

# RobotChallenge - Robot Bowling Rules

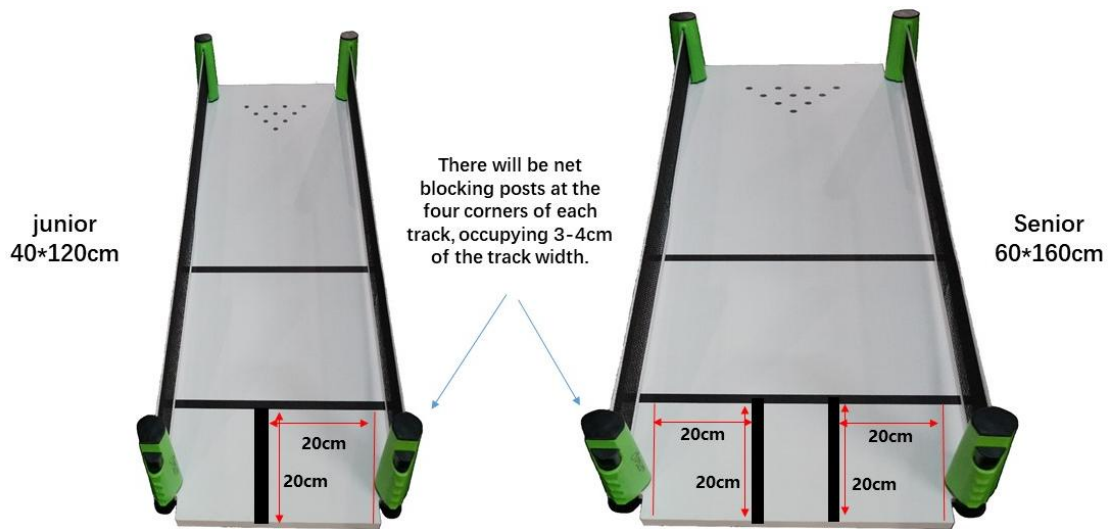
Revised on September 15, 2025

**Introduction:** Within a specified time, the robot uses an automatic launching mechanism to launch balls by any means to achieve the purpose of the bowling game.

## Group

- A. Junior
- B. Senior

Physical picture of the track



The starting area and starting direction of the bowling game are announced on-site during the game debugging, so before the debugging begins, the starting area will be posted on-site with black tape, as shown in the picture. During the on-site layout, all tracks have the same standard.

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## 1. Robot Bowling - Junior

### 1.1. Robot Requirements

#### 1.1.1. Size and Weight Restrictions

- A. The robot's inspection dimensions are 20cm \* 20cm, height is not restricted, weight is not restricted.
- B. The robot can expand during the competition, with a maximum expansion size of 30cm \* 30cm (length and width dimensions). The expanded size must also pass inspection.
- C. If the robot exceeds the dimensions during inspection, a maximum of 5 minutes is allowed for structural adjustment. Exceeding this time will result in disqualification.

#### 1.1.2. Robot Equipment Requirements

- A. Robot equipment is not restricted.

### 1.2. Competition Field Description

#### 1.2.1. Field Dimensions (See Figure 1)

- A. The competition field is 120cm long and 40cm wide. Each platform has 7 bowling lanes.
- B. The robot activity area is 50cm long and 40cm wide. The robot launching area A is 30cm long and 40cm wide as shown. This area is the valid zone for the robot to launch balls to hit the pins.
- C. The robot starting area is 20cm long and 20cm wide, as shown in the example. The starting area is either one of the two corner positions B/C. The starting area position will be announced before the debugging period begins.
- D. As shown, the three black lines are 1.5cm-2cm wide. The 40cm base side next to areas B/C has no barrier. If the robot falls off the platform, it will be considered a foul.
- E. As shown, 10 LEGO pins are arranged in a triangle on one side of the lane. The top pin of the triangle is 20cm from the edge of the lane.

