Efficient Mobile Network Drive Testing with Deep Generative Modeling

Chuanhao Sun
The University of Edinburgh

The main goal of drive testing is to assess and optimize mobile network coverage, capacity, and quality of service (QoS) through measurement. This involves collecting field measurements in a controlled manner by driving or walking in a target scenario. Drive testing continues to play a key role in mobile network optimization for operators. The principal concern with traditional drive testing is that it requires manual effort to obtain measurements, making it costly and time-consuming. Several measurement tools are available to perform drive or walk testing. One alternative approach called virtual drive testing (VDT) is limited to device/equipment testing, whereas other alternative approaches involving user device based measurement collection via 3GPP minimization of drive tests (MDT) feature or via crowdsourcing are hindered by insufficient incentives for user participation and privacy concerns.

Motivated by the above, we propose GenDT [1], a novel approach to make mobile network drive testing efficient that is driven by a tailored deep generative model to effectively mimic drive testing. Specifically, the deep generative model design at the core of GenDT aims to synthesize high-fidelity drive testing data, i.e., time series of radio network key performance indicators (KPIs) for a given drive test trajectory. The training of GenDT relies on a relatively small amount of real-world drive test measurement data, along with corresponding and easily accessible network and environment context data. Through this, GenDT learns the relationship between context and radio network KPIs as they vary over time. As a result, a trained GenDT model can subsequently be relied on to generate time series for different KPIs for new drive test routes (trajectories) without having to collect field measurements.

In this presentation, we will first motivate the need for efficient mobile network drive testing and provide a high level idea behind the proposed GenDT approach. We then outline the significant challenge that needs to be addressed to realize the GenDT approach, which is to enable dependable drive test data generation for unseen regions with minimal measurement data for training. This overall challenge is made up of four specific challenges: (i) capturing inherent stochasticity in the data; (ii) handling time varying context; (iii) dealing with long and complex scenarios; (iv) minimize measurement data needed for training. We present the GenDT model design that addresses each of these challenges with novel solutions, including a tailored graph neural network (GNN) model, use of stochastic layers and model uncertainty inference.

We will then present extensive evaluations to demonstrate the effectiveness of the GenDT design. These evaluations include: (1) assessing the fidelity of the GenDT generated radio KPI time series data with respect to real measurement data using multiple different metrics and in comparison with various baseline approaches; and (2) examining the dependability of GenDT generated data as a substitute for real drive testing measurement data to support downstream use cases (e.g., QoE prediction).

References

[1] C. Sun, K. Xu, M. K. Marina, and H. Benn, "GenDT: Mobile Network Drive Testing Made Efficient with Generative Modeling," in *Proceedings of the 18th International Conference on Emerging Networking EXperiments and Technologies*, ser. CoNEXT '22. New York, NY, USA: Association for Computing Machinery, 2022, p. 43–58. [Online]. Available: https://doi.org/10.1145/3555050.3569124