Intro? (TBA / WIP)  
Our game is influenced by the multiplayer online battle arena (MOBA) genre and we use the same map layout that can be found in popular MOBA’s such as League of Legends or DOTA 2. There are bases, a jungle, a series of towers and 3 lanes.

Flocking

Flocking algorithms use a set of behaviours that can be applied to a set of agents. These behaviours make the agents appear to move as a sensible and coordinated group. The group can exhibit patterns which make it look like there is some form of flocking manager deciding where the agents go, however, each agent is making its own decisions based on the position of its neighbours.

The flocking behaviours should apply a movement to an agent based on how many neighbours are within a given radius of it and the direction in which they are moving. If an agent has no neighbours, it should continue to move in a forward’s direction. For each agent, we iterate over its neighbours and calculate its destination by combining the results from three core behaviours.

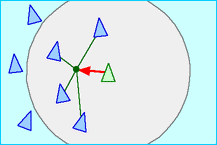


Figure 1. Cohesion (Reynolds, n.d.)

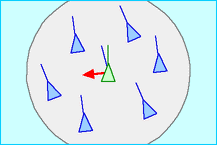
The cohesion behaviour *(Fig. 1)* tries to keep agents within the flock by finding the average position of the neighbours and moving towards it. This behaviour can sometimes cause the movement to look erratic and may need some form of steering or smoothing incorporated into it.

Figure 2. Alignment (Reynolds, n.d.)

The alignment behaviour *(Fig. 2)* tries to get the agents to move in a common direction by finding the average heading of all its neighbours and moving in that direction.

Figure 3. Avoidance (Reynolds, n.d.)

The avoidance behaviour *(Fig. 3)* helps to prevent collisions and overlapping. Agents will determine if neighbours are too close and attempt to move away from them. The distance should be a radius smaller than that used to find nearby neighbours otherwise the other behaviours may not work.

Implementing the core behaviours works well in scenes with no obstacles, but in scenes where there are many, there can be issues with agents becoming stuck or not handling obstacles correctly. Our flocking was originally set up to only consider other agents and we needed a way to avoid objects in their path and steer away from them where possible. We managed to achieve this by using Unity’s NavMesh. Our function uses the agents position to find the closest point on the closest edge of the NavMesh and then calculates a distance between the two points. When the agent gets within a set distance, we can create a new movement vector that will make the agent avoid the edges. This works well in most cases as the NavMesh wraps around every obstacle. An alternative way we could have achieved this would have been to allow each agent to get a list of every nearby object. This list could then be filtered to get the obstacles and a movement vector calculated to move the agent away.

To help fine tune how our flocks work we implemented a composite behaviour class which allows us to apply a weighting to the individual core behaviours. This weighting allows us to increase or decrease how much of an impact each behaviour has on the agent’s movement.

We encountered the issue of erratic movement caused by the cohesion behaviour and have updated our class to gradually change the agent’s vector towards the desired vector over time. This has helped to remove any jerky or sudden movements that were much more prevalent beforehand.

Our flocks can operate independently of each other. Each flock knows which members belong to it when it is created, we can use this information to filter out any neighbours that do not belong to the same flock and ignore them when calculating our movement. This allows for multiple flocks to be on screen at a given time. Two flocks may still encounter each other but they will both simply try to move past each other. This may not necessarily be needed for every game type and is more of a nice to have feature.

We originally planned to apply the flocking to the minions that travel down the lanes, however, due to the nature of MOBA style games, lane minions having very linear movement and this proved not to be a very good way of displaying how the flocking works. Instead we chose to move the flocks into the jungle where there are multiple obstacles, the agents would be able to roam more freely and eventually group up into a flock.

Conclusion (TBA)

References

Reynolds, C. (n.d.) *Boids*  
Available at: <https://www.red3d.com/cwr/boids/>  
(Accessed, 2021)