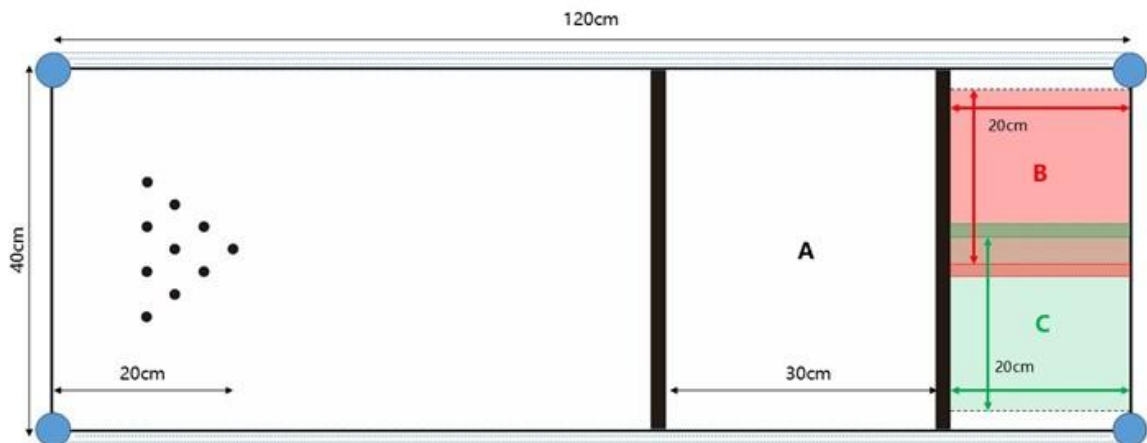


Figure 1: Top view of the competition area

### 1.2.2. Field Setup

- A. The balls used for hitting the bowling pins are standard 5cm diameter LEGO DUPLO balls.
- B. The pin construction method is shown in Figure 2. A pin consists of 1 LEGO pulley, 1 1x6 cross axle, and 2 2x2 round bricks. The pins have a front-to-back spacing of 4 LEGO units and a left-to-right spacing of 6 LEGO units. This distance refers to the distance between the centers of the pins.
- C. For pin construction, the pulley is at the bottom, flush against the round brick.



Figure 2: Pin diagram

- D. As shown in Figure 3, which is a 3D schematic of the field, the actual field has each lane separated by nets. Because the nets have fixed points on the platform board, there will be a 3-4cm wide groove in the starting area. This is a hint about the actual field and also a small test point for on-site debugging. The competition starting area will guarantee a size of 20cm \* 20cm.

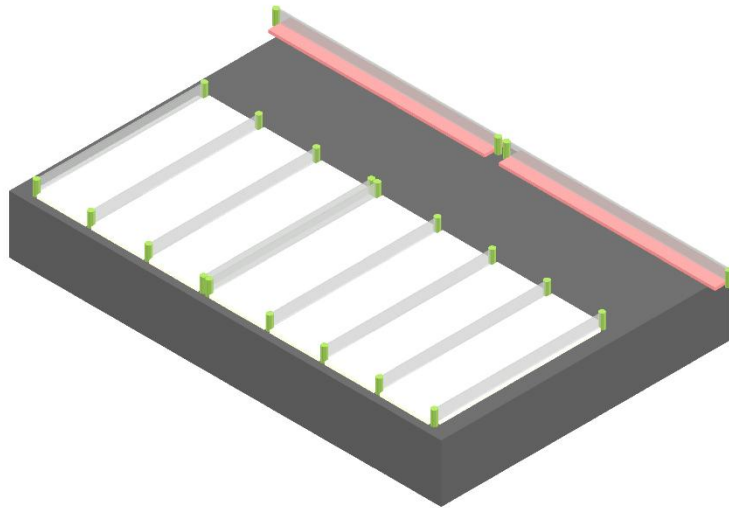


Figure 3: 3D schematic of the field

## 1.3. Competition Requirements

### 1.3.1. Competition Time

- A. Each team has a maximum of 3 minutes per round. When the 3 minutes are up, the competition stops immediately, and the total score is calculated.

