

## Affective Pathfinding in Video Games

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**Abstract.** *To allow player submerge in created environment of a video game, agents called Non-Player Characters (NPCs) should act believably. One of the most vital aspect, in case of NPCs is pathfinding. There are a few methods that allow change path finding algorithms to become more human-like. Yet, those are not considering many vital aspects of human decisions regarding path choosing. The main purpose of this paper is to present known approaches and show example of a new approach that wider considers psychological aspects of decision making in case of choosing a path.*

**Keywords:** *computer games, pathfinding, AI.*

### 1. Introduction

Non-Player characters (NPCs) are very important part in most of the modern video games. Their believability is crucial to gameplay and vibe that player perceive during exploration of the game environment. Each of NPCs has to act as its role demands, and on quality of the behavior depends how user will engage certain parts of created environment. NPCs (also referred as agents) have many aspects and abilities that can be used in different ways. Therefore, decision making of

every such agent is highly important. It has been seen that emotional component which evaluates decisions regarding future actions, can be very beneficial to believability of agents. Regarding emotion components and aspect some research and tries of simulating those were made. Most popular were WASABI engine[1], FA-TiMA, Simplex and PSI. There were also implementation that proved to be working with many extensible possibilities for future development. Yet, in this paper focus should be set on certain aspects of possible actions of the agents. [2, 3, 4, 5, 6] One of the most vital is pathfinding and moving in the environment. Pathfinding algorithms are present in game development for many years and show large variety of approaches to the aspect of finding way to the target. Usually, main issue considered by pathfinding algorithms is efficient way to reach target and avoiding obstacles. Yet, this paper considers different aspect of the human psychology in connection with pathfinding. In realism matter, most efficient way is not always the best one. It happens many times that person perceiving some stimulus, changes way. Good example can be mad dog on the way to a shop. If someone sees dangerous object on his/her way which is not element of the static environment, may decide to change the way to less efficient, yet safer. However, it is not the only option [7, 8].

## **2. Known methods**

There were few approaches to enhance that aspect of pathfinding regarding emotions. One of the known ways of resolving this aspect is method of Attractors and Repellers.[9] NPC can have emotional stance in matter of objects in its environment. Therefore, other NPCs or even player avatar can cause some emotional reactions and changes in agents' behavior.

### **2.1. Repeller and Attractor method**

For the aspect of path choosing, such stimuli can be treated like something to avoid (repeller), or something to pursue (attractor). Figure 1 presents visualisation of concept.

Here an example can be considered: person has to reach his/her destination, on the way, at the right side sees dangerous dog, and on the left side friend. Since a dog is negative stimuli and cause fear and/or anger, it should be avoided. On the other hand, friend is considered as positive stimuli causing joy, what should be pursued. Person can move around the dog and meet a friend on the left side of the

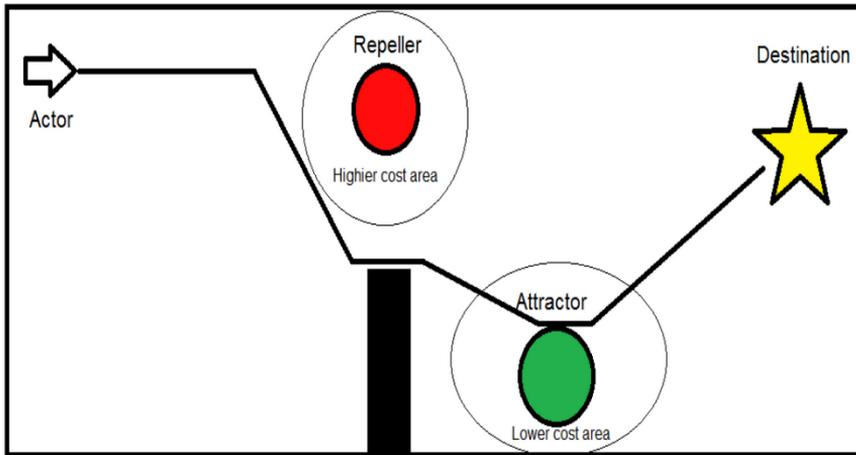


Figure 1: Concept of Repeller and Attractor method

way and then reach his/her destination. Depends on pathfinding algorithm used, such augmentation can enhance realism of agents decisions. In case of navigation mesh, area around attractor or repeller can have modified cost what results with changes in predicted path. Attractor as the positive modifier, can lower the cost of walking around and repeller can raise cost of walking nearby[9].

## 2.2. Character aspect

Another approach is to focus on personality aspect of the agent. If agent has explorative stance, then during path decision it will choose differently than one with introvert stance. Interesting example is the first stance. NPC with such aspect has lower probability to choose shortest way to the destination. Instead of finding one path, it will look for alternative ways and choose one of possibility. If certain area was already explored, it will have lower probability to be chosen as part of another way. That is how personality pushes NPC to not focus on one simple target. Introvert stance would influence on path choosing by finding the shortest and the simplest way with the lowest probability of meeting anything or anyone. This approach is very flexible for designer to project many different types of characters. It also allows to consider much more possibilities of emphasizing different roles that NPC can take. This method is very useful in heuristic algorithms as another aspect in pathfinding[9, 10].

