

## README and Results Analysis

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### Summary:

This program includes a configurable number of quidditch players that represent two teams, Slytherin and Gryffindor. Each individual team member or “rider” does not know how to coordinate with its teammates or react to the opposing team. Each rider follows a few simple urges, such as fly towards the Snitch and avoid hitting other riders. These simple rules contribute to the objective of the game; catch the snitch and gain as many points as possible for each team. When players catch the Snitch, it appears in another random place in the game arena. If players collide or “tackle” one another, the player(s) will fall towards the ground and “die”, reviving at a start point in arena.

### Implementation:

The assignment is written to be run in Unity 2019.3.0f6 Personal. All utilized objects are located in the Prefabs folder. All utilized scripts are located in the ForcesStyleScripting folder. The different versions of this program are located in the Scenes folder.

The World Manager game object begins the game, allowing the controller to select number of players for each team. The minimum and maximum number of players is set by a range slider. The World Manager calls the script, **SpawnRiders**, which creates the players and assigns each one to its respective team manager as a child object. The Snitch is instantiated as a game object at the start of the game separately but it's given as a variable in **SpawnRiders** so that each rider knows the position of the Snitch at all times.

Each team, Slytherin and Gryffindor have a specified game object called Team Manager, which allows the user to control each team's rider's maximum flight velocity, acceleration, detection of neighboring riders and avoidance of neighboring riders. The Team Manager also allows the controller to adjust the rider's ability to tackle opposing team members. The Team Manager each have a script called **TeamManager** that is written in such a way that these rider behaviors can be adjusted in the middle of play.

Each player has an urge to chase the Snitch, scripted in **FollowSnitch**. This script restricts the maximum speed of flight by multiplying the current velocity by both 1 and the maximum velocity. Each rider

measures the distance between itself and the Snitch and moves towards it by adding a force (Acceleration) to its rigid body in the direction of the Snitch. The rider then orients in the direction it's moving.

Each player has an urge to move away from its teammates around it, within a certain radius, scripted in **AvoidOtherTeam**. It measures all objects within a certain radius and checks to see whether they are on the same team, opposing team, or not a player at all. If the object is on the same team, its distance from the current rider is measured and added to a sum. That sum is then divided by the number of teammates in the sphere and added to a force on the current rider's rigid body in the average opposite direction away from that group of players. The avoidance force (controlled in the inspector) is also added to this movement.

Each rider also has an urge to tackle its neighbors if they are on the opposing team. This behavior is scripted in **RespawnRider**. The propensity to tackle is determined by the controller, but initially set to 25% for Slytherin riders and 15% for Gryffindor riders. For example, when a Slytherin rider detects an opposing team member in its radius, it has a 25% chance of tackling the other rider. When it tackles the other rider, the other rider's urge to follow the Snitch is deactivated and its individual gravity is turned on. This results in a free fall towards the floor of the arena. When a player hits the floor of the area, it "dies" and is relocated to the original point of spawning. Each team is spawned on opposing sides of the area. At this point, the urge to follow the Snitch is turned back on for that rider and gravity is disabled, allowing it to fly.

Additionally, riders that collide in the pursuit of the Snitch, regardless of a tackle, will crash and free fall to their deaths when they both collide with the area floor. Both parties are respawned at this point in a manner similar to the relocation of a rider after it is tackled.

The behavior of the Snitch is described in the **SnitchMovement** script. At every physics update, a random number is generated, based on that number, a new value for the x, y, and z coordinate is selected. These values are then added to the Snitch's current direction of movement, multiplied by the Snitch's current acceleration value. The Snitch's velocity cannot exceed its set maximum velocity. This script measures the Snitch's velocity. If it is greater than the maximum, the current velocity is multiplied by 1 and the maximum velocity. This script also ensures that the Snitch stays within the preset bounds of the area. If the Snitch's transform position touches a boundary, **ClampBounds** as an impulse force on the Snitch's rigid body towards the center of the area. The floor is included in the boundaries.

The Snitch also keeps track of the current score. Every time a rider collides with it, it detects the team of the rider through its tag and adds a point to that team's score using the **ScoreKeeping** script. It then sends the Snitch immediately to a new, randomly selected transform location within the arena. This score is displayed in a text on a canvas in the area (**ShowScore**) and also in the console.

A special script is provided to guide the movement of the camera in the scene, **CameraMovement**. This script is added to the camera in the scene. It tracks the position of the Snitch and follows the Snitch. Because the Snitch moves in a random, jerky fashion, the movement of the camera is slowed by a coroutine, a linear interpolation, and an input of elapsed time.

