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A2 4 Mass Confusion: Investigating Weight Classification in Mario Kart Wii

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Abstract

In this paper, we look to investigate if the current weight class system in *Mario Kart Wii* is feasible. We find that although separating characters based on mass is logical, the current iteration does not align with the physical forces experienced. Therefore, we have suggested the movement of Koopa Troopa and Waluigi to the Heavy and Medium weight classes respectively, as well as the introduction of a Super Heavy class for Dry Bowser and Bowser Jr.

Introduction

In the game *Mario Kart Wii*, characters are divided into weight classes (Light, Medium and Heavy), with each class having karts that are slightly different in both power and size. However, each vehicle has the same stats regardless of the driver, which creates a fair playing field. The scenario we have chosen to examine is the 150cc mode in *Mario Kart Wii*. For a fair comparison each class's 'Standard Kart' was used, therefore we investigate if a separation by weight really does create a level playing field.

To investigate this we have calculated the force required for each character to reach the maximum speed of their kart. As such, the total force is found by considering: the force due to acceleration, the frictional force and drag force. The acceleration force can be found via:

$$F_a = ma \tag{1}$$

where m is the combined mass of the character and their kart and a is the acceleration of their kart. The frictional force is found from:

$$F_f = \mu_k mg \tag{2}$$

where μ_k is the kinetic friction coefficient (0.8 for dry asphalt road), m is the same as before and g is the gravitational field strength (9.81 N/kg). The drag force is found by:

$$F_d = \frac{1}{2}\rho_{air} {v_{max}}^2 C_d A \tag{3}$$

where ρ_{air} is the density of air (1.225 kg/m^3), v_{max} is the maximum velocity of the kart, C_d is the coefficient of drag (assuming a rectangular shape with a value of 1.05) and A is the cross-sectional area.

Method and Results

We began by determining the mass and frontal area of each kart and character. The Standard Medium Kart was based off a normal Go Kart [3], these were then scaled against Baby Mario and Wario for the small and large karts, where Mario was used as the Medium Kart reference. Since complete data on character dimensions is unavailable, we estimated each character's height, mass and width against known references. To achieve this, assumptions had to be made. For the mass this includes BMI, bone mass percentage and comparisons to associated

animals; while the heights and widths were found by using pixel measurements against Mario's known height of 155 cm [1][2]. The surface area was found by summing the exposed percentage of each character and the front of their respective kart, both modelled as rectangles. These values were combined with each karts' velocity and acceleration and put into the above equations. The total force required per character is shown below in Figure 1. Note: both Bowser and King Boo were removed from the data set, this is due to Bowser having a mass of 9611 kg [4] which is incompatible with the scaled Standard Large Kart mass of 141.6 kg. King Boo was removed due to the vague nature of how he would interact with both gravity and air resistance.

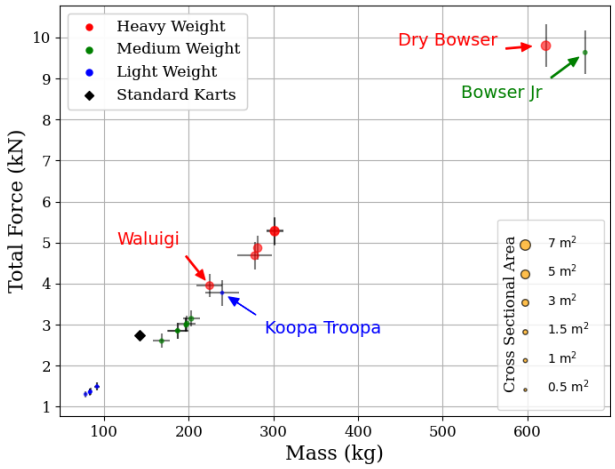

Figure 1: Mass-force plot for all characters in *Mario Kart Wii* excluding Bowser and King Boo. The colours correspond to character weight classes: Light, Medium and Heavy. The three Standard Karts are included to illustrate the forces acting on the karts when characters are not taken into account.

Discussion and analysis

Figure 1 shows the mass-force plot for all *Mario Kart Wii* characters. From this plot we can see that although the force required scales proportionally to mass, the current weight classification is not consistent. Key characters that support this argument are: Koopa Troopa, Bowser Jr and Dry Bowser; as their properties place them outside the expected range for their respective classes. Further observation also shows that character size has little effect on total force compared to the mass. As such, we find that the current method of character classification based on mass suitable, but not optimised.

We suggest reclassifying Koopa Troopa and Waluigi to the Heavy and Medium classes respectively. Even though their size might not be comparable to others in that class, it is the mass that is the key contributing factor. When combined with their new kart we believe they would be in a more comparative position to others in the same class. Along with these changes we also suggest the creation of a Super Heavy class for Dry Bowser and Bowser Jr as they do not currently fit within the previously defined classes. Following the same logical reasoning, we theorise that King Boo would be placed in the Light weight class, despite his large size, his negligible mass would align himself with the class.

Conclusion

In this paper, we have investigated the weight class system in *Mario kart Wii* and found the current method to be suitable but not optimized. We recommend that Koopa Troopa and Waluigi be reclassified to the Heavy and Medium classes respectively, as well as the introduction of a Super Heavy class for Dry Bowser and Bowser Jr. This analysis could be improved through more accurate estimates of character masses as well as a more refined model for drag dynamics.

References

[1] `https://super-mario-luigi-bros.fandom.com/wiki/Height_and_Weight_Guide` [Accessed 6 Oct. 2024].

[2] `https://www.flickr.com/photos/43466751@N07/4686704011/` [Accessed 6 Oct. 2024].

[3] `https://gokartsgo.com.au/hunter-valley/the-karts/` [Accessed Oct. 18, 2024)].

[4] `https://www.youtube.com/watch?v=aowqPQ0bybw` [Accessed 6 Oct. 2024].