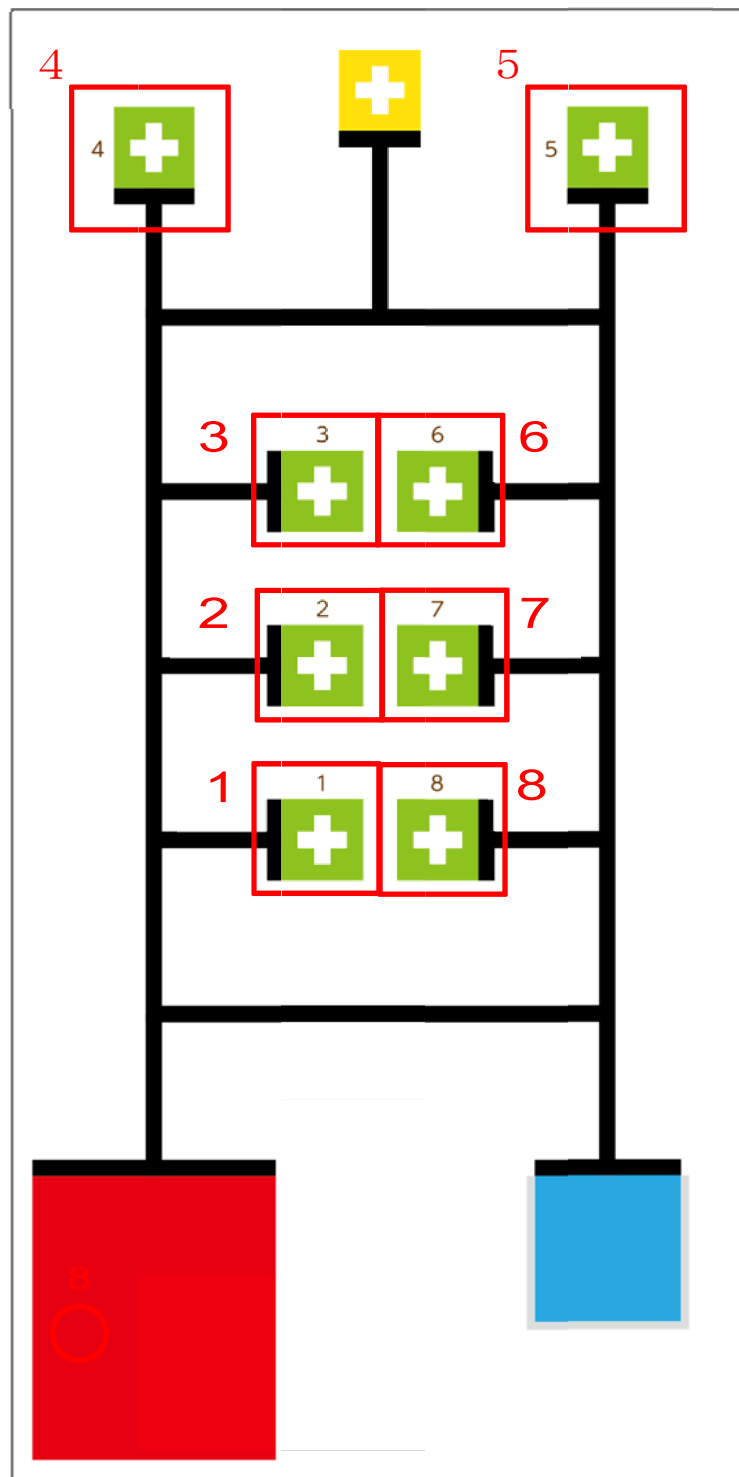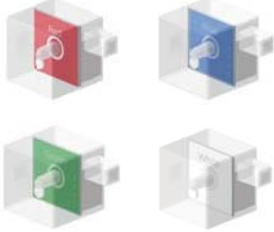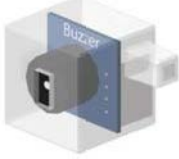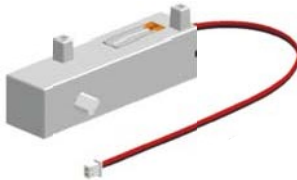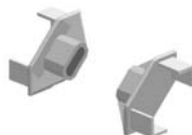
Figure 8. Apple Tree Locations

Appendix 1. Permitted ArtecRobo Parts

Studuino	Battery Box	LEDs (red, blue, green, white)	Buzzer
Touch Sensor	Light Sensor	Sound Sensor	IR Photoreflector
Accelerometer	Servomotor	DC Motor	DC Motor Connector
Sensor Connecting Cable (S) 3-wire, 15 cm	Sensor Connecting Cable (M) 3-wire, 30 cm	Sensor Connecting Cable (L) 3-wire, 50 cm	Extension Cable for Servomotors

![URC Universal Robotics Challenge]

Appendix 2. Permitted Artec Blocks

*There are no restrictions on the color of the blocks.

Basic Cube	Triangle	Half A	Half B
Half C	Half D	Axle	Wheel
Beam	Disk	Gear (L)	Gear (S)
Gear Rack	O-ring	Tire	