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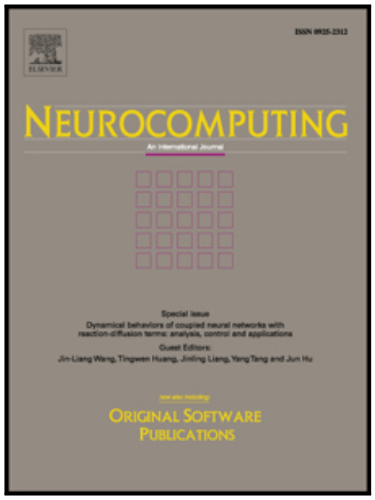

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A SMDP-based Forwarding Scheme in Named Data Networking

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Abstract

Named data networking (NDN) provides a promising networking paradigm for efficient content delivery. In NDN, adaptive request forwarding is inherently supported by enabling routers to dynamically select the next hop for each request based on the network conditions. However, due to the limitation in network resources, a well-designed forwarding strategy is necessary to achieve satisfactory network performance. In this paper, the problem of content request forwarding in the context of NDN is naturally formulated as a semi-Markov decision problem (SMDP). Since the exact SMDP solution is intractable, a variant of reinforcement learning (RL) method integrated with function approximation by neural networks is developed to find the optimal solution for our SMDP abstract. A broad set of experimental comparisons was carried out to verify the effectiveness of the resulting forwarding strategy. The simulation results show that the proposed RL method provides an efficient solution to our SMDP-based forwarding model and our approach can further enhance network performance in comparison to existing forwarding strategies by reducing rejection ratio, network load, as well as delivery time. Load balance and differentiated services are also considered in our proposal.

Keywords: named data networking, forwarding strategy, semi-Markov decision processes, reinforcement learning

1. INTRODUCTION

With the rapid growth of Internet applications and users, current Internet architecture has exposed many defects of its initial design and shown inefficiencies in adapting to the new Internet usage. Realizing that Internet users only care about the content itself rather than where it is stored, the research communities are motivated to redesign a clean-slate network architecture that shifts from host-centric to content-centric. In this context, Named Data Networking (NDN)[1] has emerged as a most promising one, which introduces many beneficial functionalities to facilitate the dissemination of information.

As a clean-slate paradigm, NDN adopts a name-based communication model, where content is identified by an addressable name instead of host address. In the context of NDN, users trigger data delivery by issuing requests for desired contents, and the network core takes full responsibility to locate and retrieve the data. Since NDN decouples content retrieval from the location where the content is stored and makes contents in transit known to the network elements by naming data, request forwarding in NDN is conducted on a hop-by-hop basis rather than end-to-end fashion, which provides native support for decentralized control. In addition, unlike its IP counterpart, the design of NDN data plane[2] allows for multiple alternative outgoing interfaces rather than a single one with respect to each item. Thus, during the request forwarding process, routers should select the efficient interface(s) by making forwarding decisions based on the network conditions. The forwarding decisions of data plane are also called forwarding strategy, which is a key functionality for NDN to realize dynamic, adaptive and intelligent request forwarding. Since forwarding strategy plays an important role in data retrieval, how to design a strategy with low complexity while simultaneously assuring the efficiency of the forwarding process is a critical issue. In this paper, we focus on designing an intelligent forwarding strategy for NDN aiming at maximizing the network resource utilization.

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