Basic Research Project (BRP)

Plain-language Rules Generation using AI and xAI for Network Management

Responsible Professor: Prof. Andreas Mitschele-Thiel

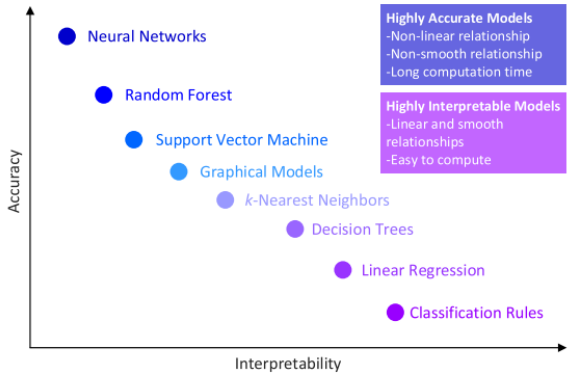
Supervisor Faiaz Nazmetdinov

❑ Description

Artificial Intelligence (AI) will broadly be used in 5G and 6G cellular networks. But there is an Interpretability vs. Accuracy trade-off. Highly complex models e.g. Neural Networks (NN) can provide higher accuracy but have a lack of interpretability. From a stakeholder (e.g. Mobile Operator) standpoint, NN is just a black box, which is difficult to understand and might not always make business sense. In order to overcome this problem, different eXplainable AI (xAI) techniques can be applied to understand how complex models behave and derive human readable rules for optimization purposes. .

❑ Tasks

- Literature study on rule/decision based AI models
- Literature study on different AI explainability techniques
- Apply AI and xAI to generate rules for MLB SON Function



❑ References

- M. E. Morocho-Cayamcela, H. Lee, and W. Lim, "Machine learning for
- 5G/B5G mobile and wireless communications: Potential, limitations, and future directions," IEEE Access, vol. 7, pp. 137184–137206, 2019.
- https://christophm.github.io/interpretable-ml-book/intro.html

❑ Focus

- 1 student theory / programming / hardware / measurements

Self-Organization Network (SON) Function for Energy Saving in Cellular Networks

Responsible Professor: Prof. Andreas Mitschele-Thiel

Supervisors Sabarish Subramanian, Tanmoy Bag

❑ Description

Minimizing energy consumption is a critical goal for any MNO and this function is responsible for switching off RAN nodes or decreasing their transmit power in case of low-traffic scenarios. Energy saving should not be at the cost of compromised QoS for consumers. Therefore, the adjacent cells (same or different RAT) should ensure that the coverage and capacity requirements of the region are met.

❑ Tasks

- Literature study on Energy Saving (ES) SON use case.
- Understand existing SON-coordination infrastructure.
- Implement specific simulation scenarios like low traffic at some specific cell-sites on a system-level network simulator .
- Implement and evaluate ES SON function for the implemented traffic scenarios.

❑ References

- 3GPP, “Telecommunication management; Energy Saving Management (ESM); Concepts and requirements,” Technical Specification (TS) 32.551, 3rd Generation Partnership Project (3GPP), Apr. 2022. Version 17.0.0.
- H. Fourati, R. Maaloul, L. Fourati and M. Jmaiel, "An Efficient Energy-Saving Scheme Using Genetic Algorithm for 5G Heterogeneous Networks," in IEEE Systems Journal, vol. 17, no. 1, pp. 589-600, March 2023, doi: 10.1109/JSYST.2022.3166228.

❑ Focus

- 1 student

theory / programming / hardware / measurements

Implementation of SON functions of MRO as an xApp on Open-RAN based RIC

Responsible Professor: Prof. Andreas Mitschele-Thiel

Supervisor Zubair Shaik

❑ Description

OpenRAN based **RIC** (RAN Intelligent Controller) provides advanced control functionality, which delivers increased efficiency and better radio resource management. These control functionalities leverage analytics and data-driven approaches, including advanced ML tools to improve resource management capabilities. The project involves setting up the ONOS platform of RIC, including an attached RAN-simulator to test SON functions like MRO as an xApp.

❑ Tasks

- Literature study of ORAN architecture
- Setup and installation of ONOS RIC, RAN simulator and xApps
- Adapting in-house SON function of MRO as an xApp using the specific interface/APIs provided by ONOS
- Design and implement a SON function for URLLC applications, based on the features supported by the RAN simulator
- Measurements and comparison of the results

❑ References

- Bonati L., Polese M., D'Oro S., Basagni S., Melodia T., Open, Programmable, and Virtualized 5G Networks: State-of-the-Art and the Road Ahead, arXiv preprint arXiv:2005.10027 [cs.NI] (2020).
- https://docs.o-ran-sc.org/en/latest/

❑ Focus

- 1 student practical / programming / measurements

Implementation of SON functions as xApp on Open-RAN based RIC

Responsible Professor: Prof. Andreas Mitschele-Thiel

Supervisor Zubair Shaik

❑ Description

OpenRAN based **RIC** (RAN Intelligent Controller) provides advanced control functionality, which delivers increased efficiency and better radio resource management. These control functionalities leverage analytics and data-driven approaches, including advanced ML tools to improve resource management capabilities. The project involves setting up the ONOS platform of RIC, including an attached RAN-simulator to test SON functions like MLB/MRO as an xApp.

❑ Tasks

- Literature study of ORAN architecture
- Setup and installation of ONOS RIC, RAN simulator and xApps
- Adapting in-house SON function of MRO/MLB as an xApp using the specific interface/APIs provided by ONOS
- Design and implement a SON function for URLLC applications, based on the features supported by the RAN simulator
- Measurements and comparison of the results

❑ References

- Bonati L., Polese M., D'Oro S., Basagni S., Melodia T., Open, Programmable, and Virtualized 5G Networks: State-of-the-Art and the Road Ahead, arXiv preprint arXiv:2005.10027 [cs.NI] (2020).
- https://docs.o-ran-sc.org/en/latest/

❑ Focus

- 1 student practical / programming / measurements

Advanced Research Project (ARP)

MRO/MLB Optimization in Open RAN as rApp/xApp

Responsible Professor: Prof. Andreas Mitschele-Thiel

Supervisor Faiaz Nazmetdinov/Zubair Shaik

❑ Description

OpenRAN based **RIC** (RAN Intelligent Controller) provides advanced control functionality, which delivers increased efficiency and better radio resource management. These control functionalities leverage analytics and data-driven approaches, including advanced ML tools to improve resource management capabilities. The project involves setting up the ONOS platform of RIC, including an attached RAN-simulator. Implementing a derivation of rules for SON function (e.g. MLB, MRO) using ML as rApp and running these rules as xApp.

❑ Tasks

- Literature study of ORAN architecture
- Setup and installation of ONOS RIC, RAN simulator, rApps and xApps
- Implementation of rules derivation for SON functions using ML in Spark as rApp
- Implementation of a hand-shake protocol between rApp and xApp
- Application of rules by xApp in RAN simulator
- Measurements and comparison of the results

❑ References

- Bonati L., Polese M., D'Oro S., Basagni S., Melodia T., Open, Programmable, and Virtualized 5G Networks: State-of-the-Art and the Road Ahead, arXiv preprint arXiv:2005.10027 [cs.NI] (2020).
- https://docs.o-ran-sc.org/en/latest/

❑ Focus