An Exploration of Artificial Curiosity and Reinforcement Learning in a Simple Robot

Curiosity: Desire to Learn

- How could we give machines their own curiosity?
- A possible solution could be to integrate a curiosity model with Reinforcement Learning (RL)
- RL is a branch of Artificial Intelligence in which the agent (the robot) learns from its experience, and is encouraged to perform the actions that will maximize cumulative reward

Implementing Curiosity

- Curiosity drives us to experiences that make the world clearer
- A proposed model of this thinking is Information Gain Motivation (IGM)
- IGM rewards the decrease in uncertainty in the robot’s knowledge of the world, after each action, as quantified by the decrease in entropy
- Entropy is a mathematical concept which measures the uncertainty of an event.

Applying a Reinforcement Learning Method

- Most RL methods have the same model of the world: the agent in a state takes an action, and the environment gives a corresponding reward and takes it to a new state changes in predictions
- The agent changes its preferences for different actions based on estimates of states’ values which it learns through accumulating reward

Curiosity

- Estimations of states’ values which it learns through accumulating reward

Reward

- How does uncertainty change over time? How is reward affected?
- How does the robot behave? Is there a change over time?
- What can we learn from its behaviour?

Observations

- In each individual run, the agent eventually developed a preference for taking a non-zero action, resulting in the robot taking the same action consecutively
- More specifically, it learned to remain stationary at the edge of its range of motion
- By observing its preferences, we found that at the edge of its range of motion, the robot increased its certainty more quickly than in the middle of its range
- The robot learned to prefer remaining still and learning nothing over further exploration because the increase in uncertainty experienced by leaving edge states results in negative value

Robot in Action

- The robot observes the positions of its motors, representative of its state
- At the start of each run, as the robot has no prior knowledge, it has equal preference towards all actions, so it behaves randomly

Actions:
- 0 rad down
- 1 rad up
- 0 rad

Environment

- Reward was

Fig. 2: Wundt’s curve

With RL being more prevalent than ever, artificial curiosity also holds great potential to be applied to technologies.
- For example, in the field of medicine, curiosity could be applied to a prosthetic arm such that it can perform a task in a manner not previously known

Acknowledgements

The author would like to thank:
- Nadia Ady, Supervisor
- Dr. Patrick Pilarski, Principal Investigator
- The BLINC Lab
- Process Solutions
- WISEST

Literature Cited