SPATIAL NAVIGATION USING ECHOLATION AND TEMPORAL-DIFFERENCE LEARNING

Dorian Desblancs
Master Mathématiques, Vision, et Apprentissage
École Normale Supérieure Paris-Saclay
4 Avenue des Sciences, 91190 Gif-sur-Yvette, France
dorian.desblancs@mail.mcgill.ca

ABSTRACT

Historically, reinforcement learning and neuroscience have greatly inspired each other (Hassabis et al., 2017). Initially, RL was used as a framework for studying algorithms that could perform complex human behaviour, using rewards and punishments. The discipline quickly blossomed, and became a source of inspiration for understanding the brain. Most notably, the reward prediction error theory of dopamine (Schultz et al., 1997) proposed that temporal-difference learning is used for learning throughout the brain. This theory has since been proven time and time again (O'Doherty et al., 2003), and has greatly improved our understanding of the mammalian brains.

One of the more interesting investigations of TD learning in the brain is related to spatial navigation. In Foster et al. (2000), TD learning was used to tackle the water maze problem. The results were similar to those found in rats, further suggesting the learning rule's correctness in neuroscience. However, most simulations relating spatial navigation and TD learning fail to incorporate the sensory inputs mammals are constantly exposed to.

In this project, the aim is to incorporate echolocation into the spatial navigation task using TD learning. More notably, bat echolocation, as described in Langer (2019), will be used as the agent's stimuli. The simulations will be conducted in a water maze-like setting with a platform to reach and a series of obstacles. Note that other projects involving the integration of sound waves in TD learning have been conducted (most notably the work of Tan et al. (2008) using SONAR) and will be used as inspiration.

The goal of this project is two-fold. First, we aim to provide a framework for integrating echolocation in reward-driven spatial navigation. As artificial intelligence converges towards recreating mammal-like intelligent machines, it is crucial that the perceptual stimuli perceived by these be well-integrated in these systems. Second, we aim to show that the integration of echolocation in intelligent path navigation vastly improves an agent's performance on tasks resembling the water maze problem. We believe the ideas explored in this project could be applied in the real world, especially in the field of robotics.

ACKNOWLEDGMENTS

Note that this project proposal is tentative. Please let me know if you see any issues with it! I would much rather do the assignments if you think my project lacks depth or is, on the contrary, too ambitious. Your honesty is welcome!

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