Reinforcement learning and robot navigation

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Reinforcement Learning

Reinforcement Learning is an area of machine learning that lies at the intersection between mathematics, computer science, optimal control and even psychology. It has recently been successfully used by a team at DeepMind to master the game of Go and has applications in robotics, operations research, finance etc.

The learning agent improves its behaviour by exploring its environment (states) and the actions it can take. It thus learns a reward function, which attributes a reward to every state-action combination. By trying to maximize the accumulated reward, the agent will reach an optimal solution to the problem it faces.

The project

The goal of this bachelor project is to get familiar with the field of reinforcement learning through the application of its techniques and algorithms on a Raspberry-Pi-controlled robot to get it to drive, avoid obstacles etc.

On the theoretical side, the student will explore subjects like Markov Decision Processes, dynamic programming, Q-learning and the interest of neural networks in reinforcement learning. On the implementation side, challenges include state representation through computer vision, motion control and onboard implementation of the algorithms. The drawing above represents one potential challenge that could be addressed, however the exact experiment setting will be determined with the student.

Milestones

- Mastering the basic theory and selecting an appropriate framework
- Modeling the environment, reward function
- Generating training data
- Implementing the algorithms and working prototype
Material

The following material will constitute a good starting point:

- Richard Sutton’s book
- Benjamin Van Roy’s course at Stanford (lecture notes)
- AlphaGo’s David Silver’s course at UCL (slides)

Prerequisites

Curiosity and high motivation, basics in optimization, linear algebra and programming.

Grading

The grading is based on the following:

- Quality of presentations (2 of them, each 30 minutes)
- Quality of (literature) research and understanding of the material
- Quality, readability and re-usability of code (git repository)
- Quality of the report (at most 15 pages).