Prey Behavior through Influence Maps

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Imagine, for a few moments, the images of an African savannah. The idea that's conjured up is often one of an endless, sunbaked field of grass through which the very distinct creatures of this region migrate, such as gazelle or zebra. Perhaps the sounds of lions bellowing out their calls come to mind or even just the sound of a pleasant British man's voice narration. Either way, the key elements of this image lie within the environment and its inhabitants, the animals.

Whatever one imagined whilst conjuring up these thoughts probably looked to things such as zoos, photographs, television documentaries, or perhaps a certain Disney movie for reference—not a video game. Imagine, now, that scene—with all of the animals, the movement, and the environment—inside of a video game. It's definitely an interesting idea, and it's something that could elevate game environments to an entirely new level. However, the implementations for such behaviors in a game setting remain a bit dark, and there is one surprisingly simple and definitely possible solution in achieving something like this. The solution proposed for this project lies in influence maps.

The Behavior of Prey Animals

Before getting to the technology behind the solution, the problem and goal should be clearly defined. The goal here is to try to gain an approximation for the movement patterns of these migratory prey animals that so highly characterize these types of environments. The image below is a photograph taken of a herd of wildebeest acting as they usually do in their natural environment.

Figure 1. A herd of wildebeest exhibit many behaviors, such as eating, standing, etc. [Savill06].

Looking at each specific animal, one can see that there are a range of actions going on between all of them. Some are walking, some sitting, and others are standing. Of the standing ones, some are eating, and some are not. Also, the wildebeest aren't all facing the same direction. However, for a number of them, their forward-facing directions mostly fall within the same range of direction.

Current Approximations

Now, with an understanding of the real life behaviors exhibited in a herd of prey animals, the next step is to look at the current progress in AI for these types of creatures. Research into the subject revealed a surprising lack of material concerning herding or any other directly related group behavior. There were only a couple related items that could be commonly found, and those were random wandering behaviors and flocking [Reynolds95]. In fact, if one visits the Wikipedia site for swarm intelligence and then goes to the featured flocking link, one will be taken to a page about behavioral flocking in AI. If one clicks on the link for herding, one will be taken to a page about actual livestock herding. This seemed a rather appropriate and amusing demonstration in the point that this area of expertise in AI is a bit of a dark area.

Back on topic, the two mentioned methods, wandering and flocking, both are well-known, tried and true methods of approximating animal behavior. However, considering the goal of trying to recreate prey behavior, they are rather lacking. They require constant movement, and there is actually no "intelligence" behind the movement. Though animal movements may appear random to us, they are actually responding to small stimuli in the environment, often beyond our own sensing abilities. They can smell predators and have much wider fields of view than our own. Is there anything technology can do to better approximate this behavior?

Influence Maps

The solution used for this project made use of influence maps. Before getting into the details of how, some introductory information on influence maps should be discussed.

Influence maps are essentially large 2D grids of values to denote some kind of information. An agent can read from this map and make decisions based on that data. They are best suited for large, open worlds, and they've had a healthy career in the RTS genre serving as markers for political territory and danger zones. They can be used to assess the current situation of a battle, track previous changes in the environment, and then from there can even be used for predictive thinking [Champandard11].

Influence Maps and Prey Behavior

The use of influence maps for this project was in dictating movement and basic behavior of prey animals in a field.

In the project, an array of simple boids represent the animals. They only have a position and a direction. They begin in a random position and with a random direction. Then from there, they begin reading from the map. The map, as mentioned before, is a 2D grid of values. In this implementation, they range from -2.0 to 2.0 and are used in deciding which direction the boid is to take as well as color calculations for debug drawing of the tiles.

There are three types of tiles in the project. There are blue tiles which represent an attracting force, so the boids alter their directions to go towards the blue. There are red tiles which are replusive and do just the opposite of the blue. Then, there are special green tiles which are used to represent grass. These tiles have a strong attractive force, and they also slow down the particles to very, very slow speeds, appearing as though they are stopping to graze at these spots. This actually requires the use of a secondary influence map for retaining information regarding the speed altering values.

Table 1. These are the types of tiles used in the project.

Type	Color	Value Range	Speed Altering
Attracting	Blue	-2.0 to -1.0	None
Repulsing	Red	1.0 to 2.0	None
“Grass”	Green	-2.5 to -2.0	Very slowed

The next step is in discussing how the project actually used these tiles in the process of duplicating the behaviors of the animals. The grouping aspect was done with walls of red on the top and bottom, and the migratory aspect was done with a wall of blue along the right. Green spots were scattered in the middle.

