Crowd Navigation RL based on Deep Reinforcement Learning
REPORT
CSE3057 Reinforcement Learning

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Introduction:

Crowd navigation is a challenging task for autonomous robots due to the dynamic and uncertain nature of crowds. Traditional robot navigation algorithms are often ineffective in crowded areas where there are multiple people moving in different directions. Hence, to overcome these challenges, researchers have proposed different techniques to enable the robots to interact with the crowd.

One such technique is Crowd-aware Robot Navigation with Attention-based Deep Reinforcement Learning. This project proposes an attention-based deep reinforcement learning approach to enable the robot to navigate in crowded environments. This paper explores the details of the research, including the motivation behind it, the proposed method, experimental results, and limitations of the approach.

Problem Statement:

The primary motivation behind the proposed approach is to enable robots to navigate through crowded environments without colliding with humans. Previous research on robot navigation in crowded environments mainly focused on motion planning and obstacle avoidance. However, these methods have limitations in situations where the environment is crowded and the behavior of humans is unpredictable.

To overcome these limitations, the proposed method uses deep reinforcement learning to enable the robot to learn from its environment and make decisions based on the current situation. Moreover, the attention mechanism is used to focus the robot's attention on the most relevant parts of the environment.

Methodology:

The proposed approach consists of two main components: an attention mechanism and a deep reinforcement learning algorithm. The attention mechanism is used to focus the robot's attention on the most relevant parts of the environment. This mechanism enables the robot to filter out irrelevant information and focus on the relevant information to make decisions.

The deep reinforcement learning algorithm is used to enable the robot to learn from its environment and make decisions based on the current situation. The algorithm consists of three main components: a state representation, an action selection policy, and a reward function.

The state representation is used to represent the current state of the environment. The state is represented as a set of features that describe the position and velocity of the robot and the humans in the environment. The state representation is used as input to the deep reinforcement learning algorithm.

The action selection policy is used to select the action to be taken by the robot based on the current state. The policy is implemented using a deep neural network that takes the state representation as input and outputs the action to be taken by the robot.

The reward function is used to provide feedback to the robot based on its actions. The reward function is designed to encourage the robot to avoid collisions with humans while reaching its goal. The reward function provides positive rewards for reaching the goal and negative rewards for colliding with humans.

Experimental Results:

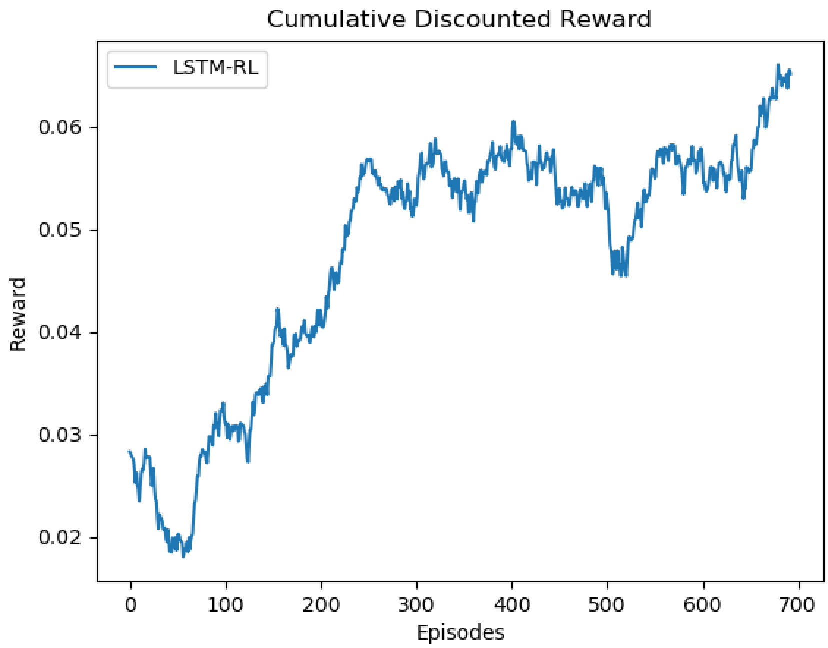
The proposed approach was evaluated using a simulation environment and a real robot. The simulation environment consisted of a crowd of pedestrians and a robot navigating through the crowd. The real robot was tested in a crowded shopping mall.

The experimental results showed that the proposed approach was effective in enabling the robot to navigate through crowded environments without colliding with humans. The robot was able to learn from its environment and make decisions based on the current situation. The attention mechanism was effective in filtering out irrelevant information and focusing the robot's attention on the most relevant parts of the environment.

The experimental results also showed that the proposed approach outperformed traditional navigation algorithms in crowded environments. The proposed approach was able to navigate through the crowd more efficiently and with fewer collisions than traditional navigation algorithms.