### 2.3. Emotion map

Another idea to affect way choosing is creating emotion map. Emotion map is clone of navigation area with distinctive areas that caused some changes in emotional state of agent. Emotion map is dynamically updated based on events in environment. For instance, if agent was frightened by explosion in one place, it will update emotion map in this area with result of emotional state change. This will cause remembering area as dangerous and in future as one that should be avoided. Such area is also updated overtime regarding decay of emotional activation. If after explosion, nothing happened, then area loses its dangerous trait. It is illustrated in Figure 2. At the left side cost of trespassing is set to high level, due to last event that occurred. At the right picture is illustrated decay of cost over time.

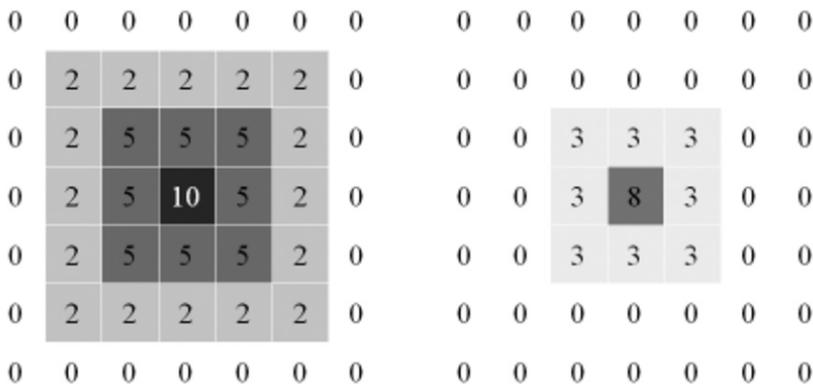


Figure 2: Illustration of dynamic change in time (decay) of trespassing cost regarding emotion aspect [11]

Moreover, in this approach emotion map is shared with all other NPCs. The main reason of this is to simulate, for example shouting about danger towards others or inform about positive event. By that kind of sharing knowledge, socially looking actions can be archived. Yet, mentioned method has important drawback, regarding individual behavior of agents. It is easy to imagine situation when lack of knowledge about navigation area plays great role in NPCs decisions and actions. In case of not knowing about the danger on the way, agent will not look for safer area or different way to reach destination. Good example is simple trap. It will not be possible to catch NPCs into the trap if all other will know about it without

need to be in close area. Shared emotion map will inform all of the agents about dangerous event in one certain place. Naturally, that kind of knowledge should not be available in absolute range in environment, since every agent would act like someone omniscient[11].

### **3. Proposed solution**

As it was possible to notice, every of those approaches has some disadvantages. To overcome such imperfections, hybrid method is proposed in this paper. Better option to simulate affective elements in pathfinding decisions, is to adapt character aspect into the Repeller and Attractor method. None of those two approaches does collide with each other, since first one works on heuristics and character and the second one on current emotional state and path choosing cost. Therefore, hybrid is possible to implement without any major issue. Only method that would collide with other approaches is emotion map. The reason of it, is influence on other agents what does not allow to simulate character aspect. Moreover, difference between Repeller and Attractor and emotional maps is based only on social aspect what would not allow to see much difference. Implementation of hybrid solution should include emotion processing module based on one of known theoretical architectures like WASABI. Such engine can ensure correct interpretation of incoming events from the environment, and by emotional state dynamics, allow to modify AI decisions responsible for reactions of a NPC. The hardest aspect of proposing new solution is comparison with known approaches. It is not trivial, since that kind of enhancement is very complex and has many aspects to consider. Yet, it is possible to plan such test. Through inquiring people as testers it can be checked if designed characters and emotional states are recognized in path decisions of NPC. To make it as objective as possible, test and invoice should be based on reaction momentum and answer correctness right after every try. However, it is important to not focus only on this kind of test. What also should be done, is looking for different ways to check if any of affective methods of pathfinding is moving closer NPC to human behavior.

### **4. Conclusions**

To summarize, pathfinding algorithms are very important in most of the modern video games. Yet, regarding realism of NPC behavior, shortest way to a desti-

nation is not always the best one. Therefore, it should be considered to include affective aspect to known pathfinding algorithms. There were a few tries to add such element. For example, by Repeller and Attractor method, which changes trespassing cost of areas around objects, that should cause some emotion reaction (positive or negative). Moreover, by modeling character of NPC there was idea to improve pathfinding heuristics, to look for alternative paths, and decide about the way based on personality. Another approach was to create emotional map, that would archive emotions state changes on navigation map, which could be used to decide about avoiding certain areas. That kind of map would be shared by all NPCs to create social aspect of agents. All of those methods have advantages and disadvantages with a lot of place to improve. Therefore, hybrid approach was presented in this paper. It is possible to assemble personality aspect to Attractor and Repeller method. This way more complex solution would be achieved. Big challenge is to design test that would show if new solution is getting closer to planned aim. However, it is not impossible and can be achieved. There is a lot of areas to improve in affective pathfinding and it is valuable regarding NPCs human-like behavior. Example of such improvement can be including other traits of human character. Another idea could be considering human habits that occur in certain emotional states. For instance in state that need fleeing action in unknown area, people try to find known place or known people in the surrounding and run to there. Future work will consider implementing mentioned methods and doing tests regarding realism of agents spacial actions.

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