Compressed Suffix Memory Algorithm for Reinforcement Learning

Feng Liu
Software Institute
Nanjing University
Nanjing, China
fengliu@nju.edu.cn

Haomin Qiu
Software Institute
Nanjing University
Nanjing, China
aquafits@outlook.com

Peng Huang
Software Institute
Nanjing University
Nanjing, China
paulwongpang@foxmail.com

Chongjun Wang
Software Institute
Nanjing University
Nanjing, China
chjwang@nju.edu.cn

***Abstract*—Instance-based approaches are effective ways to solve reinforcement learning problems. Utile Suffix Memory (USM) algorithm has shown decent results for distinguishing different states from instance chains and generating Q-value of actions of each state, but involving exponentially expanded state space and a number of redundant states. In this paper we propose a new state space compressed algorithm, called Compressed Suffix Memory (CSM) algorithm. CSM algorithm obtains heuristic information of the environment by a blind exploration, for example, the maximum L1 distance between instances in instance chains and goal frequencies, to improve efficiency and resist overfitting. Boltzmann sampling is adopted to balance between exploration and exploitation. Experiments show that both the efficiency and the effect have been improved a lot by CSM algorithm compared with USM algorithm.**

***Index Terms*—keyword1, keyword2, keyword3**

I. Introduction

Reinforcement learning is learning what to do—how to map situations to actions—so as to maximize a numerical reward signal in a provided environment [**?**]. In many reinforcement learning scenarios such as robotic exploration [**?**] and autonomous driving [**?**], the agent is only able to gain partial and noisy observations form environment, so POMDP (partially observable Markov decision process) model is wildly adopted. According to the observations, reward and the historical information, POMDPs provide a rich mathematical approach to solving sequential problems by calculating the Q-value of actions.

As the agent does not directly observe the underlying state, the generation of the state space is the key to reinforcement learning algorithms. Many instance-based methods have been put forward, including Nearest Sequence Memory (NSM) algorithm [**?**] and Utile Suffix Memory (USM) algorithm [**?**]. USM algorithm presents the state space by tree-nodes in a suffix tree building from the instance chains, and is proved effective maximizing the Q-value of actions. However, the state space of USM algorithm exponentially expands during iteration and comprises many redundant states, which reduces the efficiency. Furthermore, because the ϵ-greedy policy of USM lacks of the exploitation of overall information, it may lead to overfitting.

In this paper, we propose a new algorithm, called Compressed Suffix Memory (CSM) algorithm, which optimizes the generation of a utile tree and decision process. First, the heuristic information is obtained by the blind exploration of the environment, e.g., l as the effective path length from start to goal and p as the probability of goal during the exploration. Second, the maximum depth of the suffix tree is limited to $2l$ and the minimum instances required to trigger state splitting, the threshold b, is deduced from p. Finally, after initializing the agent with a random policy, Boltzmann sampling approach will be applied. Experiment has shown that both the efficiency and the effect have been greatly improved by CSM algorithm compared with USM algorithm.

The paper outline follows. We will briefly review reinforcement in partially observable environment and Utile Suffix Memory (USM) algorithm, in Section 2. Next, we propose Compressed Suffix Memory (CSM) algorithm, which takes advantage of heuristic information and optimizes the generation of the suffix tree, in Section 3. We measure the performance of CSM algorithm and see improvements comparing with USM algorithm, in Section 4. We close in Section 5, with a brief summary and possible means of improvement of CSM algorithm.

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TABLE I
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	Table column subhead	***Subhead***	***Subhead***
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ACKNOWLEDGMENT

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