### 1.3.2. Competition Rounds

- A. Each team will participate in 2 rounds of competition.



- B. In each round, each team will play 5 frames of bowling. Each frame allows a maximum of 2 balls to be used (if the first ball does not achieve a strike).

### 1.3.3. Start of Competition

- A. Before the referee's whistle, team members place the robot inside the starting box of the first lane, and the robot's vertical projection must be within the 20cm\*20cm box. Upon the referee's whistle, one team member loads the ball and starts the robot to automatically complete the launching task.
- B. The competition ends when the robot launches the last ball, and the timing stops.

### 1.3.4. Competition Rules

- A. There is a 30-minute debugging period before the competition. Before debugging begins, the robot's starting area position and the robot's starting orientation (the direction the robot's front moves) will be announced. Apart from facing the pins as the starting direction, any of the other three directions may be used as the starting orientation.
- B. The team member responsible for loading the ball must pick up the ball and start loading it after the referee's whistle sounds. Otherwise, a warning will be issued (restart). A second offense will be considered a foul, resulting in the loss of the 1st frame, and the competition will start from the 2nd frame (each frame represents one lane).
- C. The robot must start from the starting position, and the robot must not exceed the border of the starting area before starting (this border means the robot's vertical projection cannot press on the black line of the starting area; it must be inside the line). Each time, the team member can only load 1 ball.
- D. After starting, the robot must enter the launching area before launching the ball to record the score. If the ball is launched without the robot entering the launching area (referring to the robot body not entering the launching area), it is considered a foul for this frame, the score is 0, the lane ends, and the player can pick up the robot and proceed to the next lane. If the robot enters the launching area, but when launching the ball to hit the pins, the robot's vertical projection presses on the black line of the launching area near the starting area, or presses on the black line of the launching area near the pins, it will be considered a foul. The score for this ball is invalid (0 points), and the lane ends. If it is the second ball of the lane that is fouled, the score of the first ball will be cleared, and the frame score will be 0.
- E. After completing the first ball in the launching area, the robot must automatically return to the starting area. When the robot's tires press on any part of the black line of the starting area, the team member can pick up the robot to place the second ball, or pick up the robot to move to the second lane (abandoning the second ball of this frame is allowed, but the abandoned ball is recorded as 0 points, and this ball cannot be skipped when calculating bonus points). If the robot cannot automatically return to the starting area, or if the team member touches the robot before its tires press on the black line of the starting box, it will be considered a foul, the score for this frame is 0, and the team

member can proceed to the next lane.

- F. Team members must hit the lanes in sequential order. When the robot returns to the starting area, the team member can manually reload the ball. After restarting the robot, they must not touch it.
- G. Each round consists of 5 frames (each frame occupies one lane). If there are bonus balls in the 5th frame (a strike in the 5th frame awards 2 balls), a maximum of 7 lanes will be played, with a maximum score of 150 points. (For specific scoring calculations, please refer to Section 3 Bowling Scoring Method).
- H. Regarding foul scores for bonus balls: If a strike is achieved with the first ball in frames 1-4, the scores of the next two balls will be added as a bonus. Fouls during these bonus balls are judged as follows (using a strike in the 1st frame as an example): (1) If the first ball of the 2nd frame is a foul, the second ball of the 2nd frame cannot be played, the score for the 2nd frame is 0, then the score for the 1st frame is 10 points. (2) If the first ball of the 2nd frame hits 5 pins, and the second ball of the 2nd frame is a foul, then the 2nd frame score is 0, and the 1st frame score is 10 points plus the score of the first ball of the 2nd frame, i.e., the 1st frame score is 15 points.
- I. If the first ball of the 5th frame is a strike, then two bonus balls are awarded, to be played in the 6th lane. (1) If the first ball in the 6th lane is a strike, the remaining bonus ball can be played in the 7th lane. (2) If the first ball in the 6th lane is a foul, the score for that lane is 0, and the remaining bonus ball cannot be played. The score for the 5th frame is 10 points. (3) If the first ball in the 6th lane knocks down 5 pins, and the second ball is a foul, the score for the 5th frame is 15 points.