### **Normal Mode Observations:**

In Normal Mode, the Gryffindor riders fly slightly faster and the Slytherin riders have a high propensity to tackle. The teams tend to group together behind the path of the Snitch. The two groups tend to mingle into a single crowd following the Snitch.

The Slytherin's tackling strategy tends to outweigh the increased speed of Gryffindors players when catching the Snitch if they tackle three times more often than Gryffindor. It clears the field and the Slytherins have more of a chance of catching the Snitch. When the tackling propensity of Slytherin is double of less than that of Gryffindor, the speed of the Gryffindor players tends to increase their chance of winning over Slytherin. If you increase the Gryffindor speed too high, however (>20), they are no longer able to chase the Snitch effectively. The riders shoot past the Snitch and have wide turns. They no longer chase, they charge towards the place the Snitch was.

Generally speaking, higher acceleration seems a better strategy than velocity for catching the Snitch. When Gryffindor max acceleration is higher than velocity, the riders are able to chase the Snitch more closely and soundly defeat Slytherin.

At the current settings the urge to follow the Snitch outweighs the propensity to avoid the other team. There are waves of tackles and free falls as the groups approach the Snitch. If you increase the avoidance force metric as the riders are following the Snitch, they spread apart, which slows the chase down. This also increases the number of collisions with the other team.

The movement of the Snitch as programmed favors the center of the arena. The Snitch tends to outrun all players and is caught more often when it appears randomly on a rider's path.

### **Bludger Attack Observations:**

In this scene, a new game object is introduced, the Bludger. The Bludger's behavior is defined by the script, **AttackPlayer**. It is bounded to the area in the same way as the Snitch. If it reaches a boundary, it is sent back towards the center of the arena using the **Clamper** method. The Bludger measures all of the riders around it in a specified radius. It selects the closest rider and moves towards it by adding a force to the Bludger's rigid body (acceleration multiplied by the distance to the closest rider). The mass, radius, velocity and acceleration of the Bludger are controlled by the user and can be updated mid-play in the BLudger game object. The **BludgerTeamManager** allows the controller to adjust each team's ability to dodge the bludger. If the Bludger collides with the rider, the rider is tackled and free falls towards the floor, dying and respawning. The Bludger is then moved to a random transform locations within the boundaries of the arena.

Each rider is given a new ability, Agility. This gives each rider a chance to dodge an oncoming Bludger attack. This ability is controlled in **AvoidOtherTeam**. Each rider detects the Bludger in its radius. The program generates a random number. If that number is less than the ability to dodge, an extra value is added to the avoidance force of the rider, pushing it away from other game objects.

The movement of the Bludger tends to break of the group of riders following the Snitch. When the mass is reduced and speed of the Bludger is increased, it tends to act like a sniper, killing all riders it locks on to. When the Bludger's acceleration exceeds its velocity (15/11), it overshoots the riders it aims for and is

unable to unseat them. As the Bludger's velocity increases (over its acceleration – 15/9), it becomes more deadly. When it's radius is reduced, it gets confused by the rider movement, rarely managing to unseat any rider.

Even though Gryffindor is faster and has greater agility, with more than triple the tackle propensity, Slytherin tends to win in Bludger Attack Mode. With equal tackle propensity, both teams are evenly matched. As we increase the speed and aggression of the Bludger, the agility becomes more relevant than tackling propensity and Gryffindor wins more often.

### **Seekers Emerge Observations:**

In this scene, an additional type of rider with new behavioral rules is introduced. The type of rider is called a "Seeker". It is instantiated at the start of the game inside the World Manager. The World Manager allows the controller to select a number of Seekers generated for each team. The Gryffindor Seekers are purple and the Slytherin Seekers are blue. They have different colors from the rest of the team to help the user detect unique behavior. Each team has a **SeekerTeamManager** object and script. The Seekers have a greater maximum velocity and acceleration than other riders. The Seekers' behavior following the snitch is defined in **SeekersFollowSnitch**. Unlike other riders, the Seekers movement must be clamped to the arena boundaries. This is because the movement of the Snitch does not attract Seekers as strongly. The detection radius of Seekers is much smaller. Seekers move randomly in the arena, changing direction less frequently than the Snitch. When the Snitch enters a Seeker's smaller detection radius, the Seeker locks on to the Snitch and follows it more quickly than a normal rider.

This mode tends to produce higher scoring games. When starting this game, the instantiation of the Seeker, which is much quicker, throws all the riders out of the arena. They return to the arena and resume normal behavior, following the Snitch.

The Seekers have no boid grouping behavior. However, when the Snitch flies within their reduced radius, they may join the group of other riders occasionally before they outpace them. From time to time, both Seekers will see the Snitch pass close to them and both will race to the Snitch.