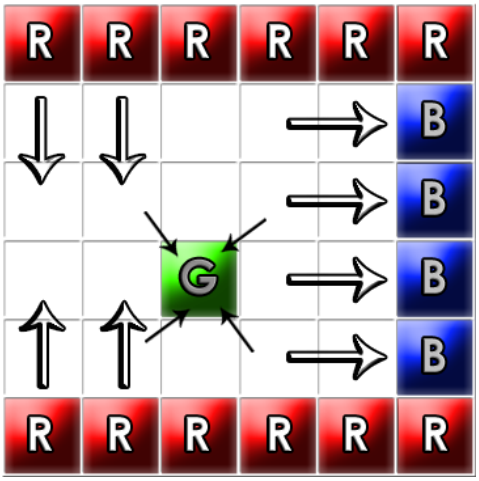

Figure 2. The tiles used for the project are as shown above.

These three walls and various spots of green are enough to give an approximation of the movement and behavior of prey animals in ways that neither flocking nor wandering can accomplish.

Another element that was added to the project to further demonstrate the ability of the influence map was bringing in the mouse as an interactive aspect. It portrayed the effect of a predator amidst the environment. It wrote to the influence map in real time using red repulsing squares. The boids would naturally run away from the mouse as though they were running from a predator.

Further Ideas for Influence Maps

More could be done to this project as well as any other projects like it. For example, more specific scenes could possibly be replicated using this method. One very well known phenomenon amongst migratory prey animals is river crossings. They are often very dramatic as hundreds and hundreds of animals attempt to cross a single point of a river, which are very often inhabited by predators, such as crocodiles. Also, even the level of steepness of the banks play a role in how the animals move from one side to the other. The attracting and repulsing tiles could be used to create a scene like this and direct the boids in a very similar manner to what realistically happens.

Figure 3. Wildebeest cross a river in the Serengeti, finding specific pathways. [Lynch10]

Another idea could be to use an entire influence map dedicated to replicating scents. Scent plays a huge role in the lives of both prey and predators; it often makes the difference between life and death. If there's a slight breeze in a certain direction, the influence map could be updated based on that. If a predator is in the area and is upwind of the prey, repulsing squares could be written to the map and then spread across as the breeze brings the scent to the prey, eventually causing them to leave the area.

Honestly, the things mentioned here for influence map ideas are not terribly different than what the industry currently sees of them as political maps in RTS games. In nature, there are two factions, prey and predator, and they have very specific effects on each other. However, as mentioned, other things can be taken into account to push the experience even further, including food availability and terrain scalability. The point here is largely just to generate new ideas and open up windows to possibilities. We have the technology, and we know the mechanics. We just need to figure out new, interesting ways to use them.

Why It Even Matters

Perhaps one question that may come from all of this is why the behaviors of animals are even something that needs to be considered at all. This is technology that could be used in a wide variety of games, especially ones featuring wide-open, outdoor environments. These kind of environments *need* to be filled with animals in order to feel alive. Without that, they're no deeper of an experience than a photograph. However, with animals added, it feels alive at least. Players will notice, though, if the animals don't seem to be acting intelligently. If they wander around a field aimlessly, players will see the environment as nothing more than a video game. With the addition of something like influence maps to help give meaning and authenticity to the animals' interactions with the environment, it will push what was previously perceived as a simple *video game* into that of a real, genuine *experience*.

If the sake of realism and experience isn't enough of a reason, then one can also consider it from an intellectual standpoint. As the research for this project research showed, there aren't very many solutions out there for this type of behavior, and the most common answers were basic and lacking. Technological progress in the realm of replicating animal behavior is something that can very possibly ultimately lead us to a better understanding of how animals behave by forcing us to really study them as we try new and improved methods of getting boids to move and act just like real creatures. After all, a game is only as good as its worst AI.

Conclusion

To end this, let's have another imagination session. This time, imagine playing *The Elder Scrolls VI: Elsweyr*. The series' latest hero of Tamriel strides proudly across the home of the Khajiit, and it's a dry, savannah-like province. The hero reaches the top of a hill cloaked in golden, shimmering grass and finds a field of gazelle—or whatever the Elder Scrolls equivalent would be. They're eating, moving, sitting, standing, and it just *feels* like life really exists within the confines of that fictional 3D space. That's what a little creative thinking and smart technology can accomplish.

References

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