### **1.3.5. Fouls and Penalties**

- A. During the competition, if the ball hits any of the left or right walls and rebounds to hit the pins, it is a foul. If the ball directly hits the pins via a rebound off the net, the score for that frame is recorded as 0 (if the first ball of the frame had a score, but the second ball of the frame hits the net and rebounds, the frame is also recorded as 0 points). The team member can pick up the robot and proceed directly to the next lane. If the ball hits the side nets and rebounds but does not hit the pins, the frame continues.
- B. If the robot launches the ball without entering the launching area, it will be recorded as a foul, the score for the frame is 0, and the team member directly takes the robot to the next lane. Explanation of not entering the launching area: If the robot's vertical projection presses on the two black lines of the launching area when launching, it is considered a foul. (The robot is allowed to use the black lines of the launching area for positioning during the competition; when launching, the vertical projection should not press on the two black lines of the launching area).
- C. Before starting, the robot must comply with the inspection dimensions (20cm20cm), and its vertical projection must be within the starting box. Balls must be loaded and the robot started according to these requirements. Otherwise, it will be recorded as a foul, the



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- score for the frame is 0, and the team proceeds to the next lane.
- D. If the ball accidentally falls off the lane after the robot starts from the starting area, it is not considered a foul, but the robot must automatically return to the starting area before the second ball of the frame can be loaded to continue the lane.
  - E. After the robot launches one ball, it must automatically return to the starting area. If a team member picks up the robot by hand before its tires touch the black line of the starting area box, it is considered a foul, the score for the frame is 0, and the team proceeds to the next lane.
  - F. The bottom of the lane has no black line and no barrier. If the robot falls off the platform from this point, it is considered a foul, the score for the frame is 0, and the team proceeds to the next lane. If the robot falls off the platform during the second ball of the frame, the score for the frame is 0.
  - G. If, when the robot launches the ball, its extended size is significantly larger than 30cm30cm, and confirmed by the referee, it will be considered a serious violation, and the score for that round will be 0.

## 2. Robot Bowling - Senior

### 2.1. Robot Requirements

#### 2.1.1. Size and Weight Restrictions

- A. The robot's inspection dimensions are 20cm \* 20cm, height is not restricted, weight is not restricted.
- B. The robot can expand during the competition, with a maximum expansion size of 30cm \* 30cm (length and width dimensions). The expanded size must also pass inspection.
- C. If the robot exceeds the dimensions during inspection, a maximum of 5 minutes is allowed for structural adjustment. Exceeding this time will result in disqualification.

#### 2.1.2. Robot Equipment Requirements

- A. Robot equipment is not restricted.

### 2.2. Competition Field Description

#### 2.2.1. Field Dimensions (See Figure 1)

- A. The competition field is 160cm long and 60cm wide. Each platform has 5 bowling lanes.
- B. The robot activity area is 50cm long and 60cm wide. The robot launching area A is 30cm long and 60cm wide as shown. This area is the valid zone for the robot to launch balls to hit the pins.
- C. The robot starting area is 20cm long and 20cm wide, as shown in the example. The starting area is either one of the two corner positions B/C. The starting area position will be announced before the debugging period begins.
- D. As shown, the four black lines are 1.5cm-2cm wide. The length and width of areas ABC do not include the dimensions of the black lines.
- E. As shown, 10 LEGO pins are arranged in a triangle on one side of the lane. The top pin of the triangle is 20cm from the edge of the lane.

