Test case prioritization with Z-Score based neuron coverage

Hyekyoung Hwang*, Jitae Shin*

** Department of Electrical and Computer Engineering, Sungkyunkwan University, Suwon, 16419, Korea*

ristar1234@skku.edu, jtshin@skku.edu

***Abstract*— Deep neural networks (DNNs) have been widely used in various applications, such as autonomous driving, healthcare, etc. However, despite achieving high accuracy, DNNs have exhibited quality issues in various aspects such as vulnerability to data corruptions, adversarial attacks, and data dependencies. To ensure the integrity and reliability of these systems, the use of systematic verification and validation methodologies before the deployment of DNN is considered an indispensable technique. Test case prioritization techniques reduce the cost of DNN verification by prioritizing test cases that could induce mispredictions of DNN.**
In this paper, we propose a neuron coverage-based test case prioritization technique for the DNN classifier that assigns sample priorities based on the ratio of outlier-valued neurons among total neurons in DNN. We evaluate the proposed method with three publicly accessible datasets with different sizes of DNN. The experimental results demonstrate that the proposed method outperforms the existing state-of-the-art neuron coverage-based approach both in error-inducing sample prioritization effectiveness and inference time efficiency.

***Keyword*— Test case prioritization, Neuron coverage, Deep neural network**

Hyekyoung Hwang is a Ph.D student and she received her BS degree from the Department of Electronic and Electrical Engineering, College of Information and Communication Engineering and mathematics, College of Natural Science, Sungkyunkwan University, Republic of Korea in 2018. Her research interests include image processing and deep learning, focused on explainable AI with uncertainty estimation.

JITAE SHIN (Member, IEEE) has been a Professor from 2002 with the School of Electronic and Electrical Engineering, Sungkyunkwan University, Suwon, South Korea. He received the B.S. degree from Seoul National University, in 1986, the M.S. degree from the Korea Advanced Institute of Science and Technology, in 1988, and the M.S. and Ph.D. degrees in electrical engineering from the University of Southern California, Los Angeles, USA, in 1998 and 2001, respectively. For former industrial experiences, he worked with Korea Electric Power Corporation and the Korea Atomic Energy Research Institute from 1988 to 1996. His current research interests include image/video signal processing using deep learning, medical image processing, and video transmission over wireless/mobile communication systems.