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Deep Learning Forwarding in NDN With a Case Study of Ethernet LAN

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ABSTRACT

In this paper, the authors propose a novel forwarding strategy based on deep learning that can adaptively route interests/data packets through ethernet links without relying on the FIB table. The experiment was conducted as a proof of concept. They developed an approach and an algorithm that leverage existing intelligent forwarding approaches in order to build an NDN forwarder that can reduce forwarding cost in terms of prefix name lookup, and memory requirement in FIB simulation results showed that the approach is promising in terms of cross-validation score and prediction in ethernet LAN scenario.

KEYWORDS

Deep Learning, Forwarding Strategy, Named Data Networking, Networking, Stochastic Gradient Descent

INTRODUCTION

Recently, Named Data Networking (NDN) has emerged as a new paradigm that could achieve better performance for the content retrieval and dissemination in a highly dynamic environment; it presented numerous advantages such as a secure scheme based on variable-length, location-independent names to fetch the content, simultaneous multiple interfaces network access without repeated IP address acquirement (D. Saxena et al, 2017), and efficient localization of requested content via in-network caching (IMBRENDA C., 2014).

Yi et al. (C. Yi et al,2013) claimed that while NDN's stateful forwarding plane should provide effective content delivery on the propagated routes, handle network problems such as congestion and short-term link failures, NDN routing only hold a supporting role that provides a starting point for the forwarding plane which explores different multipath opportunities. In return, adaptive forwarding enables a more scalable routing plane in terms of convergence time and completeness (D. Posch et al, 2016), (Rainer B. et al, 2016). We agree that the two mechanisms could not be necessary separated but each must act in its area of responsibility. (D. Posch et al, 2016), (D. Saxena, et al., 2016).

The NDN native forwarding model is based on three major tables: a Content Store (CS), that stores the content, a Pending Interest Table (PIT) that registers the forwarded interests that still waiting for their requested data, and a Forwarding Information Base (FIB) containing prefixes and identified outgoing faces based on forwarding strategy(D. Saxena, et al., 2016)

Furthermore, various surveys on aspects of Information-Centric Network (ICN) point scalability as a major challenge (TROSSEN, D.,2016). Major issues were the great number of control messages

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and the vast size of the content naming space. We suspected that the prefix lookup matching in the F.I.B. and its increasing size influenced the forwarding cost in terms of memory and computational resources requirement as highlighted in (D. Saxena, et al., 2016).

For these reasons we proposed a new forwarding model based on deep learning that should reduce the routers forwarding cost because the FIB information should be used only initially for training our model. Then the latter would predict the corresponding outgoing face for each new incoming packet without the lookup matching process in the FIB, thus reducing the number of control messages and the size of memory used in FIB for new paths towards the same content.

As application field we designed and implemented a star topology based on Ethernet interconnection in a local area network. We assumed that all routes and traffic are initially predetermined. The content could be or not distributed and all nodes might either send or receive a content. Our model was implemented and evaluated only in the NDN router. The objectives were:

1. Design, implementation and evaluation of a new intelligent NDN forwarding strategy based on deep learning.
2. Providing effective forwarding without relying on routing protocols.
3. Improving forwarding plane performance by reducing the forwarding cost related to the F.I.B prefix lookup.

To accomplish those objectives we developed and trained our deep learning model based on the stochastic gradient descent algorithm that would predict the outgoing face for each incoming packet. The training data was obtained from native NDN packets information collected by a traffic sniffer implemented in the NDN router. Our trained model was then implemented in the router and acted at forwarding plane; each incoming packet would be forwarded accordingly based on the prediction computed by our model without relying on the prefix lookup in the F.I.B

The reminder of this paper is as follows: Section 2 considers the state of art in NDN intelligent forwarding strategies. In Section 3 we present our deep learning forwarding model. In Section 4 We give a use case for our model implementation and evaluation. Then conclusion is given in Section 5

BACKGROUND

NDN routing is essentially responsible for topology settings and handling policies changes and forwarding table updates. NDN routing can also help the forwarding plane for interface ranking and probing. Thus the only difference is while routing determines available routes, forwarding makes decisions and preferences about the next hop based on the forwarding strategy and performance measurement (D. Saxena, et al., 2016).

1. Forwarding Scalability

To demonstrate its real worth, NDN needs achievement at large scale deployment level: this is to effectively process tens of thousands of interests/data packets per second, and so the size of the content store should be large which make the prefix name lookup more time consuming (H. Yuan,2012). Thus, we support that fast name lookup is the key to make NDN forwarding scalable. Subsequently many probabilistic and adaptive forwarding strategies have been proposed in the literature in order to improve the forwarding process performance based on machine learning and network conditions (Ayadi, M. I.,2018). The following paragraph gives some examples.

2. Some Existing Intelligent Fowarding StrategieS

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