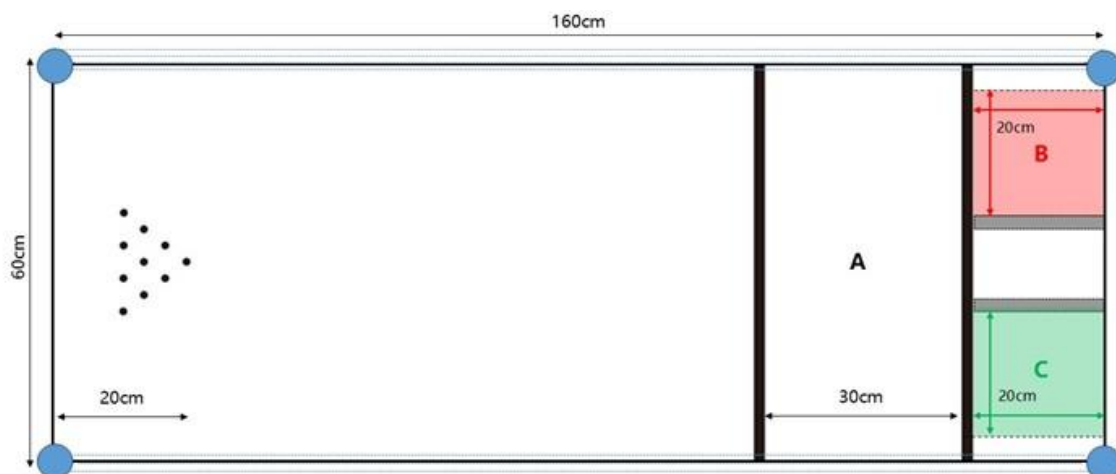


Figure 1: Top view of the competition area

### 2.2.2. Field Setup

- A. The balls used for hitting the bowling pins are standard 5cm diameter LEGO DUPLO balls.
- B. The pin construction method is shown in Figure 2. A pin consists of 1 LEGO pulley, 1 1x6 cross axle, and 2 2x2 round bricks. The pins have a front-to-back spacing of 4 LEGO units and a left-to-right spacing of 6 LEGO units. This distance refers to the distance between the centers of the pins.
- C. For pin construction, the pulley is at the bottom, flush against the round brick.



Figure 2: Pin diagram

- D. As shown in Figure 3, which is a 3D schematic of the field, the actual field has each lane separated by nets. Because the nets have fixed points on the platform board, there will be a 3-4cm wide groove in the starting area. This is a hint about the actual field and also a small test point for on-site debugging. The competition starting area will guarantee a size of 20cm \* 20cm.

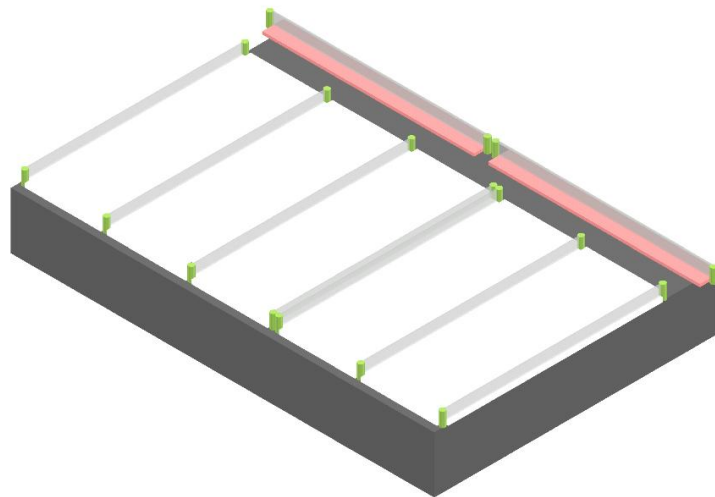


Figure 3: 3D schematic of the field

## 2.3. Competition Requirements

### 2.3.1. Competition Time

- A. Each team has a maximum of 3 minutes per round. When the 3 minutes are up, the competition stops immediately.

### **2.3.2. Competition Rounds**

- A. Each team will participate in 2 rounds of competition.
- B. In each round, each team will play 5 frames of bowling. Each frame allows a maximum of 2 balls to be used (if the first ball does not achieve a strike).

### **2.3.3. Start of Competition**

- A. Upon the referee's whistle, team members place the robot inside the starting box of the first lane, and the robot's vertical projection must be within the 20cm\*20cm box, load the ball, and start the robot to automatically complete the launching task.

### **2.3.4. Competition Rules**

- A. There is a 30-minute debugging period before the competition. Before debugging begins, the robot's starting area position and the robot's starting orientation (the direction the robot's front moves) will be announced. Apart from facing the pins as the starting direction, any of the other three directions may be used as the starting orientation.
- B. The team member responsible for loading the ball must pick up the ball and start loading it after the referee's whistle sounds. Otherwise, a warning will be issued. A second offense will be considered a foul, resulting in the loss of the 1st frame, and the competition will start from the 2nd frame (each frame represents one lane).
- C. The robot must start from the starting position, and the robot must not exceed the border of the starting area before starting (this border means the robot's vertical projection cannot press on the black line of the starting area; it must be inside the line). Each time, the team member can only load 1 ball.
- D. After starting, the robot must enter the launching area before launching the ball to record the score. If the ball is launched without the robot entering the launching area (referring to the robot body not entering the launching area), it is considered a foul for this frame, the score is 0, the lane ends, and the player can pick up the robot and proceed to the next lane. If the robot enters the launching area, but when launching the ball to hit the pins, the robot's vertical projection presses on the black line of the launching area near the starting area, or presses on the black line of the launching area near the pins, it will be considered a foul. The score for this ball is invalid (0 points), and the lane ends. If it is the second ball of the lane that is fouled, the score of the first ball will be cleared, and the frame score will be 0.
- E. After completing the first ball in the launching area, the robot must automatically return to the starting area. When the robot's tires press on any part of the black line of the starting area, the team member can pick up the robot to place the second ball, or pick up the robot to move to the second lane (abandoning the second ball of this frame is allowed, but the abandoned ball is recorded as 0 points, and this ball cannot be skipped when calculating bonus points). If the robot cannot automatically return to the starting

area, or if the team member touches the robot before its tires press on the black line of the starting box, it will be considered a foul, the score for this frame is 0, and the team member can proceed to the next lane.

- F. Team members must hit the lanes in sequential order. When the robot returns to the starting area, the team member can manually reload the ball. After restarting the robot, they must not touch it.
- G. Each round consists of 5 frames (each frame occupies one lane). If there are bonus balls in the 5th frame (a strike in the 5th frame awards 2 balls), a maximum of 7 lanes will be played, with a maximum score of 150 points. (For specific scoring calculations, please refer to Section 3 Bowling Scoring Method).
- H. Regarding foul scores for bonus balls: If a strike is achieved with the first ball in frames 1-4, the scores of the next two balls will be added as a bonus. Fouls during these bonus balls are judged as follows (using a strike in the 1st frame as an example): (1) If the first ball of the 2nd frame is a foul, the second ball of the 2nd frame cannot be played, the score for the 2nd frame is 0, then the score for the 1st frame is 10 points. (2) If the first ball of the 2nd frame hits 5 pins, and the second ball of the 2nd frame is a foul, then the 2nd frame score is 0, and the 1st frame score is 10 points plus the score of the first ball of the 2nd frame, i.e., the 1st frame score is 15 points.
- I. If the first ball of the 5th frame is a strike, then two bonus balls are awarded, to be played in the 6th lane. (1) If the first ball in the 6th lane is a strike, the remaining bonus ball can be played in the 7th lane. (2) If the first ball in the 6th lane is a foul, the score for that lane is 0, and the remaining bonus ball cannot be played. The score for the 5th frame is 10 points. (3) If the first ball in the 6th lane knocks down 5 pins, and the second ball is a foul, the score for the 5th frame is 15 points.

### **2.3.5. Fouls and Penalties**

- A. During the competition, if the ball hits any of the left or right walls and rebounds to hit the pins, it is a foul. If the ball directly hits the pins via a rebound off the net, the score for that frame is recorded as 0 (if the first ball of the frame had a score, but the second ball of the frame hits the net and rebounds, the frame is also recorded as 0 points). The team member can pick up the robot and proceed directly to the next lane. If the ball hits the side nets and rebounds but does not hit the pins, the frame continues.
- B. If the robot launches the ball without entering the launching area, it will be recorded as a foul, the score for the frame is 0, and the team member directly takes the robot to the next lane. Explanation of not entering the launching area: If the robot's vertical projection presses on the two black lines of the launching area when launching, it is considered a foul. (The robot is allowed to use the black lines of the launching area for positioning during the competition; when launching, the vertical projection should not press on the two black lines of the launching area).

- C. Before starting, the robot must comply with the inspection dimensions (20cm20cm), and its vertical projection must be within the starting box. Balls must be loaded and the robot started according to these requirements. Otherwise, it will be recorded as a foul, the score for the frame is 0, and the team proceeds to the next lane.
- D. If the ball accidentally falls off the lane after the robot starts from the starting area, it is not considered a foul, but the robot must automatically return to the starting area before the second ball of the frame can be loaded to continue the lane.
- E. After the robot launches one ball, it must automatically return to the starting area. If a team member picks up the robot by hand before its tires touch the black line of the starting area box, it is considered a foul, the score for the frame is 0, and the team proceeds to the next lane.
- F. The bottom of the lane has no black line and no barrier. If the robot falls off the platform from this point, it is considered a foul, the score for the frame is 0, and the team proceeds to the next lane. If the robot falls off the platform during the second ball of the frame, the score for the frame is 0.
- G. If, when the robot launches the ball, its extended size is significantly larger than 30cm30cm, and confirmed by the referee, it will be considered a serious violation, and the score for that round will be 0.

### 3. Bowling Scoring Method

#### 3.1. General Scoring Method

A bowling round consists of 5 frames. In the first 4 frames, except for strikes, each frame has two throws. A strike in the 5th frame awards two additional throws, and the scores of these bonus balls should be accumulated into the total score of that frame. If the 5th frame is a spare, then one additional throw is awarded, and the score is similarly accumulated into the total score of that frame. If from the first ball of the 1st frame to the two bonus balls of the 5th frame, all pins are knocked down with one throw each time, it is a perfect score of 150 points.

Mark	X	/	F	-
Represents	Strike	Spare	Foul	Miss

A foul throw results in no points for the pins knocked down. Failure to hit any pins is recorded as a miss.

#### Key Scoring Explanations:

- A. If the first ball of the 5th frame is a strike, 2 bonus balls are awarded. The team then proceeds to the 6th lane. If the first ball in the 6th lane is a strike, they proceed to the 7th lane. The scores from these 6th and 7th lanes are added to the 5th frame's score and are not counted as separate frames in the final total score. Therefore, the

maximum score when achieving a strike with the first ball of every frame is 150 points.

- B. If a strike occurs in frames 1-5, and the first bonus ball is a foul, then the second bonus ball is not awarded, and the bonus score is 0. If the first bonus ball scores 5 points and the second bonus ball is a foul, the score from the first bonus ball can be counted. As shown in the table below: Frame 1 strike, Frame 2 first ball foul: Frame 1 score 10, Frame 2 score 0. Frame 3 strike, Frame 4 first ball 5 pins, second ball foul: Frame 3 score 15, Frame 4 score 0.

1	2	3	4	5
X	F	X	5 F	
10	0	15	0	
<b>Total</b>				

### 3.2. Three Possible Situations for Each Frame

- A. **Spare.** The first throw of the frame fails to knock down all pins, and the second throw knocks down the remaining pins. This is called a "spare". The score for this frame is 10 points plus the number of pins knocked down by the next throw. If the first throw of the frame scores 0, and the second throw knocks down all pins, it is also considered a spare.
- B. **Open Frame.** In any situation, if after two throws in a frame, not all 10 pins are knocked down, the score for that frame is the total number of pins knocked down.
- C. **Strike.** The first throw of the frame knocks down all pins. This is called a "strike". The frame ends immediately, and no second throw is taken. The score for this frame is 10 points plus the number of pins knocked down by the next two throws.

