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Agent Reaction Time

How Fast Should an AI React?

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5.1 Introduction

Modeling human behavior is a core aspect of game AI, which raises a very simple, yet important question: *How fast should an enemy AI react to seeing the player?*

Like many questions concerning human behavior, it is difficult to answer precisely and largely depends on context. Researchers have investigated human response time for over 100 years, trying to time the inner workings of the brain in an area of study known as mental chronometry [Posner 05].

However, if you want the quick and dirty answer to what should be used for an AI's reaction time, then let's just spill the beans. It's somewhere between 0.2 and 0.4 seconds, possibly longer depending on context. If you're curious as to which exact number to use and where these numbers come from, you'll need to read further!

5.2 Context Is Key

There are two primary situations, studied by cognitive psychologists and neuroscientists, which are commonly applicable to game AI and result in different reaction times:

1. *Simple reaction time*: An AI agent is aiming at a doorway, expecting an enemy to come through. When the enemy is finally seen, the agent pulls the trigger and the gun fires. We want to know the time between the enemy appearing in the agent's vision and the gun fired. This time period is modeling the time taken for the agent's brain to recognize the presence of the stimulus, the time to turn that recognition into a decision to fire, the time for the finger muscle to be told to contract, and the time to physically pull the trigger until the gun fires.
2. *Recognition or go/no-go time*: An AI agent is aiming at a doorway, expecting either a fellow teammate or an enemy to come through. When someone is seen in the doorway, the AI must recognize if it is a teammate or an enemy, then only pull the trigger if it is an enemy. What makes this more difficult than a simple reaction time is that the agent must discern between two different possible stimuli. We want to know the time between the enemy appearing in the agent's vision and the gun fired. This time period is modeling the time taken for the agent's brain to see the stimulus, the time to recognize it is an enemy, the time to turn that recognition into a decision to fire, the time for the finger muscle to be told to contract, and the time to physically pull the trigger until the gun fires.

It was recognized by Donders, a Dutch physiologist and ophthalmologist, in 1868 that a simple reaction time is faster than a go/no-go reaction time [Donders 69]. It has also been found that the weaker the intensity of the stimulus, the slower the reaction time [Luce 86].

A further complication with context is whether the AI agent is experiencing a momentary attentional lapse, which is common in humans and would cause much more variability in reaction times.

5.3 What Does Cognitive Research Tell Us?

Fortunately, researchers have determined average times for our two primary situations.

5.3.1 Simple Reaction Time

In the context of a simple reaction time, the mean time of college-age individuals for an auditory stimulus is 0.16 s and the mean time for a visual stimulus is 0.19 s [Kosinski 13]. Other research puts the mean time for a visual stimulus at 0.22 s [Laming 68]. This time is typically determined by telling the human subject to tap a button when a light stimulus changes state (for example, turns from off to on or from green to red). You can try this test yourself at http://www.humanbenchmark.com/.

These simple reaction time studies are most similar to an AI agent firing a gun when they are focused, expecting an enemy, and aiming directly at the enemy when it is seen. However, there are three caveats that would increase the time beyond ~0.2 s:

1. If the stimulus is weak, then the reaction time is slower [Luce 86], for example, seeing an enemy far away versus seeing an enemy close up.
2. If the AI agent must aim after seeing the enemy, then that added time must be factored in.
3. A lapse in focused attention, which is common in humans, would cause the reaction time to be much higher.

5.3.2 Recognition or Go/No-Go Time

In the context of having to differentiate between two different stimuli and only acting on one of them, the mean time for a visual stimulus is 0.38 s [Laming 68]. The stimuli typically used in this test are two-digit numbers, where the subject must push a button when the number is above 50 and not push the button when it is below 50. You can try a version of the go/no-go test yourself at http://cognitivefun.net/test/17.

Go/no-go time studies are most similar to an AI agent firing a gun when they are focused, expecting either an enemy or a friend, and aiming directly at the subject when it is seen. As with simple reaction time, the caveats that would increase reaction time also apply here.

5.3.3 Complex Cognitive Task Reaction Time

As you would expect, the more complex the cognitive task, the more time it typically takes. When faced with a choice between several items, choosing the best one will take longer than a go/no-go reaction time [Donders 69]. However, to get reasonable response time estimates for any unique complex task, a careful experiment with human subjects would need to be constructed and executed.

5.4 Conclusion

As you program your AI behaviors, you'll be forced to choose a reaction time for your agents. However, based on the context, you should use different reaction times.

The good news is that we are fairly confident that a simple reaction time should be around 0.2 s, while a go/no-go reaction time is around 0.4 s. From there, you'll need to add additional time to account for weak stimuli, more complex cognitive recognitions, additional movement time, or lapses in attention. As for picking the ideal reaction time for your particular game, it ultimately depends on the exact context and what feels right to the player.

References

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