Robust Reinforcement Learning using Set-Based Training

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Background

Reinforcement learning is increasingly used for a variety of continuous control tasks [3, 1, 8]. However, it is well known that small perturbations may result in large deviations in the action space [2], which limits the applicability in safety-critical systems. Recent advances propose safe and provably safe reinforcement learning methods including safety penalties in the training process [6]. One crucial difficulty is the design of the penalties for non-safe behavior, where current state-of-the-art methods usually choose a safe action – via a safety shield or action projection – to a safe space and give a negative reward.

Description

The thesis aims to extend set-based training [5] to reinforcement learning. Using set-based training, the penalization of non-safety behavior can be formulated in the computed gradients. Throughout the course of this thesis, a novel reinforcement learning algorithm based on set-based training shall be developed. The aim of using set-based training is to increase the robustness of the deep reinforcement learning agent with respect to limited input noise. Multiple, differently complex versions of the novel reinforcement learning method shall be developed, implemented, and benchmarked for different continuous control tasks. The performance will be compared to commonly used point-based training, under the influence of limited input perturbations.

Tasks

1. Literature research on state-of-the-art RL methods, e.g. actor-critic
2. Implementation of different set-based training structures.
3. Performance evaluation of the novel technique.
4. Comparison to point-based learning approach under the influence of input perturbations.
5. (Optional) Design of set-based loss function to enforce correctness of output

References

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Robust Reinforcement Learning using Reachability Analysis

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MATLAB

Required skills:
Reinforcement learning, reachability analysis, set-based computation

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