Abstract

Fifth Generation (5G) of mobile networks has been envisioned to initiate socio-technical evolution through mobile communications becoming closely integrated in the daily life of the whole society. This results from enabling unprecedented levels of data throughput, ultra-reliable low-latency communication, and massive device connectivity. Fostering previously unimaginable advancements imposes also requirements to 5G system design. To meet a wide variety of demands, often contradicting, is a challenge. Creating an effective 5G ecosystem demands careful consideration and innovative solutions to harmonize the diverse operational needs. Due to strong-fitting capabilities, Artificial Intelligence (AI) is seen as a great potential, that can be employed to solve challenges faced in telecommunication networks. In fact, AI and 5G are permeating incrementally and the emergence of both is the key inspiration for this dissertation. Within the scope of this work, challenges in 5G network optimization processes are elaborated, addressing various complex and interrelated problems that are faced to ensure high-performing telecommunication networks. With a focus to provide reliability in the network operations originating from radio access, the work addresses the question: how to apply Artificial Intelligence in 5G Radio Access Network (RAN) and feed Machine Learning (ML) techniques with the radio characteristic-based automatic data collection. For this purpose, the research conducts the streamlined 5G use case traffic (namely enhanced Mobile Broadband(eMBB)) inspection in real 5G Non-Stand Alone deployment. To grasp practical effects of the 5G network on end user performance, in various deployment scenarios, the data has been collected from commercial 5G smartphones The analyses of data series uncover trends and relationships among radio performance indicators and recognize their varying importance in RAN. The findings further guide ML algorithm selection, including identification of essential parameters for data monitoring, that prove to be adequate target for predictions, when examining radio interface. Throughout training and testing three candidate Supervised Machine Learning algorithms with the collected datasets, Decision Tree algorithm with non-linear and advanced regression capability is validated, by showing best performance. To address the research question on how the ML algorithm can be integrated into RAN operation, the dissertation further proposes an effective monitoring scheme to involve commercial devices and configure them with metrics scheduled by ML-empowered automated data collection procedure by gNB. The procedure enables metrics' reporting intervals adjustments, based on the suitable algorithm outcome. This ensures effectiveness by limiting massive data collection in RAN. Additionally, the set of input metrics can be reduced and limited to just one critical parameter (i.e. received signal strength), enabling intelligent optimization of the data collection and better performance, once compared to traditional methods on data collection. In conclusion, the research validates, that replacing drive tests, with automated data collection of a few selected radio characteristics, with operational integration of learning and prediction capabilities, becomes a viable ML-enabled monitoring framework. The introduced method brings measurable benefits in the form of control and/or reduction of the amount of monitored data. Furthermore, it can be easily adopted, as integrates existing measurement collection tools with ML algorithm tailored to advance the functioning methods in place. The method can scale to address a wider range of use cases, by extension of the datasets with other type of information. Moreover, the research underscores the developed ML technique great flexibility by marking adoption capabilities to two possible approaches: the gNB-sided ML model and the UE-sided ML model

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with different operational and implementational impacts. Consequently, it proves practical viability of AI integration into 5G RAN, showcases feasibility and demonstrates advantageous strategies that can be aimed for successful uptake of AI in 5G RAN.