Quantum Neural Network for Continuous Reinforcement Learning

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Data Science Honors Project Proposal

Introduction

Quantum computing and machine learning are two exciting fields. Quantum computing brings a new perspective on computers by using properties of quantum mechanics to do computations, which can be exponentially faster than the classical computers we know today. In fact, some tasks that we thought were impossible with computers today, can be accomplished using quantum computers. (CITATION) Machine learning is another exciting field that learns complex problems from large amounts of data that are too difficult for humans to manually solve. It been used in facial recognition (CITATION) and identifying weeds in precision agriculture (CITATION). A more recent sub-field of machine learning is *reinforcement learning*. Reinforcement learning uses a positive or negative reinforcement signal from an environment, known as the *reward*, to provide feedback to the learning system so that it may learn and improve to maximize this reward. Some fields that use reinforcement learning are in economics to artificial intelligence in games. (CITATION) Reinforcement learning is an attractive tool to use. While other machine learning techniques often times require a well tuned, large dataset to learn, reinforcement learning only requires a reward from an environment. This provides substantial control over the results of learning and saves time on finding and tuning a large dataset. Even further, we can use new quantum computing techniques to exponentially increase the power of these reinforcement learning techniques.

Reinforcement learning

Reinforcement learning has been inspired by the way biological beings learn through trial and error. For example, a gazelle that is newly born stumbles around until it can fully walk and run at 30mph in 30 minutes.[1] This gazelle was not told how to walk, it learned from trial and error. Similarly, reinforcement learning learns, not from learning from observation like supervised learning, but traversing the unexplored terrain and learning from its past mistakes and successes.

The goal of reinforcement learning is to learn a new environment by trial and error by maximizing a numerical reward signal.

1. Example to understand it
2. Value Function and Action-Value Function

References

[1] R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction* (MIT Press, 1998).