### 3.3. Scoring Method for the 5th Frame

The scoring for the 5th frame is special. If the first ball is a strike, two additional throws are awarded. The score for the 5th frame is 10 points plus the number of pins knocked down by the two bonus throws. If the second throw does not result in a spare, the score for the 5th frame is the number of pins knocked down in that frame. If the second throw results in a spare, one additional throw is awarded. The score for the 5th frame is 10 points plus the number of pins knocked down by the additional throw.

### 3.4. Score Sheet Example

A. **General Scoring Method Example**

- a. Frame 1: Two throws knock down 6 and 2 pins respectively, total 8 points; Frame 2: First throw 8 pins, second throw miss, total 8 points, cumulative 16 points; Frame 3: First throw 5 pins, second throw 1 pin, cumulative 22 points.

1	2	3	4	5					
6	2	8	-	5	1				
8	8	6							
<b>Total</b>									

### B. Scoring After a Strike

- a. After a strike in Frame 4, do not score immediately. Wait until the next two throws are completed before calculating the cumulative score for that frame. For example, if the next first throw does not result in a strike and the second throw does not spare, in this example, Frame 4 scores 19 points = (10 + 7 + 2), and Frame 5 scores only 9 points.

1	2	3	4	5						
6	2	8	0	5	1	X		7	2	
8	8	6	19	9						
<b>Total</b>	50									

- b. After a strike with the first ball of Frame 2, do not score immediately. Wait until the next two throws are completed before calculating the score for that frame. After a strike with the first ball of Frame 3, similarly wait for the next two throws. Same for Frame 4. Frame 2 score = 10 + 10 + 10 = 30 points. Frame 3 score = 10 + 10 + 7 = 27 points. Frame 4 score = 10 + 7 + 2 = 19 points.

1	2	3	4	5						
6	2	X		X		X		7	2	
8	30	27	19	9						
<b>Total</b>	93									

### C. Scoring After a Spare

After a spare, if the next throw is a strike, for example, the score for Frame 2 is 10 + 5 = 15.

1	2	3	4	5					
6	2	6	/	5	1				
8	15	6							

### D. Scoring for the 5th Frame

- a. The 5th frame is special, with up to 3 throws. If there is no strike or spare, there are 2 throws.
- b. If the first ball of the 5th frame is a strike, you get 2 more throws. The sum of the scores of these three throws is the score for the frame.

1	2	3	4	5	6	7							
6	2	8	0	5	1	5	4	X		X		8	
8	8	6	9	28	0	0							
<b>Total</b>	59												

- c. If the second ball of the 5th frame is a spare, you get 1 more throw. The sum of the scores of these three throws is the score for the frame.

1	2	3	4	5	6					
6	2	8	0	5	1	5	4	5	/	8
8	8	6	9	18	0					
<b>Total</b>	49									

- d. If the first two balls of the 5th frame result in neither a strike nor a spare, the sum of these two throws is the score for the frame.

1	2	3	4	5						
6	2	8	0	5	1	5	4	4	5	
8	8	6	9	9						
<b>Total</b>										

**E. Scoring Method for Abandoned Balls (Abandoned Balls Record "-", 0 points)**

1	2	3	4	5						
X		9	-	X		8	-	8	1	
19	9	18	8	9						
<b>Total</b>										

## 4. Competition Ranking

- A. The average score of the 2 rounds will be used as the standard for ranking.  
 B. If the average scores are tied, the highest score from the 2 rounds will be used as a reference for ranking. If the highest scores are also tied, the remaining time corresponding to the highest score will be referenced. The team with more remaining time will achieve the higher ranking.

## 5. Raising Objections

### 5.1. Raising Objections

- A. There shall be no objections to the referee's decisions.



- B. If there is any disagreement regarding the application of these rules, the team captain may raise an objection with the referee.

## **6. Flexibility of Rules**

As long as the concepts and foundations of these rules are adhered to, the rules should be flexible enough to adapt to changes in the number of participants and the content of the competition.

## **7. Liability**

- A. Participating teams are always responsible for the safety of their robots and for any accidents caused by their team members or robots.
- B. The RobotChallenge organization and its personnel shall not be held liable for any accidents caused by any participating team or their equipment.