

Machine Learning for Enhanced Mobile User Positioning in 5G and Beyond

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Description

In radio access networks, conventional methods for user positioning are trilateration, triangulation, proximity, scene analysis or their hybrid. However, in some conditions such as high NLOS, conventional approaches may no longer respond to the targeted accuracy and there is a need for new solutions based on machine learning (ML) methods.

With the tremendous advances in ML/AI tools (see existing libraries such as Keras), it becomes much easier to use and experiment machine learning methods with big data. Since Rel-17, 3GPP has started 5G new radio (NR) positioning enhancement work and initiated a study item on AIML for air interface and mobile network service, focusing on enhancing accuracy, reducing latency and improving efficiency (low complexity, low power consumption, low overhead, low memory requirement, robust to changes in the radio propagation environment). Enhanced positioning is identified as machine learning based use case.

In this work, we will investigate existing ML/AI methods for example multi-layer perception (MLP) neural network and recurrent neural network (NN). It is essential to adjust the deployed number of hidden nodes and layers, advance the training and regularization method, and adapt the network architecture to optimize the user performance.

In addition, we would investigate more advanced ML/AI methods considering not only the accuracy performance but also the generalization capabilities to different contexts and environments. Possible inputs to an AI/ML model include UE cell IDs, beam IDs, and other mobile network cell-specific RAN parameters (such as LOS/NLOS classification, RSRP/ToA/AoA/AoD measurements, etc.) which would enable the model to identify the exact UE location with high accuracy. It is also expected to leverage recent research advancement in AI/ML and use effective statistical models in handling huge amount of data towards a practical and implementable solution for 5G and beyond networks.

References:

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Appendix

Nokia

We create the technologies to connect the world. With the research and innovation capabilities of Nokia Bell Labs, we provide network service providers, governments, large business companies and end users with the most comprehensive portfolio of products, services and licenses on the market. We adhere to the highest ethical standards when we create a technology with a social, quality and integrity objective. Nokia is deploying infrastructure for 5G and the Internet of Things and shaping the future of technology to transform the human experience. The rise of Artificial Intelligence in all sectors of activity, the maturity of machine learning solutions and the capacity of IT resources to implement them, as well as the availability of massively collected data, offer a revolutionary potential in mobile networks.

The team you'll be part of

Nokia Bell Labs is the world-renowned research arm of Nokia, having invented many of the foundational technologies that underpin information and communications networks and all digital devices and systems. It has produced nine Nobel Prizes, five Turing Awards and numerous other awards. Within Bell Labs, AI Research Lab conducts fundamental and applied research in machine learning, mathematics, modeling, and optimization. The Lab has a long tradition of excellence in research and currently consists of over 80 staff members with expertise in algorithmic and computing sciences, network measurement and optimization, information theory and machine learning. Within AI Research lab, Machine Learning and Systems group develops AI-based knowledge systems and fundamental algorithms, autonomous software, and data systems.

Education Recommendations

The internship is open to candidates who are in Master or PhD programme in Computer Science, Applied Mathematics or Machine Learning related.

Study: Specialization in Machine Learning and/or telecommunications, wireless networks, communication engineering, or similar.

- Expertise and experience in Machine Learning is required.
- Knowledge in wireless radio communications, telecommunications or mobile networks is highly recommended.
- It is mandatory to have good level in programming: Python (Keras, PyTorch), Matlab, C++.
- Good level in English is mandatory (oral and written).

What you will learn and contribute to

The main objective of the internship is to contribute to the research and development of machine learning algorithms in enhanced mobile user (UE) positioning for 5G networks and beyond (B5G). This requires fundamental skills in machine learning from model design to implementation and a good know-how of alternative ML approaches (such as reinforcement learning, supervised learning, unsupervised learning or hybrid, deep learning). During the internship, the validation of the proposed solutions would consist in assessing the benefit of the ML based approach compared to conventional existing 3GPP methods. The validation will be performed on a software platform embedding the usual libraries of machine learning (e.g., Keras, PyTorch) and a Nokia system platform. Your mission will consist in:

- Familiar with mobile network UE positioning procedures in 5G/5G+ networks as well as existing machine learning based positioning methods (literature studies include internal reports, scientific publications, and 3GPP documents)
- Identifying from the state-of-the-art methods, the most suitable candidate machine learning methods, to solve the identified problem
- Validating the proposed solution on machine learning software platform or on Nokia system platform.

At the end of this internship, the experience will allow you to reinforce and put into practice:

- Your theoretical expertise in Machine learning Algorithms,
- Your knowledge in mobile radio communications, especially 5G networks,
- A methodology for analysis/exploitation of large volumes of data as well as for validation of machine learning algorithms.

What we offer

You will join us at Nokia Bell Labs in Massy (Paris-Saclay) close to a major transportation hub. Nokia offers flexible and hybrid working schemes, continuous learning opportunities, well-being programs to support you mentally and physically, opportunities to join and get supported by employee resource groups, mentoring programs and highly diverse teams with an inclusive culture where people thrive and are empowered.

Internship duration

6 months and available immediately