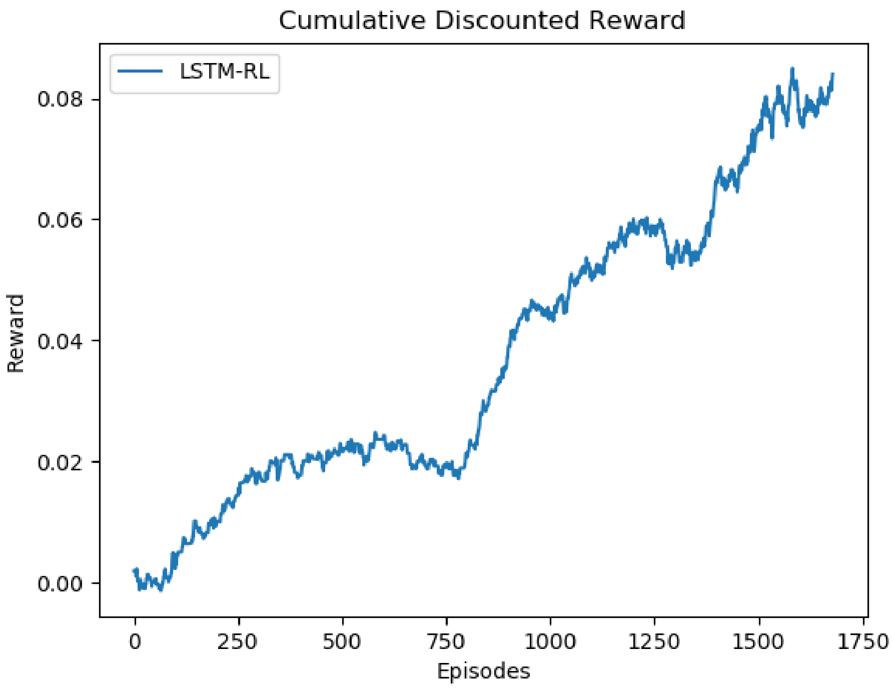
Limitations:

The proposed approach of crowd-aware robot navigation with attention-based deep reinforcement learning has several strengths, including the ability to learn from the environment and focus attention on relevant information. However, the approach also has limitations, such as the requirement of a large amount of training data, limited effectiveness in complex environments, safety concerns, and computational requirements. Future research should aim to address these limitations and improve the generalization capabilities of the model to enable safe and efficient navigation in a wide range of environments.



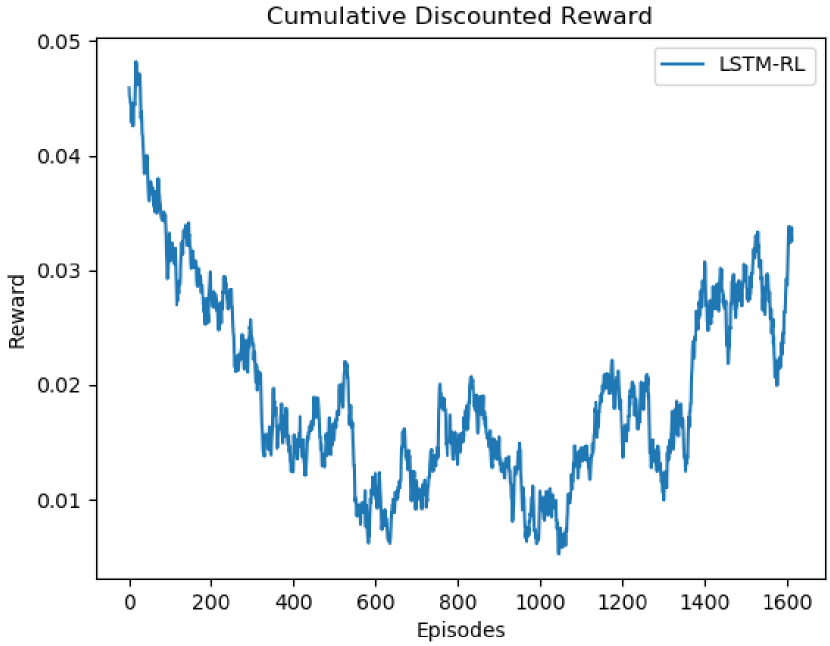
Cumulative Discounted Reward
LSTM-RL
Reward
0.06
0.05
0.04
0.03
0.02
0
100
200
300
400
500
600
700
Episodes

SARL:



Cumulative Discounted Reward
LSTM-RL
Reward
0.08
0.06
0.04
0.02
0.00
0
250
500
750
1000
1250
1500
1750
Episodes

CADRL:


Cumulative Discounted Reward
LSTM-RL
Reward
0.05
0.04
0.03
0.02
0.01
0
200
400
600
800
1000
1200
1400
1600
Episodes

LSTMRL: